The Scottish Veterans Health Study: a retrospective cohort study of 57,000 military veterans and 173,000 matched non-veterans

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Abstract

Introduction

Although the health of military personnel who have taken part in specific conflicts has been studied throughout the 20th century, there is a paucity of evidence on the long-term overall impact of military service on health. This thesis describes the establishment of and findings from the Scottish Veterans Health Study, a retrospective cohort study comparing the health outcomes of veterans with those of people with no record of service, in order to determine whether the long-term health of military veterans living in Scotland differed from that of people who had never served in the armed forces.

Methods

The study population comprised all 57,000 military veterans born between 1945 and 1985 who were resident in Scotland both before and after military service, together with a 3:1 comparison group of 173,000 people with no record of service, matched for age, sex and postcode sector of residence. The demographic data were extracted from the National Health Service Central Registry database and were linked electronically to the National Health Service Scottish Morbidity Record and national vital records data for acute and psychiatric hospital admissions, psychiatric day-case admissions, cancer registrations and death certificate data. Survival analysis was used to determine hazard ratios for those health conditions and outcomes considered to be of *a priori* interest, overall, by sex, by birth cohort and by length and period of service, both univariately and after adjusting for deprivation.

Results

Veterans were at significantly increased risk of cardiovascular disease compared to non-veterans overall, and of acute myocardial infarction, stroke and peripheral arterial disease specifically. Subgroup analysis showed the increased risk to be confined to veterans born between 1945 and 1959, reducing in more recent birth cohorts. The risk was highest in veterans who left after only a short period of service (Early Service Leavers), whilst those who served for longest exhibited a similar risk of cardiovascular disease to all non-veterans. Veterans were at no higher overall risk of cancer than non-veterans, although there were major differences in the risk of specific cancers, which changed over time.

The oldest veterans had an increased risk of cancer of the lung, oropharynx and larynx, oesophagus and stomach; the risks of these cancers reduced in more recent birth cohorts. The 1960-1964 birth cohort showed an increased risk of both bladder cancer and pancreatic cancer in comparison with non-veterans. There were increased risks of ovarian cancer in veteran women compared with non-veterans, and of breast cancer in longer-serving women. The risk of cervical cancer decreased in more recent birth cohorts. There were no differences in the risk of colorectal cancer or prostate cancer in veterans, overall or in any subgroup. There was no clear evidence of increased risk of lymphohaematopoietic cancer in veterans. Veterans were at increased risk of motor neuron disease, but not of multiple sclerosis. Veterans were at increased risk of peptic ulcer disease for all birth cohorts up to the mid-1960s but not thereafter; the risk was highest in those with the shortest service. Hepatitis C was less common in veterans than in non-veterans, in all subgroups. Analysis of mental health outcomes showed that the greatest burden of ill-health was among Early Service Leavers, whilst veterans who completed at least a minimum length of engagement were not at increased risk compared with non-veterans, except for post-traumatic stress disorder. The results for post-traumatic stress disorder, in both veterans and non-veterans, demonstrated a complexity which could not be reconciled with any operational exposure or conventional clinical pattern, but which may have reflected a 'hidden iceberg' of unmet need in the late 1990s which was uncovered by increasing awareness of the condition. Longer service was generally associated with better mental health. Veterans were at no greater risk of suicide than non-veterans; the risk was independent of length of service. Veteran women exhibited a risk profile for mental health outcomes which more closely resembled that of veteran men; this was especially marked for suicide. Veterans were not at increased risk of alcoholic liver disease overall; the only subgroup to show an increase in risk was Early Service Leavers who had completed training, and there was also evidence of increased risk of some alcohol-related cancers in trained Early Service Leavers.

Interpretation

Older veterans demonstrated an increased risk of smoking-related ill-health, including cardiovascular and respiratory disease and the smoking-related cancers, which is consistent with reported high rates of military smoking in the 1960s and early 1970s. Overall, there has been an improvement in health of veterans compared with the non-serving population in more recent generations, suggesting that the increased emphasis on health promotion and physical fitness in the armed forces since the late 1970s has been effective. Major alcohol problems were no more common in veterans than in the wider community, and were most likely to affect those who left earliest, although not those who left whilst still in training. Longer service was generally associated with better long-term health. Early Service Leavers had poorer health outcomes than longer-serving veterans, but the ability to stratify by length of service demonstrated that the poorest outcomes were in those who did not complete initial training. It is likely that their long-term health outcomes have been predominantly influenced by pre-service and post-service health and behavioural factors which, at a pre-service level, may have also contributed to their failure to complete the minimum military engagement, rather than by their short period of military service. The early period of service appears to act as an extension to the screening process for entry to service, filtering out those who prove least suited to service. The Early Service Leavers therefore form a 'less healthy leaver' group which is the counterpart to the longer-serving 'healthy worker effect'; their status as veterans means that they can be identified within the community, unlike most other occupational leaver groups, but their poorer long-term health is unlikely to be due to military occupational factors. Improved understanding of the determinants of veterans' health will inform the provision of appropriate health and community services to meet their needs.

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Bergman, B. P., Burdett, H. J. and Greenberg, N. (2014) 'Service Life and Beyond– Institution or Culture?', *The RUSI Journal,* 159(5), 60-68.

Bergman, B. P., Mackay, D. F. and Pell, J. P. (2015) 'Long-term consequences of alcohol misuse in Scottish military veterans', *Occupational and Environmental Medicine,* 72, 28-32.

Bergman, B. P., Mackay, D. F., Smith D.J. and Pell, J. P. ‘ Long-term mental health outcomes of military service: national linkage study of 57,000 veterans and 173,000 matched non-veterans’, *Journal of Clinical Psychiatry* (in press).

Conference Abstract

Bergman, B. P., Mackay, D. F. and Pell, J. P. (2014) 'Smoking-related cancer in Scottish military veterans', *European Journal of Public Health,* 24(S2), 126.

Dedicated to the memory of my parents David and Irene Bergman
and of my husband Ian Melville

Preface

In my final tour of duty in a military career spanning the years 1970-2012, I was seconded to the Scottish Government as Military Medical Liaison Officer. In the course of many conversations with Ministers, senior civil servants, NHS staff, senior military officers, executives and volunteers of the numerous ex-Service charities as well as veterans themselves and other members of the public, I came to realise how poorly the majority of civilians understand ‘the veteran’. Much has been written about the problems faced by veterans endeavouring to settle back into an unfamiliar civilian world after a career in uniform, be it long or short, but much of that writing has been based on anecdote and individual case histories. Valuable as that may be, it is inevitably unrepresentative of the veterans’ community as a whole, but there is little extant information in the United Kingdom which is founded on the scientific analysis of epidemiological data on veterans.

This lack of understanding leads readily to stereotyping; the homeless, the alcoholic, the prisoner, the sexual offender, the violent, unpredictable spouse, the drug addict, the psychotic, the traumatised, broken in mind and body as a result of their military service. The old man begging on an Edinburgh street corner, his scrawled cardboard placard proclaiming his veteran status, fits this stereotype but does not do justice to the many veterans who are valuable members of the community and workplace; loyal, disciplined, reliable, smart, good timekeepers, skilled workers, effective managers, family-orientated and enthusiastically contributing to the wider good through involvement in voluntary and community work. In a veteran population in Scotland estimated in 2005 to comprise around 400,000 people ranging in age from 17 to over 100 years, it would indeed be remarkable not to find representatives of the full range of the human condition, both positive and negative. One may even ask whether, given the heterogeneity of the veteran population, it is reasonable to consider veterans as a group. No matter. That decision has already been taken, by the Government, the mass media and, by extension, the general public. What has been missing is an understanding of veterans’ issues which is supported by science. What is unknown is how veterans compare with their civilian counterparts. Are they more or less likely to suffer physical or mental health problems, contact with the criminal justice system or homelessness?

This study uses epidemiological analysis of Scottish linked health records and contextual information drawn from a wide range of sources to develop a picture of the health status of Scotland's veterans who served after the end of National Service and, *inter alia,* makes estimates of the levels of alcoholism and drug addiction within the veterans' community, in comparison with those who have never served. It is hoped that this information will enhance understanding of veterans' issues but, most importantly, that it will assist in planning health and community services for veterans. It is also hoped that an understanding of the important health problems affecting veterans will be of value to the Ministry of Defence in targeting in-service initiatives for health improvement which will be of benefit to Service personnel long after they have returned to civilian life, and in evaluating the long-term effectiveness of the many Armed Forces health promotion initiatives which have been implemented in recent years.

Acknowledgements

This study would not have been possible without the support and collaboration of a great number of people, to whom I owe a huge debt of gratitude. Its inception was unwittingly facilitated by Major General Alan Hawley, formerly Director General Army Medical Services, early in 2009 when he arranged for my secondment to the Scottish Government as Military Medical Liaison Officer and asked me to rewrite the terms of reference for the post, which allowed me to slip in the opportunity to exploit Scottish linked health data to provide information on the long-term health of military personnel and veterans. Soon after arriving in Scotland, I met with Duncan Macniven, then Registrar General for Scotland, in his delightfully traditional office overlooking Princes Street in Edinburgh, and explained my aspiration for the study. Over a cup of lapsang souchong tea, he listened carefully. Yes, he said, the Scottish demographic, vital and health records would support such a study. He sent me to the NHS Central Registry at Dumfries, where I met the Head, Muriel Douglas and her staff, including the Deputy Head, Gail Turner, who was later to become instrumental in extracting the dataset. They too were extremely encouraging, and soon I was on my way to the Information Services Division (ISD) of NHS Scotland to meet Carole Morris, head of data analysis. What was to become the feasibility study for the Scottish Veterans Health Study was under way, supported by the then Chief Medical Officer Dr [later Sir] Harry Burns and the Director General Health and Chief Executive NHS Scotland, Derek Feeley. When funding became necessary to pay for data linkage, the Scottish Government and PoppyScotland generously shared the burden. Without their support, the vital first phase of the study could not have taken place.

The feasibility study, which examined only cardiovascular disease, provided an indication that veterans' health may indeed be a cause for concern, but also showed that the methodology needed to be refined in order to improve the robustness of the results. Muriel Douglas introduced me to Professor Jill Pell, Henry Mechan Professor of Public Health at the Institute of Health and Wellbeing, University of Glasgow. Jill's enthusiasm for the project was inspirational and, over the summer of 2012, the initial aspiration mutated into this PhD study, with Jill as my supervisor, together with Dr Danny Mackay whose statistical expertise and teaching has been of crucial importance. Professor Ewan Macdonald has been generous with his time and coffee, providing a valuable occupational health perspective, whilst Dr [now Professor] Danny Smith has played an important role as the focal point for the mental health aspects of the study and Dr David Morrison has provided advice on cancer epidemiology. Another vital contributor has been Andy Duffy, who has been the lead for data linkage at ISD and who has always been ready to answer questions and advise on 'add-ons' as the study has evolved.

As a new veteran myself, having retired from the Army in late March 2012 at the end of a full career as an Army general practitioner and, later, public health physician, the prospect of embarking on what was rapidly changing from being a minor part of my job to a full-time academic study was daunting. I must pay tribute to a number of valued friends for their encouragement during that time, in particular former Defence Consultant Advisers in Public Health Brigadier John Graham and Brigadier Alistair Macmillan, and former Army Parkes Professor of Preventive Medicine Colonel Simon Miller (who later was to apply his eagle eye as a proof-reader to the final version of this thesis), as well as my Resettlement Officer Lieutenant Colonel David Pittendreigh. Once the full study was under way, Colonel David Ross, current Defence Consultant Adviser in Public Health and Parkes Professor of Preventive Medicine at the Army Medical Directorate, has been a key figure; acting as the main link back to the Ministry of Defence, advising on current issues and providing valuable informal advice on potentially contentious matters. The current Military Medical Liaison Officer, Colonel David McArthur has provided the equally important link back to the Scottish Government, where Alistair Murphy and his staff at the Defence Policy Unit have maintained a keen interest in the study. The successive Director Generals Army Medical Services, Major General Michael von Bertele, Major General Ewan Carmichael and Major General Jeremy Rowan have all been generous with their interest and encouragement, for which I am most appreciative.

I must also thank a number of people in the many organisations providing support to serving personnel and veterans in Scotland, and in particular: Colonel Martin Gibson, Chairman of Veterans Scotland; Gary Gray, Head of Welfare Services at PoppyScotland; Paul Hayllor, formerly Head of Charitable Services at PoppyScotland; Dr Lucy Abraham and the staff of Veterans First Point, Edinburgh; Colonel Robbie Gibson, Chief Executive of the Lowland Reserve Forces and Cadets Association; Major Paul Kingham, Headquarters Edinburgh Garrison; and the many serving and ex-Service friends and colleagues who have listened to the unfolding story of veterans' health as the analysis proceeded and generously shared their comments, observations and personal narrative, adding a richness to the interpretation without which the study would have been much the poorer. I must also acknowledge the 57,000 veterans and 173,000 non-veterans whose records have anonymously formed the foundation of this study; without them, there would have been no Scottish Veterans Health Study. This study is their story, and its outcome is their future; it belongs to them.

Finally, I would like to thank my friends and colleagues in the Edinburgh Geological Society, the Heraldry Society of Scotland and the Royal Scottish Society of Arts for their forbearance and good humour as their respective Secretary/Committee/Council member embarked on this venture. I apologise for not giving you as much of my time over the last three years as you might have needed. Special thanks are due to: Professor Brian Upton, Emeritus Professor of Petrology at the University of Edinburgh, for unsuspectingly sowing the seeds of the 'less healthy leaver' concept whilst explaining fractional crystallisation in molten magma on a geological field trip to the Drumadoon Sill on the Isle of Arran; Dr Graham Leslie of the British Geological Survey for his guidance on 3D graphical presentation of data; Professor David Harrison of the School of Engineering and the Built Environment, Glasgow Caledonian University, for his generous advice; Professor Euan Clarkson for patiently listening to my grumbles and always saying just the right thing; and Professor Jim Floyd for assiduously checking and proof-reading the draft of this thesis. Any remaining gremlins are my responsibility alone, as are any inadvertent omissions from this long list of acknowledgments.

Author's Declaration

I declare that, except where explicit reference is made to the contribution of others, this thesis is the result of my own work and has not been submitted for any other degree at the University of Glasgow or any other institution.

Beverly P Bergman

Abbreviations/ Definitions

Abbreviations

AFCS – Armed Forces Compensation Scheme
AHR – Army Histopathology Registry
AHU – Army Health Unit
AMD – Army Medical Directorate
AMI – Acute myocardial infarction
AML – Acute myeloid leukaemia
AUDIT – Alcohol Use Disorders Identification Test
AWOL – Absent without leave
BAOR – British Army of the Rhine (Germany 1945-1994)
BCE – Before the Common Era (dates: secular alternative to BC)
BFT – Basic Fitness Test
BMI – Body Mass Index
BRFSS – Behavioural Risk Factors Surveillance Study (USA)
CDC – Centers for Disease Control
CFT – Combat Fitness Test
CHD – Coronary heart disease
CHI – Community Health Index
CI – Confidence intervals
CAPI – Computer Assisted Personal Interviewing
CPS-II –Cancer Prevention Study II
CVD – Cardiovascular disease
DAOR – Discharge as of right
DASA – Defence Analytical Services Agency
EPAFF - Expert Panel on Armed Forces Feeding
ESL – Early Service Leaver
ETS – Environmental tobacco smoke
FARELF – Far East Land Forces
FEPOW – Far East Prisoner of War
FOI – Freedom of Information Act 2000
GHQ – General Health Questionnaire
GIS – Geographic Information System
GROS – General Register Office for Scotland (to 31 Mar 11)
GSW – Gunshot wound
HPV – Human papilloma virus
HR – Hazard ratio
HRT – Hormone replacement therapy
HWE – Healthy worker effect
IARC – International Agency for Research on Cancer
ICD – International Classification of Disease
ICFT – Infantry Combat Fitness Test
IHD – Ischaemic heart disease
IMEG - Independent Medical Expert Group
ISD – Information Services Division
IT – Information technology
JCVI – Joint Committee on Vaccination and Immunisation

LTA – Land transport accident
MELF – Middle East Land Forces
MI – Myocardial infarction
MMR – Mass Miniature Radiography
MOD – Ministry of Defence
mTBI – Mild traumatic brain injury
NAAFI – Navy, Army and Air Force Institute
NEARELF – Near East Land Forces
NHS – National Health Service
NHSCR – National Health Service Central Registry
NRS – National Records of Scotland (from 1 Apr 11)
NRT – Nicotine replacement therapy
NSAID – Non-steroidal anti-inflammatory drug
OA – Output area (decennial census)
ONS – Office for National Statistics (England & Wales)
OR – Odds ratio
PAC – Privacy Advisory Committee
PAD – Peripheral arterial disease
PAH – Polycyclic aromatic hydrocarbons
PAR – Population attributable risk
PFT – Personal Fitness Test
PIS – Prescribing Information System
PT – Physical training
PCL-C – PTSD Checklist – Civilian version
PTSD – Post-traumatic stress disorder
PW – Prisoner of War
RBL – Royal British Legion
RR - Relative risk
RTA – Road traffic accident
SES – Socio-economic status
SIMD – Scottish Index of Multiple Deprivation
SIR – Standardised incidence ratio
SMR – Standardised mortality ratio
SMR[nn] – Scottish Morbidity Record [numeric dataset identifier]
SOCRATES - Scottish Open Cancer Registration And Tumour Enumeration System
TA – Territorial Army
UK – United Kingdom
UKLF – United Kingdom Land Forces
US – United States
USA – United States of America
VA - Veterans Administration (USA)

Definitions

GENDER - The masculine personal pronouns ('he', 'him', 'his') are to be interpreted as also including the female gender throughout, except where explicitly stated otherwise or implicit from the context. Feminine personal pronouns generally refer to issues specific to women.

MILITARY PERSONNEL - The terms 'soldier', 'military', 'Armed Forces' and 'Defence' are to be interpreted as including personnel of all three Services (Naval Service, Army, Royal Air Force), both genders, and all ranks, unless otherwise stated or implicit from the context. The Naval Service encompasses both the Royal Navy and the Royal Marines.

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NOTE ON THE TITLE OF THE STUDY – The study was entitled the Scottish Veterans [no apostrophe] Health Study in order to emphasise its main purpose. The apostrophe was omitted as its use, in indicating the genitive case, would have altered the meaning. An early aspiration to abbreviate the title to the SCOTVET Study did not materialise.

Chapter 1: Introduction

1.1 Overview

This thesis describes the establishment of and findings from the Scottish Veterans Health Study, a retrospective cohort study comparing the long-term health of veterans with that of people with no record of service. The study population comprised all military veterans resident in Scotland who were born between 1945 and 1985 and who met the inclusion criteria (57,000 people), and a 3:1 comparison group of 173,000 people with no record of military service matched for age, sex and postcode sector of residence, followed up for up to 30 years. The demographic data were linked to hospital admission records, cancer registrations and death certificates to provide information on long-term health outcomes.

1.2 Structure

The first part of this thesis (Chapter 1) sets out the background to veterans' health and the aims of the study. Chapters 2 and 3 describe the construction of the cohort and provide a baseline description of the study population, whilst Chapters 4-7 present the results of the data analysis, with commentary and interpretation, by disease or outcome groups. Chapter 8 draws together the findings and examines the implications for service provision, care of veterans, the Armed Forces Covenant, and health policy for serving personnel. Chapter 8 also makes recommendations for further research where the results indicate that additional study is needed to clarify the findings or to explore potential risk factors. Supporting information on the historical context, the demography of the serving and veteran populations, military occupational health and other factors potentially influencing veterans' health, and technical details of the dataset, is presented in the Appendices.

1.3 Background

1.3.1 Definition of a Veteran

The UK definition of 'veteran' status requires, as a minimum, only a single day's service and is one of the most inclusive in the world (Dandeker et al. 2006). It provides recognition of an individual's commitment to serve their country, irrespective of the length, outcome or reason for termination of that service. It includes many who have given valuable service, often in challenging conditions, and who have faced threats which may have impacted on their health, as well as those who have left after only a few days of military training. Becoming a member of the Armed Forces is unique. It involves a commitment to unswerving loyalty to the Crown; to move anywhere in the world at any time to take part in whatever activities are demanded; to comply unquestioningly with military orders and discipline; to accept the risk of injury or death in the line of duty; and to accept exacting standards of behaviour, even during free time[1]. As an employment, it carries unique constraints; having joined, the serviceman or woman is not free to leave (after the initial weeks[2]) until after a mandatory and lengthy period of notice[3]; failure to turn up for work is a punishable offence which may even incur imprisonment[4]; "render[ing oneself] unfit for duty"[5] (perhaps through a hangover) is a punishable offence, as is lateness for work. Unsurprisingly, some who join find that it is not for them.

Uniquely, the UK rewards the commitment to join the Armed Forces, whatever the outcome, with lifelong recognition of status as a veteran following the completion of a single day's paid service[6]. There is no other occupation in which this is paralleled. Those who enter the nursing profession, the police, the fire service, or a trade, and drop out in the first few days of training are lost to follow-up and never further considered. But all those who join the Armed Forces and subsequently leave, irrespective of the length or nature of their service or reason for discharge, are individually and collectively considered to be veterans and are the subject of much interest and concern.

Veterans are therefore not only a unique occupational group, but are also highly diverse, comprising not only those who have had a long career, and who may equate to 'retired'

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[1] "Values and Standards of the British Army". Ministry of Defence (2008) and equivalent Royal Navy and Royal Air Force policies

[2] Army Act 1955. 3 & 4 Eliz. 2 Ch. 18 Sect. 14, superseded by the Armed Forces Act 2006 Sect. 329(2)

[3] Army Act 1955. 3 & 4 Eliz. 2 Ch. 18 Sect. 5(5) , superseded by the Armed Forces Act 2006 Sect. 329(2)

[4] Army Act 1955. 3 & 4 Eliz. 2 Ch. 18 Sect. 41, superseded by the Armed Forces Act 2006 Sect. 15

[5] Army Act 1955. 3 & 4 Eliz. 2 Ch. 18 Sect. 42(1)(d), superseded by the Armed Forces Act 2006 Sect. 16

[6] *The Armed Forces Covenant*. Ministry of Defence (2011). A commitment by the UK Government to ensuring that service and ex-service personnel and their families do not experience disadvantage in comparison with the wider community.

members of other occupations, but also those who left at an early stage, either at their own volition or because of unsuitability. Of the latter group, a substantial proportion represents failures of the selection process; commonly medical or previous disciplinary problems which were not fully identified or disclosed but which come to light early in training. The ability to identify them and to monitor their long-term outcomes as an 'occupational leaver group' is therefore also unique, but it brings potential problems of interpretation, as will be discussed at Section 8.3.1.3. Veterans also demonstrate a wide variation in educational attainment, ranging from those with a reading age of less than 7 years[7] through to people with postgraduate and higher professional or technical qualifications.

1.3.2 Veterans' Health

Concerns about the health of veterans began to emerge during the First World War, when large numbers of injured personnel returned from conflict to the care of their families or of the many institutions which were being set up to provide support to the wounded[8], as described at Appendix 1. In recent years, there has been widespread media reporting of veterans' health issues, perhaps aimed at swaying public opinion about a specific military operation[9], or in an attempt to increase public awareness of, and support for, a perceived problem. Such 'newsworthy' reporting has rarely been based on scientific evidence[10]. Formal studies on the long-term health of UK veterans are rare, and as a consequence little is known about the health of the great majority of veterans, who have not sustained a life-changing injury but whose long-term health may have been affected, for better or worse, by their military service. This lack of reliable information has hampered both identification of the key issues and the provision of appropriately-targeted services for veterans. Nor have the Ministry of Defence or veterans' support organisations had access to validated evidence on which to base their response to misleading publicity. The Scottish Veterans Health Study was therefore conceived as an exploratory study which

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[7] House of Commons Defence Committee (2013) *The Armed Forces Covenant in Action? Part 4: Education of Service Personnel*, London: The Stationery Office Ltd.

[8] Including the Princess Louise Scottish Hospital of Limbless Sailors and Soldiers, established in 1916.

[9] For example, as related in Dean, E. T. (1992) 'The myth of the troubled and scorned Vietnam veteran', *Journal of American Studies,* 26(01), 59-74.

[10] For example http://www.edinburghnews.scotsman.com/news/seeing-four-motorway-lanes-of-bodies-sticks-in-your-mind-1-1490080 accessed 20 November 2015

would deliver an overarching picture of the 'landscape' of veterans' health in Scotland, founded on epidemiological evidence.

1.3.3 Stakeholders

The UK has a strong commitment to supporting its veterans, and an understanding of veterans' health is important to a wide range of stakeholders in support of policy development and service delivery. Overarching responsibility for the care of all citizens rests with central Government; in Scotland, much of this responsibility has been devolved from Westminster to the Scottish Government[11]. The nation's responsibility to its veterans is enshrined in the Armed Forces Covenant[6]. The National Health Service (NHS) has responsibility for provision of appropriate healthcare services to all members of the population including veterans, whilst community services are the responsibility of local authorities. Many local authorities have signed up to Community Covenants[12] which commit them to supporting the service community, including veterans and their families, in their local area. Within the Ministry of Defence, health protection policy for serving personnel is driven by information on the in-service risks to health; whilst immediate occupational risks are managed by a risk assessment process, knowledge of the long-term health consequences of service can contribute to the identification of hitherto unrecognised threats, as well as to the evaluation of the effectiveness of in-service health protection and promotion policies. Ultimately, the key stakeholders (and potential beneficiaries) are the veterans themselves and their families. All stakeholders have a requirement for reliable information on veterans' health status and risk which underpins policies and services.

1.4 Aim

The aim of the Scottish Veterans Health Study was to determine whether the long-term health of military veterans living in Scotland differed from that of people with no record of military service, in order to:

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[11] Although Defence policy is reserved to Westminster, devolved responsibilities of particular relevance to veterans include healthcare, housing, transport and education.

[12] https://www.gov.uk/government/publications/armed-forces-community-covenant/armed-forces-community-covenant accessed 20 November 2015. Community Covenants are a component of the overarching Armed Forces Covenant[6].

- Improve overall understanding of veterans' health issues.
- Support the Armed Forces Covenant[6] by contributing to the evidence base for developing services for veterans (needs assessment) provided by:
  - The NHS.
  - Local authorities.
  - The Third Sector (charities and voluntary providers).
- Where possible, assess the likelihood that any differences found could be attributed to service.
- Evaluate the long-term effectiveness of the Ministry of Defence health promotion strategy for serving personnel.
- Provide an evidence base to address popular myths and misconceptions[13].

1.5 Studying Veterans' Health

Throughout most of the 20th century, up to the end of National Service[14] in May 1963, the majority of British men had seen military service (Appendix 2), the exceptions being those who were medically unfit to serve and a small number who were in 'reserved' (nationally important) occupations[15]. Therefore, there was no non-veteran group which could be used as a valid health comparator, as will be discussed at Section 2.2.2.1, and veterans' health issues, other than those directly related to war injury, could not readily be identified. The establishment of an all-volunteer military force was accompanied by the emergence of a representative non-veteran group who entered adulthood in the early 1960s. Fifty years on, and with the development of modern data handling techniques which have facilitated the study of longitudinal health data at both population and individual level, it has been possible to undertake a comparison between the health of those who have served and those who remained civilians, in order to determine whether

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[13] Assumptions about military service and its effects, widely used in mass media reports, which are recognised as implausible by many serving personnel, veterans and service providers, as acknowledged in the reports by the Royal British Legion (2014) '*A UK Household Survey of the Ex-Service Community*', and by Ashcroft, M. A. (2014) *The Veterans' Transition Review*., but which are difficult to challenge or refute in the absence of scientific evidence.

[14] Compulsory military conscription, which operated in the UK from 1916-1919 and from 1939 to 1960. The last intake of National Servicemen was in November 1960 and the last were discharged in May 1963.

[15] 'Reserved occupations' included dock workers, railway workers, miners, and farmers

the health outcomes of veterans and non-veterans differ, and whether there is heterogeneity of health outcomes at subgroup level within the veteran community.

1.6 Previous Studies

Large-scale follow-up studies of military veterans have been conducted in both the United States (US) and Australia. Many of these studies are conflict-specific, covering veterans of the Vietnam, Korean and Gulf wars. Observational studies have included the US Vietnam Experience Study, the US National Vietnam Veterans Readjustment Study, the Australian Vietnam Veterans Health Study, the Australian Korean War Veterans Study, and the US National Health Study of Gulf War Era Veterans. One of the largest studies was the US Government follow-up study of almost 300,000 veterans who held Government life insurance as at 1953 (the Dorn Study), whilst by contrast, the US Veterans Affairs Normative Aging Study was a 40 year follow-up from 1963 of a much smaller group of 2,000 veterans who were aged 21-81 years at entry. Several US population-based health studies have included a question on veteran status, including the Atherosclerosis Risk in Communities (ARIC) Study, and the Centers for Disease Control (CDC) Behavioral Risk Factors Surveillance Study (BRFSS) and National Health Interview Study. Long-term cohort studies on military personnel and veterans are now well established, including the US Millennium Cohort, but older longitudinal military or veteran cohorts are rare; an example is the US Vietnam Era Twin Registry which followed up 7,000 male twin pairs over 40 years.

Some studies covered a wide range of diagnoses, for example the Australian Korean War Veterans Study, whilst others were specific to a disease or diagnostic group, for example the ARIC Study which examined only cardiovascular outcomes. Others such as the US 2010 National Veterans' Survey, although reporting on health status and disability, contained no diagnostic data[16]. Survey methodology was similarly heterogeneous, encompassing telephone surveys, questionnaires and clinical examination. The overall findings from the major conflict-specific studies were generally published as official

[16] National Survey of Veterans, Active Duty Service Members, Demobilized National Guard and Reserve Members, Family Members, and Surviving Spouses. Department of Veterans Affairs (2010). Available at http://www.va.gov/vetdata/docs/SurveysAndStudies/NVSSurveyFinalWeightedReport.pdf accessed 20 November 2015.

reports rather than peer-reviewed scientific papers[17,18], although some of the findings of these reports have been disputed in later scientific studies (McNally 2007, Sterling and Weinkam 1978). Detailed analysis of specific areas of interest within the studies has given rise to a very large number of scientific papers[19]. The circumstances of the conflict may have contributed to the observed health outcomes in conflict-specific studies, for example the high levels of drug misuse reported in US troops during the Vietnam war (Robins et al. 1974). A limitation of conflict-specific studies is that large numbers of conscript personnel may be included, and they may not be representative of an all-volunteer force; for example volunteers generally enter service between the ages of 18 and 21 years, whilst conscripts enter at any eligible age, up to and including middle age. This may be an important source of bias. Importantly, conflict-specific studies also provide no insight into veterans who were ineligible for deployment, for example those who left prior to completing training, or those who were medically unfit to deploy. Even allowing for these limitations, such studies remain an important source of baseline information on the long-term health of veterans in the absence of large-scale general studies. The exclusion of women from combat in Western armed forces, and small numbers of serving women, has resulted in few studies reporting their health outcomes.

In the UK, a major cohort established to examine the health of Gulf era personnel is maintained by the King's Centre for Military Health Research at King's College, London, and many research papers have been published[20]. Since the establishment of the cohort, many of the original cohort members have become veterans. However, no large-scale cohort studies on the health of pre-Gulf era UK veterans have been identified; nor have any studies examined the long-term health of UK veterans irrespective of length of service, deployment or exposure to combat. Identification of their health status and support needs is essential in order to underpin the UK's commitment to afford the

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[17] The Contractual Report of Findings from the National Vietnam Veterans' Readjustment Study comprises four volumes (3,000 pages)

[18] Harrex, W. K., Horsley, K. W., Jelfs, P., van der Hoek, R. and Wilson, E. J. (2003) *Mortality of Korean War veterans; the veteran cohort study. A report of the 2002 retrospective cohort study of Australian veterans of the Korean War*, Canberra.

[19] For example, a Medline search for [Agent Orange AND Vietnam] identified 295 papers relating to use of the defoliant. The same search in Embase identified 244 papers, whilst PubMed found 320 papers.

[20] Listed at http://www.kcl.ac.uk/kcmhr/pubdb/ accessed 2 November 2015.

privileges of veteran status[21] to all who meet the definition of a single day's service, as described at Section 1.3.1.

1.7 Gaps in the Literature

The major gaps in the literature which were identified were:

- There was a paucity of long-term studies on UK veterans.
- There was a lack of long-term studies examining veterans overall, unrelated to any specific conflict.
- Few studies included rank or length of service as a variable.
- There was a paucity of studies on women veterans.
- Few studies examined the health of veterans in comparison with a matched non-veteran group.
- Social deprivation was often noted as a confounder, especially in US studies on Veterans Administration patients where the lower end of the socio-economic status (SES) spectrum tends to be over-represented. No large-scale studies were found which had adjusted for this.

The Scottish Veterans Health Study was conceived in order to address this knowledge gap, by conducting an overarching exploratory analysis of a wide range of long-term health outcomes in a broad population-based national cohort of male and female veterans who served for between one day and over 40 years, over a 50-year period, irrespective of exposure to combat or length of service, together with a non-veteran comparator group matched for year of birth, sex, and area of residence, and with the ability to adjust for SES. The study used a newly-generated linked dataset, derived from routinely-collected data, to build up a picture of veterans' health at population level and contribute to an understanding of whether, and if so how, military service

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[21] Entitlement to: access veterans' services; receive support from service charities; receive community support and an assurance of no disadvantage under the Armed Forces Covenant; receive priority healthcare where nationally authorised.

affects the health of those who have served, and to facilitate planning of appropriate services for veterans.

1.8 Research Questions

The research questions to be addressed in this thesis are:

- Do military veterans have better or worse long-term health outcomes (physical or mental) than people who have never served?
- Are there specific conditions which are associated with military service, and is there evidence of causality?
- Are some sub-groups of veterans at greater risk than others?
- Are there any trends over time?
- What is the overall impact of military service on health?

1.9 Formulating the Hypothesis

As veterans are a subset of the wider population, the null hypothesis, that the overall long-term health of veterans would not differ from that of non-veterans after matching or adjusting for age, sex, deprivation or geography, was taken as the starting point. However, a large number of potential risk factors, both occupational and lifestyle, could have influenced veterans' health; these are summarised in Section 1.10 and discussed in more detail in Appendix 3. Therefore, where indicated by a review of the literature or reported health risk behaviour in serving military personnel, disease-specific supporting hypotheses were developed and are presented in the introductory sections of Chapters 4-7.

1.10 Influences on Veterans' Health

Veterans' health results from the combination of biological, social, psychological, occupational and environmental factors operating along the life-course. The predominant pre-service factors are SES, education and exposure to childhood adverse events, whilst in-service influences encompass both occupational and lifestyle factors.

The former include exposure to environmental hazards, and issues arising from operational deployment, whilst the latter may encompass nutrition, alcohol and smoking. Exercise levels in-service span both the occupational (military training and operations) and the lifestyle (recreational) spheres. Post-service, the veteran's health is affected by both civilian employment and by lifestyle choices; the latter may have been modified by in-service health promotion and other service-related factors. A wider discussion of the overall influences on veterans' health is at Appendix 3, whilst specific issues are addressed in the Introduction, Commentary or Discussion under specific chapter or disease headings in Chapters 4-7. Although the dataset provided no information on individual occupational or lifestyle risk factors, reported health behaviour in serving personnel and patterns of disease in the veterans were used to infer risk factors which were likely to have influenced veterans' health. The overall findings of the Scottish Veterans Health Study are discussed and summarised in Chapter 8.

Chapter 2: Construction and Analysis of the Cohort

2.1 Overview

As described at Section 1.1, the Scottish Veterans Health Study is a retrospective cohort study established to compare the long-term health of veterans with that of people with no record of service. The cohort comprises all military veterans resident in Scotland who met the inclusion criteria (Section 2.2.1) (57,000 individuals) and a 3:1 comparison group of individuals (173,000) with no record of military service matched for age, sex and postcode sector of residence. Participants were identified via their electronic NHS registration records, which provided the dates of entering and leaving military service as well as demographic information. These records were linked, at an individual level, to routine acute hospital admissions data, psychiatric admission and day-case data, cancer registrations, death certificates and limited prescribing data. Information was available for follow-up events that occurred between 1 January 1981 and 31 December 2012 inclusive. After data cleansing, the final dataset included in the analysis comprised 56,205 veterans and 172,741 non-veterans. Survival analysis was used to compare long-term health outcomes overall and by subgroup.

2.2 Creation of the Cohort

The cohort was developed through discussions with the Registrar General for Scotland, the Head of the NHS Central Registry (NHSCR) in Scotland, staff of the Information Services Division (ISD) of NHS Scotland and key stakeholders (Scottish Government, NHS Scotland, Ministry of Defence and charities). The consultation process is described at Section 2.2.3.3. A feasibility study was conducted in 2010-2011, examining only cardiovascular outcomes in two age groups and comparing veterans against the general Scottish population using routinely-reported data. The results indicated that older veterans were at increased risk of cardiovascular disease compared with the general population, but were insufficiently robust owing to the lack of a matched non-veterans comparison group. Nonetheless, lessons learned during the feasibility study informed the structure of the final dataset.

2.2.1 Inclusion Criteria

All participants were identified via their electronic NHS registration records held at the NHSCR in Dumfries, which as noted above provided demographic information as well as the dates of entering and leaving military service where relevant.

Individuals were included in the dataset as a 'veteran' if they met all the following criteria:

- Date of birth between 1 January 1945 and 31 December 1985
- 'Exit to Armed Forces' cipher on NHS record[22]
- 'From Armed Forces' cipher on NHS record[23]
- Current Health Board cipher on NHS record

Individuals with only one Armed Forces cipher (either exit or re-registration) were excluded from both groups. For veterans with multiple Armed Forces ciphers, corresponding to periods of interrupted service, only the dates of the first and last ciphers were used.

2.2.2 Choice of Criteria

2.2.2.1 Earliest Birth Date

The earliest birth date of 1 January 1945 was chosen in order to exclude all veterans who joined the Armed Forces as a result of conscription under the National Service Act 1948 and earlier legislation. The last date at which National Service call-up could have taken place was 31 December 1960, when the oldest of the eligible veterans would have been 15 years of age, thus providing confidence that National Service personnel were excluded[24], although in practice National Service conscription began to be phased out

[22] Derived from information provided by military recruitment centres. Believed to be reasonably complete except for a short period in the mid-1990s when a procedural change resulted in a shortfall. Information provided by NHSCR.

[23] Re-registration with NHS GP on leaving the Armed Forces, together with medical discharges (which are routinely notified to NHSCR). Information provided by NHSCR.

[24] No National Service personnel were conscripted under the age of 18 years, in accordance with the National Service Act 1948.

from 1957 and the last intake was in November 1960[25]. For the period of full implementation of National Service, selection of an appropriate comparison group would have been problematic as the majority of men (and some women) had been required to serve in the Armed Forces unless they were in certain nationally-important ('reserved') occupations[15] (Section 1.5) or were medically unfit. Therefore, any comparison group of non-veterans would have been biased towards members of the small number of occupational groups (predominantly critical manual jobs such as coal-mining or farming) who were exempt National Service, and people with long-term health conditions who were medically unfit to serve.

The earliest birth date of 1945 meant that at the start of the feasibility study in 2010, the oldest surviving veterans were aged 65 years, although re-linking of the dataset as at 31 December 2012 for the full study (see Section 2.2.8.2) resulted in the maximum age at follow-up being 67 years. The Scottish Veterans Health Study would therefore not yield information on the health needs of elderly veterans. In an analysis of the prevalence of mental, physical and behavioural difficulties identified in the 2007 Adult Psychiatric Morbidity Survey of England, Woodhead et al. found no overall differences between community-dwelling National Service veterans and non-veterans aged 65 years and over, although the veterans were less likely to have any mental health disorder than non-veterans. The authors noted methodological limitations in their study; the two groups were likely to be different, for the reasons discussed above, and it was likely that there was a 'healthy survivor' effect whereby those with problems associated with premature mortality would not have reached age 65 years to enter the study population. (Woodhead et al. 2011b). The conclusion of that study, that community-dwelling National Service veterans are not at greater risk of current adverse mental, physical or behavioural health than population controls, has been taken to imply that the health needs of veterans aged over 65 years equate to those of the general older population (Compass Partnership 2014)[26].

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[25] Richard Vaughan, aged 22 years, joined the last intake into the Royal Army Pay Corps, No. 277 National Service Intake, on 17 November 1960, after completing his training as a chartered accountant. He was discharged on 16 May 1963 in the rank of 2nd Lieutenant, officially becoming the last National Serviceman to be discharged. Source: http://www.bbc.co.uk/news/magazine-32929829 accessed 1 June 2015.

[26] "The needs experienced by older veterans are largely the same as non-veterans of the same age". Compass Partnership (2014) *A UK Household Survey of the Ex-Service Community*, London: Royal British Legion.

2.2.2.2 Latest Birth Date

The latest birth date of 31 December 1985 for the cohort was selected in order that the youngest members of the groups would enter the study at age 25 years (as at the date of the feasibility study in 2010), since the majority of the conditions of interest were those predominantly affecting the older age groups and little additional information would be gained by including the youngest veterans (age 16-24 years). This resulted in a birth cohort spanning 41 years.

2.2.2.3 Veteran Status

The UK Government definition of a veteran includes any individual who has served in the Armed Forces for at least one day (Burdett et al. 2013), with no requirement to have served in combat, in an operational theatre or even to have completed initial training, as described at Section 1.3.1. The study population was defined to be concordant with the UK definition. Although those who have left following Reserve service only are also veterans, they do not de-register from their NHS GP during service, even if they deploy operationally, and therefore they cannot be identified from the NHSCR database unless they have also had a period of Regular service. It is therefore possible that the 'non-veterans' group would include some people who had served as reservists, but their contribution to this group is likely to be small (estimated at up to 0.2%, as described in the footnote[27]).

2.2.2.4 Geography

There are known geographical variations in health in Scotland (Hart et al. 1997, Patterson et al. 1988), which could have acted as a confounder. Although the veterans and non-veterans were matched for area of residence (postcode sector), the inclusion within the

[27] The Royal British Legion estimated in 2006 that 15% of veterans were ex-Reservists (Compass Partnership (2006) *Profile and Needs of the Ex-Service Community 2005-2020*, London: Royal British Legion.). Extrapolating this gives a total of 9,918 Reservist veterans who would have been eligible for inclusion. As the non-veterans group comprised 3.3% of the total population of Scotland, around 327 Reservist veterans may have been inadvertently included with the non-veterans, equating to 0.2% of the non-veterans. Until the Reserve Forces Act 1996 came into force on 1 Apr 1997, Reservists were unable to deploy without a Queen's Order being signed (requiring declaration of a major national emergency); they normally undertook around 15 days' military training per year. Other than injuries sustained on training, the impact on their long-term health is likely to have been limited. The Reserve Forces Act facilitated call-up of Reservists for active duty, and many have since served alongside Regular personnel in Iraq and Afghanistan.

dataset of the postcode district and the Health Board area within which each individual resided also enabled exploration of regional variations to be undertaken for selected conditions. The postcode sector is the first part of the UK Royal Mail postcode plus the numeric digit of the second part[28]. There are 1,273 postcode sectors in Scotland[29], and each sector covers a range of 500-20,000 individuals (mean 4,600) although the geographical area varies with population density[30] (Figure 2-1). This unit was considered to be of suitable size to enable the comparison group to be matched by geographical area whilst not over-matching for socio-economic status. Only the higher-level postcode district (the first three or four characters, eg EH3 or EH10), of which there are 477 in Scotland[29], was supplied; the risk of inadvertent disclosure was considered to be minimal at this scale.

Image has been removed due to Copyright restrictions

Figure 2-1 - Postcode sector map for Edinburgh

The NHS health board region within which each individual was registered was also provided as part of the dataset. There are 14 regional health boards in Scotland, covering a range of 22,000-1.1 million individuals (mean 390,000). This provided a larger

[28] For example, EH10 7AB

[29] As at 2014

[30] Information from ISD Scotland http://www.isdscotland.org/Products-and-Services/GPD-Support/Geography/ last accessed 15 June 2015

geographical unit for investigation of broad regional differences in health outcomes; as health boards are responsible for the delivery of healthcare services, any regional differences discovered may have implications for local needs assessment and service provision.

2.2.2.5 Comparison Group

The 3:1 comparison group of non-veterans was intended to be selected with no 'Armed Forces' ciphers on the record but otherwise according to identical criteria. Matching was by age, sex and postcode sector of residence; the methodology will be described in detail at Section 2.2.4.

2.2.3 Variables

The variables chosen were constrained by the availability of routine data items within the NHSCR and Scottish Morbidity Record (SMR) datasets. Demographic and disease-specific data were available, together with information on military service where relevant. No lifestyle data, for example on smoking, alcohol intake, exercise, nutrition or obesity were available. No records of occupation or employment status were available.

The variables provided with the dataset are listed at Appendix 6, Table A6-1. Additional variables which would be used frequently were calculated and are listed at Appendix 6, Table A6-2.

2.2.3.1 Demographic

For each individual, a unique pseudo-anonymised 8-digit numeric identifier was generated and supplied, together with date of birth, sex, health board of last recorded address, and a binary flag for deaths. As described at Section 2.2.6 below, a separate file giving the unique identifiers and postcode districts of residence was also provided. It was hoped that *inter alia*, an estimate of the number of veterans in prison or accessing services for the homeless could be made, as separately-identifiable NHS primary care services are provided for these groups; however the primary care practice identifiers were deemed too sensitive to include in the dataset and this aspiration was dropped.

2.2.3.2 Service-Specific

A binary field recorded veteran/non-veteran status. For the veterans, the NHS database provided the dates of entering and leaving military service, for Regular personnel only (see Section 2.2.2.3). These two dates enabled a calculated variable for length of service to be derived. For the purposes of data analysis, length of service was stratified into common terms of military engagement, at three levels of granularity as described at Section 3.2.2. As the data were derived from NHS records and it was not possible to link to military service records, no information was available on the service (Naval Service[31], Army, Royal Air Force) to which an individual had belonged, on rank or in-service trade/occupation, or on deployment or exposure to combat.

2.2.3.3 Disease-Specific

An initial list of conditions and outcomes of potential interest was drawn up as a basis for discussion with stakeholders. This was based on the conditions of interest which had been identified as a result of the literature review and stakeholder consultation for the Australian study of mortality in male Korean War veterans (Harrex et al. 2003). This study was chosen as the baseline as it had a 50-year follow-up period and hence was the nearest comparable study to the Scottish Veterans Health Study, noting the limitations of a mortality study in failing to capture low-mortality conditions. The list of conditions routinely reported by ISD as Scottish national healthcare statistics[32] was then examined and the initial list was augmented with conditions which had either not been relevant to the Australian study (for example gynaecological cancers) or, having a low mortality, had not been considered in that study (for example, non-melanoma skin cancer). The revised list was then shared with veterans' charities, the Ministry of Defence and ISD and scrutinised for appropriateness and completeness. As a result of stakeholder feedback, suicide, self-harm and diabetes were added, additional ethical clearance being required for the former two. Amyotrophic lateral sclerosis, which was proposed by stakeholders, was confirmed as being synonymous with the already-included motor neuron disease. Hearing loss was suggested by the Ministry of Defence but was deemed not to be feasible as no relevant NHS dataset was available; similarly, musculo-skeletal/arthritic conditions,

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[31] The Naval Service encompasses the Royal Navy and the Royal Marines

[32] http://www.isdscotland.org/Products-and-Services/index.asp accessed 1 Nov 2015.

which were of interest to the veterans' charities as they may impact on support needs, are not routinely recorded and could not be included.

Following the stakeholder discussions, 48 conditions which were likely to give rise to an acute or psychiatric admission record, cancer registration, or death, were considered to be of *a priori* interest and to merit inclusion in the dataset. These encompassed single conditions, for example prostate cancer; aggregated groups of conditions, for example any cancer; and external causes, for example injuries due to road traffic accident. For each condition, a binary field recorded the presence or absence of the condition[33], and a date field recorded the first episode. No information was provided on the second or subsequent episodes of the same condition. The primary cause of death was given where appropriate, coded using ICD-9 for deaths prior to 1 January 1997 and ICD-10 for later deaths.

2.2.3.4 Prescribing Data

Individual-level prescribing data for nicotine replacement therapy (NRT), alcohol abstinence therapy and the main groups of psychotropic drugs[34], based on dispensed prescriptions, were available from 2009 from the NHS Prescribing Information System (PIS).

2.2.3.5 Socio-Economic Status

In Scotland, 6,505 datazones have been defined, based on census output areas (OA), with a mean population of 800 (range 500-1,000)[35]. The Scottish Index of Multiple Deprivation (SIMD) for each datazone is derived from information on income, employment, health, education (including skills and training), housing, crime, and access to services (Scottish Government 2012). Current income and employment have the highest weightings[36]. The SIMD has been used to derive quintiles of socio-economic status for the Scottish

[33] Occurrence of the specified ICD-9 or ICD-10 code or codes, at any position in the record

[34] Antidepressants, anxiolytics and anti-psychotic drugs

[35] Scottish Index of Multiple Deprivation 2004: Technical Report http://www.scotland.gov.uk/Publications/2004/10/20089/45176 accessed 18 July 2014

[36] http://www.scotland.gov.uk/Topics/Statistics/SIMD

population; ranging from 1 (most deprived) to 5 (least deprived). Postcode of residence[37] was used to categorize the study subjects according to these quintiles, and the SIMD quintile at Scotland-wide and health board level was included in the dataset for each individual.

2.2.4 Data Extraction

For veterans meeting the inclusion criteria, the Community Health Index (CHI) number was extracted from the appropriate data table by the NHSCR. This veteran group was used as the basis for the matched non-veterans comparison group. The data items on which the matching was based were postcode sector, year of birth and sex, and a Scottish Health Board posting was required. A process script to extract matching individuals was written by NHS IT Applications Support, and was run manually. The first four matching records for each individual were selected; after elimination of duplicates, this gave an output file of approximately 173,000 non-veterans in addition to the 57,000 veterans. The CHI number file was passed to the Information Services Division (ISD) of NHS Scotland for individual-level linkage to the SMR, prescribing records and death certificate data.

2.2.5 Data Linkage

The demographic data provided by NHSCR were linked directly to the routinely-collected ISD Scotland health data by the eData Research and Innovation Service (eDRIS) at ISD Scotland. Data were available covering the period 1981-2012 for hospital admissions (Scottish Morbidity Record 01 (SMR01)), mental health admissions (SMR04), cancer registrations (SMR06, derived from the Scottish Open Cancer Registration And Tumour Enumeration System (SOCRATES)[38]) and National Records of Scotland (NRS) deaths. Occurrences of each outcome were identified using ICD-9 (to 31 December 1996) or ICD-10 (from 1 January 1997) diagnostic codes (listed at Appendix 7) and were flagged against each member of the cohort, using the Community Health Index (CHI) number as the link field, along with the first date recorded for each outcome. Information was also provided from the Prescribing Information System (PIS) for specified groups of drugs

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[37] Only the most recent postcode was available from the NHS record. For the veterans, this would always be post-service.

[38] Scottish Cancer Registry http://www.isdscotland.org/Health-Topics/Cancer/Scottish-Cancer-Registry.asp accessed 15 June 2015.

(Section 2.2.3.4 and Appendix 6, Table A6-1). Flags against members of the cohort were created and the first date of prescription was recorded for each drug. PIS data were available from 2009 to 2012. Additional demographic information was added including SIMD quintiles, NHS Health Board of residence, sex and postcode district. A pseudo-anonymisation code was substituted for each CHI number before release of the dataset.

2.2.6 Ethics, Privacy & Security

Approval for the study was granted by the Privacy Advisory Committee of the Information Services Division (ISD) of NHS Scotland, PAC reference 27/12. The data extract was pseudo-anonymised but access to the original identifiers was retained securely by ISD for use in the event that emerging findings dictated a requirement to contact individuals. As the study was to be based on the analysis of pseudo-anonymised secondary data, individual patient consent was not deemed necessary.

Only the postcode district (the first part of the postcode, mean population 25,000) was released with the dataset, in order to reduce the risk of a breach of confidentiality. The pseudo-anonymised identifiers and postcode districts were provided as a separate file, a condition of its supply being that it was not to be linked to the main data file. Therefore, a dummy variable value was created for each postcode district, based on the OBJECTID field for the GIS postcode district shapefile[39].

The original .csv data file supplied, and the Excel .xlsx files created from it, were password protected. Stata datasets do not have a password protection facility, so the Stata file (see Section 2.3.1) was held on a password-protected laptop computer which was physically secured in a locked cabinet when not in use.

Care was needed to ensure that reporting of the results of the study did not inadvertently lead to the disclosure of personally identifiable information, which would have resulted in a breach of both statute and of the common-law duty of confidentiality. Guiding

[39] National Records of Scotland 2013-1 Postcode Extract shapefile, sourced from http://www.nrscotland.gov.uk/statistics-and-data/geography/nrs-postcode-extract/2013-1 accessed 14 May 2013. The shapefile is the Geographic Information Systems (GIS) data storage format for geometric attributes of geographic features, and has a standard format for compatibility across a variety of software. Shapefiles are predominantly used in mapping with GIS software but the OBJECTID field for each postcode in this shapefile found additional utility as a dummy variable.

principles were taken from the Statistical Disclosure Control Protocol published by ISD Scotland[40]. Particular problems were presented by subgroup analysis of rare conditions, where suppression of small numbers would have led to the omission of potentially important findings, and rounding or other 'blurring' techniques would have introduced major and misleading inaccuracy. Where possible, hazard ratios, odds ratios or graphical representations have been presented rather than numbers. There are several instances, most relating to deaths[41], where exact numbers less than 5 have been reported. In these instances, both the largest spatial unit (all Scotland) and largest temporal units (wide ranges of dates of birth and dates of events) have been used as the base, and no additional personal information can be deduced or implied; the probability of disclosure[42] and harm has therefore been assessed as minimal. In the tabulated subgroup analyses, which unavoidably provide a greater degree of granularity and therefore risk of disclosure, case numbers less than 10 have been suppressed.

2.2.7 Funding

No external funding for the study was received.

2.2.8 Description of the Groups – Initial Dataset

2.2.8.1 Veterans

The initial dataset delivered from ISD Scotland comprised 56,659 veterans, of whom 51,344 (90.6%) were male and 5,315 (9.4%) were female. A total of 3,546 veterans (6.3%) had died by the end of the follow-up period.

On preliminary examination of the dataset, 557 of the 'veterans' had a "Date Joined Armed Forces" but an entry of NULL under "Date left Armed Forces". Further enquiry indicated that these represented the small number of serving personnel who had registered with an NHS GP whilst still serving – either because they were living remote

[40] ISD Scotland. Statistical Disclosure Control Protocol Version 2.3 (2012).

[41] The Data Protection Act 1998 does not apply to deaths, although the common-law duty of confidentiality remains applicable

[42] Disclosure: The discovery of details that were previously unknown about an individual by someone who already has some information about them, or the identification of an individual and gain of previously unknown information about them. Adapted from ISD Scotland. Statistical Disclosure Control Protocol Version 2.3 (2012).

from a military base where they could obtain primary care or, in some cases, because they had registered with an NHS practice in contravention of military policy. With no date of exit from the Armed Forces, they did not meet the definition of veterans and were excluded.

A further 350 individuals had a calculated age at 'leaving the Armed Forces' of less than 15 years. They were considered to be the children of Service families, who had registered with an NHS practice having formerly been under the care of the Armed Forces (usually overseas) and they too were excluded. Service from age 15 years was considered to be feasible as the UK school leaving age was not raised from 15 to 16 years until 1972. Prior to this date, military service could begin at age 15 years in one of the junior soldiers' units; subsequently, entrants were taken into these units from age 16 years. Adult service could commence at age 17 years, although combat service was (and remains) precluded prior to age 18 years in accordance with international law.

Four individuals had dates of birth prior to 1945 and were excluded.

After initial data cleansing, 55,572 veterans remained in the dataset.

2.2.8.2 Non-Veterans

The initial dataset delivered from ISD Scotland comprised 178,441 non-veterans, of whom 157,447 (88.2%) were male and 20,994 (11.8%) were female. A total of 392 non-veterans (0.22%) were recorded as dead. The expected number of deaths was around 10,000 and it was immediately apparent that there had been an error in the preparation of the dataset. Further investigation showed that the non-veterans had inadvertently been selected with an additional criterion of 'Alive', the only deaths having occurred in the period between selection of the study participants and linkage with health and vital records events.

It was therefore necessary to re-select and re-link the data, and the opportunity was taken to further cleanse the dataset to remove the anomalies already identified.

2.2.9 Description of the Groups – Revised Dataset

2.2.9.1 Veterans

The revised dataset comprised 56,570 veterans, of whom 51,268 were male and 5,302 were female, with 3,556 deaths. Following a final round of data cleansing to exclude incomplete or invalid records, or those not meeting the inclusion criteria, a total of 56,205 (99.4%) veterans was included in the analysis, of whom 50,970 (90.7%) were male and 5,235 (9.3%) were female. There were 3,529 (6.3%) deaths in the group.

2.2.9.2 Non-Veterans

The new non-veterans group comprised 172,753 individuals of whom 152,046 were male and 20,707 were female, with 10,952 deaths. After final data cleansing the dataset included 172,741 non-veterans, of whom 152,038 (88.0%) were male and 20,703 (12.0%) were female. There were 10,947 (6.3%) deaths in the group.

2.2.10 Data Format

The dataset was supplied by the Information Services Division of NHS Scotland as a comma-delimited .csv file, which was imported into Excel® 2007 (©2006 Microsoft Corp), saved as an .xlsx file and then imported into Stata v12.1 (©1985-2011 StataCorp).

2.2.11 Missing Data

2.2.11.1 Regular Personnel

A search was run by NHSCR to estimate the number of veterans who were excluded from the dataset as, although they settled in Scotland on leaving the Armed Forces, they had not been resident in Scotland pre-service. Hence, their length of service could not be calculated. This group comprised 2,259 people, and their inclusion would have augmented the veteran group by an additional 4%. It is unlikely that there would be systematic differences between their health and that of those who were in Scotland prior to service, and it was not considered that their omission would introduce bias.

2.2.11.2 Reservists

Reserve personnel do not deregister from their NHS general practitioner on joining for active duty, and hence do not have Armed Forces exit and entry flags on their NHS record; therefore, they could not be separately identified in the Scottish Veterans dataset. As a result, some reservists may have been included amongst the non-veterans; this would have had the effect of weakening any observed differences between veterans and non-veterans. As discussed at Section 2.2.2.3, the number of reservists included in the non-veterans group is likely to be small[27], and since UK reservists were not normally able to deploy operationally until 1996[43], the impact of operational service[44] on the health of this group is unlikely to have been an important confounder in this study.

2.2.11.3 Unregistered

Both veterans and non-veterans would have been excluded from the dataset if they had never registered with a GP in Scotland. People who had previously been registered but were currently unregistered would have been included but recorded at their last registered location. NHS 'Access Practices' are provided in the major Scottish cities for homeless people; since the benefits of accessing NHS services include free prescriptions, few are likely to have never registered.

2.3 Data Analysis

2.3.1 Statistical Methods

A survival analysis (time-to-event) methodology was chosen as this allows different lengths and periods of service to be taken into consideration, and different ages at entry

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[43] Prior to the passing of the Reserve Forces Act 1996 (RFA 1996), any deployment of reservists required the signing of a Queen's Order. The last time this was invoked, prior to the Gulf War of 2003, was for the Korean War (1950-1953). Subsequent to the passing of RFA 1996, a Queen's Order was only required for compulsory mobilisation.

[44] Around 26,000 reservists have been called up for mobilisation since the start of Operation TELIC (Iraq 2003). Of these, around 10% or 2,600 are likely to have been resident in Scotland and contributed to the non-veteran population of approximately 1.6 million (all men aged 27-67 as at 2012, plus 10% of women) from which the 173,000 non-veterans were drawn. Thus, the expected number of deployed veterans inadvertently included in the non-veteran dataset is around 280. Population data from the General Register Office for Scotland (now National Records of Scotland) http://www.gro-scotland.gov.uk/statistics/at-a-glance/annrev/2012/figures-chapter-1.html accessed 17 October 2014. Data on reservists from Lowland Reserve Forces' and Cadets' Association.

to follow-up (age at leaving the armed forces) to be accommodated. Cox proportional hazard models were used to examine the association between veteran status and cumulative risk of each condition in turn, using age as the time dependent variable, age at first occurrence as the failure time, and death (if no occurrence of the specified condition) or the end of the study as the censor time. Hazard ratios and p values were calculated and the *a priori* rejection level was set at 0.05. The use of age, rather than time from baseline, as the time-dependent variable is recommended for longitudinal studies of this type (Korn et al. 1997, Thiébaut and Bénichou 2004). The Cox proportional hazard model assumes that the relative hazard remains constant over time. Cox proportionality assumptions were tested using methodology based on Schoenfeld residuals (Grambsch and Therneau 1994), or graphically using the method described by Hess (Hess 1995). Where non-proportionality was found, landmark analysis was used to adjust the models for time-varying effects of covariates (Van Houwelingen 2007). Landmark analysis was also used to manage potential confounding where conditions prevalent in young people would have precluded military service, for example asthma. The models were run univariately and then repeated adjusting for the potential confounding effect of socio-economic deprivation (SIMD) quintile, as the matching by postcode sector did not eliminate differences in socio-economic status. No adjustment was made for sex or year of birth as these were likely to be predictive variables rather than confounders; over-adjustment would risk masking associations of interest (Breslow 1982, Miettinen 1970). Where clinically and epidemiologically appropriate, an assessment of risk by sex was made and compared with male:female ratios reported in other studies, in order to determine whether there were important differences between veterans and non-veterans by sex. However, men and women were considered together in the overall analyses in order to contribute to an assessment of the likely impact of military service on health, and also a measure of need within the veterans' community; the combined data also provided greater statistical power.

The analyses were repeated stratifying by grouped year of birth to examine potential birth cohort effects; by geographical region to examine potential regional variations in selected conditions; and by length of service in categories reflecting common UK lengths of military engagement as described in Section 3.2.2. Where clinically relevant for conditions sharing a common aetiology (for example, all cardiovascular disease; comprising acute myocardial infarction (AMI), stroke and peripheral arterial disease

(PAD)), disease groups were defined and created in order to increase statistical power, and the analyses were repeated to examine overall differences in outcomes between veterans and non-veterans. Changing patterns of disease by year of entry to service, for which the non-veteran comparator could not be used, were assessed using kernel density plots to provide a comparison with the overall number of personnel recruited in each year. Means and medians were calculated as appropriate for age at recruitment, length of service, age at diagnosis, age at death and length of follow-up, using the mean if the data were approximately normally distributed and the median for skewed data. Co-morbidities were examined for selected conditions, using odds ratios to explore differences between veterans and non-veterans. For certain conditions, including suicide, incidence per 100,000 person-years was calculated. All-cause case-fatality was calculated and, where appropriate, Cox proportional hazard models were used to compare the risk of death within specified periods (30 days, one year or five years) between veterans and non-veterans. Age at diagnosis was assumed to be normally distributed and has been presented graphically for some diagnoses, to facilitate comparison between veterans and non-veterans; length of follow-up after diagnosis was also assumed to be normally distributed. All analyses were performed using Stata v12.1 (©1985-2011 StataCorp); certain graphical material was prepared using Excel® 2007 (©2006 Microsoft Corp).

2.3.1.1 Rare Conditions

Some rare conditions are of military interest and/or importance and were included in the list identified for study by the stakeholders. Analysis of rare conditions in a retrospective cohort study is problematic (Ho et al. 2008) as the statistical power may be insufficient to generate statistically significant results, but Douglas Altman's statement that "To consider all non-significant results as indicating no effect of importance is clearly wrong" (Altman 1980) was taken as a guiding principle. Since the Scottish Veterans study was based on a 100% sample of all veterans meeting the inclusion criteria, increasing the sample size to increase power was not an option. Pragmatic and *ad hoc* analyses were therefore performed for the rarer conditions where small numbers of cases precluded valid survival analysis; if the results have indicated a possible difference between veterans and non-veterans, recommendations have been made for further investigation, for example by means of a nested case-control study.

2.3.1.2 Healthy Worker Effect

In recognition of the complexity of the healthy worker effect in military studies, as discussed further at Section 8.3.1.1, no attempt has been made to apply a correction for the healthy worker effect in the analysis of data from the Scottish Veterans Health Study, although its implications are considered in the interpretation of the data.

2.3.1.3 Unquantifiable Risk Factors

Although no data were available on risk factors such as smoking, alcohol intake, drug misuse or combat, the possible role of these has been inferred through examination of patterns of ill-health recognised as being associated with smoking, alcohol or drug misuse. The potential role of smoking was explored through patterns of AMI, lung cancer, oropharyngeal and laryngeal cancer, oesophageal cancer, COPD and peptic ulcer, whilst alcoholic liver disease, alcohol-related death, oropharyngeal and laryngeal cancer, and oesophageal cancer provided an indication of alcohol misuse. Drug misuse is discussed through patterns of risk of hepatitis B and hepatitis C. Although these conditions are not exclusively associated with smoking, alcohol and drugs respectively (with the exception of alcoholic liver disease and alcohol-related death), the occurrence of similar patterns of risk in two or more conditions enabled inferences to be drawn. Where feasible, the order of analysis broadly follows descending order of attributability to these risk factors, within the main chapter groupings. The possible role of combat exposure has been inferred from the period of service in relation to military history, for example high-intensity operations in Northern Ireland 1969-1972, when the majority of serving personnel were deployed there.

2.3.2 Spatial Analysis

Spatial analysis was performed using ArcGIS v.10.1. An extract of the dataset was used to create a personal geodatabase file (.mdb), which enabled conditions of interest to be mapped in order to investigate geographical patterns and explore comparisons with local incidence in the non-veteran group. Analyses were performed, where appropriate, at postcode district level, health board level or by grouped health boards. The health board groups were defined as: Ayrshire & Arran, Glasgow, Lanarkshire and Lothian, constituting the predominantly urban Central Belt (South); Argyll & Clyde, Fife, Forth Valley and

Tayside, constituting Central Belt (North) which was also mainly urban; and the more rural Borders, Dumfries & Galloway, Grampian, Highland, Orkney, Shetland and Western Isles health boards which together made up the Highlands, Islands and Borders group. Maps were generated for certain conditions, showing numbers of cases at postcode sector level, in order to highlight areas of local need and provide comparisons with non-veterans, and examples are presented at Appendix 5.

2.4 Interpretation

2.4.1 Philosophical Principles

Although descriptive epidemiology could provide a picture of veterans' health, interpretation of the results was essential in order for the outcome of the study to be of value to policy-makers and service providers.

> "A theory is just a model of the universe, or just a restricted part of it, and a set of rules that relate quantities in the model to observations that we make. It exists only in our minds, and does not have any other reality (whatever that might mean). A theory is a good theory if it satisfies two requirements: it must accurately describe a large class of observations on the basis of a model that contains only a few arbitrary elements, and it must make definite predictions about the results of future observations."[45]

As with all retrospective studies, a limiting factor was the scope of data available. The veterans' sample comprised 100% of those meeting the inclusion criteria, and probability matching had ensured the best possible data linkage. Incomplete or missing data would therefore remain incomplete; a data linkage study is inevitably constrained by the data which were originally included in the linked dataset, almost certainly developed for a purpose other than the study. This dictated a pragmatic study design which 'worked around' the constraints of the available data, but would inevitably present challenges in interpretation.

The theoretical framework underpinning the drawing of conclusions, making of predictions, or construction of explanations is known as logical reasoning. The

[45] Stephen Hawking, '*A Brief History of Time*'. Bantam Press, London etc. (1988)

development of a sound interpretive model required an understanding of its principles. There are three main models of logical reasoning; deductive, inductive and abductive.

2.4.1.1 Deductive Reasoning

Deductive reasoning starts with the assertion of a general rule and proceeds from there to a guaranteed specific conclusion. Deductive reasoning moves from the general rule to the specific application. If the original assertions are true, then the conclusion must also be true. Deductive reasoning is commonly used in mathematics[46].

2.4.1.2 Inductive Reasoning

Inductive reasoning begins with specific observations, and proceeds to a generalized conclusion that is likely, but not certain, in light of evidence discovered. Inductive reasoning moves from the specific to the general. The inductive approach leads to hypothesis generation, and is common in scientific research[47].

2.4.1.3 Abductive Reasoning

Abductive reasoning starts from an incomplete set of observations and proceeds to the most likely explanation, the 'inference to best explanation' (Lipton 2003). Abductive reasoning is particularly suitable for decision-making based on incomplete information, for example medical diagnosis or judicial enquiry.[48] Importantly, abductive reasoning allows triangulation of different perspectives in order to develop an integrated explanation (Eastwood et al. 2014).

2.4.1.4 Developing a Logical Framework

The Scottish Veterans Health Study was a novel study; no previous retrospective cohort study examining a wide range of health outcomes was identified which had been conducted on a large, national cohort of veterans spanning several decades of service, and several decades of birth dates, and was independent of length of service or participation in any specific conflict or combat. Accordingly, it was necessary to develop a

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[46] Adapted from 'Deductive, Inductive and Abductive Reasoning'. Butte College Center for Academic Success http://www.butte.edu/departments/cas/tipsheets/thinking/reasoning.html accessed 25 Jul 2014

[47] Ibid.

[48] Ibid.

novel methodology to interpret the results. In the absence of similar previous studies which might have generated pre-existing general hypotheses on the health of veterans in comparison with people who had never served, and which could be applicable to this cohort, the deductive approach was rejected as an overall framework. The approach selected was a combination of abductive and inductive reasoning, which allowed the most likely conclusions to be drawn from the emerging research findings. These were then used to generate a preliminary working hypothesis, which was further tested and refined as the data analysis progressed to develop the final thesis statement. Where evaluation of the emerging evidence suggested that more than one mechanism was involved, additional hypotheses were generated, following Chamberlin's principle of 'multiple working hypotheses' (Chamberlin 1890, Elliott and Brook 2007).

The development of an excessively complex model was a theoretical risk with a dataset comprising almost 230,000 study subjects and 140 variables. From a theoretical perspective, this would have contravened the principle of ontological parsimony, which dictates that among competing hypotheses, the one with the fewest assumptions should be selected[49] (Cleophas and Zwinderman 2013). More importantly, from a practical perspective, it would have made it difficult to understand and act on the key drivers of veterans' health, thus limiting the value of the study to policy-makers and providers and, ultimately, to the veterans themselves. Thus, the overarching aim was to develop a model for veterans' health which was both simple and widely generalisable.

2.5 Scheme of Presentation

2.5.1 Literature Review

The heterogeneity of veterans' studies, the predominance of conflict-specific[50] studies, and the large number of recent studies on veterans' mental health, dictated a targeted approach rather than a single generic literature review. Accordingly, a brief review of the literature relevant to the general background has been given in Chapter 1, with supplementary material in Appendices 1 to 3, and a series of focussed reviews of the relevant literature is presented as part of the Introduction, Discussion or Commentary for

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[49] Also known as *lex parsimoniae* or Occam's Razor, after the philosopher and theologian William of Ockham (c.1287-1347)

[50] As described at Section 1.6

each condition discussed in Chapters 4-7. Studies were selected for inclusion on the basis of their relevance to the issue under discussion, using appropriate search strategies followed by review of the abstracts and, where indicated, reading of the full papers. Where a consensus between authors was clear, only one or more representative papers were selected; where there was lack of consensus amongst researchers, an adequate number of references was included to reflect the competing views. Recent publications were chosen where available and relevant; review papers and meta-analyses were cited if available.

2.5.2 Results

A systematic approach was taken whereby 'core' analyses of cumulative incidence and Cox proportional hazard ratios, comparing veterans and non-veterans, are presented for each diagnosis or outcome as defined at Section 2.2.3.3 and Appendix 6; overall, by sex, by age, by birth cohort[51] and by length of service[52]. For some rare conditions, small numbers precluded subgroup analysis by birth cohort and/or length of service; where this was the case, these analyses have been omitted. Where differences between veterans and non-veterans were found in the 'core' analyses, additional focussed analyses such as period of service were undertaken to clarify the findings where appropriate; these are presented within the relevant subsection, or as an additional subsection. Geographical distribution was examined for conditions where the number of cases was sufficient to yield meaningful results. Age at diagnosis was compared for conditions where it was considered important to determine whether a difference existed between veterans and non-veterans, for example mental health and substance abuse-related conditions and outcomes, and neurological conditions, but was omitted where it would not have added materially to the understanding of veterans' health. Other than as described above, the full analysis is presented for each diagnosis or outcome deemed to be of *a priori* interest, whether or not differences were found between veterans and non-veterans. It was considered to be equally important to be able to demonstrate robustly that no difference

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[51] In 5-year groups, except for some rare conditions where 10-year groups were used. Where numbers were sufficiently large, a combined analysis of length of service and birth cohort (in two categories, pre-1960 and 1960 onwards) was also presented in order to clarify changing patterns over time.

[52] By common lengths of military engagement, including classification as Early Service Leavers, who were further subdivided into those who left before completing training, and those who completed training but left before completing the minimum term of engagement. Comparison is made against all veterans.

could be shown to exist as it was to identify differences; some conditions were widely believed to be more prevalent in the veterans' community but analysis of the data gave no cause for concern, whereas the identification of unexpected differences at subgroup level in other conditions has highlighted the need for further research.

Principal results have been presented graphically, and also in tabular form where there were sufficient numbers of cases and where the greater degree of granularity added clarity. Nelson-Aalen plots were used to compare cumulative hazards, thereby demonstrating the probability of having experienced the outcome under investigation by a given age, for both veterans and non-veterans. This was considered to be a more appropriate form of presentation than the Kaplan-Meier plot, which shows the survivor function and hence the likelihood of *not* having experienced the outcome under investigation. All Nelson-Aalen plots showing cumulative hazards by subgroup, and forest plots depicting hazard ratios by birth cohort[53], present univariate results unless otherwise stated or implicit from the context. For rare but potentially important conditions, where statistical power was limited, a graphical presentation has been used to highlight apparent differences between veterans and non-veterans. Ethical issues in respect of the presentation of small numbers have been discussed at Section 2.2.6; graphical presentation alone was used where small numbers rendered the underlying data potentially disclosive.

A table of, or commentary on, co-morbidities has been included for those diagnoses and outcomes where the literature indicated that co-morbidities may have an important role, or where there was a likelihood of shared aetiological factors.

2.5.3 Context

A study of veterans' health would be of limited value if it did not seek to place the findings into the wider context of military culture, ethos, operational activity or policy. Accordingly, a broad range of sources has been used to provide this contextual background, including legislation, military policy documents, information obtained from

[53] Error bars on forest plots are terminated with a short horizontal line; those which are unterminated have been truncated. Owing to software limitations, it was not possible to show truncated error bars with the convential arrowhead terminator.

the Ministry of Defence through specific Freedom of Information (FOI)[54] inquiry, published and unpublished dissertations, military historical sources and soldiers' and veterans' own narrative[55]. These sources have been used to inform the interpretation of the results and the implications for service delivery and military policy.

[54] Freedom of Information Act 2000. Chap.36

[55] Websites run by regimental associations and veterans' groups have provided a rich source of narrative, providing important qualitative information on such issues as alcohol use.

Chapter 3: Cohort Description

3.1 Aim

The aim of this chapter is to describe the baseline characteristics of the cohort and to make some preliminary observations on the patterns identified.

3.2 Veterans and Non-Veterans

3.2.1 Demographic Information

After data cleansing as described at Sections 2.2.8 and 2.2.9, the cohort comprised 228,946 people; 56,205 veterans and a comparison group of 172,741 people with no record of military service, matched for age, sex and last recorded postcode sector of residence. The main characteristics of the cohort are summarised at Table 3-1.

People with birth dates between 1 January 1945 and 31 December 1985 met the inclusion criteria for date of birth, and were thus aged between 27 and 67 years of age at the end of follow-up on 31 December 2012. The rationale for selection of this date range has been described at Sections 2.2.2.1 and 2.2.2.2. The composition of the study population stratified by birth cohort in 5-year bands is shown at Table 3-1. The smaller size of the later birth cohorts is a consequence both of the downsizing of the Armed Forces (Appendix 2, Section A2.1.1) and of more recently-joined personnel who are still serving. The smaller number of women than men reflects the gender balance of the Armed Forces.

Table 3-1 – Demographic characteristics of the cohort

	Veterans 56,205 n (%)	Non-veterans 172,741 n (%)
Sex		
Male	50,970 (90.7)	152,038 (88.0)
Female	5,235 (9.3)	20,703 (12.0)
Year of Birth		
1945-1949	8,194 (14.6)	24,867 (14.4)
1950-1954	10,052 (17.9)	28,856 (16.7)
1955-1959	11,463 (20.4)	32,706 (18.9)
1960-1964	10,392 (18.5)	31,651 (18.3)
1965-1969	8,764(15.6)	28,138 (16.3)
1970-1974	4,684 (8.3)	16,110 (9.3)
1974-1979	1,404 (2.5)	5,459 (3.2)
1980-1985	1,252 (2.2)	4,954 (2.9)
Vital Status[56]		
Alive or undetermined[57]	52,676 (93.7)	161,794 (93.7)
Dead	3,529 (6.3)	10,947 (6.3)
SIMD quintile		
1 (most deprived)	11,880 (21.3)	34,116 (19.8)
2	12,228 (21.9)	35,279 (20.5)
3	11,882 (21.3)	36,454 (21.2)
4	11,373 (20.4)	36,544 (21.2)
5 (least deprived)	8,468 (15.2)	29,971 (17.4)
Early Service Leavers[58]		
Male	12,798 (25.1)	N/A
Female	1,904 (36.4)	N/A

3.2.2 Veterans – Length of Service

Among all veterans, the mean length of service was 8.57 years (SD 7.98). For men the mean was 8.91 years (SD 8.13), and for women it was 5.35 years (SD 5.35). A kernel

[56] At the end of follow-up

[57] Deaths of individuals who have left Scotland but have a current health board cipher (ie have not deregistered from NHS Scotland) on the NHSCR record are notified to NHSCR if they occur in England or Wales. A current health board cipher was a requirement for inclusion in the cohort. Deaths of UK nationals occurring overseas are only notified to NHSCR if registered with the consular authorities. Around 15,000 people within the cohort age-group per year migrate out of Scotland to an overseas destination, equating to around 0.5% of the population; this group includes asylum seekers. Neither the number of individuals in the cohort who subsequently moved overseas, nor the period for which they remained overseas, can be quantified. The assumption has been made that there is no systematic difference between veterans and non-veterans in this respect, and that the number who died elsewhere, and were not notified to NHSCR, is unlikely to exceed 0.5% of deaths each year. [Based on information from NHSCR, and statistical data on migrations from NRS]

[58] As defined at Section 2.2.3.2

density plot (Figure 3-1) showed the length of service data to be highly skewed, with the majority of personnel serving for only a short time and a much smaller number going on to complete long service. Therefore, the median is a more appropriate statistic than the mean, notwithstanding that mean length of service is more often quoted in reports[59]. The median length of service was 6.25 years (IQR 2.17-12.24 years) overall. The median lengths of service by sex were 6.50 years (IQR 2.42-12.83 years) for men and 3.92 years (IQR 1.34-7.50 years) for women. In some of the Discussion sections, it has been necessary to use the mean, even where the median would have been more appropriate, for comparability with published studies.

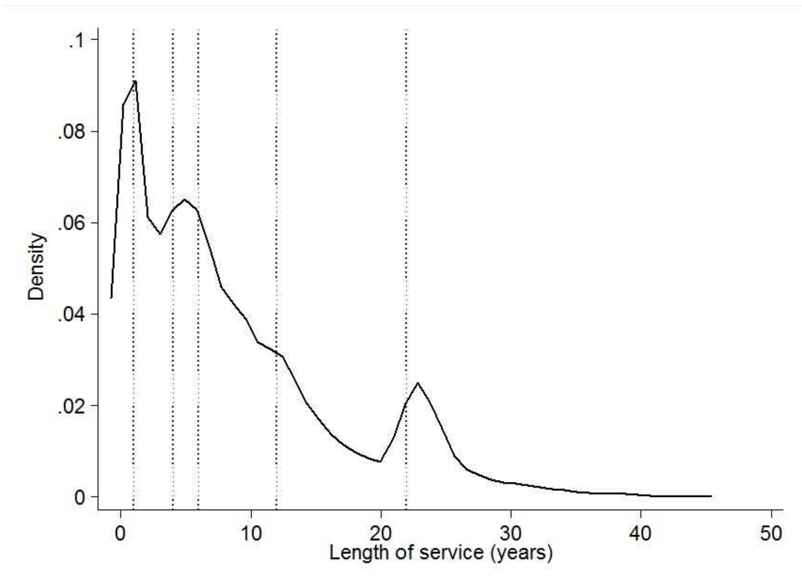

Figure 3-1 - Kernel density plot of length of service
Reference lines at 1, 3, 6, 12 and 22 years

Subgroup analysis by length of service was generally based on one of two classifications: a breakdown by the most common lengths of engagement, in 8 categories[60], and a simplified subdivision into four categories: two categories of Early Service Leaver[61] (ESL) and two categories of veterans who served for at least the minimum engagement,

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[59]For example, the study conducted on behalf of the Royal British Legion. Compass Partnership (2014) *A UK Household Survey of the Ex-Service Community*, London: Royal British Legion.

[60] Early Service Leavers still in training and trained; the Manning Control Points at 3, 6 and 12 years; and the 'full career' point of 22 years; with a subdivision of the long 13-22 year period into two categories 13-16 years and 17-22 years; with a further category for all those serving in excess of 22 years

[61] The term is defined by the Ministry of Defence. 'Early Service Leavers. Guidance Notes for Resettlement Staff'. JSP 575. Ministry of Defence (2010) (issue 4).

broadly corresponding to highest rank achieved[62] and to level of seniority and job responsibility.

Although no data were available on rank, there is an association between rank and length of service which is discussed more fully in Appendix 3, Sections A3.3.2 and A3.3.3. The assumption was made that the majority of people leaving after 3 years' service or less would not have progressed beyond their rank on entry. The 12-year point represents a career landmark; the majority of those leaving after 12 years' service or less would not have progressed beyond the rank of corporal or equivalent (NATO rank OR4) whilst that those leaving after more than 12 years are likely to have reached senior NCO or warrant rank (NATO rank OR5 to OR9) or to have been officers[63]. Those who leave after less than 12 years include officers on short service commissions; they could not be separately identified[64].

While the division into 8 categories facilitated the most precise assessment of the impact of length of service on health, it was only useful in the analysis of common conditions, where there were large numbers in the subgroups. For less common conditions it was necessary to use a simplified four-category breakdown in order to give adequate statistical power in the subgroups. For graphical presentations of the effect of length of service, only the four-category division was used, as the use of 8 categories resulted in excessively detailed graphs which lacked visual clarity. Nelson-Aalen cumulative hazard plots were used to show overall risk in specific conditions compared with all non-veterans, stratifying the veterans by; ESL status in two groups (discharged during training or completed training but discharged before completing initial engagement); completion of 4-12 years service; and over 12 years service. A third, binary categorisation of the veterans, either into ESL/non-ESL or stratified at the 12-year point, was employed in selected analyses, where it would add clarity.

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[62] Private soldier and equivalent for ESL, up to corporal and equivalent (junior management) for 4 to 12 years' service; senior non-commissioned officer, warrant officer, field officer and above (middle to senior management) with over 12 years' service.

[63] As at 1 April 2014, officers comprised 14.5% of the Army, 20.4% of the Naval Service and 22.3% of the Royal Air Force. Source: UK Armed Forces Annual Personnel Report. Ministry of Defence (2014).

[64] The long-term health outcomes of the officers included in this subgroup are likely to be better than those of the non-commissioned ranks. Ismail, K., Blatchley, N., Hotopf, M., Hull, L., Palmer, I., Unwin, C., David, A. and Wessely, S. (2000) 'Occupational risk factors for ill health in Gulf veterans of the United Kingdom', *Journal of Epidemiology and Community Health,* 54(11), 834-838. The effect would be to reduce the differences between veterans and non-veterans in this subgroup.

Table 3-2 and Table 3-3 show the number of veterans, overall and by socio-economic status, in each of the leaver categories in 8 and four groups respectively.

Table 3-2 - Veterans by length of service, in 8 categories, and socio-economic status

	Veterans n=56,205 (100%)					
	SIMD 1 n(%) (most deprived)	**SIMD 2 n(%)**	**SIMD 3 n(%)**	**SIMD 4 n(%)**	**SIMD 5 n(%)** (least deprived)	**Total n(%)**
Basic training	1,433 (2.5)	1,367 (2.4)	1,147 (2.0)	1,080 (1.9)	796 (1.4)	5,823 (10.4)
Up to 3 years[65]	3,119 (5.5)	2,877 (5.1)	2,405 (4.3)	2,046 (3.6)	1,509 (2.7)	11,956 (21.3)
4-6 years	2,499 (4.4)	2,494 (4.4)	2,214 (3.9)	2,096 (3.7)	1,507 (2.7)	10,810 (19.2)
7-9 years	1,570 (2.8)	1,677 (3.0)	1,606 (2.9)	1,535 (2.7)	1,148 (2.0)	7,536 (13.4)
10-12 years	1,082 (1.9)	1,197 (2.1)	1,234 (2.2)	1,226 (2.2)	908 (1.6)	5,647 (10.0)
13-16 years	865 (1.5)	933 (1.7)	1,010 (1.8)	962 (1.7)	636 (1.1)	4,406 (7.8)
17-22 years	636 (1.1)	767 (1.4)	977 (1.7)	966 (1.7)	761 (1.4)	4,107 (7.3)
>22 years	569 (1.0)	810 (1.4)	1,173 (2.1)	1,358 (2.4)	1,086 (1.9)	4,996 (8.9)
Total	11,773(20.9)	12,122 (21.6)	11,766 (20.9)	11,269 (20.0)	8,351 (14.9)	55,281 (98.4)[66]

Table 3-3 - Veterans by length of service, in 4 categories, and socio-economic status

	Veterans n=56,205 (100%)					
	SIMD 1 n(%) (most deprived)	**SIMD 2 n(%)**	**SIMD 3 n(%)**	**SIMD 4 n(%)**	**SIMD 5 n(%)** (least deprived)	**Total n(%)**
Basic training	1,433 (2.5)	1,367 (2.4)	1,147 (2.0)	1,080 (1.9)	796 (1.4)	5,823 (10.4)
Less than init. engagement[65]	2,323 (4.1)	2,125 (3.8)	1,759 (3.1)	1,494 (2.7)	1,093 (1.9)	8,794 (15.6)
4-12 years	5,151 (9.2)	5,368 (9.6)	5,054 (9.0)	4,857 (8.6)	3,563 (6.3)	23,993 (42.7)
>12 years	2,177 (3.9)	2,616 (4.7)	3,276 (5.8)	3,390 (6.0))	2,600 (4.6)	14,059 (25.0)
Total	11,084 (19.7)	11,476 (20.4)	11,236(20.0)	10,821 (19.3)	8,052 (14.3)	52,669 (93.7)[67]

[65] Excluding those who left in basic training

[66] Some data on socio-economic status were missing. Percentages are based on the entire dataset

[67] The smaller number of veterans in Table 3-3, compared with Table 3-2, reflects the omission of those with between 2.5 and 3.5 years' service, whose status as Early Service Leavers is uncertain owing to changes in the length of minimum engagement over time and between Services.

The positive association between ESL and poorer socio-economic status ($p<0.001$) was consistent with earlier studies (Buckman et al. 2013). However, whilst there was an overall gradient of higher socio-economic status with longer service, the data highlighted that long service was not necessarily associated with higher status and there was a small, but perhaps vulnerable, subgroup of veterans (1-2%) who, having completed a long career in uniform, were living in deprived circumstances (SIMD 1) post-service.

Because of the changes in length of minimum term of service, as described at Appendix 3, Section A3.3.3, for the avoidance of doubt a cut-off of 2.5 years was applied to analyses of health effects in ESL. This cut-off has always represented departure prior to completing the minimum term for the purposes of the study, although inevitably it results in the exclusion from some analyses of an 'indeterminate' group whose ESL/full engagement status could not be identified with confidence (3,182 people, 5.7% of veterans). It is likely that their health outcomes were intermediate between the 'trained' category of ESL and the group of non-ESL with the shortest service. The 'indeterminate' group was not excluded from any analyses other than those requiring classification by ESL status. Similarly, although there is (and historically has been) much variation in the duration of initial training, it was pragmatically defined as 0.4 years for the purposes of data analysis; this was considered to be a reasonably representative period.

Among the ESL as defined in the Scottish Veterans study[68], 12,798 were men (25.1% of all male veterans) whilst 1,904 were women (36.4% of all female veterans), an unadjusted odds ratio of 1.45, 95% CI 1.39-1.51 for women. This accords with Buckman et al.'s finding that women were more likely to be ESL than men, unadjusted odds ratio (OR) 2.22, 95% CI 1.20-4.09 (Buckman et al. 2013); a possible explanation for this will be presented in Section 5.37.3.

3.2.3 Veterans - Age at Entry and Discharge

Analysis of age at entry and discharge, by length of service, showed an inverse association between age at recruitment and length of service. The median age at recruitment was highest for Early Service Leavers who did not complete initial training, and lowest for the veterans who had the longest service (Table 3-4).

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[68] i.e. served for less than 2.5 years

Table 3-4 - Median age at entry and discharge, by length of service in 4 categories

Length of Service	Median age at entry (years)	IQR	Median age at discharge (years)	IQR
All veterans	18.1	16.8-20.4	26.0	21.6-32.4
Basic training	19.5	17.4-24.0	19.6	17.6-24.1
Trained ESL	18.0	16.7-20.4	19.3	17.9-21.7
4-12 years	18.1	16.9-20.1	25.9	23.4-28.6
>12 years	17.6	16.6-19.6	39.9	33.7-42.0

The inverse association between age at recruitment and duration of service was unexpected. It is plausible that those older recruits who became ESL had joined the Services after a period of unemployment; their poor pre-service employment record may have been a risk factor for failure to complete training or minimum engagement, as well as contributing to their later risk of ill-health (Hammarström and Janlert 2002). By contrast, those who were youngest at recruitment may have been more likely to have joined one of the junior entrant schemes (junior leader, apprentice or equivalent) as school leavers at age 15[69], 16 or 17 years. Initial training at one of the junior entrant units[70] is recognised by the Army as a fast track pathway to promotion[71]; this appears borne out by the finding of a positive association between longer service[72] and younger age at entry in the Scottish Veterans data, as are the benefits of progressing directly from school into further education and then full employment. Notwithstanding, there is pressure on the UK Government to phase out recruitment of minors (under 18 years of age) as part of a growing wave of international concern about 'child soldiers'[73].

3.2.4 Veterans and Non-Veterans – Geographical Distribution

Scotland is divided geographically into the generally urban Central Belt region, characterised by the major conurbations of Glasgow and Edinburgh and linked by the M8 motorway corridor, and the more rural Highlands, Islands and Borders. For the purposes

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[69] Prior to the raising of the UK school leaving age from 15 to 16 years in 1972.

[70] For the Army, now termed Army Foundation Colleges; the terminology has changed over time.

[71] 'Army Colleges for School-Leavers aged 16 to 17'. Army Recruiting Group, Ministry of Defence (2010). p.10.

[72] Generally associated with higher rank

[73] 'The recruitment of under 18s into the UK Armed Forces'. ForcesWatch briefing paper http://www.parliament.uk/documents/joint-committees/human-rights/Briefing_from_Forces_Watch_age_of_recruitment.pdf accessed 10 December 2014

of this study, the Central Belt was further subdivided into north[74] and south[75] regions, based on Health Board regions as described at Section 2.3.2. The majority of the cohort lived in the Central Belt region, whilst approximately 25% of the cohort lived in the Highlands, Islands and Borders regions. Details of area of residence and regional Health Board for veterans and non-veterans are shown at Table 3-5.

Table 3-5 - Geographical characteristics of the cohort

	Veterans 56,205 n (%)	Non-veterans 172,741 n (%)
Region		
Borders	2,777 (4.9)	9,184 (5.3)
Central Belt (South)	22,026 (39.2)	71,579 (41.4)
Central Belt (North)	19,738 (35.1)	57,872 (33.5)
Highlands	10,884 (19.4)	32,073 (18.6)
Islands	573 (1.0)	2,012 (1.2)
Not recorded	207 (0.4)	21 (<0.1)
Health Board		
Lothian	8,052 (14.3)	25,746 (14.9)
Grampian	7,740 (13.8)	22,232 (12.9)
Fife	6,469 (11.5)	17,338 (10.0)
Tayside	5,445 (9.7)	16,233 (9.4)
Glasgow	5,313 (9.5)	18,185 (10.5)
Argyll & Clyde	4,585 (8.2)	14,092 (8.2)
Lanarkshire	4,534 (8.1)	14,661 (8.5)
Ayrshire & Arran	4,127 (7.3)	12,987 (7.5)
Forth Valley	3,239 (5.8)	10,209 (5.9)
Highland	3,144 (5.6)	9,841 (5.7)
Dumfries & Galloway	1,691 (3.0)	5,533 (3.2)
Borders	1,086 (1.9)	3,651 (2.1)
Western Isles	256 (0.5)	881 (0.5)
Orkney	159 (0.3)	572 (0.3)
Shetland	158 (0.3)	559 (0.3)
Not recorded	207 (0.4)	21 (<0.1)

The availability of the postcode district for each individual enabled the location of veterans to be mapped, as described at Section 2.3.2. The initial mapping was

[74] Corresponding to Argyll & Clyde, Fife, Tayside and Forth Valley Health Board regions

[75] Corresponding to Ayrshire & Arran, Glasgow, Lanarkshire and Lothian Health Board regions

undertaken as part of the pilot study and has already established its value as an aid to needs assessment[76], as discussed at Appendix 3, Section A3.4.3.

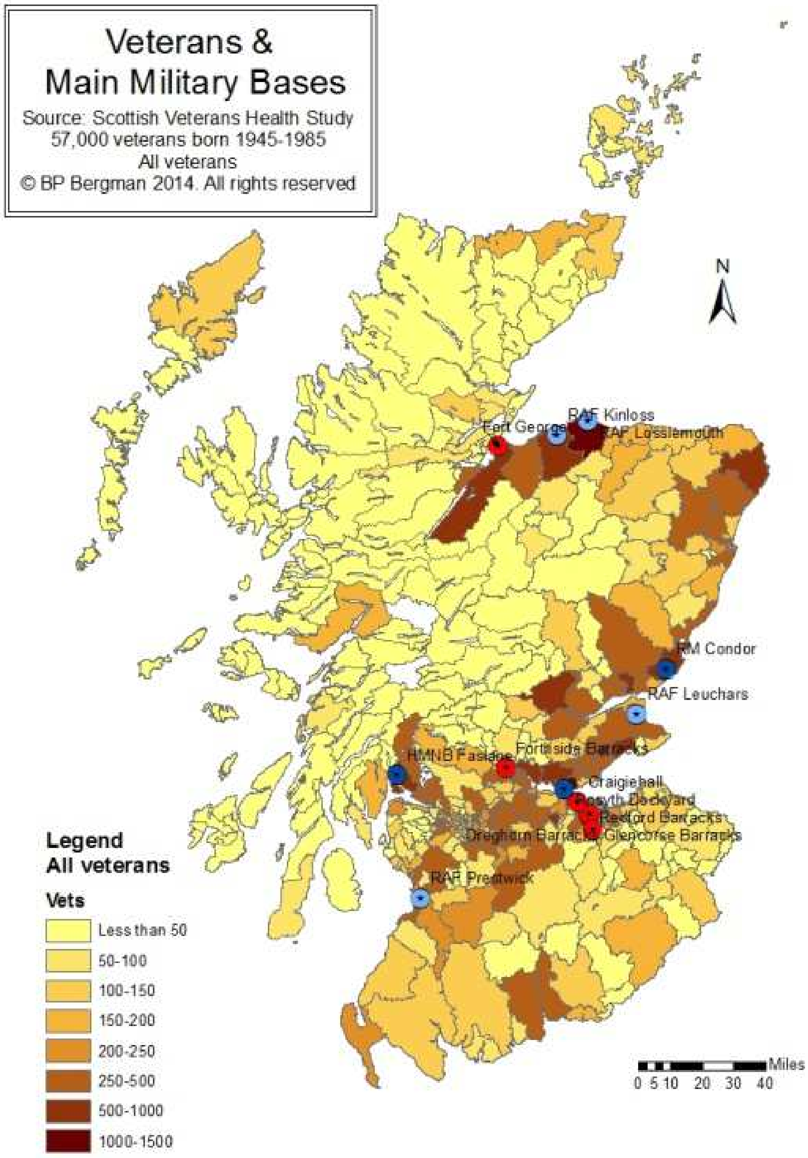

Figure 3-2 - Locations of veterans and main military bases
(red – Army, dark blue – Naval Service, light blue – Royal Air Force)

Figure 3-2, showing absolute numbers, demonstrates that veterans tended to be clustered around the main military bases and the nearest major towns and cities. The Scottish Veterans dataset has also facilitated the creation of more detailed maps showing the location of veterans with specific conditions; examples are included at Appendix 5. As

[76] "New map to help services for veterans". Service Personnel and Veterans Agency, 27 October 2011. http://servicepersonnelandveteransagency.blogspot.co.uk/2011/10/new-map-to-help-services-to-veterans.html accessed 9 December 2014.

the maps are postcode-based, care must be taken that the modifiable areal unit problem (Páez and Scott 2005) does not lead to inappropriate conclusions being drawn. The modifiable areal unit problem is a source of bias which results from the effect of using zones of differing sizes (postcode boundaries) and population densities. For example, the large, sparsely-populated IV36 (Forres and Kinloss) postcode district has the appearance of representing a larger group of veterans than the geographically smaller but more densely populated EH54 (Livingston) district, although it has 644 veterans, similar to the 652 veterans resident in EH54.

3.3 Mortality

Since the age of the cohort ranged from 27 to 67 years at the end of follow-up, most deaths represented premature mortality. By the end of follow-up, 3,529 (6.28%) veterans had died, compared with 10,947 (6.32%) non-veterans. The Cox proportional hazard model demonstrated that the difference in all-cause mortality was not statistically significant, either unadjusted (HR 1.02, 95% CI 0.98-1.06, p=0.387) or after adjusting for deprivation (HR 0.97, 95% CI 0.93-1.01, p=0.097). The mean age at death was 51.9 years (SE 0.14) for veterans and 49.9 years (SE 0.09) for non-veterans, and one-way ANOVA demonstrated the difference to be statistically significant, p<0.001. Analysis of specific causes of death will be presented in subsequent chapters.

3.4 Commentary

The Scottish Veterans Health Study cohort was broadly comparable with the veteran population described in the 2014 study carried out for the Royal British Legion[77], albeit that the latter covered a wider range of ages and periods of service. Less than 3 years' service was reported in 37% of the RBL veterans, compared with 31.5% of the Scottish veterans; it is likely that the difference arose from a greater percentage of the RBL cohort, which included older veterans, having served at a time when the minimum engagement was only 3 years. This would also have had the effect of reducing the mean length of service, 7 years in the RBL study compared with 8.6 years in the Scottish Veterans study. Women made up 11.2% of the RBL veterans, compared with 9.3% of the Scottish

[77] Compass Partnership (2014) *A UK Household Survey of the Ex-Service Community*, London: Royal British Legion.

Veterans group and 12% of the non-veteran comparison group[78]. Comparison based on socio-economic status was not possible as the classification used in the RBL study[79] could not be mapped to SIMD categories.

[78] The difference in the percentage of women between the veterans and the matched non-veterans group in the Scottish Veterans Health Study cohort arises from differences in the number of duplicate individuals (later eliminated) who were selected by the automated matching process

[79] For example, Category E in the RBL study was applied to any household where the chief income earner was entirely dependent on state benefits (including State Pension), unemployed for more than 6 months or a casual worker with no regular income.

Chapter 4: Cardiovascular Disease

4.1 Introduction

The term 'cardiovascular disease' encompasses a group of diseases including coronary heart disease (CHD), stroke (Yusuf et al. 2001) and PAD (Diehm et al. 2004, Bakhai 2004). It is a major cause of morbidity and mortality in developed nations (Yusuf et al. 2001). The terms CHD, ischaemic heart disease (IHD), coronary artery disease and, especially in older publications, arteriosclerotic or atherosclerotic heart disease, are used interchangeably; where possible, in citing published works, the authors' original terminology has been retained. IHD is the leading cause of mortality worldwide, accounting for 12.9% of all deaths in 2011 (World Health Organisation 2013), and it has been estimated that 7 million people suffer an AMI each year (White and Chew 2008). Risk factors encompass genetic, environmental and lifestyle factors including family history, tobacco smoking, alcohol misuse, physical inactivity, obesity, type 2 diabetes and hypertension (O'Donnell and Elosua 2008). The role of stress is less clearcut (Steptoe et al. 1996) but it is widely believed to be a risk factor. A positive association between all major mental health disorders and cardiovascular disease is well documented (Keyes 2004, Osborn and Levy 2007).

4.2 Aim

The aim of this chapter is to explore the risk of cardiovascular disease (as measured by AMI, stroke and PAD), separately and overall, in veterans compared to people with no record of service, in order to examine patterns of risk in specific subgroups, to identify trends over time, and to postulate reasons for any differences identified.

4.3 Overview

The Scottish Veterans Health Study examined cardiovascular morbidity and mortality in a large, national cohort of veterans spanning over 50 years of service and 30 years of follow-up, as described in Chapter 3. Records were available for hospitalisation and death for three major cardiovascular diagnoses; AMI, stroke, and PAD.

4.4 Military Cardiovascular Risk

Military personnel present a mixed picture for cardiovascular risk (Bergman et al. 2014b); they generally benefit from a higher level of physical activity during service (although this varies with trade or occupational group), but are known to have a higher prevalence of smoking than their civilian peers (Brown 2010) although the difference has changed over time (Lewthwaite and Graham 1992). Paradoxically, military personnel and veterans have been shown to be more likely to exhibit unfavourable health behaviours than those who have never served (Hoerster et al. 2012). Diet during service is likely to have been relatively high in energy, in accordance with the needs and choices of a predominantly young, physically active population (Andersen et al. 1995, Edholm et al. 1970), especially for earlier generations of veterans, but diet post-service may be influenced more by family and societal norms. In-service nutrition, and research on the prevalence of obesity in serving personnel and veterans, are discussed in more detail in Appendix 3, and the use of tobacco in the Armed Forces is explored in Appendix 4. Achieving health behaviour change in young people presents challenges (Gibbons and Gerrard 1995), especially in military personnel who are known to exhibit higher levels of risk-taking behaviour (Verrall 2011). Nonetheless, physical exercise and obesity avoidance are in keeping with the military ethos (Crowdy 1987). Risk factors such as type 2 diabetes or severe hypertension are unlikely to affect serving personnel to any large extent, as they are likely to lead to medical discharge, but they will contribute to risk in the veteran population, as will cases developing after leaving service. No studies have been identified which examine their prevalence in UK veterans.

A review of cardiovascular risk factors in US military personnel examined known risk factors in relation to the serving population, and cited a number of studies reporting an association between war-related stressors and acute cardiac events, whilst noting significant gaps in the literature on cardiovascular risk assessment in military personnel (McGraw et al. 2007). As early as 1990, Blanchard predicted a "wave of cardiovascular and other diseases" as the Vietnam-era cohort ages (Blanchard 1990), predominantly in relation to the well-documented association between post-traumatic stress disorder and cardiovascular disease (Bedi and Arora 2007, Coughlin 2011). Long-term follow-up has indeed indicated higher cardiovascular mortality among Vietnam veterans with PTSD, HR 1.7, p=0.034 (Boscarino 2006), although perhaps at a lower level than was anticipated by

Blanchard (Blanchard 1990). Traumatic lower limb amputation is a risk factor for IHD; in a major study of US veterans of World War 2 followed up for 31 years, there was a relative risk for cardiovascular mortality of 1.58, $p<0.001$ for unilateral above-knee amputation and 4.00, $p<0.01$, for bilateral above-knee amputation, compared with controls with disfigurement only (Hrubec and Ryder 1980). A review by Naschitz and Lenger found the increased risk to be consistent across a number of studies, and in addition an increased risk of abdominal aortic aneurysm has been demonstrated. Both haemodynamic changes and altered lifestyle have been postulated as explanatory factors (Naschitz and Lenger 2008).

Other than the studies that have been published on cardiovascular outcomes in military veterans who have taken part in specific conflicts or who have been exposed to hazardous agents (Boscarino 2008, Kang and Bullman 2009) or undergone amputation (Hrubec and Ryder 1980), there is a paucity of studies examining long-term cardiovascular outcomes in a general population of veterans to assess the net effect of all aspects of military service. In one of the few such studies identified, Brown reported an age-adjusted prevalence of self-declared CHD of 6.5% in US male veterans compared with 5.5% in male non-veterans, with comparative rates for females of 4.5% and 3.5% respectively, using data from the CDC Behavioral Risk Factors Surveillance Study (BRFSS) (Brown 2010). Hoerster reported a prevalence of 20.9% for all cardiovascular disease in male veterans, using the same dataset, compared with 6.4% for male non-veterans (Hoerster et al. 2012). A study of long-term mortality in Australian veterans of the 1951 Korean War found increased mortality from IHD in those who had served in the Army and Navy although not in former Air Force personnel (Harrex et al. 2003). This paucity of research is surprising as UK studies in the early 1980s highlighted increased cardiovascular risk amongst serving military personnel (Lynch and Oelman 1981, Lynch 1985), and it might have been expected that follow-up studies would be performed to investigate whether they remained at risk in later life. The Scottish Veterans Health Study therefore provided an opportunity to examine long-term cardiovascular outcomes in veterans with a wide range of military experience.

4.4.1 Smoking and Cardiovascular Disease

The earliest suggestion of an association between smoking and coronary artery disease appears to have been made in 1934 when an increased incidence of coronary disease was noted in Europe in the years following the First World War, coinciding with an increase in smoking rates (Lakier 1992). The first major epidemiological study was published in 1958 and examined death rates in a cohort of 187,783 men followed for 44 months; a mortality ratio of 1.68 was found for all-cause deaths in cigarette smokers compared with non-smokers. There was a strong dose-response relationship with a ratio of 1.34 for those smoking less than half a pack[80] per day, rising to 2.23 in men smoking two or more packs per day, compared with non-smokers. A quarter of the excess deaths were due to cancer and half the excess to coronary artery disease (Hammond and Horn 1958).

Evidence for an association between smoking and CHD continued to accrue and, by 1983, a report by the US Surgeon General presented the results of five major cohort studies, including the Framingham study[81], which showed a risk ratio for incidence of CHD ranging from 2.2 to 3.3 for smokers using more than one pack per day compared with light smokers, pipe/cigar smokers and non-smokers. Epidemiological studies covering over 20 million person-years of exposure in a variety of national settings were reviewed and showed a high degree of consistency, with smokers overall experiencing a 70% higher risk of CHD mortality than non-smokers. The excess risk for CHD was independent of other risk factors (Shopland 1983).

In the UK, a review of 20-year mortality in the British male physicians' study demonstrated a 37% higher IHD mortality in all smokers (including pipe and cigar smokers, who may be at lower risk) than in non-smokers (Doll and Peto 1976). This high-quality study, using a large sample (34,000) with almost complete follow-up, and diagnoses confirmed from death certificates, also demonstrated a highly significant gradient in IHD mortality ($p<0.001$) from non-smokers through light smokers to heavy

[80] In the 1950s the standard pack size was 10 cigarettes, as opposed to the modern pack which normally contains 20 cigarettes, although the tar and nicotine content was higher. Ten cigarettes in the 1950s had approximately the same nicotine content as 25 modern cigarettes and the same tar content as 34 modern cigarettes [nicotine and tar data from International Smoking Statistics http://www.pnlee.co.uk/ISS.htm accessed 18 December 2012].

[81] The US Framingham study was set up in 1948 under the direction of the then National Heart Institute to monitor the cardiovascular health of 5,209 adults who were in good health at baseline. It remains in progress and now encompasses the children and grandchildren of the original cohort.

smokers, with an annual mortality rate of 413 per 100,000 in non-smokers, 608 per 100,000 in people smoking less that 15 cigarettes per day and 792 in those smoking 25 or more per day. The reduction in IHD mortality after stopping smoking was variable but the greatest benefit was seen in the youngest ex-smokers. After 15 or more years as an ex-smoker, the ratio of the number of observed deaths in ex-smokers to the number which would have been expected in non-smokers was 1.3 in men aged 30-64, falling from 3.5 at baseline in men aged 30-54 and 1.7 in men aged 55-64. The small number of study subjects who stopped smoking before the age of 30, after smoking for an average of 7 years, showed a similar all-cause mortality rate to non-smokers. The authors categorised the level of evidence for attributability of the observed excess IHD mortality as "2A[82] – Probably wholly or partly attributable to smoking", the uncertainty arising largely in respect of the older age groups. A follow-up study at the 50-year point demonstrated a gain in life expectancy of 10 years after stopping smoking at age 30 years, reducing with age at cessation although even at age 60 years there was a gain of 3 years of life (Doll et al. 2004). Although stopping smoking reduces cardiovascular risk, the benefit increasing with time (Ockene and Miller 1997), levels of CRP, a marker of inflammation known to be related to cardiovascular risk, remain strongly correlated to pack-years smoked even in old age, irrespective of time since smoking cessation (Tracy et al. 1997).

4.4.1.1 Environmental Tobacco Smoke

The first reports of the adverse health effects of environmental tobacco smoke (ETS) exposure were in relation to lung cancer, and the association between ETS and IHD was not recognised until much later. One of the earliest studies to identify an association followed a cohort of 91,909 individuals recorded in a private census in Maryland, USA for 12 years from 1963. The study demonstrated a relative risk for deaths from arteriosclerotic heart disease in non-smoking men with household exposure to ETS of 1.31, 95% CI 1.1-1.6, and for women, RR = 1.24, 95% CI 1.1-1.4. Men aged 25-44 exposed to high levels of ETS were found to be at greatest risk (RR 5.70, 95% CI 1.5-21.4) (Helsing

[82] Categorisation by levels of evidence is a fundamental tenet of evidence-based medicine. Many authors and organisations have developed systems to categorise levels of evidence; that used by Doll and Peto is described at Table XII of their paper. Burns, P. B., Rohrich, R. J. and Chung, K. C. (2011) 'The levels of evidence and their role in evidence-based medicine', *Plastic and Reconstructive Surgery,* 128(1), 305. Doll, R. and Peto, R. (1976) 'Mortality in relation to smoking: 20 years' observations on male British doctors', *British Medical Journal,* 2(6051), 1525-1536.

et al. 1988). A Scottish study followed up 16,171 healthy middle-aged adults to 1982 after establishing their smoking pattern at baseline in 1972 and noted that myocardial infarction was more common in both men and women exposed to ETS, although the study had a number of methodological limitations including self-reporting of ETS exposure, small numbers of incident disease and deaths, and the absence of any tests of statistical significance from the data analysis (Gillis et al. 1984). The first UK cohort study to use salivary cotinine as an objective measure of ETS exposure was the British Regional Heart Study; this demonstrated an 86% fall in cotinine levels in non-smokers over 20 years, from 1978-1980 to 1998-2000. The percentage of men with a cotinine level previously found to be associated with low cardiovascular risk rose from 27% to 83% over the same period (Jefferis et al. 2009). A study of Norwegian Army conscripts showed that although the prevalence of smoking was 51%, 91% were exposed to ETS in dormitories (Schei and Sogaard 1994), suggesting that even non-smoking military personnel may have experienced substantial exposure to tobacco from this source. There is evidence from the EPIC[83] study that exposure to ETS is more harmful to former smokers than to never-smokers (Vineis et al. 2005), which may be especially relevant to military (and, by extension, veteran) populations where a high percentage are former smokers (Figure 8-4) (Lodge 1991).

A meta-analysis of 19 studies examining the risk of IHD in never-smoking spouses of smokers demonstrated a relative risk of 1.30, 95% CI 1.22-1.38, $p<0.001$, and noted that earlier, smaller meta-analyses had found similar results (Law et al. 1997). The excess risk associated with inhaling ETS was approximately half the excess risk which would result from smoking 20 cigarettes per day although the exposure[84] equates to only about 1% of that experienced by a smoker. In order to try and explain this disproportionate risk, the authors assessed possible confounders and sources of bias. They dismissed publication bias as requiring an implausibly large number of studies, and assessed the role of diet, body mass index, social class, blood pressure and serum cholesterol to be insufficient to explain the findings. They examined dose-response relationships in five major studies and concluded that although the risk of IHD increased with number of cigarettes smoked, the relationship was non-linear and extrapolation back to zero dose did not yield a RR of

[83] European Prospective Investigation into Cancer and Nutrition.

[84] As measured by nicotine; may differ for other components of cigarette smoke

1.0; the weighted average risk of smoking one cigarette per day was 1.38, 95% CI 1.18-1.64, p<0.001, increasing to a RR of 1.78 at 20 cigarettes per day. The authors hypothesised that platelet aggregation would explain IHD not only in smokers but also in those inhaling ETS, on the basis of experimental studies on platelet aggregation demonstrating an immediate increase in risk of IHD of 43% for smoking and 34% for ETS, close to the observed excess risk (Law et al. 1997). This was disputed by Smith and co-workers (Smith et al. 2000) who considered that it was inconsistent with the biochemistry and physiology of platelets. Ahijeviych and Wewers have summarised the evidence and concluded that the mechanism is multifactorial; increased platelet aggregation plays a part, as does reduced oxygen transport due to elevated carbon monoxide levels. Coronary artery endothelial dysfunction has also been shown to occur following ETS inhalation and is especially important as it is associated with an increased risk of atherosclerosis (Ahijevych and Wewers 2003). Furthermore, ETS is predominantly composed of sidestream tobacco smoke, which carries a higher content of volatile agents than does the mainstream smoke inhaled by the smoker (Brunnemann et al. 1977). Studies of biomarkers have confirmed the disproportionately higher cardiovascular risk which arises from the inhalation of even low concentrations of ETS, compared with actively smoking (Lu et al. 2014).

4.5 Implications for the Hypothesis

The pattern of cardiovascular disease in serving personnel during the 1960s and 1970s (Appendix 3), and the well-documented high prevalence of military smoking during this period (Appendix 4), suggested that an increased risk of cardiovascular disease may be found in veterans compared with non-veterans. It was possible that this could be mitigated by higher exercise levels in the veterans but the net effect, including the impact of factors arising before and after service, could not be predicted. An examination of the risk of cardiovascular disease in veterans would inform the evolution of the hypothesis on the net impact of military service on health.

Results

4.6 Acute Myocardial Infarction

AMI was defined as ICD-9 code 410 or ICD-10 code I21, at any position in the record.

4.6.1 Incidence

4.6.1.1 Overall

The risk of AMI was higher among veterans than non-veterans (Figure 4-1). Over the follow-up period of 32 years, 2,106 veterans experienced a first episode of AMI, compared with 5,261 non-veterans, equivalent to a cumulative incidence of 3.8% and 3.1% respectively. Cox proportional hazard analysis confirmed the higher risk in veterans, HR 1.22, 95% CI 1.16-1.29, p<0.001 in the unadjusted model. Testing for non-proportionality of the hazards was non-significant, p=0.211. The difference remained after adjustment for socio-economic status (SES), adjusted HR 1.18, 95% CI 1.12-1.24, p<0.001. The overall mean age at first AMI was 50.5 years for both veterans and non-veterans, SD 7.7 and 7.9 respectively.

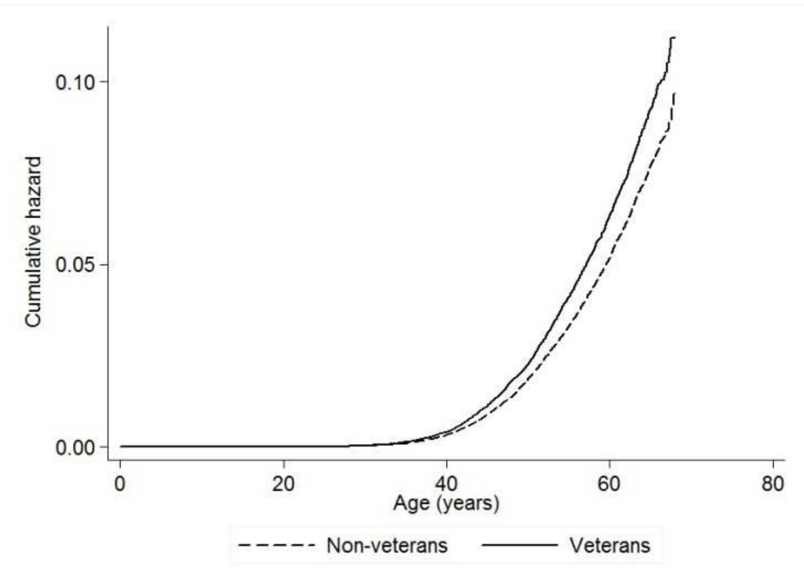

Figure 4-1 - Nelson-Aalen plot of AMI by veteran status

4.6.1.2 Sex

Subgroup analysis stratifying by sex showed an increased risk of AMI in men, with 2,071 (4.06%) first episodes among the male veterans compared with 5,102 (3.36%) in the male non-veterans, unadjusted HR 1.21, 95% CI 1.15-1.27, p<0.001. The difference persisted after adjusting for SES, HR 1.17, 95% CI 1.11-1.23, p<0.001. There were only 35 (0.7%) female veterans who experienced a first AMI compared with 159 (0.8%) female non-veterans. This represented a non-significant reduction in risk in the veteran women, both univariately (HR 0.90, 95% CI 0.62-1.29, p=0.559), and following adjustment for SES (HR 0.88, 95% CI 0.61-1.27, p=0.489).

4.6.1.3 Birth Cohort

Analysis of risk of AMI by birth cohort demonstrated an overall reducing trend over time. There was a statistically significantly increased risk in veterans born between 1945 and 1959 in comparison with non-veterans, but no difference between veterans and non-veterans for those born from 1960 to 1964 and a non-significantly reduced risk in those born 1965-1985 (Figure 4-2). The birth cohort effect remained after adjusting for the confounding effect of SES.

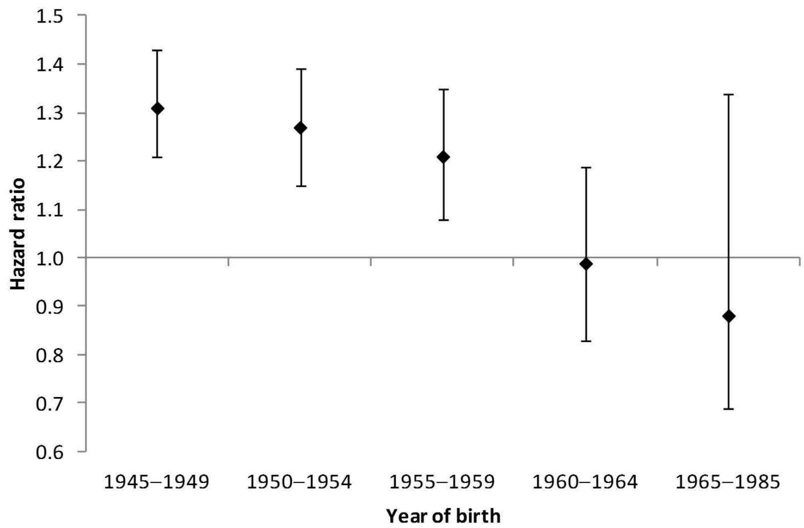

Figure 4-2 - Hazard ratios for AMI by birth cohort
Veterans referent to non-veterans

Analysis by time-varying covariate using year of birth as the covariate confirmed this trend. There was no difference in age at first AMI between the veterans and non-veterans when stratified by birth cohort (Table 4-1).

Table 4-1 - Mean age at first AMI, stratified by birth cohort

Birth year	Veterans			Non-veterans		
	Cases n	Mean age (years)	SD	Cases n	Mean age (years)	SD
Overall	2,106	50.54	7.66	5,261	50.54	7.88
1945-1949	766	53.81	7.85	1,819	54.89	7.38
1950-1954	629	51.03	6.81	1,465	51.45	6.83
1955-1959	456	48.30	5.97	1,102	48.17	6.04
1960-1964	178	45.49	4.79	573	45.09	4.96
1965-1985	77	39.48	5.25	302	39.78	5.36

The trend demonstrated in the birth cohort analysis was further tested by plotting crude incidence of AMI by year of birth. Figure 4-3 shows that the crude incidence was higher in the veterans for all those born from 1945 to 1958, but veterans born from 1959 onwards showed no difference from non-veterans.

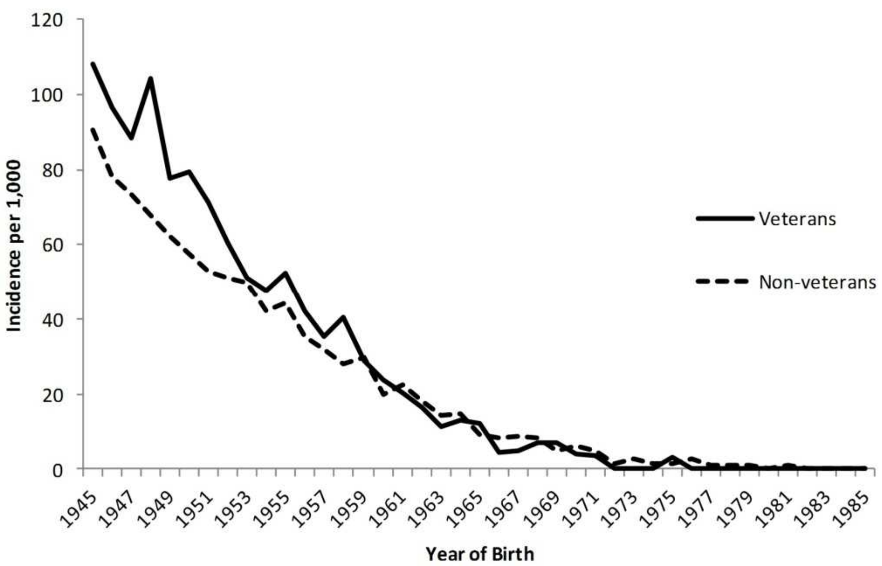

Figure 4-3 - Incidence of AMI by year of birth
Veterans and non-veterans

4.6.1.4 Length of Service

Analysis by length of service showed the highest risk to be in the two categories of Early Service Leaver, whilst the risk in veterans with the longest service was similar to that of all non-veterans. Veterans with between 4 and 12 years' service were at elevated risk compared with non-veterans, but their risk was lower than for ESL (Figure 4-4).

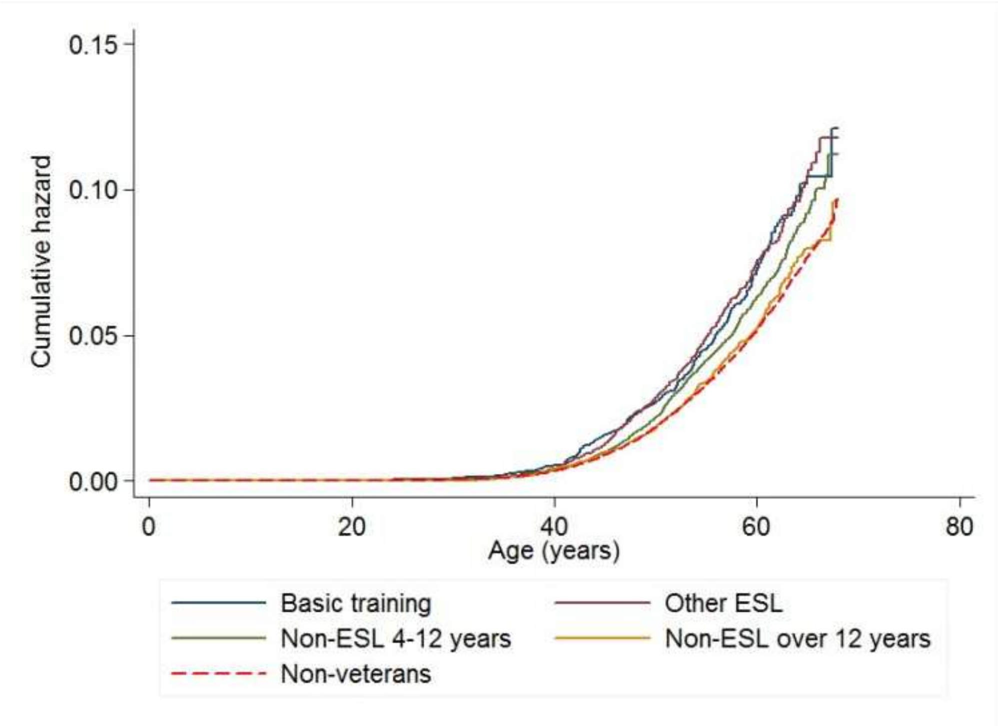

Figure 4-4 - Hazard ratios for AMI by length of service
All non-veterans for comparison

4.6.2 Geographical Distribution

Analysis by geographical area of residence based on Health Board regions showed the increased risk in veterans to be consistent across all areas (Table 4-2).

Table 4-2 - Cox proportional hazard model of the association between veteran status and risk of AMI, stratified by geographical region

Region	Veteran cases	Univariate			Multi-variable[85]		
	n	HR	95% CI	p	HR	95% CI	p
Overall	2,106	1.22	1.16-1.29	<0.001	1.18	1.12-1.24	<0.001
Central Belt (South)	908	1.25	1.15-1.35	<0.001	1.20	1.11-1.30	<0.001
Central Belt (North)	751	1.23	1.10-1.34	<0.001	1.20	1.10-1.30	<0.001
Borders, Highland & Islands	446	1.22	1.09-1.36	0.001	1.21	1.08-1.35	0.001

[85] Adjusted for SES

4.6.3 Case-Fatality

The mean follow-up from date of diagnosis of AMI to the date of death or the end of the study on 31 December 2012 was 7.39 years (range 0-31.71 years) for veterans and 6.61 years (range 0-31.94 years) for non-veterans, representing 15,563 person-years of follow-up in the veterans and 34,775 person-years in the non-veterans. There were 576 (27.4%) deaths in veterans with AMI, equating to 37.0 per 1,000 person-years, and 1,483 (28.2%) deaths in non-veterans (42.6 per 1,000 person-years).

Myocardial infarction accounted for the deaths of 386 (18.3%) veterans with a history of AMI compared with 974 (25.8%) of the non-veterans. Veterans were at lower risk of immediate death from the first episode of AMI (defined as date of death = date of first AMI, and cause of death = AMI), with 292 (13.9%) experiencing a fatal outcome on the day of the event compared with 830 (15.8%) of the non-veterans, OR = 0.89, 95% CI 0.81-0.99, p=0.039. Thirty day case-fatality was significantly lower among veterans, HR 0.87, 95% CI 0.76-0.98, p=0.028 in the univariate model. One-year and five-year case-fatality rates were also lower among veterans (Table 4-3). The differences were similar after adjusting for deprivation. On subgroup analysis, the effect was confined to older veterans, born prior to 1960. When analysed geographically, the lower 30-day case-fatality in veterans was only seen in the predominantly urban Central Belt, and not in the more rural Borders, Highlands and Islands (Table 4-4).

Table 4-3 - Cox proportional hazard model of the association between veteran status and 30-day, one year and five year case-fatality following AMI

		Univariate			Multi-variable	
Case-fatality	**HR**	**95% CI**	**p**	**HR**	**95% CI**	**p**
30 days	0.87	0.76- 0.98	0.028	0.86	0.76-0.98	0.025
1 year	0.88	0.78-1.00	0.047	0.88	0.78-1.00	0.042
5 years	0.87	0.77-0.97	0.012	0.86	0.77-0.96	0.009

Table 4-4 - Cox proportional hazard model of the association between veteran status and 30-day case-fatality following AMI, overall and stratified by geographical region, sex and birth year

		Univariate			Multi-variable	
	HR	95% CI	p	HR	95% CI	p
Overall	0.87	0.76-0.98	0.028	0.86	0.76-0.98	0.025
Region						
Central Belt (North & South)	0.84	0.72-0.97	0.015	0.84	0.72-0.97	0.015
Borders, Highland & Islands	1.07	0.81-1.43	0.621	1.06	0.80-1.41	0.680
Sex						
Men	0.87	0.76-0.99	0.033	0.87	0.76-0.99	0.030
Women	0.94	0.42-2.11	0.876	0.91	0.40-2.05	0.813
Birth year						
1945-1959	0.83	0.73-0.95	0.008	0.83	0.72-0.95	0.006
1960-1985	1.08	0.73-1.59	0.704	1.09	0.73-1.61	0.680

4.7 Stroke

Stroke was defined as ICD-9 code 430-432, 434 or 436, or ICD-10 code I60-I64, at any position in the record.

4.7.1 Incidence

4.7.1.1 Overall

For stroke, a landmark analysis beginning at age 40 was performed in order to minimise confounding by acute cerebrovascular events of non-atheromatous origin in younger people. A total of 77 veterans and 292 non-veterans experienced a cerebrovascular event prior to age 40 years and were excluded. During the 32 year period of follow-up, 466 veterans experienced a first episode of stroke from age 40 years, compared with 1,159 non-veterans, equivalent to a cumulative incidence of 0.83% and 0.67% respectively. The difference was statistically significant, unadjusted HR 1.21, 95% CI 1.09-1.35, p=0.001 (Figure 4-5). Testing for non-proportionality of the hazards was non-significant, p=0.639.

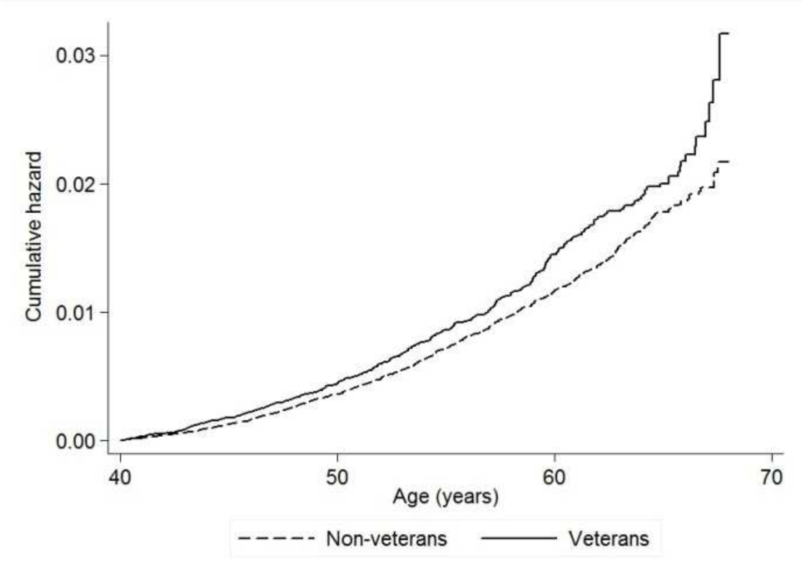

Figure 4-5 - Nelson-Aalen plot of stroke by veteran status
Landmark age 40 years

4.7.1.2 Sex

Stroke was more common in men than in women, in both veterans and non-veterans. There were 441 (0.87%) cases in male veterans compared with 1,061 (0.70%) in male non-veterans, a statistically significant difference, unadjusted HR 1.22, 95% CI 1.09-1.36, p=0.001. For women, there were 25 (0.48%) cases in veterans compared with 98 (0.47%) cases in non-veterans. The difference in women was not significant, unadjusted HR 1.03, 95% CI 0.67-1.60, p=0.884. The hazard ratios were similar after adjusting for deprivation.

4.7.1.3 Birth Cohort

Analysis by birth cohort showed the increased risk of stroke to be confined to veterans born between 1945 and 1954, with the greatest increase in risk in the 1950-1954 cohort. There was no difference in risk for veterans born between 1955 and 1964, and a non-significant reduction in risk for veterans born after 1964 (Figure 4-6).

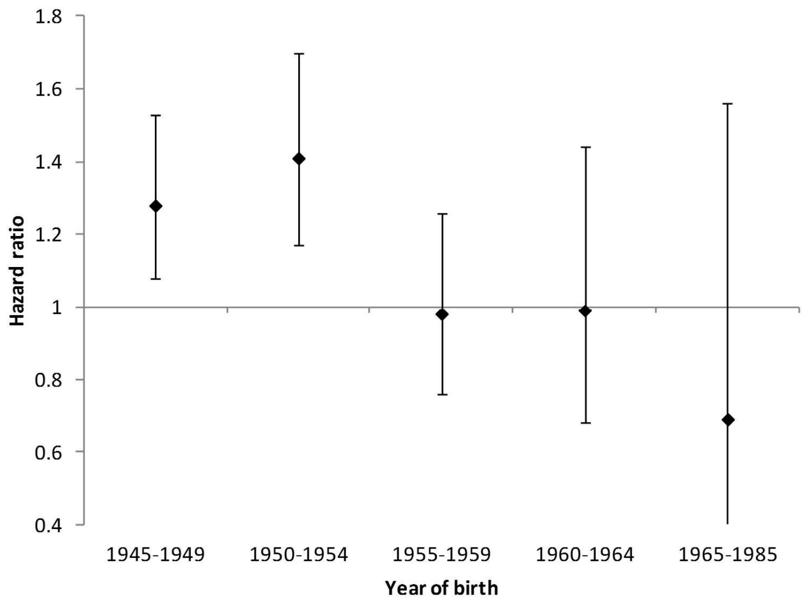

Figure 4-6 - Hazard ratios for stroke by birth cohort
Veterans referent to non-veterans
Landmark age 40 years

4.7.1.4 Length of Service

All veterans except those with the longest service showed an increase in risk of stroke compared with non-veterans, although the increase in risk was greatest in those ESL who left prior to completion of initial training. Veterans with over 12 years' service exhibited a slight decrease in risk of stroke compared with non-veterans (Figure 4-7).

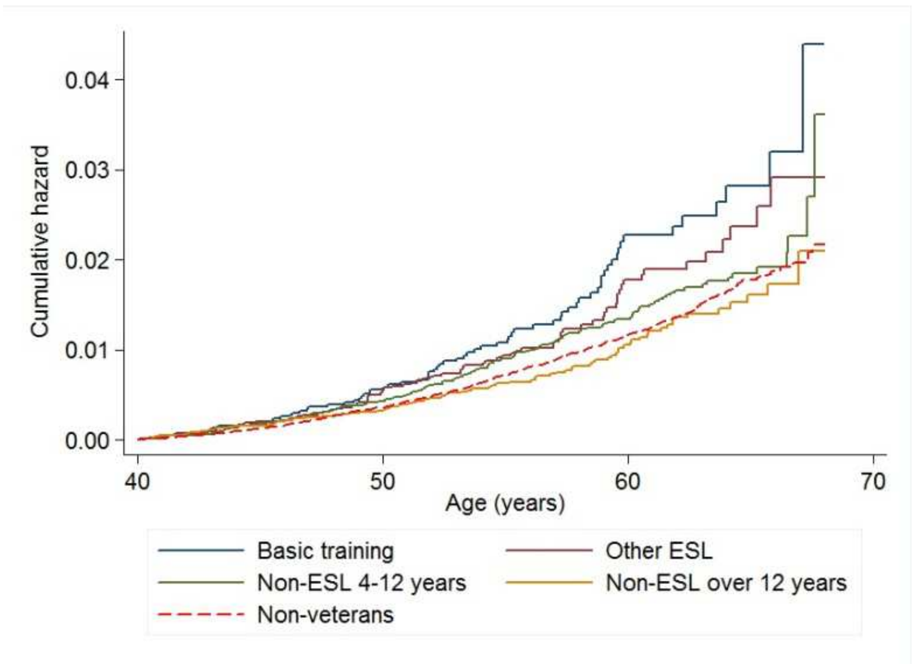

Figure 4-7 – Nelson-Aalen plot of stroke by length of service
All non-veterans for comparison
Landmark age 40 years

4.7.2 Geographical Distribution

When the data were analysed by geographical region based on Health Board boundaries, only Argyll & Clyde (subsumed into Greater Glasgow & Clyde and Highland in 2006) showed a statistically significant difference in veterans in the univariate Cox model, HR 1.50, 95% CI 1.08-2.08, p=0.015. Grouping the predominantly urban Central Belt Health Boards together showed HR 1.24, 95% CI 1.11-1.39, p<0.001, whilst for the more rural Highlands, Islands and Borders regions grouped together, the difference was not statistically significant, HR 1.03, 95% CI 0.82-1.29, p=0.796. The significance persisted, where present, in the multi-variable model after adjusting for deprivation.

4.7.3 Case-Fatality

The mean follow-up from date of initial admission for stroke occurring after age 40 years, to the date of death or the end of the study, was 6.16 years (range 0-24.91 years) for veterans and 5.33 years (range 0-24.91 years) for non-veterans, representing 2,871 person-years of follow-up in the veterans and 6,177 person-years in the non-veterans. There were 152 (32.6%) deaths in veterans who had experienced a stroke, equating to 52.95 per 1,000 person-years, and 423 (36.5%) deaths in non-veterans (68.47 per 1,000 person-years).

Thirty-day case-fatality after first episode of stroke was statistically significantly lower for veterans, HR 0.77, 95% CI 0.60-0.98, p=0.031. Both one-year and five-year case-fatality were also lower, HR 0.74, 95% CI 0.58-0.92, p=0.009 and HR 0.80, 95% CI 0.65-0.98, p=0.030 respectively. When stratified geographically, five-year survival was higher in the urban Central Belt, HR 0.79, 95% CI 0.63-1.00, p=0.051, than in the rural Highlands, Islands and Borders, HR 0.85, 95% CI 0.56-1.29, p=0.434, although neither achieved significance.

4.8 Peripheral Arterial Disease

PAD was defined as ICD-9 code 443.9 or 440.2, or ICD-10 code I702 or I73-I79, at any position in the record.

4.8.1 Incidence

Most cases of PAD are diagnosed and managed in the community, and only the most severe result in hospitalisation. Reasons for admission include invasive investigation, revascularisation and amputation. Recorded cases therefore do not reflect overall incidence or prevalence. The assumption has been made that there are no systematic differences in completeness of ascertainment between veterans and non-veterans, and that any differences reflect real differences in incidence or severity.

4.8.1.1 Overall

During the 32 years of follow-up, 696 veterans were hospitalised with PAD compared with 1,443 non-veterans, equivalent to a cumulative incidence of 1.24% and 0.84% respectively. The difference in risk was statistically highly significant, unadjusted HR 1.47, 95% CI 1.34-1.61, p<0.001 (Figure 4-8). The difference was only slightly attenuated after adjusting for deprivation, HR 1.39, 95% CI 1.27-1.52, p<0.001. Testing for non-proportionality of the hazards was non-significant, p=0.734.

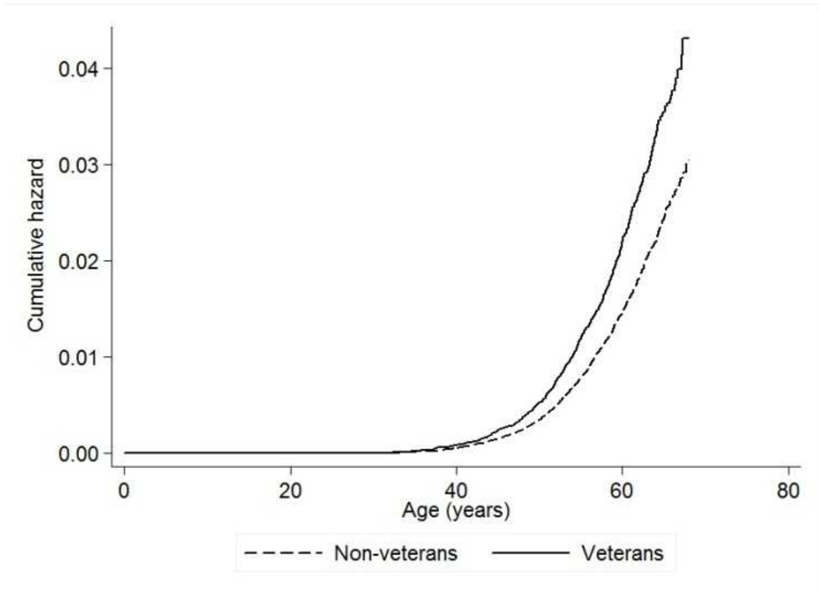

Figure 4-8 - Nelson-Aalen plot of PAD by veteran status

4.8.1.2 Sex

PAD resulting in hospitalisation was more common in men than in women, in both veterans and non-veterans. There were 675 (1.32%) cases in male veterans compared with 1,347 (0.89%) in male non-veterans, and 21 (0.40%) in female veterans compared with 91 (0.46%) in non-veterans. The difference was statistically highly significant for men, with the veterans at higher risk, unadjusted HR 1.48, 95% CI 1.35-1.63, p<0.001 and HR 1.40, 95%CI 1.2-1.54, =<0.001 after adjusting for deprivation. For women, PAD was less common in the veterans although the difference was not statistically significant, unadjusted HR 0.89, 95% CI 0.56-1.43, p=0.632 and HR 0.86, 95% CI 0.53-1.38, p=0.525 after adjusting for SES.

4.8.1.3 Birth Cohort

Analysis of the risk of PAD by birth cohort showed a similar pattern to the risk of stroke, with the highest risk relative to non-veterans in the 1950-1954 birth cohort. However the risk was also significantly higher among veterans born 1955-1959 and non-significantly higher in those born 1960-1964. For those born from 1965 onwards, the risk did not differ from non-veterans (Figure 4-9).

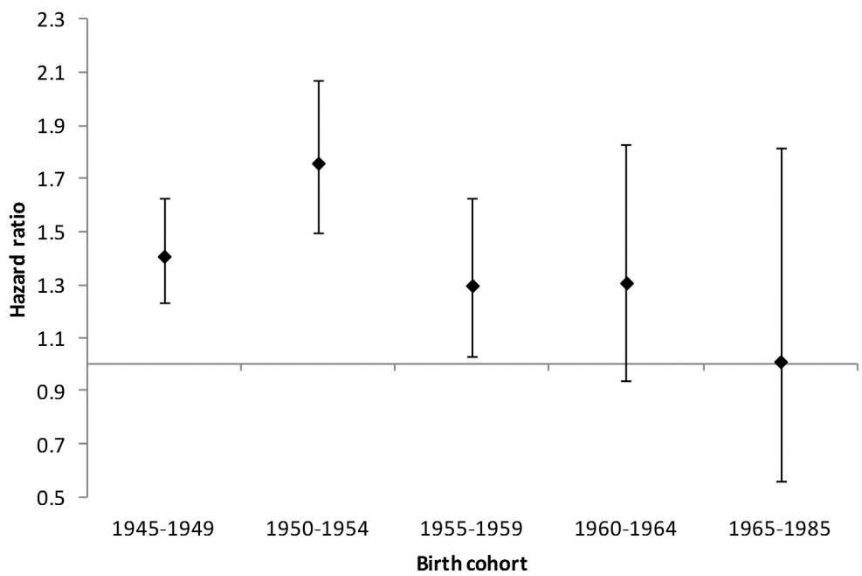

Figure 4-9 - Hazard ratios for PAD by birth cohort
Veterans referent to non-veterans

4.8.1.4 Length of Service

All veterans with up to 12 years' service showed an increased risk of PAD, whilst the risk for those with over 12 years' service was similar to all non-veterans (Figure 4-10).

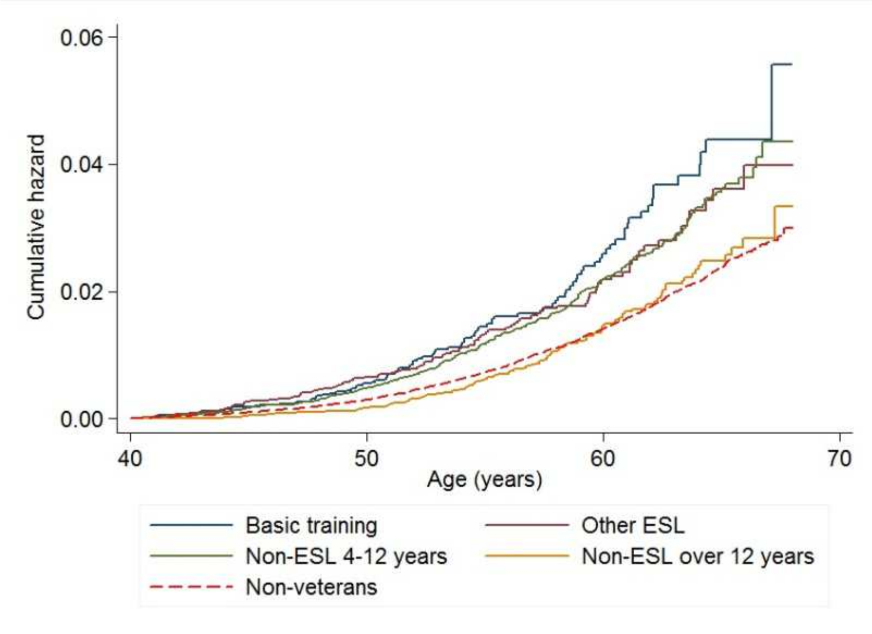

Figure 4-10 - Hazard ratios for PAD by length of service
All non-veterans for comparison
Landmark age 40 years

4.8.2 Geographical Distribution

When analysed by geographical region of residence, there was a statistically significant increased risk in all areas except the Islands (Orkney, Shetland and the Western Isles) in the univariate Cox model. Grouping into Central Belt and 'all other regions combined' showed similar hazard ratios; 1.46, 95% CI 1.21-1.77, p<0.001 in the Central Belt and 1.47, 95% CI 1.33-1.3, p<0.001 for all other regions. Results were similar after adjusting for SES in the multi-variable model.

4.8.3 Case-Fatality and Co-Morbidity

The mean follow-up from date of initial admission for PAD to the date of death or the end of the study was 6.42 years (range 0-31.29 years) for veterans and 6.04 years (range 0-31.02 years) for non-veterans, representing 4,468 person-years of follow-up in the veterans and 8,701 person-years in the non-veterans. There were 179 (25.7%) deaths in veterans who had been hospitalised with PAD, equating to 40.06 per 1,000 person-years, and 397 (27.5%) deaths in non-veterans (45.63 per 1,000 person-years).

The commonest cause of death in veterans with a history of PAD was IHD, accounting for 29 deaths (0.82% of all deaths in veterans), compared with 50 deaths (0.46% of the total) in non-veterans. For non-veterans, the commonest cause of death in those with a history of PAD was lung cancer, accounting for 60 cases (0.55% of all non-veteran deaths) compared with 27 deaths in veterans with PAD (0.77% of all veteran deaths). Ten of the veterans and 13 of the non-veterans with PAD died of stroke. Other notable causes of death in those with a history of PAD were oesophageal cancer (13 veterans and 35 non-veterans), and alcoholic liver disease (5 veterans and 8 non-veterans). In comparison, none of the veterans and only 3 non-veterans with a history of PAD died of colorectal cancer.

4.9 All Cardiovascular Disease

4.9.1 Incidence

4.9.1.1 Overall

The three cardiovascular diagnoses (AMI, stroke, and PAD) were aggregated as 'any cardiovascular disease'. Only the first episode of any of the three conditions was included, to eliminate multiple counting. Overall, 3,046 veterans experienced any cardiovascular disease, compared with 7,360 non-veterans over the 32 year period of follow-up, equivalent to a cumulative incidence of 5.42% and 4.26% respectively. The difference in risk was statistically significant in both the unadjusted Cox proportion hazard model, HR 1.23, 95% CI 1.18-1.29, p<0.001, and after adjusting for deprivation, HR 1.19, 95% CI 1.14-1.24, p<0.001 (Figure 4-11).

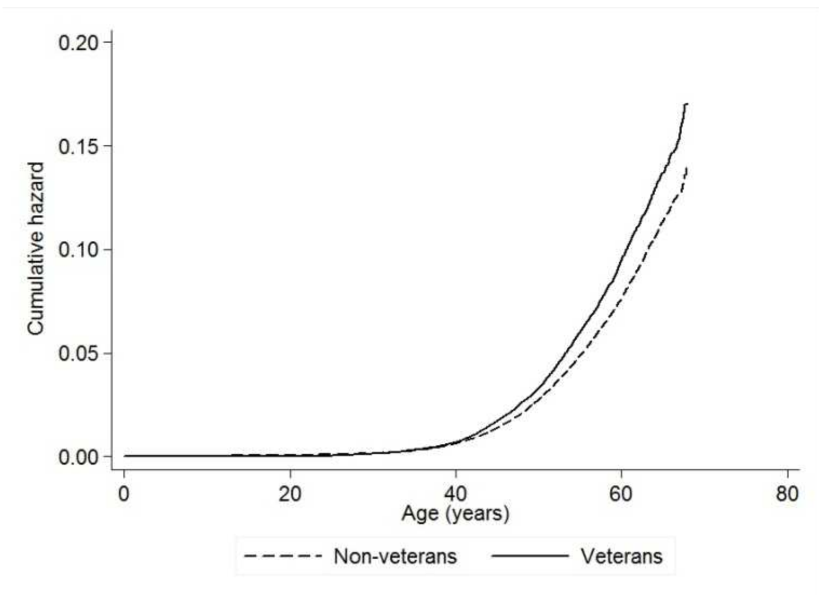

Figure 4-11 - Nelson-Aalen plot of all cardiovascular disease by veteran status

4.9.1.2 Sex

There were 2,965 (5.81%) cases of any cardiovascular disease in male veterans compared with 7,262 (4.78%) in male non-veterans, and 81 (1.55%) in female veterans compared with 368 (1.78%) in non-veterans. The increase in risk was confined to men (HR 1.23, 95% CI 1.17-1.28, p<0.001 unadjusted and HR 1.18, 95% CI 1.13-1.23, p<0.001 after adjusting for deprivation); the hazard ratio for women was 0.89, 95% CI 070-1.14, p=0.365 unadjusted, and remained non-significant, p=0.269, after adjusting for deprivation.

4.9.1.3 Birth Cohort

The analysis was repeated stratifying by birth cohort. There was a steady reduction in risk from the 1950-1954 birth cohort onwards. The risk was statistically significantly elevated in all pre-1960 birth cohorts, with a small peak in the 1950-1954 cohort, and there was a non-significant reduction in risk in all birth cohorts from 1965 onwards (Figure 4-12).

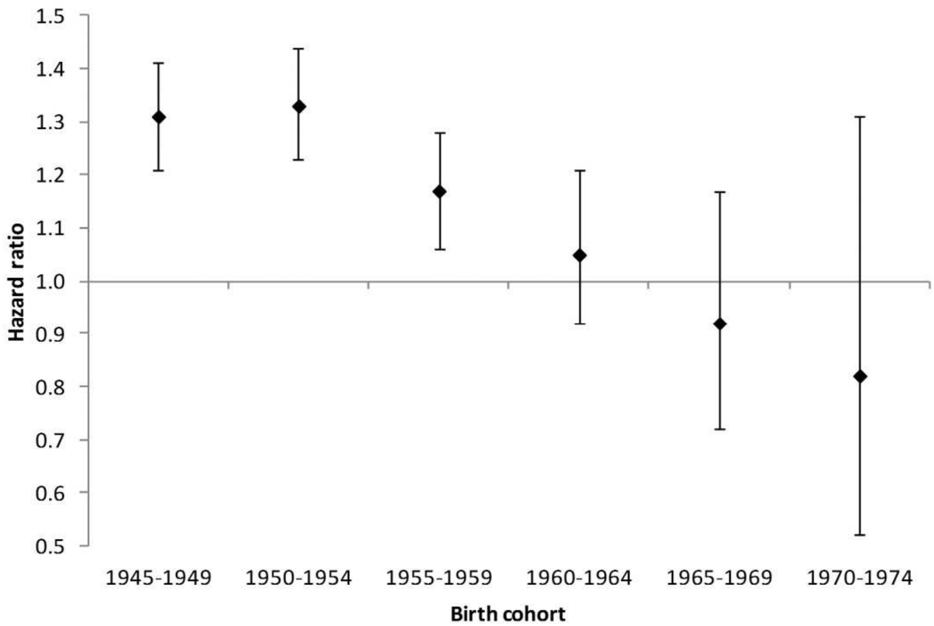

Figure 4-12 - Hazard ratios for all cardiovascular disease in veterans referent to non-veterans by birth cohort

4.9.1.4 Length of Service

Results for risk of cardiovascular disease stratified by length of service are tabulated at Table 4-5, overall and in two birth cohorts (1945-1959 and 1960-1985), and are shown graphically at Figure 4-13.

Table 4-5 - Cox proportional hazard model of the association between veteran status and all cardiovascular disease (AMI, stroke and PAD), overall and stratified by length of service and birth cohort

	Veteran cases	All Veterans *n*-56,205			Born 1945-1959 *n*=29,709			Born 1960-1985 *n*=26,496		
	n	HR	95% CI	p	HR	95% CI	p	HR	95% CI	p
Overall										
Univariate	3,046	1.23	1.18-1.29	<0.001	1.28	1.22-1.34	<0.001	1.00	0.89-1.12	0.939
Multi-variable	3,046	1.19	1.14-1.24	<0.001	1.23	1.17-1.28	<0.001	0.99	0.88-1.11	0.894
Length of service in 8 categories										
Basic training[86]	409	1.49	1.35-1.65	<0.001	1.52	1.36-1.68	<0.001	1.32	1.01-1.73	0.044
ESL[87] (0-3 years)	740	1.42	1.31-1.53	<0.001	1.44	1.33-1.56	<0.001	1.26	1.03-1.55	0.025
4-6 years	563	1.22	1.12-1.33	<0.001	1.23	1.12-1.35	<0.001	1.13	0.90-1.42	0.274
7-9 years	388	1.21	1.10-1.35	<0.001	1.27	1.14-1.42	<0.001	0.95	0.71-1.26	0.714
10-12 years	310	1.24	1.10-1.39	<0.001	1.33	1.17-1.50	<0.001	0.83	0.60-1.16	0.277
13-16 years	216	1.19	1.04-1.36	0.013	1.30	1.12-1.51	0.001	0.83	0.59-1.18	0.307
17-22 years	190	1.01	0.87-1.17	0.864	1.08	0.93-1.26	0.316	0.59	0.36-0.99	0.044
23 yrs & over	224	0.82	0.72-0.95	0.007	0.88	0.76-1.01	0.074	0.31	0.15-0.65	0.002
Length of service in 2 categories										
≤ 12 years	2,416	1.32	1.26-1.38	<0.001	1.35	1.29-1.42	<0.001	1.12	0.99-1.26	0.075
> 12 years	630	0.98	0.90-1.07	0.693	1.05	0.97-1.15	0.237	0.60	0.46-0.79	<0.001

This clearly demonstrated the highest risk of cardiovascular disease to be in veterans who did not complete initial training, whilst the risk in those who completed more than 12 years of service did not differ from the non-veteran population.

[86] Veterans who did not complete basic training, defined as serving for less than 0.4 years

[87] ESL = Early Service Leavers, who did not complete the minimum term of engagement

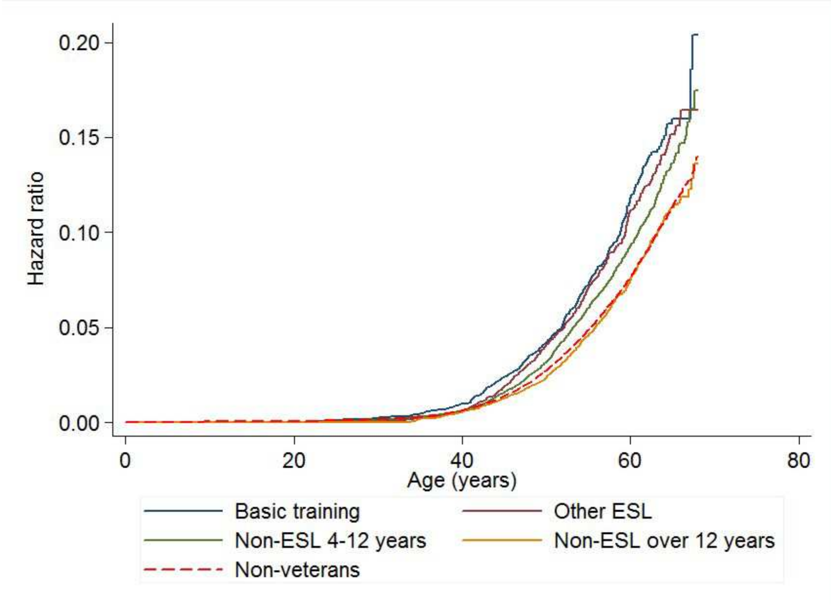

Figure 4-13 - Hazard ratios for cardiovascular disease by length of service. All non-veterans for comparison

4.9.2 Case-Fatality

The mean follow-up from date of initial admission for cardiovascular disease to the date of death or the end of the study was 7.49 years (range 0-31.98 years) for veterans and 6.89 years (range 0-31.95 years) for non-veterans, representing 22,815 person-years of follow-up in the veterans and 52,342 person-years in the non-veterans. There were 808 (26.5%) deaths in veterans who had been hospitalised with cardiovascular disease, equating to 35.4 per 1,000 person-years, and 2,139 (28.0%) deaths in non-veterans with cardiovascular disease (40.9 per 1,000 person-years). Overall, veterans who had a diagnosis of any cardiovascular disease were at significantly lower risk of all-cause death than non-veterans, unadjusted HR 0.91, 95% CI 0.84-0.98, p=0.020 in the Cox proportional hazard model. The difference remained statistically significant after adjusting for deprivation, HR 0.90, 95% CI 0.83-0.98, p=0.011.

4.10 Chapter Discussion

4.10.1 Main Findings

Analysis of the incidence of AMI, stroke, PAD and all cardiovascular disease combined revealed an overall increase in risk in veterans compared with age, sex and geographically matched non-veterans, which persisted after adjusting for SES. There was a pattern of highest risk in the earliest birth cohorts, and in the veterans who had served for shorter periods, which was observed in each condition separately and in all three conditions analysed together. The greatest increase in risk was in older veterans who had left the Armed Forces prior to completing initial training, whilst the veterans in the most recent birth cohorts and with the longest service demonstrated a statistically significant reduction in overall risk (Table 4-5). This is summarised graphically at Figure 4-14 and Figure 4-15.

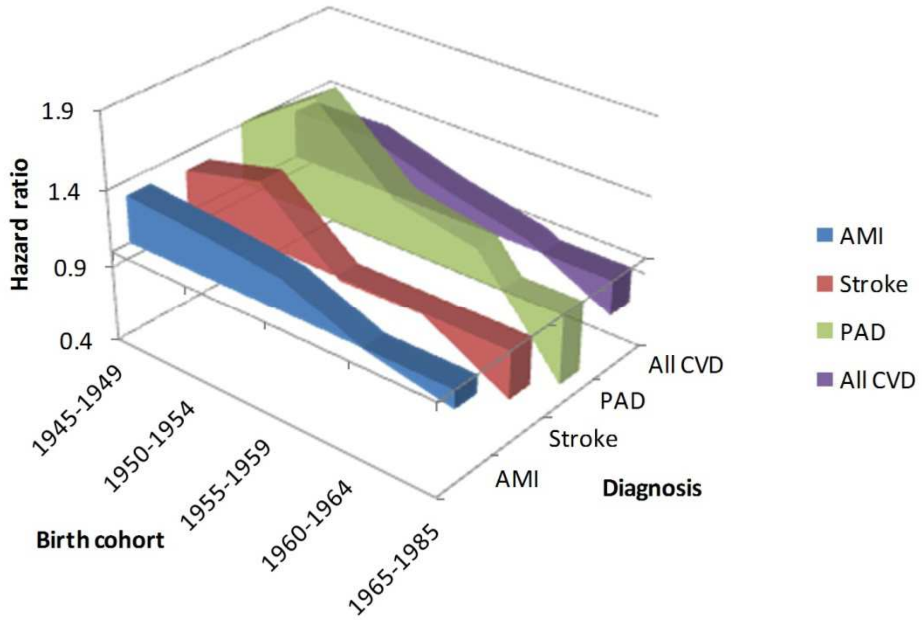

Figure 4-14 - 3D plot of cardiovascular hazard ratios in veterans by diagnosis and birth cohort, referent to non-veterans

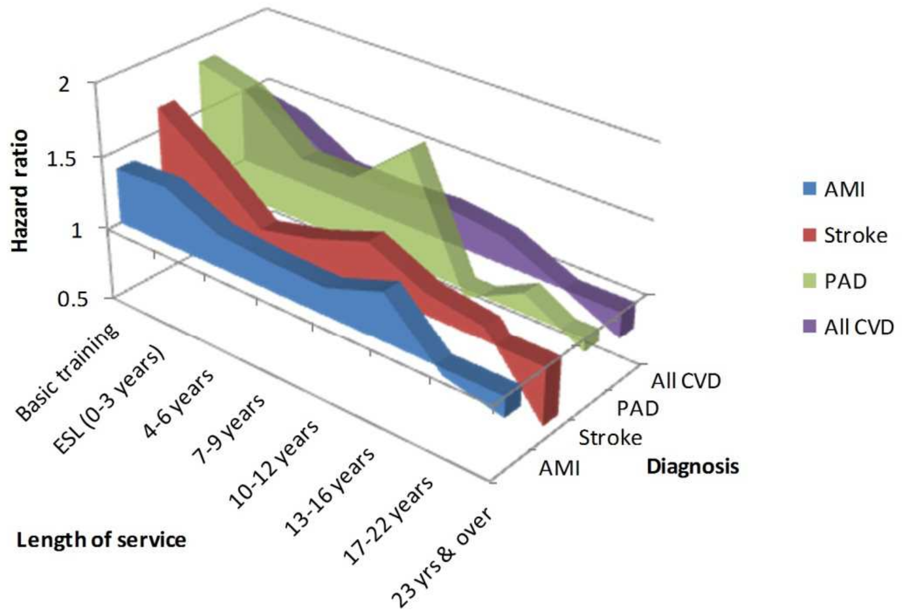

Figure 4-15 - 3D plot of cardiovascular hazard ratios in veterans by diagnosis and length of service, referent to non-veterans

4.10.2 Interpretation

In the general population, occupational factors have been estimated to give rise to a 19% increase in cardiovascular mortality in men, and 9% in women (Nurminen and Karjalainen 2001). Occupational risk factors for cardiovascular disease which may be relevant to Armed Forces personnel are described at Appendix 3 and include heavy physical exertion (especially in association with low or moderate physical fitness) (Holtermann et al. 2010), heavy lifting (Steenland 1996), high job strain and low job control (Theorell et al. 1998), exposure to both direct and environmental tobacco smoke (Wells 1998, Ockene and Miller 1997), exposure to noise and extremes of temperature (Kristensen 1989), shift work and disturbed sleep patterns (Wang et al. 2011), exposure to carbon monoxide, for example from vehicle exhaust fumes (Koskela 1994), and psychological stress (Dimsdale 2008). Moderate physical exertion is cardio-protective, and a high level of cardio-respiratory fitness protects against the adverse cardiovascular effects of heavy physical exertion (Holtermann et al. 2010). The combined effect of shift work and other cardiovascular risk factors, such as smoking, has been considered to be multiplicative (Tenkanen et al. 1998).

Although many authors have calculated attributable fractions for the occupational risk factors, the lack of data on occupational exposure within the Scottish Veterans Health Study population means that it is not possible to make specific estimates of effect. However, the pattern of risk in relation to both length and period of service provides an indication of factors which are likely to be relevant. The risk was highest in those who did not complete initial training, and lowest in those with the longest service. Occupational hazards are highly unlikely to give rise to this pattern of reducing risk with longer service, although protective factors of occupational origin could be explanatory. Pre-service factors, together with lifestyle factors which may be modified early in the course of service, are likely to be relevant to the increased risks seen in those with the shortest service. The risk factor having the best fit appears to be tobacco smoking; there is consistent evidence that military personnel smoke more than civilians, and that smoking prevalence increases early in recruit training but decreases with rank and seniority (and therefore by implication, with length of service) (Lodge 1991, Shahar and Carel 1991). Furthermore, the prevalence of smoking in the Armed Forces has decreased over time (Lewthwaite and Graham 1992), which would be consistent with the reduction in risk in veterans in the more recent birth cohorts. The changing pattern of military tobacco smoking is described at Appendix 4. The small peak in risk of cardiovascular disease in veterans with 10-12 years' service coincides with a group of veterans of whom most are likely to have left after reaching a rank no higher than corporal[88]; Lodge's study shows that corporals and below are the heaviest smokers (Figure 8-4), whilst those with the longest service are generally officers, warrant officers and senior non-commissioned officers, who are more likely to have been never-smokers or ex-smokers (Lodge 1991). This hypothesis will be tested in subsequent chapters by examining other smoking-related disorders in veterans, as described at Section 2.3.1.3.

Although smoking is generally regarded as a lifestyle choice, the military smoking culture of former years meant that many people were encouraged to smoke through comradeship and in order to enjoy the benefits of the 'smoke break', and even non-smokers were exposed to environmental tobacco smoke in shared barrack-rooms. Therefore, for military personnel, it may nonetheless be argued that there was an 'occupational' element to smoking. Early indications are that the more recent emphasis on smoke-free Ministry of Defence workplaces, and the provision of smoking cessation services to serving personnel, have been of benefit to the cardiovascular health of veterans, as seen in the reducing cardiovascular risk in more recent birth cohorts, although the impact of recent operations in Iraq and Afghanistan, and a reduction in funding for military smoking cessation services (Appendix 4, Section A4.1.3), cannot yet be determined.

The lower risk of immediate death observed in veterans may result from a postulated persistence into civilian life of the need for military personnel to seek prompt medical care, since serving military personnel are unable to self-certify sickness absence and must report all ill-health to a healthcare provider. Alternatively, it may reflect residual higher fitness levels in veterans, or a lower prevalence of co-morbidities owing to selection bias in a group who have previously had to meet military health standards. The geographical pattern of reduced mortality after AMI or stroke in the urban Central Belt region, but not

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[88] Twelve years of service represents the 'Manning Control Point' at which many personnel who had not progressed beyond the rank of corporal, and who showed no potential for further promotion, were discharged. Described in a Defence Policy news release: 'Rebalancing Army Manpower'. http://webarchive.nationalarchives.gov.uk/20121026065214/http://www.mod.uk/DefenceInternet/DefenceNews/DefencePolicyAndBusiness/RebalancingArmyManpower.htm accessed 15 Jul 2014.

in the more rural districts, suggests that ready accessibility of healthcare is an important factor.

4.10.3 Developing the Hypothesis

Findings from the analysis of data on cardiovascular disease established that the initial null hypothesis did not hold true, and that there was a greater overall risk of cardiovascular disease in veterans compared with non-veterans. The results of the subgroup analysis also showed that shorter service was associated with higher risk, suggesting that a lifestyle factor such as smoking may be more likely to be responsible for the observed differences between veterans and non-veterans than an occupational exposure. The changing pattern of risk over time closely mirrored changes in the prevalence of military smoking (Appendix 4, Section A4.1.3). This hypothesis is further explored in subsequent chapters through examination of the risk of other smoking-related conditions.

4.10.4 Key Points

- Overall, veterans had a 23% higher incidence of cardiovascular disease than non-veterans.

- The increased risk was observed for AMI, stroke and PAD, individually and together, and was highest for PAD.

- The risk was only increased in male veterans.

- Veterans born 1945-1959 were at increased risk of AMI, stroke and PAD.

- The increase in risk was highest for the 1950-1954 birth cohort.

- There was no overall increase in risk of AMI, stroke or PAD for veterans born from 1960 onwards.

- Veterans who had not completed initial training had the greatest increase in risk of cardiovascular disease overall compared with non-veterans.

- The risk of cardiovascular disease was reduced in the veterans who had served for longest.

- A higher rate of tobacco smoking in service personnel, especially in the earlier period, is the most likely main explanatory factor.

Chapter 5: Cancer

5.1 Overview

There is a 43% lifetime risk of developing cancer in the UK (as at 2014, and excluding non-melanoma skin cancer); the commonest cancers are breast, lung, prostate, and colorectal, which account for over half of cancer diagnoses[89]. More than 60% of new cancers are diagnosed over the age of 65[90]. In 2012 over 30,000 new cases of cancer were diagnosed in Scotland, equating to an age-standardised[91] incidence of 6.26 per 1,000 (6.72 per 1,000 men (95% CI 6.61-6.84) and 5.80 per 1,000 women (95% CI 5.71-5.90))[92]. Known risk factors are diverse, and include chemical agents (eg tobacco smoke (Sasco et al. 2004), benzene (Lynge et al. 1997)), physical agents (eg asbestos fibres (O'Reilly et al. 2007), solar radiation (Ramani and Bennett 1993)), and biological agents (eg human papillomavirus (HPV) (Clifford et al. 2003), Epstein-Barr virus (Thompson and Kurzrock 2004)), although many cases are idiopathic. Increasingly, associations with genotypes or gene mutations are being identified (Davies et al. 2002).

In a worldwide military context, there has been widespread popular anxiety about the carcinogenic potential of substances such as chemical warfare agents, ionising radiation (Gardner 1988), defoliants, industrial chemicals, and the smoke from the destruction of industry and infrastructure, to which military personnel may have been exposed in the course of their duties[93]. Other militarily-relevant occupational carcinogens are described at Section 5.4 and Appendix 3, Sections A3.3.5.7 to A3.3.5.12. Operationally-specific follow-up studies on UK personnel have been generally reassuring, demonstrating no increased risk either in people deployed to the Falklands or the first Gulf conflict (Defence Statistics (Health) 2013, Defence Statistics (Health) 2014a), or in veterans of the nuclear

[89] Data from Cancer Research UK http://www.cancerresearchuk.org/cancer-info/cancerstats/incidence/risk/statistics-on-the-risk-of-developing-cancer#source4 accessed 17 Mar 2015. Lifetime risk projections have been calculated by the Statistical Information Team at Cancer Research UK, based on data provided by the Wolfson Institute of Preventive Medicine, Queen Mary University of London.

[90] Derived from figures provided by Cancer Research UK – Average number of new cases per year 2009-2011 http://www.cancerresearchuk.org/cancer-info/cancerstats/incidence/age/ accessed 4 Aug 2014.

[91] Age-standardised using the 2013 European Standard Population

[92] Figures from ISD Scotland http://www.isdscotland.org/Health-Topics/Cancer/Cancer-Statistics/All-Types-of-Cancer/#all-cancer-types accessed 4 Aug 2014.

[93] For example, 'OPERATION PURPLE HEART: Supporting US soldiers returning from Iraq and Afghanistan with cancer'. http://operationpurpleheart.blogspot.co.uk/ accessed 4 Aug 2014.

test programmes of the 1950s and 1960s (Muirhead et al. 2003b); further studies are described at Appendix 1, Sections A1.3.2 and A1.3.2.1. However no studies have been identified which explore the long-term risks of cancer in a broad spectrum of UK veterans, which would provide pointers to the overall impact of military service on health and would facilitate understanding and mitigation of any potential health risks identified.

5.2 Aim

The aim of this chapter is to explore the risk of cancer, both overall and for a range of specific cancers, in veterans relative to people with no record of service, to examine patterns of risk in specific subgroups, to identify trends over time, and to postulate reasons for any differences identified.

5.3 Hypothesis

The finding of an increased risk of cardiovascular disease in veterans, highest in those with the shortest service, suggested that smoking was a plausible explanation. Analysis of the data on cancer incidence allowed this hypothesis to be tested, examining lung, oropharyngeal and laryngeal, and other smoking-related cancers. The nature of military service also gives rise to a range of potential cancer risks, which are described in the following sections. Since military service may involve exposure to a wide range of carcinogens, the decision was taken to explore all major cancer sites for which routinely-collected ISD data were available (23 cancer sites) in order to build up the broadest possible picture. It was considered important to include cancers where numbers were small, notwithstanding that the interpretation of the findings may be problematic, as this group included cancers of military importance such as mesothelioma of the pleura and malignant melanoma. It was anticipated that cancer sites where the literature suggested that no difference should be expected or plausible, such as colorectal cancer, would act as a control, indicating that where differences were found in other sites, they were likely to be real.

The hypothesis to be tested was therefore that cancers associated with smoking and with exposure to hazards likely to be encountered during military service would prove more common in veterans and, if military service was causally associated, that longer service would be associated with increased risk.

5.4 Military Cancer Risks

5.4.1 Occupational Carcinogens

Some military personnel working in specialised areas may have been exposed to known occupational carcinogens, as described in Appendices 1 and 3. The Armed Forces implemented the Control of Substances Hazardous to Health (COSHH) Regulations 2002 and earlier legislation, but prior to 1987, military personnel were unable to take legal action for occupational injury or ill-health,[94] although a War Disability Pension was payable for injury or ill-health attributable to service, irrespective of whether it arose in connection with hostilities. As a result, there was a tacit acceptance of hazards which would later be deemed unacceptable. In 1987 the Crown Proceedings (Armed Forces) Act 1987[95] repealed Section 10 of the Crown Proceedings Act 1947[96], clearing the way for personnel to sue the Crown for illness or injury. One consequence was full compliance by the Armed Forces with national health and safety legislation, other than in connection with national emergency or for the purposes of any warlike operations in any part of the world outside the United Kingdom, when the Section may be revived. The Act was not made retrospective, so those who served prior to 1987 and may have been exposed to occupational carcinogens such as the solvent tetrachloroethylene (Scott and Chiu 2006, Blair et al. 1998), which were subject to greater controls in later years, had no recourse to litigation.

5.4.2 Non-Occupational Cancer Risks

Service personnel have historically had higher rates of tobacco use than civilians, as discussed at Section 4.4 and Appendix 4, Section A4.1.4. Tobacco smoke is a complex mix of numerous substances known to be carcinogenic to humans, including polycyclic aromatic hydrocarbons, *N*-nitrosamines and even radioactive polonium-210. Exposure to environmental tobacco smoke also results in inhalation of harmful levels of carcinogens. Tobacco-associated cancers include lung, oral cavity, oropharynx, nasopharynx,

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[94] "Nothing done or omitted to be done by a member of the armed forces of the Crown while on duty as such shall subject either him or the Crown to liability in tort for causing the death of another person, or for causing personal injury to another person, in so far as the death or personal injury is due to anything suffered by that other person while he is a member of the armed forces of the Crown etc . . ." [Crown Proceedings Act 1947 Part I Section 10]

[95] 1987 Chap. 25

[96] 1947 10 & 11 Geo. 6. Chap. 44

oesophagus, stomach, bladder, ureter, and kidney. Smoking is associated with an increased risk of liver cancer independent of alcohol, and also increases the risk of cervical cancer (Hecht 2006). The association between smoking and colorectal cancer is not clear-cut. A 26-year follow-up of US veterans showed an association (Heineman et al. 1994), but Doll considered that any apparent association was likely to be due to confounding (Doll 1996). A review paper published in 2001 concluded that there was positive evidence of a causal association and that the difficulty in demonstrating an association in earlier publications may have arisen because of a postulated delay of 35-40 years between onset of smoking and the emergence of an increased risk of colorectal cancer; the effect would only be observed in studies having sufficiently long follow-up. (Giovannucci 2001). Nonetheless, the IARC has been unable to conclude that there is a causal association, and has stated that inadequate adjustment for confounders may explain any observed small increase (IARC 2004).

There are dietary associations with increased cancer risk, but the relationship between diet and cancer is complex and has not yet been fully elucidated. There are wide geographical variations in diet (Goodwin and Brodwick 1995), as well as confounders; furthermore, diet is not independent of other lifestyle choices such as smoking and alcohol use (Coulson et al. 1997). Obesity also carries an increased risk of malignancy including gastro-intestinal cancers and leukaemia (Vucenik and Stains 2012). Obesity is less prevalent in serving UK military personnel than in the civilian community up to the age of 35 years; thereafter the prevalence is the same (Fear et al. 2011). However, no data are available on the prevalence of obesity in UK veterans. Heavy alcohol use is associated with an increased risk of cancer, especially of the oropharynx/larynx and oesophagus (Bagnardi et al. 2001); nine percent of liver cancer and 12% of colorectal cancer is also attributable to alcohol consumption (Parkin 2011a). These risk factors will be further addressed in the discussion of individual cancers.

Multiple sexual partners and high-risk sexual behaviours (inconsistent condom use, exposure to commercial sex workers) have been reported to be especially common in military populations (Malone et al. 1993, Whitehead and Carpenter 1999) and may increase the risk of reproductive and oropharyngeal cancers through exposure to oncogenic strains of HPV (Goyal et al. 2012, Kreimer et al. 2013).

5.5 Healthy Worker Effect

There is controversy as to whether the 'healthy worker effect', whereby those in employment enjoy better health and lower mortality than those who do not work (Section 2.3.1.2), influences cancer incidence. Studies require a large population of workers from a wide range of occupations in order to eliminate the confounding effect of exposure to specific occupational carcinogens. Furthermore, the healthy worker effect attenuates with time elapsed since first employment (Li and Sung 1999) so it is less likely to influence conditions such as cancer which are more prevalent in later life. A Norwegian study examined a cohort of 366,000 people followed between 1981 and 2003 and found a healthy worker effect for all cancers for male workers (SIR 0.91, 95% CI 0.89-0.93) but not for female workers (SIR 0.99, 95% CI 0.95-1.03). There was a significantly lower incidence of cancer of the head and neck, lung, prostate, kidney, bladder and leukaemia in men and a lower incidence of lung and bladder cancer in women, but an increased incidence of malignant melanoma in both men and women. There was an increased risk of ovarian cancer in female workers, (SIR 1.32, 95% CI 1.14-1.53) (Kirkeleit et al. 2013). Conversely, a study of 1.6 million Swedish women followed up from 1971 to 1989 showed a slightly increased incidence of all cancers (SIR 1.05, 95% CI 1.04-1.06) and a higher incidence of lung cancer in the employed group. As in the Norwegian study, there was an increased incidence of ovarian cancer in the working women (Gridley et al. 1999). Aspects of the applicability of the healthy worker effect to service personnel are discussed at Section 8.3.1.1.

Results

5.6 All Cancers

A binary field in the dataset recorded the first instance of any cancer, defined as ICD-9 codes 140-209 and 230-234, and ICD-10 codes C00-C97 and D00-D09. The *in situ* neoplasms were included (D* codes and 23* codes) in order to ensure that all skin cancers, including those of occupational origin, were captured in the overall analysis. Since a history of childhood cancer would normally have precluded acceptance for military service, and is unlikely to have been relevant to veterans' health, a landmark analysis was performed starting at age 20 years. Only 5 cancers in veterans, but 75 cancers in non-veterans, occurred under the age of 20 years, consistent with a history of childhood cancer acting as a bar to service.

5.6.1 Incidence

5.6.1.1 Overall

There were 3,588 cases of any cancer in veterans during the 32 year period of follow-up, compared with 11,560 cases in non-veterans, equivalent to a cumulative incidence of 6.38% and 6.69% respectively. There was no statistically significant difference in risk between veterans and non-veterans; the unadjusted HR for any cancer in veterans relative to non-veterans was 0.98, 95% CI 0.94-1.01, p=0.197 and the adjusted HR was similar at 0.97, 95% CI 0.94-1.01, p=0.171 (Figure 5-1).

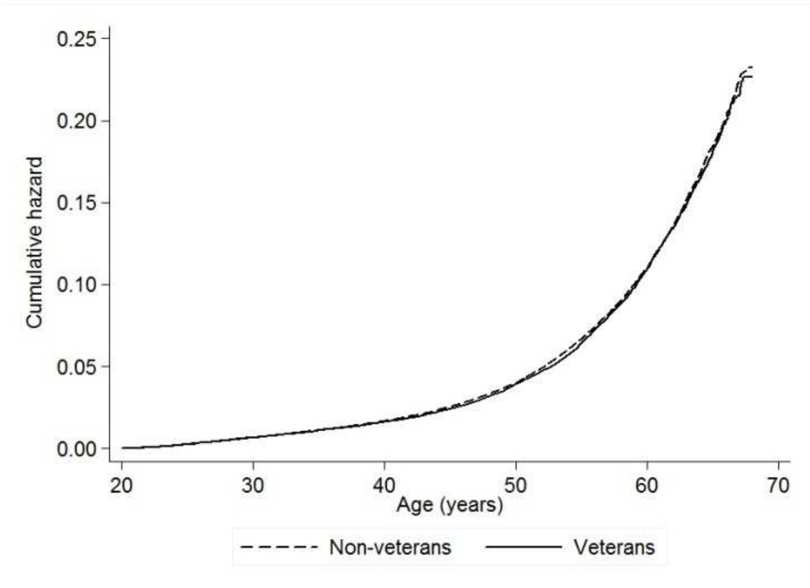

Figure 5-1 - Nelson-Aalen plot of all cancer, landmark age 20 years by veteran status

5.6.1.2 Sex

When stratified by sex, there were 3,059 (6.00%) cases of any cancer in male veterans compared with 9,212 (6.06%) in male non-veterans. For women the figures were 529 (10.11%) in veterans and 2,348 (11.34%) in non-veterans. The unadjusted Cox proportional hazard ratio for men was 0.99, 95% CI 0.95-1.04, p=0.775 and for women 0.98, 95% CI 0.89-1.07, p=0.611. The hazard ratios after adjusting for deprivation were 0.99, 95% CI 0.95-1.03, p=0.691 for men and 0.97, 5% CI 0.88-1.07, p=0.593 for women.

5.6.1.3 Birth Cohort

Analysis by birth cohort in 5-year groups showed that the hazard ratios were close to unity for veterans born between 1945 and 1954, indicating that there was no difference in risk between veterans and non-veterans. There was an overall downward trend from the 1950-1954 birth cohort onwards, with a small, non-significant decrease in risk in veterans born between 1955 and 1964 compared with non-veterans. The youngest veterans, born between 1965 and 1985, had a significantly lower risk than non-veterans, HR 0.83, 95% CI 0.73-0.95, p=0.006 unadjusted (Figure 5-2). The decrease in risk in the youngest veterans was similar after adjusting for deprivation, HR 0.84, 95% CI 0.74-0.96, p=0.008.

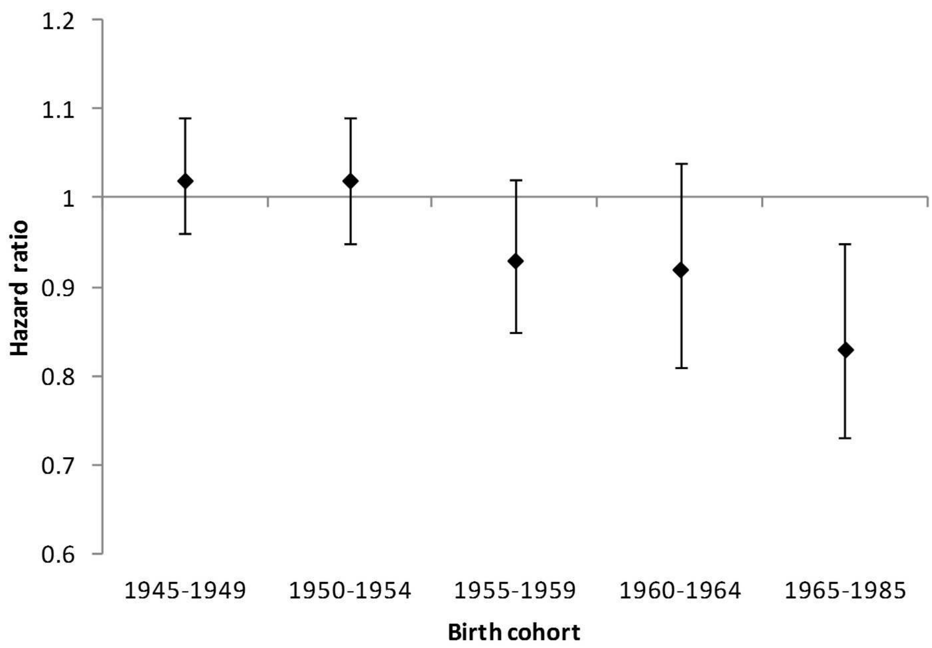

Figure 5-2 - Hazard ratios for all cancer in veterans referent to non-veterans by birth cohort

5.6.1.4 Length of Service

Analysis by length of service in veterans overall and in two birth cohorts, compared against all non-veterans, showed no significant difference in risk of any cancer for any length of service in either older or younger veterans, apart from a statistically significant reduction in risk in both older and younger veterans who had served for 17-22 years[97].

[97] The 22-year point represents completion of a full career in the Army for those who are not commissioned as officers. The majority of veterans who left after 17-22 years are likely to have been senior non-commissioned officers (NCOs) (sergeants and staff-sergeants, and equivalent in the Royal Navy and Royal Air Force) and warrant officers, in middle managerial or senior technical roles.

There was a non-significant reduction in risk in veterans with over 22 years' service. The results are summarised at Table 5-1.

Table 5-1 - Cox proportional hazard model of the association between veteran status and any cancer, overall and stratified by length of service and birth cohort

	Veteran cases	All Veterans *n*-56,205			Born 1945-1959 *n*=29,709			Born 1960-1985 *n*=26,496		
	n	HR	95% CI	p	HR	95% CI	p	HR	95% CI	p
Overall										
Univariate	3,588	0.98	0.94-1.01	0.197	1.00	0.96-1.04	0.976	0.88	0.80-0.96	0.004
Multi-variable	3,588	0.97	0.94-1.01	0.171	1.00	0.96-1.04	0.873	0.88	0.81-0.97	0.006
Length of service										
Basic training[98]	413	0.99	0.90-1.09	0.855	1.03	0.93-1.15	0.541	0.83	0.65-1.06	0.114
ESL (0-3 years)[99]	820	1.04	0.96-1.11	0.331	1.06	0.98-1.15	0.156	0.97	0.82-1.14	0.691
4-6 years	677	0.98	0.90-1.06	0.554	0.99	0.91-1.08	0.886	0.93	0.78-1.10	0.383
7-9 years	480	1.00	0.92-1.10	0.921	1.02	0.92-1.13	0.747	0.95	0.77-1.17	0.626
10-12 years	374	0.98	0.88-1.09	0.698	0.99	0.88-1.11	0.866	0.93	0.73-1.18	0.545
13-16 years	261	0.99	0.88-1.13	0.918	1.05	0.92-1.21	0.459	0.78	0.58-1.04	0.096
17-22 years	215	0.79	0.69-0.91	0.001	0.82	0.71-0.96	0.011	0.59	0.38-0.91	0.018
≥23 years	342	0.92	0.83-1.03	0.169	0.95	0.85-1.07	0.401	0.63	0.40-1.00	0.052

5.7 Specific Cancers

A total of 23 specific cancers were considered to be of *a priori* interest, including respiratory, gastro-intestinal, reproductive, lymphohaematopoietic, intracranial, and skin cancers, as described at Sections 2.2.3.3 and 5.4. These are summarised in order of frequency in veterans, with crude cumulative incidences in veterans and non-veterans, at Table 5-2.

[98] Veterans who did not complete basic training, defined in this study as serving for less than 0.4 years

[99] ESL = Early Service Leavers, who did not complete the minimum term of engagement

Table 5-2 - Crude cumulative incidence of specific cancers in veterans and non-veterans (with ICD codes)

	ICD 10 codes	ICD 9 codes	Veterans *n*=56,205 n (%)	Non-veterans *n*=172,741 n (%)	p value[100]
Non-melanoma skin	C44	173	712 (1.27)	2344 (1.36)	0.106
Lung	C33, C34	162	445 (0.79)	1106 (0.64)	<0.001
Colorectal	C18-C21	153-154	330 (0.59)	993 (0.57)	0.739
Oropharynx/larynx	C00-C14, C32	140-149, 161	291 (0.52)	707 (0.41)	<0.001
Oesophageal	C15	150	150 (0.27)	373 (0.22)	0.028
Non-Hodgkin lymphoma (age > 19)	C82-C86	200, 202.0, 202.7, 202.8	144 (0.26)	539 (0.31)	0.035
Bladder	C67	188	136 (0.24)	339 (0.20)	0.039
Malignant melanoma	C43	172	134 (0.24)	476 (0.28)	0.138
Leukaemia	C90-C95	203-208	125 (0.22)	373 (0.22)	0.621
Renal	C64, C65	189.0, 189.1	115 (0.20)	356 (0.21)	0.946
Stomach	C16	151	98 (0.17)	252 (0.15)	0.133
Intracranial (age > 19)	C71	191	82 (0.15)	296 (0.17)	0.196
Pancreatic	C25	157	63 (0.11)	206 (0.12)	0.667
Hodgkin lymphoma (age > 19)	C81	201	59 (0.10)	189 (0.11)	0.980
Liver	C22	155	44 (0.08)	180 (0.10)	0.088
Small intestine	C17	152	17 (0.03)	63 (0.04)	0.493
Mesothelioma	C38.4, C45	163	14 (0.02)	76 (0.04)	0.047
Sex-specific cancers					
Female			5,235 (100)	20,703 (100)	
Breast	C50	174	128 (2.54)	540 (2.61)	0.634
Ovarian	C56	183	22 (0.42)	61 (0.29)	0.151
Cervical	C53	180	18 (0.34)	81 (0.39)	0.619
Uterine	C54, C55	182	11 (0.21)	62 (0.30)	0.276
Male			50,970 (100)	152,038 (100)	
Prostate	C61	185	246 (0.48)	777 (0.51)	0.433
Testicular	C62	186	156 (0.31)	510 (0.34)	0.316
Breast	C50	175	4 (0.01)	26 (0.02)	0.137

The commonest cancers overall in both veterans and non-veterans were the non-melanoma skin cancers, although the incidence of breast cancer in women was higher. Lung cancer was the commonest non-cutaneous cancer, followed by colorectal, oropharyngeal and laryngeal, and prostate cancer in men. The specific cancers will be explored in detail in the following sections.

[100] p values for odds ratios

5.8 Lung Cancer

Cancer of the lung was defined as ICD-9 code 162, or ICD-10 code C33 or C34, at any position in the record.

5.8.1 Incidence

5.8.1.1 Overall

Veterans had a higher incidence of lung cancer than non-veterans. During the 32 years of follow-up, there were 445 cases of lung cancer in veterans compared with 1,106 in non-veterans, equivalent to a cumulative incidence of 0.79% and 0.64% respectively. Of these, 437 (98.2%) cases in veterans and 1,076 (97.3%) cases in non-veterans occurred over age 40 years. The difference in risk between veterans and non-veterans was highly significant; Cox proportional hazard ratios, using a landmark age 40 years to minimise confounding by lung tumours of non-bronchogenic origin in younger people, showed an unadjusted hazard ratio of 1.22, 95% CI 1.09-1.36, p=0.001. After adjusting for deprivation, the hazard ratio was 1.16, 95% CI 1.04-1.30, p=0.008. Testing for non-proportionality of the hazards was non-significant, p=0.775. The Nelson-Aalen plot demonstrates the increased risk in veterans (Figure 5-3).

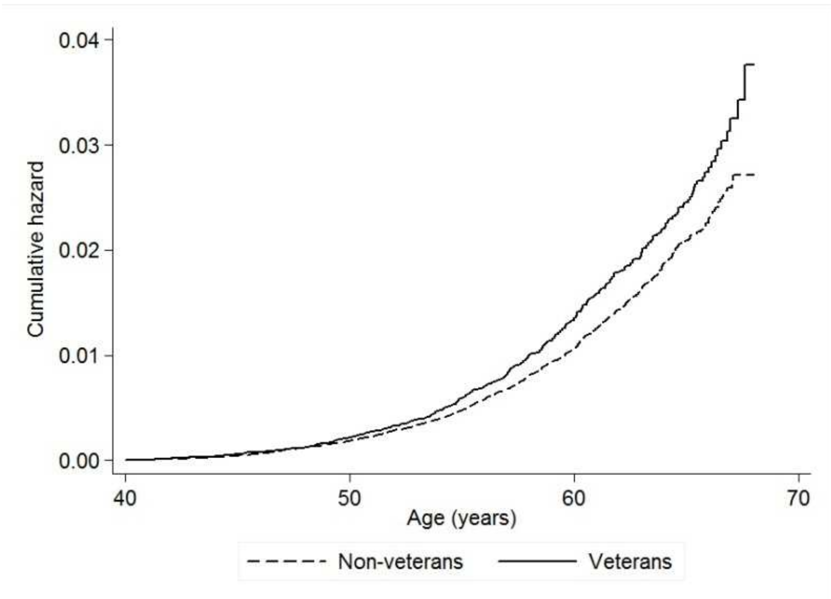

Figure 5-3 - Nelson-Aalen plot of lung cancer in veterans and non-veterans
Landmark age 40 years

5.8.1.2 Sex

When stratified by sex, there were 408 (0.80%) cases in male veterans and 972 (0.64%) cases in male non-veterans aged over 40 years. For women, the figures were 29 (0.55%) and 104 (0.50%) cases for veterans and non-veterans respectively. The difference was highly significant for men but non-significant for women (Table 5-3).

Table 5-3 - Cox proportional hazard model of the association between veteran status and risk of lung cancer, stratified by sex

Sex	Veteran cases	Univariate			Multi-variable		
	n	HR	95% CI	p	HR	95% CI	p
Men	408	1.23	1.09-1.38	0.001	1.17	1.04-1.31	0.008
Women	29	1.09	0.72-1.66	0.671	1.07	0.70-1.62	0.760

5.8.1.3 Birth Cohort

Stratification by birth cohort showed the increase in risk to be greatest in veterans born between 1950 and 1954. There was an overall reducing risk from the 1950-1954 birth cohort onwards. There was a non-significant increase for veterans born 1945-1949 and 1955-1959, and a non-significant decrease in risk in veterans born after 1960 (Figure 5-4). The differences were similar after adjusting for deprivation.

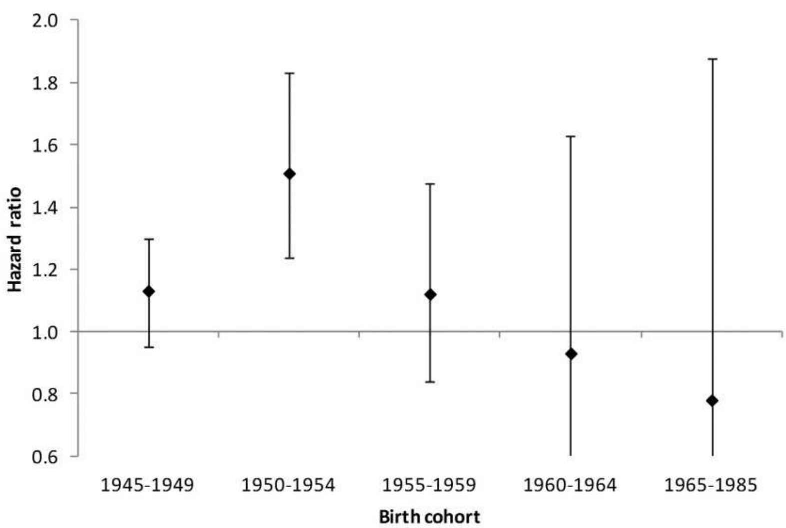

Figure 5-4 - Hazard ratios for lung cancer by birth cohort
Veterans referent to non-veterans

Analysis of the incidence of lung cancer per 100,000 person-years showed a pattern of reducing incidence in both veterans and non-veterans with successive birth cohorts. Although the veterans started from a higher incidence, their rate fell more steeply in those born in the early 1950s, and there was no difference in rates, compared to non-veterans, for those born from 1965 onwards (Figure 5-5).

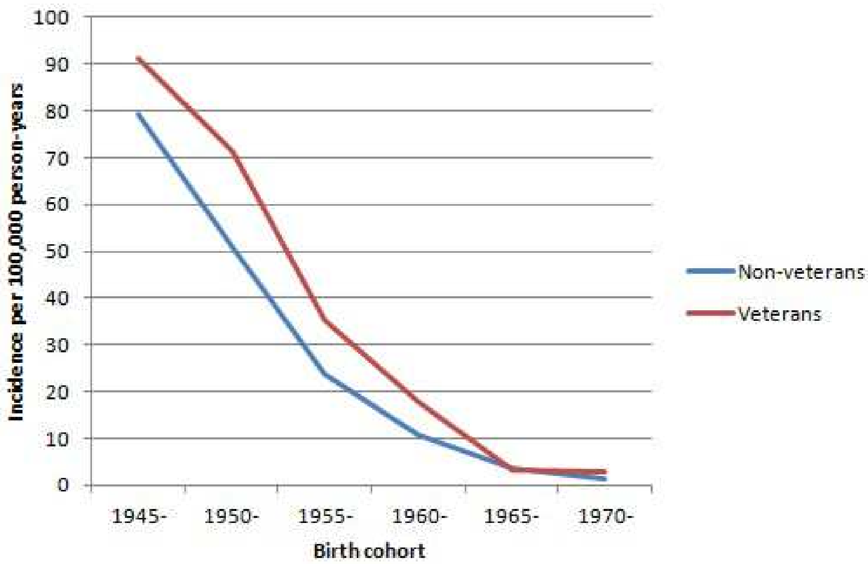

Figure 5-5 - Incidence of lung cancer per 100,000 person-years Veterans and non-veterans

The mean age at diagnosis of lung cancer was 54.9 years (SD 6.8) for veterans and 54.6 years (SD 7.2) for non-veterans. The kernel density plot confirmed that there was no difference in age at diagnosis (Figure 5-6).

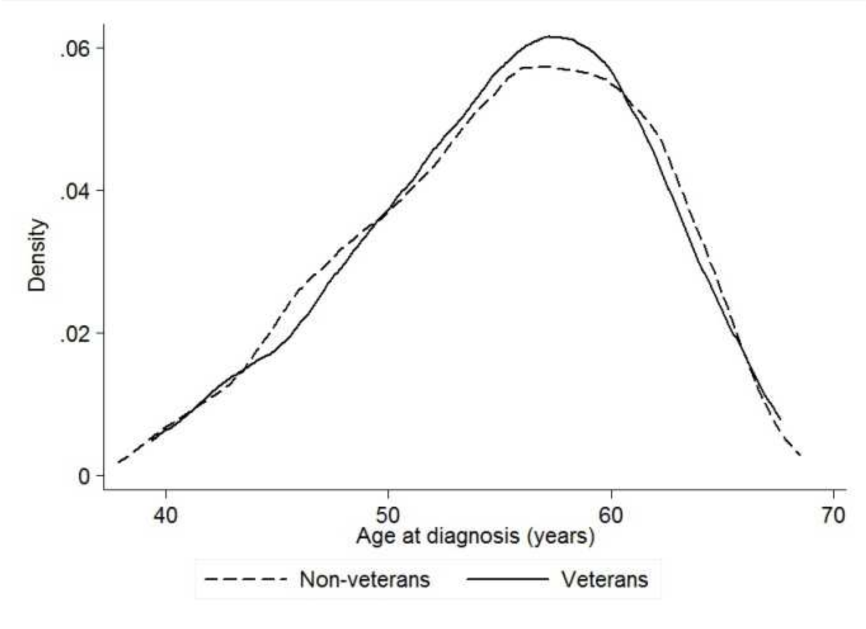

Figure 5-6 – Kernel density plot - age at diagnosis of lung cancer

5.8.1.4 Length of Service

Stratifying by length of service, overall and in two birth cohorts, showed a gradient of decreasing risk with longer service, with the highest risk in those who did not complete initial training. The increase in risk was highest for those born before 1960, whilst for those born from 1960 onwards, there was a non-significant decrease overall. The pattern of decreasing risk with length of service was seen across both birth cohorts, although small numbers of cases in the post-1959 cohort gave rise to wide confidence intervals (Table 5-4).

Table 5-4 - Cox proportional hazard model of the association between veteran status and lung cancer, overall and stratified by length of service and birth cohort

	Veteran cases	All Veterans *n*-56,205			Born 1945-1959 *n*=29,709			Born 1960-1985 *n*=26,496		
	n	HR	95% CI	p	HR	95% CI	p	HR	95% CI	p
Overall										
Univariate	437	1.22	1.09-1.36	0.001	1.24	1.11-1.39	<0.001	0.78	0.44-1.35	0.361
Multi-variable	437	1.16	1.04-1.30	0.008	1.18	1.06-1.32	0.004	0.77	0.44-1.35	0.358
Length of service in 8 categories										
Basic training[98]	61	1.52	1.17-1.97	0.002	1.49	1.14-1.95	0.004	1.93	0.70-5.30	0.204
ESL (0-3 years) [99]	109	1.46	1.19-178	<0.001	1.46	1.19-1.79	<0.001	1.30	0.52-3.23	0.575
4-6 years	85	1.32	1.06-1.65	0.013	1.36	1.08-1.70	0.008	0.59	0.50-2.43	0.470
7-9 years	55	1.21	0.92-1.59	0.170	1.26	0.96-1.65	0.102	0.40	0.05-2.85	0.357
10-12 years	38	1.02	0.74-1.42	0.868	1.10	0.79-1.52	0.574	*	*	*
13-16 years	30	1.21	0.84-1.74	0.300	1.30	0.90-1.88	0.165	0.47	0.07-3.40	0.456
17-22 years	18	0.61	0.38-0.99	0.047	0.65	0.41-1.06	0.083	*	*	*
≥23 years	41	0.97	0.71-1.33	0.861	0.96	0.60-1.32	0.810	1.24	0.30-5.08	0.765
Length of service in 2 categories										
≤12 years	348	1.33	1.18-1.50	<0.001	1.35	1.19-1.53	<0.001	0.85	0.46-1.58	0.615
> 12 years	89	0.92	0.74-1.15	0.466	0.95	0.76-1.19	0.651	0.54	0.17-1.73	0.302

* No cases

The data were also stratified by length of service in 4 broad categories; ESL who did not complete initial training, other ESL (completed initial training but not initial term of engagement), individuals who served for 4-12 years, and those who served for over 12 years[101], and the results were presented graphically (Figure 5-7). This clearly demonstrated the effect of seniority on lung cancer risk, with the highest risk in ESL. Those who left at the most senior level had a risk slightly lower than non-veterans, whilst those with an intermediate length of service demonstrated lower risk than the ESL, but higher than non-veterans.

[101] The placement of the boundary at 12 years is a proxy for the highest rank achieved, most people leaving prior to 12 years reaching no higher than corporal whilst most of those who served longer will have been senior non-commissioned officers or officers

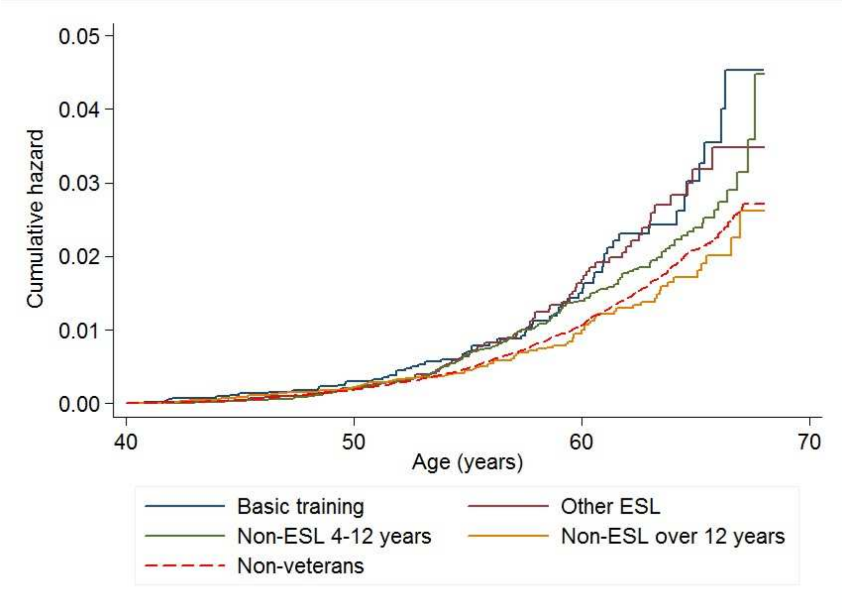

Figure 5-7 – Nelson Aalen plot of lung cancer by length of service Non-veterans for comparison

5.8.2 Case-Fatality

The mean follow-up from date of initial admission for lung cancer to the date of death or the end of the study on 31 December 2012 was 1.27 years (range 0-20.04 years) for veterans and 1.32 years (range 0-23.09 years) for non-veterans, representing 555 person-years of follow-up in the veterans and 1,420 person-years in the non-veterans. There were 365 (77.2%) deaths in veterans with lung cancer, equating to 657.7 per 1,000 person-years, and 882 (82.0%) deaths in non-veterans (621.0 per 1,000 person-years). There was no difference between veterans and non-veterans for either one-year or 5-year case-fatality rates; HR 1.00, 95% CI 0.74-1.37, p=0.988 at one year and 1.03, 95% CI 0.80-1.34, p=0.796 at 5 years in the univariate model. The results were unaltered after adjusting for deprivation.

5.8.3 Commentary

5.8.3.1 Risk Factors

The main risk factor for lung cancer is tobacco smoke. The majority of cases occur in smokers (either current or past) but 15-20% of cases occur in non-smokers, many of whom have been exposed to environmental tobacco smoke, although not all can be attributed to passive smoking (Jenkins 2008a). Other risk factors include the naturally-occurring radioactive gas radon, which is itself associated with an increased risk of lung cancer but acts synergistically with tobacco to increase the risk multiplicatively (Darby et al. 2005). Inhalation of asbestos fibres also increases the risk of lung cancer, in addition to increasing the risk of mesothelioma (Hodgson and Darnton 2000); like radon, asbestos acts synergistically with tobacco smoke (Saracci 1977).

The pattern of highest risk in those with the shortest service, and reducing risk with increasing length of service, is not consistent with exposure to any occupational carcinogen, where longer exposure would be expected to give rise to increasing risk. Instead, it points to a lifestyle risk which may be modified very early in service, but which reduces over time in those who continue to serve[102]. Tobacco is likely to be the best fit as smoking rates are known to be higher in military personnel than civilians, to increase in the first few weeks of service, and to reduce with longer service and higher rank, as discussed at Section 8.3.2 and Appendix 4, Section A4.1.3.

5.8.3.2 Implications for the Hypothesis

The finding of a pattern of increased risk of lung cancer, consistent with tobacco smoking as a possible risk factor, was concordant with the conclusion which emerged from the analysis of cardiovascular disease (Chapter 4, Sections 4.10.2 and 4.10.3). Accordingly, the emerging hypothesis that smoking was an important influence on the health of veterans, and that the effect was greatest in those with the shortest service, was further tested by examining the risk profiles for the other major smoking-related cancers.

The absence of data on the prevalence of smoking in the cohort was a limitation which could only be fully addressed in other research; however, data from military studies from the 1960s onwards provided a comparison between military and civilian smoking prevalence at a time when many of the veterans were serving, as discussed at Appendix 4, Section A4.1.3.

[102] Lodge’s study demonstrates that the percentages of both never-smokers and ex-smokers increases with rank (and hence, by implication, length of service), indicating both that longer-serving people are more likely to stop smoking and that non-smokers are more likely to have longer military careers. Lodge, L. H. (1991) 'Tri-service Health Questionnaire - 1989', *Journal of the Royal Army Medical Corps,* 137(2), 80-83.

5.9 Oropharyngeal/Laryngeal Cancer

Cancer of the oropharynx and larynx was defined as ICD-9 codes 146, 161 and ICD-10 C01, C09, C10, C32, at any position in the record.

5.9.1 Incidence

5.9.1.1 Overall

Over the period of follow-up, there were 291 cases of oropharyngeal and laryngeal cancer in veterans compared with 707 in non-veterans, equating to a cumulative incidence of 0.52% and 0.41% respectively. The difference was statistically significant both in the unadjusted Cox model, HR 1.23, 95% CI 1.07-1.41, p=0.003 and after adjusting for deprivation, HR 1.19, 95% CI 1.04-1.37, p=0.013 (Figure 5-8). Testing for non-proportionality of the hazards was non-significant, p=0.084. The mean age at diagnosis was 52.7 years (SD 7.7) for veterans and 51.6 years (SD 8.0) for non-veterans.

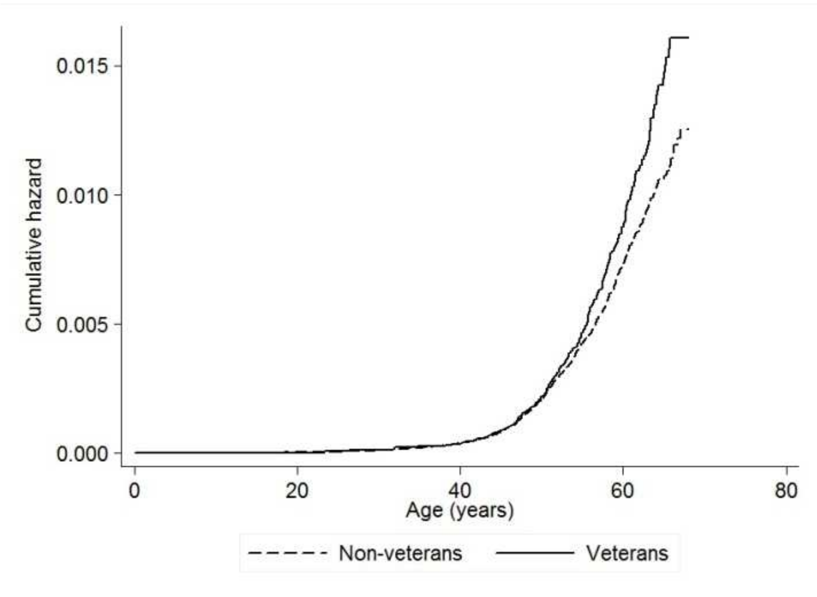

Figure 5-8 – Nelson-Aalen plot of oropharyngeal and laryngeal cancer by veteran status

5.9.1.2 Sex

The majority of cases of cancer of the oropharynx and larynx were in men, in both veterans (98.28%) and non-veterans (96.89%). The difference in men was statistically significant, HR 1.21, 95% CI 1.05-1.39, p=0.007 unadjusted and 1.17, 95% CI 1.02-1.35, p=0.026 after adjusting for deprivation. Only 5 (1.72%) of the cases of cancer of the oropharynx and larynx were in women veterans. For the non-veterans, there were 22 (3.11%) cases in women. The difference between veteran and non-veteran women was not statistically significant, HR 0.97, 95% CI 0.36-2.56, p=0.947 in the unadjusted model. The hazard ratio was similar after adjusting for deprivation.

5.9.1.3 Birth Cohort

The hazard ratios, for both men and women together, decreased steadily for the oldest three birth cohorts (1945-1959 births); the risk was only statistically significantly increased in veterans in the oldest (1945-1949) cohort. For veterans born from 1955 onwards, the hazard ratio was close to unity, indicating that there was little or no difference in risk of oropharyngeal and laryngeal cancer between veterans and non-veterans (Figure 5-9).

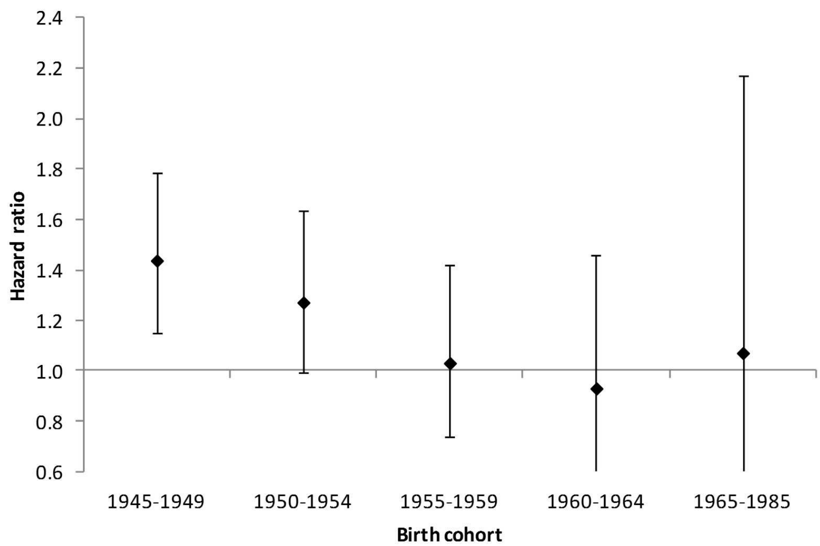

Figure 5-9 - Hazard ratios for oropharyngeal & laryngeal cancer in veterans by birth cohort referent to non-veterans

5.9.1.4 Length of Service

There was a complex pattern of risk of oropharyngeal and laryngeal cancer by length of service, stratified by common lengths of engagement[103] and compared against all non-veterans, as shown at Table 5-5. There was an increased risk for all lengths of service apart from 13-16 years and over 22 years, but this was only statistically significant for the ESL who had completed training, and for people who had served for 10-12 years. The

[103] Terms of military service

analysis by birth cohort and length of service together was omitted; only 40 (13.75%) of the veteran cases were born from 1960 onwards and there were insufficient numbers in each category of length of service to yield meaningful results. The overall impact of length of service is illustrated in the Nelson-Aalen plot at Figure 5-10, and only becomes clear beyond the age of 60 years; the risk in veterans was increased in all those who served for up to 12 years, but was no different from non-veterans for those with over 12 years' service. For those with under 12 years' service, ESL who completed basic training but served for less than 3 years were at higher risk than those who left in basic training; the risk in the latter was similar to those with 4-12 years service. However the lines for these categories cross, indicating that the proportional hazards assumptions have been violated and thus the Cox model is not strictly applicable at this level of detail (Hess 1995). Analysis in 2 broad categories of length of service, stratified at the 12-year point, demonstrates a highly significant increase in risk of oropharyngeal and laryngeal cancer for veterans with less than 12 years service, and no difference in risk from non-veterans for those with longer service (Table 5-5, section 3).

Table 5-5 - Cox proportional hazard model of the association between veteran status and oropharyngeal and laryngeal cancer, overall and stratified by length of service, referent to all non-veterans

	Veteran cases *n*	HR	All Veterans *n*=56,205 95% CI	p
Overall				
Univariate	291	1.23	1.07-1.41	0.003
Multi-variable	291	1.19	1.04-1.04	0.013
Length of service in 8 categories				
Basic training[98]	33	1.27	0.90-1.80	0.178
ESL[99] **(0-3 years)**	68	1.39	1.08-1.78	0.010
4-6 years	55	1.26	0.95-1.66	0.102
7-9 years	34	1.15	0.82-1.63	0.420
10-12 years	38	1.58	1.13-2.19	0.007
13-16 years	13	0.73	0.41-1.29	0.278
17-22 years	24	1.15	0.73-1.79	0.547
≥23 years	26	1.02	0.69-1.53	0.911
Length of service in 2 categories				
≤ 12 years	228	1.32	1.13-1.54	<0.001
>12 years	63	0.96	0.73-1.26	0.767

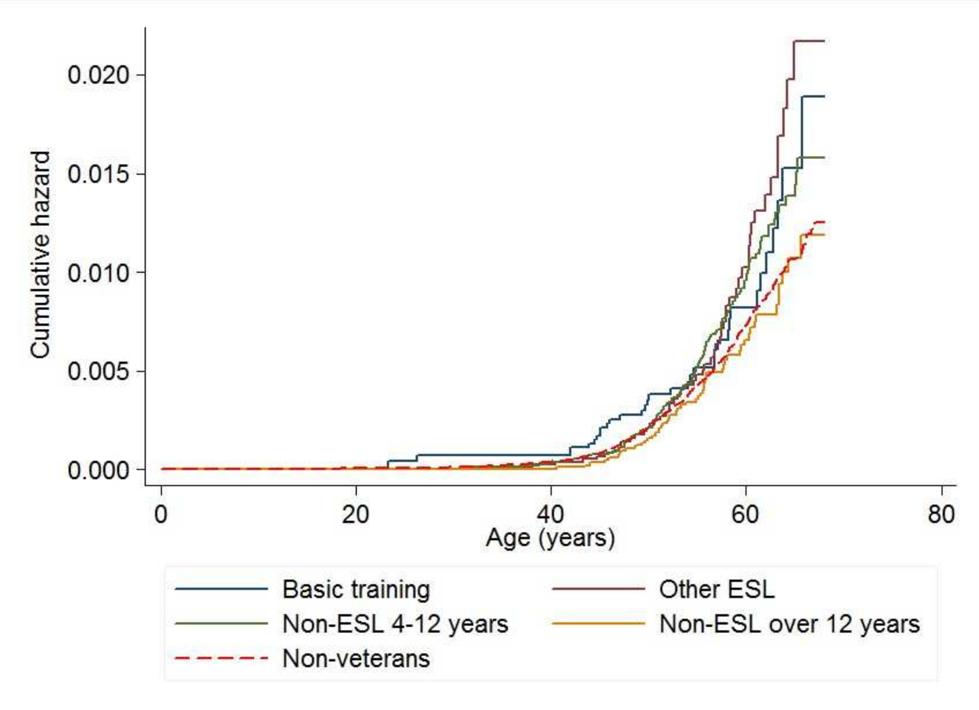

Figure 5-10 – Nelson-Aalen plot of oropharyngeal and laryngeal cancer by length of service Non-veterans for comparison

5.9.2 Case-Fatality

The mean follow-up from date of initial admission for oropharyngeal or laryngeal cancer to the date of death or the end of the study was 4.95 years (range 0-28.89 years) for veterans and 5.17 years (range 0-31.49 years) for non-veterans, representing 1,440 person-years of follow-up in the veterans and 3,655 person-years in the non-veterans. There were 113 (38.8%) deaths in veterans with cancer of the oropharynx or larynx, equating to 78.5 per 1,000 person-years, and 284 (40.1%) deaths in non-veterans (77.7 per 1,000 person-years). The commonest cause of death, in both veterans and non-veterans, was the oropharyngeal or laryngeal cancer itself although about 10% of deaths were from lung cancer.

5.9.3 Commentary

The most important risk factors for oropharyngeal cancer are tobacco smoking and alcohol. The risk associated with smoking increases with number of packs per day and years of smoking, and a study by Blot et al. has demonstrated an OR of 3.6 (95% CI 2.3-5.6) after adjusting for alcohol for oropharyngeal cancer in men who have smoked for over 40 years. The odds ratio for heavy drinking is even higher, 8.8 (95% CI 5.4-14.3) after adjusting for smoking for men drinking more than 30 alcoholic drinks per week, with beer and spirit drinkers showing a greater risk than wine drinkers. The risk for both drinking and smoking has been shown to be multiplicative, the OR reaching 37.7 for the heaviest drinkers and smokers (Blot et al. 1988); a similar conclusion was reached by Tuyns et al. (Tuyns et al. 1988). The combined attributable risk for drinking and smoking was 80% in men and 61% in women (Blot et al. 1988). Using data from the American Cancer Society's second 'Cancer Prevention Study' (CPS-II), a prospective study of mortality in relation to smoking involving over a million adults, Parkin et al. estimated the relative risk for male current smokers aged over 35 years to be 27.5 for cancer of the lip, oral cavity and pharynx, and 10.5 for cancer of the larynx , and estimated 67% of laryngeal cancers and 41% of oropharyngeal cancers to be attributable to smoking (Parkin et al. 1994).

It is therefore likely that the data for oropharyngeal and laryngeal cancer provide an insight into the long-term impact not only of smoking but also of alcohol use in veterans. The finding that the rate was higher in ESL who did not complete a basic engagement than in those who left before completing initial training, thereby differing from the findings in respect of cardiovascular disease and lung cancer (Sections 4.10.2 and 5.8.3.1), is consistent with partial attributability of the risk to alcohol. Heavy drinking is not permitted during recruit training (Appendix 4, Section A4.2.3) but increases in the social environment of the junior ranks' mess, whilst personnel who leave close to the 12-year point have the longest exposure to the junior ranks' mess, having generally not progressed beyond the rank of corporal or equivalent. The increased risk seen in the 1945-1954 birth cohorts is also consistent with the pattern of heavier smoking in these veterans, providing further evidence supporting a pattern of smoking-related disease. The finding that there was no increased risk in those with over 12 years' service is consistent with the findings for lung cancer, and also provides no evidence of long-term alcohol-related harm in those with the longest service, notwithstanding their long exposure to the social environment of military messes, suggesting that seniority, which is generally associated with higher educational attainment, is protective.

5.10 Oesophageal Cancer

Cancer of the oesophagus was defined as ICD-9 code 150 or ICD-10 code C15, at any position in the record.

5.10.1 Incidence

5.10.1.1 Overall

There were 150 cases of oesophageal cancer in veterans compared with 373 in non-veterans, equating to a cumulative incidence of 0.27% and 0.22% respectively. The difference was statistically significant in the unadjusted model, HR 1.22, 95% CI 1.01-1.47, p=0.043 although it became non-significant after adjusting for deprivation, HR 1.19, 95% CI 0.99-1.44, p=0.068. Testing for non-proportionality of the hazards was non-significant, p=0.397. The cumulative hazard plot shows that the difference was predominantly seen in veterans over the age of 60 (Figure 5-11).

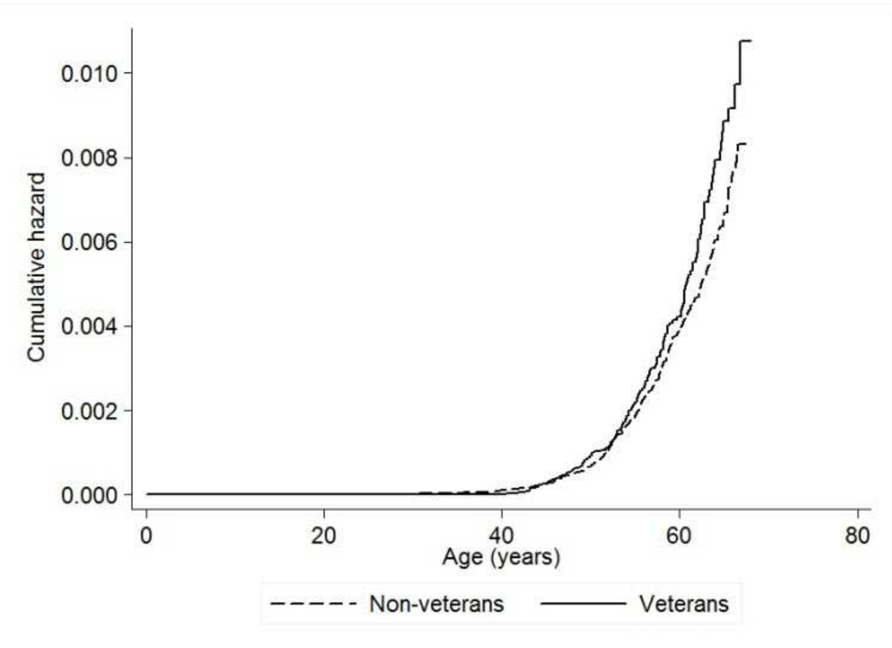

Figure 5-11 - Nelson-Aalen plot of oesophageal cancer by veteran status

5.10.1.2 Sex

Only 5 (3.33%) of the cases in veterans and 10 (2.68%) in non-veterans were in women. Although the hazard ratio showed a higher risk in women veterans, the increase did not achieve statistical significance, HR 2.01, 95% CI 0.69-5.88, p=0.203 in the unadjusted model. The figures were similar after adjusting for deprivation. The mean age at diagnosis, for men and women together, was 54.9 years (SD 6.3) for veterans and 54.1 years (SD 7.1) for non-veterans.

5.10.1.3 Birth Cohort

The risk of oesophageal cancer was only statistically significantly increased in veterans in the 1945-1949 birth cohort, p=0.029. Thereafter, the risk declined steadily and it was close to unity for all birth years from 1955 onwards (Figure 5-12).

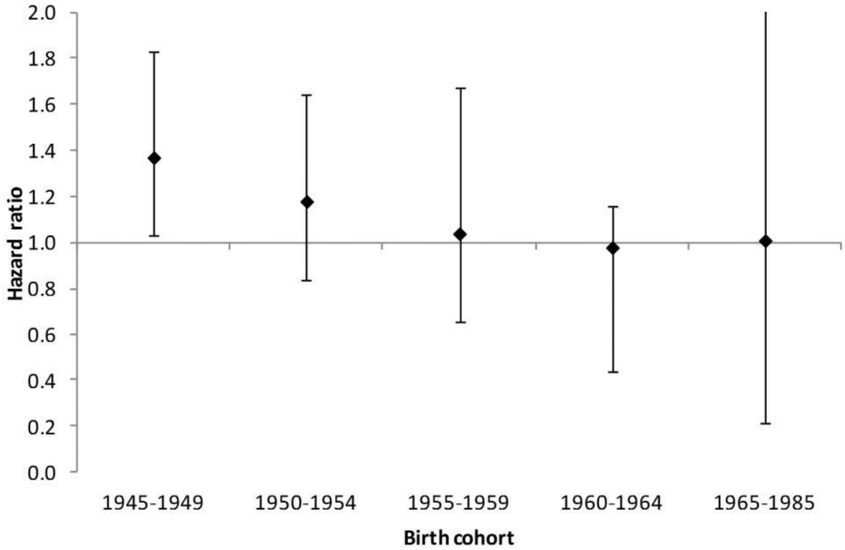

Figure 5-12 – Hazard ratios for oesophageal cancer in veterans by birth cohort Veterans referent to non-veterans

5.10.1.4 Length of Service

Subgroup analysis by length of service was difficult to interpret owing to small numbers in the subgroups, and the clearest picture was obtained when the results were presented graphically. Analysing all age-groups together, there was little indication of a length of service effect in veterans (Figure 5-13), but when the analysis was restricted to the higher-risk 1945-1949 birth cohort, there was clear evidence of increased risk compared to non-veterans for all lengths of service apart from those who left without completing initial training; the greatest increase in risk was in ESL who had entered trained service (Figure 5-14).

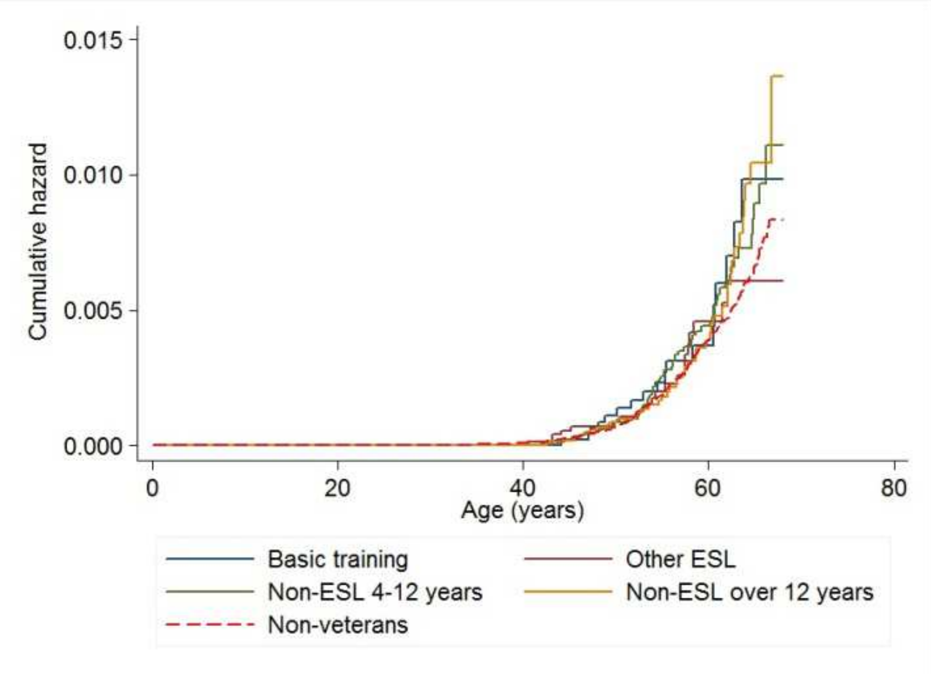

Figure 5-13 – Nelson-Aalen plot of oesophageal cancer by length of service All veterans. Non-veterans for comparison

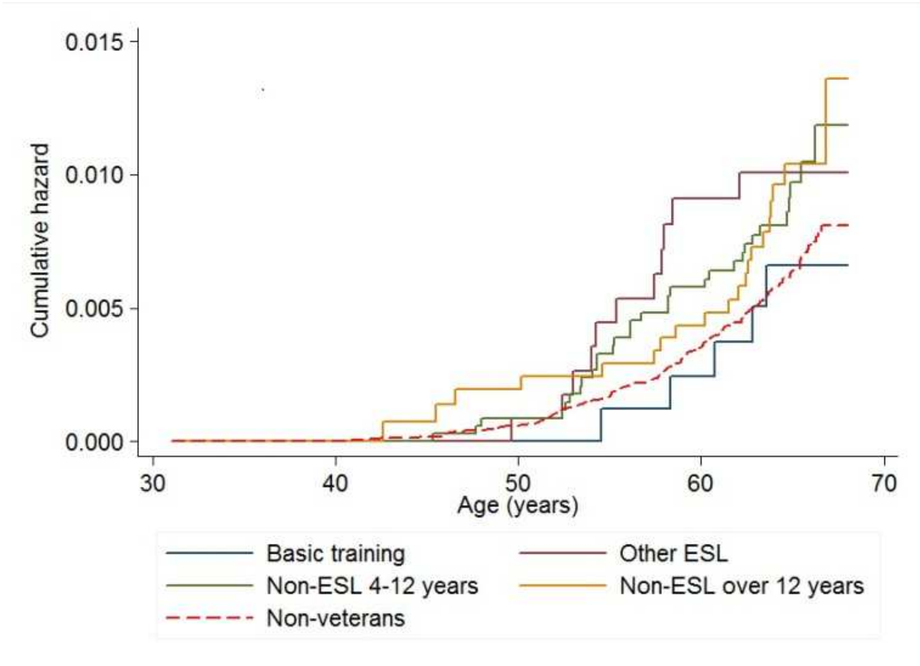

Figure 5-14 – Nelson-Aalen plot of oesophageal cancer by length of service 1945-1949 birth cohort only. Non-veterans for comparison

A kernel density plot comparing cases in veterans born 1945-1949 with the total number of veterans in that birth cohort who had served, by length of service, showed a lower density in those with the shortest service[104]; subsequently the cases broadly tracked the

[104] The early peak in the 'All veterans' curve predominantly represents ESL who left before completing training

number of leavers, with some flattening and spreading of the 22-year peak of leavers[105] (Figure 5-15).

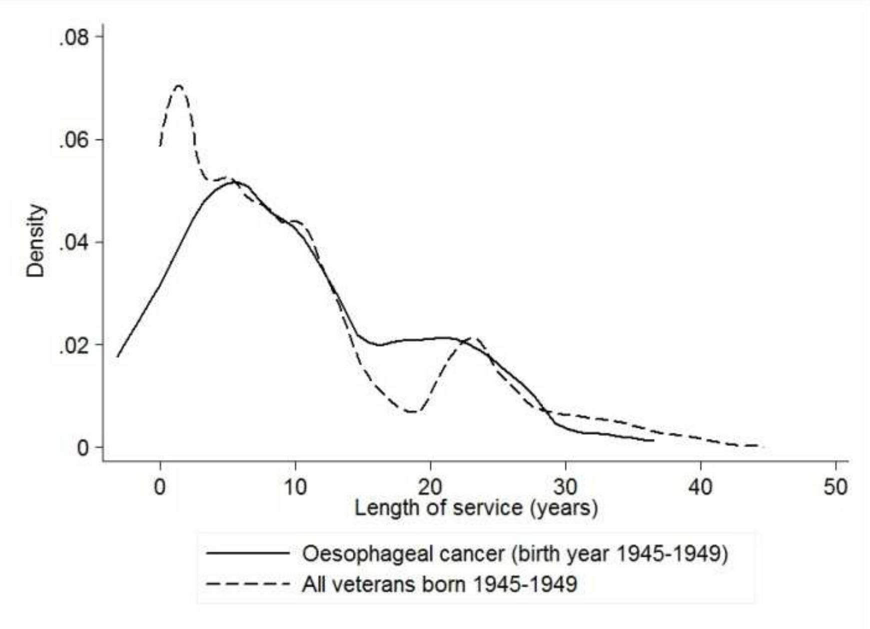

Figure 5-15 - Kernel density plot of oesophageal cancer by length of service referent to all veterans. 1945-1949 births only

5.10.2 Case-Fatality

The mean follow-up from date of first admission for oesophageal cancer to the date of death or the end of the study on 31 December 2012 was 1.82 years (range 0-18.01 years) for veterans and 1.76 years (range 0-25.48 years) for non-veterans, representing 272 person-years of follow-up in the veterans and 656 person-years in the non-veterans. There were 121 (80.7%) deaths in veterans with oesophageal cancer, equating to 443.2 per 1,000 person-years, and 289 (77.4%) deaths in non-veterans (440.2 per 1,000 person-years).

5.10.3 Commentary

The nature and epidemiology of oesophageal cancer have changed over the period covered by this study, from a pattern dominated by squamous cell carcinoma and strongly linked to tobacco and alcohol, to an increasing incidence of adenocarcinoma of more uncertain aetiology, although a strong link between adenocarcinoma and obesity

[105] The 22-year leavers correspond to those who have completed a 'full career' 22 year engagement, most leaving as a senior non-commissioned officer or warrant officer.

has been documented (Blot and McLaughlin 1999). With no data on histological type available in the Scottish Veterans Health Study dataset, the scope for interpretation is limited. However, Vaughan et al. examined risk factors for both histological types and found that both were significantly associated with cigarettes and alcohol although the odds ratios were very much higher for squamous cell carcinoma. A high BMI was inversely associated with risk of squamous cell carcinoma but positively associated with adenocarcinoma (Vaughan et al. 1995). Other studies have reported no association between alcohol and adenocarcinoma. *Helicobacter pylori* may be protective against adenocarcinoma (Holmes and Vaughan 2007); the role of *H. pylori* will be discussed further in Section 5.11.4. A study in Taiwan found that duration of smoking was an important risk factor for squamous cell carcinoma, but duration of alcohol consumption was not. The authors found that the strongest risk factor for oesophageal cancer was alcohol, and that there was a multiplicative effect with smoking (Lee et al. 2005).

Examining the 1945-1949 birth cohort only, the pattern of highest risk in the ESL who completed initial training, followed by those with 4-12 years service, is consistent with the pattern seen in oropharyngeal and laryngeal cancer, although the protection enjoyed by those who left the services during initial training is even stronger. These results suggest that although alcohol and smoking are relevant risk factors for oesophageal cancer in veterans, alcohol may play a far bigger part than smoking. This is consistent with research by Engel et al. who found a population attributable risk (PAR) of 80.2 (95% CI 57.6-92.4) for any alcohol consumption and 57.6 (95% CI 32.3-79.5) for ever smoking, for squamous cell carcinoma of the oesophagus in men (Engel et al. 2003). Since the majority of cases of oesophageal cancer in the wider UK population occur over the age of 60 years[106], it may be too early to be certain whether the trend demonstrated in Figure 5-12 represents a true reduction over time in the excess risk faced by veterans, or whether it is simply a function of small numbers of cases in the younger cohorts.

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[106] 83% of cases occur over the age of 60 years. Figures from Cancer Research UK http://www.cancerresearchuk.org/cancer-info/cancerstats/types/oesophagus/incidence/uk-oesophageal-cancer-incidence-statistics#By2 accessed 18 Aug 2014.

5.11 Stomach Cancer

Cancer of the stomach was defined as ICD-9 code 151 or ICD-10 code C16, at any position in the record.

5.11.1 Incidence

5.11.1.1 Overall

Stomach cancer was relatively infrequent, affecting 98 (0.17%) veterans and 252 (0.15%) non-veterans over the follow-up period, a non-significant increase in risk, unadjusted HR 1.19, 95% CI 0.94-1.51, p=0.139 and HR 1.18 (95% CI 0.93-1.49, p=0.171) after adjusting for deprivation. Testing for non-proportionality of the hazards was non-significant, p=0.196. The Nelson-Aalen plot demonstrates a small increase in risk in veterans older than mid-50 years (Figure 5-16).

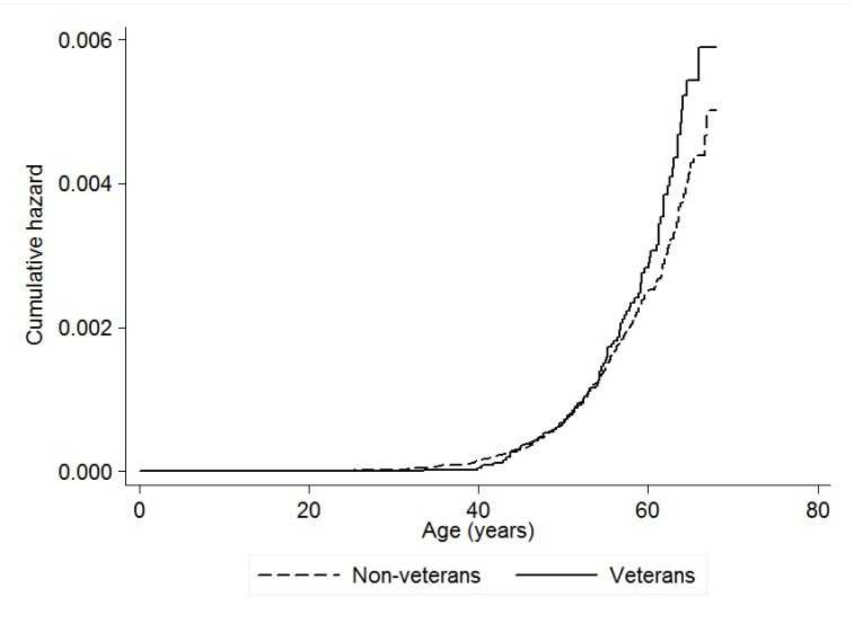

Figure 5-16 – Nelson-Aalen plot of stomach cancer by veteran status

5.11.1.2 Sex

There were 96 (0.19%) cases in male veterans compared with 234 (0.15%) cases in male non-veterans. For women, there were only 2 (0.04%) cases in veterans and 18 (0.09%) cases in non-veterans.

5.11.1.3 Birth Cohort

Only the 1950-1954 birth cohort showed a statistically significant increase in risk compared with non-veterans. There was a non-significant increase in the 1945-1949 birth cohort, but there was a non-significant decrease in risk for all veterans born after 1955 (Figure 5-17).

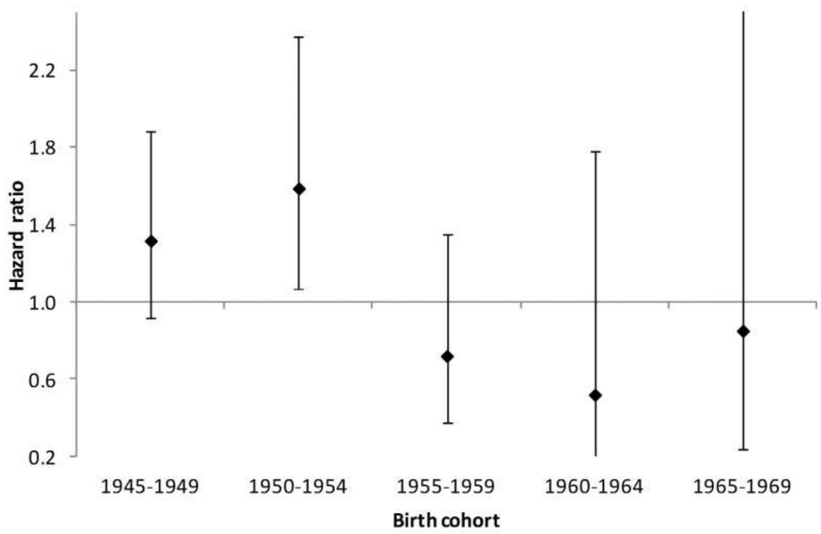

Figure 5-17 – Hazard ratios for stomach cancer in veterans by birth cohort Veterans referent to non-veterans

5.11.1.4 Length of Service

The number of cases was insufficient to permit valid analysis by length of service other than in broad groups, presented graphically at Figure 5-18. This showed the highest risk to be in ESL who had completed initial training, followed by people with 4-12 years service. There was no increase in risk for those with over 12 years' service, other than in the over-60s, whilst ESL who left before completing initial training showed a similar risk to non-veterans.

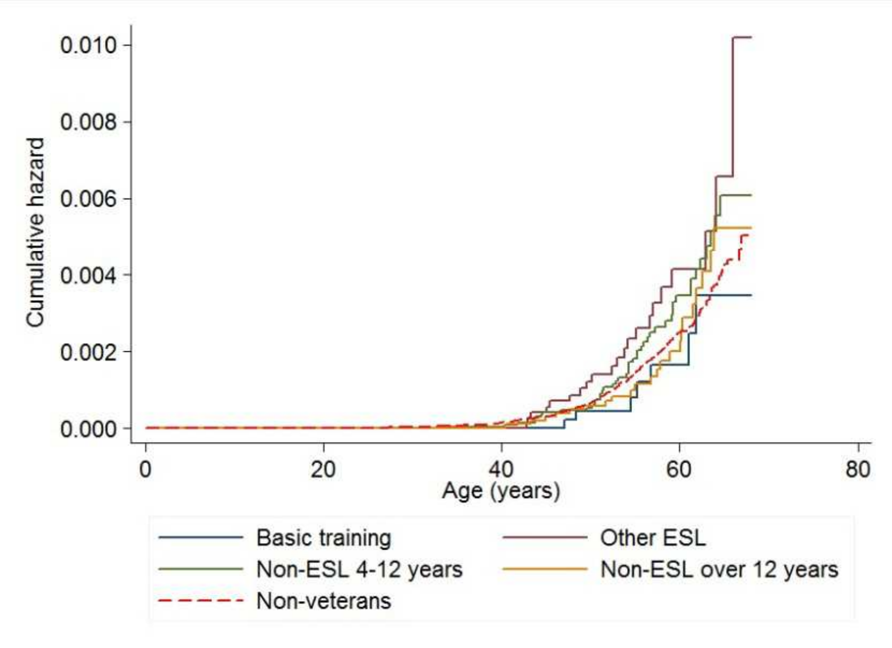

Figure 5-18 – Nelson-Aalen plot of stomach cancer by length of service Non-veterans for comparison

5.11.2 Regional Variation

Analysis by Health Board region showed a statistically significant increased risk of stomach cancer in veterans born prior to 1955 who were resident in two contiguous regions in the West of Scotland, Argyll & Clyde (subsumed into Highland and Greater Glasgow & Clyde in 2006) and Glasgow. Hazard ratios were 2.97 (95% CI 1.21-7.32, p=0.018) for Argyll & Clyde and 2.46 (95% CI 1.09-5.54, p=0.030) for Glasgow in the univariate Cox model. After adjusting for deprivation, the hazard ratios were 3.00 (95% CI 1.22-7.40, p=0.017) for Argyll & Clyde and 2.35 (95% CI 1.04-5.30, p=0.039) for Glasgow. There were no significant differences for any other Health Board region.

5.11.3 Case-Fatality

The mean follow-up from date of diagnosis of stomach cancer to the date of death or the end of the study on 31 December 2012 was 1.87 years (range 0-22.04 years) for veterans and 2.13 years (range 0-24.69 years) for non-veterans, representing 183 person-years of follow-up in the veterans and 537 person-years in the non-veterans. There were 81 (82.7%) deaths in veterans with stomach cancer, equating to 442.0 per 1,000 person-years, and 192 (76.2%) deaths in non-veterans (357.7 per 1,000 person-years). There was no difference between veterans and non-veterans in case-fatality at one year, HR 0.98, 95% CI 0.71-1.34, p=0.866, or at 5 years, HR 1.11, 95% CI 0.86-1.45, p=0.416 in the unadjusted Cox model. The hazard ratios were similar after adjusting for deprivation.

5.11.4 Commentary

Both the incidence and mortality of gastric cancer have been falling through the second half of the 20th century, although this fall has been accompanied by a rise in oesophageal adenocarcinoma, some of which may be attributed to obesity and gastro-oesophageal reflux. Many risk factors for gastric cancer have been described although most, including smoking and alcohol, are only weakly associated. *Helicobacter pylori* infection may account for around half of cases of gastric cancer, whilst a history of gastric ulcer (with or without surgery) is also a risk factor but is difficult to separate from *H. pylori*. The declining prevalence of *H. pylori* infection in the developed world (Go 2002) further hinders estimation of attribution, although the age-group in the Scottish Veterans study who were at highest risk of stomach cancer[107] are likely to have been exposed to *H. pylori* in early life (Blaser et al. 1995), prior to this decline. A diet which is low in fruit and vegetables, and a high intake of nitrates or nitrites, may also be associated with an increased risk (Kelley and Duggan 2003). Engels et al. found a PAR of 50.8 (95% CI 34.9-66.5) for ever-smoking in men for adenocarcinoma of the gastric cardia and 28.6 (95% CI 12.7-52.5) for the more common non-cardia cancers. The PAR was 15.0 (95% CI 7.0-29.2) for BMI in the uppermost quintile, referent to the lowest quintile, for cancers of the gastric cardia (Engel et al. 2003). With this uncertain pattern of risk, it is more difficult to explain the pattern seen in the Scottish Veterans dataset. The slight excess risk of gastric cancer may be explained by the small contribution of smoking to the risk of this disease, although there was also a high prevalence of peptic ulceration in service personnel from the Second World War through to around 1980 (Halsted and Weinberg 1946, Bergman and Miller 2000), which is likely to have been associated with high rates of *H. pylori* carriage[108], and may have contributed to a later risk of gastric cancer. There is no obvious

[107] Age 55 years and older. Source: Cancer Research UK http://www.cancerresearchuk.org/about-cancer/type/stomach-cancer/about/stomach-cancer-risks-and-causes#age accessed 24 March 2015

[108] The association between *H pylori* and peptic ulceration was not made until 1982, and thus carriage rates were not studied in military personnel during the period of high prevalence of peptic ulcer disease

explanation for the regional variation, which does not appear to reflect regional variations in the wider community[109].

5.12 Smoking-Related Cancers Excluding Lung

In order to provide a broad overview and increase the statistical power, the principal cancers associated with smoking, excluding lung cancer, were aggregated as 'other smoking-related cancer', and defined as cancer of the stomach (ICD-9 151.9, ICD-10 C16), oesophagus (ICD-9 150, ICD-10 C15), oropharynx and larynx (ICD-9 146, 161, ICD-10 C01, C09, C10, C32), bladder (ICD-9 188, ICD-10 C67) and kidney (ICD-9 189.0, ICD-10 C64), at any position in the record. A new binary variable was created for any instance of these conditions. A new date variable was created for the first instance of any of the specified diagnoses; all subsequent records were ignored to eliminate double counting. For the hazard ratios, a landmark analysis starting at age 40 years was performed for comparability with the lung cancer analysis.

5.12.1 Incidence

5.12.1.1 Overall

During the 32-year period of follow-up to 31 December 2012, there were 737 cases of smoking-related cancer (other than lung) in veterans compared with 1,883 in non-veterans, equating to a cumulative incidence of 1.31% in veterans and 1.09% in non-veterans. There was an incidence of 5.66 per 10,000 person-years in veterans compared with 3.47 in non-veterans, RR 1.63, 95% CI 1.49-1.77. In the Cox proportional hazard models, including both men and women, veterans were at significantly higher risk in both the univariate (HR 1.20, 95% CI 1.10-1.31, p<0.001) and multi-variable[110] analyses (HR 1.18, 95% CI 1.08-1.29, p<0.001) (Figure 5-19).

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[109] Data from ISD Scotland http://www.isdscotland.org/Health-Topics/Cancer/Cancer-Statistics/Stomach/ accessed 16 January 2015.

[110] Adjusted for deprivation

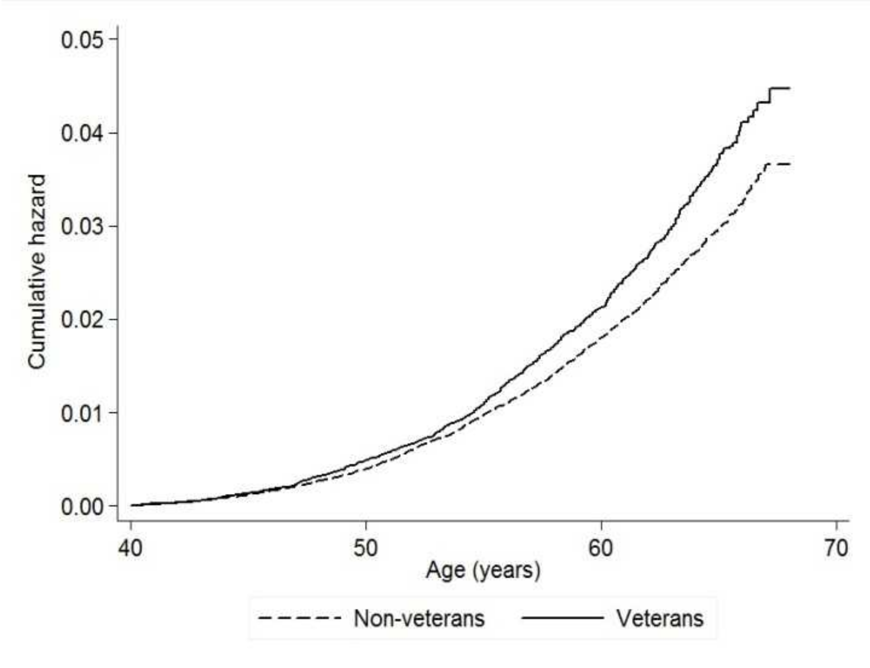

Figure 5-19 - Nelson-Aalen plot of other smoking-related cancer by veteran status

The risk was increased for all smoking-related cancers except kidney, although it only achieved statistical significance for oropharyngeal/laryngeal cancer and for oesophageal cancer (Table 5-6).

Table 5-6 - Cox proportional hazard model of the association between veteran status and risk of other smoking-related cancer, aggregated and by individual diagnosis

Cancer	Veteran cases	Univariate			Multi-variable[111]		
	n	HR	95% CI	p	HR	95% CI	p
'Other smoking-related cancer' (less lung)	737	1.20	1.10-1.31	<0.001	1.18	1.08-1.29	<0.001
Oropharyngeal/laryngeal cancer	291	1.25	1.09-1.44	0.002	1.21	1.05-1.39	0.009
Oesophageal cancer	150	1.26	1.04-1.52	0.019	1.23	1.02-1.49	0.032
Stomach cancer	98	1.27	1.00-1.61	0.052	1.24	0.98-1.58	0.074
Kidney cancer	115	0.98	0.79-1.22	0.863	0.97	0.78-1.21	0.809
Bladder cancer	136	1.21	0.98-1.49	0.082	1.21	0.98-1.49	0.077

[111] Adjusted for deprivation

5.12.1.2 Sex

In men, there were 713 (1.40%) cases of other smoking-related cancer in veterans and 1,796 (1.18%) cases in non-veterans; in women, there were 24 (0.46%) and 87 (0.42%) cases respectively. The hazard ratios were increased in veterans for both men and women but were only statistically significant for men (Table 5-7).

Table 5-7 - Cox proportional hazard model of the association between veteran status and risk of other smoking-related cancer, stratified by sex

Sex	Veteran cases	Univariate			Multi-variable		
	n	HR	95% CI	p	HR	95% CI	p
Men	713	1.18	1.08-1.29	<0.001	1.16	1.06-1.27	0.001
Women	24	1.21	0.75-1.96	0.424	1.21	0.75-1.95	0.430

5.12.1.3 Birth Cohort

When stratified by birth cohort, there was a statistically significant increase in risk of other smoking-related cancer for veterans born between 1945 and 1954, but the risk did not differ from non-veterans for those born from 1955 onwards (Figure 5-20).

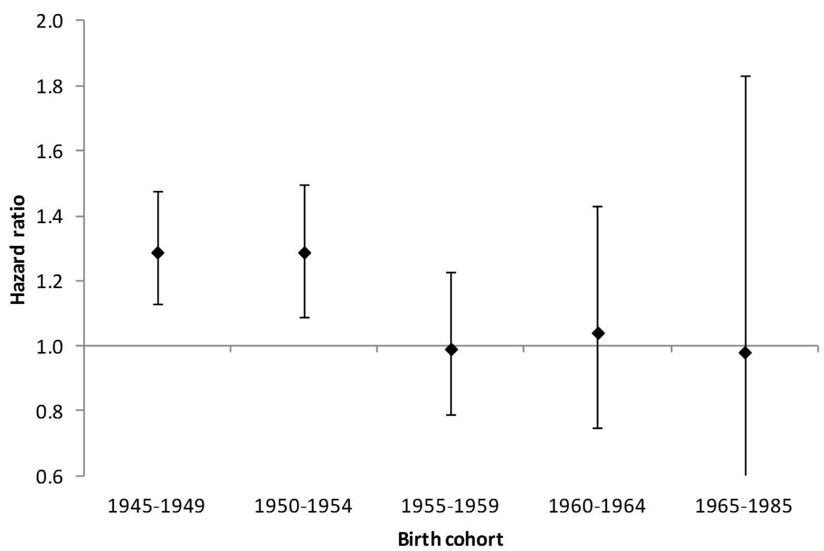

Figure 5-20 - Hazard ratios for other smoking-related cancer by birth cohort Veterans referent to non-veterans

5.12.1.4 Length of Service

Analysis by length of service revealed a more complex pattern. There was a small non-significant increase in risk of other smoking-related cancer in the older ESL who left during initial training, but the greatest increase was in veterans who left service at the 10-12 year point, when the majority would have reached a rank no higher than corporal or equivalent, unadjusted HR 1.41, 95% CI 1.13-1.75, p=0.002. ESL who started trained service but did not complete their initial engagement had a similar but slightly lower increase in risk, HR 1.29, 95% CI 1.10-1.52, p=0.002. The graph at Figure 5-21 shows the pattern of risk for the two categories of ESL and the two categories of non-ESL, and shows that even those with the longest service were at increased risk compared with non-veterans, in the oldest age-groups, whilst for the ESL who did not complete initial training, a difference from non-veterans only emerged beyond age 60 years.

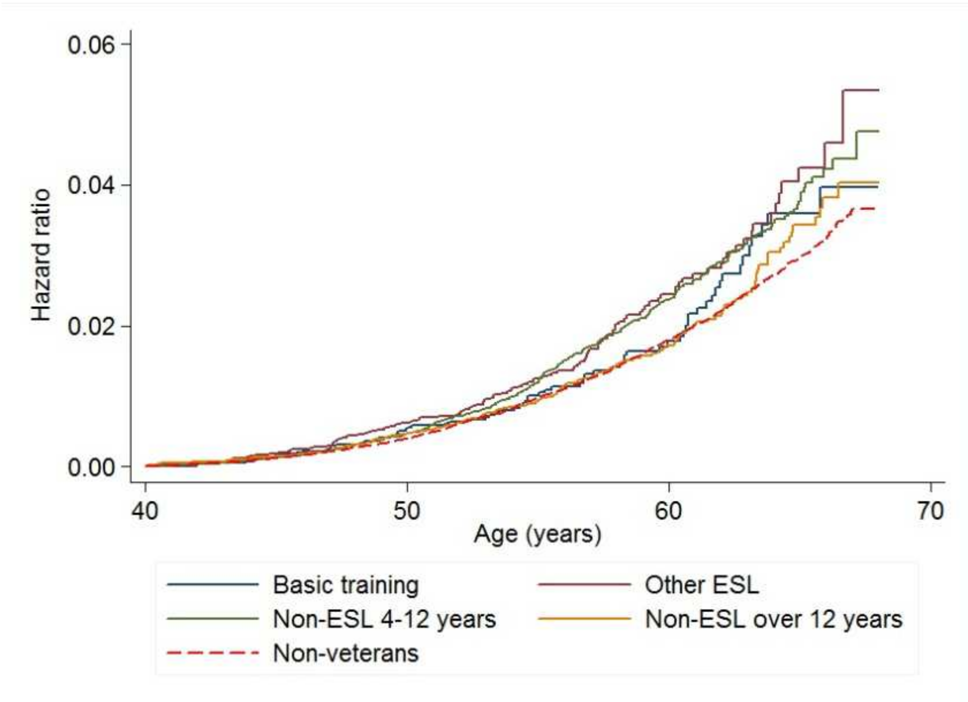

Figure 5-21 – Nelson-Aalen plot of other smoking-related cancer by length of service Non-veterans for comparison

5.12.2 Commentary

Interpretation of the pattern of risk for 'other smoking-related cancer' presents more challenges than for lung cancer, where 91% of deaths in men and 80% in women can be attributed to smoking (Table 8-6). For the other smoking-related cancers examined, the attributable percentage ranges from 77% of upper respiratory cancer in men and 58% in women, through 70% in men and 72% in women for oesophageal cancer, to 35% in men and 12% in women for stomach cancer (Twigg 2004). The analysis shows an overall significant increase in risks of oropharyngeal/laryngeal cancer and oesophageal cancer, the two cancer diagnoses (apart from lung) with the highest attributable risk arising from smoking, and therefore consistent with the hypothesis that smoking is a major factor in the difference between the health of veterans and that of non-veterans. However, analysis of the aggregated data for all 5 conditions suggests that there are additional factor(s) which may be service-related, and which may be particularly associated with serving in a junior rank, but with a lower association with having left before completing training. For both oropharyngeal/laryngeal cancer and oesophageal cancer, the additional major risk factor which is the 'best fit' is alcohol, for which a dose-response effect is recognised (Boffetta and Hashibe 2006) and for which, at least for oropharyngeal/ laryngeal cancer, exposure time is also positively related (Blot et al. 1988). That the association is strongest in those who left before progressing to senior non-commissioned officer rank suggests that heavy social drinking in the junior ranks may have been associated with a reduced likelihood of promotion; lower educational attainment is also likely to be a feature of this group. The increased risk for stomach cancer, which is only weakly associated with smoking, is discussed above at Section 5.11.4, whilst urinary cancers will be explored at Section 5.19 *et seq*.

5.13 Other Respiratory Cancers

5.13.1 Mesothelioma

Mesothelioma of the pleura was defined as ICD-9 code 163 or ICD-10 code C38.4 or C45, at any position in the record.

5.13.2 Incidence

5.13.2.1 Overall

Mesothelioma of the pleura accounted for only 14 cases of cancer in veterans and 76 in non-veterans, giving a crude cumulative incidence of 0.02% in veterans and 0.04% in non-veterans over the entire period of follow-up. Veterans were at statistically significantly reduced risk in the unadjusted model, HR 0.55, 95% CI 0.31-0.98, p=0.042. The hazard ratio was unchanged after adjusting for deprivation. The reduction in risk in veterans is illustrated at Figure 5-22; however, this shows that the lines cross and the proportional hazards assumption is violated, as confirmed by the *estat phtest* for non-proportionality, which was significant p=0.042. The analysis was therefore repeated using a landmark age of 55 years; the *estat phtest* was no longer significant, p=0.966, and the hazard ratio was 0.32, 95% CI 0.13-0.80, p=0.015, confirming the reduction in risk in older veterans.

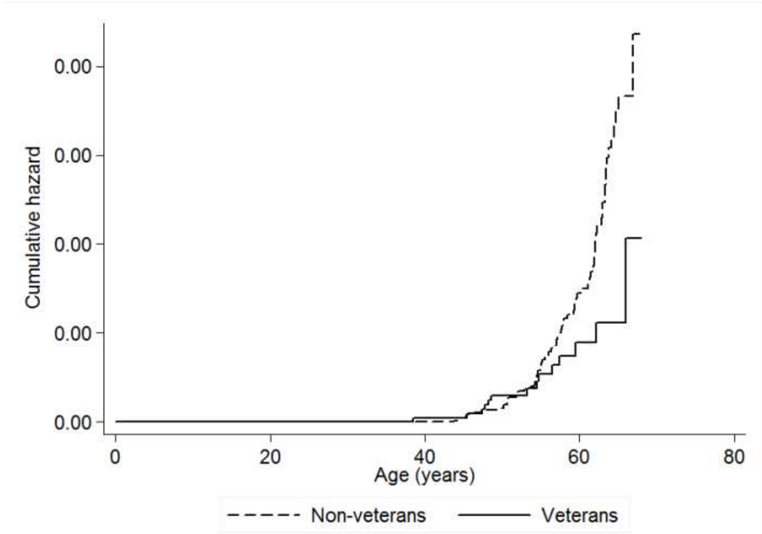

Figure 5-22 - Nelson-Aalen plot of mesothelioma by veteran status

Mean age at diagnosis was 52.8 years (SD 7.4) for veterans and 56.5 years (SD 5.9) for non-veterans.

5.13.2.2 Sex

There was one case of mesothelioma in a veteran woman, and none in the comparison non-veteran women.

5.13.2.3 Birth Cohort and Length of Service

There were insufficient numbers of cases to analyse by birth cohort or length of service, but 4 (29%) of the veterans had served for 2 years or less.

5.13.3 Case-Fatality

The mean follow-up from date of diagnosis of mesothelioma to the date of death or the end of the study on 31 December 2012 was 0.71 years (range 0.23-1.32 years) for veterans and 1.49 years (range 0.01-23.27 years) for non-veterans, representing 10 person-years of follow-up in the veterans and 113 person-years in the non-veterans. There were 13 (92.9%) deaths in veterans with mesothelioma, equating to 1,307.9 per

1,000 person-years, and 65 (85.5%) deaths in non-veterans (574.0 per 1,000 person-years). Mean survival from diagnosis, in those who died before the end of the study, was 0.69 years (SD 0.39) in veterans and 0.91 years (SD 0.71) in non-veterans.

The longer survival time in non-veterans arose from four outliers; one surviving for five years, two for 10 years and one for 23 years. The latter in particular may represent misdiagnosis or miscoding. Excluding the three longest-surviving outliers, the mean follow-up for non-veterans was reduced to 0.95 years (range 0.01-4.81 years), giving 69 person-years of follow-up in this group and equating to 937.3 deaths per 1,000 person-years.

5.13.4 Commentary

The most important risk factor for mesothelioma is exposure to asbestos, either occupationally, by sharing a household with an asbestos worker or through other environmental exposure such as living in the vicinity of asbestos mines (Bourdès et al. 2000). Unlike some respiratory carcinogens such as radon where the risk is increased in smokers, the risk of mesothelioma in people exposed to asbestos appears to be independent of smoking (Berry et al. 1985). Prior to the introduction of controls, military veterans may have been exposed occupationally during service, as discussed at Appendix 3, Section A3.3.5.11, or in the course of post-service employment if in a high-risk occupation such as ship-building. Despite the theoretical risks, there is no evidence to suggest increased risk of mesothelioma in veterans; rather, the reverse is the case although possible reasons for this are unclear. In-depth subgroup analysis, including geographical analysis to examine the distribution of cases in areas associated with ship-building in Scotland, was precluded by small numbers. Mesothelioma of the pleura has a very poor prognosis, one study reporting a mean survival time of 8.4 months from diagnosis (Ribak and Selikoff 1992). Observations from the Scottish Veterans study support this finding.

5.14 Other Digestive System Cancers

Data were available on colorectal cancer (ICD-9 153-154, ICD-10 C18-C21), pancreatic cancer (ICD-9 157, ICD-10 C25), cancer of the small intestine (ICD-9 152, ICD-10 C17) and liver cancer (ICD-9 155, ICD-10 C22). These will be examined individually.

5.15 Colorectal Cancer

5.15.1 Incidence

5.15.1.1 Overall

There were 330 cases of colorectal cancer in veterans and 993 in non-veterans, equating to a cumulative incidence of 0.59% in veterans and 0.57% in non-veterans, over the 32-year follow-up period. The difference was not significant in the unadjusted model, HR 1.00, 95% CI 0.88-1.13, p=0.965, and was unchanged after adjusting for deprivation. The Nelson-Aalen cumulative hazard plot demonstrated no difference in risk between veterans and non-veterans (Figure 5-23).

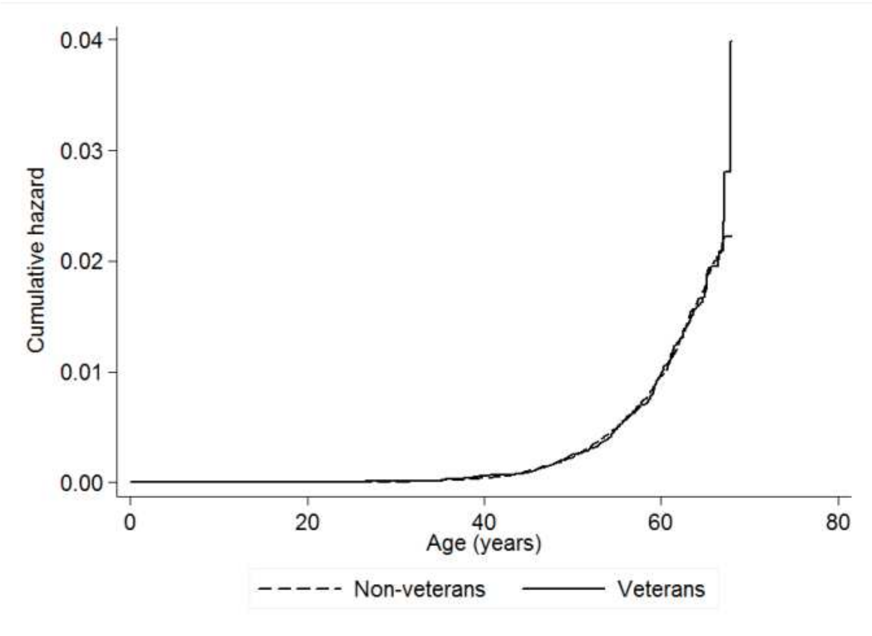

Figure 5-23 – Nelson-Aalen plot of colorectal cancer by veteran status

5.15.1.2 Sex

There were 306 (0.60%) cases in male veterans compared with 916 (0.60%) cases in male non-veterans, unadjusted HR 0.97, 95% CI 0.85-1.11, p=0.677. There were 24 cases (0.46%) in female veterans compared with 77 (0.37%) cases in female non-veterans, unadjusted HR 1.28, 95% CI 0.81-2.02, p=0.295. The hazard ratios were unchanged after adjusting for deprivation.

5.15.1.3 Birth Cohort

There was no statistically significant association between risk of colorectal cancer and any birth cohort in 5-year bands (Figure 5-24), although there was a non-significant increased risk among veterans in the 1955-1959 birth cohort and a reduced risk in veterans born from 1960 onwards. When stratified into two groups, those born prior to 1960 and born 1960 onwards, there was no difference for the earlier cohort but there was a non-significant reduced risk in the later cohort.

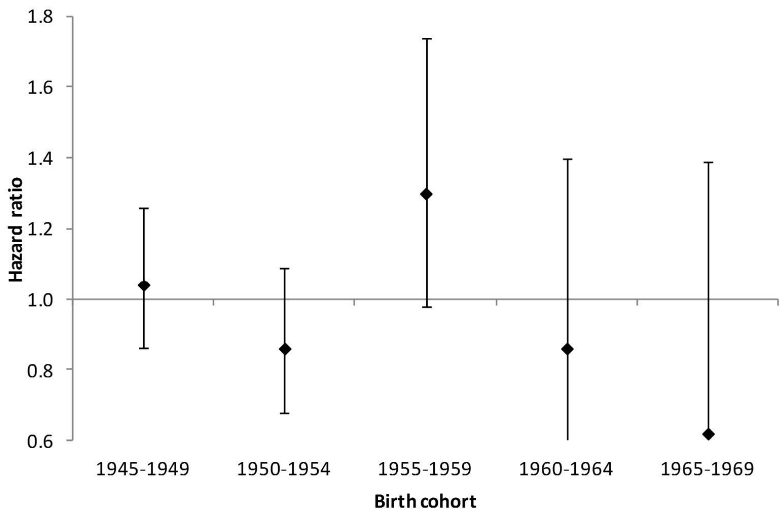

Figure 5-24 - Hazard ratios for colorectal cancer by birth cohort Veterans referent to non-veterans

5.15.1.4 Length of Service

There was no statistically significant difference in risk for any length of service, although there was a non-significant increased risk in ESL (whether or not completing initial training) born from 1960 onwards (Table 5-8).

Table 5-8 - Cox proportional hazard model of the association between veteran status and colorectal cancer, overall and stratified by length of service and birth cohort

	Veteran cases *n*	All Veterans *n*-56,205 HR	95% CI	p	Born 1945-1959 *n*=29,709 HR	95% CI	p	Born 1960-1985 *n*=26,496 HR	95% CI	p
Overall										
Univariate	330	1.00	0.88-1.13	0.965	1.02	0.90-1.17	0.737	0.78	0.51-1.20	0.254
Multi-variable	330	0.99	0.87-1.12	0.898	1.02	0.90-1.17	0.731	0.75	0.48-1.15	0.190
Length of service in 8 categories										
Basic training[98]	39	1.07	0.77-1.47	0.690	1.03	0.73-1.46	0.840	1.36	0.56-3.33	0.501
ESL[99] **(0-3 years)**	77	1.11	0.88-1.40	0.378	1.06	0.82-1.36	0.657	1.55	0.84-2.88	0.164
4-6 years	62	1.04	0.80-1.34	0.785	1.12	0.86-1.45	0.398	0.32	0.78-1.28	0.108
7-9 years	36	0.86	0.61-1.19	0.350	0.91	0.50-1.28	0.583	0.43	0.11-1.74	0.238
10-12 years	33	0.94	0.66-1.34	0.745	0.96	0.67-1.40	0.846	0.79	0.25-2.49	0.680
13-16 years	26	1.13	0.77-1.67	0.530	1.28	0.86-1.91	0.218	0.30	0.04-2.14	0.229
17-22 years	21	0.81	0.52-1.27	0.364	0.85	0.54-1.34	0.490	0.44	0.06-3.20	0.421
≥23 yrs	36	0.92	0.65-1.30	0.631	0.95	0.66-1.35	0.754	0.48	0.07-3.44	0.464

5.15.2 Regional Variation

Analysis by Health Board showed no significant difference in any region, either in the univariate model or after adjusting for deprivation.

5.15.3 Case-Fatality

The mean follow-up from date of diagnosis of colorectal cancer to the date of death or the end of the study was 4.61 years (range 0-29.36 years) for veterans and 4.43 years (range 0-28.50 years) for non-veterans, representing 1,521 person-years of follow-up in the veterans and 4,399 person-years in the non-veterans. There were 126 (38.2%) deaths in veterans with colorectal cancer, equating to 82.8 per 1,000 person-years, and 380 (38.3%) deaths in non-veterans (86.4 per 1,000 person-years). There was no difference between veterans and non-veterans for either one-year or 5-year case-fatality rates; HR 1.13, 95% CI 0.84-1.51, p=0.418 at one year in the univariate model and HR 1.10, 95% CI 0.82-1.48, p=0.506 after adjusting for deprivation, and HR 0.95, 95% CI 0.77-1.18, p=0.633 at 5 years in the univariate model and 0.92, 95% CI 0.74-1.14, p=0.463, in the multi-variable model. The difference between veterans and non-veterans remained non-significant at 10 years, univariate HR 0.95, 95% CI 0.78-1.17, p=0.639 and HR 0.92, 95% CI 0.75-1.13, p=0.448 after adjusting for deprivation.

5.15.4 Commentary

In a comprehensive meta-analysis of prospective cohort studies published between 1966 and 2008, Huxley et al. identified the strongest association with risk of colorectal cancer to be heavy alcohol intake, compared with light or non-drinking (RR 1.56, 95% CI 1.42-1.70). Current smoking was associated with a 16% increase in risk when compared with never smoking, across 22 studies, although the IARC do not accept that the association is causal (IARC 2004), as discussed at Section 5.4.2. Diabetes was associated with a 20% increase in risk, as were both BMI ≥30 and a high red meat intake. Physical activity was protective, active individuals having a 20% lower risk compared with those who were inactive; the protective effect was stronger in men (22%) than women (13%) (Huxley et al. 2009).

The prevalence of obesity and diabetes are unknown in veterans; it is likely that there is a high intake of red meat in-service, as meat (especially processed meat such as bacon and sausage) is a popular component of the military diet[112], but there is no information on dietary preferences in veterans. Smoking prevalence is higher in military personnel (Lewthwaite and Graham 1992), and may be higher in veterans, especially in the older cohorts, and military service is known to be associated with increased alcohol intake (Jones and Fear 2011). Physical activity is likely to have had a greater impact in Army personnel who joined after the introduction of the Basic Fitness Test in 1978, after which there was a greatly increased emphasis on cardio-respiratory fitness; these individuals were born from 1960 onwards, although even before this, levels of activity were likely to have been higher than in the general population. The multiplicity of risk factors and small contribution made by each, combined with the lack of any statistically significant differences in risk of colorectal cancer between veterans and non-veterans, makes interpretation speculative at best. However, it is possible that any increase in risk due to smoking in the earlier birth cohorts, or arising from other behavioural factors, may have

[112] Author's personal recollection of military catering. A study of in-barracks nutrition in 1987 did not report meat consumption, but noted that 44% of the energy content of the military diet was derived from fat and that the intake of saturated fat was 23% above the then recommended level. It is likely that much of this was derived from meat. (Edwards, M. J. and Thomson, J. (1987) 'British Army Diet', *Nutrition & Food Science,* 87(6), 18-21.)

been outweighed by higher levels of physical activity. The oldest members of the 1960s and later birth cohorts were aged only 52 years at the end of follow-up so conclusions about their risk of colorectal cancer cannot be drawn with confidence[113]. Overall however, there is no evidence that the risk of colorectal cancer in veterans differs from that of the wider population. There may be emerging evidence of a reduction in risk in more recent veterans, but longer follow-up is needed.

5.16 Pancreatic Cancer

5.16.1 Incidence

5.16.1.1 Overall

During the follow-up period to 31 December 2012, there were 63 cases of pancreatic cancer among veterans, compared with 206 cases in non-veterans, equating to a cumulative incidence of 0.11% and 0.12% respectively. For men and women together, the difference was not statistically significant in the univariate model, HR 0.93, 95% CI 0.70-1.24, p=0.639. The hazard ratio was unchanged after adjusting for deprivation, HR 0.93, 95% CI 0.70-1.24, p=0.622. Mean age at diagnosis of pancreatic cancer was 53.5 years (SD 8.4) for veterans and 53.8 years (SD 7.8) for non-veterans. The *estat phtest* for non-proportionality of the hazards was non-significant, p=0.478, and the Nelson-Aalen plot confirms that the overall risk in veterans did not differ from non-veterans.

[113] Between 2009 and 2011, 95% of cases in the UK were diagnosed over the age of 50 years, Data from Cancer Research UK, collated from cancer registry figures. Source: http://www.cancerresearchuk.org/cancer-info/cancerstats/types/bowel/incidence/#By2 accessed 28 Aug 2014.

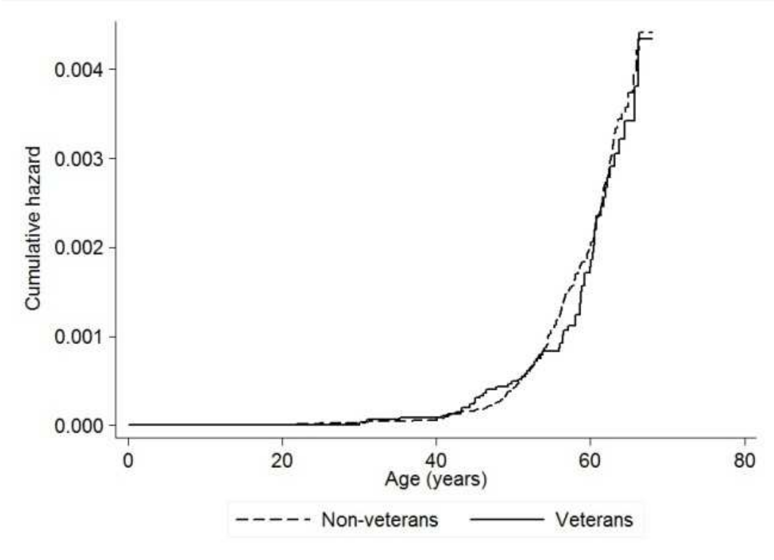

Figure 5-25 - Nelson-Aalen plot of pancreatic cancer by veteran status

5.16.1.2 Sex

There were 58 (0.11%) cases of pancreatic cancer in male veterans compared with 189 (0.12%) in male non-veterans, unadjusted HR 0.91, 95% CI 0.68-1.23, p=0.548. There were only 5 (0.10%) cases in female veterans, compared with 17 (0.08%) female non-veterans, unadjusted HR 1.19, 95% CI 0.44-3.22, p=0.737. The hazard ratios were similar after adjusting for deprivation.

5.16.1.3 Birth Cohort

Only the 1960-1964 birth cohort showed a statistically significant increase in risk of pancreatic cancer in veterans compared with non-veterans, as shown at Figure 5-26. However, as this was based on only 10 cases in veterans and 13 in non-veterans, the significance of the observation is uncertain. As this birth cohort is approaching the peak age for incidence of pancreatic cancer within the dataset, longer follow-up will be need to establish whether this represents a genuinely higher risk in risk in these veterans, or whether the incidence in the comparison cohort was unusually low during the follow-up period. Currently, the kernel density plot by year of birth suggests that there may indeed be an excess in this sub-group of veterans (Figure 5-27).

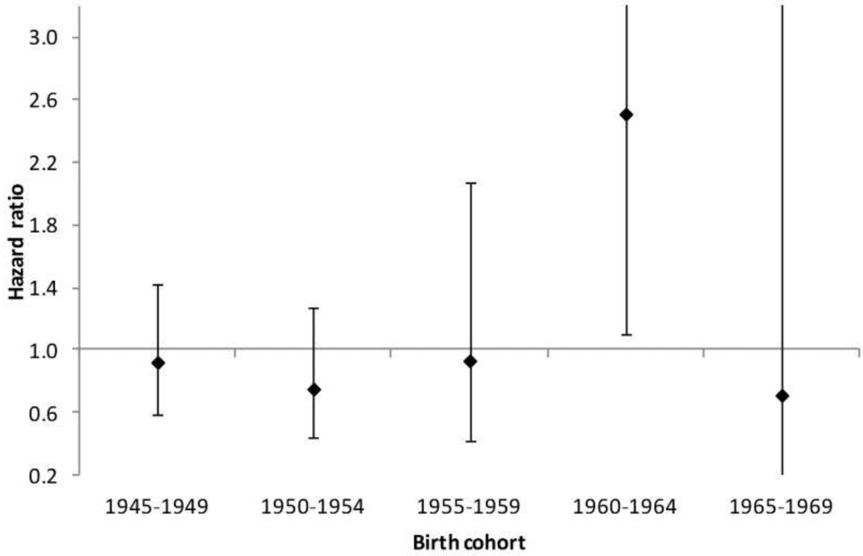

Figure 5-26 - Hazard ratios for pancreatic cancer by birth cohort Veterans referent to non-veterans

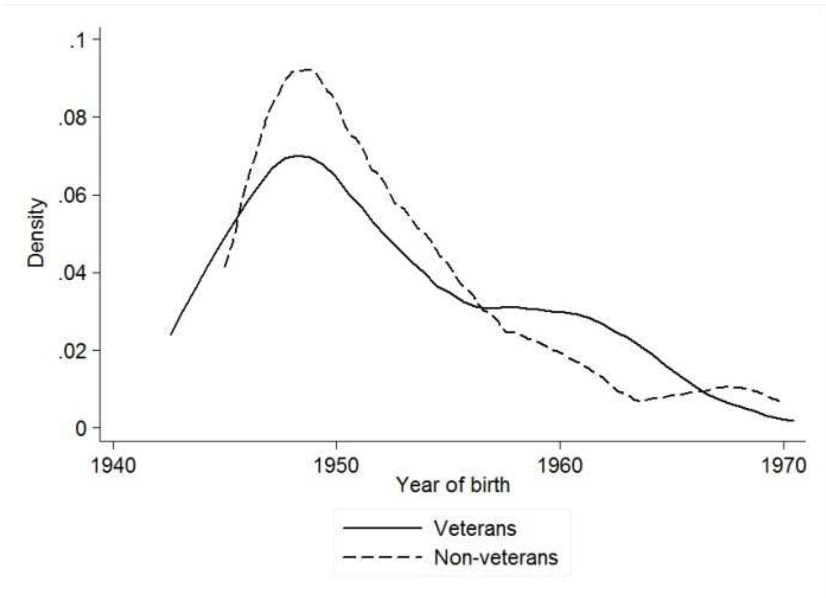

Figure 5-27 - Kernel density plot of pancreatic cancer by year of birth and veteran status

5.16.1.4 Length of Service

There were insufficient cases of pancreatic cancer to conduct a formal analysis by length of service. The cumulative hazard plot by ESL status and length of service status, in four categories, compared with all non-veterans, did not show any evidence of a relationship with length of service (Figure 5-28).

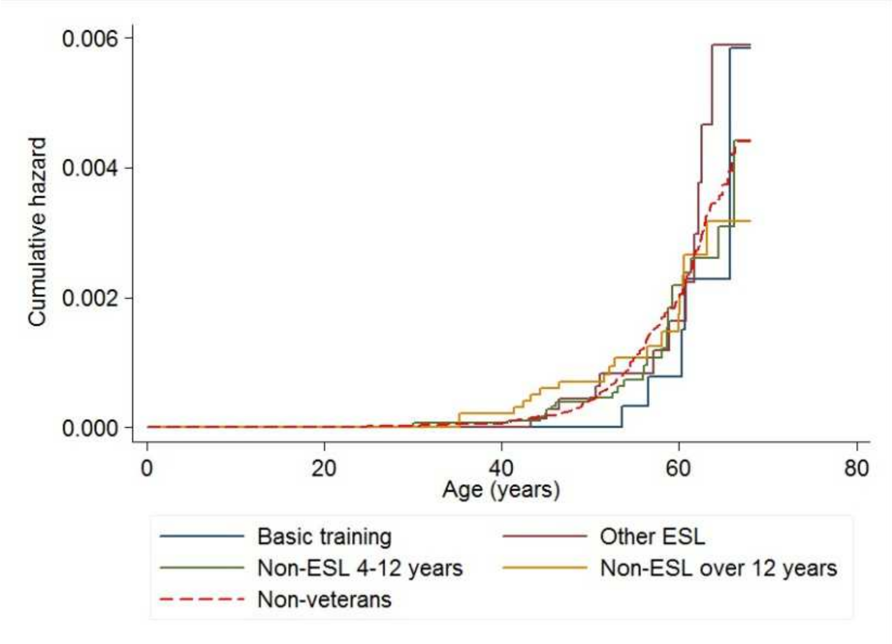

Figure 5-28 – Nelson-Aalen plot of pancreatic cancer by length of service Non-veterans for comparison

5.16.2 Co-Morbidity

One veteran (1.6%) and 7 non-veterans (3.4%) with pancreatic cancer had a co-morbid diagnosis of alcoholic liver disease. Two veterans (3.2%) and 10 non-veterans (4.9%) with pancreatic cancer also had a diagnosis of liver cancer. No veterans or non-veterans with pancreatic cancer had co-morbid hepatitis B, and only one non-veteran, and no veterans, had hepatitis C. Peptic ulcer, which may be indicative of *Helicobacter pylori* infection, was recorded in 4 (6.4%) veterans and 14 (6.8%) non-veterans with pancreatic cancer, compared with 3.4% of all veterans and 3.0% of all non-veterans. The hazard ratio for peptic ulceration, in veterans with pancreatic cancer, was 1.34, 95% CI 0.48-3.70, p=0.568, compared with 1.79, 95% CI 1.04-3.08, p=0.036 for non-veterans with pancreatic cancer. Three of the veterans (4.8%) and 8 (3.9%) of the non-veterans also had a record of colorectal cancer, HR 4.95, 95% CI 1.55-15.82, p=0.007 for veterans and HR 4.08, 95% CI 2.01-8.28, p<0.001 for non-veterans.

5.16.3 Case-Fatality

The mean follow-up from date of diagnosis of pancreatic cancer to the date of death or the end of the study was 1.19 years (range 0-25.67 years) for veterans and 1.28 years (range 0-31.50 years) for non-veterans, representing 75 person-years of follow-up in the veterans and 264 person-years in the non-veterans. There were 57 (90.5%) deaths in veterans with pancreatic cancer, equating to 760.3 per 1,000 person-years, and 174 (84.4%) deaths in non-veterans (659.9 per 1,000 person-years).

There was one outlier among the veterans and three amongst the non-veterans who survived more than 15 years from diagnosis, suggesting misdiagnosis or miscoding[114]. Exclusion of these outliers gave a mean follow-up of 0.80 years (range 0-7.48 years) in veterans and 0.92 years (range 0-9.33 years) in non-veterans, representing 50 person-years of follow-up in the veterans and 187 person-years in the non-veterans. The number of deaths was unchanged, giving a rate of 1149.2 per 1,000 person-years in veterans and 931.7 per 1,000 person-years.

Veterans had a higher one year case-fatality overall than non-veterans although the difference was not statistically significant, HR 1.36, 95% CI 0.98-1.88, p= 0.068. The difference was smaller at 5 years, HR 1.23, 95% CI 0.91-1.66, p=0.180.

5.16.4 Commentary

Although pancreatic cancer is relatively uncommon, it is of concern because of its very high mortality. Globally, it is ranked 13th for incidence but 8th for mortality among cancers. The most important risk factor is tobacco smoking, which is estimated to be responsible for 25% of cases. There is little evidence of dietary association. Known disease associations include chronic pancreatitis, diabetes[115], and infection with *H. pylori* (Lowenfels and Maisonneuve 2006). Alcohol was formerly not considered to be correlated with risk of pancreatic cancer, despite being associated with an increased risk of chronic pancreatitis (Talamini et al. 1999), although a recent meta-analysis has shown a 20% increase in risk associated with a daily intake of >30g alcohol (Maisonneuve and Lowenfels 2014). Genetic factors may also be important, and familial cases have been described (Lowenfels and Maisonneuve 2006). Obesity is a risk factor (Aune et al. 2012), although moderate physical activity is protective; O’Rorke et al. reported a 28% reduction in risk for both total and occupational activity (O'Rorke et al. 2010). A meta-analysis of

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[114] Ten-year survival rate for pancreatic cancer in England and Wales is 1.1%. Source: Cancer Research UK http://www.cancerresearchuk.org/cancer-info/cancerstats/types/pancreas/survival/pancreatic-cancer-survival-statistics accessed 20 March 2015

[115] The picture is complicated by reverse causality, whereby diabetes can be a presenting feature of pancreatic disease.

occupational risk factors identified increased risk of pancreatic cancer in association with exposure to chlorinated hydrocarbon solvents, nickel, polycyclic aromatic hydrocarbons and organochlorine insecticides, but not to diesel exhaust, petrol, lead or cadmium (Ojajärvi et al. 2000), although a more recent meta-analysis has graded the level of evidence for occupational exposure as generally 'poor' (Maisonneuve and Lowenfels 2014). Veterans are therefore likely to present a mixed picture for risk, with higher rates of smoking but also higher physical activity levels, at least during service. The inferred association with *H.pylori* might also be expected to give rise to increased risk in veterans (see Section 6.12.5). The net effect is consistent with the observed findings of no significant difference in risk between veterans and non-veterans. However, the increased risk in the 1960-1964 birth cohort requires further investigation to exclude an occupational association.

5.17 Liver Cancer

Liver cancer was defined as ICD-9 155 or ICD-10 C22 (at any position in the record) in order to capture only primary tumours of the liver.

5.17.1 Incidence

5.17.1.1 Overall

There were 44 (cumulative incidence 0.08%) cases of liver cancer among veterans, compared with 180 (0.10%) cases in non-veterans, equating to a statistically non-significant reduction in risk of liver cancer in the univariate model, HR 0.74, 95% CI 0.54-1.04, p=0.080, which was similar after adjusting for deprivation HR 0.73, 95% CI 0.52-1.02, p=0.063. The Nelson-Aalen cumulative hazard plot (Figure 5-29) illustrates the reduction in risk in veterans. Testing for non-proportionality of the hazards was non-significant, p=0.893. Mean age at diagnosis of liver cancer was 55.2 years (SD 5.1) for veterans and 54.6 years (SD 8.0) for non-veterans.

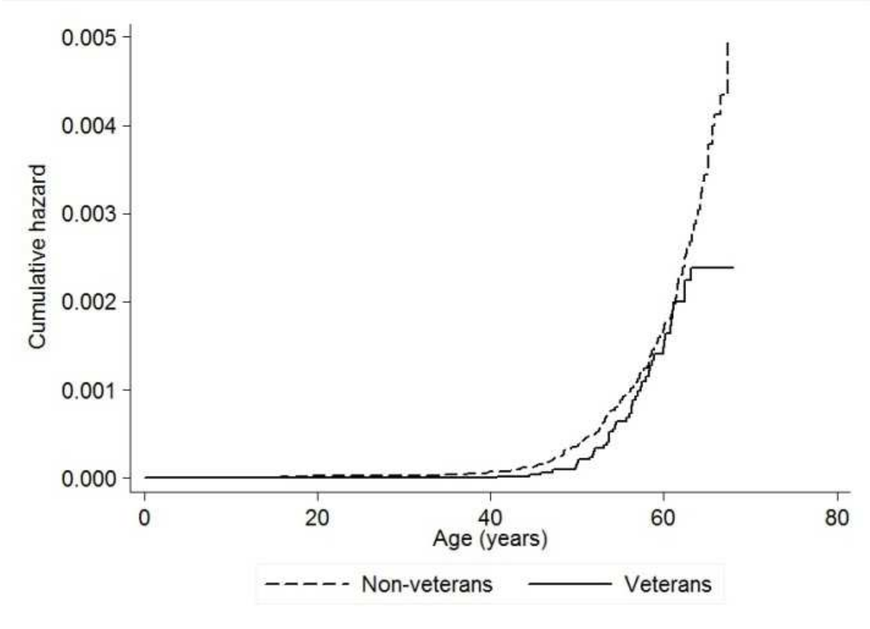

Figure 5-29 - Nelson-Aalen plot of liver cancer by veteran status

5.17.1.2 Sex

There were 39 (0.11%) cases of liver cancer in male veterans compared with 168 (0.12%) in male non-veterans, unadjusted HR 0.69, 95% CI 0.49-0.98, p=0.036. There were 5 (0.10%) cases in female veterans, compared with 12 (0.06%) female non-veterans, unadjusted HR 1.68, 95% CI 0.59-4.78, p=0.327.

5.17.1.3 Birth Cohort

The non-significant reduction in risk of liver cancer in veterans was seen across all birth cohorts, with no evidence of a systematic trend over time.

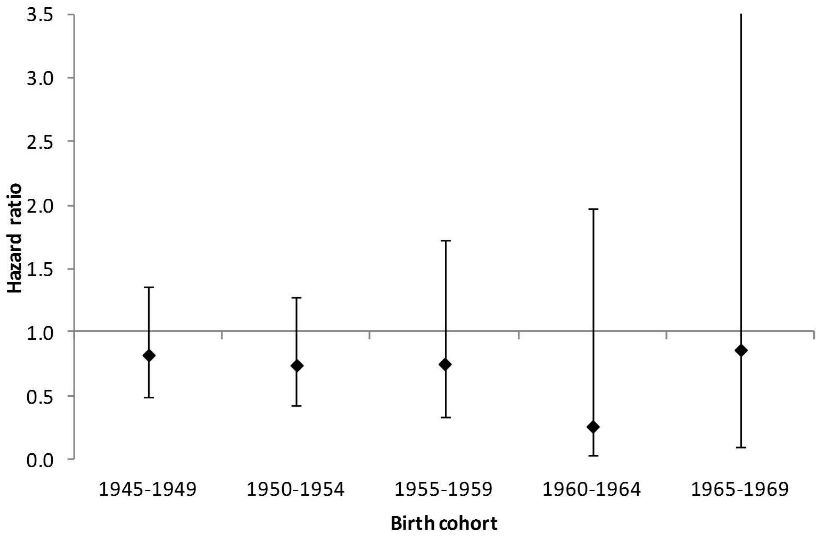

Figure 5-30 - Hazard ratios for liver cancer by birth cohort
Veterans referent to non-veterans

5.17.1.4 Length of Service

The number of cases of liver cancer in veterans was insufficient to allow detailed analysis of risk by length of service. The cumulative hazard plot in four categories clearly showed the highest risk of liver cancer to be in ESL who left before completing initial training, and in ESL who did not complete the initial engagement. The curve for those who entered trained service and left at or before the 12-year point approximated to that for non-veterans, whereas the curve for those with the longest service was slightly lower than for either shorter-serving veterans or non-veterans (Figure 5-31).

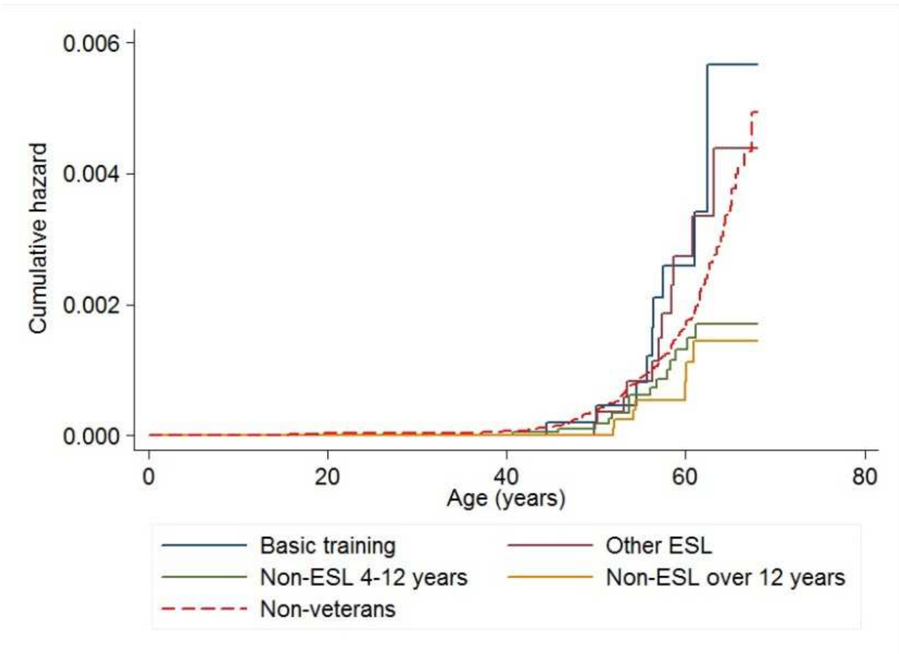

Figure 5-31 – Nelson-Aalen plot of liver cancer by length of service
Non-veterans for comparison

Re-examining the hazard ratios in the light of these findings showed a non-significant increase in risk for the 2 ESL categories together, unadjusted HR 1.36, 95% CI 0.86-2.12. p=0.188, whilst there was a statistically significant reduction in risk for the two categories of veterans with longer service together, 4-12 years and over 12 years, unadjusted HR 0.55, 95% CI 0.35-0.85, p=0.007. The hazard ratios were similar after adjusting for deprivation.

5.17.2 Case-Fatality

The mean follow-up from date of diagnosis of liver cancer to the date of death or the end of the study was 0.82 years (range 0-8.84 years) for veterans and 1.21 years (range 0-15.04 years) for non-veterans, representing 36 person-years of follow-up in the veterans and 218 person-years in the non-veterans. There were 57 (84.1%) deaths in veterans with liver cancer, equating to 1025.5 per 1,000 person-years, and 174 (77.8%) deaths in non-veterans (642.8 per 1,000 person-years). Veterans had a non-significantly higher one-year case-fatality than non-veterans, HR 1.44, 95% CI 0.99-2.10, p=0.054. Veterans had a shorter survival time from diagnosis than non-veterans, median 85.5 days (IQR 31-243.5) compared with 133.5 days (IQR 37-507).

5.17.3 Co-Morbidity

Co-morbidities with liver cancer for selected conditions are shown at Table 5-9.

Table 5-9 - Co-morbidities with liver cancer
Crude overall cumulative incidence for comparison

	Veterans		Non-veterans		Veterans referent to non-veterans		
	Cases *n*=44 No. (%)	Pop. *n*=56,205 (%)	Cases *n*=180 No. (%)	Pop. *n*=172,741 (%)	OR	95% CI	p
Alcoholic liver disease	11 (25.0)	(1.2)	45 (25.0)	(1.3)	1.00	0.57-1.77	1.000
Diabetes	8 (18.2)	(3.4)	39 (21.7)	(3.3)	0.84	0.42-1.67	0.611
Hepatitis C	8 (18.2)	(0.2)	34 (18.8)	(0.4)	0.96	0.48-1.93	0.914
Hepatitis B	3 (6.8)	(0.1)	13 (7.2)	(0.1)	0.94	0.28-3.17	0.926
Peptic ulcer	3 (6.8)	(3.4)	23 (12.8)	(3.0)	0.53	0.17-1.70	0.269

Among the veterans with liver cancer and hepatitis C, 71.4% were ESL. All but one of the veterans with liver cancer and hepatitis C were born in the 1950s. Three (6.8%) of the veterans had a history of peptic ulcer, compared with 23 (12.8%) of non-veterans.

5.17.4 Commentary

The commonest cause of primary liver cancer worldwide is hepatitis B or C infection; in the UK it accounts for 16% of cases (Parkin 2011b). In the UK, a larger percentage (estimated at 23% overall) is linked to tobacco smoking (Parkin 2011c). A further 9% is attributable to alcohol (Parkin 2011a), where it is associated with heavy drinking but not moderate or light drinking (Turati et al. 2014). Overweight and obesity are strongly associated (Larsson and Wolk 2007).

Although, with only 44 cases over 30 years, liver cancer is a minor contributor to veterans' health, it provides an insight into long-term outcomes in a vulnerable subset of the population, the Early Service Leavers. Between 60% and 90% of injecting drug abusers are infected with hepatitis C (Schaefer and Mauss 2008); hepatitis C infection is associated with a 20-fold increase in risk of liver cancer (Parkin 2011b). The 25% prevalence of co-morbid alcoholic liver disease, and the strong association with older ESL, suggests that a small number of this group (who would have left service in the late 1960s and early 1970s) may have become drug and alcohol abusers. The shorter survival time may be explained by late presentation in this group. By contrast, those who served a full minimum engagement or longer have enjoyed relative protection from liver cancer in comparison with the wider population. The reduction in risk in those with longer service provides further evidence that alcohol misuse is unlikely to be a major problem in this group; smoking rates are also known to reduce with longer service (Lodge 1991), and injecting drug abuse in longer-serving people is highly unlikely in view of the Armed Forces' policy of random testing and zero-tolerance, which results in automatic dismissal on detection of any banned substance in the majority of cases (Personnel Services 2 (Army) 2004).

An association between liver cancer and diabetes, which was seen in both veterans and non-veterans (Table 5-9), has been reported in a small number of studies (Adami et al. 1996, La Vecchia et al. 1997, Fujino et al. 2001). The causal mechanism remains unclear; shared risk factors such as obesity are an important confounder (Fujino et al. 2001).

5.18 Small Bowel Cancer

Small bowel cancer was defined as ICD-9 code 152 or ICD-10 code C17, at any position in the record.

5.18.1 Incidence

5.18.1.1 Overall

Small bowel cancer was recorded in only 17 veterans and 63 non-veterans, equating to a cumulative incidence of 0.03% in veterans and 0.04% in non-veterans throughout the 32-year period of follow-up. The difference was not statistically significant, unadjusted HR 0.84, 95% CI 0.49-1.44, p=0.537 (Figure 5-32). The hazard ratio was similar after adjusting for deprivation. The mean age at diagnosis was 50.8 years (SD 8.5) in veterans and 52.6 years (SD 9.9) in non-veterans.

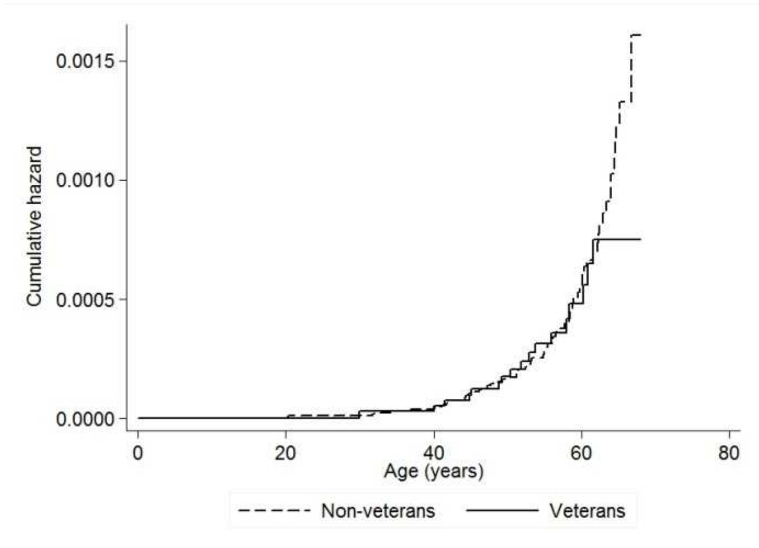

Figure 5-32 - Nelson-Aalen plot of small bowel cancer by veteran status

5.18.1.2 Sex

Among the veterans, one case occurred in a woman (6.0% of cases), compared with 5 cases (7.9%) in female non-veterans. The difference was not statistically significant, unadjusted HR 0.82, 95% CI 0.10-6.98, p=0.852, and was unchanged after adjusting for deprivation.

5.18.1.3 Subgroup Analysis

The inferences that can be drawn from subgroup analysis of the data for small bowel cancer are limited by very small numbers and consequent wide confidence intervals. There was no clear evidence of an association with birth cohort (Figure 5-33). Numbers in each category were insufficient to analyse by length of service.

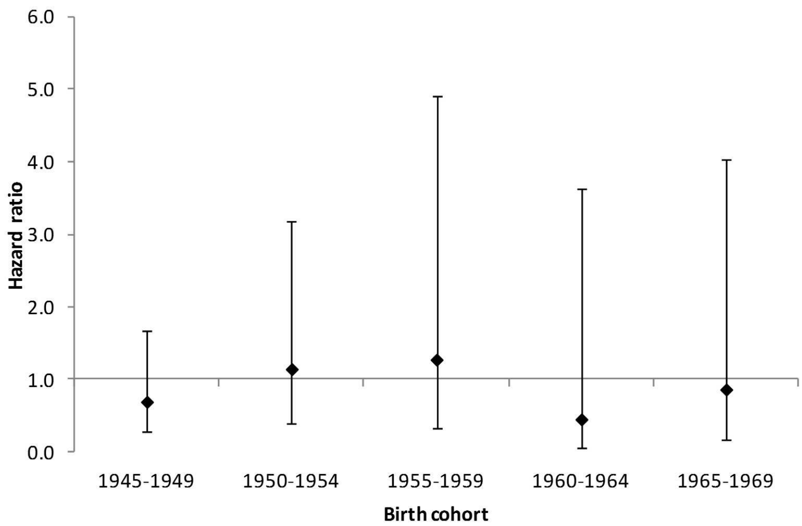

Figure 5-33 - Hazard ratios for small bowel cancer by birth cohort Veterans referent to non-veterans

5.18.2 Case-Fatality

The mean follow-up from date of diagnosis of small bowel cancer to the date of death or the end of the study was 3.06 years (range 0.12-14.22 years) for veterans and 2.54 years (range 0-23.08 years) for non-veterans, representing 52 person-years of follow-up in the veterans and 160 person-years in the non-veterans. There were 10 (58.8%) deaths in veterans with small bowel cancer, equating to 192.2 per 1,000 person-years, and 36 (57.1%) deaths in non-veterans (225.0 per 1,000 person-years).

5.18.3 Commentary

Small bowel cancer is the rarest digestive malignancy, with an estimated annual incidence of 1 per 100,000. Adenocarcinomas make up 40% of cases, whilst 30% are of neuroendocrine origin including carcinoid tumours. Smoking and alcohol have been implicated as risk factors but the evidence is conflicting. Human immunodeficiency virus (HIV) is associated with lymphoma of the small bowel. Familial adenomatous polyposis, Peutz-Jeghers syndrome and inflammatory bowel disease are known risk factors, although most cases are idiopathic. In most studies, the incidence in men is higher than in women. There is an association with a number of other malignancies including colorectal cancer, prostate and lung cancer (Neugut et al. 1998). This pattern of risk factors suggests that small bowel cancer should be no more common in veterans than in non-veterans, and may be less common since a diagnosis of inflammatory bowel disease would preclude enlistment. The findings of the data analysis support this interpretation.

5.19 Urological Cancers

5.20 Kidney Cancer

Kidney cancer was defined as ICD-9 189.0 and 189.1, and ICD-10 C64 and C65, at any position in the record.

5.20.1 Incidence

5.20.1.1 Overall

Over the 32-year period of follow-up, there were 115 cases of kidney cancer in veterans and 356 cases in non-veterans, equating to a cumulative incidence of 0.20% in veterans and 0.21% in non-veterans. There was no statistically significant difference (Figure 5-34), either in the unadjusted model (HR 0.97, 95% CI 0.78-1.20, p=0.778), or after adjusting for deprivation (HR 0.96, 95% CI 0.78-1.19, p=0.719). Mean age at diagnosis in veterans was 52.8 years (SD 6.9), and in non-veterans it was 52.1 years (SD 7.8).

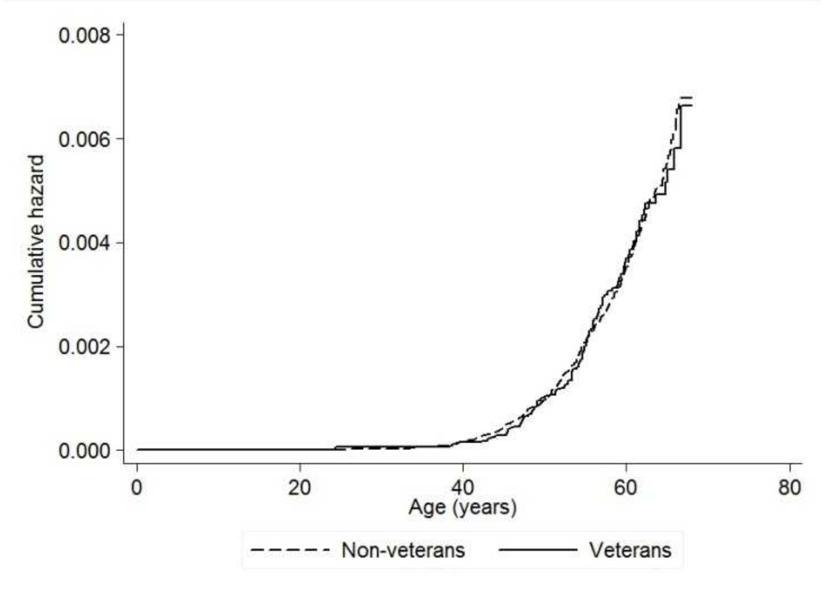

Figure 5-34 - Nelson Aalen plot of kidney cancer by veteran status

5.20.1.2 Sex

Seven (6.1%) of the veteran cases were women, compared with 22 (6.2%) of the non-veterans. The difference in risk between veteran and non-veteran women was not statistically significant, HR 1.29, 95% CI 0.55-3.02, p=0.557.

5.20.1.3 Birth Cohort

The overall pattern shows a steady risk in non-veterans compared with non-veterans for people born 1945-1954, followed by a steady fall, although none of the differences reached statistical significance. No cases have occurred in the veterans born after 1964, although there have been 22 cases in the non-veterans born between 1965 and 1975.

Figure 5-35 – Hazard ratios for kidney cancer by birth cohort Veterans referent to non-veterans

5.20.1.4 Length of Service

Analysis by length of service, and also stratified by birth cohort in two groups, showed that the only group to have a statistically significant increased risk was ESL who completed training and were born prior to 1960. Although the overall risk for ESL was elevated, this was entirely accounted for by the earlier births. Otherwise, there was no evidence that the risk of kidney cancer is associated with length of service. Overall, there was a significant reduction in risk for all veterans born after 1960 (Table 5-10).

Table 5-10 - Cox proportional hazard model of the association between veteran status and kidney cancer, overall and stratified by length of service and birth cohort

	Veteran cases	All Veterans *n*-56,205			Born 1945-1959 *n*=29,709			Born 1960-1985 *n*=26,496		
	n	HR	95% CI	p	HR	95% CI	p	HR	95% CI	p
Overall										
Univariate	115	0.97	0.78-1.20	0.788	1.08	0.86-1.35	0.510	0.39	0.18-0.86	0.019
Multi-variable	115	0.96	0.78-1.19	0.719	1.07	0.86-1.34	0.557	0.39	0.18-0.86	0.019
Length of service in 8 categories										
Basic training[98]	12	0.91	0.51-1.62	0.759	1.08	0.61-1.92	0.799	*	*	*
ESL[99] **(0-3 years)**	37	1.45	1.03-2.05	0.032	1.58	1.10-2.26	0.013	0.80	0.25-2.55	0.709
4-6 years	17	0.79	0.48-1.28	0.333	0.88	0.53-1.45	0.610	0.30	0.04-2.15	0.229
7-9 years	13	0.87	0.50-1.51	0.610	1.04	0.60-1.81	0.893	*	*	*
10-12 years	10	0.83	0.44-1.56	0.568	0.90	0.47-1.75	0.763	0.48	0.07-3.48	0.470
13-16 years	<10	1.08	0.56-2.09	0.826	1.22	0.60-2.46	0.580	0.54	0.70-3.88	0.538
17-22 years	<10	0.91	0.45-1.83	0.787	0.92	0.44-1.95	0.829	0.83	0.12-6.04	0.858
≥23 years	<10	0.65	0.32-1.31	0.228	0.71	0.35-1.44	0.342	*	*	*

Cases: Figures <10 in subgroups suppressed to minimise risk of disclosure * = no cases

5.20.2 Case-Fatality

The mean follow-up from date of diagnosis of kidney cancer to the date of death or the end of the study was 3.91 years (range 0-24.81 years) for veterans and 4.34 years (range 0-31.14 years) for non-veterans, representing 450 person-years of follow-up in the veterans and 1,545 person-years in the non-veterans. There were 62 (53.9%) deaths in veterans with kidney cancer, equating to 137.9 per 1,000 person-years, and 140 (39.3%) deaths in non-veterans (90.6 per 1,000 person-years).

5.21 Bladder Cancer

Bladder cancer was defined as ICD-9 code 188 or ICD-10 code C67, at any position in the record.

5.21.1 Incidence

5.21.1.1 Overall

There were 136 cases of bladder cancer in veterans over the period of follow-up, compared with 339 in non-veterans, equating to a cumulative incidence over the period of follow-up of 0.24% and 0.20% respectively. The difference did not quite achieve significance, HR 1.22, 95% CI 1.00-1.49, p=0.054 in the unadjusted model and was unchanged after adjusting for deprivation, although the Nelson-Aalen plot confirmed a pattern of higher risk in veterans, particularly between the ages of 55 and 60 years (Figure 5-36). Testing for non-proportionality of the hazards was non-significant, p=0.501. Mean age at diagnosis in veterans was 52.1 years (SD 9.1), compared with 52.4 years (SD 9.1) in non-veterans.

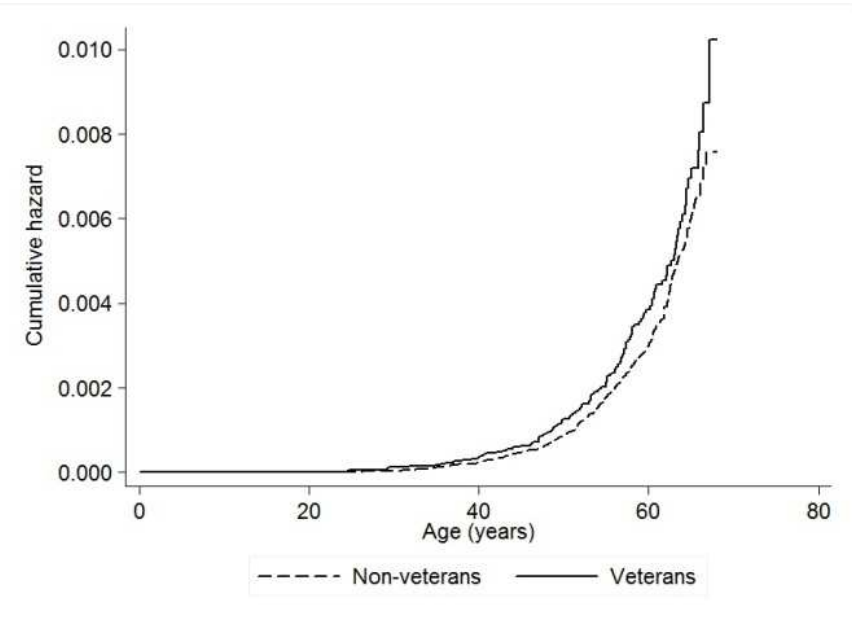

Figure 5-36 – Nelson-Aalen plot of bladder cancer by veteran status

5.21.1.2 Sex

Only 5 (3.67%) of the veteran cases and 18 (5.31%) of the non-veterans were women, p=0.852. The difference when veteran women were compared with non-veteran women was not statistically significant, HR 1.18, 95% CI 0.44-3.18, p=0.746.

5.21.1.3 Birth Cohort

Analysis by birth cohort showed a statistically significant increase in risk for veterans born between 1960 and 1964, with a hazard ratio of 2.62, 95% CI 1.36-5.04, p=0.004. There was no significant difference in any other birth cohort.

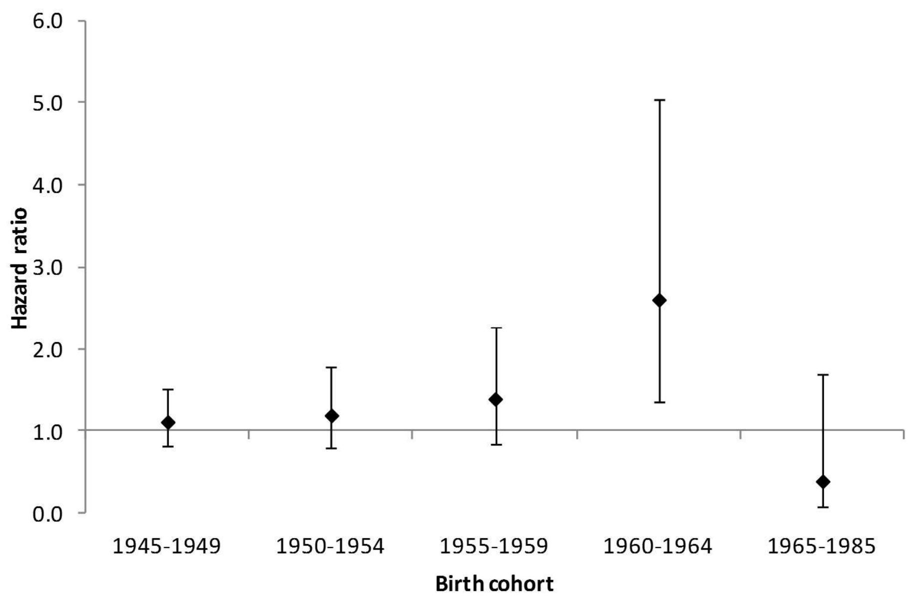

Figure 5-37 – Hazard ratios for bladder cancer by birth cohort Veterans referent to non-veterans

5.21.1.4 Length of Service

Analysis by length of service showed the greatest overall increase in risk to be in those with between 7 and 16 years' service, with the risk peaking at longer service (13-16 years) for veterans born prior to 1960 and earlier (7-12 years) for those born from 1960 onwards (Table 5-11).

Table 5-11 - Cox proportional hazard model of the association between veteran status and bladder cancer, overall and stratified by length of service and birth cohort

	Veteran cases	All Veterans n-56,205			Born 1945-1959 n=29,709			Born 1960-1985 n=26,496		
	n	HR	95% CI	p	HR	95% CI	p	HR	95% CI	p
Overall										
Univariate	136	1.22	1.00-1.49	0.054	1.17	0.95-1.46	0.145	1.60	0.91-2.80	0.102
Multi-variable	136	1.22	1.00-1.49	0.053	1.18	0.95-1.46	0.133	1.59	0.91-2.79	0.106
Length of service in 8 categories										
Basic training[98]	12	0.97	0.50-1.73	0.924	0.89	0.48-1.68	0.730	1.62	0.39-6.70	0.510
ESL[99] **(0-3 yrs)**	22	0.95	0.61-1.46	0.800	0.91	0.57-1.44	0.676	1.25	0.39-4.04	0.711
4-6 years	26	1.28	0.86-1.91	0.227	1.20	0.78-1.86	0.399	1.91	0.68-5.35	0.219
7-9 years	24	1.69	1.12-2.55	0.013	1.58	1.01-2.49	0.365	2.59	0.92-7.27	0.070
10-12 years	14	2.22	0.71-2.08	0.467	0.98	0.52-1.84	0.956	3.17	1.13-8.91	0.028
13-16 years	14	1.67	0.96-2.91	0.069	1.82	1.02-3.24	0.042	0.93	0.12-6.68	0.941
17-22 years	<10	0.63	0.26-1.51	0.299	0.69	0.28-1.66	0.406	*	*	*
≥23 years	19	1.47	0.90-2.39	0.125	1.56	0.95-2.54	0.077	*	*	*

Cases: Figures <10 in subgroups suppressed to minimise risk of disclosure * = no cases

Examination of crude cumulative incidence for each birth year, for veterans and non-veterans, revealed an excess of bladder cancer in veterans throughout the period of the study, up to a birth year of 1965 (Figure 5-38).

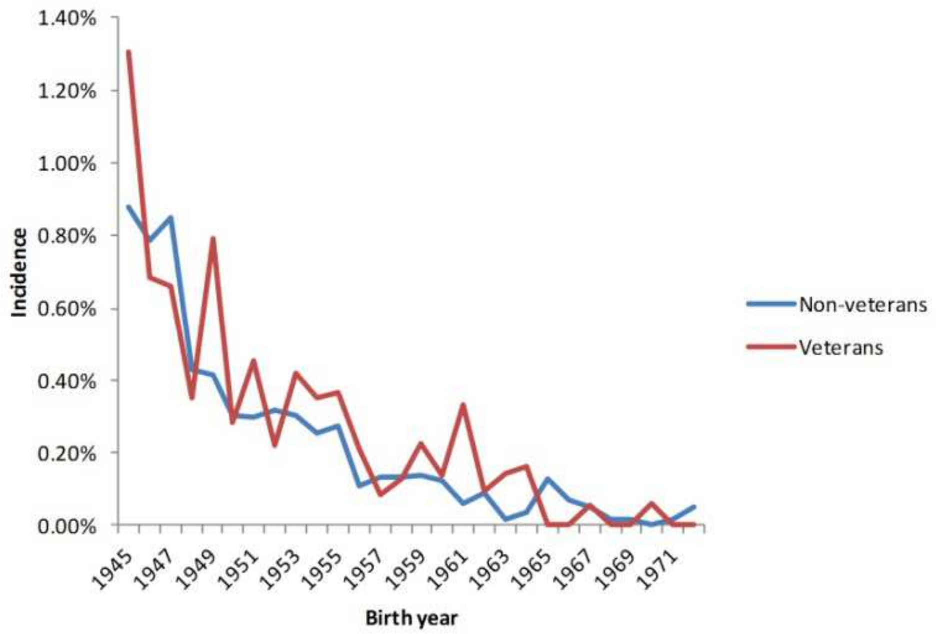

Figure 5-38 - Crude incidence of bladder cancer by birth year Veterans and non-veterans

5.21.2 Case-Fatality

The mean follow-up from date of diagnosis of bladder cancer to the date of death or the end of the study was 6.86 years (range 0-31.68 years) for veterans and 6.92 years (range 0-31.43 years) for non-veterans, representing 933 person-years of follow-up in the veterans and 2,346 person-years in the non-veterans. There were 34 (25.0%) deaths in veterans with bladder cancer, equating to 36.4 per 1,000 person-years, and 101 (29.8%) deaths in non-veterans (43.1 per 1,000 person-years).

5.21.3 Commentary

Cancer of the kidney encompasses a number of histological types including renal cell carcinoma, which is the most common and comprises around 85% of all cases, transitional cell carcinoma of the renal pelvis which accounts for around 8% of cases, and a number of rarer cancers including sarcoma, medullary carcinoma, lymphoma and metastatic tumours (Dingwall 2008). The incidence varies widely but is generally less than 10 per 100,000 population per year in European men; the incidence in women is around half that for men. The incidence rose to the mid 1990s but has since stabilised or slightly reduced. A number of risk factors have been identified, but all are associated with only a modest increase in risk; they include cigarette smoking, obesity, hypertension, diabetes mellitus, and genetic factors, while physical activity is protective, as is alcohol intake. Several occupational carcinogens have been identified, including trichloroethylene (classified by the IARC as Group 2A 'probable') (Chow et al. 2010), solder fumes, paints, asbestos and benzene (Pesch et al. 2000).

The Scottish Veterans Health Study provides no evidence for an association between military service and cancer of the kidney. It is likely that any excess risk which may have accrued from smoking or exposure to benzene or solvents is counterbalanced by the protective effects of physical activity and alcohol.

By contrast, there is a worrying and hitherto undocumented[116] increase in risk of bladder cancer in veterans which is associated with service of between 7 and 16 years, and is particularly marked in the 1960-1964 birth cohort, although as the subsequent birth cohorts had reached a maximum of 47 years of age at the end of follow-up, any increase in risk in this group is unlikely to have yet become apparent[117]. Nor is it yet clear whether the increase in hazard ratio seen in the 1960-1964 birth cohort represents a real increase in lifetime incidence, or whether it marks earlier onset of the disease *vis à vis* the non-veterans. This pattern of increased risk with longer service is entirely different from that seen in the smoking and/or alcohol-related cancers and, *prima facie*, suggests an occupational association.

The Ministry of Defence's published synopsis of causation for bladder cancer notes that it is the fourth most common malignancy in white European men, with an annual incidence of 35 per 100,000 per year and a 3% lifetime risk. The rate for women is stated to be approximately one-third of that for men. There is a well-recognised association with smoking (Jankovic and Radosavljevic 2007), and with a number of occupational carcinogens, especially polycyclic aromatic hydrocarbons (PAH) which occur in fuels, oils, tars and soots (Mastrangelo et al. 1996), but around one-third of cases are idiopathic. Occupational associations include the dyeing, rubber, leather and aluminium industries, truck drivers, and painters (Baxby 2008, Negri and La Vecchia 2001). No convincing link with artificial sweeteners, alcohol or coffee has been demonstrated (Wynder and Stellman 1980, Sala et al. 2000, Brownson et al. 1987, Thomas et al. 1983). Infection with

[116] To the best of the author's knowledge

[117] 75% of cases of kidney cancer occur at age 60 and above; the age-specific incidence begins to rise between ages 45-49 years. Data from Cancer Research UK http://www.cancerresearchuk.org/cancer-info/cancerstats/types/kidney/incidence/uk-kidney-cancer-incidence-statistics accessed 2 Sept 2014.

Schistosoma haematobium or *mansoni* is a known risk factor (Mostafa et al. 1999). A high fluid intake has been shown to be protective (Michaud et al. 1999). The Synopsis notes that "There is no recognised link between military service *per se* and bladder cancer" (Baxby 2008). However, few studies have specifically examined the risk of bladder cancer in relation to military service. In a population-based study in New Hampshire, USA, Colt et al. reported OR 1.0, 95% CI 0.7-1.4 for male 'military occupations' and OR 1.1, 95% CI 0.4-3.1 for female (Colt et al. 2004). A study of cancer mortality in veterans found elevated rates of bladder cancer in current, former and ever-smokers but did not undertake a comparison with the general population (McLaughlin et al. 1995). Since 1964, many UK service personnel have undertaken training exercises in Kenya, where schistosomiasisis is endemic, and it is not currently possible to exclude this or other occupational exposure as a risk factor. A nested case control study is recommended to evaluate possible occupational risk factors, and the incidence of bladder cancer in veterans should be monitored.

5.22 Skin Cancer

5.23 Malignant Melanoma

Malignant melanoma was defined as ICD-9 172 or ICD-10 C43, at any position in the record.

5.23.1 Incidence

5.23.1.1 Overall

Over the 32-year period of follow-up, 134 veterans were diagnosed with malignant melanoma, compared with 476 non-veterans, equating to a cumulative incidence of 0.24% and 0.28% respectively. The difference was not statistically significant, unadjusted HR 0.91, 95% CI 0.75-1.10, p=0.329. After adjusting for deprivation, the hazard ratio was 0.93, 95% CI 0.76-1.12, p=0.429. However the Nelson-Aalen plot shows that the lines cross, indicating that the proportional hazards assumption has been violated (Hess 1995) and hence the single Cox model is not appropriate (Figure 5-39). The Stata *estat phtest* confirmed violation of the proportional hazards assumption, p=0.002 for non-proportionality.

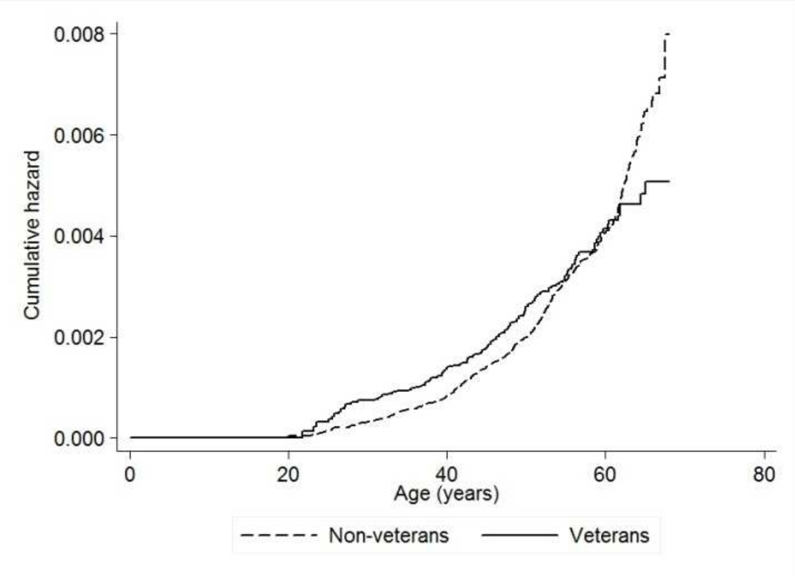

Figure 5-39 - Nelson-Aalen plot of malignant melanoma by veteran status

The data were therefore stratified by age at diagnosis; this showed no significant difference between veterans and non-veterans aged 25-50 years, unadjusted HR 1.09, 95% CI 0.86-1.39, p=0.480, whilst for those aged > 55 years, there was a non-significant reduction in risk in veterans, unadjusted HR 0.66, 95% CI 0.42-1.02, p=0.065. The hazard ratios were similar after adjusting for deprivation.

5.23.1.2 Sex

Among the veterans, 17 cases of malignant melanoma were in women, a cumulative incidence of 0.32% over the duration of follow-up. For non-veterans, there were 60 cases in women (cumulative incidence 0.29%). The risk was non-significantly increased in veteran women compared with non-veteran women, unadjusted HR 1.29, 95% CI 0.75-2.22, p=0.354. The hazard ratio was 1.32, 95% CI 0.77-2.26, p=0.321 after adjusting for deprivation.

5.23.1.3 Birth Cohort

Analysis by birth cohort showed no significant difference for any birth cohort, although there was a consistent non-significant reduction in risk in veterans in the pre-1960 birth cohorts.

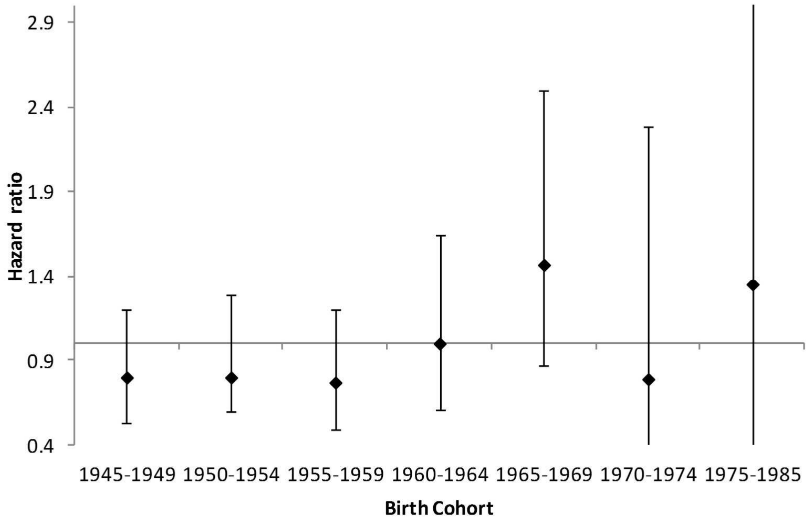

Figure 5-40 – Hazard ratios for malignant melanoma by birth cohort Veterans referent to non-veterans

5.23.1.4 Length of Service

There was no significant association within any length of service, although Table 5-12 confirms the indication of non-significantly lower risk in the earlier birth cohorts.

Table 5-12 - Cox proportional hazard model of the association between veteran status and malignant melanoma, overall and stratified by length of service and birth cohort

	Veteran cases	All Veterans *n*-56,205			Born 1945-1959 *n*=29,709			Born 1960-1985 *n*=26,496		
	n	HR	95% CI	p	HR	95% CI	p	HR	95% CI	p
Overall										
Univariate	134	0.91	0.75-1.10	0.329	0.82	0.64-1.04	0.107	1.14	0.81-1.59	0.457
Multi-variable	134	0.93	0.76-1.12	0.436	0.84	0.66-1.07	0.158	1.15	0.82-1.62	0.405
Length of service in 8 categories										
Basic training[98]	10	0.59	0.32-1.11	0.104	0.82	0.44-1.55	0.549	*	*	*
ESL[99] (0-3 years)	28	0.86	0.59-1.26	0.447	0.74	0.45-1.20	0.222	1.20	0.65-2.21	0.556
4-6 years	25	0.88	0.59-1.32	0.549	0.75	0.45-1.26	0.275	1.24	0.65-2.35	0.511
7-9 years	28	1.42	0.96-2.09	0.077	1.26	0.78-2.06	0.347	1.78	0.94-3.39	0.077
10-12 years	10	0.67	0.36-1.26	0.218	0.47	0.19-1.13	0.092	1.18	0.48-2.89	0.714
13-16 years	12	1.06	0.58-1.93	0.841	0.99	0.47-2.09	0.980	1.15	0.43-3.13	0.777
17-22 years	11	1.14	0.63-2.08	0.669	0.91	0.43-1.93	0.814	2.00	0.73-5.48	0.176
≥23 years	10	0.65	0.32-1.31	0.231	0.76	0.37-1.53	0.437	*	*	*

5.23.2 Case-Fatality

The mean follow-up from date of diagnosis of malignant melanoma to the date of death or the end of the study was 8.96 years (range 0-30.32 years) for veterans and 8.23 years (range 0-31.43 years) for non-veterans, representing 1,201 person-years of follow-up in the veterans and 3,917 person-years in the non-veterans. There were 32 (23.9%) deaths in veterans with malignant melanoma, equating to 26.7 per 1,000 person-years, and 83 (17.4%) deaths in non-veterans (21.2 per 1,000 person-years).

5.24 Non-Melanoma Skin Cancer

Non-melanoma skin cancer was defined as ICD-9 173 or ICD-10 C44, at any position in the record.

5.24.1 Incidence

5.24.1.1 Overall

Non-melanoma skin cancer (excluding in-situ cancers) was the commonest malignancy in both veterans and non-veterans. There were 712 cases in veterans, compared with 2,344 cases in non-veterans, a cumulative incidence of 1.27% in veterans and 1.36% in non-veterans over the 32-year follow-up period. The reduction in risk in veterans did not quite achieve significance in the unadjusted model, HR 0.92, 95% CI 0.85-1.00, p=0.056. The hazard ratio was similar after adjusting for deprivation. The Nelson-Aalen plot confirms that there was little overall difference in risk of skin cancer between veterans and non-veterans (Figure 5-41).

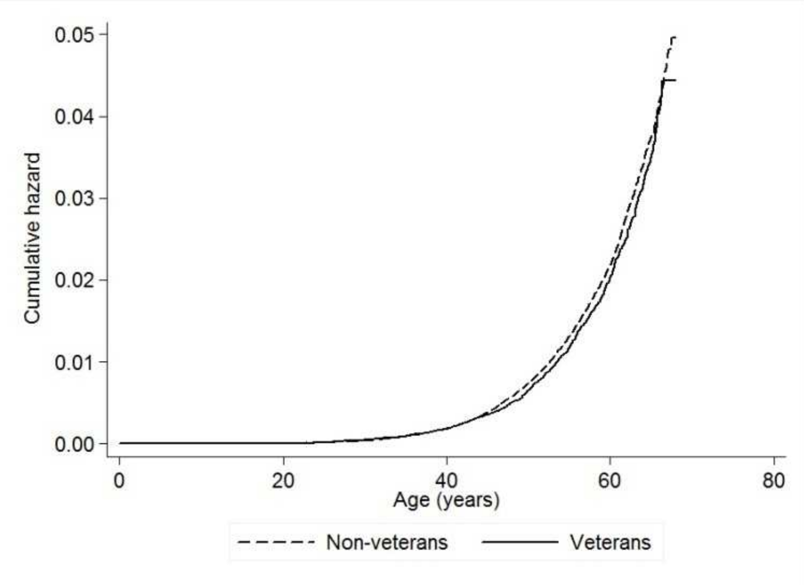

Figure 5-41 - Nelson-Aalen plot of non-melanoma skin cancer by veteran status

5.24.1.2 Sex

Only 39 of the cases of non-melanoma skin cancer in veterans occurred in women, equating to 0.74% of veteran women and 5.48% of veteran cases. There were 212 cases in non-veteran women, equating to 1.02% of non-veteran women and 9.04% of non-veteran cases. The Cox proportional hazard model showed a reduction in risk in veteran women, compared to non-veteran women, but it was not statistically significant, unadjusted HR 0.75, 95% CI 0.53-1.06, p=0.106. The hazard ratio was similar after adjusting for deprivation. Veteran women had a significantly reduced risk of non-melanoma skin cancer compared with veteran men, unadjusted HR 0.69, 95% CI 0.50-0.96, p=0.027, whereas the reduction was not significant for non-veteran women compared with non-veteran men, HR 0.87, 95% CI 0.76-1.01, p=0.060.

5.24.1.3 Birth Cohort

Subgroup analysis showed no significant difference in risk of non-melanoma skin cancer in veterans for any birth cohort, apart from a reduction in the 1950-1954 and 1960-1974 cohorts, which was only significant for the 1965-1969 band, p=0.038 (Figure 5-42).

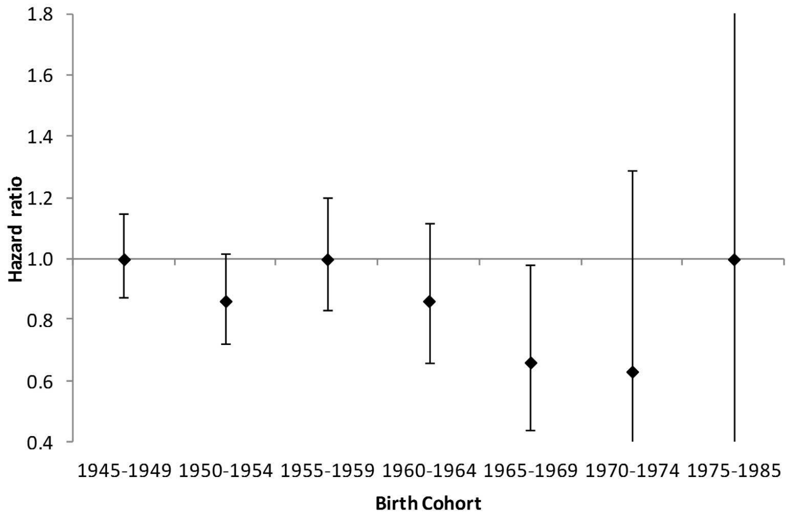

Figure 5-42 – Hazard ratios for non-melanoma skin cancer by birth cohort
Veterans referent to non-veterans

5.24.1.4 Length of Service

When veterans were stratified by length of service in four broad groups[118] and compared against all non-veterans, there were no differences in risk for any length of service.

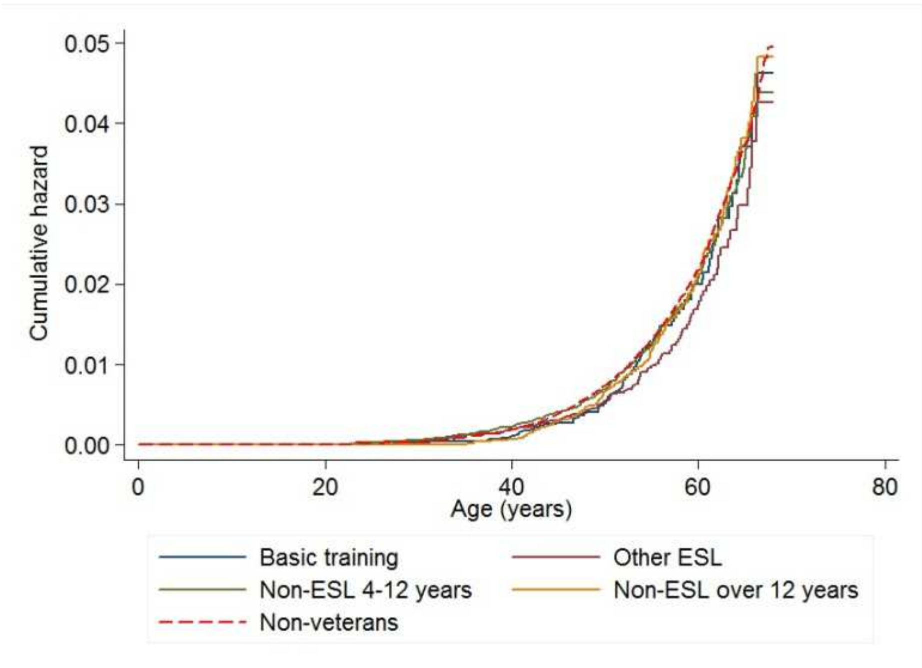

Figure 5-43 – Nelson-Aalen plot of non-melanoma skin cancer by length of service
All non-veterans for comparison

[118] Early Service Leavers (ESL) who did not complete initial training; other ESL; trained personnel with 4-12 years' service; trained personnel with over 12 years' service.

5.24.2 Case-Fatality

The mean follow-up from date of diagnosis of non-melanoma skin cancer to the date of death or the end of the study was 7.26 years (range 0-30.51 years) for veterans and 7.09 years (range 0-31.89 years) for non-veterans, representing 5,169 person-years of follow-up in the veterans and 16,619 person-years in the non-veterans. There were 57 (8.0%) deaths in veterans with non-melanoma skin cancer, equating to 11.0 per 1,000 person-years, and 167 (7.1%) deaths in non-veterans (10.1 per 1,000 person-years).

5.24.3 Commentary – Skin Cancer

Skin cancer is the commonest malignancy in the UK, with a crude incidence of 22.2 cases of malignant melanoma and 204.6 cases of non-melanoma skin cancer per 100,000 per year in Scotland in 2012. The incidence of both types has been rising steadily and has more than doubled since 1992[119]. The most important risk factors for all types of skin cancer[120] are solar ultraviolet radiation (particularly when resulting in sunburn), use of sunbeds, exposure to mineral oils[121] and a positive family history. An estimated 86% of melanoma, 50-70% of squamous cell carcinoma and 50-90% of basal cell carcinoma has been attributed to solar radiation (Parkin et al. 2011, Lucas et al. 2008). Treatment with immunosuppressant drugs also increases the risk of skin cancer; this is less likely to be a relevant factor in serving personnel as conditions requiring such therapy would normally result in medical discharge from service. Intermittent episodes of sunburn carry a greater risk than chronic exposure to sunlight (Gandini et al. 2005), whilst a fair skin or red hair increases the risk posed by sunbathing multiplicatively (Han et al. 2006). Paradoxically, chronic occupational exposure protects against melanoma, in contrast to recreational exposure. In an important meta-analysis of 57 studies examining risk factors for malignant melanoma which met the authors' inclusion criteria, Gandini et al. identified a

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[119] Data from ISD Scotland http://www.isdscotland.org/Health-Topics/Cancer/Publications/data-tables.asp?id=1233#1233 accessed 9 Sept 2014

[120] Malignant melanoma, basal cell carcinoma and squamous cell carcinoma

[121] Cancer of the scrotum in lathe workers and other machinists from use of industrial cutting oils has been recognised since 1950 (Coggon, D., Inskip, H., Winter, P. and Pannett, B. (1996) 'Mortality from scrotal cancer in metal machinists in England and Wales, 1979–80 and 1982–90', *Occupational Medicine,* 46(1), 69-70.). The Armed Forces take the risk seriously and appropriate splash guards, personal protective clothing and washing facilities are provided to protect those whose duties include metal-working. [Based on the author's personal recollection, as a Territorial Army trainee in the Royal Electrical and Mechanical Engineers (REME) in 1970-71]. Today, the Armed Forces are fully compliant with UK Health & Safety legislation and practice unless exempt by reason of military operational necessity.

high degree of heterogeneity, and noted the likelihood of recall bias in recording sun exposure in retrospective studies (Gandini et al. 2005). Nonetheless, there were sufficient well designed studies to conclude that there was evidence of an inverse association with chronic high sun exposure, consistent with the findings of other researchers who had examined occupational exposure (Diepgen and Mahler 2002). Both the risk associated with sunburn, and the inverse association with occupational exposure, were stronger at higher latitudes (Gandini et al. 2005). Many service personnel have been exposed to strong sunlight as a consequence of overseas service, as discussed at Appendix 3, Section A3.3.5.6. The lack of evidence of any net increased risk of either malignant melanoma or non-melanoma skin cancer in veterans provides reassurance, and is consistent with the hypotheses that both occupational exposure to sunlight, and smoking (Grant 2008), protect against melanoma. This may also account for the reduced risk of melanoma, albeit non-significant, in the earlier birth cohorts who served at a time when long tours of duty overseas in tropical stations were common, and when exposure to tobacco smoke, either directly or indirectly, was almost universal.

5.25 Lymphohaematopoietic Cancer

5.26 All Lymphohaematopoietic Cancers

5.26.1 Introduction

Lymphohaematopoietic cancer was defined as leukaemia (ICD-10 C90-C95 and ICD-9 203-208), Hodgkin lymphoma (ICD-10 C81 and ICD-9 201) or non-Hodgkin lymphoma (ICD-10 C82-C85 and ICD-9 200 and 202), at any position in the record. A composite outcome of any lymphohaematopoietic cancer was used, based on the first occurrence of any of the ICD codes, in order to eliminate double counting or revision of diagnosis. A landmark analysis from age 20 years was performed, to avoid confounding by childhood leukaemia or lymphoma, which would normally preclude enlistment.

5.26.2 Incidence

5.26.2.1 Overall

During the period of follow-up, 294 (0.52%) veterans had a diagnosis of leukaemia, Hodgkin lymphoma or non-Hodgkin lymphoma, compared with 974 (0.56%) non-veterans. The difference was not statistically significant, unadjusted HR 0.96, 95% CI 0.84-1.10, p=0.541. The hazard ratio was unchanged after adjusting for deprivation. The Nelson-Aalen plot confirmed no significant overall difference between the veterans and non-veterans (Figure 5-44).

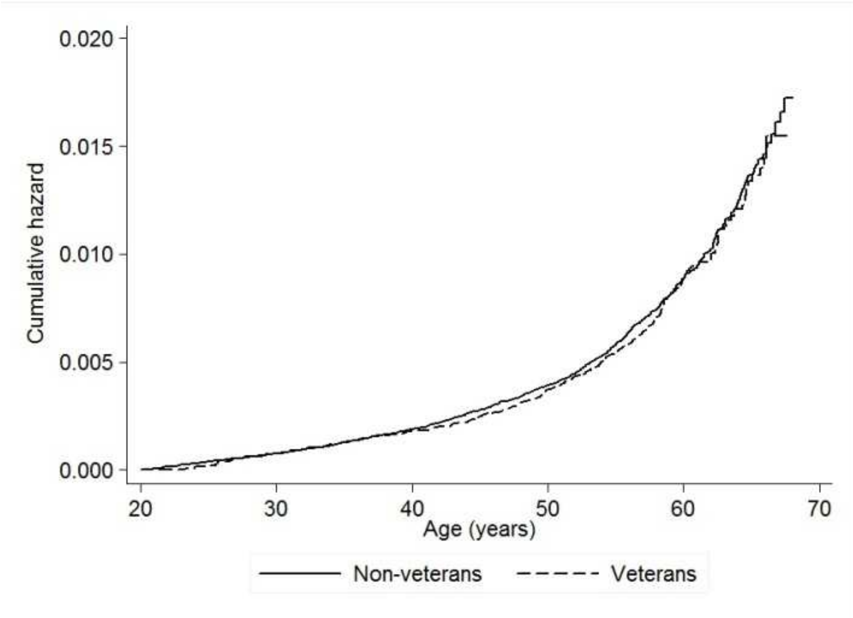

Figure 5-44 - Nelson-Aalen plot of lymphohaematopoietic cancer by veteran status

5.26.2.2 Sex

A total of 19 (6.5% of cases) of the veteran cases and 94 (9.7% of cases) of the non-veteran cases were women, p=0.306. The unadjusted hazard ratio for male veterans compared with non-veterans was 0.97, 95% CI 0.84-1.11, p=0.644, and for female veterans it was 0.80, 95% CI 0.48, p=0.405.

5.26.2.3 Birth Cohort

There was no significant difference in risk of lymphohaematopoietic cancer between veterans and non-veterans for any birth cohort (Figure 5-45).

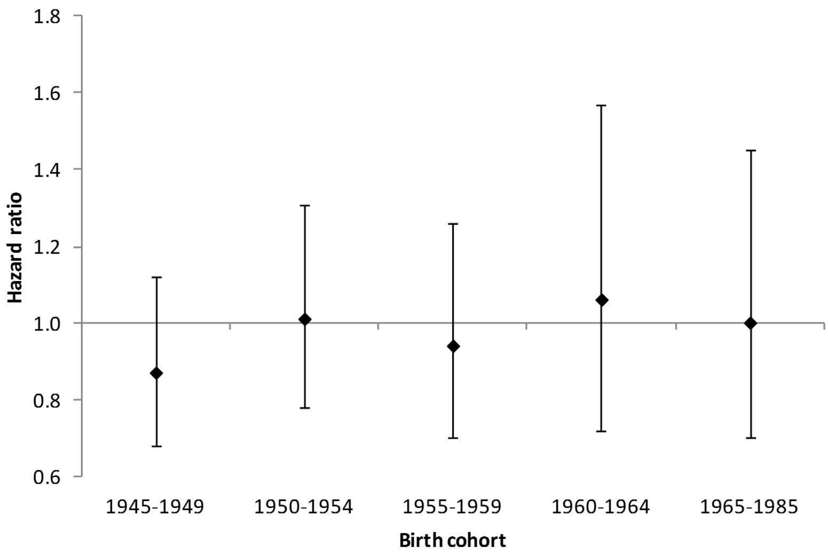

Figure 5-45 - Hazard ratios for lymphohaematopoietic cancer by birth cohort Veterans referent to non-veterans

5.26.2.4 Length of Service

The Nelson-Aalen cumulative hazard plot for risk of lymphohaematopoietic cancer by length of service in 4 categories[118] revealed no clear pattern (Figure 5-46). Early Service Leavers who completed training, and trained veterans with 4-12 years' service, showed a pattern of risk similar to all non-veterans. Both Early Service Leavers who did not complete training, and veterans with the longest service, exhibited a reduction in risk compared with all non-veterans, up to age 60 years; beyond that age, the risk in the longer-serving veterans appeared similar to all non-veterans, as well as to the other two veteran categories. There were only 3 cases diagnosed in untrained ESL over the age of 60 years. Neither the untrained ESL subgroup nor the veterans with over 12 years' service showed a statistically significant reduction in risk compared with all non-veterans, unadjusted HR 0.74, 95% CI 0.43-1.25, p=0.256 for the untrained ESL and HR 0.94, 95% CI 0.73-1.22, p=0.658 for veterans with over 12 years service.

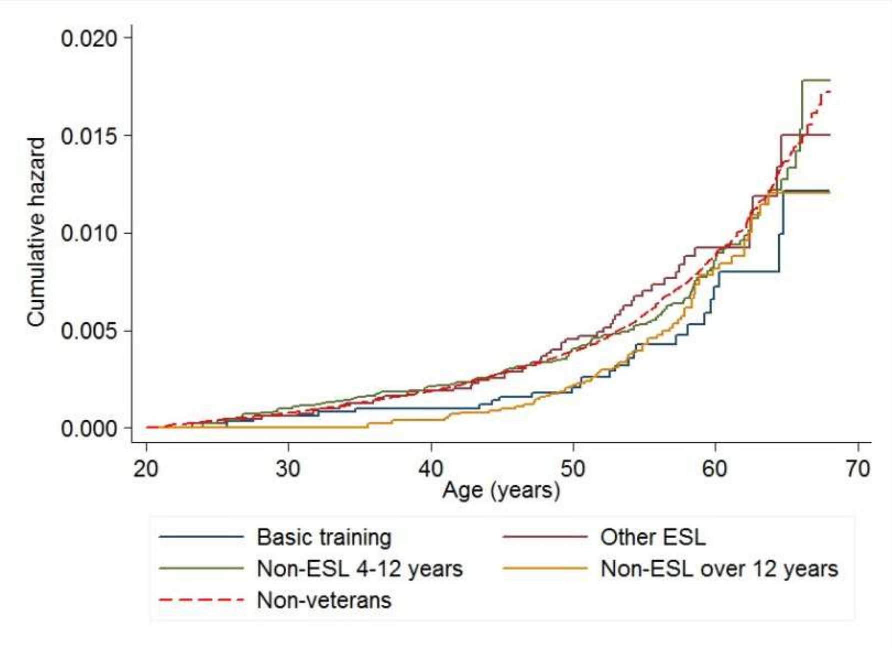

Figure 5-46 – Nelson-Aalen plot of lymphohaematopoietic cancer by length of service Non-veterans for comparison

5.26.3 Case-Fatality

The mean follow-up from date of initial diagnosis of any lymphohaematopoietic cancer to the date of death or the end of the study was 6.46 years (range 0-31.49 years) for veterans and 7.77 years (range 0-31.96 years) for non-veterans, representing 1,889 person-years of follow-up in the veterans and 7,731 person-years in the non-veterans. There were 101 (34.4%) deaths in veterans with lymphohaematopoietic cancer, equating to 58.2 per 1,000 person-years, and 338 (34.0%) deaths in non-veterans (43.7 per 1,000 person-years). Case-fatality at one year and 5 years from diagnosis was non-significantly higher for veterans, unadjusted HR 1.15, 95% CI 0.82-1.60, p=0.41 at one year and HR 1.13,95% CI 0.89-1.43, p=0.305 at 5 years. Results were similar after adjusting for deprivation.

5.27 Leukaemia

5.27.1 Incidence

5.27.1.1 Overall

There were 125 cases of adult[122] leukaemia[123] in veterans compared with 365 in non-veterans, representing a cumulative incidence over the period of follow-up of 0.22% in

[122] Age 20 years and older

veterans and 0.21% in non-veterans. The difference was not statistically significant, unadjusted HR 1.03, 95% CI 0.84-1.27, p=0.782, as demonstrated in the Nelson-Aalen plot (Figure 5-47). The hazard ratio was unchanged after adjusting for deprivation.

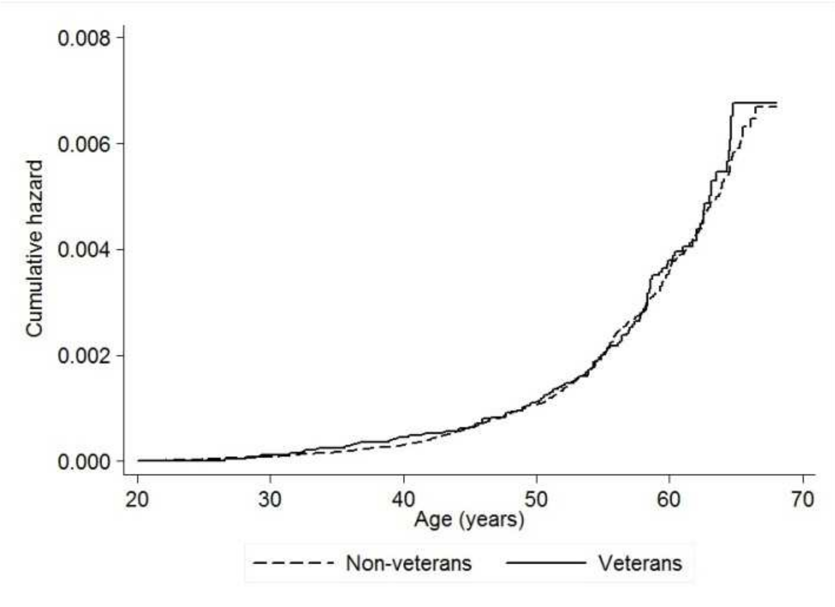

Figure 5-47 - Nelson-Aalen plot of leukaemia by veteran status Landmark age 20 years

Mean age at diagnosis was similar for both veterans (51.0 years, SD 9.7) and non-veterans (50.2 years, SD 10.8).

5.27.1.2 Sex

Only 6 of the veteran cases were in women (5.04% of veteran cases), compared with 35 (10.36%) in non-veterans, equating to a cumulative incidence of 0.11% in veteran women and 0.17% in non-veteran women. The reduction in risk in veteran women compared to non-veteran women was not statistically significant, unadjusted HR 0.71, 95% CI 0.30-1.68, p=0.433. The adjusted HR was the same. For men, the unadjusted hazard ratio was 1.05, 95% CI 0.85-1.30, p=0.638, unchanged after adjusting for deprivation.

5.27.1.3 Birth Cohort

There was no statistically significant difference in risk between veterans and non-veterans for any birth cohort in 5-year bands, although there was a non-significant increase in risk

[123] All leukaemia diagnoses were aggregated in the linked dataset; it was not possible to differentiate between acute or chronic, lymphocytic, lymphoblastic or myeloid leukaemia, other than for deaths where individual ICD codes for primary cause of death were included in the dataset.

in veterans born from 1965 onwards (Figure 5-48). For this subgroup, the hazard ratio was 1.84, 95% CI 0.99-3.43, p=0.053, based on a small number of cases (16 veterans and 39 non-veterans).

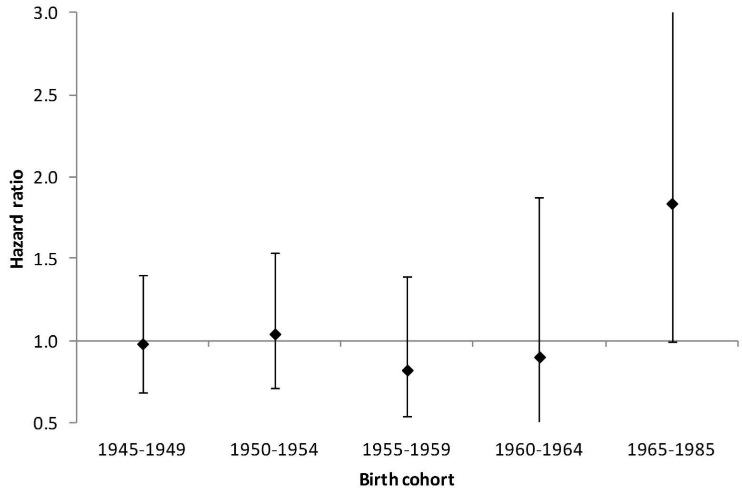

Figure 5-48 – Hazard ratios for leukaemia by birth cohort
Veterans referent to non-veterans

5.27.1.4 Length of Service

There were insufficient numbers to permit detailed subgroup analysis by length of service. However, the Nelson-Aalen plot by length of service in 4 categories[118], compared with all non-veterans, showed no clear pattern (Figure 5-49). The slightly reduced risk in veterans who left during initial training is based on only 9 cases and is not statistically significant.

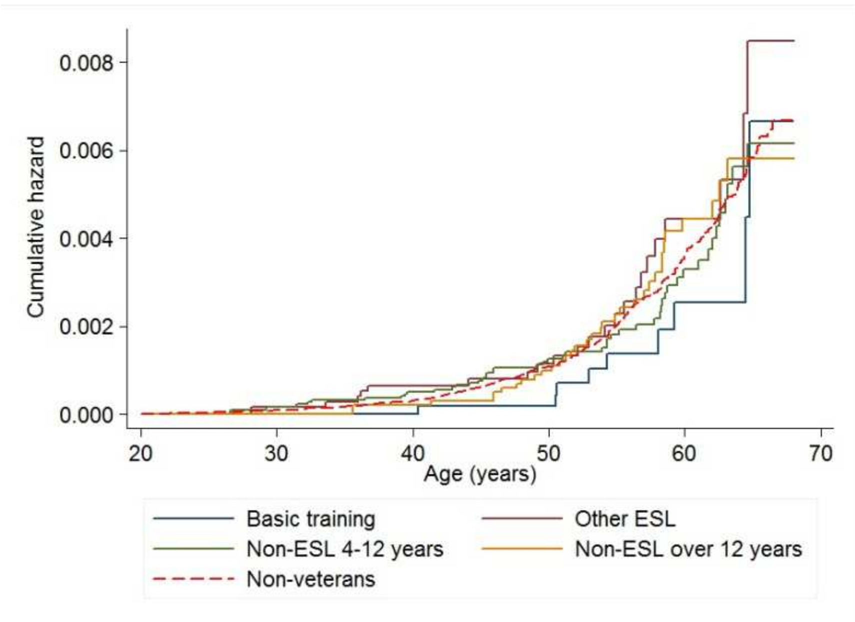

Figure 5-49 – Nelson-Aalen plot of leukaemia by length of service
All non-veterans for comparison

5.27.2 Case-Fatality

The mean follow-up from date of diagnosis of leukaemia to the date of death or the end of the study was 4.68 years (range 0-24.16 years) for veterans and 5.26 years (range 0-31.23 years) for non-veterans, representing 585 person-years of follow-up in the veterans and 1,962 person-years in the non-veterans. There were 52 (41.6%) deaths in veterans with leukaemia, equating to 88.9 per 1,000 person-years, and 151 (40.4%) deaths in non-veterans (77.0 per 1,000 person-years). Case-fatality at both one year and 5 years were non-significantly higher in veterans, HR 1.40, 95% CI 0.89-2.20, p=0.150 at one year and 1.28, 95% CI 0.92-1.79, p=0.139 at 5 years. Although hospital admissions for all types of leukaemia were aggregated, it was possible to separate out acute myeloid leukaemia (AML) for those who had died; 16 (30.77%) of the 52 deaths in veterans with a leukaemia diagnosis had an ICD code for AML, compared with 44 (29.13%) in non-veterans, p=0.765.

5.28 Hodgkin Lymphoma

5.28.1 Incidence

5.28.1.1 Overall

Over the period of follow-up, there were 59 cases of Hodgkin lymphoma in veterans compared with 182 cases in non-veterans, equating to a cumulative incidence of 0.10% and 0.11% respectively. There was a small non-significant increase in risk in veterans in the Cox proportional hazard model, HR 1.17, 95% CI 0.86-1.59, p=0.318. After adjusting for deprivation, the hazard ratio was 1.19, 95% CI 0.87-1.61, p=0.272. However the Nelson-Aalen cumulative hazard plot showed veterans to be at higher risk than non-veterans (Figure 5-50). Visual inspection indicated non-proportionality of the hazard (Hess 1995), although the Stata *estat phtest* for non-proportionality was non-significant, p=0.814; subgroup analysis restricted to age 55 and over at diagnosis gave a much higher hazard ratio, HR 1.71, 95% CI 0.86-3.38, p=0.124 after adjusting for deprivation, although it failed to achieve statistical significance. The absolute number of cases in this older subgroup was small (13 cases in veterans and 23 in non-veterans).

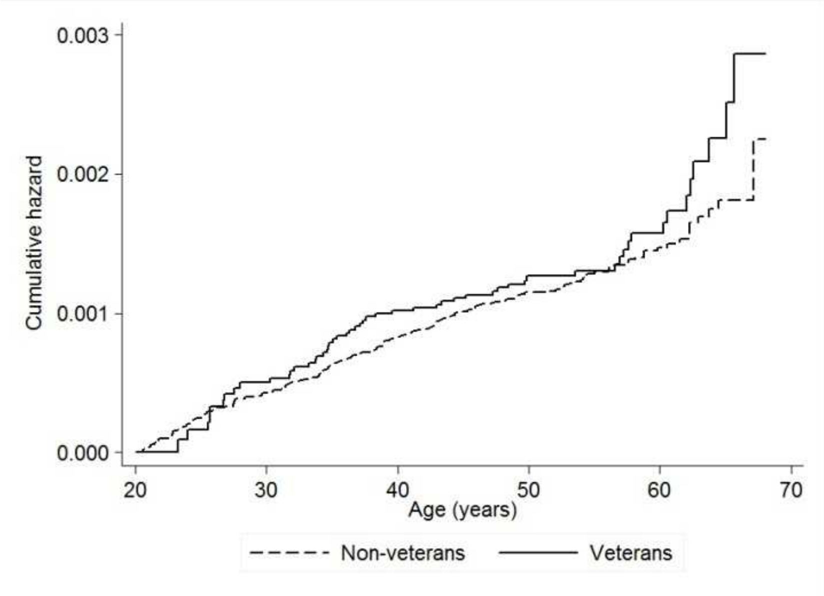

Figure 5-50 - Nelson-Aalen plot of Hodgkin lymphoma by veteran status

Mean age at diagnosis was 40.9 years (SD 12.7) for veterans and 37.5 years (SD 12.2) for non-veterans.

5.28.1.2 Sex

Four of the veteran cases (6.78%) and 18 of the non-veteran cases (9.89%) were in women, p=0.668. Overall, there was a cumulative incidence of Hodgkin lymphoma of 0.08% in veteran women and 0.09% in non-veteran women over the 32-year follow-up period, compared with 0.11% in both veteran and non-veteran men. The Cox proportional hazard ratio was non-significantly increased for veteran men compared with non-veteran men, unadjusted HR 1.21, 95% CI 0.61-2.41, p=0.581 and 1.18, 95% CI 0.58-2.38, p=0.644 after adjusting for deprivation, but the numbers were too small to give a reliable hazard ratio for women.

5.28.1.3 Birth Cohort

None of the hazard ratios for risk of Hodgkin lymphoma by birth cohort in 5-year bands showed any significant difference between veterans and non-veterans, although there was evidence of a steady non-significant increase between 1950 and 1964, which then reversed in the most recent birth cohort (Figure 5-51), with a peak HR of 1.59, 95% CI 0.77-3.28 for the 1960-1964 birth cohort.

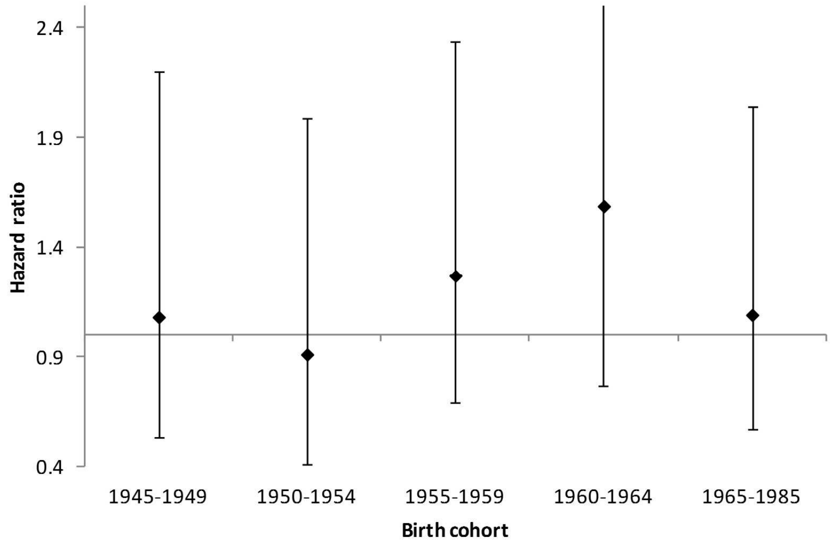

Figure 5-51 – Hazard ratios for Hodgkin lymphoma by birth cohort Veterans referent to non-veterans

5.28.1.4 Length of Service

There were insufficient numbers of cases to permit subgroup analysis by length of service.

5.28.2 Case-Fatality

The mean follow-up from date of diagnosis of Hodgkin lymphoma to the date of death or the end of the study on 31 December 2012 was 10.57 years (range 0.01-31.49 years) for veterans and 13.18 years (range 0-31.96 years) for non-veterans, representing 624 person-years of follow-up in the veterans and 2,491 person-years in the non-veterans. There were 17 (28.8%) deaths in veterans with Hodgkin lymphoma, equating to 27.3 per 1,000 person-years, and 50 (26.5%) deaths in non-veterans (20.1 per 1,000 person-years). Veterans had a non-significantly lower case-fatality at one year than non-veterans, HR 0.70, 95% CI 0.2-2.42, p=0.542. By 5 years, case-fatality was non-significantly higher in the veterans, HR 1.21, 95% CI 0.61-2.41, p=0.581.

5.29 Non-Hodgkin Lymphoma

5.29.1 Incidence

5.29.1.1 Overall

As with the other lymphohaematopoietic malignancies, a landmark analysis was performed beginning at age 20 years in order to avoid confounding by conditions arising in childhood and adolescence which would have precluded military service. There was a total of 144 cases of non-Hodgkin lymphoma in veterans and 539 in non-veterans, representing a cumulative incidence of 0.26% and 0.31% respectively over the period of follow-up. The Cox proportional hazard ratio showed a non-significant reduction in risk for veterans, HR 0.85, 95% CI 0.71-1.02, p=0.096, which was similar after adjusting for deprivation (Figure 5-52).

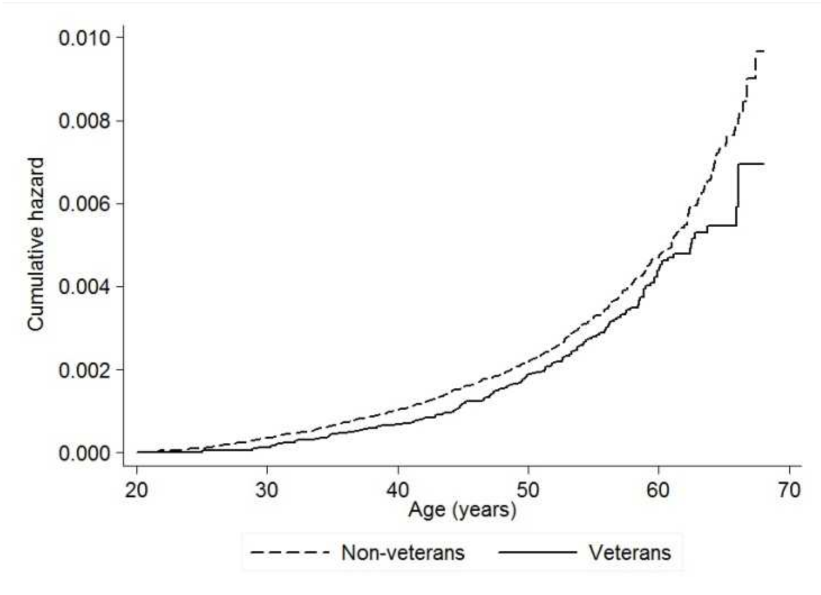

Figure 5-52 - Nelson-Aalen plot of non-Hodgkin lymphoma by veteran status

Mean age at diagnosis was 48.4 years (SD 9.5) for veterans and 46.8 years (SD 11.5) for non-veterans.

5.29.1.2 Sex

Eleven (0.21%) veteran women developed non-Hodgkin lymphoma, compared with 49 (0.24%) non-veteran women. The difference was not significant, unadjusted HR 0.99, 95% CI 0.51-1.90, p=0.966. In men, 0.26% of veterans and 0.32% of non-veterans developed Hodgkin lymphoma, a reduction in risk in veterans which did not quite achieve statistical significance (unadjusted HR 0.84, 95% CI 0.69-1.02, p=0.078, unchanged after adjusting for deprivation).

5.29.1.3 Birth Cohort

There was a statistically significant reduction in risk of non-Hodgkin lymphoma in the oldest veterans, unadjusted HR 0.67, 95% CI 0.46-0.97, p=0.036, which remained significant after adjusting for deprivation, HR 0.68, 95% CI 0.47-0.99, p=0.044. The hazard ratios were close to unity for the 1950-1964 cohorts, with a non-significant reduction in risk in the youngest veterans compared with non-veterans (Figure 5-53).

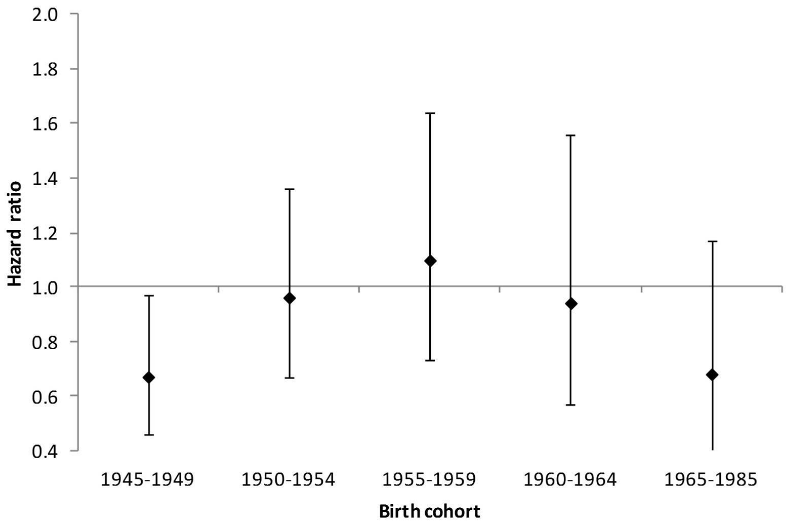

Figure 5-53 – Hazard ratios for non-Hodgkin lymphoma by birth cohort Veterans referent to non-veterans

5.29.1.4 Length of Service

Analysis by length of service in 8 categories[124] revealed no statistically significant differences, overall or for the oldest (pre-1960) and younger (1960 onwards) birth cohorts for any length of service, referent to all non-veterans. When examined graphically in 4 categories[99], the slight reduction in risk in veterans was evident at all lengths of service apart from ESL who completed initial training, whose risk was similar to the reference population (Figure 5-54).

[124] Reflecting the commonest lengths of military engagement; detailed analysis not shown

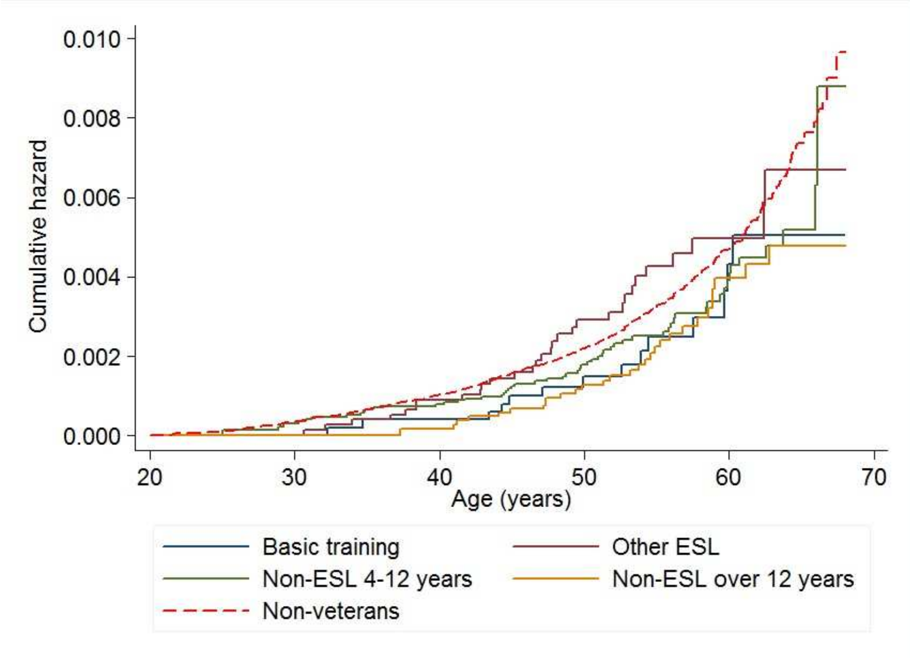

Figure 5-54 – Nelson-Aalen plot of non-Hodgkin lymphoma by length of service Non-veterans for comparison

5.29.2 Case-Fatality

The mean follow-up from date of diagnosis of non-Hodgkin lymphoma to the date of death or the end of the study on 31 December 2012 was 6.32 years (range 0-30.40 years) for veterans and 7.21 years (range 0-31.91 years) for non-veterans, representing 910 person-years of follow-up in the veterans and 3,929 person-years in the non-veterans. There were 46 (31.9%) deaths in veterans with non-Hodgkin lymphoma, equating to 50.6 per 1,000 person-years, and 186 (34.1%) deaths in non-veterans (47.3 per 1,000 person-years). Case-fatality was non-significantly lower at one year in the veterans, HR 0.86, 95% CI 0.53-1.40, p=0.546. There was no difference at 5 years, HR 1.03, 95% CI 0.74-1.44, p=0.852.

5.29.3 Commentary – Lymphohaematopoietic Cancer

Lymphohaematopoietic malignancies are relatively common in the general population, leukaemia accounting for 3% of all new cancers, with an age-standardised incidence rate of 10.2 per 100,000 per year in the UK. In addition there are 15.1 cases of non-Hodgkin lymphoma per 100,000 population (4% of all new cancers), whilst Hodgkin lymphoma accounts for a further 2.9 cases per 100,000 per year. The lymphomas are the second most common cancers in male adolescents and young adults, whilst leukaemia is the fourth commonest (Cancer Research UK 2012). The main risk factors for both Hodgkin lymphoma and non-Hodgkin lymphoma are similar to those for the leukaemias and include age, gender and family history. A number of studies suggest that smoking is a risk factor for Hodgkin lymphoma (Briggs et al. 2002, Lim et al. 2007), whilst the evidence in respect of smoking is inconclusive for non-Hodgkin lymphoma (Morton et al. 2005). Radiation, chemotherapy and immunosuppression are also risk factors for non-Hodgkin lymphoma, as are viral infections such as Epstein-Barr virus (which also increases the risk of Hodgkin lymphoma) and HIV. Infection with *Helicobacter pylori* is known to be associated with gastric lymphoma.

Occupational factors such as exposure to industrial solvents, herbicides and benzene are thought to account for between 4% and 11% of cases of non-Hodgkin lymphoma (Hartge and Devesa 1992), and concerns have been expressed that occupational exposure to radiation (Gardner 1988), fuels (Austin et al. 1988) and electromagnetic fields (Garland et al. 1990) may increase the risk of leukaemia in military personnel. In 1980, a US report linked 9 cases of leukaemia to participation in military exercises during the 1957 nuclear test explosion (Caldwell et al. 1980). In 2001, it was reported that military service in the Balkans may have been associated with an increased risk of leukaemia as a consequence of the use of depleted uranium munitions some 5 years earlier, following the deaths of 6 Italian soldiers who had served there (Dyer 2001). However, formal epidemiological evidence has provided a conflicting picture, with most studies reporting no increased risk associated with either radiation (Muirhead et al. 2003a) or exposure to electromagnetic fields (Garland et al. 1990) in military personnel.

Although there were no differences in risk between veterans and non-veterans when all lymphohaematopoietic cancers were analysed together, the individual cancers revealed a mixed picture. For leukaemia there was no overall difference in incidence, although it was not possible to separate acute or chronic, lymphocytic or myeloid leukaemia. There was a non-significant increase in risk in the youngest birth cohort, based on small numbers; this will need to be monitored as this cohort ages. A similar increase was observed in the early years of follow-up of the nuclear test veterans but the difference disappeared with longer follow-up, except for some leukaemias (Darby et al. 1988, Muirhead et al. 2003a), as discussed at Appendix 1, Section A1.3.2.

Hodgkin lymphoma is known to have a bimodal age distribution, peaking at ages 15-34 years and over 60 years in most populations (Cartwright and Watkins 2004). This was clearly demonstrated in the veteran dataset (Figure 5-55).

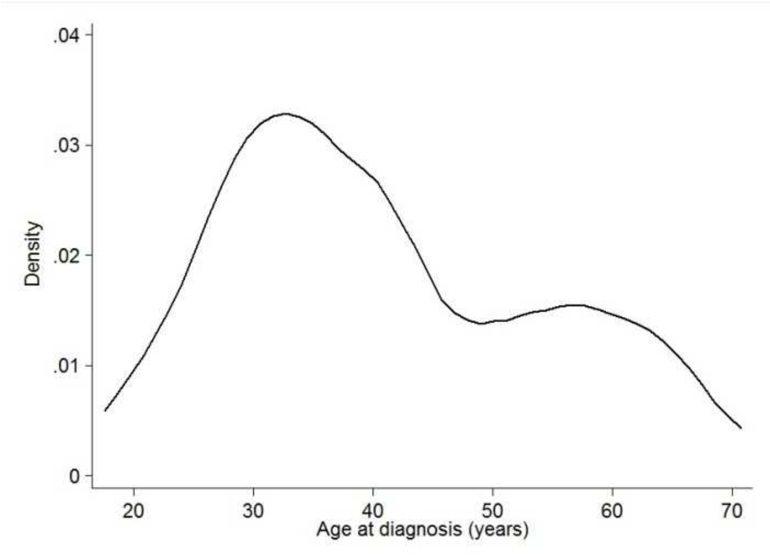

Figure 5-55 - Kernel density plot of Hodgkin lymphoma by age at diagnosis Veterans only

The finding of an overall (albeit non-significantly) increased risk of Hodgkin lymphoma and reduction in risk of non-Hodgkin lymphoma in veterans cannot readily be explained. Misdiagnosis is unlikely; Hodgkin lymphoma is more likely to be misclassified as non-Hodgkin lymphoma (Hartge and Devesa 1992) which would have given rise to the opposite effect from that observed. Furthermore, since all patients were treated in NHS facilities, systematic misdiagnosis in the veterans seems implausible. Although a simple classification into leukaemia, Hodgkin lymphoma and non-Hodgkin lymphoma is widely used for reporting purposes, the lymphohaematopoietic malignancies encompass a wide range of distinct diseases (Campo et al. 2011), with differing risk factors; this renders any interpretation of patterns of risk in veterans problematic. However, it may be concluded that any differences in risk between veterans and non-veterans are minor, although longer follow-up of leukaemia in veterans born from 1965 onwards is needed.

5.30 Male Reproductive Cancer

Male reproductive cancer was defined as prostate cancer (ICD-9 185 or ICD-10 C61) or testicular cancer (ICD-9 186 or ICD-10 C62) , recorded at any position in the record.

5.31 Prostate Cancer

5.31.1 Incidence

5.31.1.1 Overall

Over the period of the study, there were 246 cases of prostate cancer in veterans and 777 in non-veterans, a cumulative incidence of 0.48% in veteran men and 0.51% in non-veteran men. The reduction in risk in veterans did not achieve statistical significance, unadjusted HR 0.92, 95% CI 0.80-1.07, p=0.278 (Figure 5-56). The hazard ratio was similar after adjusting for deprivation.

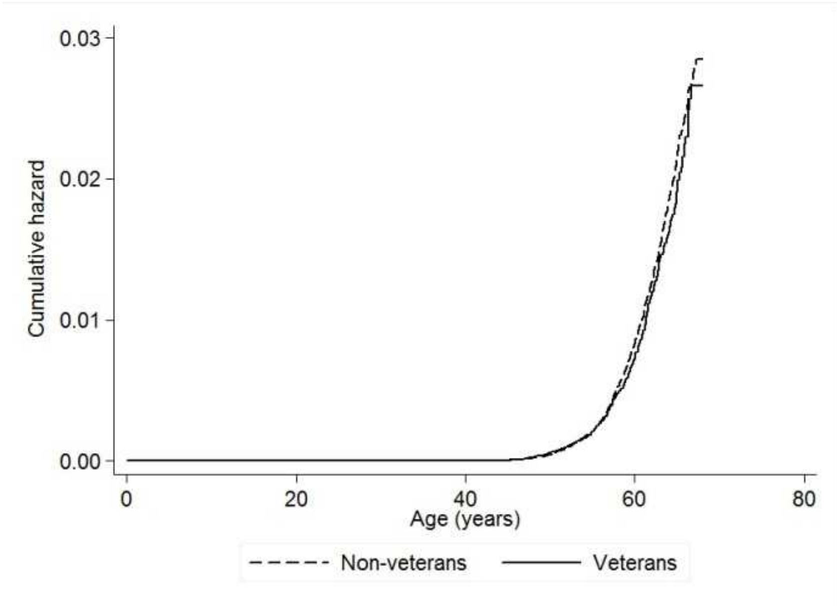

Figure 5-56 - Nelson-Aalen plot of prostate cancer by veteran status

Mean age at diagnosis was 58.1 years (SD 5.1) in veterans and 58.3 years (SD 5.0) in non-veterans.

5.31.1.2 Birth Cohort

The hazard ratios for prostate cancer in veterans compared with non-veterans, by birth cohort, were close to unity for all birth years prior to 1965. The small reduction in the later births is not significant; there was only one veteran case and 6 non-veterans in this subgroup.

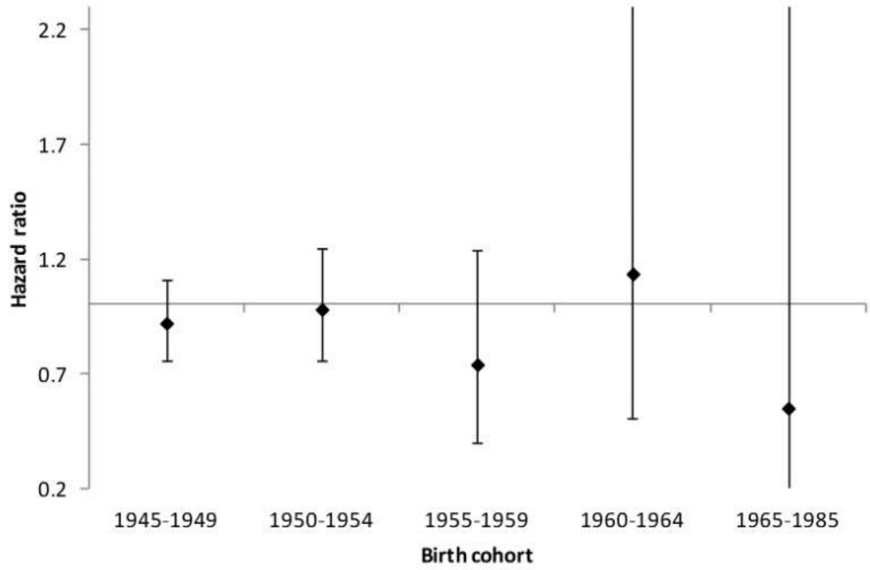

Figure 5-57 – Hazard ratios for prostate cancer by birth cohort
Veterans referent to non-veterans

5.31.1.3 Length of Service

When veterans were stratified by length of service, there was no significant difference from all non-veterans for any category of length of service (Table 5-13). The boundary at 12 years (part 3 of Table 5-13) represented junior and senior non-commissioned officers, and junior and senior officers, and confirmed that there was no difference.

Table 5-13 - Cox proportional hazard model of the association between veteran status and prostate cancer, overall and stratified by length of service

	Veteran cases *n*	Male Veterans *n*=50,970 HR	95% CI	p
Overall				
Univariate	246	0.92	0.80-1.07	0.278
Multi-variable	246	0.93	0.81-1.07	0.328
Length of service in 8 categories				
Basic training[98]	26	0.91	0.61-1.34	0.624
ESL[99] **(0-3 years)**	49	0.99	0.74-1.32	0.958
4-6 years	49	1.03	0.77-1.38	0.827
7-9 years	25	0.69	0.46-1.03	0.067
10-12 years	22	0.72	0.47-1.10	0.126
13-16 years	24	1.24	0.83-1.86	0.302
17-22 years	16	0.74	0.45-1.21	0.233
≥23 years	35	0.96	0.68-1.34	0.802
Length of service in 2 categories				
≤ 12 years	171	0.90	0.76-1.06	0.250
>12 years	75	0.98	0.77-1.24	0.868

5.31.2 Case-Fatality

The mean follow-up from date of diagnosis of prostate cancer to the date of death or the end of the study on 31 December 2012 was 3.95 years (range 0-16.78 years) for veterans and 3.78 years (range 0-19.23 years) for non-veterans, representing 972 person-years of follow-up in the veterans and 2,937 person-years in the non-veterans. There were 46 (18.7%) deaths in veterans with prostate cancer, equating to 47.3 per 1,000 person-years, and 130 (16.7%) deaths in non-veterans (44.3 per 1,000 person-years). Case-fatality at one year was no different for veterans compared with non-veterans, HR=1.00, 95% CI 0.51-1.96, p=0.990, and there was no significant difference at 5 years, HR 1.10, 95% CI 0.79-1.55, p=0.557.

5.32 Testicular Cancer

Testicular cancer was defined as ICD-9 code 186 or ICD-10 code C62, at any position in the record.

5.32.1 Incidence

5.32.1.1 Overall

Over the period of follow-up there were 156 cases of testicular cancer in veterans and 510 cases in non-veterans, equating to a cumulative incidence of 0.31% in veteran men and 0.34% in non-veteran men. The difference was not statistically significant in either the unadjusted or adjusted model, HR 1.04, 95% CI 0.86-1.25, p=0.686 and 1.04, 95% CI 0.87-1.26, p=0.641 respectively. The Nelson-Aalen plot confirmed that there was little difference in risk of testicular cancer overall between the veterans and non-veterans (Figure 5-58).

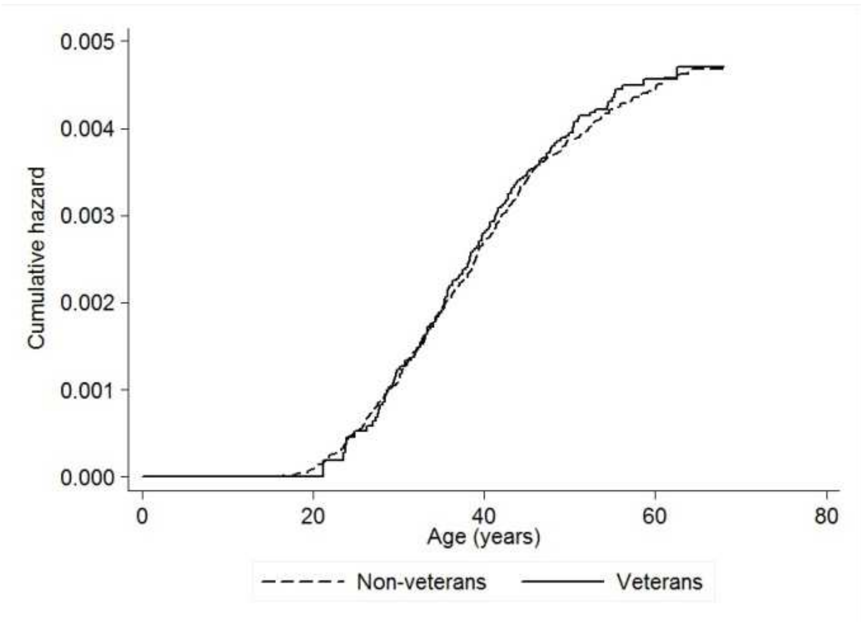

Figure 5-58 - Nelson-Aalen plot of testicular cancer by veteran status

5.32.1.2 Birth Cohort

Apart from a non-significant increase in the 1945-1949 birth cohort (unadjusted HR 1.38, 95% CI 0.81-2.35, p=0.236), the hazard ratios for testicular cancer in all birth cohorts were close to unity.

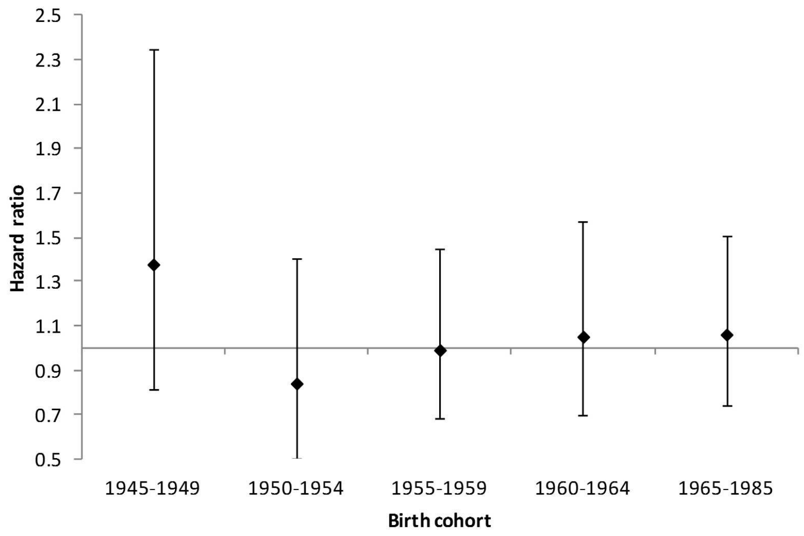

Figure 5-59 – Hazard ratios for testicular cancer by birth cohort Veterans referent to non-veterans

5.32.1.3 Length of Service

Small numbers of cases in each category did not permit detailed analysis by common lengths of engagement; stratification into 3 broad categories showed no significant increase for any length of service, although there was a gradual increase in the hazard ratios with increasing length of service in the veterans when compared with all non-veterans (Table 5-14).

Table 5-14 - Cox proportional hazard model of the association between veteran status and testicular cancer, overall and stratified by length of service

	Veteran cases *n*	HR	Male Veterans *n*=50,970 95% CI	p
Overall				
Univariate	156	1.04	0.86-1.25	0.686
Multi-variable	156	1.05	0.87-1.26	0.641
Length of service in 3 categories				
All ESL[99]	42	0.84	0.62-1.15	0.284
≤12 years	117	1.12	0.88-1.44	0.353
>12 years	37	1.29	0.88-1.89	0.186

There was also some evidence of clustering in specific years of entry to service; 1967, 1972 and 1979, although absolute numbers were small and statistical significance was not achieved.

5.32.2 Case-Fatality

The mean follow-up from date of diagnosis of testicular cancer to the date of death or the end of the study on 31 December 2012 was 13.68 years (range 0-31.44 years) for veterans and 13.85 years (range 0-31.97 years) for non-veterans, representing 2,134 person-years of follow-up in the veterans and 7,064 person-years in the non-veterans. There were 19 (12.2%) deaths in veterans with testicular cancer, equating to 8.9 per 1,000 person-years, and 49 (9.6%) deaths in non-veterans (6.9 per 1,000 person-years). Case-fatality at one year was much higher in the veterans, HR 3.31, 95% CI 1.16-9.43, p=0.025, based on 7 deaths in the veterans and the same number in the 3:1 non-veterans group. By 5 years, there was no difference in case-fatality, HR 0.85, 95% CI 0.39-1.85, p=0.687.

5.32.3 Commentary – Male Reproductive Cancer

Prostate cancer is the commonest cancer in men in the UK, with a standardised incidence[125] of 104.7 per 100,000 per year[126], accounting for 25% of all incident cancers in men. Survival rates are high, with 93.5% alive at one year after diagnosis, 81.4% at 5 years and 68.5% at 10 years,[127] although it is the second commonest cause of cancer death in men. Risk factors include age and family history, a history in a first-degree relative more than trebling the risk (Kiciński et al. 2011). Risk also varies with ethnicity, being lower in Asian men and higher in African men. There is no strong evidence for any occupational association (Parent and Siemiatycki 2013). A case control study of 606 cases and 471 controls in Australia found a non-significant increase in military veterans who had deployed to Vietnam, which persisted after adjusting for family history, although there was no association with either a history of military service or service in conflict otherwise (Leavy et al. 2006). Darby et al. reported a reduced risk of death from prostate

[125] European age-standardised rate

[126] UK figures for 2011. Source Cancer Research UK http://publications.cancerresearchuk.org/downloads/Product/CS_KF_PROSTATE.pdf accessed 16 Sep 2014

[127] Ibid. England/E&W, various dates 2005-2009.

cancer in veterans of the UK nuclear test programme compared with controls, but this was influenced by a higher than expected number of deaths in the controls (Darby et al. 1988). Zhu et al. examined prostate cancer in serving US military personnel, but did not look at veterans. They found a higher rate than in civilians but surmised that this may have been a consequence of US military screening programmes (Zhu et al. 2009). There is conflicting evidence for an association with cigarette smoking, with some studies reporting an increased risk, although a comprehensive meta-analysis reported no association in the majority of studies, noting methodological shortcomings in many of them (Plaskon et al. 2003, Hickey et al. 2013). It is unlikely that there is a systematic difference between veterans and non-veterans in the likelihood of having a close family member with prostate cancer. Overall, therefore, there is no theoretical basis for the risk of prostate cancer in veterans to differ from that in non-veterans; findings from the Scottish Veterans study support this hypothesis.

By contrast, there have been conflicting reports of associations between military service and testicular cancer. A report in 1991 concluded that Vietnam veterans had a two-fold increase in risk compared with all veterans, after excluding other risk factors such as cryptorchidism, low birth weight and non-Hodgkin lymphoma (Tarone et al. 1991). That study followed reports of a similar increase in risk of testicular cancer in military working dogs deployed to Vietnam (H.M. Hayes et al. 1990). However a later study, as part of the Agent Orange follow-up, demonstrated only a significant increase in US Navy veterans; there was no increase in risk of testicular cancer for ground troops. A study of US Gulf War era veterans based on cancer registry records showed a higher crude proportional incidence in those who had deployed to the Gulf, based on 17 cases in the deployed group and 11 in the non-deployed personnel. The peak incidence occurred 5 years after the conflict (Levine et al. 2005). Hayes et al. examined occupational associations with testicular cancer in a case control study at two US military hospitals and a civilian hospital; controls were patients with non-genital cancers. They concluded there was an association between professional occupations and seminoma, and between working in the production industries and other germ-cell tumours, although no specific occupational linkage within those groups could be determined. There was a strong association between self-reported exposure to microwaves or radio waves, especially in the military subjects (OR 3.5, 95% CI 1.3-10.2) although when analysed by job title based on the likelihood of exposure to microwaves or radio waves, the correlation was poor (R.B.

Hayes et al. 1990). The possible role of high-frequency electromagnetic radiation as a risk factor for cancer is discussed at Appendix 3, Section A3.3.5.7. In a large cohort of US Navy personnel exposed to radar waves and followed up for 40 years, the relative risk of mortality from testicular cancer was 1.30, 95% CI 0.35-4.89, but this was based on only 5 cases in the high-exposure group and 4 cases exposed to low levels of radiation (Groves et al. 2002). Furthermore, there is a high survival rate for testicular cancer, and mortality studies may not therefore reflect incidence.

The MOD's Synopsis of Causation notes cryptorchidism, low birth weight, infantile hernia and tall stature as risk factors but reports no firm scientific evidence for occupational risk factors, and no evidence in respect of vasectomy or trauma (Fisher 2008). Whilst the Scottish Veterans Health Study provides reassurance that there is little overall difference in risk of testicular cancer between veterans and non-veterans, for any birth cohort, the steady (although small and non-significant) increase in risk with increasing length of service, and indication of clustering, suggests that there may be a small occupational association. Of the known and postulated risk factors, exposure to high-frequency electromagnetic radiation from military radio equipment and radar installations seems the most likely. Further studies are needed to examine the occupational histories of the 156 cases in veterans in order to clarify patterns of risk.

5.33 Female Reproductive Cancer

Female reproductive cancer was defined as cancer of the cervix uteri (ICD-9 180 or ICD-10 C52), corpus uteri (ICD-9 182, ICD-10 C54 or C55) or ovary (ICD-9 183 or ICD-10 C56), at any position in the record.

5.34 Cervical Cancer

5.34.1 Incidence

5.34.1.1 Overall

Among the veteran women, 18 developed cervical cancer compared with 81 of the non-veteran women over the period of follow-up, equating to a cumulative incidence of 0.34% in veterans and 0.39% in non-veterans. The difference was not statistically significant, unadjusted HR 0.97, 95% CI 0.58-1.62, p=0.906, adjusted HR 0.95, 95% CI 0.57-1.59, p=0.853. The Nelson-Aalen plot confirmed a small overall reduction in risk (Figure 5-60). Testing for non-proportionality of the hazards was non-significant, p=0.493.

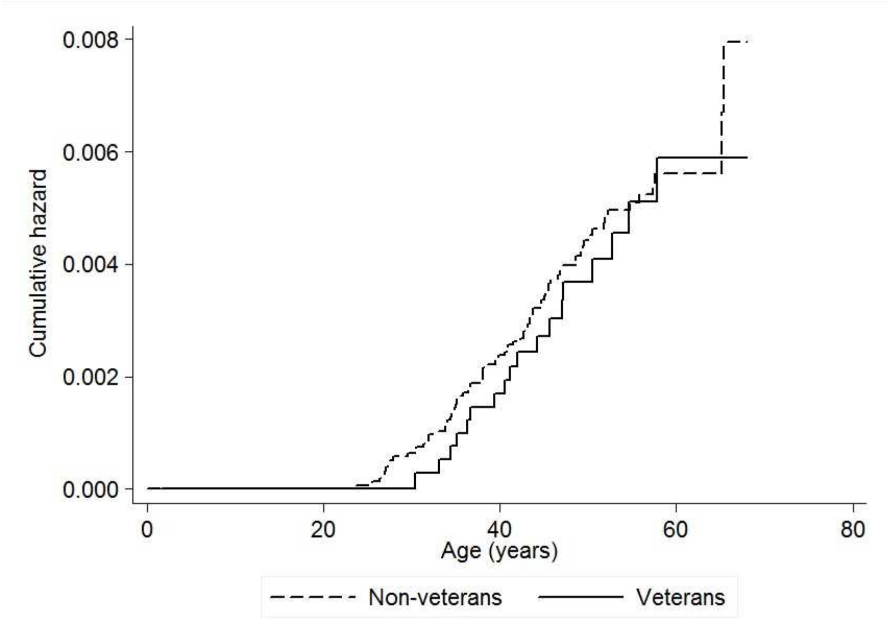

Figure 5-60 - Nelson-Aalen plot of cervical cancer by veteran status

5.34.1.2 Birth Cohort

Analysis by birth cohort was limited by small numbers, and accordingly wide confidence intervals, but demonstrated a lower risk in women born after 1960 which did not reach statistical significance.

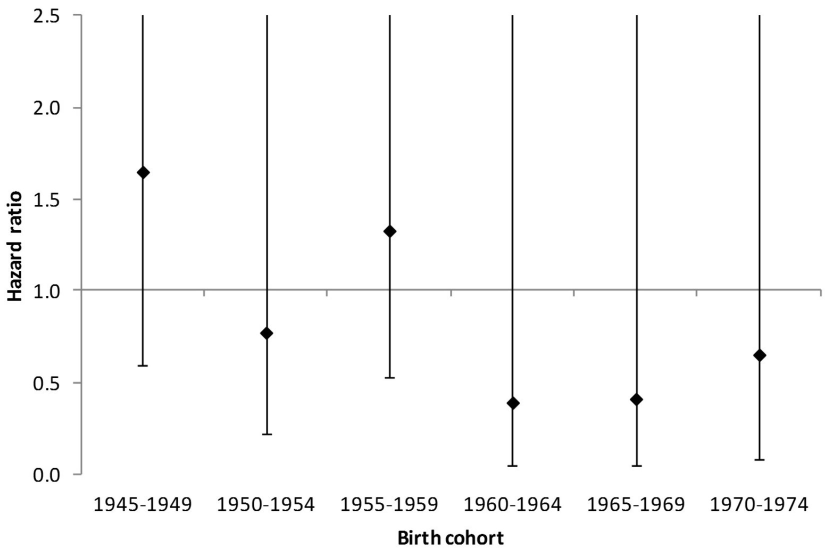

Figure 5-61 – Hazard ratios for cervical cancer by birth cohort Veteran women referent to non-veterans

Since military cervical screening was established more than 20 years earlier than the programme for civilians (1967 and 1988 respectively) and therefore could potentially have impacted on servicewomen born from the mid-1950s, a more detailed analysis was undertaken and a 'population pyramid' was constructed to show the incidence of cervical cancer in veteran and non-veteran women by year of birth (Figure 5-62).

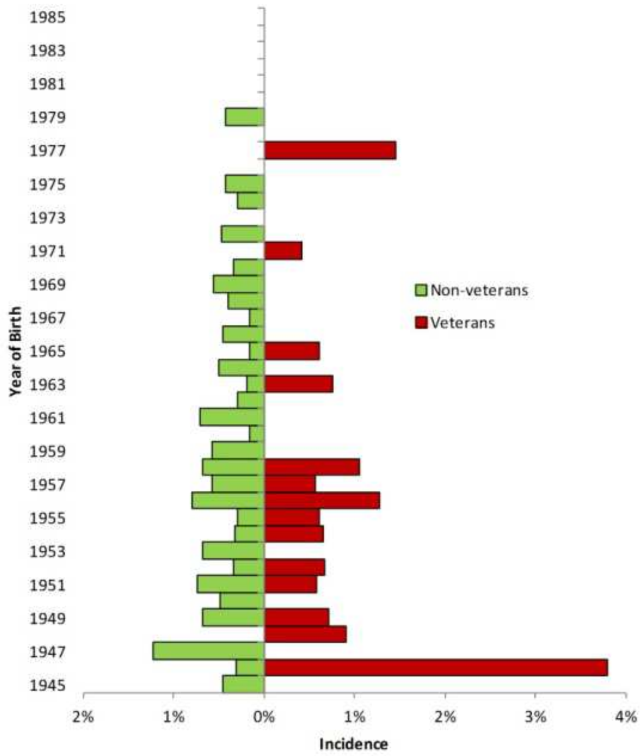

Figure 5-62 – 'Population pyramid' of cervical cancer incidence Veteran and non-veteran women (Bergman et al. 2015a)

Visual inspection of Figure 5-62 indicated a substantial reduction in incidence in veterans born after 1958. For women born 1945-1958, there were 14 (0.69%) cases of cervical cancer in the veterans compared with 45 (0.56%) in non-veterans, unadjusted HR 1.31, 95% CI 0.72-2.40, p=0.372, adjusted HR 1.24, 95% CI 0.68-2.26, p=0.480. For women born between 1959 and 1985, the corresponding numbers of cases were 4 (0.12%) in the veterans and 36 (0.28%) in the non-veterans, unadjusted HR 0.51, 95% CI 0.18-1.43, p=0.202 and adjusted HR 0.51, 95% CI 0.18-1.44, p=0.206. This represented a reduction of 83% in the veteran women and 50% in the non-veterans in the 1959-1985 birth cohort. Despite the apparent large reduction in incidence of cervical cancer in women veterans born since 1958 compared with non-veterans, the difference did not achieve statistical significance owing to the small overall number of cases, HR 0.51, 95% CI 0.18-1.44, p=0.204.

5.34.1.3 Length of Service

The number of cases of cervical cancer in veterans was insufficient to permit any analysis by length of service.

5.34.2 Case-Fatality

The mean follow-up from date of diagnosis of cervical cancer to the date of death or the end of the study on 31 December 2012 was 12.61 years (range 0-31.44 years) for veterans and 12.09 years (range 0-31.97 years) for non-veterans, representing 227 person-years of follow-up in the veterans and 979 person-years in the non-veterans. There were 2 (11.1%) deaths from all causes in veterans with cervical cancer, equating to 8.8 per 1,000 person-years, and 17 (21.0%) deaths in non-veterans (17.4 per 1,000 person-years). There was one death from cervical cancer in the veterans, giving a crude mortality rate of 5.6%, compared with 8 deaths in the non-veterans (crude mortality rate 9.9%), although the difference did not achieve statistical significance.

5.34.3 Commentary

Cervical cancer is the third commonest cancer in women worldwide, although the implementation of screening programmes in developed countries has had a major impact and in the UK, it ranks only 11th, accounting for 2% of all new cancers in women. The peak incidence is in the 4th decade of life although there is a smaller peak in the 9th decade. There is a crude incidence in Scotland of 11 per 100,000 per annum, with a lifetime risk of 1 in 112 (Cancer Research UK 2013;ISD Scotland 2014). There has been a 49% reduction in incidence between 1985/87, prior to the introduction of the UK national screening programme, and 2002/04, although since then an increase in incidence, greatest in women aged 20-34, has been reported and has been mirrored in other countries (Trent Cancer Registry 2012, Foley et al. 2011).

Cervical cytology as a screening tool was developed in the 1920s by Papanicolaou, but it was not until 1947 that the details of the procedure for sampling the cervix were published (Koss 1989). Screening was introduced on an *ad hoc* basis in the UK in 1967 (Foley et al. 2011), and in 1988 a national programme of call and recall was established (Peto et al. 2004). The British Army, which operated a health care service independently from the NHS, established its own Cervical Cytology Screening Service in 1962, collocated with the Army Histopathology Registry (AHR) at the Royal Army Medical College, Millbank, London, and the Royal Navy and Royal Air Force offered similar services. Initially, screening was only offered to women over 35 years of age but in 1967 the service was extended to all women for whom the Army provided primary care[128] (Editorial 1969). Although there was no formal call/recall system, opportunistic screening was widely offered, often in association with contraceptive or sexual health consultations, and individual practice nurses devised and operated local call/recall systems. Abnormal results were followed up by the AHR and, failing receipt of repeat cytology or a biopsy specimen taken in a military hospital, details of follow-up elsewhere were required to be submitted. This system worked surprisingly well and in an audit of 748 Army women (serving and dependant), Zaklama found that 677 (90%) had undergone screening in the last 5 years. Four percent had been referred for further investigation following an abnormal result (Zaklama and Birkett 1987).

The Army Histopathology Registry was disbanded on the closure of the Royal Army Medical College in 1997 and the opportunity was taken to establish a Service-wide call and recall system in collaboration with the NHS, initially with Warwickshire Health Authority following a competitive tendering process although following local reorganisation, responsibility passed to Coventry and Warwickshire Registration and Screening Service[129] (Bergman et al. 2015a). The service 'went live' in 2001. Initially, screening was offered to all Servicewomen aged 20 years and over, although in 2004 the lower age-limit was changed to 25 years, in line with the recommendations which gave rise to a change in national policy in England and Wales (Sasieni et al. 2003). Servicewomen recruited from Scotland, which retained a lower age limit of 20 years, continued to be included in the screening programme prior to age 25 years if they had already had their first test prior to joining the Services. Since 2013, human papilloma virus (HPV) vaccine catch-up has been offered to female recruits under the age of 18 who are not fully immunised on entry[130]. The service provided to the Armed Forces by the NHS

[128] All Servicewomen; Service dependants overseas; entitled civilians overseas; and dependants and civilians registered with Service primary care practices in the UK serving remote communities, or registered with Service GP training practices in the UK where family care was offered.

[129] Surgeon General's Policy Letter 13/00: Cervical Cytology Service – Transfer of Data to Warwickshire Health Authority. D/SG(MedPol)/330/3/1.

[130] JSP 950 Leaflet 7-1-1. Immunological Protection of Entitled Personnel. Ministry of Defence (2013).

was audited in line with national audit policy although the results were reported separately. Rates of abnormality for the Service community were at the upper end of the national range. Rates of 7% borderline/mild abnormality and 2-2.5% moderate/severe abnormality were reported in most reporting periods[131], compared with an average of 5.6-6.2% and 1.3-1.5% respectively nationally (2002-2011)[132], and may be related to exposure to HPV infection owing to the high prevalence of genital warts in the Armed Forces (Barrett et al. 1954). Genital warts affect as many as 20% of male and 10-15% of female attendees at military sexual health clinics and tend to recur at times of stress[133], especially in relation to overseas deployment. Overall prevalence of genital warts in military personnel is unknown as, in the UK, they are free to attend NHS sexual health clinics, where they are not separately identified, if they prefer.

The reported prevalence of cytological abnormalities appears to have given rise to a misconception within the UK screening service that servicewomen have a higher rate of cervical cancer than do civilian women[134]. Data from the Scottish Veterans Study have demonstrated that whilst this may have been true for the earlier birth cohorts (although not achieving statistical significance), it does not hold good for those servicewomen in later birth cohorts who have had access to the MOD's screening programme, at least for those veteran women who settled in Scotland post-Service. As the median length of service for women was only 3.9 years (IQR 1.3-7.5 years) (Section 3.2.2), few who joined prior to the start of the military screening programme in the late 1960s would have had the opportunity to access it later in service, and most would probably not have

[131] Director General Army Medical Services Annual Report on the Health of the Army 2001, 2003, 2005 and 2006. Army Medical Directorate.

[132] National Statistics: Cervical Screening Programme England 2010-2011. The Health and Social Care Information Centre 2011.

[133] Director General Army Medical Services Annual Report on the Health of the Army 2006. Army Medical Directorate.

[134] "Women in HM Forces or in prison are at higher risk of developing cervical cancer than the general population, however they are not registered with an NHS GP and they do not receive standard NHS screening. Due to the effort involved in finding information on these women and the fact that they are not part of the NHS screening programme the audit management group recommended that they should not be included in the audit. At the moment we recommend that QARCs keep a note of the year and age of the women at diagnosis for future reference, but they will not be included in the audit." Last Updated (Tuesday, 26 February 2013 14:58)

Source: http://www.csad.org.uk/index.php?option=com_content&view=article&id=85:8-should-women-serving-in-the-armed-forces-or-in-prison-diagnosed-with-cervical-cancer-be-included-in-the-audit&catid=36 Accessed 5 Jun 13 and still extant as at 20 January 2015.

commenced screening until the NHS programme became established nearly 20 years later.

This study has demonstrated a lower risk of cervical cancer in ex-Servicewomen born after 1958 than for age, sex and area of residence matched civilians with no record of service, although no such difference existed for women born in earlier years. The majority of women born after 1958 joined the Services from 1976 onwards, at a time when the military cervical cytology service was well established and available to all women registered with an HM Forces primary care practice. Although screening was always subject to informed consent, Zaklama's study (Zaklama and Birkett 1987) suggests that refusal was rare. The results of the Scottish Veterans study indicate that, notwithstanding the higher risk of exposure to HPV (Barrett et al. 1954, Army Health Unit 2007), the widespread acceptance of in-service screening reported by Zaklama (Zaklama and Birkett 1987) was highly effective in preventing later cervical cancer in veterans, whether by timely treatment and follow-up of pre-invasive disease or by inculcating a culture of regular screening from an early age in a group who, as fit young servicewomen, were highly motivated to maintain their health.

5.35 Cancer of the Corpus Uteri

5.35.1 Incidence

5.35.1.1 Overall

There were 11 cases of uterine cancer in veteran women and 62 cases in non-veterans, equating to a cumulative incidence, over the period of follow-up, of 0.21% in veterans and 0.30% in non-veterans. With small numbers of cases, the reduction in risk in veterans did not achieve statistical significance, unadjusted HR 0.72, 95% CO 0.38-1.36, p=0.308, adjusted HR 0.70, 95% CI 0.37-1.34, p=0.283 (Figure 5-63).

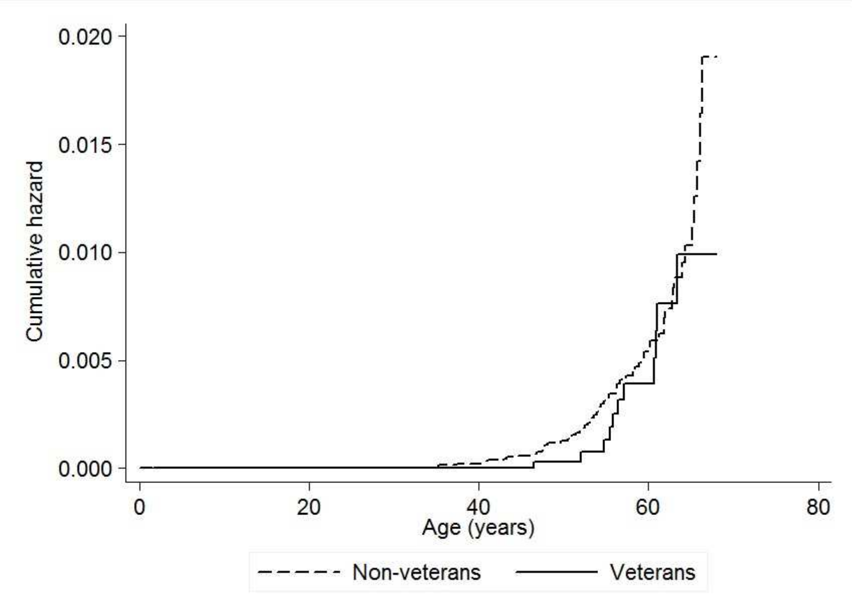

Figure 5-63 - Nelson-Aalen plot of uterine cancer by veteran status

5.35.1.2 Subgroup Analysis

The small number of veteran cases (11) precluded subgroup analysis by birth cohort or length of service. Most veteran cases had less than 7 years' service; one had served in excess of 20 years.

5.35.2 Case-Fatality

The mean follow-up from date of diagnosis of uterine cancer to the date of death or the end of the study on 31 December 2012 was 3.86 years (range 0.15-8.72 years) for veterans and 6.00 years (range 0.14-23.80 years) for non-veterans, representing 42 person-years of follow-up in the veterans and 372 person-years in the non-veterans. There were 3 (27.3%) deaths in veterans with uterine cancer, equating to 70.7 per 1,000 person-years, and 11 (17.7%) deaths in non-veterans (29.6 per 1,000 person-years).

5.35.3 Commentary

Uterine cancer is the fourth most common cancer in women in the UK, with a standardised incidence[135] of 26.3 per 100,000 per year[136]. The majority of cancer of the

[135] European age-standardised rate

[136] 2011 figures, from Cancer Research UK http://www.cancerresearchuk.org/cancer-info/cancerstats/keyfacts/uterine-cancer-key-facts accessed 23 Sep 2014

corpus uteri arises as adenocarcinoma of the endometrium, which may secondarily invade the myometrium; primary sarcoma of the myometrium occurs rarely. Risk factors for endometrial cancer include obesity, nulliparity, late menopause, diabetes mellitus and exposure to exogenous oestrogen (MacMahon 1974). A recent meta-analysis demonstrated a relative risk of 2.54 (95% CI 2.11-3.06) for obesity and 1.32 (95% CI 1.16-1.50) for overweight (Zhang et al. 2014). There is an inverse association with physical activity (Zheng et al. 1993, Moore et al. 2010). It might therefore be anticipated that veteran servicewomen have a lower risk of uterine cancer than do non-veteran women; they are less likely to have been obese (Fear et al. 2011) and, by virtue of military fitness programmes, more likely to be physically active, during service, and it is plausible that these behaviours persist into post-service life. Although pregnancy resulted in automatic discharge from service until 1991, the relatively short duration of service for most women[137] means that most had left service by the early to mid-20s; only those with longer service are likely to have had fewer children than the general population, or to have been nulliparous. Results from the Scottish Veterans study tentatively support this theoretical lower net risk in women who have served in the Armed Forces, notwithstanding the small number of cases which precludes statistical significance.

5.36 Ovarian Cancer

5.36.1 Incidence

5.36.1.1 Overall

During the period of the study, there were 22 cases of ovarian cancer in veteran women and 61 cases in non-veterans, equating to a cumulative incidence of 0.42% in veterans and 0.29% in non-veterans. The increase did not reach statistical significance in either the univariate or multi-variable[138] model, HR 1.55, 95% CI 0.95-2.54 p=0.078 and HR 1.56, 95% CI 0.96-2.55, p=0.076 respectively. The Nelson-Aalen plot (Figure 5-64) demonstrated the higher risk in veterans but also showed that the lines cross at age 38 years, indicating that the proportional hazards assumptions had been violated (Hess 1995). However the Stata *estat phtest* for non-proportionality was non-significant, p=0.751.

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[137] As noted at Section 3.2.2

[138] Adjusted for deprivation

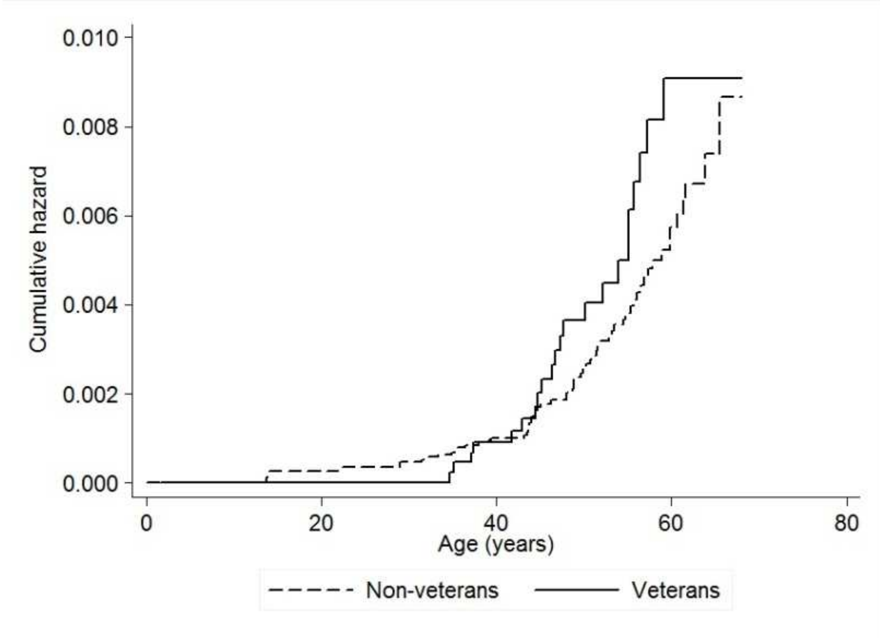

Figure 5-64 - Nelson-Aalen plot of ovarian cancer by veteran status

Inspection of the age at diagnosis showed a number of cases of ovarian cancer in young non-veteran women, which would have precluded enlistment. Therefore, the analysis was repeated using a landmark age of 35 years. This showed an unadjusted hazard ratio of 1.64, 95% CI 0.99-2.73, p=0.055. The result was similar after adjusting for deprivation, HR 1.64, 95% CI 0.99-2.72, p=0.057. The Nelson-Aalen plot no longer indicated violation of the proportional hazards assumption (Figure 5-65).

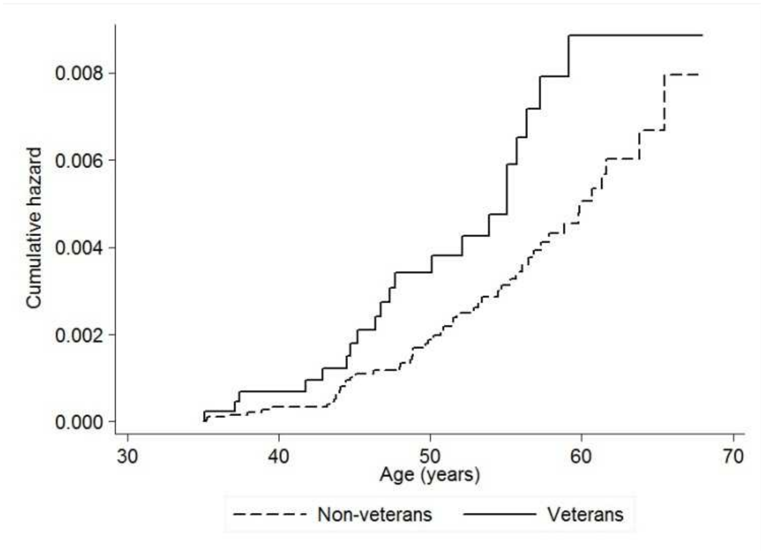

Figure 5-65 - Nelson-Aalen plot of ovarian cancer by veteran status Landmark age 35 years

5.36.1.2 Birth cohort

There were insufficient cases to analyse by birth cohort in 5-year bands. When stratified into 2 groups, women born prior to 1960 and women born from 1960 onwards, using a landmark age of 35 years, there was no statistically significant difference for women born prior to 1960, unadjusted HR 1.35, 95% CI 0.74-2.47, p=0.329 and HR 1.34, 95% CI 0.73-2.45, p=0.347 after adjusting for deprivation. However, for women born from 1960 onwards, the increase in risk among veterans was statistically significant, HR 2.86, 95% CI 1.09-7.51, p=0.033 and HR 2.87, 95% CI 1.09-7.55, p=0.032 respectively in the univariate and multi-variable models. The results are summarised at Table 5-15.

Table 5-15 - Cox proportional hazard model of the association between veteran status and ovarian cancer, overall and stratified by birth cohort

	Veteran cases	Univariate			Multi-variable		
	n	HR	95% CI	p	HR	95% CI	p
Overall							
All women	22	1.55	0.95-2.54	0.078	1.56	0.96-2.55	0.076
Landmark age 35 years	22	1.64	0.99-2.73	0.055	1.64	0.99-2.72	0.057
Birth cohort in 2 categories							
1945-1959	14	1.35	0.74-2.47	0.329	1.34	0.73-2.45	0.345
1960-1985	<10	2.86	1.09-7.51	0.033	2.87	1.09-7.55	0.032

Cases: Figures <10 in subgroups suppressed to minimise risk of disclosure

5.36.1.3 Length and Period of Service

None of the veterans with ovarian cancer had served for more than 8 years, and 72.3% had served for less than 3 years, thus falling into the category of Early Service Leavers. Eight cases (36.7%) left the Armed Forces before completion of initial training. All the cases joined for service between 1969 and 1991, with 50% of the cases joining in the 7 year period from 1969 to 1976.

5.36.2 Co-Morbidity

Four (18.2%) of the veterans and 7 (11.5%) non-veterans with ovarian cancer also had a diagnosis of breast cancer, suggesting a genetic susceptibility such as the BRCA1 or BRCA2 mutation.

5.36.3 Case-Fatality

The mean follow-up from date of diagnosis of ovarian cancer to the date of death or the end of the study on 31 December 2012 was 6.28 years (range 0.07-20.33 years) for veterans and 7.37 years (range 0.08-31.11 years) for non-veterans, representing 138 person-years of follow-up in the veterans and 450 person-years in the non-veterans. There were 8 (36.4%) deaths in veterans with ovarian cancer, equating to 57.9 per 1,000 person-years, and 27 (44.3%) deaths in non-veterans (60.1 per 1,000 person-years).

5.36.4 Commentary

Risk factors for ovarian cancer include age, family history, reproductive history, exposure to exogenous hormones, smoking, tall stature, and obesity. Around 5-10% of cases have a genetic origin resulting from an inherited mutation of the BRCA1 or BRCA2 gene; these women are also at increased risk of breast cancer. Oral contraceptives are protective, the reduction in risk increasing with duration of use and persisting after cessation of use (Collaborative Group on Epidemiological Studies of Ovarian Cancer 2008). There is a modest increase in risk with hormone replacement therapy (HRT), and particularly with unopposed oestrogen therapy (Pearce et al. 2009). Pregnancy protects against ovarian cancer, the reduction in risk increasing with number of pregnancies even if uncompleted. There is a mixed picture in respect of smoking and obesity depending on histological type (Kurian et al. 2005). Smoking is a risk factor for mucinous carcinoma of the ovary (Jordan et al. 2006), which accounts for only 2% of cases of ovarian cancer in the UK (Parkin 2011c), but is not a risk factor for the other histological types (Kurian et al. 2005). Both sunlight exposure and occupational physical exercise are protective (Freedman et al. 2002, Zheng et al. 1993). One study reported a 3.9 times increase in risk in women with self-declared rubella infection aged 12-18 years whose menarche had been at age 12 or later (McGowan et al. 1979).

Night shift work has been shown to be associated with an increased risk of ovarian cancer, possibly due to disruption of circadian cycles (Bhatti et al. 2013). This may be relevant to the increased risk in military women, many of whom worked as nurses, undertook night shifts as telecommunications operators or took part in guard duties involving night work. Wu et al. demonstrated an increased incidence of ovarian cancer with duration and frequency of use of non-steroidal anti-inflammatory drugs (NSAID) (Wu et al. 2009). Another study showed a reduced risk with regular use of acetaminophen (paracetamol) but not with aspirin (Moysich et al. 2001). Use of analgesics, especially NSAID, is common in military personnel for treatment of minor sports injuries[139].

A Swedish study examined occupational risks for ovarian cancer in 1.67 million women followed up between 1971 and 1989 and found statistically significant increases in a wide range of occupations, including graphics and printing, engineering, social work and police work, relative to all employed women. There was also an increased risk in women in the telecommunications industry, which may be important in respect of military women who worked as signallers, although exposure to electromagnetic fields was not found to be associated with increased risk. In that study there was no relationship to exposure to diesel fuel or sunlight, and insufficient numbers of women were exposed to ionising radiation or asbestos to make an assessment of risk (Shields et al. 2002). Other studies have shown that occupational exposure to asbestos is associated with an increased risk of ovarian cancer, and asbestos fibres have been found in the ovaries of women with household exposure to asbestos through their husband's occupation (Heller et al. 1996). The International Agency for Research on Cancer (IARC) has accepted the evidence that asbestos exposure is causally related to ovarian cancer (Straif et al. 2009). Significant occupational exposure to asbestos in servicewomen is unlikely as most women who served in the 1960s, 1970s and 1980s were employed in clerical, telegraphic or nursing roles.

Use of talc on the perineum is a known risk factor for ovarian cancer (Huncharek et al. 2003). As discussed at Appendix 3, Section A3.3.5.12, cosmetic-grade talc was potentially contaminated with asbestos until the introduction of controls in 1976, although the ovarian cancer risk may arise from the talc particles themselves rather than from asbestos contamination. In 1971, Henderson et al. identified talc particles, ranging in size from 0.1-2.0 microns, deeply embedded in 10/13 (75%) of samples of ovarian tumour tissue, using electron microscopy. In 1982 a study of 215 cases and their matched controls in the Greater Boston US area showed a relative risk for ovarian cancer of 1.92, $p<0.003$, in

[139] Author's recollection, as a military general practitioner. NSAID, particularly ibuprofen, were widely available from unit paramedical staff, without prescription. Referred to as 'infantry candy' or 'military candy' by service personnel, eg https://www.rallypoint.com/answers/common-use-of-ibuprofen-by-soldiers and http://www.nutrapharma.com/newsroom/display.php?newsid=201 accessed 31 March 2014.

women who used talc on sanitary towels and/or for dusting the perineum. The authors commented that an earlier study had shown that inert particles placed in the vagina could migrate to the Fallopian tubes within 30-60 minutes (Egli and Newton 1961, Cramer et al. 1982). A meta-analysis of 16 observational studies showed an increased risk of ovarian cancer with perineal use of talcum powder, RR 1.33, 95% CI 1.16-1.45, although there was no consistent dose-response relationship (Huncharek et al. 2003). A study in Los Angeles did however demonstrate a clear dose-response relationship, with RR 2.08, 95% CI 1.34-3.23, for daily use of talcum powder in excess of 20 years (Wu et al. 2009). The increased risk was restricted to women who started using talcum powder before 1975, and the authors noted that other studies (although not all) had found an increased risk for use in the 1960s and 1970. A study of US military women reported the use of 'baby powder' to compensate for inability to wash frequently or change underwear whilst in the field (Wardell and Czerwinski 2001). An earlier (1943) US military training film on personal hygiene for women[140] recommended sprinkling underwear and sanitary towels with a 'deodorant powder' (many of which were, and still are, talc-based) for additional hygiene. Habits developed early in training may have persisted into civilian life, irrespective of length of service. This could have contributed to the excess of cases of ovarian cancer seen in the veteran women, and especially in those who may have used talcum powder manufactured before 1976. No studies from any nation have been identified which examine ovarian cancer rates in women veterans, and further studies are needed to confirm or refute this hypothesis.

With only 22 cases in veterans, it would be invidious to consider implicating sexuality as a risk factor in veteran women. Nonetheless, there is evidence from the civilian world that lesbian women face an increased risk of ovarian cancer, predominantly due to a higher prevalence of obesity, lower likelihood of oral contraceptive use and lower parity or nulliparity (Dibble et al. 2002). Whilst homosexuality (male or female) was proscribed in the Armed Forces until 1999, many lesbian women did join; they were dismissed if their sexuality came to light, and Heggie states that 113 women were formally discharged for this reason between 1990 and 1995, although she notes from her own research that many more left 'voluntarily' under pressure (Heggie 2003) and that the true number was much higher. The reason for the absence of any further cases of ovarian cancer in

[140] "Personal Hygiene for Women" (1943) http://www.military.com/video/operations-and-strategy/second-world-war/personal-hygiene-for-women-1943/2841807991001/ accessed 23 Sep 2014

women who joined the Armed Forces after 1991 can only be speculative; it may be that the younger women had not reached the peak age for ovarian cancer by the end of the follow-up period, or may reflect higher parity in women who were permitted to continue to serve during pregnancy and after childbirth, following a change in MOD policy in that year. 1991 was also the last year in which there were separate women's services; in April 1992 they were disbanded and women began to serve alongside men, in the same units and on equal terms, in all areas other than front-line combat and submarine service. Any implications of these policy changes, in respect of ovarian cancer, remain unclear; they may be no more than coincidental, and further studies with longer follow-up will be needed.

The short period of service of all the affected veteran women suggests that any service-related excess risk of ovarian cancer may derive from lifestyle rather than occupational factors, although early departure for the reasons discussed above cannot be excluded without further studies. Lifestyle risk factors modified by military service in men include smoking and alcohol; few studies have been conducted on these risk factors in servicewomen until recently (Lehavot et al. 2012), and there remains little information about UK servicewomen. There is conflicting evidence about the role of alcohol in ovarian cancer; a multi-centre study conducted by the Centers for Disease Control (CDC) found no overall evidence of an association, although there was evidence of a small reduction in risk for women who consumed more than 20 drinks per week compared with non-drinkers (Gwinn et al. 1986). On the other hand a meta-analysis of five studies found a small increased risk, with a dose-response relationship (Bagnardi et al. 2001). It seems unlikely that differences in use of tobacco or alcohol could have made a major contribution to the excess cases in the Scottish Veterans study.

The Scottish Veterans Health Study has demonstrated an increased risk of ovarian cancer, especially in women who joined the Armed Forces in the late 1960s and early 1970s, and in women born from 1960 onwards. Most left after only a short period of service, making an occupational aetiology unlikely. Reasons are likely to be complex and could be further explored by means of a nested case-control study.

5.37 Breast Cancer

5.37.1 Incidence

5.37.1.1 Overall/Sex

During the period of follow-up, there were 124 (2.37%) cases of breast cancer in female veterans and 4 (0.008%) cases in males, compared with 514 (2.48%) cases in female non-veterans and 26 (0.017%) cases in males. The Cox proportional hazard ratios showed no difference in risk between veteran and non-veteran women, unadjusted HR 0.99, 95% CI 0.81-1.20, p=0.906 (Figure 5-66). After adjusting for deprivation, the risk was identical, HR 1.00, 95% CI 0.82-1.21, p=0.970. In men, there was a non-significant reduction in risk in the veterans (Figure 5-67), unadjusted HR 0.47, 95% CI 0.16-1.35, p=0.160 and HR 0.48, 95% CI 0.17-1.39, p=0.178 after adjusting for deprivation.

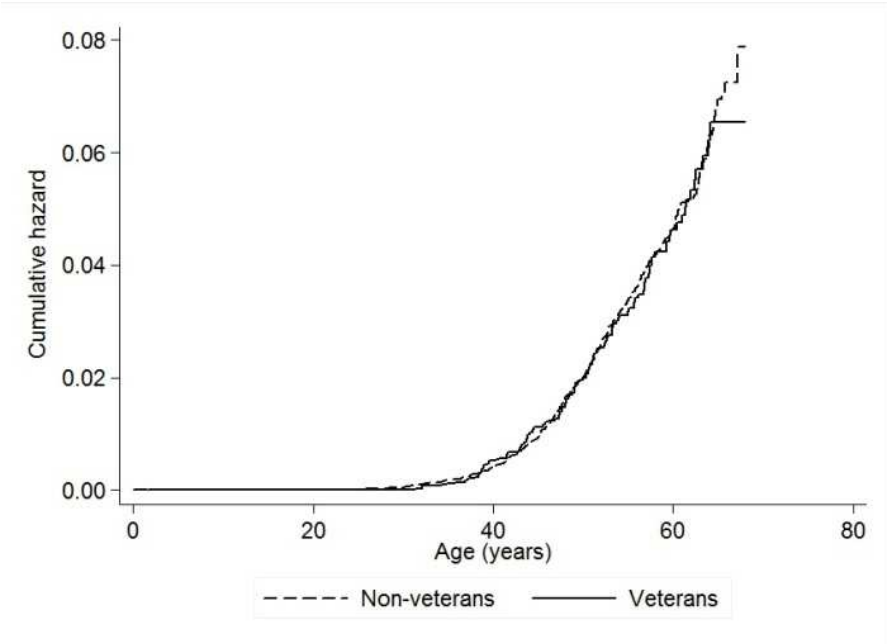

Figure 5-66 - Nelson-Aalen plot of breast cancer in women by veteran status

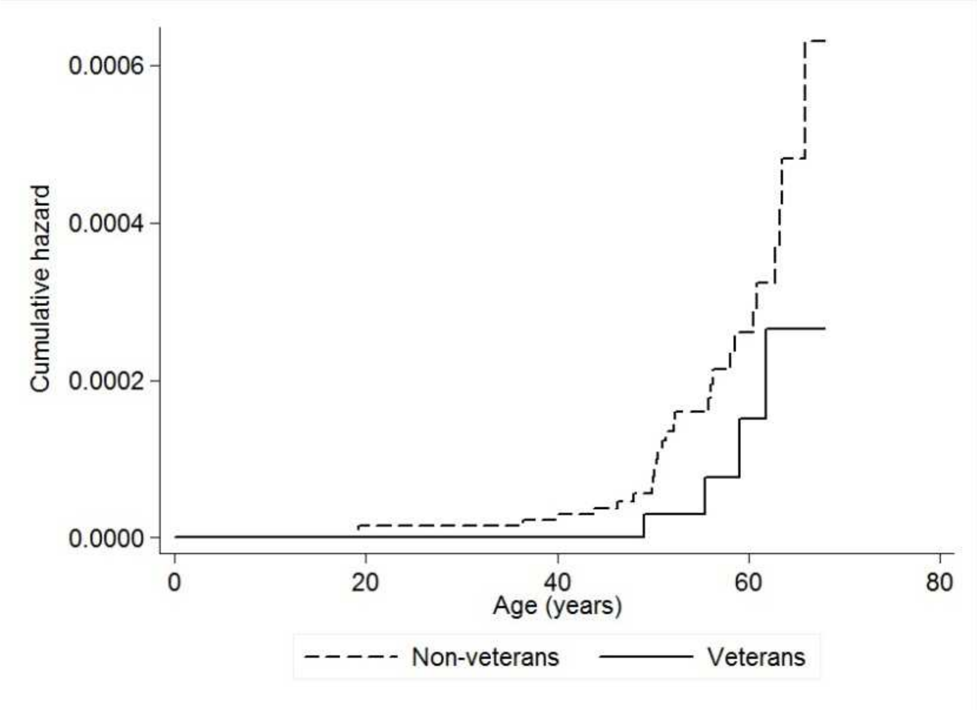

Figure 5-67 - Nelson-Aalen plot of breast cancer in men by veteran status

5.37.1.2 Birth Cohort

Analysis of the data for breast cancer in women by birth cohort showed no significant differences within any band. For women born prior to 1960, the hazard ratios were close to unity. For women born from 1960 onwards, there was a small, non-significant increase in risk but the number of cases in these subgroups was small and longer follow-up will be needed to assess whether this becomes significant (Figure 5-68).

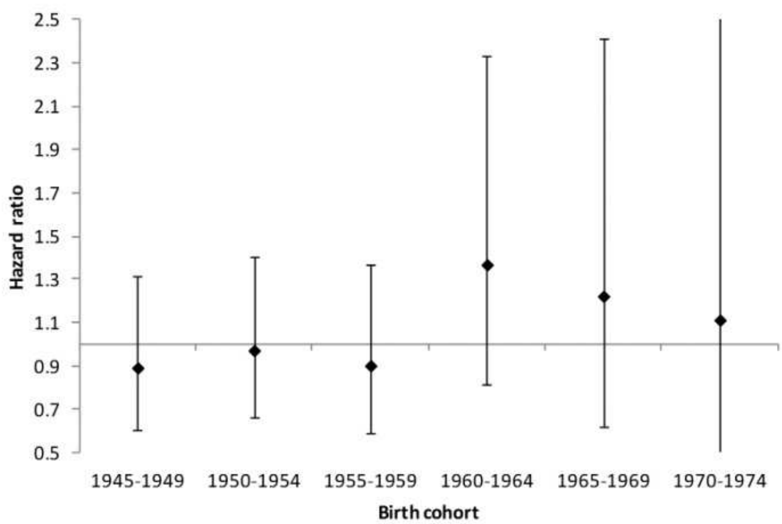

Figure 5-68 – Hazard ratios for breast cancer in women by birth cohort Veterans referent to non-veterans

All the veteran cases in men were born between 1949 and 1956; the non-veteran cases were born between 1945 and 1967.

5.37.1.3 Length of Service

Analysis of the data for women by length of service presented a complex picture. The risk in women who left prior to completing initial training differed little from that of non-veteran women; the same was true of women who served for over 12 years. For women who completed initial training but left service prior to completion of the minimum engagement, their risk appeared to be slightly lower than that of non-veteran women, whilst it was slightly higher for women with between 4 and 12 years service (Figure 5-69). The Cox proportional hazard ratio confirmed a statistically significant decrease in risk in the Early Service Leavers, unadjusted HR 0.73, 95% CI 0.53-1.00, p=0.049, which became non-significant after adjusting for deprivation, HR 0.75, 95% CI 0.54-1.02, p=0.067, whilst in those who had served between 4 and 12 years, there was a significant increase, unadjusted HR 1.33, 95% CI 1.02-1.73, p=0.038, which was unchanged after adjusting for deprivation. For women with more than 12 years' service, the hazard ratio was 0.95, 95% CIO 0.50-1.78, p=0.874. However, at a greater level of granularity, the highest risk was for women with 13-16 years' service, unadjusted HR 2.03, 95% CI1.01-4.08, p=0.047.

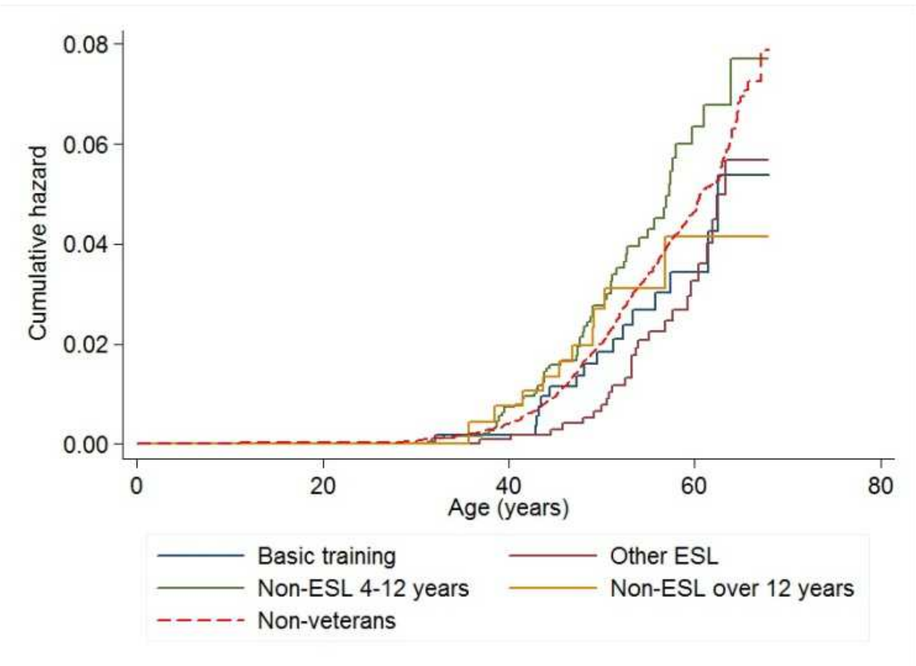

Figure 5-69 – Nelson-Aalen plot of breast cancer in women by length of service
All non-veteran women for comparison

None of the male veterans with breast cancer had served for more than 8 years.

5.37.2 Case-Fatality

The mean follow-up from date of diagnosis of breast cancer in women to the date of death or the end of the study on 31 December 2012 was 6.96 years (range 0.14-31.53 years) for veterans and 7.06 years (range 0-30.37 years) for non-veterans, representing 863 person-years of follow-up in the veterans and 3,629 person-years in the non-veterans. There were 25 (20.2%) deaths in veteran women with breast cancer, equating to 29.0 per 1,000 person-years, and 114 (22.2%) deaths in non-veterans (31.2 per 1,000 person-years).

The mean follow-up from date of diagnosis of breast cancer in men to the date of death or the end of the study on 31 December 2012 was 3.82 years (range 0.14-31.53 years) for veterans and 5.90 years (range 0-30.37 years) for non-veterans, representing 15 person-years of follow-up in the veterans and 153 person-years in the non-veterans. There was one (25.0%) death among the veteran men with breast cancer, equating to 65.5 per 1,000 person-years, and 8 (30.8%) deaths in non-veterans (52.2 per 1,000 person-years).

5.37.3 Commentary

In Scotland there were 4,578 cases of breast cancer in women in 2011, giving an age-standardised rate[141] of 130.2 per 100,000 population, the highest of all the UK nations[142]. In men, the age-standardised rate was 0.9 per 100,000 population. There is a lifetime risk of 1 in 8 for women, and 1 in 868 for men[143]. There is an inverse association with deprivation. Risk factors for breast cancer in women include alcohol, oral contraception, hormone replacement therapy, and obesity, whilst higher parity, younger age at first pregnancy, breastfeeding, and physical activity are protective (Kelsey et al. 1993, Collaborative Group on Hormonal Factors in Breast Cancer 2002, Harvie et al. 2003, McTiernan et al. 2003, Zheng et al. 1993). Night shift work also increases risk, as discussed at Appendix 3, Section A3.3.5.4, as does smoking (Megdal et al. 2005, Hansen and Lassen 2012, Terry and Rohan 2002). A positive family history in a first-degree

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[141] European age-standardised rate

[142] Data from Cancer Research UK http://www.cancerresearchuk.org/cancer-info/cancerstats/types/breast/incidence/uk-breast-cancer-incidence-statistics accessed 25 Sep 2014

[143] Cancer Research UK estimate as at 2010

relative increases risk, whilst the BRCA1 and BRCA2 genetic mutations are associated with an increased risk of both breast and ovarian cancer (Ford et al. 1998).

Although the overall risk of breast cancer in female veterans did not differ from that in non-veterans, subgroup analysis showed that women who had served longer were at greater risk than those with the shortest service. There are a number of candidate risk factors which may be relevant. Women with longer service are likely to have both lower parity and higher age at first pregnancy, especially if they served prior to 1991 when pregnancy resulted in automatic discharge from service. Figure 5-70 shows in-service pregnancy rates for officers and other rank women in the Army, based on a study in 2000, showing that officers generally delayed childbearing until the fourth decade of life, whilst pregnancies in other rank women were more evenly distributed, providing evidence that those with longer service were older at first pregnancy[144]. Some longer-serving women would have remained nulliparous; prior to 1991, all serving women, of whatever length of service, were nulliparous except for the very few who joined or rejoined after having a child.

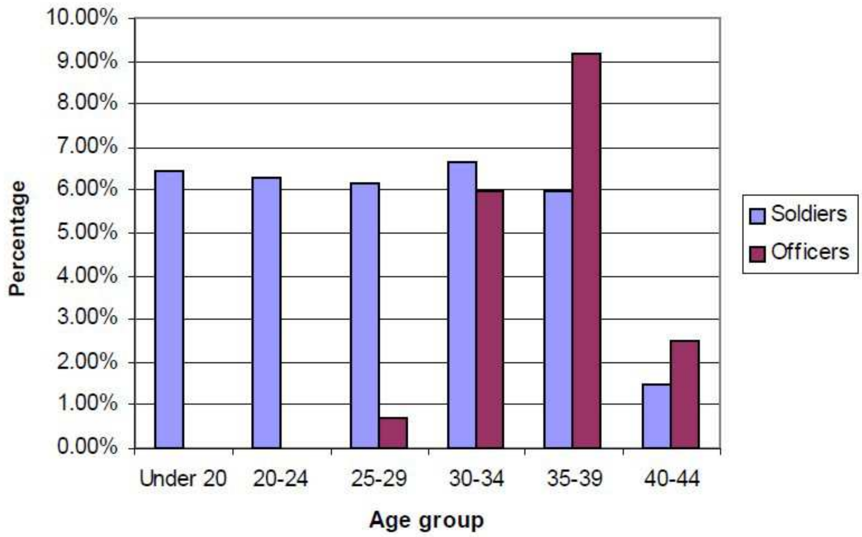

Figure 5-70 - Pregnancy rates by age group and rank in serving Army women as at 1 Aug 2000[144]

[144] Figure 5-70 from Director General Army Medical Services Annual Report on the Health of the Army 2000. Army Health Unit, Camberley

Breast-feeding may prove challenging for servicewomen who return to work after childbirth[145], leading to early cessation of breast-feeding. Many servicewomen use oral contraception[146]. Nursing and telecommunications ('signals') work involve night shifts; until the disbandment of the women's services in 1991, servicewomen were predominantly employed in these and in clerical roles; since that date, women have also undertaken guard duties, which involve night work. Hansen et al. found an adjusted OR of 1.4, 95% CI 0.9-2.1, for breast cancer in military women ever doing shift work, but for the highest tertile of exposure, the OR was 2.3, 95% CI 1.2-4.6 (Hansen and Lassen 2012). Obesity is unlikely to be responsible for increased breast cancer risk in the military; the prevalence of obesity in servicewomen aged 35 years and over was 25%, similar to the rate found in the Health Survey for England (Fear et al. 2011, Rennie and Jebb 2005).

The reduced risk relative to non-veterans in women who were Early Service Leavers, but not in those who left before completing initial training (Figure 5-69), is consistent with pregnancy as a reason for leaving. Although the policy of mandatory discharge on pregnancy was rescinded in 1991, it remained (and still remains) an option for women to choose to leave on confirmation of pregnancy[147]. A study by the Defence Analytical Services Agency (DASA) in 2003 showed a rate of medical downgrading in the Army (alteration of medical employability category) for pregnancy of 39.8 per 1,000 women, with the highest rate (57.5 per 1,000) in those under 20 years of age[148]. Although it has not been possible to obtain a detailed breakdown, it is likely that few of these very junior pregnant female personnel would have opted to continue to serve. On the other hand, few would have left for this reason during initial training; the medical examination at the start of training would have excluded those who were already pregnant, and few pregnancies are likely to have been both initiated and diagnosed in the following 16 weeks[149]. Therefore, it is likely that many servicewomen who were discharged prior to

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145 Author's personal recollection of conversations with servicewomen (patients and colleagues) who had recently given birth. Nonetheless, military policy supports breast-feeding for up to six months after birth (Defence Council Instruction JS 99/04 para 39).

146 Author's personal recollection, as an Army general practitioner

147 Army Health Unit, Camberley. Pers. comm.

148 Director General's Annual Report on the Health of the Army 2003. Army Medical Directorate, Camberley.

149 Data on Army discharges from training show only 5 recruits discharged "Free on family grounds" (Queen's Regulations for the Army Sect. 9.395) between 2010 and 2013. It is likely that most were

completion of their initial engagement, but after completion of initial training, left on grounds of pregnancy and thus benefited, in terms of breast cancer risk, from earlier age at first confinement than those who served for longer. The findings of the Scottish Veterans Study are consistent with this hypothesis.

Risk factors for breast cancer in men that have been identified include Jewish religion[150], employment in blast furnaces or rolling mills, and military service; in respect of the latter, in a case control study of 52 cases in the US, cases had an average of 5.5 years of military service compared with 3.3 years for controls. There was no significant association with alcohol or tobacco. Mumps infection at age 20 years or over was strongly associated, although cases were few. However, the authors speculated that the association with military service could have been due to chance (Mabuchi et al. 1985). Other studies have shown a positive association with alcohol. The BRCA2 mutation is a risk factor in men, but BRCA1 is not (Fentiman et al. 2006). In the light of the study by Mabuchi et al., it is reassuring that the Scottish Veterans Health Study provides no evidence for an increased risk of male breast cancer in veterans; rather, the reverse is the case.

5.38 Intracranial Cancer

All intracranial cancers were aggregated as ICD-9 code 191 and ICD-10 code C71. A landmark age of 20 years was employed in order to minimise confounding by intracranial cancers of childhood and adolescence, which would have precluded enlistment.

5.38.1 Incidence

5.38.1.1 Overall

During the period of follow-up, there were 82 cases of intracranial cancer in veterans and 296 cases in non-veterans, equating to a cumulative incidence of 0.15% and 0.17% respectively. The reduction in risk in veterans did not achieve statistical significance, either in the unadjusted model, HR 0.85, 95% CI 0.66-1.09, p=0.200, or after adjusting for

discharged on grounds of pregnancy although some may have been for compassionate reasons such as family ill-health. Figures from Directorate of Personnel Services (Army), PS4(A), Andover (2014).

150 Associated with increased frequency of the BRCA2 gene mutation in Ashkenazi Jewish populations. Roa, B. B., Boyd, A. A., Volcik, K. and Richards, C. S. (1996) 'Ashkenazi Jewish population frequencies for common mutations in BRCA1 and BRCA2', *Nature Genetics,* 14(2), 185-187.

deprivation, HR 0.84, 95% CI 0.65-1.08, p=0.176. The Nelson-Aalen plot demonstrates the small reduction in risk in veterans. Testing for non-proportionality of the hazards was non-significant, p=0.436.

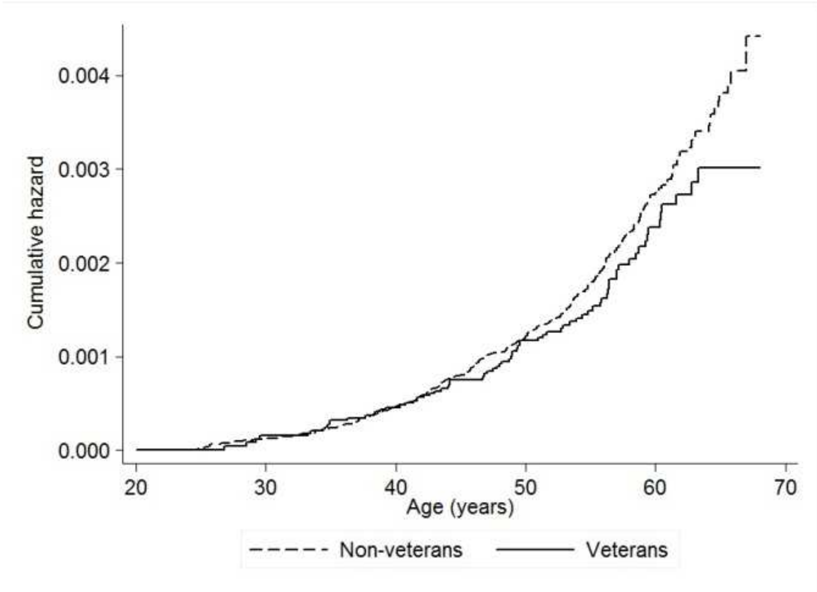

Figure 5-71 - Nelson-Aalen plot of intracranial cancer in veterans and non-veterans Landmark age 20 years

5.38.1.2 Sex

Only 3 (0.06%) cases occurred in veteran women and 19 (0.09%) in non-veteran women. The hazard ratio did not achieve statistical significance owing to very small numbers, unadjusted HR 0.65, 95% CI 0.19-2.20, p=0.489 (similar after adjusting for deprivation).

5.38.1.3 Birth Cohort

Analysing the data for both men and women together, there was no difference in risk of intracranial cancer for any birth cohort, nor was there any evidence of a trend over time (Figure 5-72).

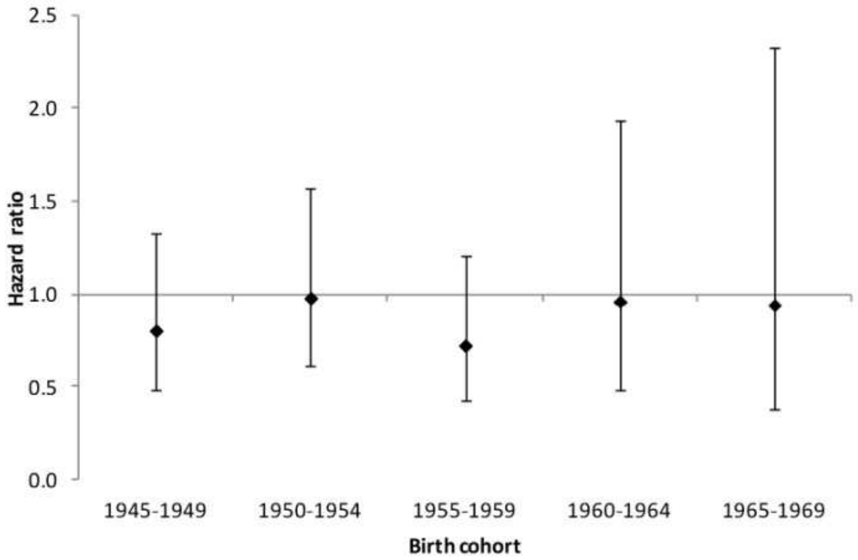

Figure 5-72 – Hazard ratios for intracranial cancer by birth cohort Veterans reference to non-veterans

5.38.1.4 Length of Service

There was no evidence of any significant difference in risk of intracranial cancer for any length of service (Table 5-16).

Table 5-16 - Cox proportional hazard model of the association between veteran status and intracranial cancer, overall and stratified by length of service

	Veteran cases *n*	HR	All Veterans *n*=56,205 95% CI	p
Overall				
Univariate	82	0.85	0.66-1.09	0.200
Multi-variable	82	0.84	0.65-1.08	0.176
Length of service in 8 categories				
Basic training[98]	<10	0.48	0.20-1.15	0.099
ESL[99] **(0-3 years)**	15	0.69	0.40-1.18	0.176
4-6 years	13	0.73	0.42-1.27	0.269
7-9 years	16	1.32	0.80-2.19	0.273
10-12 years	13	1.39	0.80-2.42	0.246
13-16 years	<10	0.76	0.32-1.85	0.552
17-22 years	<10	0.66	0.24-1.76	0.402
≥23 years	<10	0.90	0.42-1.91	0.792
Length of service in 2 categories				
≤ 12 years	63	0.87	0.66-1.15	0.326
>12 years	19	0.77	0.47-1.28	0.320

Cases: Figures <10 in subgroups suppressed to minimise risk of disclosure

5.38.2 Case-Fatality

The mean follow-up from date of diagnosis of intracranial cancer to the date of death or the end of the study on 31 December 2012 was 5.25 years (range 0-29.67 years) for veterans and 4.41 years (range 0-31.14 years) for non-veterans, representing 431 person-years of follow-up in the veterans and 1,349 person-years in the non-veterans. There were 58 (70.7%) deaths in veterans with intracranial cancer, equating to 134.7 per 1,000 person-years, and 225 (73.5%) deaths in non-veterans (166.7 per 1,000 person-years).

5.38.3 Commentary

Causal associations with intracranial malignancy are poorly understood, and the evidence remains largely inconsistent, despite many epidemiological studies. No definite associations with chemical exposure have been identified (Wrensch et al. 2002).

Therapeutic and diagnostic ionising radiation is recognised as a risk factor, especially in children (Wrensch et al. 2002). The role of non-ionising (electromagnetic) radiation has been studied extensively in relation to mobile phone use; in a large international collaborative case-control study, no increased risk was demonstrated at average usage levels, and indeed there was a reduced risk of both meningioma and glioma with recent regular mobile phone use although a genuine protective effect was thought to be implausible (INTERPHONE Study Group 2010). Members of the Armed Forces may be exposed to non-ionising radiation through use of military high-frequency radio equipment, as discussed at Appendix 3, Section A3.3.5.7. A study of US Air Force personnel who served for at least one year in the period 1970-1989 showed a statistically significant increased risk for radio frequency/microwave exposure, OR 1.39, 95% CI 1.01-1.90, with some evidence of a dose-response effect, and a non-significant increase in risk for extremely low frequency electromagnetic field exposure, OR 1.28, 95% CI 0.95-1.74. The highest risk was found in senior officers, and the author considered that higher socio-economic status was most likely to explain the findings (Grayson 1996). Thomas et al. noted two studies of UK military personnel showing elevated SMRs for brain tumour of 1.67 in 1961 and 1.83 in 1970-1972 (Thomas and Waxweiler 1986).

Therefore, it is reassuring that there is no evidence from the Scottish Veterans Health Study to suggest an increased risk of intracranial cancer in veterans. Although Table 5-16 appears to show an increasing risk with length of service at 7-9 years and 10-12 years, this is based on only 16 cases in the former category and 13 cases in the latter, and thus cannot be interpreted with confidence. No data are available on rank although senior officers are likely to have served for longest; there is no evidence of increased risk in this category.

5.39 Chapter Discussion

5.39.1 Main Findings

5.39.1.1 Overall

Analysis of cancer risk in the Scottish Veterans Health Study population showed that, overall, there were few differences between veterans and non-veterans. The only statistically significantly increased risks in veterans were for cancers of the lung, oropharynx/larynx, and oesophagus, whilst there was a significant decrease in the risk of mesothelioma of the pleura. There were moderate although non-significant increases in risk of bladder cancer, Hodgkin lymphoma in older veterans and ovarian cancer in women aged over 35 years, whilst the risks of non-melanoma skin cancer and non-Hodgkin lymphoma were non-significantly decreased overall (Table 5-17).

Table 5-17 - Statistically significant differences in cancer risk overall Veterans referent to non-veterans

Increased risk	No significant difference	Decreased risk
Lung	All cancer	Mesothelioma
Oropharynx/larynx	Stomach	
Oesophagus[1]	Colorectal cancer	
All smoking-related cancer[2]	Pancreas	
	Liver	
	Small bowel	
	Kidney	
	Bladder[3]	
	Malignant melanoma	
	Non-melanoma skin cancer[4]	
	Leukaemia	
	Hodgkin lymphoma[5]	
	Non-Hodgkin lymphoma[6]	
	Prostate	
	Testicular cancer	
	Cervix	
	Corpus uteri	
	Ovary[7]	
	Breast (F)	
	Breast (M)	
	Intracranial cancer	

[1]Non-significant after adjusting for deprivation
[2]Stomach, oropharynx/larynx, oesophagus, bladder, kidney
[3]Bladder cancer closely approached a statistically significant increase, p=0.054
[4]Non-melanoma skin cancer closely approached a statistically significant decrease, p=0.056
[5]Non-significant increase in Hodgkin lymphoma in older (>55 years) veterans
[6]Non-significant decrease in risk of non-Hodgkin lymphoma in veterans, p=0.096
[7]Increase in risk of ovarian cancer in veteran women aged 35 years and over, not quite achieving statistical significance, p=0.055

5.39.1.2 Birth Cohort

Subgroup analysis by birth cohort showed that veterans born between 1945 and 1949 had the greatest increase in risk of oropharyngeal/laryngeal cancer and oesophageal cancer, whilst those born between 1950 and 1954 exhibited the greatest increase in risk of lung cancer and stomach cancer compared with non-veterans. The 1960-1964 birth cohort showed a statistically significant increase in risk of pancreatic and bladder cancer, whilst women born between 1960 and 1985 had an increased risk of ovarian cancer.

There was a decreased risk of non-Hodgkin lymphoma in the oldest veterans, whilst the youngest veterans had a reduced risk of kidney cancer, and of all cancers aggregated (Table 5-18).

Table 5-18 - Maximum statistically significant difference in cancer risk by birth cohort Veterans referent to non-veterans

1945-1949	1950-1954	1955-1959	1960-1964	1965-1985
Increased risk				
Oropharynx/larynx Oesophagus	Lung Stomach		Pancreas Bladder	Ovary[1]
Decreased risk				
Non-Hodgkin lymphoma				All cancer Kidney[1] Non-melanoma skin cancer[2]
No statistically significant effect in any birth cohort				
Colorectal cancer Liver Small bowel Malignant melanoma Prostate Testicular cancer Cervix Breast (F) Intracranial cancer Leukaemia Hodgkin lymphoma				

[1] 1960-1985 [2] 1965-1969

Insufficient numbers of cases: Mesothelioma, corpus uteri, breast (M)

When all non-significant differences in risk were included, the impact of smoking-related and alcohol-related cancers was clearly demonstrated in the older birth cohorts. In addition, there was a non-significant increase in non-Hodgkin lymphoma and leukaemia in younger veterans (Table 5-19). Older servicewomen were at non-significantly increased risk of cervical cancer, and older servicemen were at non-significantly increased risk of testicular cancer. Younger veterans had a decreased risk of cancer overall compared with non-veterans.

Table 5-19 - Any difference in cancer risk >10% by birth cohort
Veterans referent to non-veterans

1945-1949	1950-1954	1955-1959	1960-1964	1965-1985
Increased risk				
Lung Oropharynx/larynx Oesophagus Stomach Testicular cancer Cervix	Lung Oropharynx/larynx Oesophagus Stomach	Lung Colorectal Hodgkin lymphoma Cervix	Pancreas Bladder Hodgkin lymphoma	Ovary[1] Leukaemia Breast (F)
Decreased risk				
Non-Hodgkin lymphoma		All cancer Stomach	All cancer Stomach Liver	All cancer Lung Kidney[1] Colorectal Non-melanoma skin cancer Non-Hodgkin lymphoma
No difference >10% in any birth cohort				
Small bowel Malignant melanoma Prostate Testicular cancer Intracranial cancer				

[1]1960-1985

Insufficient numbers of cases: Mesothelioma, corpus uteri, breast (M)

5.39.1.3 Length of Service

When analysed by length of service, Early Service Leavers who failed to complete initial training had the highest increase in risk of both lung cancer and liver cancer, whilst the increase in risk was highest in ESL who completed initial training, but not their initial engagement, for cancers of the oropharynx/larynx, oesophagus, stomach, and kidney. Service of between 4 and 12 years was associated with the highest increase in risk of cancer of the bladder and of the breast in women, whilst there was no increased risk of any cancer associated with service over 12 years, other than breast cancer in women with 13-22 years' service. There was a reduced risk of cancer of the breast in ESL women who completed training but left before fulfilling their initial engagement. Service of 4 years and over was associated with a reduced risk of liver cancer, and both lung cancer and all cancers (aggregated) were reduced in veterans who had served for over 12 years (Table 5-20).

Table 5-20 - Maximum statistically significant difference in cancer risk by length of service Veterans by subgroup referent to all non-veterans

ESL Basic training	ESL < 3 years	4-12 years	13-22 years	23 years & over
Increased risk				
Lung Liver	Oropharynx/larynx Oesophagus[1] Stomach Kidney	Bladder	Breast (F)[2]	
Decreased risk				
	Breast (F)	Liver	All cancer Lung Liver	
No significant difference for any length of service				
Colorectal cancer Malignant melanoma Non-melanoma skin cancer Leukaemia Non-Hodgkin lymphoma Prostate Testicular cancer Intracranial cancer				

[1]1945-1949 birth cohort only
[2]13-16 years' service

Insufficient numbers: Mesothelioma, pancreas, small bowel cancer, Hodgkin lymphoma, testicular cancer, cervix, corpus uteri, ovary, breast (M)

5.39.2 Interpretation

5.39.2.1 Smoking

Analysis of cancer data from the Scottish Veterans Health Study provides further evidence to support the hypothesis that smoking has had a major impact on the health of veterans. It has confirmed a pattern of increased risk of smoking-related cancers in older veterans, the risk reducing in more recent birth cohorts. The risk was highest in ESL, with the maximum increase in risk of lung cancer being seen in those ESL who left before completing initial training. The risk of smoking-related cancer reduced with longer service. These findings are consistent with the demonstration by Shahar and Carel that smoking rates increase early in military recruit training (Shahar and Carel 1991), with Lodge's observation that the prevalence of smoking decreases with longer service (Lodge 1991), and with Lewthwaite and Graham's review of earlier studies showing a decrease in the prevalence of military smoking over time (Lewthwaite and Graham 1992), taken together.

5.39.2.2 Alcohol

The finding of the greatest increase in risk of oropharyngeal/laryngeal and oesophageal cancer in ESL who had entered trained service but left prior to completing the initial engagement may be explained by alcohol, as discussed at Sections 5.9.3 and 5.10.3. This hypothesis is supported by the lack of any increase in risk in the ESL who did not complete training, this group not being permitted to drink heavily during recruit training, but points to a heavier drinking habit in those who entered trained service but left early (see Appendix 4, Section A4.2.3A4.2.3). The post-service alcohol habit of those who left without completing training is likely to be influenced only by factors within the civilian community, and therefore their risk may be expected not to differ from that of non-veterans. This is partially supported by the study of ESL by Buckman et al., which found no association between being an ESL and post-Service alcohol misuse. A limitation was that the study did not distinguish between ESL who left before completing training and ESL who entered trained service (Buckman et al. 2013). Some ESL may have left as a result of alcohol-related disciplinary problems; with no linkage to in-service records, the Scottish Veterans Health Study does not provide any evidence in this respect and further studies would be needed. Those who served longer show no significant increase in risk, and it may be that moderate drinking habits were associated with a greater likelihood of promotion. Furthermore, they would have had longer exposure to military health promotion measures aiming at combating heavy drinking.

5.39.2.3 Drugs

The UK Armed Forces have had a zero-tolerance policy for drug misuse for many years (Section 5.17.4), unlike the US military where Bray et al. noted a prevalence of 8.4% among serving personnel (Bray et al. 1991). The policy of random testing and automatic discharge on positive testing results in a very low prevalence. The finding of the highest rate of liver cancer in ESL who did not compete initial training, albeit in a very small number of veterans, is consistent with a pathway of drug abuse and hepatitis B and/or C in vulnerable members of this population. It contrasts with the finding of a reduced risk of liver cancer in longer-serving individuals in whom, because of the zero-tolerance policy, drug misuse is much less likely. Hepatitis B and C will be discussed in Sections 6.8 and 6.9 but further studies are needed to confirm this hypothesis.

5.39.2.4 Occupational Factors

Only those cancers which exhibit increased risk with longer service can be considered as *prima facie* candidates for an occupational origin. The two conditions which meet this criterion are bladder cancer and cancer of the female breast. The association between breast cancer and longer service is likely to be indirect and non-causal, as discussed at Sections 5.37.3 and 5.39.2.5. The increased risk of bladder cancer in veterans with 7-16 years service, and in particular those born between 1960 and 1964, cannot be readily explained although a causal occupational association appears likely, as discussed at Section 5.21.3. A nested case control study is recommended to investigate possible risk factors for bladder cancer, and it is also recommended that this cohort be carefully followed up, as many of them have not yet reached the peak age of onset for bladder cancer.

5.39.2.5 Parity

The finding of the greatest increase in risk of breast cancer in women veterans with 13-16 years' service, but a decreased risk in those who left as ESL, after completing training but prior to finishing the minimum engagement, is likely to be entirely explained by parity and age at first childbirth, as discussed at Section 5.37.3. The lack of a relationship between ovarian cancer, for which low parity or nulliparity is also a risk factor, and longer service within the veteran cohort may be a spurious consequence of the very much smaller number of cases of ovarian cancer compared with breast cancer, but the pattern of ovarian cancer in veterans is more problematic to explain (Section 5.39.2.6).

5.39.2.6 Unexplained

The increased risk of pancreatic cancer in the 1960-1964 birth cohort (Section 5.16.1.3) cannot be readily explained. It may be a spurious finding as a result of small numbers, as this cohort had not reached the peak age for incidence of pancreatic cancer at the end of follow-up. Alternatively it may represent a true increase in risk. The incidence of pancreatic cancer in veterans should be monitored to assess whether this cohort remains at increased risk; if it does, further studies may be warranted as pancreatic cancer may be associated with occupational exposure.

There is no clear explanation for the isolated finding of an increased risk of kidney cancer in ESL who had completed initial training, compared with all veterans. The number of cases was small and it is difficult to interpret the results with confidence, notwithstanding that the increase in risk was statistically significant. The same may be true of stomach cancer in this subgroup, although the role of smoking and infection with *H. pylori* cannot be ruled out, as discussed at Section 5.11.4. The role of alcohol may also be contributory in the light of the findings for other alcohol-related cancers in this subgroup.

Possible reasons for the increased risk of ovarian cancer in women veterans are highly speculative, as discussed at Section 5.36.4. There may be justification for a nested case control study to clarify the picture, although the increase in risk does not appear to be affecting more recent generations of servicewomen.

5.39.3 Developing the Hypothesis

The hypothesis which emerged from the analysis of cardiovascular disease indicated that higher rates of smoking would help to explain the observed differences between veterans and non-veterans. Analysis of the cancer data has supported the role of smoking, and has also indicated that alcohol may have influenced the health of some veterans, the greatest impact being seen in those who only served for a short period, but who had completed initial training. Unlike the smoking-related disorders, the pattern of alcohol-related cancers did not point to increased risk in those who were discharged before completing training. For the smoking and alcohol-related cancers, the oldest veterans exhibited the highest increase in risk. There was a possible occupational association with bladder cancer and pancreatic cancer.

5.39.4 Key Points

- Overall, there was no difference in risk of cancer in veterans compared with non-veterans, when all cancers were aggregated.

- Veterans were at greater risk of lung cancer than non-veterans. There was a pattern of highest risk in the pre-1960 birth cohorts, reducing over time, which was consistent with the pattern seen in cardiovascular disease and attributed to smoking.

- The risk of lung cancer was highest in ESL who did not complete initial training, consistent with the pattern in cardiovascular disease.

- Veterans were at reduced risk of mesothelioma of the pleura.

- There was a significantly increased risk of oropharyngeal/laryngeal cancer and oesophageal cancer, and a non-significantly increased risk of stomach cancer, which was highest in the earlier birth cohorts and in those with shorter service, apart from in ESL who did not complete initial training. This pattern suggested alcohol as a risk factor, acting synergistically with smoking.

- For cancers of the lung, oropharynx/larynx, oesophagus and stomach, there was generally an inverse relationship between risk and length of service.

- Older veterans (born prior to 1955) living in the Glasgow area had a higher risk of stomach cancer than non-veterans.

- There were unexplained increases in risk of bladder cancer and ovarian cancer which would benefit from nested case-control studies.

- There was an apparent increased risk of pancreatic cancer in veterans born between 1960 and 1964, but longer follow-up is needed.

- There was no difference in risk of colorectal cancer or prostate cancer, overall or for any sub-group.

- There was an increased risk of breast cancer in longer-serving veteran women, and a reduced risk in women with short service. This pattern is consistent with differences in age at first childbirth, and parity, with length of service.

- Few of the veterans in the Scottish Veterans dataset have reached the peak age for cancer incidence; the observed patterns may change with longer follow-up.

Chapter 6: Other Physical Conditions

6.1 Introduction

This chapter explores whether veterans are at increased risk of selected neurological diseases (multiple sclerosis and motor neuron disease), liver disease (alcoholic liver disease, hepatitis B and hepatitis C), respiratory disease (tuberculosis and chronic obstructive pulmonary disease), digestive disease (peptic ulcer), diabetes, alcohol-related death, and road traffic accidents.

6.2 Aim

The aim of this chapter is to complete the analysis of the physical conditions and secondary outcomes in the linked Scottish Veterans Health Study dataset which were considered to be of *a priori* relevance to veterans' health but which are not encompassed by the chapters on cardiovascular disease and cancer.

6.3 Hypothesis

Unlike the chapters on cardiovascular disease and cancer, there are no aetiologically unifying factors underpinning the conditions considered in this chapter. The opportunity has therefore been taken to examine conditions where: there has been controversy as to whether there is an association with military service (for example, multiple sclerosis); where studies in other countries have demonstrated an association with service (for example, motor neuron disease); where an analysis of patterns of risk may provide an indication of the role of risk factors such as alcohol or drugs which cannot otherwise be quantified (alcoholic liver disease, alcohol-related death, hepatitis B and C); or where the results may contribute to an evaluation of in-service health protection policy (tuberculosis). The analysis of data on COPD and peptic ulcer provides further evidence on patterns of smoking-related disease, whilst an examination of the risk of road traffic accidents in veterans takes forward earlier work on risky driving and road safety in serving personnel (Defence Logistics Organisation 2001, Fear et al. 2008).

Drawing on the conclusions from the earlier chapters, an hypothesis to be tested was that smoking-related conditions would show a similar pattern of association with shorter service and earlier birth cohort. Data on alcohol-related cancers (Sections 5.9.3 and 5.10.3) suggested that the highest risk of alcoholic liver disease and alcohol-related death would be seen in ESL veterans who had completed initial training, but that those who left before completing training would show no increase in risk; this too would be tested. Findings in respect of hepatitis B and C would provide further indication of whether ESL were at increased risk of drug abuse, as tentatively suggested by the results for liver cancer.

6.4 Multiple Sclerosis

6.4.1 Introduction

Multiple sclerosis (MS) is a chronic progressive neurological disorder of unknown aetiology which often follows a relapsing and remitting course. It is highly variable in its symptomatology, in the degree of disability to which it gives rise and in its long-term prognosis. In most countries, prevalence is highest in the 35-49 year age group although in the UK, the prevalence of MS is more widely spread between the ages of 5 and 64 years (Pugliatti et al. 2006). Prevalence is highest in more northerly latitudes, and for Scotland, it has been estimated at 187 per 100,000 in the south of the country and nearly 200 per 100,000 in Orkney (Rosati 2001). Female cases outnumber male cases by a factor of 2.2 to 2.8. The mean incidence in England was 5.1 per 100,000 per year although a rate of 12.0 per 100,000 per year was recorded in Scotland (Pugliatti et al. 2006).

Formerly, a War Disablement Pension could be awarded to a veteran for MS if it was considered, on the balance of probabilities, that it was attributable to military service. In a Parliamentary Written Answer on 29 October 2007, the then Parliamentary Under-Secretary for the Ministry of Defence, Derek Twigg, reported that there were 380 former service personnel in receipt of a War Disablement Pension with an accepted claim for MS[151]. In 2013, the Independent Medical Expert Group (IMEG) published its report and recommendations[152] on the Armed Forces Compensation Scheme (AFCS), the scheme

[151] Hansard HC Deb, 29 October 2007, c951W

[152] Taylor, A. N. (2013) *The Independent Medical Expert Group Report and recommendations on medical and scientific aspects of the Armed Forces Compensation Scheme*, Imperial College, London.

which succeeded the War Pensions Scheme on 6 Apr 2005. The Group reported that there was no evidence that MS was 'uniquely occupational', and noted that in military personnel, it was clinically indistinguishable from the disorder in the wider population. On the basis of current understanding, they were unable to support military service as being causal. Compensation would only be payable where service could be shown to have caused worsening of the condition, and where such worsening had led to medical downgrading[153] and medical discharge. They noted that the Armed Forces were committed to high standards of human resource management and occupational medicine, and that care should be taken to provide affected individuals with an appropriate working environment in order to avoid deterioration.

6.4.2 Incidence

Multiple sclerosis was defined as ICD-9 code 340 or ICD-10 code G35, at any position in the record. The data for multiple sclerosis have to be interpreted with caution since the SMR01 dataset reflects in-patient care. Many cases of MS are diagnosed in an outpatient setting and would only be recorded in SMR01 if admitted as a result of a complication or co-morbidity, for in-patient treatment, or incidentally in the course of admission for an unrelated condition. It is unlikely therefore that the data represent all cases occurring in the study cohort. For the purposes of analysis of the dataset, it has been assumed that there are no systematic differences in completeness of ascertainment of MS between veterans and non-veterans, and that any differences reflect real differences in incidence or severity.

6.4.2.1 Overall

During the period of follow-up, there were 139 cases of multiple sclerosis in veterans resulting in admission, compared with 481 in non-veterans, equating to a cumulative incidence of 0.25% in veterans and 0.28% in non-veterans. The Cox proportional hazard model showed a non-significant reduction in risk in veterans, HR 0.92, 95% CI 0.75-1.11, p=0.379 unadjusted. The hazard ratio was the same after adjusting for deprivation. The Nelson-Aalen plot confirms the slight reduction in risk in veterans (Figure 6-1). Testing for non-proportionality of the hazards was non-significant, p=0.324.

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[153] Reduction in occupational employability/deployability category

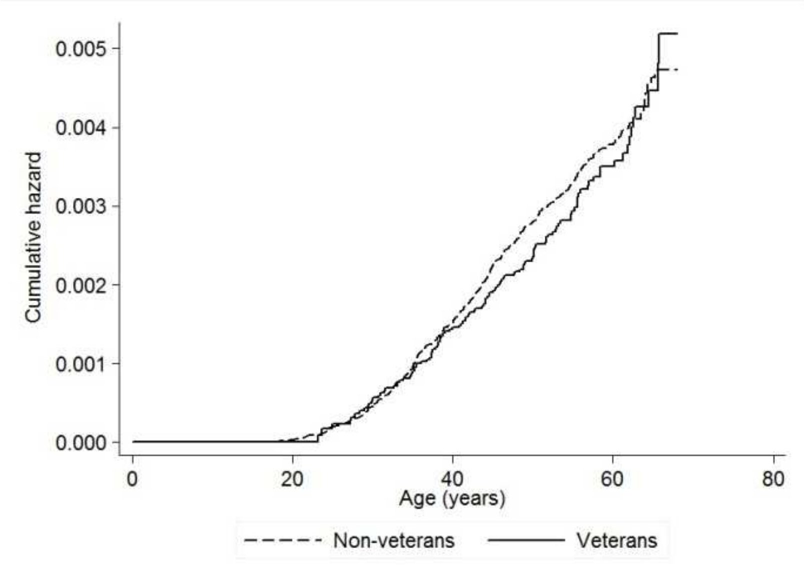

Figure 6-1 - Nelson-Aalen plot of multiple sclerosis by veteran status

6.4.2.2 Sex

There were 30 cases of multiple sclerosis in veteran women and 106 cases in non-veteran women, equating to 21.6% of all cases in veterans and 22.0% of all cases in non-veterans. The Cox proportional hazard ratios for veterans referent to non-veterans were significant neither for women, unadjusted HR 1.15, 95% CI 0.75-1.75, p=0.531, nor for men, HR 0.89, 95% CI 0.71-1.11, p=0.312.   Women were much more likely to have a diagnosis of multiple sclerosis than men, unadjusted HR 2.90, 95% CI 1.89-4.45, p<0.001 for veterans and HR 2.28, 95% CI 1.84-2.83, p<0.001 for non-veterans.

6.4.2.3 Age

The mean age at first admission with MS was 42.6 years (SD 10.8) for veterans and 41.4 years (SD 9.6) for non-veterans. The kernel density plot showed a lower peak in veterans, and more cases in the older age groups, but otherwise showed no major difference in the pattern of incidence (Figure 6-2).

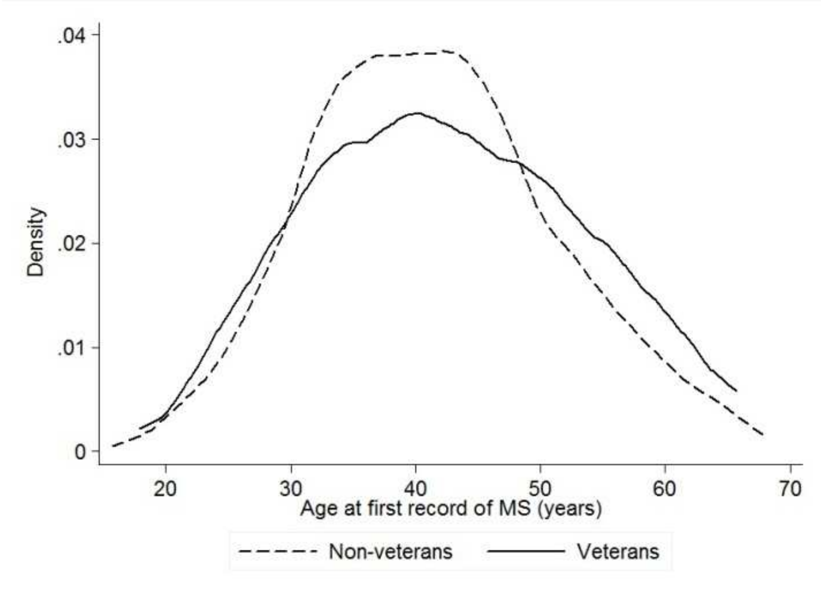

Figure 6-2 - Kernel density plot of age at first record of multiple sclerosis Veterans and non-veterans

6.4.2.4 Birth Cohort

Taking men and women together, there was no significant difference in the risk of multiple sclerosis in any birth cohort (Figure 6-3).

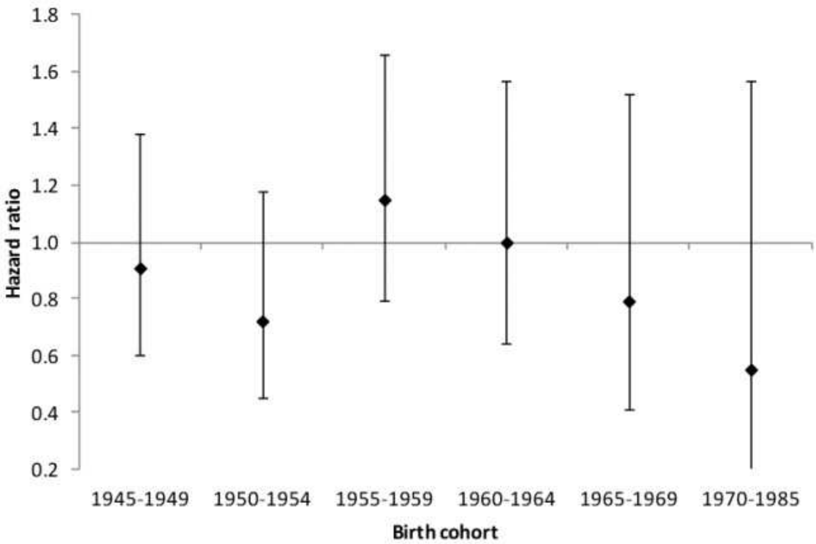

Figure 6-3 - Hazard ratios for multiple sclerosis, by birth cohort Veterans referent to non-veterans

6.4.2.5 Length of Service

Figure 6-4 indicates a minor degree of inverse relationship between risk of MS and length of service, with the risk in ESL similar to, or slightly higher than, the risk in all non-veterans whereas for those with longer service, the risk was similar to, or slightly lower than, the non-veterans. However, the small number of cases in each length of service category gave insufficient statistical power to demonstrate a significant difference. Premature termination of service due to diagnosis of MS is unlikely to be an important confounder since only 3 cases of MS were diagnosed in ESL before the age of 25 years (6.1% of ESL cases and 2.2% of all cases in veterans).

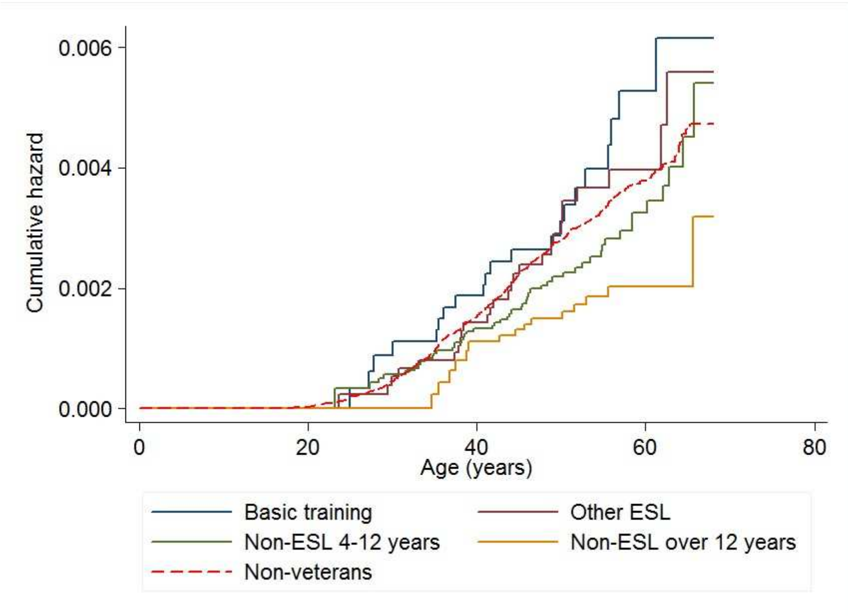

Figure 6-4 – Nelson-Aalen plot of multiple sclerosis by length of service
All non-veterans for comparison

6.4.3 Case-Fatality

The mean follow-up from date of first record of multiple sclerosis to the date of death or the end of the study was 11.15 years (range 0-31.50 years) for veterans and 12.20 years (range 0-31.96 years) for non-veterans, representing 1,550 person-years of follow-up in the veterans and 5,868 person-years in the non-veterans. There were 42 (30.2%) deaths in veterans with multiple sclerosis, equating to 27.1 per 1,000 person-years, and 109 (22.7%) deaths in non-veterans (18.6 per 1,000 person-years). Most deaths were recorded as being due to multiple sclerosis.

6.4.4 Commentary

Data from the Scottish Veterans Health Study provide no evidence of a causal link between military service and MS, thus supporting the IMEG conclusion[152]. There may be a small protective effect, exhibiting a dose relationship with length of service. The increased risk of MS in higher latitudes where sun exposure is reduced, and reduction in risk with exposure to sunlight, is well documented (Pugliatti et al. 2006, Van der Mei et al. 2003). Veterans resident in Scotland are likely to have spent some time away from Scotland during their service, often in sunnier climes, and it is plausible that the slight reduction in risk of MS compared with non-veterans reflects this occupational exposure to sunlight. The higher case-fatality in veterans cannot be readily explained.

6.5 Motor Neuron Disease[154]

6.5.1 Introduction

Motor neuron disease (MND), also known as amyotrophic lateral sclerosis (ALS) in the United States, is a rare but serious progressive degenerative neurological condition. In a study in Scotland the crude incidence was 2.25 cases per 100,000 population per year, the median survival time from diagnosis was 2.5 years and the 5-year survival was 28%. It is more common in men than women. The mean age at onset varies between studies but is generally between 45 and 65 years (Chancellor et al. 1993).

In 2003 the first report of an association between service in the US Armed Forces in the first Gulf War (1991) and ALS was published (Haley 2003). Case-finding confirmed an increased risk among all deployed personnel, RR 1.92, 95% CI 1.29-2.84, although the increase was non-significant for Reserves and National Guard (Horner et al. 2003). The US Veterans Administration accepted ALS as a Gulf War-related illness, but Rose cautioned against over-interpretation of the findings of the studies (Rose 2003), whilst Armon noted under-ascertainment of cases in Horner et al.'s non-deployed cohort (Armon 2007).

In 2005, Weisskopf et al. analysed data from the American Cancer Society Cancer Prevention Study II (CPS II) to compare the rates of ALS in veterans of military service over a wide range of dates, periods of service and conflicts, compared with people with no record of service. The study population included 281,874 veterans and 126,414 non-veterans, with a total of 3.6 million person-years of follow-up. Military service included

[154] This Section is dedicated to the memory of the author's colleague at Medical Branch, Headquarters Scotland, Major Jimmie James, who died on 12 January 2015 after a long battle with motor neuron disease. Together with his twin brother, he retired from the Army in 2009 after 50 years' service, having joined at the age of 15 years.

World War 1, World War 2, the Korean War and the Vietnam War, as well as the intervening periods, and extended to a latest possible date of service of 1982. The authors found an increased risk of ALS for any military service, RR 1.58, 95% CI 1.12-2.09. The risk was elevated in every birth cohort examined (1915 to 1939) and was irrespective of length of service (Weisskopf et al. 2005). In 2006 the Institute of Medicine of the National Academies published a review of the scientific literature on ALS in veterans. The review committee concluded that there was “limited but suggestive evidence of an association between military service and ALS”, and that putative risk factors included intensive physical activity, smoking, alcohol, trauma, transmissible agents, lead, pesticides and environmental toxicants. The committee recommended that further studies should take place using other existing cohorts including in the United Kingdom (Johnson et al. 2006). No such studies are known to have taken place in the UK. The Scottish Veterans Health Study provided an opportunity to examine the risk of MND in a large cohort of UK veterans.

6.5.2 Incidence

Motor neuron disease was defined as ICD-9 code 335.2 or ICD-10 code G12.2, at any position in the record.

6.5.2.1 Overall

During the period of follow-up, 38 veterans had a diagnosis of MND compared with 78 non-veterans, equating to a cumulative incidence of 0.07% in veterans and 0.04% in non-veterans. The difference was statistically significant, unadjusted HR 1.56, 95% CI 1.06-2.30, p=0.025, notwithstanding the small number of cases. The difference persisted after adjusting for deprivation, HR 1.49, 95% CI 1.01-2.21, p=0.046. The Nelson-Aalen plot demonstrated the increased risk in veterans (Figure 6-5). Testing for non-proportionality of the hazards was non-significant, p=0.527.

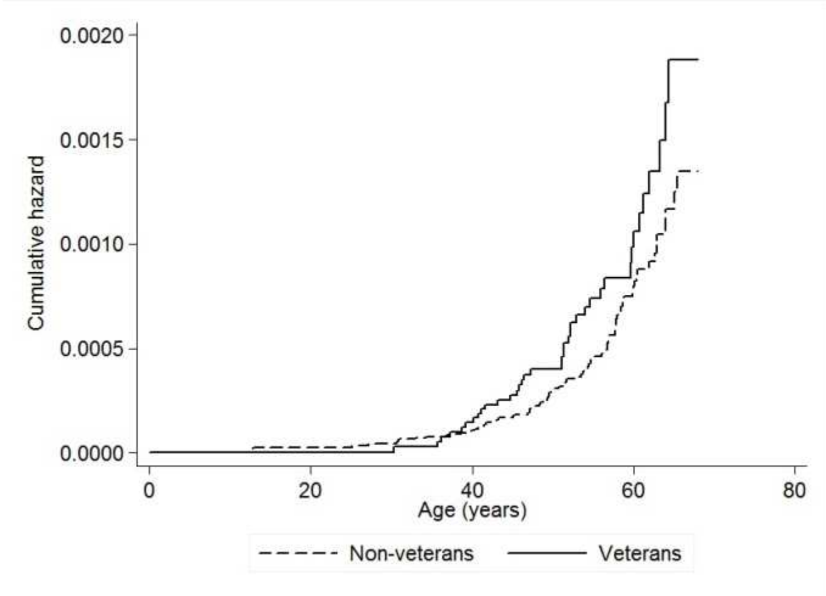

Figure 6-5 - Nelson-Aalen plot of motor neuron disease by veteran status

6.5.2.2 Sex

There was only one case of motor neuron disease in a female veteran and four in female non-veterans, representing 2% of all cases in veterans and 5% in non-veterans. Veteran women were not at significantly increased risk compared with non-veteran women, unadjusted HR 1.10, 95% CI 0.11-9.06, p=0.991; statistical power was low owing to small numbers of cases. However, veteran men were at significantly increased risk compared with non-veteran men, unadjusted HR 1.57, 95% CI 1.05-2.33, p=0.027. After adjusting for deprivation, the sex-specific hazard ratios for veterans compared with non-veterans were 1.03, 95% CI 0.11-9.22, p=0.979 for women and 1.49, 95% CI 1.00-2.22, p=0.050 for men.

6.5.2.3 Age

The mean age at diagnosis in veterans was 49.7 years (SD 9.1). Age at diagnosis was the same for non-veterans, 49.7 years (SD 10.6). Year of birth for the veteran cases ranged from 1945 to 1970 and from 1945 to 1977 for the non-veterans, and the veteran cases entered the Armed Forces between 1961 and 1999.

6.5.2.4 Birth cohort

Analysis by birth cohort was performed in 10-year bands because of the small number of cases. This demonstrated an increased risk in each band, although it was only statistically significant for the 1955-1964 birth cohort, HR 2.07, 95% CI 1.03-4.17, p=0.042 (Figure 6-6).

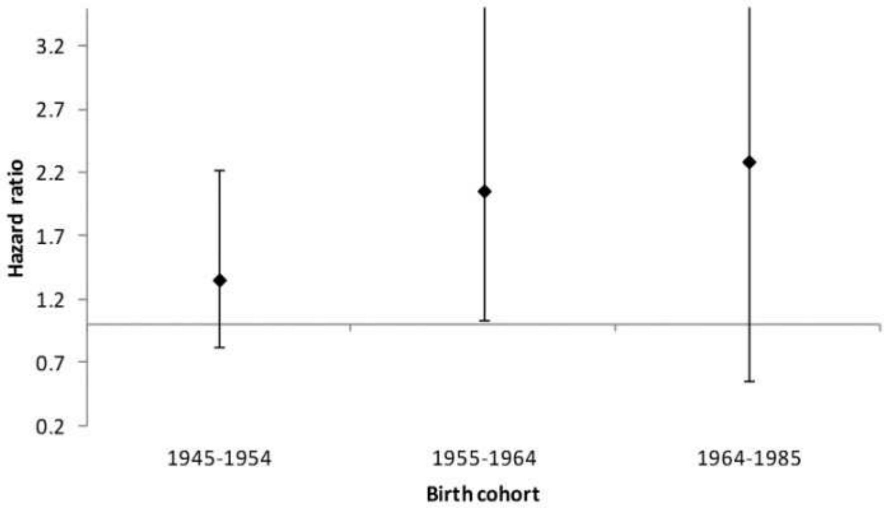

Figure 6-6 – Hazard ratios for motor neuron disease by birth cohort Veterans referent to non-veterans

Although Figure 6-6 suggests an increasing risk with successive birth cohorts, the trend did not reach statistical significance; testing for interaction with birth cohort showed p=0.088.

6.5.2.5 Length and Period of Service

The small number of cases precluded plotting Nelson-Aalen cumulative hazard curves for length of service. The kernel density plot for veterans with MND by length of service, compared with all veterans, did not show any major difference for those affected, suggesting that a diagnosis of MND was independent of length of service of veterans and that there was no 'dose relationship' (Figure 6-7). The peaks in the 'all veterans' curve represent ESL and common lengths of engagement (4-6, 12 and 22 years). Similarly, there was no clear evidence of association with any year of entry to service, the curves for affected veterans and all veterans broadly tracking one another, other than for the recruitment peak in the late 1980s (Figure 6-8).

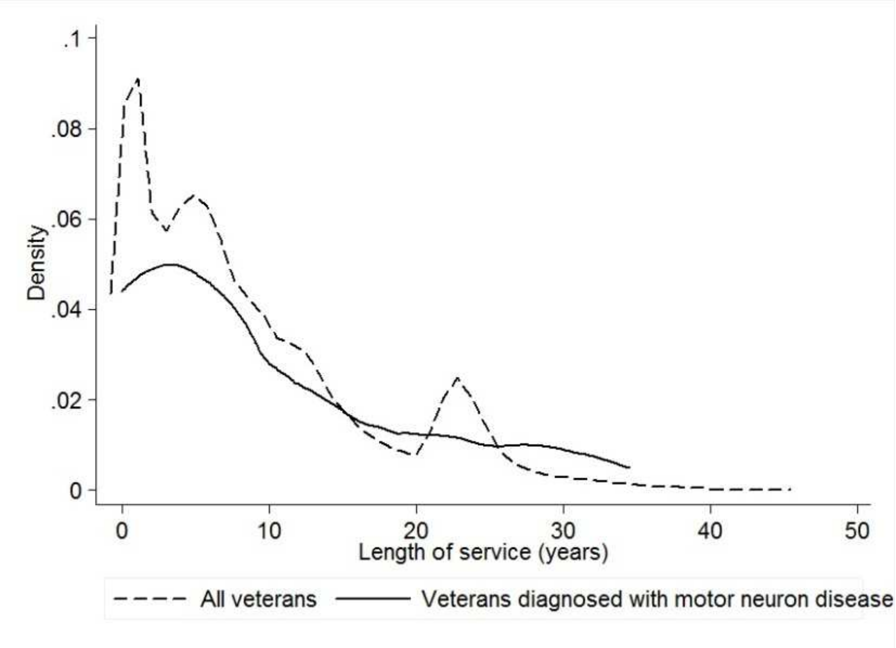

Figure 6-7 - Kernel density plot of motor neuron disease in veterans by length of service All veterans for comparison

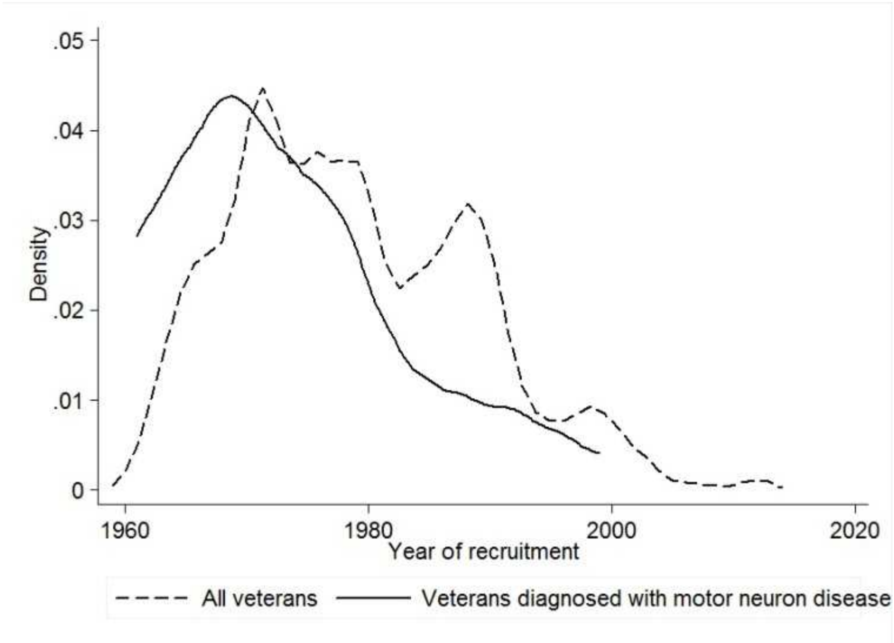

Figure 6-8 - Kernel density plot of motor neuron disease in veterans by year of entry All veterans for comparison

6.5.3 Co-Morbidity

Co-morbidities which could provide evidence for the putative risk factors for MND of smoking and alcohol were COPD, lung cancer, oropharyngeal and laryngeal cancer and alcoholic liver disease. The early age of onset of MND and short survival meant that most people with MND did not reach the age at which these conditions were likely to develop. For smoking, there was one case of co-morbid lung cancer in a veteran and none in non-veterans, and four cases of COPD in veterans compared with 7 in non-veterans. For the latter, there was a non-significantly increased odds ratio for veterans, OR 1.17, 95% CI 0.37-3.76, p=0.789. In respect of alcohol, there were two cases of co-morbid alcoholic liver disease in non-veterans but none in veterans; there were no cases of oropharyngeal or laryngeal cancer, in either veterans or non-veterans.

6.5.4 Trauma

Trauma was a putative risk factor and was independently associated with MND, both overall and by veteran/non-veteran subgroup. The odds ratio for MND with a history of either trauma or road traffic accident in the entire cohort, compared with people with no such history, was 1.51, 95% CI 1.26-1.81, p<0.001. For veterans alone the odds ratio was 1.71, 95% CI 1.29-2.28, p=0.002 and for non-veterans it was 1.43, 95% CI 1.14-1.80, p=0.006.

6.5.5 Case-Fatality

The mean follow-up from date of first record of motor neuron disease to the date of death or the end of the study was 4.42 years (range 0-26.26 years) for veterans and 3.59 years (range 0-30.49 years) for non-veterans, representing 168 person-years of follow-up in the veterans and 280 person-years in the non-veterans. There were 29 (76.3%) deaths in veterans with motor neuron disease, equating to 172.7 per 1,000 person-years, and 53 (67.9%) deaths in non-veterans (189.3 per 1,000 person-years). Veterans had a lower case-fatality than non-veterans at one year, HR 0.80, 95% CI 0.42-1.53, p=0.500 in the unadjusted model. The results were unchanged after adjusting for SES. There were 7 survivors (18.4%) among the veterans at 5 years and 16 (20.5%) among the non-veterans.

6.5.6 Commentary

Analysis of the risk of motor neuron disease has highlighted the challenges inherent in the epidemiology of rare conditions, and initiatives such as the establishment of disease registries may be needed in order to collate data on a sufficient number of cases to permit meaningful analysis (Nagel et al. 2013). Notwithstanding that there were only 38 veteran and 78 non-veteran cases in the Scottish Veterans dataset, statistical analysis showed a significantly increased risk in the veterans, unadjusted HR 1.56, 95% CI 1.06-

2.30, p=0.025. The increase was numerically remarkably close to the relative risk of 1.58, 95% CI 1.14-2.19, found by Weisskopf et al. for ALS in the CPS II study (Weisskopf et al. 2005). Weisskopf also adjusted for smoking, which was not possible in the Scottish Veterans study as the dataset did not include information of smoking status, and for age; the Scottish non-veterans comparison cohort was matched for both age and sex.

The period of military service covered by the Scottish Veterans Health Study cohort overlapped the CPS II study for the period 1960-1982; the CPS II data commenced with World War 1 veterans and the Scottish Veterans data extended to those serving up to 2012. Therefore, the two datasets together cover nearly 100 years of military service. Both Weisskopf and, now, the Scottish Veterans Health Study found that the increased risk of ALS was independent of period of service; this precludes putative risk factors such as pesticides and environmental toxicants which are unlikely to have remained unchanged over nearly 100 years. The finding of an almost identical increase in risk in two discrete national armed forces introduces a further degree of heterogeneity of military experience. It is therefore necessary to explore risk factors which are unlikely to have changed over time. The remaining putative risk factors identified by the National Academies report were intensive physical activity, smoking, alcohol, trauma, and lead.

Trauma is highly plausible; the analyses at Section 6.5.4 demonstrated that there was an association with trauma, but that the association was stronger in veterans than in non-veterans, suggesting that veterans may have experienced one or more additional risk factors as a result of military service, or that there were differences in the nature or severity of trauma experienced. A number of studies have also demonstrated an association between high levels of physical activity and MND (Huisman et al. 2013). At a symposium held at the Royal Society of Medicine in 1962, it was observed that “the average male case is not a clerk who sits in an office but is a heavy labourer”, and the suggestion was also made that “a past history of unnecessary muscular movement carried out for no obvious reason may be followed in later life by the development of motor neuron disease in a statistically significant number of cases” although no reference was given to the research on which this observation was based (Ferguson 1962). Several leading sportsmen have died from ALS (Harwood et al. 2009). In particular, an association with professional football has been identified (Chio et al. 2005). Despite initial scepticism (Al-Chalabi and Leigh 2005), subsequent research has provided confirmation of a strong association, especially for players in 'speed' positions (Lehman et al. 2012). Longstreth et al. found a significant association with participation in organised high school sport but no overall association with lifetime physical activity, based on assessment at interview (Longstreth et al. 1998). Veldink et al. were also unable to confirm an association between lifetime physical activity and overall risk of developing MND, but found that higher levels of leisure time activity were associated with earlier age at disease onset, especially for high levels of activity before age 25 years when the onset of disease was, on average, 7 years earlier (Veldink et al. 2005). By contrast, in an important paper considering causal pathways to the development of MND, Strickland et al. used frequency of sweating as a measure of the intensity of work or leisure activity in the third decade of life, and found clear evidence of an association, OR 1.6, 95% CI 1.1-2.4 for work, 1.1-2.5 for leisure. Achieving recognition of excellence in sport at any time was associated with increased risk, OR 3.1, 95% CI 1.04-9.3. There was also a strong association with severe trauma to the head, back or neck, OR 5.6, 95% CI 1.7-17.0. There was no interaction between sporting excellence and severe head, back or neck trauma (Strickland et al. 1996). Heavy physical exertion is an inevitable concomitant of military service (Horner et al. 2013), as is participation in active sport, commencing from the earliest days of recruit training and continuing through to retirement, or even beyond in those who choose to maintain their physical fitness post-service. It has been estimated that the exercise levels of a front-line soldier are equivalent to those of a professional sportsman (Hopkins 1992). Participation in physical exertion and contact sport inevitably increases the risk of physical injury, whilst military service, and especially operational service, has been shown to increase the risk of involvement in road traffic accidents (Fear et al. 2008). Increased risk of injury in road traffic accident in veterans is also confirmed by the Scottish Veterans study (Section 6.14.2.1).

There is a consistent positive association between MND and ever smoking, and with recently stopping smoking (Kamel et al. 1999); military personnel have been shown to smoke more than civilians (Lewthwaite and Graham 1992), as discussed in Appendix 4, Sections A4.1.3 and A4.1.4 , and veterans are more likely to be ever-smokers (Klevens et al. 1995). There is little evidence of an association between alcohol and ALS/MND, and one study has shown a protective effect of ever/current alcohol use (de Jong et al. 2012). Family history is a risk factor (Kamel et al. 1999) but there is no plausible reason why military personnel should be more likely than civilians to have a family member with

MND. Genetic factors may also play a part, whether alone or in combination with the environmental modifiers described, but are as yet poorly understood (Bruijn et al. 2004) and, for the same reasons as family history, are therefore unlikely to account for the differences observed between veterans and non-veterans. Several authors have reported an association between blood lead levels and ALS (Kamel et al. 2002, Fang et al. 2010). Veterans may have been exposed to increased levels of atmospheric lead during service, particularly in the past, prior to the introduction of strict controls; sources of possible exposure are explored at Appendix 3, Section A3.3.5.13.

It is therefore suggested that factors which may place veterans at increased risk of MND in comparison with non-veterans are energetic physical exercise, trauma, smoking and, in the past, exposure to lead from ammunition and vehicle exhausts. The absence of a length of service 'dose relationship' suggests a dominant factor which is independent of length of service; physical exertion is a plausible candidate as it may be surmised that those who join the Services generally have a more active lifestyle than civilians, although data are lacking. In view of the rarity of MND, it is unlikely that sufficient epidemiological data could be collected on this rare condition to yield further insight into the relative roles of these common risk factors, but work should continue to monitor MND in military personnel and veterans, and case control studies may be appropriate.

The range of lengths of follow-up, in both veterans and non-veterans, indicates that some people survived for long periods of time after diagnosis. Examination of the data showed that 5 (13.2%) veterans and 9 (11.5%) non-veterans with MND survived in excess of 10 years. This is in excess of the 4% survival for more than 10 years reported in a study of 985 patients entered on the King's College clinic database (1990-2002) and reported by Turner et al. (Turner et al. 2003). That study found that younger age at onset was associated with longer survival. In the Scottish Veterans study, long survivors (>10 years) who were veterans had a mean age at first record of MND of 40.3 years (SD 3.7), compared with a mean age at first record of 51.2 years (SD 8.8) among veterans who survived less than 10 years. For non-veterans, the corresponding ages at first record were 37.7 years (SD 11.9) and 51.2 years (SD 9.4) respectively. Findings from the Scottish Veterans study therefore broadly support the observation by Turner et al. that those who survive for longer than 10 years are, on average, 14 years younger at disease onset than those whose survival is shorter. The exclusion of any people older than 67 years from the

Scottish Veterans cohort may explain the higher proportion of long survivors; the oldest of the King's patients was 72 years of age at disease onset and the mean age at onset among the shorter survivors was 62 years.

6.6 Alcoholic Liver Disease

Alcoholic liver disease was defined as the occurrence of ICD-9 code 571.0. 571.1 or 571.2, or ICD-10 code K70, at any position in the record.

6.6.1 Incidence

6.6.1.1 Overall

During the period of follow-up, 677 (1.20%) veterans had a diagnosis of alcoholic liver disease compared with 2,175 (1.26%) non-veterans. The difference was not statistically significant in the unadjusted model, HR 0.97, 95% CI 0.89-1.06, p=0.487, but after adjusting for deprivation, the veterans were at lower risk, HR 0.91, 95% CI 0.84-0.98, p=0.035. The Nelson-Aalen plot illustrates the small reduction in risk in veterans (Figure 6-9).

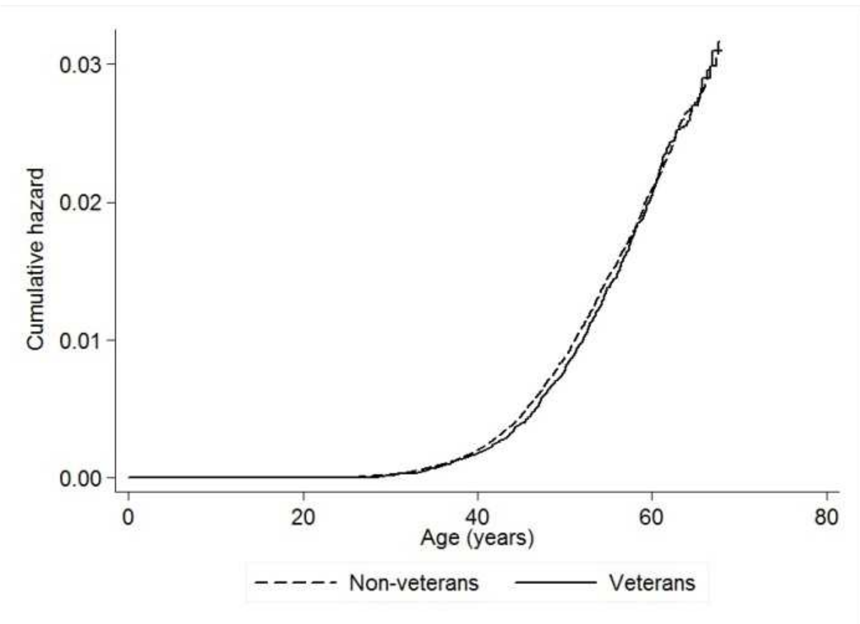

Figure 6-9 - Nelson-Aalen plot of alcoholic liver disease by veteran status

6.6.1.2 Sex

Only 26 cases of alcoholic liver disease in veterans occurred in women, representing a cumulative incidence of 0.50% of female veterans. In non-veteran women, there were 126 cases (0.61%). The difference was not statistically significant, unadjusted HR 0.84, 95% CI 0.55-1.29, p=0.439. The hazard ratio was similar after adjusting for deprivation. Female veterans were at statistically significantly lower risk of alcoholic liver disease than male veterans, unadjusted HR 0.47, 95% CI 0.32-0.69, p<0.001; non-veteran women were similarly at lower risk than non-veteran men, unadjusted HR0.53, 95% CI 0.44-0.63, p<0.001.

6.6.1.3 Age

The mean age at first record of alcoholic liver disease for veterans was 50.0 years (95% CI 49.4-50.6 years), compared with 48.9 years (95% CI 48.5-49.2 years) for non-veterans. Age at first episode did not differ between men and women, for either veterans or non-veterans.

6.6.1.4 Birth Cohort

Analysis by birth cohort showed a pattern of reducing risk over time. There was a statistically significant increase in risk in the oldest cohort, born 1945-1949. The hazard ratio reduced to unity in the 1950-1954 birth cohort and then continued to fall in later birth cohorts, although the reduced hazard ratios did not achieve statistical significance other than in the 1960-1964 subgroup, owing to smaller numbers in the more recent subgroups (Figure 6-10).

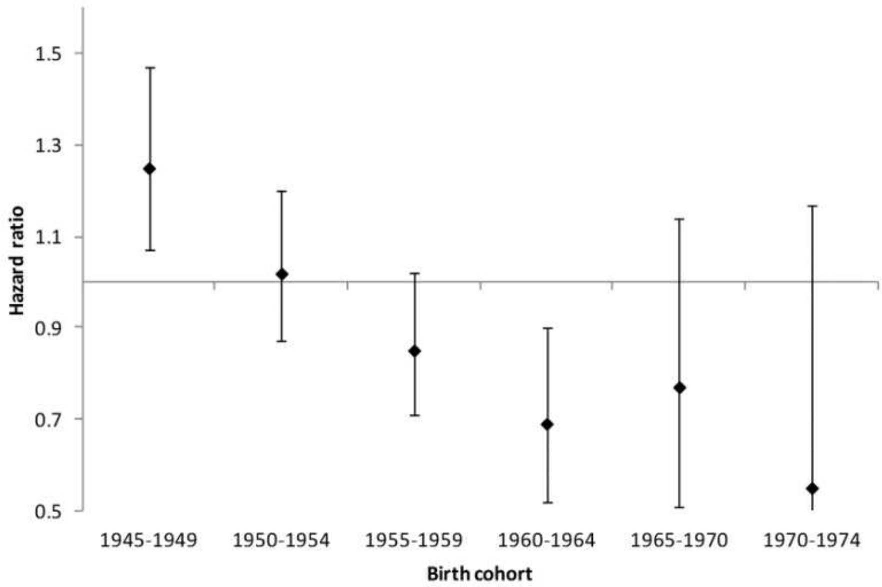

Figure 6-10 - Hazard ratios for alcoholic liver disease by birth cohort Veterans referent to non-veterans

6.6.1.5 Length of Service

When examined graphically by length of service, the only subgroup to demonstrate an increased risk of alcoholic liver disease was Early Service Leavers who had completed initial training. ESL who failed to complete training had a similar pattern of risk to non-veterans, as did veterans with between 4 and 12 years service. Longer-serving veterans (over 12 years' service) showed a reduction in risk, particularly in veterans over 50 years of age (Figure 6-11). Detailed analysis by common lengths of service, and by birth cohort in two categories, showed the excess risk in trained ESL to be confined to older veterans (born prior to 1960); a modest increase in risk in this birth cohort among those with 7-9 years' service was also demonstrated. There was no increased risk in any sub-group for people born after 1959, and their overall reduction in risk was statistically highly significant (Table 6-1).

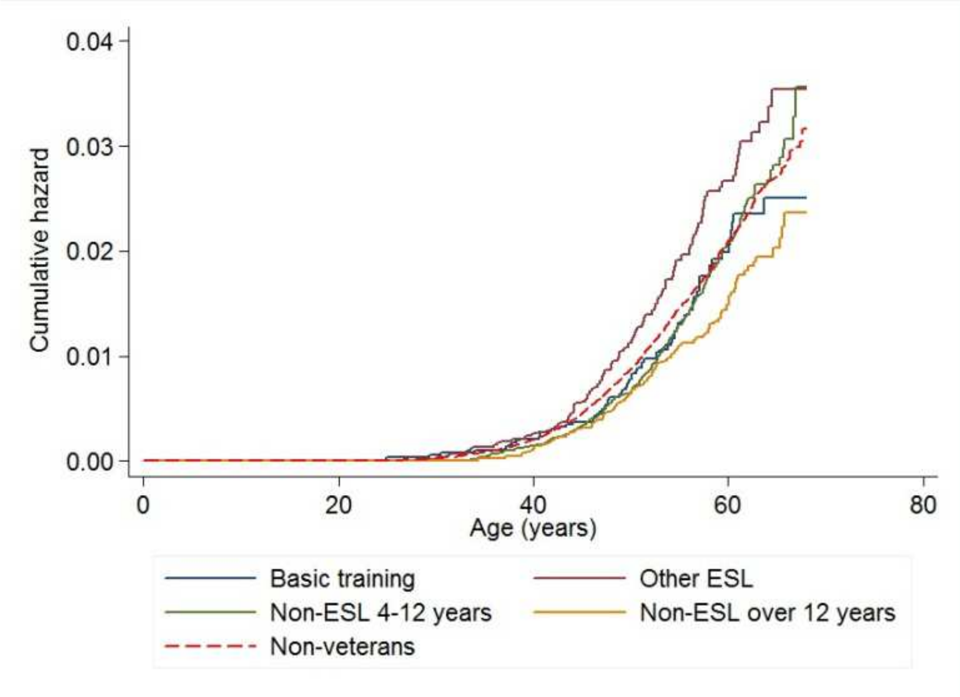

Figure 6-11 - Hazard ratios for alcoholic liver disease by length of service Non-veterans for comparison

Table 6-1 - Cox proportional hazard model of the association between veteran status and alcoholic liver disease, overall and stratified by length of service and birth cohort

	Veterans cases	All Veterans *n*-56,205			Born 1945-1959 *n*=29,709			Born 1960-1985 *n*=26,496		
	n	HR	95% CI	p	HR	95% CI	p	HR	95% CI	p
Overall										
Univariate	677	0.97	0.89-1.06	0.487	1.05	0.95-1.15	0.349	0.69	0.55-0.85	0.001
Multi-variable	677	0.90	0.82-0.98	0.017	0.96	0.88-1.06	0.439	0.67	0.54-0.83	<0.001
Length of service in 8 categories										
Basic training	73	0.92	0.73-1.16	0.487	0.98	0.76-1.26	0.871	0.70	0.39-1.28	0.245
ESL (0-3 years)	190	1.25	1.07-1.45	0.004	1.36	1.16-1.60	<0.001	0.81	0.54-1.20	0.293
4-6 years	118	0.89	0.74-1.07	0.209	0.92	0.76-1.14	0.465	0.74	0.48-1.15	0.184
7-9 years	101	1.11	0.91-1.36	0.288	1.25	1.01-1.55	0.044	0.66	0.39-1.12	0.125
10-12 years	64	0.89	0.70-1.14	0.373	1.00	0.77-1.31	0.973	0.53	0.27-1.02	0.058
13-16 years	42	0.80	0.59-1.09	0.152	0.84	0.59-1.20	0.337	0.69	0.37-1.29	0.245
17-22 years	38	0.75	0.54-1.03	0.080	0.77	0.54-1.09	0.137	0.68	0.30-1.52	0.350
≥23 years	50	0.78	0.59-1.03	0.082	0.81	0.60-1.09	0.158	0.55	0.20-1.47	0.232

The biphasic pattern of risk by length of service which was demonstrated in older veterans (ESL who had entered trained service and veterans with 7-9 years' service) was unexpected, and additional analyses were therefore undertaken to explore possible reasons. A kernel density plot of alcoholic liver disease by year of entry to service, compared with all veterans, demonstrated a disproportionate risk in those who entered service in the early 1970s, with a peak at 1971 which coincided with, but was higher than, the peak in recruiting at the start of operations in Northern Ireland (Figure 6-12).

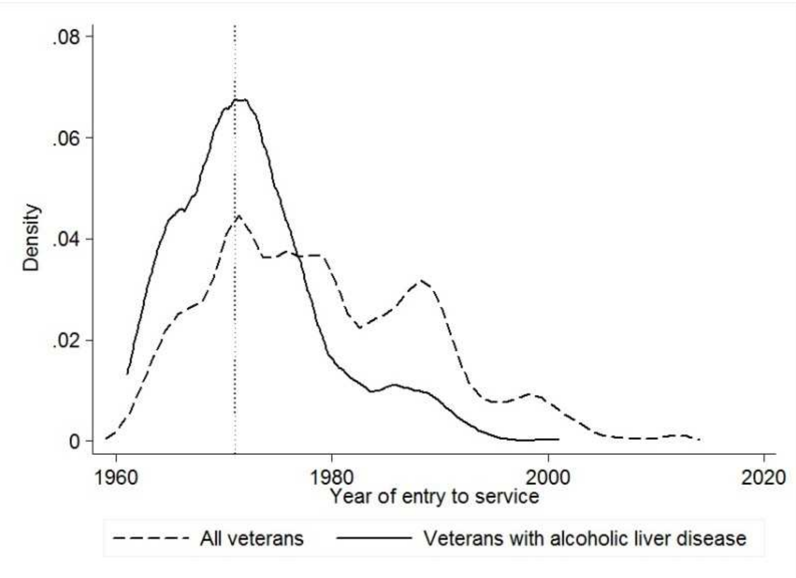

Figure 6-12 - Kernel density plot of alcoholic liver disease in veterans by year of entry to service
All veterans for reference
Dotted line at 1971

A Lexis diagram of risk of alcoholic liver disease by year of birth and year of entry to service was plotted, and this demonstrated the greatest increase in risk to be in veterans who were born between 1945 and 1949, who joined the Services between 1969 and 1971 and who were therefore older than most of their peers at recruitment. The detailed data are potentially disclosive and are not presented in full. The mean length of service of veterans who developed alcoholic liver disease, in this birth and entry cohort, was 7.5 years (SD 7.5).

6.6.2 Case-Fatality

The mean follow-up from date of first record of alcoholic liver disease to the date of death or the end of the study was 4.32 years (range 0-28.98 years) for veterans and 4.21

years (range 0-31.74 years) for non-veterans, representing 2,925 person-years of follow-up in the veterans and 9,157 person-years in the non-veterans. There were 445 (65.7%) deaths in veterans with alcoholic liver disease, equating to 152.2 per 1,000 person-years, and 1,361 (62.6%) deaths in non-veterans (148.6 per 1,000 person-years). The commonest recorded cause of death, for both veterans and non-veterans, was alcoholic liver disease.

6.6.3 Treatment

Data on cashed prescriptions for alcohol abstinence drugs were available from 2009. All drugs recognised in the British National Formulary for this use were aggregated; data were not available for the individual drugs. Only 30 (4.4%) veterans and 122 (5.6%) non-veterans with alcoholic liver disease had received a prescription for alcohol abstinence drugs; the difference was not statistically significant, OR 0.79, 95% CI 0.53-1.17, p=0.234. If only diagnoses of alcoholic liver disease recorded from 2009 are considered, 19 (13.6%) veterans and 64 (12.1%) non-veterans received these drugs; again the difference was non-significant, OR 1.12, 95% CI 0.69-1.80, p=0.649. There is no evidence from these data that veterans who misuse alcohol are less likely than non-veterans to receive care.

6.6.4 Co-Morbidity

Co-morbidities for a range of conditions likely to be associated with alcohol misuse or liver disease were examined in veterans and non-veterans. The results are summarised at Table 6-2.

Table 6-2 - Co-morbidities with alcoholic liver disease
Crude overall incidence for comparison

	Veterans		Non-veterans		Veterans referent to non-veterans		
	Cases *n*=677 No. (%)	Pop. *n*=56,205 (%)	Cases *n*=2,175 No. (%)	Pop. *n*=172,741 (%)	OR	95% CI	p
Physical							
Peptic ulcer	133 (19.6)	(3.4)	361 (16.6)	(3.0)	1.18	0.99-1.42	0.067
COPD	94 (13.9)	(4.3)	292 (13.4)	(4.5)	1.03	0.83-1.28	0.760
Diabetes	81 (12.0)	(3.4)	250 (11.5)	(3.3)	1.04	0.82-1.32	0.739
Any cancer	77 (11.4)	(6.4)	242 (11.1)	(6.7)	1.02	0.80-1.30	0.859
AMI	44 (6.5)	(3.7)	108 (5.0)	(3.0)	1.31	0.93-1.84	0.121
Oropharyngeal & laryngeal cancer	24 (3.5)	(0.5)	29 (1.3)	(0.4)	2.66	1.56-4.53	<0.001
Hepatitis C	15 (2.2)	(0.2)	103 (4.7)	(0.4)	0.47	0.27-0.80	0.004
Hepatitis B	13 (1.9)	(0.1)	35 (1.6)	(0.1)	1.19	0.64-2.24	0.583
Liver cancer	11 (1.6)	(0.1)	45 (2.1)	(0.1)	0.79	0.41-1.51	0.467
Lung cancer	7 (1.0)	(0.8)	35 (1.6)	(0.6)	0.64	0.29-1.44	0.278
Oesophageal cancer	4 (0.6)	(0.3)	10 (0.5)	(0.2)	1.29	0.40-4.08	0.670
Mental							
Any mental health disorder	125 (18.5)	(5.0)	400 (18.4)	(4.5)	1.00	0.84-1.20	0.966
Any mental health disorder less PTSD	91 (13.4)	(3.9)	342 (15.7)	(3.8)	0.85	0.69-1.06	0.148
Non-fatal self-harm	91 (13.5)	(2.9)	281 (13.1)	(2.5)	1.04	0.83-1.29	0.749
Mood disorder	75 (11.1)	(2.8)	277 (12.7)	(2.5)	0.87	0.68-1.11	0.252
Anxiety	64 (9.5)	(2.5)	166 (7.6)	(2.0)	1.24	0.94-1.63	0.129
Stress/PTSD	34 (5.0)	(1.1)	58 (2.7)	(0.7)	1.88	1.24-2.85	0.003
Anxiety less stress/PTSD	30 (4.7)	(1.4)	108 (5.1)	(1.3)	0.91	0.62-1.36	0.657
Psychosis	19 (2.8)	(1.0)	76 (3.5)	(1.1)	0.80	0.49-1.32	0.384
Suicide	5 (0.7)	(0.5)	22 (1.0)	(0.5)	0.73	0.28-1.92	0.522
Dementia	4 (0.6)	(0.1)	7 (0.3)	(0.1)	1.84	0.54-6.25	0.324

There was a complex pattern of co-morbidity with alcoholic liver disease. Among the physical disorders, peptic ulcer, COPD, diabetes and any cancer were strongly associated, in both veterans and non-veterans. There was also an increased risk of AMI, in both veterans and non-veterans although the increase was non-significantly higher in veterans. Hepatitis B, hepatitis C and liver cancer were all associated with alcoholic liver disease in both veterans and non-veterans, although veterans were at significantly lower risk of hepatitis C than non-veterans. Whilst oesophageal cancer was rare in both veterans and non-veterans with alcoholic liver disease, oropharyngeal and laryngeal cancer was not only increased in both groups but showed a much higher risk in veterans when compared with non-veterans, OR 2.66, 95% CI 1.56-4.53, p>0.001. There was a greatly increased risk of oropharyngeal and laryngeal cancer in veterans with alcoholic liver disease compared with all veterans, HR 6.96, 95% CI 4.58-10.57, p<0.001. The corresponding hazard ratio for non-veterans was 3.2, 95% CI 2.27-4.78, p<0.001. There was only one case of pancreatic cancer in a veteran with alcoholic liver disease, and 7 in non-veterans. Stomach cancer was also rare, with two cases in veterans and four in non-veterans.

Only 18.5% of veterans and a similar percentage of non-veterans with alcoholic liver disease had received in-patient or day-case care for any mental health disorder. This is perhaps lower than might be expected, as is the small number of suicides in this group. A diagnosis of stress or PTSD had been made in 5.0% of the veterans and 2.7% of the non-veterans, OR 1.88, 95% CI 1.24-2.85, p=0.003. There was no significant difference in risk of alcoholic liver disease between veterans and non-veterans for mood disorder, anxiety other than stress or PTSD, psychosis, suicide or non-fatal self-harm. A small number of cases of dementia was associated with alcoholic liver disease; the difference in risk between veterans and non-veterans was not statistically significant although the risk was higher in veterans.

6.7 Alcohol-Related Death

Alcohol-related death was determined in accordance with the Office for National Statistics definition (Office for National Statistics 2014). This definition includes only those deaths where alcohol is most likely to have had a direct causal relationship, and not those where alcohol is a known risk factor such as oropharyngeal or laryngeal cancer. It also excludes external causes of death where alcohol may have been a contributory factor, such as road traffic accidents. The ICD-10 codes for alcohol-related causes of death which are reported by ONS[155] are summarised at Table 6-3, together with the ICD-9 codes to which they have been mapped for the purposes of the Scottish Veterans Health Study.

[155] Office for National Statistics (2014) *Alcohol-related deaths in the United Kingdom, registered in 2012*, London: National Statistics. p.22.

Table 6-3 - National Statistics definition of alcohol-related death ICD-10 codes and definitions, mapped to ICD-9

ICD-10 Code	Diagnosis	Mapped to ICD-9 code
F10	Mental and behavioural disorders due to use of alcohol	303.0, 303.9, 305.0
G31.2	Degeneration of nervous system due to alcohol	357.5
G62.1	Alcoholic polyneuropathy	357.5
I42.6	Alcoholic cardiomyopathy	291.*
K29.2	Alcoholic gastritis	535.3
K70	Alcoholic liver disease	425.5
K73	Chronic hepatitis, not elsewhere classified	571.3
K74 less K74.3-K74.5	Fibrosis and cirrhosis of liver (excluding biliary cirrhosis)	571.* less 571.5, 571.6 and 571.8
K86.0	Alcohol-induced chronic pancreatitis	577.1
X45	Accidental poisoning by and exposure to alcohol	E860.0
X65	Intentional self-poisoning by and exposure to alcohol	E860.9
Y15	Poisoning by and exposure to alcohol, undetermined intent	E860.9

*= any digit

6.7.1 Incidence

6.7.1.1 Overall

Generally, the findings for alcohol-related death mirrored those for alcoholic liver disease. Death from alcohol-related causes was recorded in 356 (0.63%) veterans compared with 1,147 (0.66%) non-veterans (Bergman et al. 2015b). The difference was not statistically significant, unadjusted OR 0.96, 5% CI 0.88-1.06, p=0.435. The Cox proportional hazard ratio was 0.95, 95% CI 0.84-1.07, p=0.412 unadjusted (Figure 6-13); there was an overall reduction in risk in veterans which became statistically significant after adjusting for deprivation, HR 0.88, 95% CI 0.79-1.00, p=0.044. The mean age at alcohol-related death was 51.9 years for veterans and 50.4 years for non-veterans.

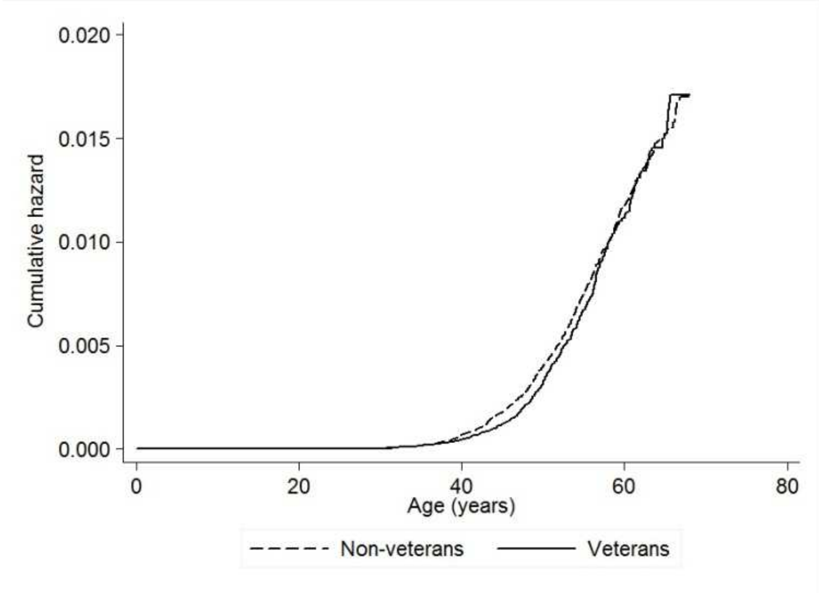

Figure 6-13 - Nelson-Aalen plot of alcohol-related death by veteran status

6.7.1.2 Sex

There were 340 alcohol-related deaths in male veterans, compared with 16 in female veterans. Male veterans were at non-significantly lower risk than male non-veterans, unadjusted HR 0.93, 95% CI 0.82-1.05, p=0.223, whereas there was a non-significant increase in risk in female veterans, unadjusted HR 1.23, 95% CI 0.70-2.16, p=0.463. After adjusting for deprivation, male veterans were at significantly lower risk of alcohol-related death than non-veterans, HR 0.86, 95% CI 0.76-0.97, p=0.016, whilst the increase for women was attenuated, HR 1.19, 95% CI0.68-2.08, p=0.544.

6.7.1.3 Birth Cohort

Subgroup analysis by birth cohort showed an increased risk only in the 1945-1949 cohort, unadjusted HR 1.28, 95% CI 1.03-1.58, p=0.026, but this became non-significant after adjusting for deprivation, HR 1.19, 95% CI 0.96-1.47, p=0.113. There was a steady decrease in risk in veterans compared with non-veterans with successive birth cohorts, with some flattening of the rate of decrease in the more recent birth cohorts (Figure 6-14). There was a significant reduction in risk when veterans born from 1960 onwards were examined together, unadjusted HR 0.67, 95% CI 0.46-0.90, p=0.009; the hazard ratio was similar after adjusting for deprivation.

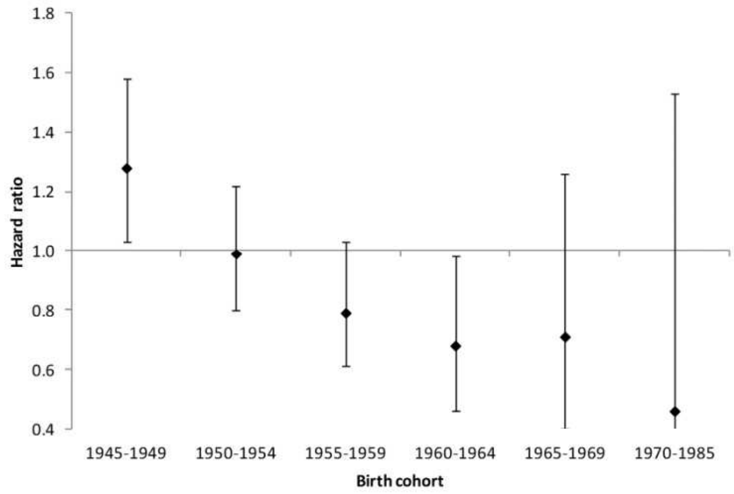

Figure 6-14 - Hazard ratios for alcohol-related death by birth cohort
Veterans referent to non-veterans

6.7.1.4 Length of Service

The only subgroup by length of service that showed an increased risk of alcohol-related death was the older Early Service Leavers (born prior to 1960) who had completed training; their unadjusted hazard ratio for alcohol-related death was 1.35, 95% CI 1.09-1.69, p=0.007 (Table 6-4 and Figure 6-15).

Table 6-4 - Cox proportional hazard model of the association between veteran status and alcohol-related death, overall and stratified by length of service and birth cohort

	Veteran cases	All Veterans *n*-56,205			Born 1945-1959 *n*=29,709			Born 1960-1985 *n*=26,496		
	n	HR	95% CI	p	HR	95% CI	p	HR	95% CI	p
Overall										
Univariate	356	0.95	0.84-1.07	0.412	1.03	0.90-1.17	0.709	0.67	0.49-0.90	0.009
Multi-variable	356	0.88	0.79-1.00	0.044	0.94	0.83-1.08	0.390	0.66	0.49-0.90	0.008
Length of service in 8 categories										
Basic training	41	0.97	0.71-1.32	0.844	1.00	0.71-1.41	0.984	0.87	0.41-1.85	0.724
ESL (0-3 years)	102	1.27	1.03-1.55	0.023	1.35	1.09-1.69	0.007	0.95	0.57-1.60	0.852
4-6 years	66	0.94	0.73-1.20	0.613	0.98	0.75-1.29	0.906	0.77	0.42-1.40	0.389
7-9 years	47	0.98	0.73-1.31	0.883	1.09	0.80-1.49	0.583	0.56	0.25-1.25	0.155
10-12 years	37	0.97	0.70-1.35	0.857	1.18	0.85-1.66	0.325	0.23	0.06-0.91	0.037
13-16 years	22	0.81	0.53-1.23	0.317	0.75	0.45-1.26	0.277	0.91	0.43-1.94	0.813
17-22 years	19	0.67	0.43-1.06	0.087	0.77	0.48-1.23	0.270	0.21	0.03-1.49	0.119
≥23 years	22	0.59	0.39-0.90	0.015	0.63	0.41-0.97	0.037	0.26	0.04-1.85	0.178

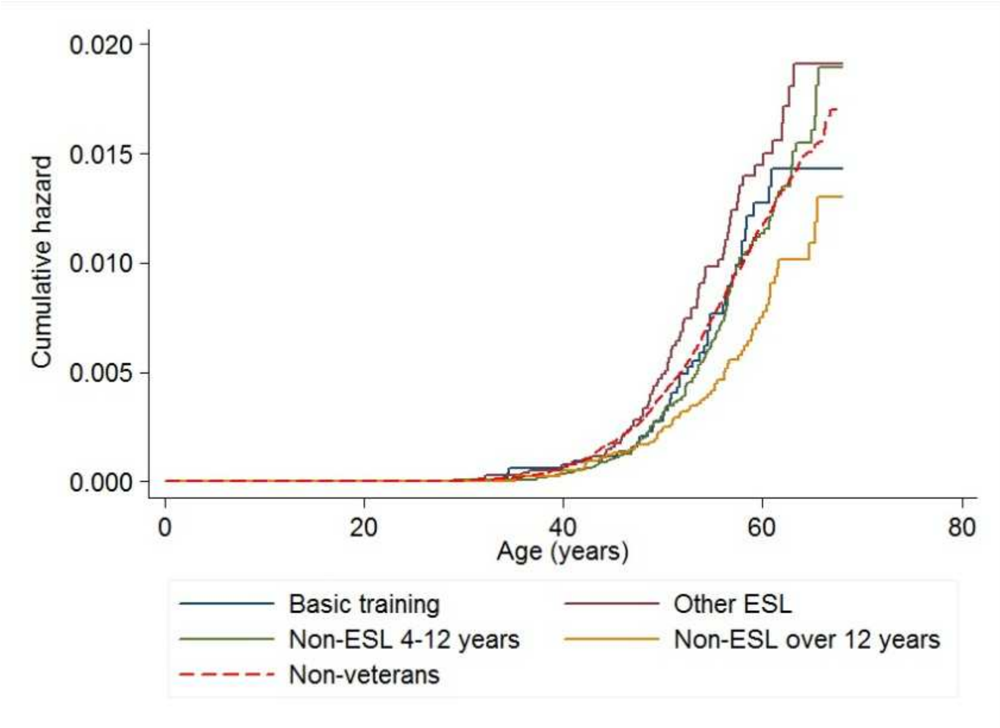

Figure 6-15 - Hazard ratios for alcohol-related death by length of service Non-veterans for comparison

6.7.2 Commentary

Data from the Scottish Veterans Health Study have demonstrated that overall, veterans were at no greater risk of alcoholic liver disease or alcohol-related death than the general population, and they were at slightly but significantly reduced risk after adjusting for deprivation (Bergman et al. 2015b). The overall rate of alcoholic liver disease, for both veterans and non-veterans, was similar to the 1.13% population prevalence reported in the Italian Dionysus Study, which also showed that only 5.5% of those drinking more than 30g alcohol per day had evidence of alcoholic liver damage (Bellentani et al. 1997). Subgroup analysis of the Scottish Veterans dataset showed a complex picture of changing risk over time. There was an increased risk of both alcoholic liver disease and alcohol-related death in the earliest birth cohort (born 1945-1949), although this lost statistical significance after adjusting for deprivation. The increase arose predominantly from people born 1946-1949 who joined the Services 1970-1971 and who were older than the majority of recruits at entry to service. Younger veterans were at lower risk than age-matched non-veterans. Fewer of the veterans with alcoholic liver disease had co-morbid hepatitis C, suggesting that drug misuse was less prevalent in veterans than non-veterans. The 2.8% prevalence of co-morbid hepatitis C was substantially lower than the prevalence of 18.4% reported in a study of US veterans with alcoholic liver disease (Mendenhall et al. 1993).

The finding of a single period of entry to service which was associated with especially high risk of developing alcoholic liver disease, centred around 1970-1971 and predominantly affecting those who were older at entry, was unexpected (Bergman et al. 2015b). The years 1970-1972 represented a period of intense operational activity in Northern Ireland (codenamed Operation BANNER), especially for the Army and Royal Marines, who made up the greater part of the Armed Forces. At the peak of the operation, around 28,000 soldiers were deployed in Northern Ireland. There were few who served during that period who were not deployed there; even those who were in a reduced medical category were permitted to deploy unless specifically precluded on medical advice. Many were new to service and lacked military experience; it was not unusual to deploy directly from recruit training, and repeated tours of duty within a short period of time were common. Those with longer service, who joined from the mid 1960s, may also have served in the Aden Emergency (December 1963 – November 1967) and are likely to have been in junior management roles (corporal rank) in the early years of Operation BANNER. The initial period of the campaign represented a novel operation[156] for the British Armed Forces for which they were unprepared, untrained and poorly equipped (Ministry of Defence 2006).

Older recruits constituted only 14-20% of each year's intake and they may have found it harder to bond socially with their younger fellow recruits. As more mature entrants, they may also have experienced increased pressure as a result of higher expectations of their ability (see Appendix 9). Thus, they may have felt relatively socially isolated, and may have been more likely to resort to alcohol. As a result of their social isolation, they may also have experienced a reduced level of peer support during service, lowering their resilience and increasing their vulnerability to deployment-related stress. Whilst there is no information on their pre-recruitment social history, personnel who joined the Army in their 20s, during the period of rising unemployment in the early 1970s (Denman and McDonald 1996), may be more likely to have experienced unemployment than those who joined as teenagers. A history of unemployment has previously been shown to be a risk

[156] Counter-insurgency operations within a UK urban environment

factor for alcohol misuse in young people (Dooley and Prause 1998). Risk aversion has also been shown in numerous studies to increase with age, although most studies have been based on financial risk rather than physical risk (Wang and Hanna 1998). In a perceptive paper, Steinberg examined risk-taking in adolescents and concluded that group behaviour was a strong motivator towards risk-taking, and that adolescents were less likely than adults to evaluate the potential costs or benefits before embarking on a risky activity. Self-regulatory competency matured slowly, probably into young adulthood (Steinberg 2004). It is plausible that the more mature recruit, poorly bonded with a peer-group of younger fellow recruits and facing a conflict situation in which he was better able to appreciate the possible dangers and adverse consequences than his peers, may have felt especially vulnerable and marginalised, and may have been more likely to ruminate and later to seek solace in alcohol.

Lynch examined alcohol-related deaths in serving Army personnel for the decade 1968-1977 and found an incidence of 12.36 per 100,000 personnel, for deaths occurring off-duty. The commonest cause of alcohol-related death was road traffic accidents, which accounted for 49% of the deaths, followed by acute alcohol poisoning (23%), suicide (9%), drowning (8%), falls from height (7%), burns (3%) and fights (1%). The mean age at death was 24 years. There was an increase in the number of deaths from acute alcohol poisoning in the latter half of the period (Lynch 1987). Further examination of Lynch's data showed a mean of 1.8 deaths per year from acute alcohol poisoning between 1968 and 1972 compared with a mean of 5.2 per year between 1973 and 1978, an increase of nearly 200% (Bergman et al. 2015b). With hindsight, it seems probable that deployment as a young soldier to Northern Ireland in the early years of Operation BANNER contributed to the increased toll of alcohol-related deaths.

Overall, the risks both of alcoholic liver disease and of alcohol-related death in former Armed Forces personnel have reduced over time. The current focus on alcohol misuse predominantly as a sequela of psychological trauma may be misleading in the context of veterans' health. For many soldiers who served during the period encompassed by the Scottish Veterans Health Study, heavy alcohol use was an accepted social activity, as described at Appendix 4, Section A4.2.2. A stoical attitude to adverse experiences generally prevailed. In a review of the first 2000 casualties (to 1977) to be entered onto the Hostile Action Casualty System[157] at the Military Wing, Musgrave Park Hospital, Belfast, Owen-Smith reported psychiatric sequelae in only 21 individuals (Owen-Smith 1981) although paradoxically the rate of medical discharge (invaliding) for psychiatric morbidity at that time was much higher than in later years (Bergman and Miller 2000).

Recent publications have focussed on alcohol misuse as a consequence of the mental health impacts of combat exposure and have largely overlooked the social role of alcohol (Jones and Fear 2011). Evidence from the Scottish Veterans Health Study and a re-evaluation of Lynch's paper (Lynch 1987) now suggest that there is a complex relationship. Extreme operational exposure in the early 1970s does appear to have been associated with a lasting increase in the level of alcohol use following departure from the operational situation. Underpinning factors may have included an intense social response to the removal of restrictions imposed during deployment and the general increase in risk-taking behaviour following combat exposure which has been described elsewhere (Fear et al. 2008, Killgore et al. 2008), in addition to the role played by the as-then largely unrecognised psychological effects of operational deployment. The Scottish Veterans Heath Study has demonstrated that a small subgroup of older veterans were at increased risk of alcoholic liver disease, both compared with non-veterans and with later generations of Service personnel (Bergman et al. 2015b). In particular, veterans who entered service in 1970 and 1971, and who therefore served in Northern Ireland in the earliest days of Operation BANNER, were at higher risk than veterans who entered service in all other years, irrespective of their length of service. From late 1972 onwards, the operation moved into a more mature phase, and personnel were only deployed after undergoing intensive training and preparation for their role. Although Operation BANNER continued to 2007, the data provide no evidence that later deployment carried the same risk of alcoholic liver disease.

Changes in the military drinking culture in the late 20th century are explored at Appendix 4, Section A4.2.2. Personnel born after 1960 joined the Armed Forces in the late 1970s; their overall reduction in risk has been demonstrated. More recent generations of Service personnel show a decreasing risk of alcoholic liver disease and alcohol-related death, and a lower risk than in non-veterans, suggesting that in-service health promotion

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[157] An early IT-based record system, developed specifically for military hospital use in Northern Ireland

has been effective although isolated extreme episodes of alcohol misuse still occur[158]. The Scottish Veterans Study has highlighted that exposure of inadequately prepared junior military personnel to a novel military situation may be a hitherto unrecognised risk factor for the later development of alcoholic liver disease, but that the risk may attenuate rapidly with appropriate preparation and training for deployment on a mature operation. Because of the long lead time for alcoholic liver disease, it is impossible to predict the impact of current operations, and those who deployed to the then unfamiliar military scenarios of the 1991 Gulf conflict, the first Afghanistan deployment in 2001 and the first Operation TELIC (Iraq 2003) roulement[159] should be followed up carefully in this respect, especially if they were in the early years of their service at the time of deployment. Follow-up will be facilitated by the existence of the major longitudinal cohorts which have been set up and are being monitored by the King's Centre for Military Health Research. If the model proposed for Operation BANNER (Northern Ireland) holds good, it may be anticipated that any adverse effect of deployment resulting from the early part of the campaigns will have been rapidly mitigated as training and preparation for those theatres were quickly developed and refined.

6.8 Hepatitis B

6.8.1 Introduction

Hepatitis B is a blood-borne virus infection which is contracted through contact with blood or body fluids of an infected person. Healthcare providers (including first aiders) are at risk, as are those who receive healthcare in locations with sub-optimal standards of infection control. Injecting drug users are at particular risk, especially if sharing injecting equipment. Hepatitis B may be transmitted sexually, and transplacental transmission from mother to fetus occurs[160]. Chronic hepatitis, which may lead to cirrhosis, develops in 5-10% of those infected, and may progress to hepatocellular carcinoma (Thomas et al. 1993). Despite the theoretical risks faced by military personnel (foreign travel (Keystone 2005), tattooing (Armstrong 2000), wounding on the battlefield and administration of

[158] Evans SJ. Soldier died after downing 16 shots of "Top Shelf" alcohol. *Daily Mail* 3 Dec 2013. http://www.dailymail.co.uk/news/article-2517718/Buckley-Barracks-soldier-Andrew-Murgatroyd-died-downing-16-shots.html accessed 13 March 2014

[159] Deployment of successive groups of military personnel on a continuing operation

[160] http://www.nhs.uk/Conditions/Hepatitis-B/Pages/Causes.aspx accessed 14 November 2014

first aid in high-risk settings (Siegel-Itzkovich 2001)), the prevalence of hepatitis B seropositivity in military personnel has generally been low. A US military survey in 1991 showed anti-HBc seropositivity of 3.7%, with the highest rates in those of Black or Filipino race, foreign birth, and in those with a history of sexually transmitted infection. There was also an association with overseas deployment (Hawkins et al. 1992). An anonymous unlinked survey of UK recruits was conducted in order to establish baseline seroprevalence levels and found similar results; 3.63% of recruits had evidence of past cleared infection and 0.37% of recruits showed serological evidence of active infection. Rates were higher in recruits of African origin than in UK-born personnel (Brown et al. 2011).

A vaccine against hepatitis B has been available since 1981. The first vaccine was derived from the blood of high-risk people and concerns (later shown to be ill-founded) were expressed about its safety; it was replaced by a yeast-derived recombinant vaccine in 1986[161]. In August 1993, the UK Government Health Departments jointly published guidance on protecting healthcare workers and patients from hepatitis B, including policy on immunisation[162]; the Armed Forces followed this guidance[163,164]. The definition of 'healthcare worker' was interpreted to include anyone whose duties might be expected to include significant handling of casualties, but not those who might incidentally administer first aid, for whom post-exposure prophylaxis was available. As military operations in the Gulf and Afghanistan evolved, so it became more difficult to anticipate risk of accidental exposure, and hepatitis B immunisation was extended to all military personnel in 2008[165], although there was no requirement for tests of seroconversion other than for healthcare workers.

[161] http://en.wikipedia.org/wiki/Hepatitis_B_vaccine accessed 14 November 2014

[162] Protecting Health Care Workers and Patients from Hepatitis B: Recommendations of the Advisory Group on Hepatitis. UK Health Departments. August 1993.

[163] The UK Armed Forces policy on immunisation generally follows the recommendations of the Joint Committee on Vaccination and Immunisation (JCVI), unless otherwise dictated following Service-specific risk assessment.

[164] Surgeon General's Policy Letter 3/98 (AD Med Pol(H&R) 10/2 dated 12 Feb 98).

[165] Surgeon General's Policy Letter 03/08 (DMSD/13/8 dated 12 Feb 08).

6.8.2 Incidence

Hepatitis B was defined as ICD-9 code 070.2-070.3 or ICD-10 code B16 or B18.0-B18.1, at any position in the record. The data do not represent overall prevalence of hepatitis B infection or seropositivity in the community as only active cases experiencing complications or requiring treatment will have been admitted to hospital. It has been assumed that there are no systematic differences in completeness of ascertainment of hepatitis B between veterans and non-veterans, and that any differences reflect real differences in incidence or severity.

6.8.2.1 Overall

Over the period of follow-up, there were 46 (0.08%) cases of hepatitis B in veterans, compared with 245 (0.14%) in non-veterans. Only one case in a non-veteran was in a child under the age of 15 years; as this would not have precluded military service, it was not excluded from the analysis. Although the crude odds ratio indicated a protective effect of military service, OR 0.60, 95% CI 0.44-0.83, p=0.001, the Cox proportional hazard ratio did not achieve statistical significance in either the univariate model or after adjusting for deprivation owing to the small number of veteran cases, HR 0.83, 95% CI 0.60-1.14, p=0.240 and HR 0.76, 95% CI 0.55-1.06, p=0.102 respectively. The reduction in risk in veterans is demonstrated in Figure 6-16. However, testing for non-proportionality of the hazards was significant, p=0.028; visual inspection of Figure 6-16 showed that the pattern of risk differed substantially between veterans and non-veterans, with an approximately linear increase with age in the veterans but a much steeper increase in young adults in the non-veterans.

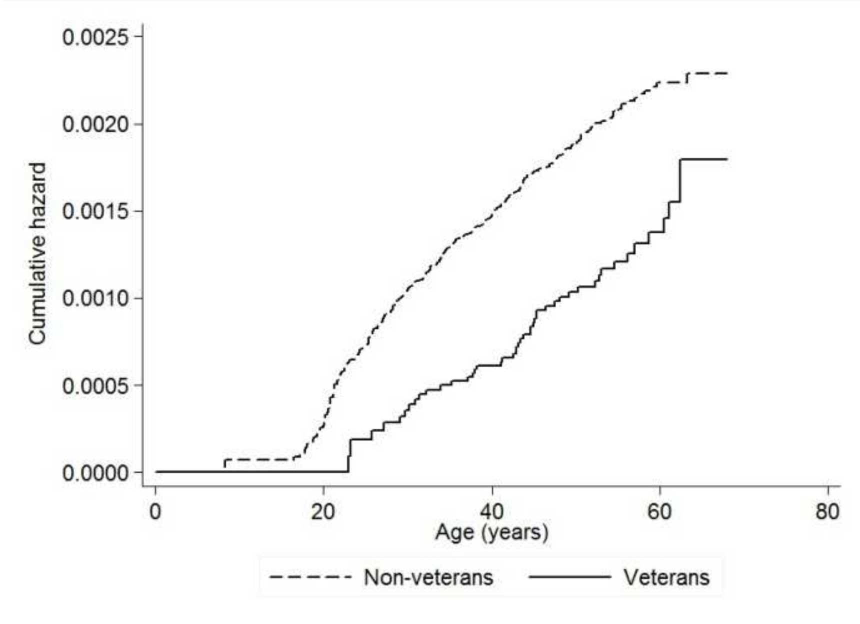

Figure 6-16 - Nelson-Aalen plot of hepatitis B by veteran status

6.8.2.2 Sex

Only one case of hepatitis B was recorded in a veteran woman, compared with 14 cases in non-veteran women, equating to 2.2% of cases in veterans and 5.7% of cases in non-veterans. There were 45 cases in veteran men and 231 cases in non-veteran men. Although veteran women were at much lower risk than veteran men, the difference did not reach statistical significance in either men or women, unadjusted HR 0.42, 95% CI 0.05-3.22, p=0.402 and HR 0.83, 95% CI 0.60-1.15, p=0.267 respectively.

6.8.2.3 Age

With a mean age of 43.2 years (SD 10.7) at first record of hepatitis B, veteran cases were considerably older than non-veterans, whose mean age was 34.6 years (SD 11.0).

6.8.2.4 Birth Cohort

Analysis of risk by birth cohort showed the highest risk to be in the earliest birth cohort (1945-1949). The risk reduced steadily through to the 1960-1964 birth cohort, but remained lower than the risk in non-veterans for all birth cohorts from 1955 onwards. However, the differences were non-significant for all except the 1945-1949 and 1960-1964 birth cohorts (Figure 6-17).

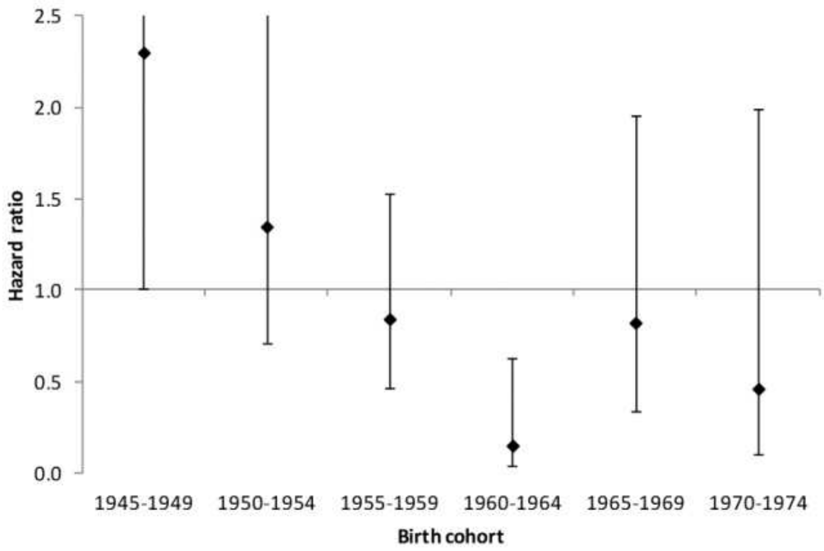

Figure 6-17 – Hazard ratios for hepatitis B by birth cohort
Veterans referent to non-veterans

The kernel density plot showing year of birth revealed a marked difference between veterans and non-veterans Figure 6-18.

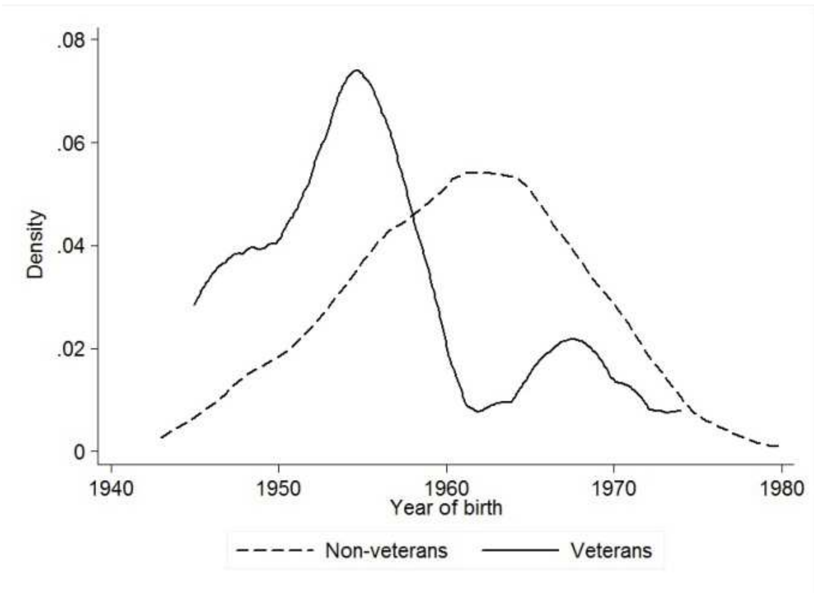

Figure 6-18 – Kernel density plot of hepatitis B by year of birth
Veterans and non-veterans

6.8.2.5 Length of Service

Analysis of incidence by length of service was hampered by the small number of cases in veterans, but generally showed that there was no association with longer service. The risk was similar to the non-veterans for ESL who had completed training, but was reduced compared with non-veterans for all other length of service subgroups (Figure 6-19). The kernel density plot confirmed clustering towards the lower end of the spectrum of length of service (Figure 6-20); only 2 (4.3%) of the veteran cases had served for more than 12 years.

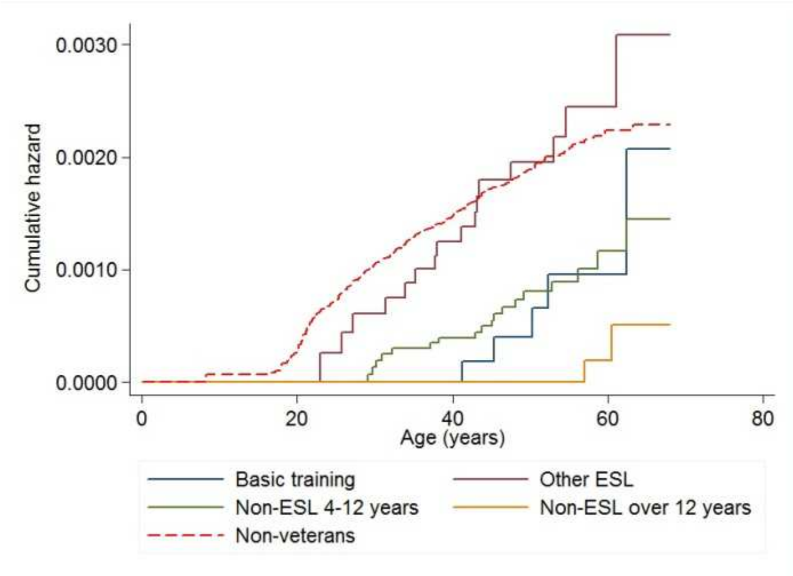

Figure 6-19 – Nelson-Aalen plot of hepatitis B stratified by length of service
All non-veterans for comparison

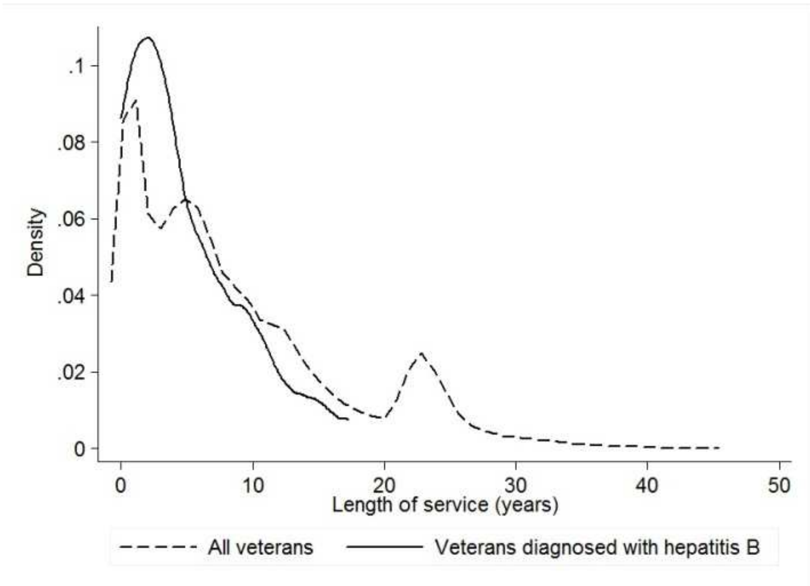

Figure 6-20 - Kernel density plot of hepatitis B by length of service
All veterans for comparison

6.8.3 Co-Morbidity

The commonest co-morbidity with hepatitis B was hepatitis C, affecting around 35% of both veterans and non-veterans and suggesting that an important cause of hepatitis B is injecting drug abuse in both groups; 62.5% of veterans with co-morbid hepatitis B and C were ESL. Hepatitis B was also strongly associated with alcoholic liver disease, and was statistically significantly more likely to be associated in veterans. The risk of smoking-related disease and mental health disorder was also increased in both veterans and non-veterans with hepatitis B, although less so in veterans. A diagnosis of liver cancer was recorded in 6.5% of veterans and 5.3% of non-veterans with hepatitis B (Table 6-5).

Table 6-5 - Selected co-morbidities with hepatitis B in veterans and non-veterans Crude overall cumulative incidence for comparison

	Veterans		Non-veterans		Veterans referent to non-veterans		
	Cases *n*=46 No. (%)	Pop. *n*=56,205 (%)	Cases *n*=245 No. (%)	Pop. *n*=172,741 (%)	OR	95% CI	p
Physical							
Hepatitis C	16 (34.7)	(0.2)	86 (35.1)	(0.3)	0.99	0.64-1.52	0.967
Alcoholic liver disease	13 (28.3)	(1.2)	35 (14.2)	(1.3)	1.97	1.14-3.44	0.019
Peptic ulcer	9 (19.6)	(3.4)	27 (11.0)	(3.0)	1.78	0.89-3.52	0.106
COPD	4 (8.7)	(4.3)	31 (12.7)	(4.5)	0.69	0.25-1.85	0.449
Diabetes	4 (8.7)	(3.4)	17 (6.9)	(3.3)	1.25	0.44-3.55	0.627
Liver cancer	3 (6.5)	(0.1)	13 (5.3)	(0.1)	1.23	0.36-4.14	0.740
Lung cancer	1 (2.2)	(0.8)	6 (2.4)	(0.6)	0.89	0.11-7.20	0.911
Mental							
Mood disorder	5 (10.9)	(2.8)	32 (13.1)	(2.5)	0.83	0.34-2.02	0.682
Anxiety	2 (4.3)	(2.5)	24 (9.8)	(2.0)	0.44	0.11-1.81	0.235

6.8.4 Case-Fatality

The mean follow-up from date of first record of hepatitis B to the date of death or the end of the study was 10.48 years (range 0-31.79 years) for veterans and 14.30 years (range 0-31.82 years) for non-veterans, representing 482 person-years of follow-up in the veterans and 3,504 person-years in the non-veterans. There were 15 (32.6%) deaths in veterans with hepatitis B, equating to 31.1 per 1,000 person-years, and 83 (33.9%) deaths in non-veterans (23.7 per 1,000 person-years).

6.8.5 Commentary

Hepatitis B recorded through admission or death was rare in veterans; numbers were comparable with the number of cases of motor neuron disease (45 cases of hepatitis B compared with 38 cases of MND). Although military service theoretically exposes personnel to occupational risk of infection with hepatitis B, analysis of the data suggests that injecting drug abuse was the biggest risk factor, in both veterans and non-veterans; the Armed Forces’ zero tolerance policy towards drug abuse is likely to have resulted in a reduced likelihood of veterans misusing drugs. There was also evidence of an association with alcohol, and with heavy smoking. There was an association with both mood disorder and anxiety although the latter was only weakly associated in veterans. None of the co-morbidities reached statistical significance apart from alcoholic liver disease.

The pattern of year of birth of people with hepatitis B differed markedly between veterans and non-veterans. The veterans were predominantly clustered around the early 1950s, whilst the non-veterans showed a peak density for birth in the early 1960s. A similar, although less marked, divergence of peak densities for year of birth has already been highlighted in respect of stress and PTSD (Figure 7-17 and Section 7.9.1.4). The data for hepatitis B provide further evidence of poorer health outcomes in a small number of veterans who were born in the early 1950s and who are likely to have served in Northern Ireland in the early part of the Op BANNER campaign (1969-2007) (see Section 6.7.2), and in non-veterans who were born in the early 1960s, who may have experienced family breakdown as children, followed by rising youth unemployment as they reached working age as discussed at Section 7.9.4.4.

6.9 Hepatitis C

6.9.1 Introduction

One of the group of infections formerly classified as 'non-A, non-B hepatitis' and initially recognised in association with blood transfusion, hepatitis C was formally identified in 1989 (Alter et al. 1989). It is estimated that some 170 million people are chronically infected, with 3-4 million new cases occurring each year. The prevalence is highest in the Middle East, North Africa and parts of Asia at over 3.5%, whilst it is around 2.4% (95% CI 2.2-2.7%) in Western Europe (Mohd Hanafiah et al. 2013). Transmission is predominantly through injecting drug abuse (Kaldor et al. 1992), although in the developing world, unsafe blood transfusion and medical procedures are a common source of infection (Prati 2006). Traumatic sexual intercourse (Tohme and Holmberg 2010), unsafe tattooing (Ko et al. 1992), shared personal items and vertical transmission from mother to child are also risk factors (Conte et al. 2000). Around 15-20% of people who are infected with hepatitis C clear the virus within 6 months of infection; the remainder go on to become chronic carriers. It is estimated that around 0.4% of people in the UK have chronic hepatitis C infection, many remaining asymptomatic[166]. In the anonymous unlinked survey (Section 6.8.1), serological evidence of hepatitis C infection in UK military recruits was rare, occurring in 0.03% (95% CI 0.01-0.11%) of UK recruits and 0.31% (95% CI 0,.05-1.73%) of people recruited from sub-Saharan Africa (Brown et al. 2011).

6.9.2 Incidence

Hepatitis C was defined as ICD-9 code 070.4, 070.7 or 070.5 or ICD-10 code B17.1 or B18.02, at any position in the record. As with hepatitis B, the data do not represent overall prevalence of hepatitis C in the community as only active cases experiencing complications or requiring treatment would have been admitted to hospital; furthermore, many cases are asymptomatic and are only discovered on screening of high-risk groups. It has been assumed that there are no systematic differences in completeness of ascertainment of hepatitis C between veterans and non-veterans, and that any differences found reflect real differences in incidence or severity.

6.9.2.1 Overall

Over the period of follow-up, 106 (0.19%) veterans were recorded with a diagnosis of hepatitis C, compared with 622 (0.36%) non-veterans. The reduced risk in the veterans compared with the non-veterans was highly statistically significant, Cox proportional hazard ratio 0.58, 95% CI 0.48-0.72, p<0.001 in the unadjusted model, and remained so after adjusting for deprivation, HR 0.54, 95% CI 0.43-0.66, p<0.001. Figure 6-21 confirms the much lower risk of hepatitis C in veterans. Testing for non-proportionality of the hazards was non-significant, p=0.215.

[166] http://www.hpa.org.uk/Topics/InfectiousDiseases/InfectionsAZ/HepatitisC/GeneralInformation/ accessed 18 November 2014

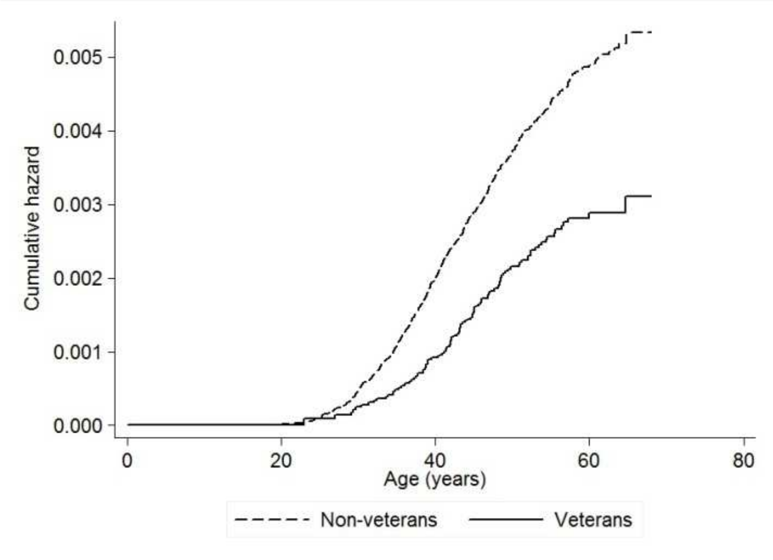

Figure 6-21 - Nelson-Aalen plot of hepatitis C by veteran status

6.9.2.2 Sex

Only 4 (3.77%) of the cases of hepatitis C in veterans occurred in women, compared with 25 (4.02%) in non-veterans. The reduction in risk in veteran women compared with non-veteran women did not reach statistical significance, unadjusted HR 0.71, 95% CI 0.25-2.04, p=0.522.

6.9.2.3 Age

The mean age at first record of hepatitis C in veterans was 43.1 years (SD 8.0). Non-veterans were slightly younger, mean age 41.0 years (SD 8.4).

6.9.2.4 Birth Cohort

The reduction in risk of hepatitis C in veterans was seen across all birth cohorts, and was especially marked in the 1960-1974 birth cohorts (Figure 6-22).

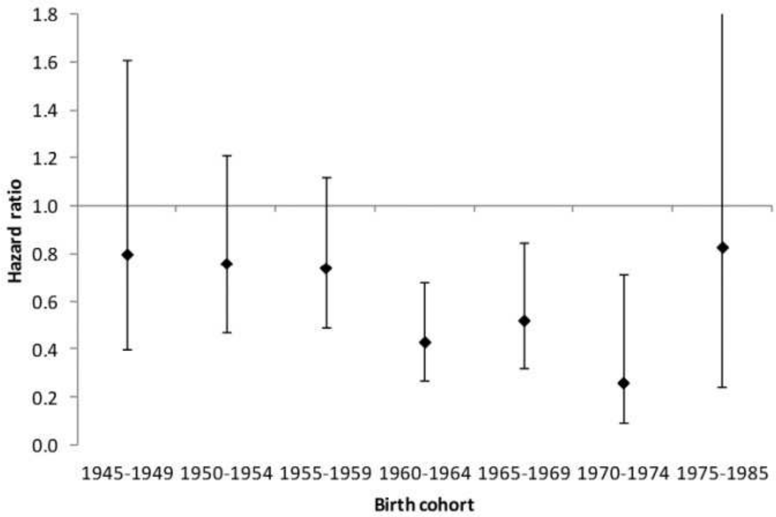

Figure 6-22 - Hazard ratios for hepatitis C by birth cohort
Veterans referent to non-veterans

6.9.2.5 Length of Service

No subgroup of veterans, by length of service, had a higher risk of hepatitis C than non-veterans. Early Service Leavers had a similar risk to non-veterans, and the risk decreased with longer service (Figure 6-23).

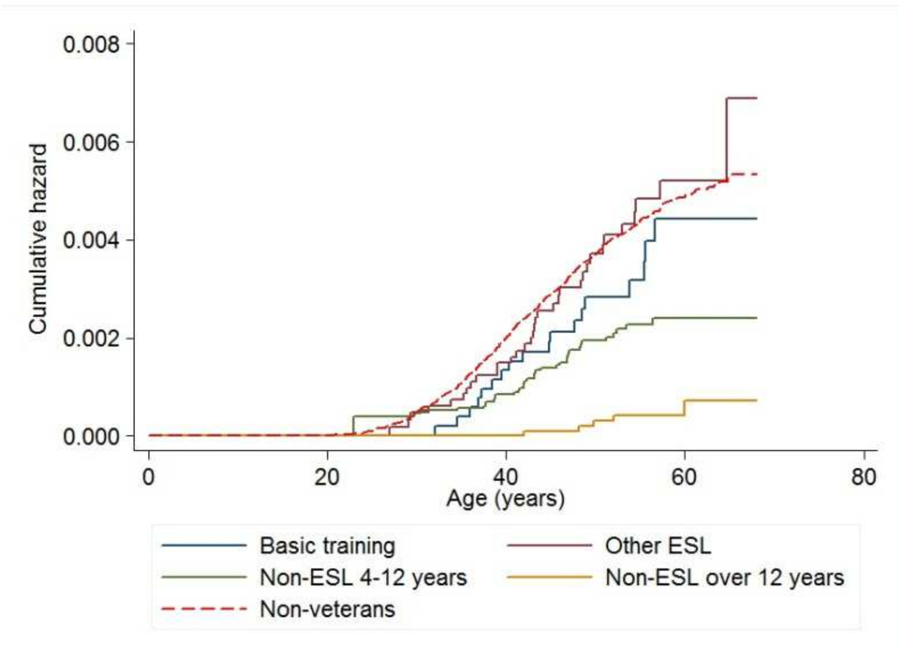

Figure 6-23 – Nelson-Aalen plot of hepatitis C stratified by length of service
All non-veterans for comparison

6.9.3 Co-Morbidity

Co-morbidities with hepatitis C were similar to those for hepatitis B, in both veterans and non-veterans, although the associations with hepatitis B and with alcoholic liver disease were weaker (Table 6-6).

Table 6-6 - Selected co-morbidities with hepatitis C in veterans and non-veterans
Crude overall cumulative incidence for comparison

	Veterans		Non-veterans		Veterans referent to non-veterans		
	Cases *n*=106 No. (%)	Pop. *n*=56,205 (%)	Cases *n*=622 No. (%)	Pop. *n*=172,741 (%)	OR	95% CI	p
Physical							
Hepatitis B	16 (15.1)	(0.2)	86 (13.8)	(0.3)	1.09	0.67-1.79	0.782
Alcoholic liver disease	15 (14.2)	(1.2)	103 (16.5)	(1.3)	0.85	0.52-1.41	0.534
Peptic ulcer	14 (13.2)	(3.4)	51 (8.2)	(3.0)	1.61	0.92-2.80	0.946
COPD	12 (11.3)	(4.3)	97 (15.6)	(4.5)	0.73	0.41-1.28	0.254
Diabetes	10 (9.4)	(3.4)	41 (6.6)	(3.3)	1.43	0.74-2.77	0.289
Liver cancer	8 (7.5)	(0.1)	34 (5.5)	(0.1)	1.38	0.66-2.90	0.396
Lung cancer	3 (2.8)	(0.8)	11 (1.8)	(0.6)	1.60	0.45-5.64	0.462
Mental							
Mood disorder	13 (12.2)	(2.8)	88 (14.1)	(2.5)	0.87	0.50-1.49	0.604
Anxiety	10 (9.4)	(2.5)	53 (8.5)	(2.0)	1.11	0.58-2.11	0.757

The year of birth of veterans with hepatitis C peaked in the early 1950s, unlike non-veterans where it was a decade later, as shown in the kernel density plot (Figure 6-24). The difference echoed the patterns seen for hepatitis B and also for stress and PTSD (Figure 6-18 and Figure 7-17).

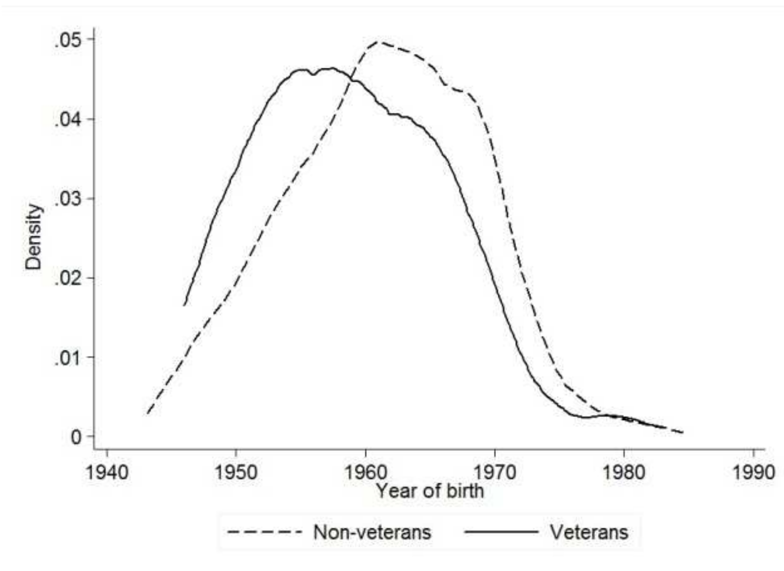

Figure 6-24 – Kernel density plot of hepatitis C by year of birth
Veterans and non-veterans

This pattern was also reflected in the data for comorbid hepatitis B and hepatitis C. Veterans with both hepatitis B and hepatitis C were born between 1950 and 1969, with a clustering towards the early 1950s. By contrast, for non-veterans, there was a peak for birth years in the early 1960s, as illustrated at Figure 6-25.

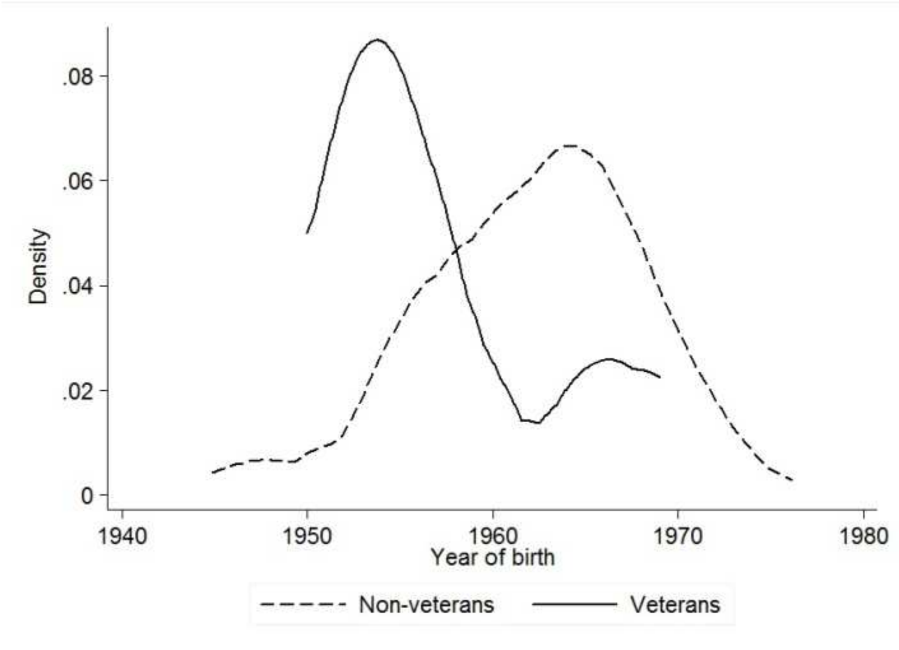

Figure 6-25 - Kernel density plot of year of birth for co-morbid hepatitis B & hepatitis C Veterans and non-veterans

6.9.4 Case-Fatality

The mean follow-up from date of first record of hepatitis C to the date of death or the end of the study was 8.30 years (range 0-27.10 years) for veterans and 7.62 years (range 0-31.60 years) for non-veterans, representing 880 person-years of follow-up in the veterans and 4,740 person-years in the non-veterans. There were 34 (32.1%) deaths in veterans with hepatitis C, equating to 38.7 per 1,000 person-years, and 214 (34.4%) deaths in non-veterans (45.2 per 1,000 person-years).

6.9.5 Commentary

A record of hepatitis C was more common than a record of hepatitis B, for both veterans and non-veterans. However, it is problematic to make assumptions about absolute incidence or prevalence from these data as people with hepatitis C may have been more likely to be admitted to hospital, for example for initiation of interferon therapy. Nonetheless, the data provide information on the risk of hepatitis C in veterans compared with non-veterans. Overall, veterans were at much lower risk of hepatitis C than non-veterans, providing further evidence to support a lower risk of injecting drug abuse. Even among ESL, the risk was no higher than in the non-veterans, and the risk was lower in veterans with the longest service. Taking the data for hepatitis B and C together, it is therefore possible to conclude that veterans are unlikely to be at increased risk of injecting drug abuse, and that even for ESL, the risk is no higher than in their matched non-veteran peers.

The results also suggest poorer health in the non-veteran community among people born in the 1960s. Figure 6-22 shows a reduced risk of hepatitis C among veterans born during this period *vis à vis* non-veterans. There is no plausible reason why this subgroup of veterans should have experienced an absolute reduction in incidence of hepatitis C compared with those born before or after, and it is more likely that this represents an increase in risk among the non-veterans, some of whom were exposed to unemployment and economic hardship on leaving school. Evidence for poorer health among members of the non-veteran cohort who were born in the 1960s will be further explored at Section 7.9.4.4.

An important difference between the data for hepatitis B and for hepatitis C is the risk in the 1945-1954 birth cohorts (Figure 6-17 and Figure 6-22). There is an increased risk among veterans in these cohorts for hepatitis B but it is less marked for hepatitis C. Drug misuse as an explanation for the increased risk of hepatitis B would be inconsistent with the pattern of risk for hepatitis C. Possible explanations include occupational (healthcare or first aid) or sexual exposure, or tattooing (which carries a higher risk of transmission of hepatitis B then hepatitis C (Ko et al. 1992)), although it is unclear why the risk reduced from the 1955-1959 birth cohort onwards, these individuals having joined the Armed Forces well before the implementation of the first military hepatitis B vaccination programme[167] in the 1990s.

[167] Restricted to healthcare workers; see footnote 164

6.10 Tuberculosis

6.10.1 Introduction

In 1891, tuberculosis accounted for around 17% of medical discharges from the Army (3 per 1,000 strength per year), and was the commonest disease-related cause of discharge. Although the rate fell to around 1.5 per 1,000 during the early 20th century with improvements in public health, it did not decrease further until the 1950s (Bergman and Miller 2000). The Second World War years saw a heavy burden of tuberculosis and between September 1939 and September 1951, 60,645 individuals had been discharged from the Armed Forces and awarded a pension for tuberculosis which was considered to have been either caused by or aggravated by war service (Stevens 1957). With the introduction of effective treatment and a control programme for tuberculosis in the Armed Forces, the rate of medical discharge fell throughout the late 1950s and 1960s, and the last discharge of a soldier from the Army for tuberculosis took place in 1990 (Bergman and Miller 2000). The Scottish Veterans Health Study enabled the impact of tuberculosis to be examined in more recent generations of military veterans, and an assessment to be made of the effectiveness of control measures.

6.10.2 Incidence

6.10.2.1 Overall

During the period of follow-up, 69 (0.12%) veterans were hospitalised with, or died from, tuberculosis, compared with 267 (0.15%) non-veterans. The reduction in risk among veterans did not achieve statistical significance, unadjusted HR 0.90, 95%CI 0.69-1.19, p=0.463. After adjusting for deprivation, the risk among veterans was lower but remained non-significant, HR0.85, 95% CI 0.65-1.12, p=0.247. The lower risk among veterans is demonstrated at Figure 6-26. Testing for non-proportionality of the hazards was non-significant, p=0.106.

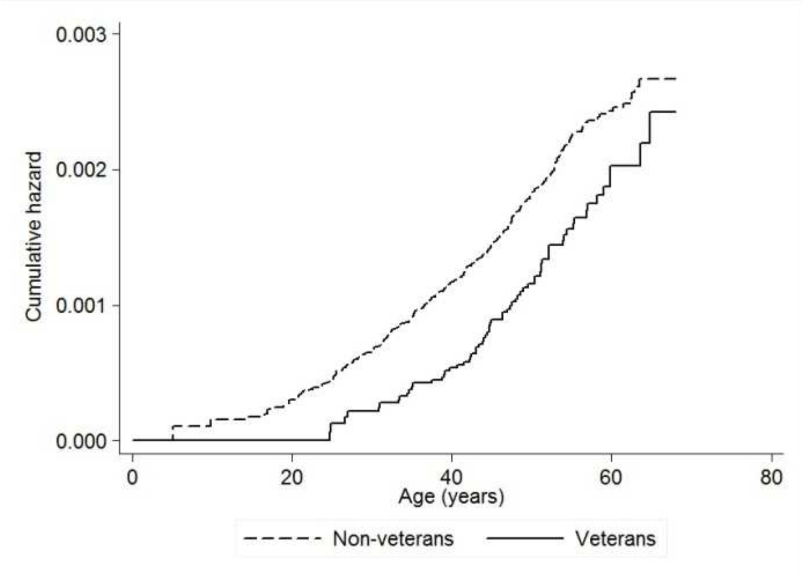

Figure 6-26 - Nelson-Aalen plot of tuberculosis by veteran status

It is evident from Figure 6-26 that there was a contribution from childhood TB (which is likely to have precluded military service) affecting the non-veterans; the analysis was therefore repeated using a landmark age of 20 years, and the reduced risk in veterans remained evident (Figure 6-27). The hazard ratios remained unchanged.

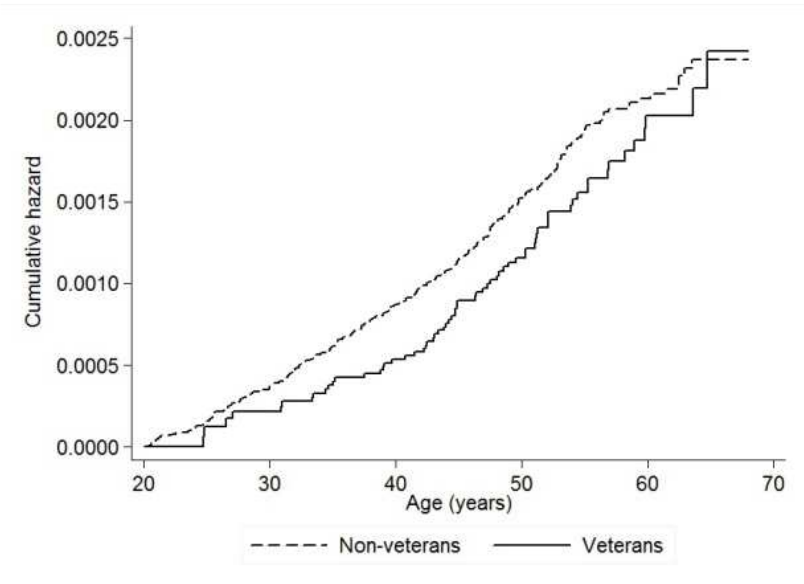

Figure 6-27 - Nelson-Aalen plot of tuberculosis by veteran status, landmark age 20 years

6.10.2.2 Sex

Only two female veterans had incident TB recorded, compared with 19 female non-veterans, equating to 2.9% of veteran cases and 7.1% of non-veteran cases. The reduction in risk did not achieve statistical significance as the small numbers precluded adequate statistical power, unadjusted HR 0.25, 95% CI 0.03-1.82, p=0.168.

6.10.2.3 Age

Veterans were older on average at diagnosis of tuberculosis; mean 43.9 years (SD 11.0) compared with 39.8 years (SD 11.1) for non-veterans. If childhood and adolescent cases (occurring under age 20 years) were excluded, the mean age in non-veterans rose to 40.8 years (SD 10.1) but remained below the revised mean age in veterans of 44.9 years (SD 9.7).

6.10.2.4 Birth Cohort

Only the 1945-1949 birth cohort showed an increase in risk compared with non-veterans, although this was not statistically significant. For all other birth cohorts, the risk was either lower than or, for the most recent cohort, comparable with, non-veterans (Figure 6-28).

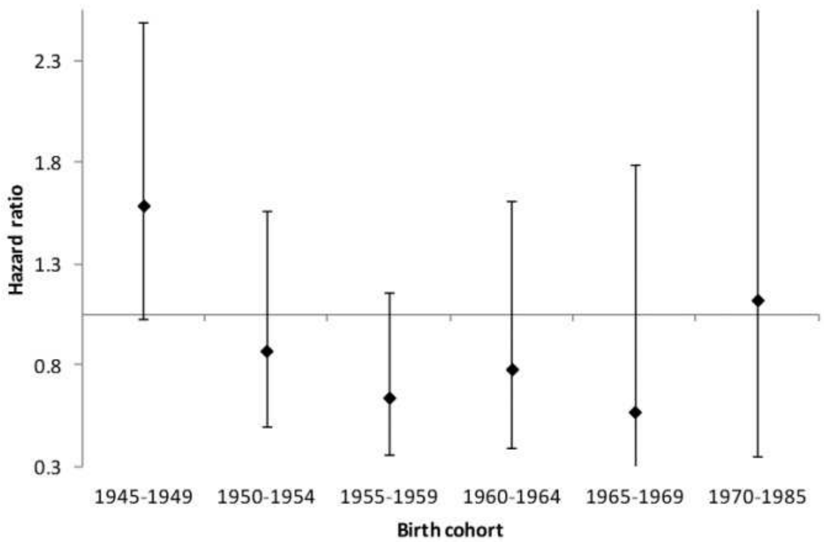

Figure 6-28 - Hazard ratios for tuberculosis by birth cohort
Veterans referent to non-veterans

6.10.2.5 Year of Birth

For the veterans, cases of tuberculosis were clustered around a birth year of 1950. For the non-veterans, there was a much broader spread from the late 1940s to around 1960, before starting to reduce (Figure 6-29). There were only 15 cases in veterans born after 1960, compared with 78 in non-veterans.

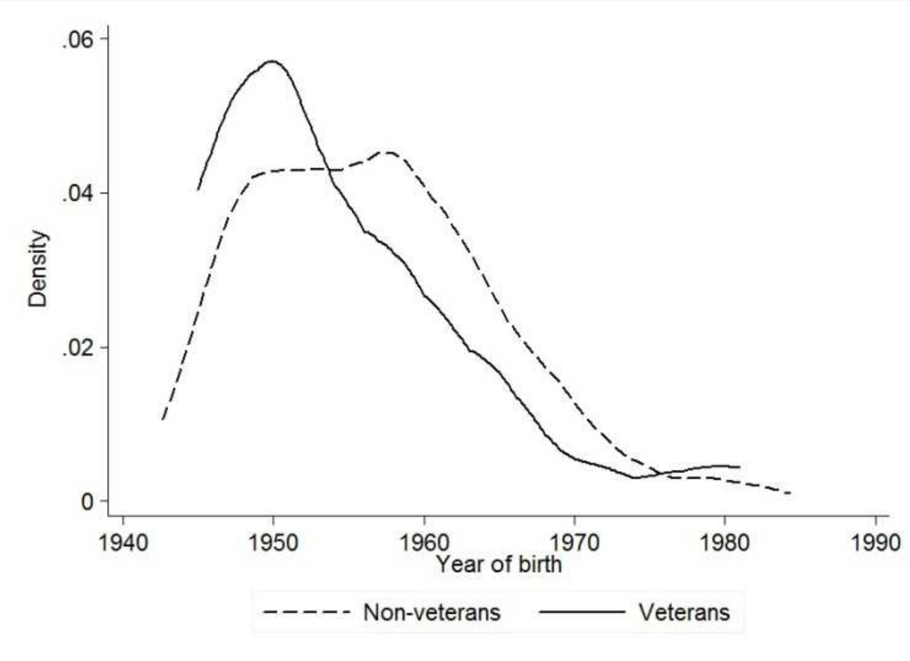

Figure 6-29 - Kernel density plot of tuberculosis by year of birth
Veterans and non-veterans

6.10.2.6 Length of Service

Notwithstanding the small numbers in each category, analysis by length of service provided no evidence that military service is associated with increased risk of tuberculosis. The only two cases aged over 60 years at presentation were both ESL, and are therefore disproportionately prominent on the graph.

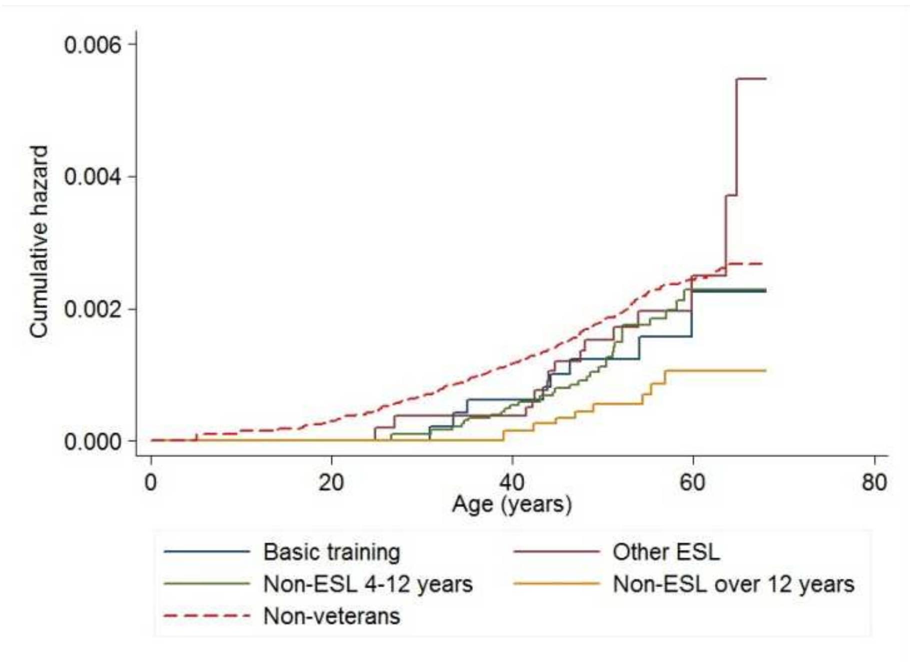

Figure 6-30 – Nelson-Aalen plot of tuberculosis by length of service
All non-veterans for comparison

6.10.2.7 Date of Presentation

For both veterans and non-veterans, there was a biphasic pattern with a peak in diagnoses in the mid-1980s and a further peak around the year 2000.

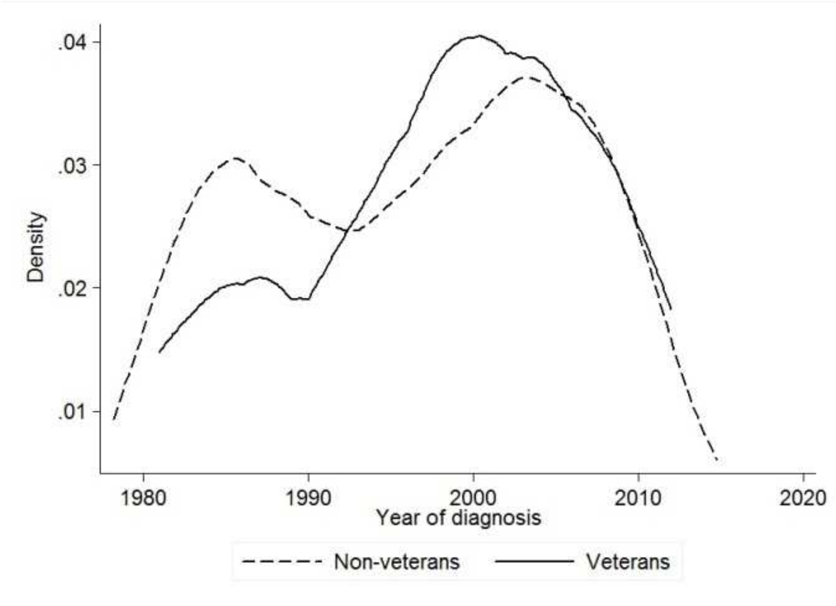

Figure 6-31 – Kernel density plot of tuberculosis by year of presentation Veterans and non-veterans

6.10.3 Case-Fatality

The mean follow-up from date of first admission with tuberculosis to the date of death or the end of the study was 11.32 years (range 0-31.66 years) for veterans and 13.25 years (range 0-31.94 years) for non-veterans, representing 781 person-years of follow-up in the veterans and 3,538 person-years in the non-veterans. There were 27 (39.1%) deaths in veterans with tuberculosis, equating to 34.6 per 1,000 person-years, and 81 (30.3%) deaths in non-veterans (22.9 per 1,000 person-years).

6.10.4 Commentary

Data on the incidence or prevalence of tuberculosis in veterans are sparse but Levine reported an incidence of hospitalisation for tuberculosis 1.3 times higher in US veterans than in age-matched US men between 1984 and 1993 (29.1/100,000 compared with 22.1/100,000) (Levine 1998). However, the veterans were patients receiving care from Veterans Administration Medical Centres, access to which is limited to the lowest income group (11.3% of veterans). They may have been at higher risk of tuberculosis for reasons other than their veteran status; the author notes co-morbidity with AIDS (up to r=0.8, p<0.001). In the major Australian study of mortality in Korean War veterans covering 50 years of observation, the SMR for tuberculosis was 0.95 (95% CI 0.40-1.49) after excluding unknowns but this was based on only 12 deaths (out of a total of 7,514 deaths) (Harrex et al. 2003).

The Scottish Veterans Health Study has demonstrated that tuberculosis resulting in hospitalisation is rare in veterans who served between 1960 and 2012. In 1953, the UK commenced routine administration of BCG vaccine to all 13-year old children whose parents consented. Because of the impact of tuberculosis in the Armed Forces, as noted at Section 6.10.1, and the risk of cross-infection in shared accommodation, a sub-committee of the Research Committee of the British Tuberculosis Association was convened in November 1951 to consider the case for BCG vaccination of Service entrants (Stevens 1957). They quickly identified practical difficulties; 63.5% of 18-year olds were already tuberculin-positive, and the rapid dispersal of recruits from the training centres made it impractical to meet the timetable which would be required for tuberculin testing, reading and vaccination of 220,000 men per year (150,000 National Service and 70,000 regular recruits). The vaccine was also unstable and had to be administered within 48 hours of receipt at a military establishment, presenting major logistic difficulties and a risk of wastage (Anon. 1951). Military vaccinations commenced with certain categories of medical and nursing staff in 1951 and Gurkha[168] soldiers in 1952. A scheme for extending the programme to all recruits was proposed, linked to the Mass Miniature Radiography (MMR) screening programme[169] which by then reached 85% all recruits (although the quality of some films gave rise to concern), noting that 50-60% would be likely to prove tuberculin positive for some years to come. It was agreed that post-vaccination re-testing could be omitted as other evidence had been presented showing a high seroconversion rate. The Ministry of Labour and National Service considered that youths over 16 years of age were normally sufficiently mature to consent to testing and immunisation without the need for parental consent. The future impact of school-based immunisation was noted, with the proviso that it was not yet known whether immunity would wane. The slow development of immunity following BCG administration was also considered to present a case for the establishment of immunity prior to the commencement of service.

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[168] Nepalese

[169] An MMR unit could screen 400 men per day

The authors of the report recommended that both radiography and BCG vaccination were required in order to effect a substantial reduction in the incidence of tuberculosis in the Armed Forces, and that the two were complementary. They recommended (in 1957) a pilot scheme for a national BCG vaccination programme in Service recruits, and this was implemented at around the time that the oldest members of the Scottish Veterans cohort commenced their service. The benefits for this generation of veterans have been clearly demonstrated. However, those who were already Mantoux positive on entry would not have been immunised. The high burden of tuberculosis faced by earlier generations of UK Service personnel therefore means that there are still many older veterans living who were treated for, and/or medically discharged for, tuberculosis during their service, or who lived with latent tuberculosis. As immune function becomes impaired in this cohort through age, disease or immunosuppressive treatment, reactivation of latent disease remains a theoretical risk and may account for the higher level of recent diagnoses.

6.11 Chronic Obstructive Pulmonary Disease

6.11.1 Introduction

Chronic obstructive pulmonary disease (COPD) was defined as the occurrence of ICD-9 codes 490-496, less 494 and 495, or ICD-10 codes J40-J45, at any position in the record. The diagnostic codes encompass chronic bronchitis, emphysema and COPD, but also include asthma; a landmark analysis from age 40 years was therefore undertaken in order to exclude asthma in adolescents and young adults, which would normally have precluded military service. Since most cases of COPD are diagnosed and managed in primary care, the recorded date of first episode reflects the date of the first admission, or of death, and not the date of initial diagnosis. The data therefore also represent only the more severe end of the spectrum of COPD; it has been assumed that there are no systematic differences in completeness of ascertainment of COPD between veterans and non-veterans, and that any differences reflect real differences in incidence or severity.

6.11.2 Incidence

6.11.2.1 Overall

During the period of follow-up, there were 1,927 (3.5%) cases of COPD resulting in secondary care admission or death in veterans aged 40 years and over, compared with

5,451 (3.2%) cases in non-veterans. The difference was statistically significant, unadjusted HR 1.09, 95% CI 1.04-1.15, p=0.001, although it became non-significant after adjusting for SES, HR 1.05, 95% CI 1.00-1.10, p=0.074. Testing for non-proportionality of the hazards was highly significant, p<0.001, and examination of the Nelson-Aalen plot showed that a difference in risk between veterans and non-veterans only started to emerge from the mid-50s. Repeating the analysis using a second landmark age of 55 years, therefore, showed an unadjusted HR of 1.28, 95% CI 1.18-1.39, p<0.001, adjusted HR 1.22, 95% CI 1.13-1.32, p<0.001. The *estat phtest* for non-proportionality of the hazards was no longer significant, p=0.460.

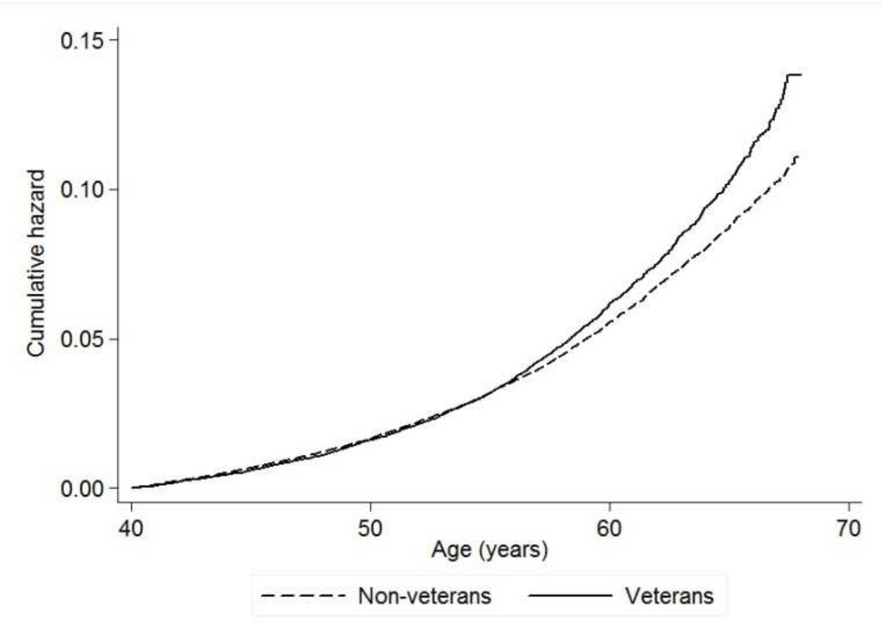

Figure 6-32 - Nelson-Aalen plot of COPD by veteran status

6.11.2.2 Sex

Using a landmark age of 55 years in order to ensure validity of the Cox model, both veteran and non-veteran women were more likely to have a diagnosis of COPD than men, although the increased risk in veteran women was not statistically significant. The unadjusted hazard ratios were 1.20, 95% CI 0.94-1.52, p=0.145 for veteran women compared with veteran men, and 1.26, 95% CI 1.10-1.44, p=0.001 for non-veteran women compared with men. The hazard ratios were similar after adjusting for SES.

6.11.2.3 Birth Cohort

There was a steadily decreasing risk of COPD among veterans compared with non-veterans in the later birth cohorts. The greatest increase in risk in veterans was in those born prior to 1955, whilst those born from 1960 onwards showed a statistically significant reduction in risk compared with non-veterans (Figure 6-33).

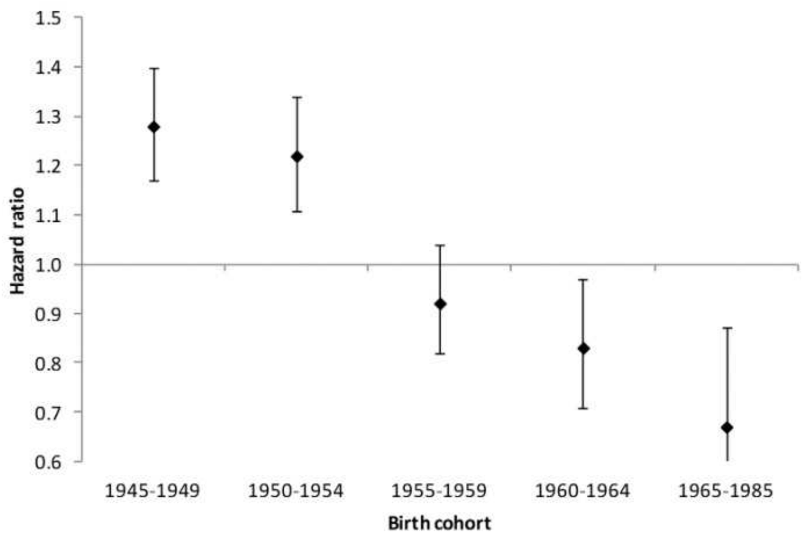

Figure 6-33 - Hazard ratios for COPD by birth cohort
Veterans referent to non-veterans

6.11.2.4 Length of Service

Analysis of hazard ratios for COPD in veterans by length of service, compared with all non-veterans, overall and in two birth cohorts, 1945-1959 and 1960-1972 (landmark age 40 years) showed a clear increase in risk in the earlier birth cohort in the veterans with the shortest service. The difference became non-significant beyond 6 years of service (Table 6-7).

Table 6-7 - Cox proportional hazard model of the association between veteran status and COPD, overall and stratified by length of service and birth cohort, landmark age 40 years

	Veteran cases	All Veterans *n*-56,205			Born 1945-1959 *n*=29,709			Born 1960-1985 *n*=26,496		
	n	HR	95% CI	p	HR	95% CI	p	HR	95% CI	p
Overall										
Univariate	1,927	1.09	1.04-1.15	0.001	1.17	1.10-1.23	<0.001	0.80	0.70-0.91	0.001
Multi-variable	1,927	1.05	1.00-1.10	0.074	1.11	1.05-1.17	<0.001	0.80	0.70-0.91	0.001
Length of service in 8 categories										
Basic training	276	1.42	1.26-1.60	<0.001	1.57	1.38-1.78	<0.001	0.84	0.58-1.20	0.339
ESL (0-3 years)	563	1.54	1.41-1.68	<0.001	1.63	1.48-1.78	<0.001	1.24	0.99-1.54	0.061
4-6 years	363	1.14	1.02-1.26	0.016	1.16	1.03-1.30	0.013	1.08	0.84-1.39	0.541
7-9 years	231	1.02	0.90-1.17	0.737	1.10	0.95-1.26	0.199	0.71	0.50-1.00	0.053
10-12 years	164	0.89	0.77-1.04	0.156	0.95	0.80-1.12	0.552	0.65	0.44-0.96	0.031
13-16 years	121	0.94	0.79-1.13	0.528	1.07	0.88-1.30	0.517	0.54	0.35-0.84	0.006
17-22 years	86	0.61	0.49-0.75	<0.001	0.71	0.57-0.57	0.002	0.18	0.07-0.43	<0.001
≥23 years	118	0.59	0.49-0.71	<0.001	0.63	0.52-0.77	<0.001	0.31	0.15-0.62	0.001

Repeating the analysis using the revised landmark age of 55 years (which excluded the entire younger subgroup) gave a similar pattern, although the absolute hazard ratios were higher (Table 6-8).

Table 6-8 - Cox proportional hazard model of the association between veteran status and COPD, overall and stratified by length of service, landmark age 55 years

	Veteran cases	All Veterans		
	n	HR	95% CI	p
Overall				
Univariate	764	1.28	1.18-1.39	0.001
Multi-variable	764	1.22	1.13-1.32	0.001
Length of service in 8 categories				
Basic training	102	1.61	1.33-1.93	<0.001
ESL (0-3 years)	221	1.83	1.60-2.09	<0.001
4-6 years	136	1.28	1.09-1.51	0.003
7-9 years	86	1.17	0.96-1.42	0.115
10-12 years	69	1.05	0.84-1.32	0.653
13-16 years	48	1.23	0.94-1.61	0.137
17-22 years	40	0.87	0.65-1.17	0.363
≥23 years	62	0.77	0.61-0.97	0.028

The Nelson-Aalen plot by length of service in 4 categories, compared with all non-veterans, confirmed that the highest risk of COPD was in ESL who had completed training, as demonstrated in Table 6-7 and Table 6-8. Veterans with 4-12 years service, who were likely to have reached the rank of no higher than corporal or equivalent, demonstrated an increased risk only beyond the age of 60 years, whilst there was a reduction in risk in veterans with the longest service (Figure 6-34).

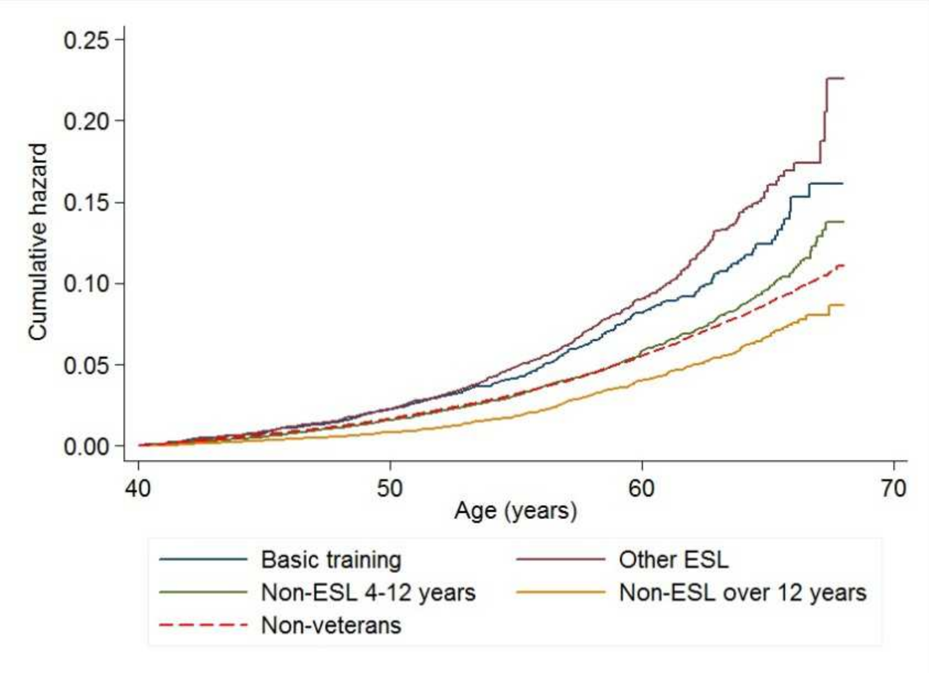

Figure 6-34 – Nelson-Aalen plot of COPD stratified by length of service
All non-veterans for comparison

6.11.3 Case-Fatality

The mean follow-up from date of first admission with COPD, in people over the age of 40 years, to the date of death or the end of the study was 5.29 years (range 0-24.09 years) for veterans and 5.38 years (range 0-27.14 years) for non-veterans, representing 10,400 person-years of follow-up in the veterans and 29,246 person-years in the non-veterans. There were 451 (22.9%) deaths in veterans with COPD, equating to 43.4 per 1,000 person-years, and 1,096 (20.2%) deaths in non-veterans (37.5 per 1,000 person-years).

The commonest cause of death, in both veterans and non-veterans, was lung cancer, which accounted for 12.8% of deaths in veterans with COPD and 12.6% of deaths in non-veterans. The second commonest recorded cause of death was COPD itself (8.4% of deaths in veterans with COPD and 10.8% of non-veterans). AMI accounted for 7.7% of deaths in veterans with COPD and 8.3% in non-veterans, whilst the recorded cause of death was alcoholic liver disease in 5.3% of veterans and 5.6% of non-veterans with COPD who had died.

6.11.4 Commentary

The diagnosis of chronic obstructive pulmonary disease encompasses chronic bronchitis, emphysema and chronic asthma, when associated with irreversible airways obstruction

(Viegi et al. 2000). The most important cause is cigarette smoking, although some cases arise as a consequence of congenital α_1-antitrypsin deficiency; respiratory infection and atmospheric pollution are also risk factors. There is evidence that heavy alcohol consumption is an independent risk factor for both mortality and complications (for example, prolonged cough, bronchitis) in COPD (Sisson 2007, Tabak et al. 2001), although other authors have found that the increase is no longer evident after controlling for smoking (Greene et al. 2008). COPD is the fourth commonest cause of death in the USA and Europe, and there has been an increasing burden of COPD in women in the later 20th century. It has been estimated that 15-20% of smokers will develop clinically significant COPD, although the true prevalence may be higher (Celli et al. 2004).

Interpretation of the data for COPD in the Scottish Veterans study presents problems. As discussed at Section 6.11.1, the recorded episodes reflect only the most severe disease. Furthermore, the inclusion of the ICD code for asthma, which is encompassed in the definition of COPD but also covers childhood asthma and reversible airways obstruction, is also an important source of selection bias. A pre-existing diagnosis of asthma precludes military service and therefore will be over-represented in the non-veterans and under-represented in the veterans, notwithstanding the use of a landmark age of 40 years to remove people with an earlier first episode from the analysis. This will have reduced the magnitude of any apparent effect in veterans. Thus, it is likely that the finding of no difference in the risk of COPD/asthma between veterans and non-veterans between the ages of 40 and 55 years does in fact indicate an increase in risk in the veterans even at these younger ages; the nature of military selection should mean that the veterans' risk is lower. It is also likely that the true difference between older veterans and non-veterans is greater than shown in Figure 6-32. It may therefore be concluded with confidence that veterans experience an increased risk of COPD compared with non-veterans, the risk being highest in those with the shortest service and in the earlier birth cohorts. However, the reduction in risk seen in the younger birth cohorts (Figure 6-33) may in part be explained by selection bias, in addition to any impact of recent reductions in the prevalence of in-service smoking.

These results are consistent with high rates of military smoking in the 1960s and 1970s (Richards and Crowdy 1961, Crowdy and Sowden 1975), and with later falling rates of in-service smoking (Lewthwaite and Graham 1992), and are consistent with the pattern for the other smoking-related diagnoses of cardiovascular disease (Section 4.9), lung cancer (Section 5.8) and other smoking-related cancers (Section 5.12) observed in the Scottish Veterans study. The finding of the highest risk for COPD, by length of service, in ESL who completed training is consistent with a role for alcohol as a contributory factor (Tabak et al. 2001).

6.12 Peptic Ulcer

6.12.1 Introduction

Risk factors for peptic ulcer are known today to include *H. pylori* infection, cigarette smoking and non-steroidal anti-inflammatory drugs (NSAID), with an attributable risk in the general population of 48% for *H. pylori*, 24% for NSAID and 23% for smoking (Kurata and Nogawa 1997). Peptic ulcer was rare in young men until the beginning of the 20th century (Jennings 1940), but its prevalence (as measured by perforations, a valid objective measure in the absence of reliable diagnostic investigations such as endoscopy) rose up to around 1955 before starting to fall (Susser and Stein 1962). It was an important military condition in the first half of the 20th century. The Second World War saw a rise in cases, and by 1943, 2.4 per 1,000 soldiers were invalided for this diagnosis, equating to 13.7% of all medical discharges (Bergman and Miller 2000). It was postulated that some cases were manifestations of an underlying mental health disorder ('neurotic dyspepsia')[170] (Howell 1942), but 64.2% of a series of 246 patients investigated in a UK military hospital had a confirmed diagnosis of peptic ulcer, whilst gastritis accounted for a further 24.4%. Many had symptoms predating their service, and reported that they were teetotal and only smoked lightly (Graham and Kerr 1941). The rate of medical discharge for peptic ulcer fell after the end of the Second World War to 1.3 per 1,000 by 1951, still equivalent to 5% of all medical discharges, but it was not until the early 1980s, with improvements in medical treatment, that medical discharge for this condition became rare (Bergman and Miller 2000). Thus, the period of service of the older members of the Scottish Veterans cohort overlapped a period of high prevalence of peptic ulceration in serving personnel.

[170] "Those people of poor personality who in peacetime are only just able to accommodate themselves to their home environment are no longer able to do so when this is changed on enlistment to the discipline of Army environment. Whether it is pure chance that their neurosis is centred on their digestion it is difficult to say, but in my opinion a constitutional weakness is inherent in them." Howell, C. H. (1942) 'Dyspepsia in the Army in 1940 and 1941', *British Medical Journal,* 1(4248), 692.

6.12.2 Incidence

Peptic ulcer was defined as the occurrence of ICD-9 code 531-533, or ICD-10 code K25-K27, at any position in the record. Figures for incidence record only those cases which resulted in hospitalisation or death, and therefore represent only the more severe cases, or those requiring in-patient management. Cases diagnosed and treated wholly within primary care are not included. Completeness of capture therefore reduces in later years with the introduction of outpatient diagnosis and of effective treatment which can be administered in primary care. The assumption has been made that there are no systematic differences in completeness of ascertainment of peptic ulcer between veterans and non-veterans at any point in time, and that any differences reflect real differences in incidence or severity.

6.12.2.1 Overall

During the period of follow-up, there were 1,913 (3.4%) cases of peptic ulcer resulting in hospitalisation or death in veterans, compared with 5,118 (3.0%) cases in non-veterans. The difference was highly statistically significant, unadjusted HR 1.31, 95% CI 1.24-1.39, $p<0.001$ and HR 1.26, 95% CI 1.19-1.33, $p<0.001$ after adjusting for deprivation. However, testing for non-proportionality of the hazards was highly significant, $p<0.001$, so the Cox model was not reliable. Nonetheless, a clear difference in risk is illustrated in the Nelson-Aalen plot (Figure 6-35). As development of a satisfactory alternative model in the presence of non-proportionality is problematic (Royston 2001), the Cox model has nonetheless been employed here, but should be interpreted with caution.

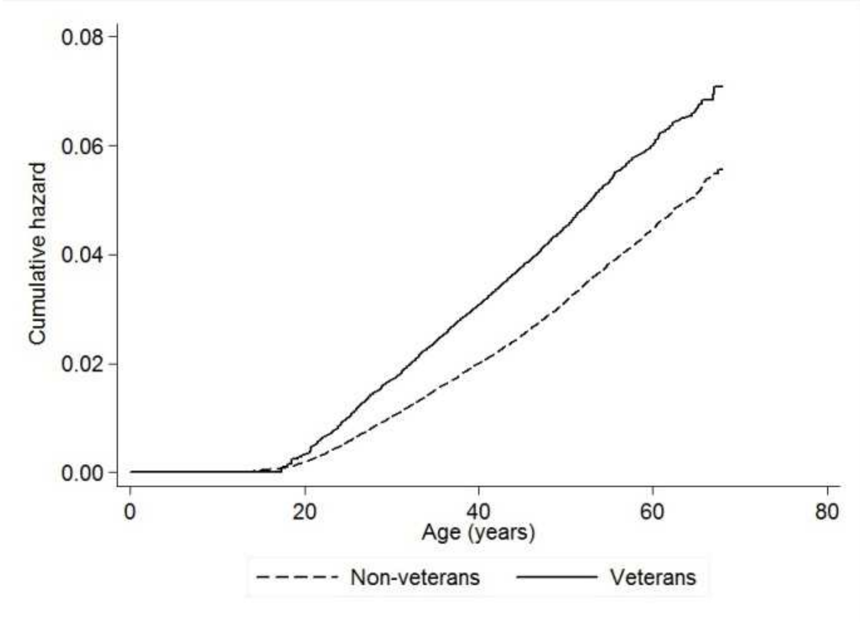

Figure 6-35 - Nelson-Aalen plot of peptic ulcer by veteran status

6.12.2.2 Sex

Peptic ulcer leading to hospitalisation or death was more common in men than women, in both veterans and non-veterans. Only 70 (1.3%) veteran women had a recorded diagnosis of peptic ulcer, compared with 313 (1.5%) non-veteran women. For men, there were 1,843 (3.6%) cases in veterans compared with 4,805 (3.2%) in non-veterans. The difference for women was not statistically significant, unadjusted HR 0.97, 95% CI 0.74-1.26, p=0.803. The hazard ratio for women was similar after adjusting for deprivation, 0.95, 95% CI 0.73-1.23, p=0.688. Since women made up only around 10% of the cohort, the hazard ratios for men alone were similar to those for all veterans, 1.32, 95% CI 1.25-1.39, p<0.001 unadjusted and 1.27, 95%CI 1.20-1.34, p<0.001 in the adjusted model.

6.12.2.3 Age

Veterans were slightly older at first record of peptic ulcer, mean age 41.0 years (SD 10.3) for veterans and 40.2 years (SD 11.1) for non-veterans. The kernel density plot showed the pattern by age to be broadly similar apart from a slight shift to the right in the curve for veterans (Figure 6-36).

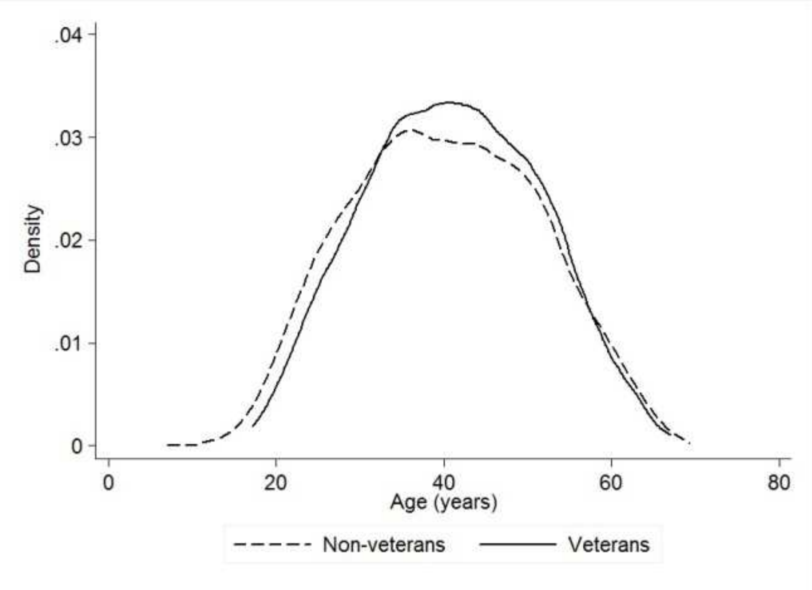

Figure 6-36 - Kernel density plot of age at first record of peptic ulcer

6.12.2.4 Birth Cohort

Analysis by birth cohort showed all veterans born prior to 1965 to be at statistically significantly increased risk compared with non-veterans, with a peak in the 1950-1954 birth cohort, whilst there was a non-significant decrease in risk for those born from 1965 onwards (Figure 6-37).

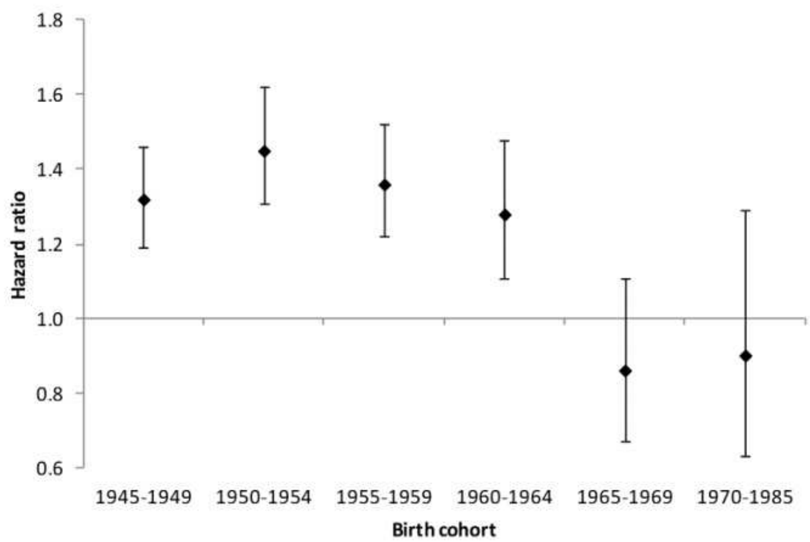

Figure 6-37 - Hazard ratios for peptic ulcer by birth cohort
Veterans referent to non-veterans

A kernel density plot of year of birth for veterans and non-veterans with a diagnosis of peptic ulcer against all veterans confirmed that peptic ulcer was predominantly a disease of veterans born prior to 1965, and non-veterans born prior to 1970 (Figure 6-38).

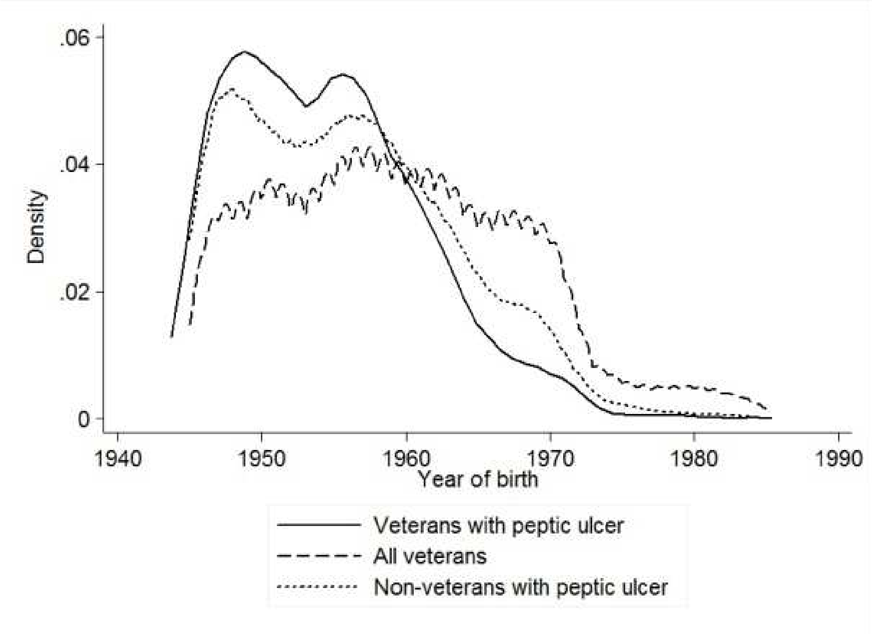

Figure 6-38 - Kernel density plot of peptic ulcer in veterans and non-veterans by year of birth
All veterans for comparison

6.12.2.5 Length of Service

Analysis of risk of peptic ulcer by length of service, stratified into two birth cohorts (pre-1965 and 1965 onwards, identified in Figure 6-37 as showing distinctly different patterns of risk) revealed a clear difference, most prominent in the earlier birth cohort, with the highest risk in those with the shortest service and, in particular, in Early Service Leavers who did not complete training. There was a non-significant reduction in risk in most people serving for 4 years and over in the more recent birth cohort; for those with 17-22 years' service (likely to have been predominantly full-career senior non-commissioned officers and warrant officers) the reduction was statistically significant in the older birth cohort (Table 6-9).

Table 6-9 - Cox proportional hazard model of the association between veteran status and peptic ulcer, overall and stratified by length of service and birth cohort

	Veteran cases	All Veterans *n*-56,205			Born 1945-1964 *n*=29,709			Born 1965-1985 *n*=26,496		
	n	HR	95% CI	p	HR	95% CI	p	HR	95% CI	p
Overall										
Univariate	1,913	1.31	1.24-1.39	<0.001	1.36	1.28-1.44	<0.001	0.87	0.71-1.06	0.181
Multi-variable	1,913	1.26	1.19-1.33	<0.001	1.30	1.22-1.37	<0.001	0.87	0.71-1.07	0.190
Length of service in 8 categories										
Basic training	274	1.62	1.43-1.83	<0.001	1.57	1.31-1.81	<0.001	1.62	1.26-2.07	<0.001
ESL (0-3 yrs)	500	1.47	1.34-1.62	<0.001	1.50	1.35-1.67	<0.001	1.28	1.05-1.56	0.012
4-6 years	419	1.42	1.28-1.57	<0.001	1.55	1.38-1.73	<0.001	0.96	0.75-1.22	0.742
7-9 years	252	1.28	1.12-1.46	<0.001	1.35	1.16-1.56	<0.001	1.12	0.85-1.47	0.436
10-12 years	187	1.27	1.09-1.48	0.002	1.39	1.17-1.64	<0.001	0.97	0.68-1.40	0.878
13-16 years	98	0.88	0.71-1.10	0.258	1.00	0.78-1.27	0.997	0.68	0.41-1.13	0.137
17-22 years	72	0.72	0.55-0.94	0.017	0.73	0.55-0.98	0.037	0.61	0.27-1.37	0.230
≥ 23 yrs	109	0.87	0.69-1.10	0.243	0.89	0.70-1.13	0.357	0.58	0.21-1.55	0.274

The Nelson-Aalen plot by length of service in 4 categories, compared with all non-veterans, demonstrated the highest risk in ESL who did not complete training and the overall reduction in risk with longer service (Figure 6-39).

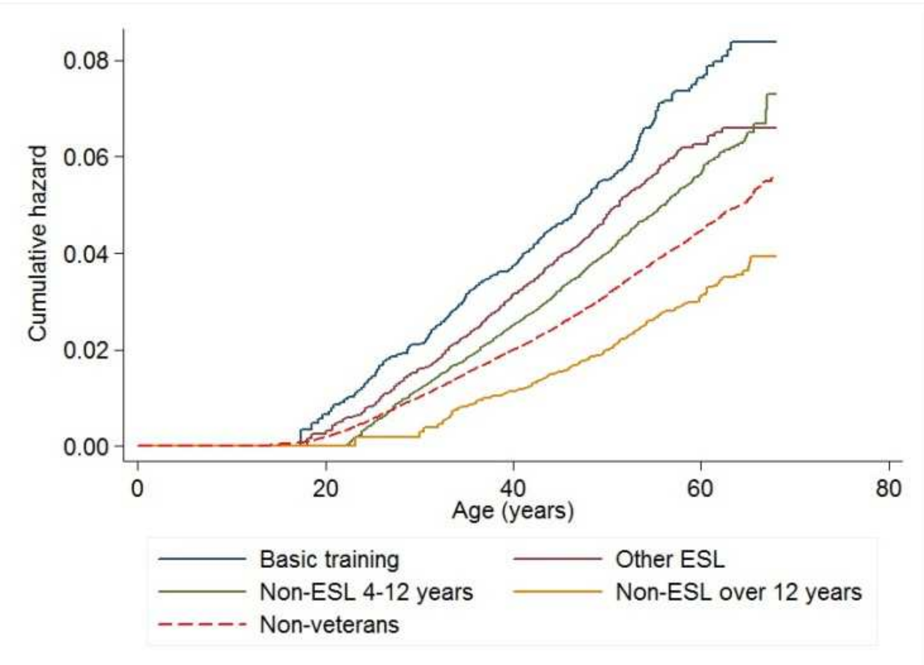

Figure 6-39 – Nelson-Aalen plot of peptic ulcer stratified by length of service All non-veterans for comparison

6.12.3 Case-Fatality

The mean follow-up from date of first hospitalisation with peptic ulcer to the date of death or the end of the study was 15.69 years (range 0-31.99 years) for veterans and 15.19 years (range 0-31.99 years) for non-veterans, representing 30,015 person-years of follow-up in the veterans and 77,742 person-years in the non-veterans. There were 323 (16.9%) deaths in veterans with a record of peptic ulcer, equating to 10.8 per 1,000 person-years, and 819 (16.0%) deaths in non-veterans (10.5 per 1,000 person-years).

The commonest cause of death, in both veterans and non-veterans, was alcohol misuse (alcoholic liver disease and alcohol dependence syndrome), followed by AMI/IHD. The third most common cause of death was lung cancer, in both veterans and non-veterans. A total of 65 veterans with peptic ulcer died of alcohol-related causes (defined in Table 6-3) compared with 166 non-veterans, equating to 20.1% of all deaths in people with peptic ulcer among veterans and 20.7% among non-veterans. The difference was not statistically significant, OR 0.99, 95% CI 0.77-1.28, p=0.956. Around 20% of deaths in veterans with peptic ulcer were explained by alcohol-related causes in veterans with less than 12 years' service[171], irrespective of ESL status; for those with longer service[172] the risk was reduced to 12%.

6.12.4 Co-Morbidity

Analysis of co-morbidities with peptic ulcer was informed by the conditions identified as important causes of death, and tabulated at Table 6-10. Because of the association with alcohol-related death, co-morbidities with mental health conditions were also examined.

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[171] likely to have reached no higher than corporal (or equivalent) rank

[172] likely to reached higher rank (senior non-commissioned officer, warrant officer or commissioned officer)

Table 6-10 - Co-morbidities with peptic ulcer
Crude overall cumulative incidence for comparison

	Veterans		Non-veterans		Veterans referent to non-veterans		
	Cases *n*=1,913 No. (%)	Pop. *n*=56,205 (%)	Cases *n*=5,118 No. (%)	Pop. *n*=172,741 (%)	OR	95% CI	p
Physical							
Any cancer	217 (11.3)	(6.4)	529 (10.3)	(6.7)	1.10	0.95-1.27	0.222
COPD	205 (10.7)	(4.3)	498 (9.7)	(4.5)	1.10	0.94-1.28	0.220
Diabetes	184 (9.6)	(3.4)	372 (7.3)	(3.3)	1.32	1.12-1.57	0.001
AMI	166 (8.7)	(3.7)	374 (7.3)	(3.0)	1.19	1.00-1.41	0.055
Alcoholic liver disease	133 (7.0)	(1.2)	361 (7.1)	(1.3)	0.99	0.81-1.19	0.883
Lung cancer	27 (1.4)	(0.8)	59 (1.2)	(0.6)	1.22	0.78-1.92	0.380
Oropharyngeal/ laryngeal cancer	29 (1.5)	(0.5)	46 (0.9)	(0.4)	1.69	1.06-2.67	0.025
Stomach cancer	19 (1.0)	(0.2)	36 (0.7)	(0.1)	1.41	0.81-2.46	0.220
Hepatitis C	14 (0.7)	(0.2)	51 (1.0)	(0.4)	0.73	0.41-1.32	0.302
Oesophageal cancer	10 (0.5)	(0.3)	27 (0.5)	(0.2)	0.99	0.48-2.04	0.980
Pancreatic cancer	4 (0.2)	(0.1)	14 (0.3)	(0.1)	0.76	0.25-2.32	0.634
Liver cancer	3 (0.2)	(0.1)	23 (0.4)	(0.1)	0.35	0.10-1.16	0.072
Mental							
Any mental health disorder	227 (11.9)	(5.0)	518 (10.1)	(4.5)	1.17	1.01-1.36	0.034
Any mental health disorder less PTSD	174 (9.1)	(3.9)	447 (8.7)	(3.8)	1.04	0.88-1.23	0.634
Mood disorder	133 (7.0)	(2.8)	305 (6.0)	(2.6)	1.17	0.96-1.42	0.125
Anxiety	128 (6.7)	(2.5)	248 (4.8)	(2.0)	1.38	1.12-1.70	0.002
Stress/PTSD	53 (2.8)	(1.1)	71 (1.3)	(0.7)	2.00	1.40-2.84	<0.001
Anxiety less stress/PTSD	75 (4.0)	(1.4)	177 (3.5)	(1.3)	1.15	0.88-1.50	0.302
Psychosis	30 (1.6)	(1.0)	99 (1.9)	(1.1)	0.81	0.54-1.22	0.309
Suicide	18 (0.9)	(0.5)	40 (0.7)	(0.5)	1.20	0.69-2.09	0.511
Non-fatal self-harm	128 (6.8)	(2.9)	310 (6.1)	(2.5)	1.11	0.91-1.35	0.324

6.12.5 Commentary

The high incidence of peptic ulcer disease in the older generation of service personnel, which was widely reported in the earlier literature (Howell 1942, Graham and Kerr 1941, Bergman and Miller 2000), was clearly apparent in the pre-1965 birth cohorts of the Scottish Veterans Health Study, and was associated with serious co-morbidities. The change to a much lower incidence, and a pattern of risk slightly (but non-significantly) lower than the comparison non-veteran population, occurred quite abruptly. A similar reduction in incidence of recorded peptic ulcer occurred in non-veterans, but later and more gradually than in the veterans (Figure 6-38).

In an otherwise comprehensive meta-analysis of risk factors for peptic ulceration noted at Section 6.12.1, Kurata dismissed both alcohol and stress as risk factors[173] (Kurata and Nogawa 1997), although a postulated association with both acute physical stress and psychological stress was prominent in both the civilian and military literature earlier (Mahl 1950, Berkowitz et al. 1957, Howell 1942). Østensen et al., in a prospective study, similarly reported that "intake of alcohol seem[ed] to be of no importance" (Østensen et al. 1985), noting that tobacco smoking and a positive family history were risk factors. The findings summarised at Table 6-10 have demonstrated that peptic ulcer is far from a benign condition, among both veterans and non-veterans. It was strongly associated with a wide range of adverse cardiovascular, respiratory, malignant, alcohol-related and mental health outcomes. There was a statistically significantly higher risk among veterans than non-veterans for diabetes, oropharyngeal and laryngeal cancer, any mental health disorder, and anxiety (stress and PTSD only), although not for alcoholic liver disease, hepatitis C, liver cancer, oesophageal cancer, pancreatic cancer or psychosis. The association between peptic ulcer disease and suicide and self-harm will be discussed at Section 7.12.2. What cannot be determined from these data is whether the relationship is causal and, if so, the direction of causality; it is equally plausible that stress is causative, that the chronic pain of ulcer disease predisposes to mental health problems, or that there are shared risk factors. The association with IHD, lung cancer and COPD (higher in veterans, albeit non-significantly) points to the role of tobacco smoking, as does the association with oropharyngeal and laryngeal cancer. Alcohol may also be a relevant factor in the latter, at the level of heavy social drinking as well as at the higher levels of misuse giving rise to alcoholic liver disease.

The identification by Warren and Marshall in 1982 of the role of *H. pylori* in gastritis and peptic ulceration led to the development of curative antibacterial treatment in the late 1980s (Marshall 1995), bringing treatment into the realm of primary care and rendering surgical management unnecessary in the majority of cases. Infection with *H. pylori* is thought to be mainly acquired in childhood (Wizla-Derambure et al. 2001), and there is evidence of person-to-person transmission in people living in close proximity such as submarine crews, although it could not be demonstrated in a sample of French infantry

[173] "Other possible environmental risk factors such as psychological stress, salt, low-fiber diet, and alcohol appear to be less important in the etiology of ulcer disease and are not included in this study." Kurata, J. H. and Nogawa, A. N. (1997) 'Meta-analysis of risk factors for peptic ulcer: nonsteroidal antiinflammatory drugs, Helicobacter pylori, and smoking', *Journal of Clinical Gastroenterology,* 24(1), 2-17.

recruits. Notably, the infantry recruits who were negative for *H. pylori* at baseline did not seroconvert during one year of follow-up (Hammermeister et al. 1992). By contrast however, a study of Greek naval recruits showed that 14.8% seroconverted, and that living in crowded conditions during deployment was a risk factor (Kyriazanos et al. 2001).

In view of the higher risk in ESL, who are known from other work to be more likely to come from deprived backgrounds (Lauren van Staden et al. 2007) and therefore to be more at risk of *H. pylori* infection (Malcolm et al. 2004), it is postulated that a major risk factor for peptic ulcer disease in veterans is the pre-service environment. Although there was a strong association with deprivation, Table 6-11 shows that the excess risk in veterans was observed across all categories of socio-economic status, and indeed the gap between veterans and non-veterans increased with better socio-economic status. It seems likely that communal service accommodation (which may be cramped in the deployed environment) and higher rates of smoking and alcohol use explain the remainder of the excess risk.

Table 6-11 - Peptic ulcer by socio-economic status

SIMD category (1 = most deprived)	Veterans n=55,831 n(%)	Non-veterans n=172,364 n (%)	Unadjusted HR	95% CI	p
1	627 (5.3%)	1638 (4.8%)	1.17	1.07-1.29	0.001
2	488 (4.0%)	1240 (3.5%)	1.25	1.12-1.39	<0.001
3	364 (3.1%)	939 (2.6%)	1.35	1.19-1.53	<0.001
4	272(2.4%)	790 (2.2%)	1.33	1.15-1.54	<0.001
5	158 (1.9%)	497 (1.7%)	1.37	1.13-1.65	<0.001

There is evidence of declining prevalence of both *H. pylori* infection and peptic ulcer disease throughout the developed world, although some of the benefits of reducing levels of *H. pylori* infection have been outweighed by increasing use of NSAID (Go 2002, Post et al. 2006). It is likely that the decline in excess risk of peptic ulceration in personnel born from 1965 onwards is multi-factorial in origin, notwithstanding loss of visibility of cases in this dataset due to the increasing proportion of cases being treated in primary care. Veterans born from 1965 generally joined the Armed Forces from 1983 onwards. Other than the changes in management of peptic ulcer disease which were common to both civilian and military clinical management, the only relevant change which has been identified is the number of people accommodated in a barrack-room, which has gradually reduced over the period, and continues to do so as military single living accommodation is modernised. However, there is much variability, with recruits generally living in the most populous barrack-rooms and more senior personnel generally having their own rooms, whilst service aboard ship or submarine, or deployment to austere conditions, can involve living in cramped conditions for many weeks or months at any rank.

Whilst the reasons for these findings from the analysis of peptic ulcer disease in the Scottish Veterans dataset may be complex, the key message to be drawn is that a diagnosis of peptic ulcer, or even a history of treated peptic ulcer, should alert healthcare providers to the possibility of important co-morbidities for which support (eg smoking cessation, alcohol management or mental health support) may be required in order to reduce the risk of further ill-health or premature death.

6.13 Diabetes

6.13.1 Introduction

Interpretation of the analysis of data for diabetes in the Scottish Veterans dataset is problematic. The majority of cases of diabetes in adults are diagnosed and treated solely in primary care, or in the outpatient setting, and therefore are not captured by the SMR01 dataset. SMR01 records of diabetes are only likely to arise in connection with complications of diabetes, or where diabetes is recorded as an incidental co-morbidity in the course of admission for another reason. Therefore, the data do not reflect absolute incidence or prevalence of diabetes. It may be argued that these limitations render analysis of the data for diabetes inappropriate; therefore, the analysis and interpretation are included for completeness, but are presented with the major caveats outlined above. For the purposes of this section, it has nonetheless been assumed that there are no systematic differences in completeness of ascertainment of diabetes between veterans and non-veterans, and that any differences reflect real differences in incidence or severity, or the adequacy of control.

6.13.2 Incidence

Diabetes was defined as ICD-9 code 250 or ICD-10 codes E10-E14, at any position in the record. The record for 'diabetes' is stored as a binary code, hence it was not possible to distinguish between type 1 and type 2 diabetes in the SMR01 data. Since the onset of type 1 diabetes most commonly occurs in childhood and adolescence, and would preclude enlistment in the Armed Forces, a landmark analysis was performed starting at age 18 years.

6.13.2.1 Overall

During the period of follow-up, 1,936 (3.4%) veterans had a record of diabetes, compared with 5,663 (3.3%) non-veterans. The difference was statistically significant, unadjusted HR 1.12, 95% CI 1.06-1.18, p<0.001. The difference remained significant after adjusting for deprivation, HR 1.08, 95% CI 1.03-1.14, p=0.003. The Nelson-Aalen plot showed the curves for veterans and non-veterans to be identical up to around age 55 years, when the risk in veterans increased relative to non-veterans (Figure 6-40). Testing for non-proportionality of the hazards was significant, p=0.008, adding to the unreliability of the analysis as outlined above. Using a landmark age of 55 years, the unadjusted hazard ratio was 1.20, 95% CI 1.11-1.31, p<0.001 (adjusted HR 1.17, 95% CI 1.07-1.27, p<0.001), and testing for non-proportionality was no longer significant p=0.592.

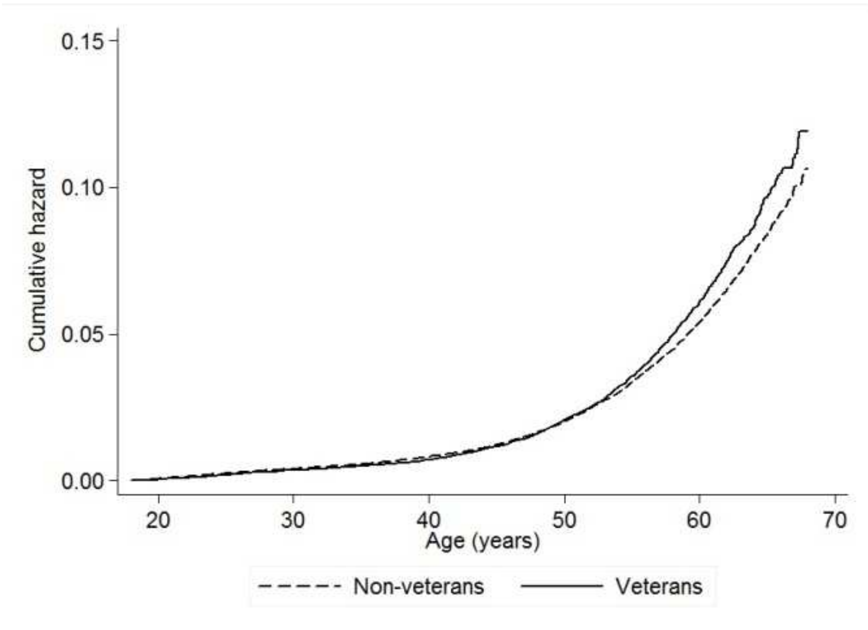

Figure 6-40 - Nelson-Aalen plot of diabetes by veteran status

6.13.2.2 Sex

Of the 1,936 veterans with diabetes, only 92 (4.8%) were women, compared with 430 (7.6%) non-veterans. The reduction in risk in veteran women did not achieve statistical significance, HR 0.97, 95% CI 0.77-1.22, p=0.772. The overall increase in risk when all veterans were analysed together remained significant when the data for men alone were examined, HR 1.11, 95% CI 1.06-1.18, p<0.001.

6.13.2.3 Age

The mean age at first record of diabetes was 51.1 years (SD 9.2 years) for veterans and 48.1 years (SD 12.0) for non-veterans. Using a landmark analysis from age 18 years, the mean age for veterans was unchanged and the mean age for non-veterans was 49.0 years (SD 10.8).

6.13.2.4 Birth Cohort

Analysis by birth cohort demonstrated an overall trend of reducing risk in veterans compared with non-veterans over time. There was an excess risk in veterans which was confined to those born before 1960; it was only statistically significant for veterans born prior to 1955. For veterans born from 1975 onwards, there was a non-significant reduction in risk (Figure 6-41).

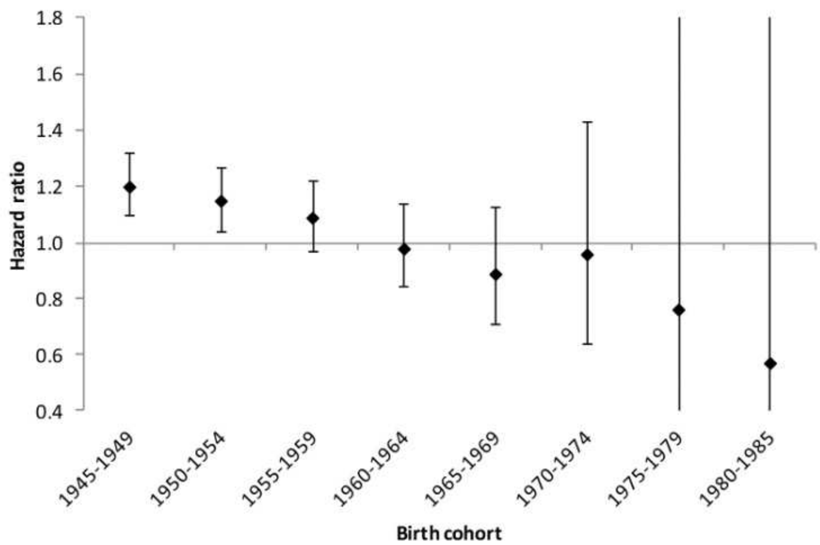

Figure 6-41 - Hazard ratios for diabetes by birth cohort Veterans referent to non-veterans

6.13.2.5 Length of Service

Preliminary analysis by length of service showed little difference between veterans with more than 4 years' service and all non-veterans, with a slight increase in risk in ESL veterans, irrespective of whether they had completed training (Figure 6-42).

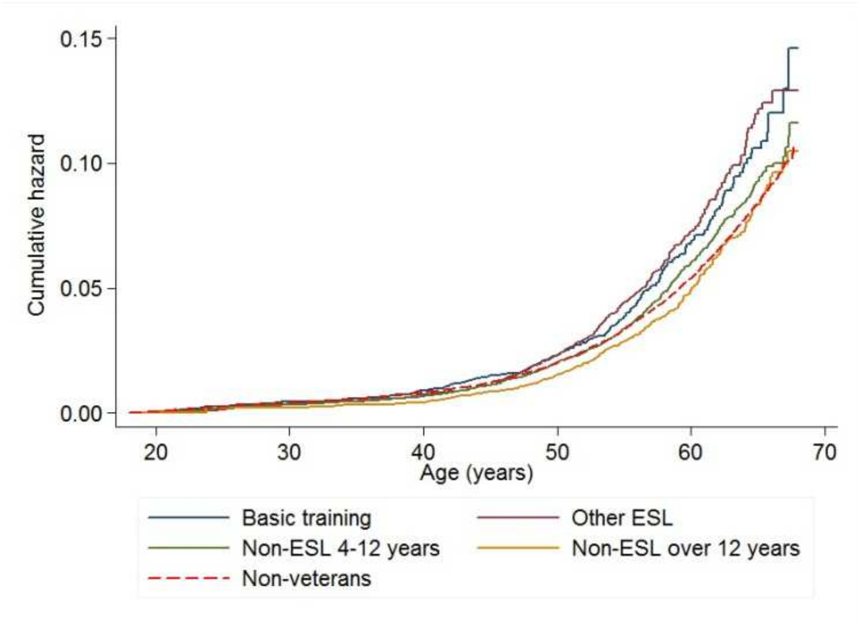

Figure 6-42 - Nelson Aalen plot of diabetes stratified by length of service
All non-veterans for comparison

Detailed sub-group analysis by length of service and birth cohort showed the excess risk to be confined to both categories of ESL[174], and to personnel with between 10 and 16 years' service who were born prior to 1960. There was no statistically significant increase in risk for any other sub-group; for veterans born from 1960 onwards, there were non-significant reductions in risk beyond 6 years of service (Table 6-12).

[174] Those who left prior to completion of training, and those who left after completing training but before finishing the minimum term of engagement.

Table 6-12 - Cox proportional hazard model of the association between veteran status and diabetes, overall and stratified by length of service and birth cohort

	Veteran cases	All Veterans *n*-56,205			Born 1945-1959 *n*=29,709			Born 1960-1985 *n*=26,496		
	n	HR	95% CI	p	HR	95% CI	p	HR	95% CI	p
Overall										
Univariate	1,936	1.12	1.05-1.18	<0.001	1.16	1.09-1.23	<0.001	0.95	0.84-1.07	0.375
Multi-variable	1,936	1.08	1.03-1.14	0.003	1.12	1.06-1.19	<0.001	0.94	0.83-1.06	0.305
Length of service in 8 categories										
Basic training[98]	244	1.24	1.09-1.41	0.001	1.26	1.09-1.45	0.002	1.20	0.90-1.60	0.225
ESL (0-3 yrs)	483	1.28	1.17-1.41	<0.001	1.36	1.23-1.51	<0.001	1.01	0.80-1.26	0.960
4-6 years	346	1.06	0.95-1.18	0.330	1.05	0.93-1.19	0.408	1.07	0.84-1.36	0.572
7-9 years	228	1.01	0.88-1.16	0.874	1.04	0.90-1.21	0.596	0.89	0.65-1.21	0.449
10-12 years	216	1.22	1.06-1.40	0.005	1.28	1.10-1.49	0.001	0.95	0.68-1.33	0.777
13-16 years	135	1.12	0.94-1.33	0.202	1.22	1.01-1.48	0.038	0.76	0.51-1.14	0.192
17-22 years	128	1.01	0.84-1.21	0.935	1.09	0.90-1.32	0.361	0.57	0.31-1.03	0.061
23 yrs & over	153	0.87	0.74-1.03	0.106	0.89	0.75-1.06	0.188	0.72	0.41-1.28	0.266

6.13.3 Case-Fatality

The mean follow-up from date of first record of diabetes (at age 18 years or over) to the date of death or the end of the study was 6.85 years (range 0-31.87 years) for veterans and 7.78 years (range 0-31.98 years) for non-veterans, representing 13,255 person-years of follow-up in the veterans and 43,000 person-years in the non-veterans. There were 379 (19.6%) deaths in veterans with a record of diabetes, equating to 28.6 per 1,000 person-years, and 1,039 (18.8%) deaths in non-veterans (24.1 per 1,000 person-years).

The commonest cause of death, in both veterans and non-veterans with diabetes, was AMI or IHD. The second commonest cause of death was lung cancer. Other important causes of death in association with diabetes were alcoholic liver disease, diabetes, oesophageal cancer, pneumonia, COPD and stroke.

6.13.4 Co-Morbidity

Co-morbidities were examined for those conditions previously identified as having an association with diabetes, or identified as common causes of death in those with a recorded diagnosis of diabetes, and are summarised at Table 6-13. The crude cumulative incidence in the entire cohort, by veteran status, is given for comparison.

Table 6-13 - Selected co-morbidities with diabetes
Crude overall cumulative incidence for comparison

	Veterans *n*=1,936/56,205		Non-veterans *n*=5,663/172,741		Veterans referent to non-veterans		
	Cases No. (%)	Pop. (%)	Cases No. (%)	Pop. (%)	OR	95% CI	p
AMI	344 (17.8)	(3.7)	829 (14.6)	(3.0)	1.21	1.08-1.36	0.001
COPD	307 (15.9)	(4.3)	779 (13.8)	(4.5)	1.15	1.02-1.30	0.023
Any cancer	250 (12.9)	(6.4)	708 (12.5)	(6.7)	1.03	0.90-1.18	0.638
Any mental health diagnosis	248 (12.8)	(5.0)	613 (10.8)	(4.5)	1.18	1.03-1.36	0.017
Peptic ulcer	184 (9.5)	(3.4)	372 (6.6)	(3.0)	1.45	1.22-1.71	<0.001
PAD	178 (9.2)	(1.2)	390 (6.9)	(0.9)	1.33	1.13-1.58	<0.001
Alcoholic liver disease	81 (4.2)	(1.2)	250 (4.4)	(1.3)	0.95	0.74-1.21	0.668
Stroke	79 (4.1)	(1.0)	195 (3.4)	(0.8)	1.19	0.92-1.53	0.194
Lung cancer	36 (1.9)	(0.8)	74 (1.3)	(0.6)	1.42	0.96-2.11	0.079
Oropharyngeal/ laryngeal cancer	15 (0.7)	(0.5)	40 (0.7)	(0.4)	1.10	0.61-1.98	0.759
Oesophageal cancer	15 (0.8)	(0.3)	27 (0.5)	(0.2)	1.63	0.87-3.05	0.127
Hepatitis C	10 (0.5)	(0.2)	41 (0.7)	(0.4)	0.71	0.36-1.42	0.335
Liver cancer	8 (0.4)	(0.1)	39 (0.7)	(0.1)	0.60	0.28-1.28	0.182
Pancreatic cancer	8 (0.4)	(0.1)	37 (0.7)	(0.1)	0.63	0.30-1.36	0.235

6.13.5 Commentary

Adiposity is strongly associated with the risk of type 2 diabetes (Chan et al. 1994, Wang et al. 2005). Other risk factors include family history, ethnicity and a history of gestational diabetes[175]. As discussed at Section 6.13.1, interpretation of the data for diabetes is limited by the lack of data on those managed exclusively in outpatient clinics and primary care, for both veterans and non-veterans, as well as by the lack of lifestyle data. Nonetheless, if the assumption holds true that there are no systematic differences between veterans and non-veterans in the likelihood of admission for (or death from) diabetes other than disease incidence/prevalence and severity, the data provide a

[175] Source: Diabetes UK http://www.diabetes.org.uk/Guide-to-diabetes/What-is-diabetes/Know-your-risk-of-Type-2-diabetes/Diabetes-risk-factors/ accessed 2 Dec 2014.

comparison between the two groups. It may therefore be concluded that there is a higher incidence of diabetes and/or higher risk of complications in veterans born prior to 1960, but that the excess predominantly occurs in Early Service Leavers and in those who left service after 10-16 years[176].

Like peptic ulcer, diabetes was associated with major co-morbidities including cardiovascular disease, respiratory disease, cancer, poor mental health and alcohol misuse. Veterans with diabetes were at significantly higher risk of AMI, PAD, COPD and peptic ulcer disease than non-veterans, suggesting a role for smoking as a shared risk factor, although diabetes is an independent risk factor for cardiovascular disease (Grundy et al. 1999). Mikhailidis et al. have demonstrated that smoking is a risk factor not only for insulin resistance and non-insulin dependent diabetes, but also that smoking increases the risk of diabetic complications (Mikhailidis et al. 1998). Veterans with diabetes were at non-significantly reduced risk of alcoholic liver disease, hepatitis C, pancreatic cancer and liver cancer compared with non-veterans, although the crude incidence of these conditions in diabetics was elevated in comparison with both groups in the whole cohort. The Framingham study conclusively demonstrated an association between diabetes and cardiovascular disease and death, and noted a particularly strong association with intermittent claudication, concluding that "the special risks of cardiovascular sequelae to diabetics remain unexplained" (Kannel and McGee 1979). That association has been confirmed in the Scottish Veterans Health Study. It has been estimated that the risk of cardiovascular disease in diabetics who smoke is up to 14 times higher than for smoking or diabetes alone (Tibbs and Haire-Joshu 2002). It is therefore likely that the excess risk seen in veterans compared with non-veterans is explained by higher rates of smoking in the veterans, especially in older veterans who are known to have smoked heavily during service (Lewthwaite and Graham 1992). The excess risk in ESL is also consistent with higher rates of smoking-related disease in this group (see Sections 4.9.1.2 and 5.39.2.1).

There was an increased risk of alcohol-related disease (alcoholic liver disease, oropharyngeal and laryngeal cancer) in both veterans and non-veterans with a record of diabetes, compared with those with no such record, but the risk was lower in veterans than non-veterans. Koppes et al. conducted a meta-analysis of studies on the relationship

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[176] who are likely to have achieved the rank of corporal or sergeant (Army), or equivalent in the Royal Navy and Royal Air Force.

between alcohol consumption and the risk of type 2 diabetes and concluded that there was a U-shaped curve; moderate alcohol consumption was protective, but the pooled risk did not go above unity for any level of alcohol consumption (Koppes et al. 2005). This suggests that the increased risk of diabetes seen in association with alcohol-related disease may have been a confounder due to concomitant pancreatic dysfunction in those with alcohol-related disease, although in the absence of information on acute or chronic pancreatitis in the dataset, this remains speculative.

The association between diabetes and mental health disorders is less widely recognised, although the World Mental Health Surveys, which estimated 12 month prevalence of mental health disorders in a study population of 85,000 people across 17 countries found odds ratios of 1.38 (95% CI 1.15-1.66) for depression and 1.20 (95% CI 1.01-1.42) for anxiety in people with diabetes, and the authors noted that other longitudinal studies had shown a 37% increased risk of developing Type 2 diabetes in people with depression. They recommended further research into mechanisms contributing to the association between diabetes and psychological illness that are shared with other chronic conditions, such as smoking status, obesity and physical activity (Lin and Korff 2008).

As with peptic ulcer disease, the most important conclusion to be drawn from the analysis of the Scottish Veterans data is that a diagnosis of diabetes is likely to be associated with important co-morbidities to which healthcare providers should be alert. In particular, evidence of cardiovascular disease, and especially PAD, should be sought and the need for smoking cessation advice should be determined. The association with increased risk of mental ill-health should not be overlooked.

6.14 Road Traffic Accidents

6.14.1 Introduction

Until overtaken by deaths due to hostile action in 2007, road traffic accidents (RTA)[177] were the largest single cause of death in the Army[178], accounting for 37% of all deaths

[177] The term 'land transport accident' (LTA) is used in Defence reports, in preference to 'road traffic accident' (RTA), to encompass off-road vehicle accidents as well as those occurring on-road. The term 'road traffic accident' is used in this thesis as few accidents to veterans involving off-road vehicle use are likely to have occurred.

between 1998 and 2007[179]. The majority of accidents occurred off-duty[180]. Studies have consistently shown that there is an excess risk of RTA in personnel returning from deployment (Fear et al. 2008), which declines over time (Macfarlane et al. 2005). In a study of 10,000 UK Service personnel, half of whom had deployed to the Gulf in 2003, 19% were classified as risky drivers. Risk-taking was associated with being young, male, Army, and with deployment (especially in a combat role) and childhood adversity (Fear et al. 2008).

There has been a reduction in reported land transport accidents (LTA)[177] deaths in serving personnel from 28 per 100,000[181] in 1990 to 8 per 100,000 in 2013, the greatest decrease having occurred since 2006 when the first of a number of major road safety initiatives was launched by the MOD (Defence Statistics (Health) 2014b).

There is a high level of heterogeneity in the data for road traffic accidents in the Scottish Veterans dataset which complicates interpretation. Victims may have been drivers or riders, passengers or pedestrians, at fault or innocent; details are not recorded in the dataset. Furthermore, in the absence of lifestyle data, it is impossible to speculate on the role of risk factors such as alcohol or drugs.

6.14.2 Incidence

Road traffic accident was defined as ICD-9 code E809-E819 or E820-E825, or ICD-10 code V00-V99, at any position in the record. RTA-related death was defined as the occurrence of any of these codes in the cause of death field.

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[178] Historically, the Army has experienced higher rates of LTA deaths than the other two Services, accounting for 77% of all LTA deaths 2009-2013. The data exclude any vehicle-related deaths occurring as a result of hostile action. Defence Statistics (Health) (2014b) *Annual UK Regular Armed Forces Land Transport Accident Deaths 1 January 2009 - 31 December 2013*, Abbeywood: Ministry of Defence.

[179] Annual Report on the Health of the Army 2007. Director General Army Medical Services. Camberley (2008).

[180] Annual Report on the Health of the Army 2004. Director General Army Medical Services. Camberley (2005)

[181] 28 per 100,000 represents the overall figure for all three Services; for the Army, the rate peaked at 38 per 100,000 in the same year.

6.14.2.1 Overall

A total of 7,937 (14.1%) veterans and 25,137 (14.6%) non-veterans had a record of hospital admission or death as a result of road traffic accident. Cox proportional hazard analysis showed that veterans were at statistically significantly higher risk, unadjusted HR 1.17, 95% CI 1.14-1.20, p<0.001. Adjusting for deprivation did not alter the hazard ratio. The Nelson-Aalen cumulative hazard curve demonstrated that childhood road traffic accidents were a confounder; they occurred commonly in the non-veterans but were rare in veterans as a history of serious injury would normally preclude enlistment (Figure 6-43). This pattern gave rise to a highly significant test result for non-proportionality of the hazards, p<0.001.

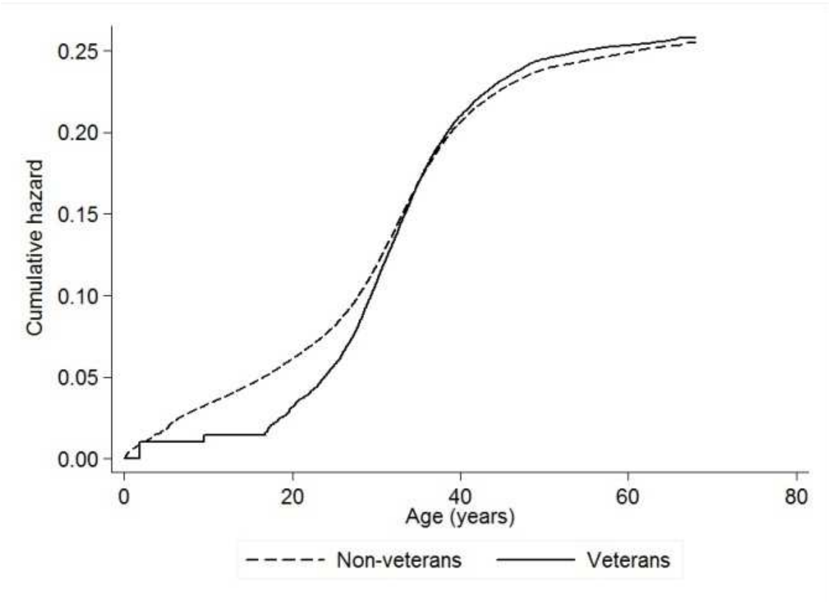

Figure 6-43 - Nelson-Aalen plot of road traffic accident - all ages

Accordingly, the analysis was repeated using a landmark age of 18 years, to exclude childhood RTA. Although the hazard ratio was almost unchanged, unadjusted HR 1.17, 95% CI 1.14-1.20, p<0.001, this clearly demonstrated the steeper rise in risk of RTA in veterans in the fourth decade, with the curves running almost parallel from age 40 years onwards (Figure 6-44). However, non-proportionality of the hazards remained significant. Examining the data using a further landmark entry point at age 40 years confirmed that there was no increased risk of RTA in older veterans, unadjusted HR 1.04, 95% CI 0.98-1.10, p=0.231.

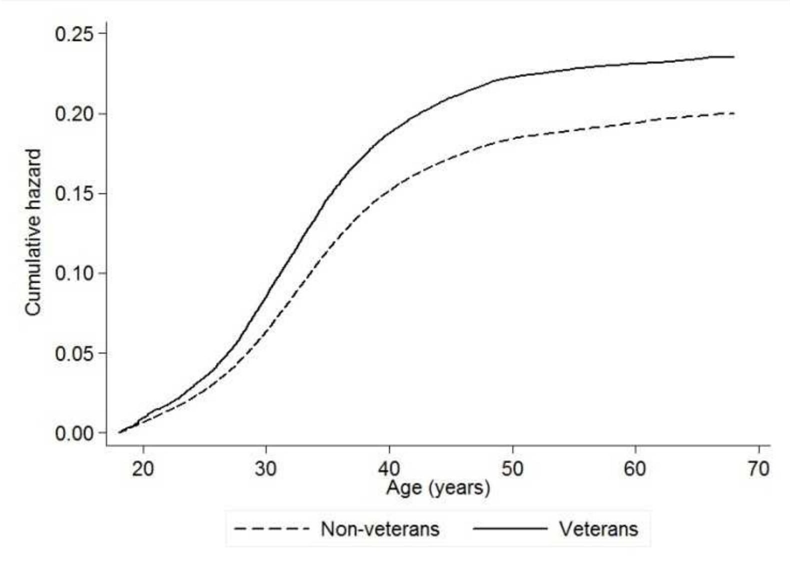

Figure 6-44 - Nelson-Aalen plot of road traffic accident - landmark age 18 years

If the Cox model was censored at age 40 years, corresponding to the steepest part of the graph at Figure 6-44, the hazard ratio increased to 1.21, 95% CI 1.17-1.25, p<0.001, and was unchanged after adjusting for deprivation.

6.14.2.2 Sex

There was a record of RTA in 764 veteran women (14.6% of all veteran women) compared with 3,398 (16.4%) non-veteran women. For men, the figures were 7,173 (14.1%) veterans and 21,739 (14.3%) non-veterans. Veteran women had a risk of RTA similar to veteran men, unadjusted HR 1.02, 95% CI 0.94-1.11, p=0.577, whereas in non-veterans, the risk was higher in women than in men, HR 1.20, 95% CI 1.15-1.24, p<0.001.

6.14.2.3 Birth Cohort

Analysis by birth cohort showed a modest but statistically significant increase in risk for all birth cohorts prior to 1970, with the highest risk in veterans born in the 1960s. From the 1970 births onwards, there was little difference between veterans and non-veterans, with a slight but non-significant reduction in risk in the most recent birth cohort (Figure 6-45).

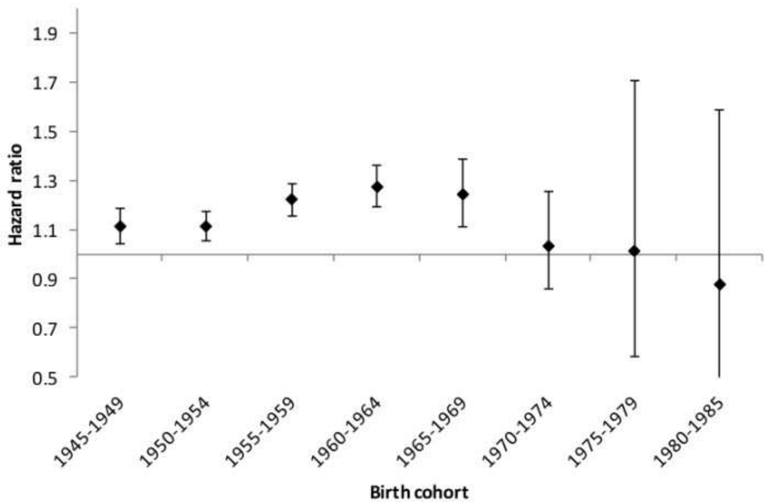

Figure 6-45 - Hazard ratios for road traffic accident by birth cohort Veterans referent to non-veterans

6.14.2.4 Age and Length of Service

Age at first recorded episode of RTA, by veteran status and length of service, is summarised at Table 6-14. Since a kernel density plot demonstrated age at first episode to be normally distributed, the mean age is appropriate.

Table 6-14 - Age at first record of road traffic accident

	Cases	Mean age (years)	SD
All veterans	7,934	34.0	7.9
Basic training	1,016	33.7	7.8
Trained ESL	1,534	33.5	7.7
4-12 years	3,464	33.8	8.0
Over 12 years	1,398	36.1	7.8
All non-veterans	25,137	33.1	8.7

522 veteran cases omitted from length of service analysis owing to uncertain ESL status

When analysed by length of service, using a landmark entry point of age 18 years, the highest risk was demonstrated in Early Service Leavers. The risk reduced with longer service, and was lower than in non-veterans for those with more than 12 years' service, at all ages (Figure 6-46).

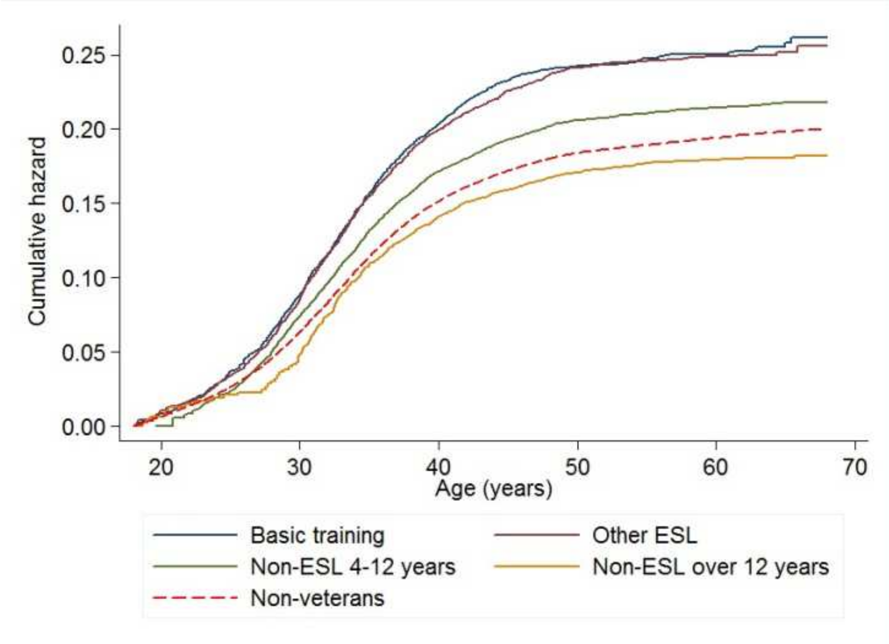

Figure 6-46 - Nelson Aalen plot of road traffic accident stratified by length of service
All non-veterans for comparison

6.14.3 'Case-Fatality'

The mean follow-up from date of first record of road traffic accident to the date of death or the end of the study was 20.88 years (range 0-31.98 years) for veterans and 20.99 years (range 0-31.99 years) for non-veterans, representing 165,725 person-years of follow-up in the veterans and 527,626 person-years in the non-veterans. There were 776 (9.8%) deaths in veterans with a record of road traffic accident, equating to 4.7 per 1,000 person-years, and 2,356 (9.4%) deaths in non-veterans (4.5 per 1,000 person-years).

6.14.4 Death due to Road Traffic Accident

During the period of follow-up, 66 (1.2%) veterans died as a direct result of road traffic accident, compared with 288 (1.7%) non-veterans. Veterans were at statistically significantly reduced risk, OR 0.70, 95% CI 0.54-0.92, p=0.010. Figure 6-47 illustrates the reduction in risk in veterans and shows that the risk was similar to non-veterans in younger people but reduced in the older age groups.

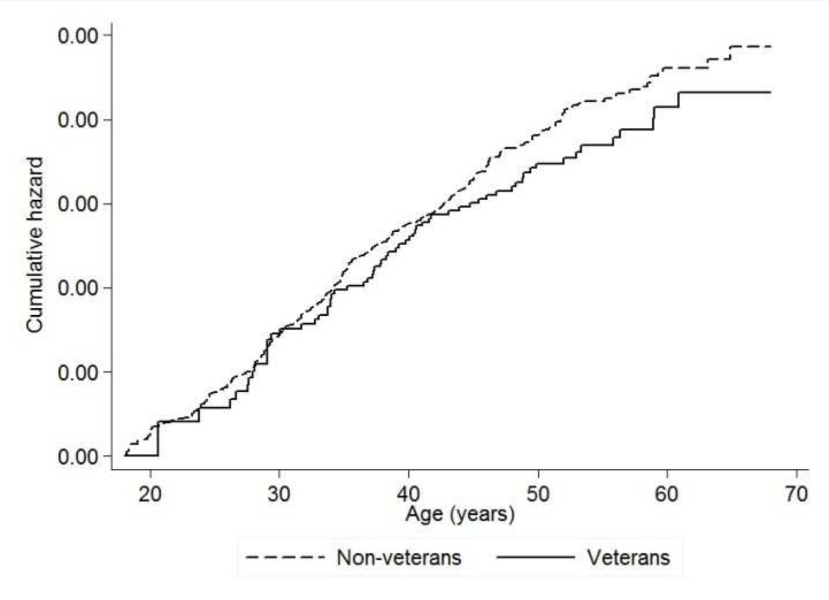

Figure 6-47 - Nelson-Aalen plot of death from road traffic accident by veteran status

Small numbers in the subgroups precluded valid analysis by birth cohort or length of service.

Women were much less likely to be killed as a result of RTA; only 4 veteran women (6.1% of veteran RTA deaths, 0.5% of veteran RTA victims) and 11 non-veteran women (3.8% of non-veteran RTA deaths, 0.3% of veteran RTA victims) died as a result of RTA, compared with 62 (0.9%) male veteran victims and 277 (1.3%) male non-veteran victims.

6.14.5 Commentary

Analysis of data from the Scottish Veterans cohort has demonstrated that the increased risk of road traffic accident which has been reported in serving military personnel persists into civilian life as a veteran up to the end of the fourth decade of life. If the assumption that there is no plausible reason for veterans to have a higher risk of RTA than non-veterans if they are 'innocent victims' holds true, then it is postulated that the difference in risk is a measure of increased risk-taking in veterans, whether as drivers/riders or as pedestrians. The 17% overall increase in risk of RTA, or 21% if people of 'serving age' only[182] are considered, is remarkably close to the figure of 19% of serving personnel found by Fear et al. to exhibit risky driving behaviour (Fear et al. 2008).

The data provide no evidence that the period immediately following discharge is especially risky. The mean age at first recorded RTA was similar for all subgroups of veterans by length of service, except those with over 12 years service, and was similar to the age recorded for non-veterans (Table 6-14). The mean age for ESL veterans was the same as for all non-veterans. The older age in the longer-serving veterans is likely to be a function of delayed entry to follow-up, as their mean age at discharge was 39.4 years (Table 3-4). However, ESL showed the steepest increase in risk of RTA in the period between age 30 and age 40 years, compared with other categories of veterans and with non-veterans (Figure 6-46), despite having a mean age at discharge of only 21 years. Although the overall risk in veterans with the longest service was slightly lower than in non-veterans, Figure 6-46 demonstrates that this is largely explained by delayed entry to the veterans cohort; this group exhibits the same steep rise in risk in the fourth decade as in those with shorter service. The mean age of 34.0 years in veterans and 33.1 years in non-veterans at first record of RTA is comparable with the mean age of in-service RTA fatalities, 33 years, reported by the Ministry of Defence for the year 2000/2001 (Defence Logistics Organisation 2001).

The higher cumulative incidence of RTA injury in women compared with men in the non-veterans group (Section 6.14.2.2) is at variance with published civilian data for Scotland[183] which show higher casualty rates for males than females at all ages apart from some periods in childhood, and cannot readily be explained. It also contrasts with the lower incidence of RTA death in women compared with men, in both veterans and non-veterans (Section 6.14.4).

The increased risk in veterans born prior to 1970, with the highest risk in those born in the 1960s (Figure 6-45) is also problematic to explain and could possibly be related to

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[182] The normal maximum engagement for a soldier in the Army is 22 years; hence the majority of Army personnel have left by age 40 years. Thus 'serving age' was taken to be age 18-40 years. The Army is the largest service, and the Defence Health (Statistics) report (footnote 178) shows that the incidence of LTA is highest in Army personnel.

[183] Transport Scotland: Reported Road Casualties Scotland 2013 – Datasets; Table 31. http://www.transportscotland.gov.uk/reported-road-casualties-scotland-2013-datasets accessed 19 May 2015

higher rates of car ownership among young veterans. Many served overseas during this period, especially in Germany and Cyprus where the tax exemption enjoyed by UK Service personnel under the Status of Forces Agreements meant that both cars and fuel were affordable even to the most junior ranks. Although no data on car ownership by Armed Forces personnel have been identified, in a House of Commons debate in 1975 it was implied that the majority of soldiers serving in Germany owned a car, and that many had been purchased under the tax-free scheme[184]. With high rates of civilian unemployment during the recession of the late 1970s and 1980s, it is plausible that the prevalence of car ownership was higher in young Service personnel than in civilians, and that higher rates of driving, albeit of a risky nature, persisted for some time after discharge.

The mean age at first recorded RTA of around 33 years implies that the 1970-1974 birth cohort will be the first in which the impact of the MOD's safer driving campaigns from 2006 onwards would be detectable. The lack of increased risk seen in the birth cohorts from 1970 onwards provides guarded reassurance that the campaigns may indeed have made a difference, although other, unidentified, factors cannot be excluded.

6.15 Chapter Discussion

Despite the heterogeneity of conditions covered in this chapter, a number of consistent findings emerged. ESL generally experienced poorer outcomes than longer-serving personnel, especially in relation to COPD, peptic ulcer, diabetes, alcoholic liver disease and alcohol-related death. In the case of the latter two, the effect was only seen in ESL who completed training, similar to the effect seen in cancer of the oropharynx and larynx and cancer of the oesophagus which had been tentatively ascribed to alcohol. ESL who left during training had a similar risk of hepatitis B and C to the non-veteran population, whilst all others were at lower risk, suggesting that military service carried no increased risk of drug misuse and that longer service was protective. Non-significantly increased risk of hepatitis B, but not hepatitis C, in the oldest veterans may be related to tattooing or to overseas service. Road traffic accidents after leaving service were also more common in ESL, although the age at first record was not related to age at leaving service and demonstrated that all but the longest-serving veterans remained at increased risk for many years after leaving.

[184] Hansard HC Deb 16 December 1975 vol 902 cc1357-64.

The results for COPD, peptic ulcer and diabetes demonstrated a pattern consistent with that for cardiovascular disease and the smoking-related cancers in respect to birth cohort and length of service, with both the earliest birth cohorts and veterans with the shortest service having the greatest increase in risk. Therefore, these results provide further corroboration of the likelihood that smoking is an important influence on the health of older veterans.

Alcoholic liver disease was strongly associated with oropharyngeal and laryngeal cancer, OR 2.66, $p<0.001$. Alcohol and smoking as risk factors for oropharyngeal and laryngeal cancer have been discussed at Sections 5.39.2.1 and 5.39.2.2; the association with alcoholic liver disease which has been demonstrated provides further support for the utility of data on oropharyngeal and laryngeal cancer as a proxy for alcohol misuse in the absence of information on lifestyle risk factors.

6.16 Implications for the Hypothesis

The analysis of all remaining physical conditions and outcomes found that conditions associated with smoking, and with alcohol, were most likely to demonstrate an increase in risk in veterans compared with non-veterans. The risks were generally highest in veterans with the shortest service, and in the earlier birth cohorts. The results provided further support for the emerging findings from the analysis of data on cardiovascular disease and cancer.

6.17 Key Points

6.17.1 Neurological Disorders

- Veterans were not at increased risk of multiple sclerosis, and there has been a small protective effect associated with military service.

- There was an overall statistically significant increased risk of motor neuron disease in veterans, which showed no relation to length or period of service.

- US studies have shown a similar increase in risk of motor neuron disease in military personnel.

- High levels of physical exertion have been postulated as a risk factor for motor neuron disease; the association with military service is plausible as high levels of physical activity are inherent in military service.

- There was an association with a history of trauma or road traffic accident in both veterans and non-veterans with motor neuron disease, and the increase in risk was non-significantly higher in veterans than in non-veterans.

- The role of other putative causal factors for motor neuron disease such as smoking and exposure to lead cannot be ruled out in explaining the increased risk in veterans.

6.17.2 Alcohol-related Outcomes

- The risk of adverse alcohol-related outcomes in ESL was only increased in those who completed training, and not in those who left whilst still in recruit training.

- Alcoholic liver disease was no more common in veterans than non-veterans, except in ESL who had completed training and were born prior to 1960. There was an overall protective effect of military service in veterans born from 1960.

- Personnel who were older when they joined the Services, and who joined during a period of high operational intensity, were at increased risk of alcoholic liver disease.
- The pattern of risk for alcoholic liver disease supports deployment as a risk factor if the military operation is of a novel type and if a comprehensive predeployment training package is not yet in place.
- There was no overall difference in risk of alcohol-related death in veterans. Veterans born between 1945 and 1949 were at non-significantly increased risk, whilst veterans born from 1960 were at significantly lower risk.
- Oropharyngeal and laryngeal cancer may be a useful proxy for alcohol misuse, in the absence of data on lifestyle risk factors.

6.17.3 Communicable Diseases

- Hepatitis B was rare in veterans, although the reduction in risk compared with non-veterans did not achieve statistical significance.

- The risk of hepatitis B in Early Service Leavers was similar to non-veterans; it was non-significantly reduced in veterans with longer service.

- The risk of hepatitis C was statistically highly significantly lower in all veterans taken together than in non-veterans; for ESL it was similar to non-veterans.

- It is likely that the findings for hepatitis B and C reflect lower levels of drug abuse in the veterans' community than in non-veterans, other than for ESL where the risk was similar to non-veterans. Some of the increase in risk of hepatitis B in the oldest veterans may have been related to exposure on overseas service, or other risk factors such as healthcare or tattooing.

- There were associations between hepatitis B, hepatitis C and peptic ulcer, and with alcoholic liver disease, in both veterans and non-veterans. The association between hepatitis B and alcoholic liver disease was significantly higher in veterans, as was the association between hepatitis B and peptic ulcer.

- Hepatitis B and hepatitis C were both associated with increased risk of smoking-related disease (lung cancer and COPD), and with mental health disorders (anxiety and mood disorder), in both veterans and non-veterans. The differences between veterans and non-veterans were not statistically significant.

- The majority of veterans who had both hepatitis B and hepatitis C were born between 1950 and 1969, with a clustering in the early 1950s, in contrast to non-veterans where the peak birth years clustered in the early 1960s.

- Tuberculosis was uncommon in veterans, although the reduction in risk compared with non-veterans did not achieve statistical significance. The lower risk may be related to the early adoption of BCG immunisation by the Armed Forces.

6.17.4 Peptic Ulcer

- Peptic ulcer was statistically significantly more common in veterans than in non-veterans, affecting all birth cohorts prior to 1965.

- The increase in risk of peptic ulcer was highest for ESL who did not complete training, but was elevated for all lengths of service up to 12 years.

- In veterans with under 12 years' service, 20% of all deaths in people with peptic ulcer resulted from alcohol-related causes.

- Peptic ulcer was strongly associated with mental health disorder, and veterans with peptic ulcer were at statistically significantly increased risk compared with non-veterans for any mental health disorder, and for severe stress or PTSD.

- It is likely that *H. pylori* infection (either contracted pre-service, or related to shared junior ranks' accommodation) and smoking are also important factors in the increased risk of peptic ulcer disease in veterans.

6.17.5 Diabetes

- Diabetes resulting in hospitalisation, or recorded incidentally during an episode of secondary care, was more common in veterans, the increase in risk only becoming apparent after age 55 years.

- There was a statistically significant increase in risk of diabetes in veterans born prior to 1955, and a non-significant increase in the 1955-1959 birth cohort. The risk was highest in ESL.

- Diabetes was strongly associated with adverse cardiovascular outcomes, any cancer, any mental health diagnosis and alcoholic liver disease, in both veterans and non-veterans. The increase in risk was significantly greater in veterans than non-veterans for AMI, PAD, COPD, peptic ulcer and any mental health diagnosis.

6.17.6 Road Traffic Accidents

- A history of road traffic accident was more common in veterans than in non-veterans, the greatest increase in risk occurring in the fourth decade of life.

- The risk was highest for veterans born in the 1960s. There was no increase in risk in veterans born from 1970 onwards.

- ESL were at highest risk of road traffic accident although their mean age at first recorded episode was similar to that for all veterans. Veterans with the longest service had a reduced risk of road traffic accident compared with all non-veterans.

- The data suggest that the MOD's recent road safety campaigns have been beneficial, although it is too early to be certain and longer follow-up is needed.

Chapter 7: Mental Health

7.1 Introduction

The limited evidence available suggests that the majority of military personnel do well after service, as noted by Iversen and Greenberg, and for many people, military service is a positive experience. Only a small minority of veterans develop serious mental health disorders (Iversen and Greenberg 2009). Medical discharge (invaliding) from the UK Armed Forces for psychiatric disorder currently accounts for only about 200 (1%) of the 20,000 people who leave the UK Armed Forces annually, or about 10% of all those medically retired from service (DASA 2012). By contrast, Hoge showed that mental ill-health was the leading cause of medical retirement from the US Armed Forces in men in the early 1990s (Hoge et al. 2002), whilst Creamer demonstrated that those who develop a mental health disorder are more likely to leave service (Creamer et al. 2006). In the UK, the pattern of invaliding for mental health disorders has changed over time, from a rate of around 1 per 1,000 strength per year between 1891 and 1931, increasing to 6.4 per 1,000 in 1943 and then gradually decreasing to less than 1 per 1,000 strength in the 1990s (Bergman and Miller 2000). In recent years, attention has largely focussed on post-traumatic stress disorder (PTSD) (Jones and Wessely 2007), although PTSD has been shown to account for only a small percentage of mental ill-health in the UK Armed Forces, with common mental disorders and alcohol misuse making up the majority of cases (Iversen et al. 2009). A small minority of veterans drift into social exclusion, homelessness or prison; their plight has received much media attention, leading to a widespread erroneous public perception of veterans as having been physically, mentally or emotionally damaged by their time in the Armed Forces (Ashcroft 2014, Compass Partnership 2014). There has been a number of relatively short-term studies on the mental health of veterans, predominantly focussed on recent campaigns (Iversen and Greenberg 2009, Vogt et al. 2005, Ismail et al. 2002) and, in the US, longer-term studies have been conducted on Vietnam veterans, but there have been fewer studies on the long-term mental health of veterans in general, particularly in the UK. The Scottish Veterans Health Study provided an opportunity to examine whether the long-term mental health of a broad cross-section of veterans differed from that of non-veterans, and whether there were differences in specific subgroups.

7.2 Aim

The aim of this chapter is to examine the risk of mental health disorder in veterans compared with people with no record of service, to examine patterns of risk in specific subgroups, to identify trends over time, and to postulate reasons for any differences identified.

Records were available for day-case care, hospitalisation and death for the major mental health diagnoses; mood disorder, anxiety, stress and PTSD (as a subset of anxiety), psychosis, and dementia, as well as for the mental health-related outcomes of suicide and non-fatal self-harm.

7.3 Previous Studies

7.3.1 Introduction

Mental health disorders are common both in military populations and in the wider community, but may be especially so in military populations (Goodwin et al. 2015). Military personnel are recruited from the general population and are subject to many of the same stresses, including a history of adverse childhood events (Iversen et al. 2007), relationship problems (Sayers et al. 2009), health problems and worries, and financial concerns (Roberts et al. 1999), in addition to any occupational stressors to which they may have been exposed. Jones et al. identified good unit cohesion, morale and leadership as protective against mental health disorders in serving personnel (Jones et al. 2012), whilst low morale is a risk factor for PTSD (Iversen et al. 2008). Sections 7.3.2 and 7.3.3 respectively present a brief overview of key findings from major UK and US studies, whilst Sections 7.3.4 and 7.4 examine the evidence for reserve service and combat as risk factors. Section 7.4.2 presents sex differences in the incidence of mental health disorder. In view of the possible role of smoking as a determinant of veterans' health as identified in Chapters 4-6, evidence for an association between smoking and mental health disorder is described at Section 7.4.3 and subsections. Co-morbidity with mental ill-health is examined at Section 7.5, and in particular the association between mental ill-health and cardiovascular disease (Section 7.5.1).

7.3.2 UK Studies

In a cross-sectional study of UK military personnel who had deployed to Iraq, Iversen et al. found a prevalence of common mental health disorders of 28.9%, measured by PHQ[185]. The commonest disorder was alcohol abuse (18%), followed by neurotic disorders (13.5%). The prevalence of any depressive syndrome, at 11%, was comparable to that reported in the general population. There was no overall increase in prevalence of common mental disorders in regular personnel who had deployed operationally compared with those who had not deployed (Iversen et al. 2009), whilst Hacker Hughes et al. reported an improvement in overall mental health after deployment (as measured by GHQ-28[186] and Trauma Screening Questionnaire scores) in a study of 733 UK military personnel who deployed to Iraq in 2004 (Hughes et al. 2005). In Jones et al.'s study of 1,431 UK personnel who had deployed to Afghanistan in 2010, 17.1% showed caseness for common mental health disorders and 2.7% had probable PTSD (Jones et al. 2012). Many other studies have been conducted; results are generally similar. The findings from other studies will be discussed in the Commentary sections under specific conditions.

7.3.3 US Studies

In a major study of nearly 300,000 US veterans of the Iraq and Afghanistan campaigns followed up between 2002 and 2008, Seal et al. found a cumulative prevalence of 36.9% for any mental health diagnosis, of which 21.8% were for PTSD and 17.4% for depression. Young age was a risk factor for any mental health diagnosis except depression, with especially high risks for PTSD, drug and alcohol misuse compared with older veterans, whilst female veterans were at higher risk of depression. Combat exposure was associated with an increased risk of PTSD (Seal et al. 2009). A baseline assessment of data from the US Millennium Cohort Study has shown an increased risk of all mental health problems in women, including PTSD, although overall, the prevalence of mental health disorders in the military was low compared with national survey data (Riddle et al. 2007).

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[185] Patient Health Questionnaire, a structured survey instrument based on the Primary Care Evaluation of Mental Disorders (PRIME-MD) diagnostic tool developed by Pfizer Inc.

[186] General Health Questionnaire - 28, a 28-item measure of emotional distress developed by Goldberg in 1978. Sterling, M. (2011) 'General Health Questionnaire–28 (GHQ-28)', *Journal of Physiotherapy,* 57(4), 259.

7.3.4 Reserve Personnel

Many studies have consistently identified a higher risk of adverse mental health outcomes in reserve personnel who have deployed operationally. Reasons may include disruption from civilian employment, more domestic and family problems whilst deployed, and poorer supportive networks on returning home (Seal et al. 2009, Iversen and Greenberg 2009, Browne et al. 2007). As noted at Section 2.2.2.3, deployed reserve personnel could not be separately identified in the Scottish Veterans dataset and it is possible that up to around 300 (<0.2%) were included with the non-veterans. The impact of combat on the mental health of this subgroup is unlikely to have been a major confounder in this study[187].

7.4 Risk Factors

7.4.1 Combat

Combat experience is not universal for military personnel. Some join for service and leave without ever deploying operationally; either through not completing training, or through not being required to deploy despite being fully trained and operationally ready. Even among personnel who are actively engaged in war, those who directly experience combat are usually in the minority. Many operate in a trade or professional group which does not primarily have a fighting role. An effective fighting force requires strong logistic and administrative support, and many military personnel are engaged solely in supply, administration, catering and medical duties, albeit that they too can experience the effects of hostile action if, for example, an encampment comes under incoming mortar or rocket fire. Jones et al. showed that fewer than 24% of UK personnel who deployed to Iraq or Afghanistan had a combat role (Jones et al. 2013) whilst McNally reported that only 15% of male Vietnam veterans served in a combat unit (McNally 2007). In a study of 821 British Army personnel who had deployed to Iraq, Iversen et al. reported that 21% of regular personnel had fired a weapon whilst on deployment, although 68% reported feeling in danger of being killed and 56% stated that they had witnessed someone being wounded or killed (Iversen et al. 2009). Since around 100,000 UK personnel served in

[187] Deployed reservists are estimated to have made up no more than 2,600 (0.16%) of the 1.6 million non-veterans from which the comparison group of 173,000 people was drawn. A description of the methodology for estimation of numbers is at footnotes 27 and 44.

Iraq[188], with 179 deaths[189] during the entire campaign (2003-2009) and 315 individuals classified as Wounded in Action during the 3.5 years of the most intense operational activity[190], these figures seem implausible unless the sample was drawn predominantly from front-line infantry and the individuals surveyed were present during an especially intense period of fighting; notwithstanding that one casualty may be witnessed by several people. In a sample of 133 ex-service personnel who presented to an assessment service with mental health problems which they had attributed to their operational service, Palmer reported that 16% had experienced direct combat and 29% had witnessed the death or body of a comrade (Palmer 2012). Woodhead et al. found that combat experience was associated with higher levels of both common mental disorders and PTSD, but that combat exposure did not predict alcohol misuse (Woodhead et al. 2012). Frueh et al. found that, paradoxically, US soldiers who had no record of combat were more likely to report witnessing or committing battlefield atrocities than those who had been in combat (Frueh et al. 2005).

7.4.2 Sex

In the wider community, there are differences between men and women in the incidence of mental health disorder, with neurotic, affective and personality disorders being generally more common in women while psychotic disorders and drug and alcohol misuse are more common in men (Halliwell et al. 2007). Recent crude incidence ratios by sex for mental health admissions in Scotland are shown at Table 7-1. A study of personnel deployed to Iraq found an association between female gender and common mental health disorders, although other studies in deployed UK serving personnel were less clear-cut (Hunt et al. 2014) and, in particular, both Iversen and Rona have found no increased risk of PTSD in UK servicewomen (Iversen et al. 2008, Rona et al. 2007).

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188 Figures from the Ministry of Defence, quoted by the BBC http://news.bbc.co.uk/1/hi/uk_politics/8259818.stm dated 17 Sep 2009. Accessed 15 Oct 2014.

189 Figures from the Ministry of Defence http://www.mod.uk/DefenceInternet/FactSheets/OperationsFactsheets/OperationsInIraqBritishFatalities.htm accessed via The National Archives 15 Oct 2014. Of the 179 fatalities, 136 were as a result of hostile action and 43 as a result of illness, accident or non-combat injury.

190 Figures from the Ministry of Defence http://www.mod.uk/DefenceInternet/FactSheets/OperationsFactsheets/OperationsInIraqBritishCasualties.htm accessed via The National Archives 15 Oct 2014.

Table 7-1 - Mental health admissions Scotland 2011-2012. Ratio of crude female:male rates[191]

Diagnosis	Ratio F:M
All diagnoses	0.90
Dementia	1.08
Alcohol misuse	0.45
Drug misuse	0.38
Schizophrenia	0.34
Mood (affective) disorders	1.41
Bipolar affective disorder	1.41
Depressive episode	1.30
Recurrent depressive disorder	2.39
Other psychotic disorders	0.83
Disorders of childhood	0.49
Neurotic, stress-related and somatoform disorders	1.36
Personality disorders	3.35
Mental handicap	1.41
Other conditions	0.92

7.4.3 Tobacco

Many studies have reported an association between tobacco smoking and poor mental health (Lasser 2000, Lawrence et al. 2009), although the direction of causality is not clearcut (Fergusson et al. 2003). The relationship between smoking and mental health is important in view of the increased prevalence of smoking in military personnel identified in earlier publications (Lewthwaite and Graham 1992) and the increased risk of a number of smoking-related conditions in veterans which has been demonstrated in the Scottish Veterans study population. The toxic effects of nicotine[192] include increased blood pressure and heart rate and, in higher doses, abdominal pain, diarrhoea, dizziness, mental confusion, faintness and sweating[193], which may be interpreted as symptoms of anxiety. Nonetheless, many patients claim that smoking has a 'calming' effect (Dilsaver 1987). This paradox was explored in a review of the evidence on the smoking-stress relationship (Parrott 1999). In earlier studies the author had reported that smokers report increasing stress levels with time elapsed since the last cigarette, and that smoking only resulted in

[191] Source: Mental Health (Psychiatric) Hospital Activity Statistics year ending 31 March 2012. ISD Scotland 2012.

[192] Nicotine is a plant alkaloid which acts as an acetylcholine agonist. It is readily absorbed though the buccal and nasal mucosa following inhalation. With a half-life of around 2 hours, plasma levels build throughout the day with repeated smoking. It is highly addictive, activating the dopamine-mediated reward pathway in the brain.

[193] Martindale, The Extra Pharmacopoeia 26th Ed. 1972

an improvement in mood when the individual was nicotine-deprived. He therefore postulated that the 'relaxing' effect of smoking reported by established adult smokers simply reflected the relief of unpleasant nicotine abstinence symptoms which had built up since the last cigarette. Overall, the fluctuating moods reported by smokers as their nicotine levels wax and wane lead to higher overall levels of stress and anxiety than in non-smokers. Studies on adolescents have also demonstrated a gradient of increasing stress levels from non-smokers to occasional smokers to regular smokers (Lloyd and Lucas 1998) although the relationship is complex as perceived stress may also be related to smoking uptake. The effect of smoking cessation was to ameliorate stress levels provided that there was total abstinence; lapsed quit attempts or occasional smoking negated any benefit (Parrott 1999).

7.4.3.1 Smoking and Post-Traumatic Stress Disorder

In the light of studies on the relationship between smoking and stress (Parrott 1999), an association between smoking and PTSD may be predicted. A systematic review of the published literature (Fu et al. 2007) identified 45 primary studies in English on the relationship between smoking and PTSD and showed that individuals with PTSD were more likely to be smokers than those without PTSD, and to smoke more heavily. The difference persisted after adjusting for confounders. Quit rates were also lower in those with PTSD. The prevalence of smoking among those with PTSD ranged from 34% to 86%, with an average of 45% for current smoking and 63% for lifetime smoking. By contrast, only 26% of UK adults in 2000, and 20% in 2012, were current smokers (Health & Social Care Information Centre 2014). Eight out of 10 studies showed a positive association between smoking and PTSD, in comparison with individuals without PTSD; odds ratios ranged from 2.04 to 4.52. Following exposure to trauma, smoking increased in those with PTSD compared to those who had been exposed to the same trauma but did not develop PTSD. The direction of causality was less clear, in other words whether smoking predisposed to PTSD or PTSD predisposed to smoking, and the authors concluded that the evidence suggests bidirectionality. Several studies included in the review examined military groups, including Vietnam combat veterans; one study found that combat veterans with PTSD were more likely to be heavy smokers (≥25 cigarettes per day) than combat veterans without PTSD. The association between level of nicotine dependence and PTSD symptoms was stronger for male smokers than for female smokers (Fu et al. 2007).

The view that PTSD predisposes to smoking, implying that that individuals start smoking after the traumatic event, is inconsistent with the evidence on age at smoking initiation. Analysis of the US National Comorbidity Survey Replication showed that the median age of onset of PTSD in the USA was 23 years (Kessler and Berglund 2005), whilst 90% of American smokers have started smoking by the age of 18 years and only 1% commence smoking after the age of 26 years (National Cancer Institute 2012). It is more plausible that the majority of adults who smoke after having been exposed to a traumatic incident are either already established smokers or ex-smokers who relapse following the incident. Data on the latter appear lacking; whilst a number of studies have examined quit rates in individuals with established PTSD, no studies have been identified which estimate the risk of relapse after a traumatic event, with or without PTSD, in those whose had previously quit. A major cohort study failed to discuss concurrent psychological trauma in the context of quit failure (Zhou et al. 2009), although there is other evidence that PTSD is likely to result in an individual restarting smoking after a quit attempt (Zvolensky et al. 2008).

These studies suggest that there is a complex relationship between anxiety symptoms, including PTSD, and smoking, and that military personnel who smoke may be more susceptible to PTSD (for reasons which may be shared or causal) or, alternatively, may be smoking in consequence of exposure to trauma. Support for the latter is provided by DiNicola et al., who found that 35% of US personnel serving in Afghanistan in 2011 cited 'stress' as their reason for smoking (DiNicola et al. 2011), albeit that the term may have encompassed job or personal stress, as identified by Hodgson (Hodgson 1997), as well as traumatic stress.

7.5 Co-Morbidity

7.5.1 Mental Illness and Cardiovascular Disease

A positive association between cardiovascular disease and veteran status, in the Scottish Veterans Health Study, has been demonstrated at Chapter 4, and this section will explore the evidence for an association between mental illness and cardiovascular disease. This has been postulated for many years, initially based on empirical observations of patients in mental health in-patient facilities (Tsuang et al. 1983). Mental illness is commonly associated with multiple cardiovascular risk factors and their relative roles are difficult to separate, as is the direction of effect. Obesity, tobacco smoking, alcohol misuse and drug abuse are all common in mental health patients and are all independently associated with cardiovascular risk (Kendrick 1996). A 15 year UK study (1987-2002) using data derived from the General Practice Research Database examined 46,136 patients with severe mental illness and 300,426 controls and found a significantly increased risk of death from CHD in mental health patients aged 18-75 years even after adjusting for age, sex, smoking and social deprivation, adjusted HR 2.88, 95% CI 1.77-2.88 for age 18-49 years and 1.76, 95% CI 1.54-2.01 for age 50-75 years. There was also an increased risk of stroke in older patients with severe mental illness, adjusted HR 1.83, 95% CI 1.45-2.31 for age 50-75 years and 1.33, 95% CI 1.16-1.52 for age 75 years and over. The authors also examined cancer mortality in patients with severe mental illness and found an increase for respiratory cancers in those aged 50-75 years, HR 1.32, 95% CI 1.04-1.68, but not for other common cancers, although the difference for respiratory cancers became non-significant when adjusted for smoking, deprivation and other confounders (Osborn and Levy 2007).

A comprehensive review examined 88 papers published between 1964 and 2005 on the link between depression and CHD and concluded that there was evidence to support a causal role for depression in CHD (Frasure-Smith and Lesperance 2006). The study was updated to include papers published to 2009 and a meta-analysis gave an effect size of 1.5-2.7, depending on the definition of CHD and the covariates for which adjustment was made (Frasure-Smith and Lesperance 2010). Although there was good evidence to show an association between depression and CHD, proof of causation was lacking; the authors recommended that further research into causality was of less importance than improving outcomes in depressed patients.

The association between anxiety and CHD was explored as a nested case-control study in the US Normative Aging Study of 2,280 men aged 21 to 80 years at baseline in 1961 who were followed up for 32 years (Kawachi et al. 1994b). The 402 cases who developed CHD were compared with 1,869 CHD-free controls and significant associations were found to occur with age, BMI, cholesterol and blood pressure. There was no increase in age-adjusted OR or multi-variable OR with level of anxiety (assessed using a scale constructed for the study) for total CHD, non-fatal MI or non-fatal CHD but there was an elevated age-adjusted OR for fatal CHD, OR 3.20, 95% CI 1.27-8.09. This became non-significant when adjusted for smoking, BMI, blood pressure, cholesterol, alcohol and family history of heart disease, OR 1.94, 95% CI 0.70-5.41. There was an increased risk for sudden cardiac death although the numbers were very small. The Northwick Park Heart Study, a prospective study drawn from three occupational groups in north-west London, examined psychological profiles of the 127 participants out of 1408 who completed a questionnaire and were free of IHD at baseline who developed fatal IHD during the 25 year follow-up period to 1997 and found a positive association for both obsessional neurosis and functional somatic complaints (Haines et al. 2001). In a shorter follow-up, the Northwick Park Heart Study also demonstrated a strong association between anxiety and IHD in a subset of 1,457 white men aged 40-64, of whom 105 had a first major episode of IHD during follow-up to 1993. Fatal cases scored particularly strongly for phobic anxiety, RR 3.77, 95% CI 1.64-8.64, although the later study showed that this association diminished in a linear fashion with time elapsed since questionnaire completion. The associations remained significant even after adjusting for smoking and other cardiovascular risk factors (Haines et al. 1987). These findings were supported by the US Health Professionals Follow-up Study (Kawachi et al. 1994a). Questionnaires were received from 33,999 men aged 42-77 who were free of known cardiovascular disease at baseline in 1988. At the two year point there had been 168 cases of IHD, of which 40 were fatal. There was no association between phobic anxiety and non-fatal MI but there was a dose-response relationship with fatal MI with an age-adjusted RR of 3.01, 95% CI 1.31-6.90 for the highest phobic anxiety score. The excess risk persisted after controlling for BMI, smoking, diabetes, hypertension, cholesterol, family history, alcohol and physical activity, adjusted RR 2.5, 95% CI 1.00-5.96. An association between mental ill-health and cardiovascular disease therefore appears clear.

7.6 Hypothesis

As veterans are a subset of the wider population, the start point was the null hypothesis that their risk of mental health disorder would not differ from that of non-veterans. However, an increase in the risk of common mental health disorders has been demonstrated in the serving population (Goodwin et al. 2015), and the Scottish Veterans

Health Study has already demonstrated increased risk of lifestyle-related illness, including cardiovascular disease and the smoking and alcohol related cancers, in the earliest birth cohorts and in those with the shortest service (Chapters 4-6). It may therefore be postulated that owing to shared risk factors, the same subgroups would exhibit a higher risk of mental health disorder. This hypothesis was tested, overall and by subgroup, using the same methodology as for cardiovascular disease and cancer.

The role of combat is more difficult to assess in the Scottish Veterans Health Study, in the absence of data on individual deployment histories; inference of deployment history from knowledge of major military operations in relation to specific periods of service is possible, although it remains speculative in its impact on specific individuals. Furthermore, wider societal trends may also impact on the mental health not only of the veterans but also of the comparison group of non-veterans; for example, changes in economic milieu and unemployment levels.

Results

7.7 Initial Mental Health Data Analysis

Data were available on a range of primary mental health diagnoses including mood disorders, anxiety, stress or PTSD (as a subset of anxiety), psychosis and dementia, and on mental health-associated outcomes including alcoholic liver disease, alcohol-related death, suicide and self-harm. The data were drawn from SMR01 general hospital admission data, SMR04 mental health inpatient and hospital day case data, and death certificates, and therefore reflect only the more severe end of the spectrum of mental ill-health; they are not representative of the overall incidence of mental health conditions in either veterans or non-veterans. The assumption has been made that there are no systematic differences in the likelihood of admission or day case treatment between veterans and non-veterans, other than the incidence and severity of disease, and therefore the relative magnitude of severe cases will equate to the relative magnitude of total cases.

The crude incidence for any primary mental health diagnosis, and for each diagnosis individually, is shown at Section 1 of Table 7-2. For the category of 'any mental health diagnosis', the analysis was restricted to the first recorded episode, in order to eliminate double counting. There was a statistically significant higher crude incidence in veterans for all diagnoses except dementia, where there was no difference, and psychosis, where the odds ratio was lower in veterans. The OR for stress or PTSD was very much higher in veterans (OR 1.61, 95% CI 1.47-1.78, p<0.001), but inspection of the data showed that dual diagnosis (stress/PTSD plus another mental health diagnosis) was common, and as the codes for stress/PTSD were a subset of the codes for anxiety, there had been some double counting in this group. Accordingly, the analysis was repeated, excluding anyone with a diagnosis of stress/PTSD at any position in the record. This showed that there were no significant differences in odds ratio for a diagnosis of mental health disorder between veterans and non-veterans after excluding anyone with a recorded diagnosis of stress or PTSD, other than for psychosis where the reduction in OR in veterans was highly significant, as shown at Section 2 of the table. The third section examines mental health-related outcomes and shows no significant differences in crude incidence for suicide, although the overall risk of non-fatal self-harm was significantly increased in the veterans.

Table 7-2 – Crude cumulative incidence of mental health outcomes in veterans and non-veterans (with ICD codes)

	ICD-9/ICD-10 Code	Veterans *n*=56,205 n (%)	Non-veterans *n*=172,741 n (%)	p value[194]
Primary diagnoses				
Any mental health diagnosis[195]	All codes below	2,794 (4.97)	7,779 (4.50)	<0.001
Mood disorders	F30-F39, 296	1,578 (2.81)	4,371 (2.60)	<0.001
Anxiety	F40-F48, 300, 308-309	1,415 (2.52)	3,512 (2.03)	<0.001
Stress/PTSD	F43, 308-309	630 (1.12)	1,200 (0.69)	<0.001
Psychosis	F20-F29, 295	537 (0.96)	1,867 (1.08)	0.011
Dementia	G30, F00-F03, 290, 331.0	66 (0.12)	191 (0.11)	0.673
Primary diagnoses after excluding PTSD				
Any mental health diagnosis[196]	All codes below	2,164 (3.85)	6,579 (3.81)	0.654
Mood disorders	F30-F39, 296	1,309 (2.33)	3,881 (2.25)	0.203
Anxiety	F40-F48 (less F43), 300	785 (1.40)	2,312 (1.34)	0.253
Psychosis	F20-F29, 295	470 (0.84)	1,711 (0.99)	0.001
Dementia	G30, F00-F03, 290, 331.0	62 (0.11)	184 (0.11)	0.789
Secondary outcomes				
Suicide	See Section 7.12	267 (0.48)	918 (0.53)	0.106
Non-fatal self-harm	See Section 7.13	1,628 (0.29)	4,247 (0.25)	<0.001

[194] p values for odds ratios

[195] Mood disorders, anxiety, psychosis, stress/PTSD

[196] Mood disorders, anxiety, psychosis

Detailed analyses of individual diagnoses and mental health-related outcomes were undertaken in order to explore patterns of risk in veterans, overall and by subgroup.

7.8 Mood Disorder

Mood disorder was defined as the occurrence of ICD-9 code 296 or ICD-10 codes F30-F39, at any position in the record. As with all mental health disorders discussed in this chapter, the data reflect only the more severe cases and are not representative of overall incidence within the community, either in veterans or non-veterans.

7.8.1 Incidence

7.8.1.1 Overall

Over the period of the study, 1,578 veterans and 4,371 non-veterans were recorded as having a diagnosis of mood disorder, equating to a cumulative incidence of 2.81% in veterans and 2.60% in non-veterans. Using Cox proportional hazard analysis, veterans had a statistically significant increase in risk compared with non-veterans, unadjusted HR 1.22, 95% CI 1.15-1.29, p<0.001 (Figure 7-1). The difference remained significant after adjusting for deprivation, although it was slightly attenuated, HR 1.16, 95% CI 1.09-1.23, p<0.001. The hazard ratio for mood disorder after excluding anyone with a diagnosis of stress or PTSD was lower, although it remained significantly increased for veterans, HR 1.13, 95% CI 1.06-1.21, p<0.001 in the unadjusted model, HR1.09, 95% CI 1.02-1.16, p=0.012 after adjusting for deprivation. Testing for non-proportionality of the hazards was non-significant, p=0.215.

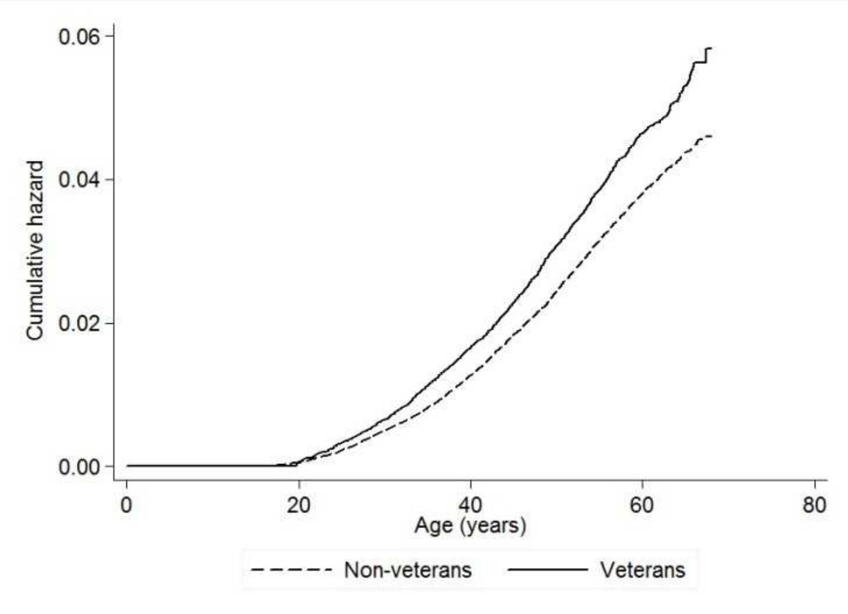

Figure 7-1 – Nelson-Aalen plot of all mood disorder by veteran status

7.8.1.2 Sex

Mood disorder affected 3.38% of veteran women (177 cases) compared with 3.48% of non-veteran women (722 cases) and 2.75% of veteran men; the crude cumulative incidence for non-veteran men was 2.49%. The difference in risk of all mood disorder between veteran women and non-veteran women was not statistically significant, HR 1.05, 95% CI 0.88-1.24, p=0.604 in the unadjusted model and HR 1.02, 95% CI 0.87-1.21, p=0.775 after adjusting for deprivation, but for men it was significantly increased, unadjusted HR 1.26, 95% CI 1.18-1.34 and HR 1.20, 95% CI 1.13-1.28, p<0.001 after adjusting for deprivation. In both veterans and non-veterans, women had an increased risk of mood disorder compared with men, but the increase was greater in non-veteran women. For veterans, the hazard ratios for mood disorder in women referent to men were 1.32, 95% CI 1.13-1.55, p=0.001 unadjusted and 1.20, 95% CI 1.20-1.28, p<0.001 adjusted for deprivation, whilst for non-veterans the corresponding hazard ratios were 1.61, 95% CI 1.49-1.75, p<0.001 and 1.67, 95% CI 1.55-1.81, p<0.001.

7.8.1.3 Age

Veterans were slightly older at first recorded episode of mood disorder than were non-veterans, mean ages 43.6 years (SD 9.6) for veterans and 42.5 years (SD 10.1) for non-veterans. Overall there was little difference in the distribution of age at first recorded episode (Figure 7-2).

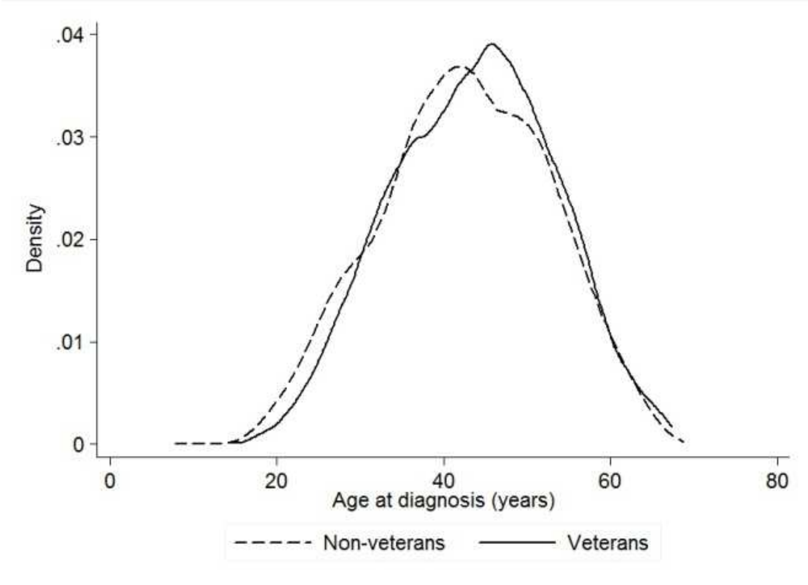

Figure 7-2 - Kernel density plot of age at first recorded episode of mood disorder

Veterans with a diagnosis of mood disorder who were Early Service Leavers had an earlier age at diagnosis than non-ESL veterans; mean 42.5 years (SD 9.8) for ESL compared with 44.4 years (SD 9.4)) for longer-serving veterans. Veterans with mood disorder did not differ in age at recruitment from all veterans (Figure 7-3).

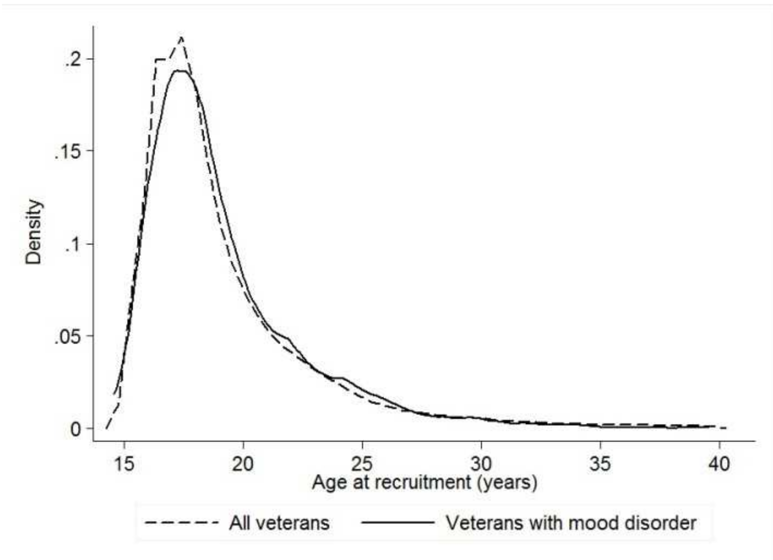

Figure 7-3 - Kernel density plot of age at recruitment Veterans with mood disorder & all veterans

7.8.1.4 Birth Cohort

Analysis by birth cohort, for all mood disorder and examining men and women together, showed a statistically significant increase in risk only for the oldest birth cohorts, 1945-1954 (Figure 7-4). There was a gradual decrease in risk from the oldest birth cohorts to the 1970-1974 cohort. There was then some evidence of increasing risk in the youngest birth cohorts, giving a U-shaped curve, although the confidence intervals were wide in the latter subgroups.

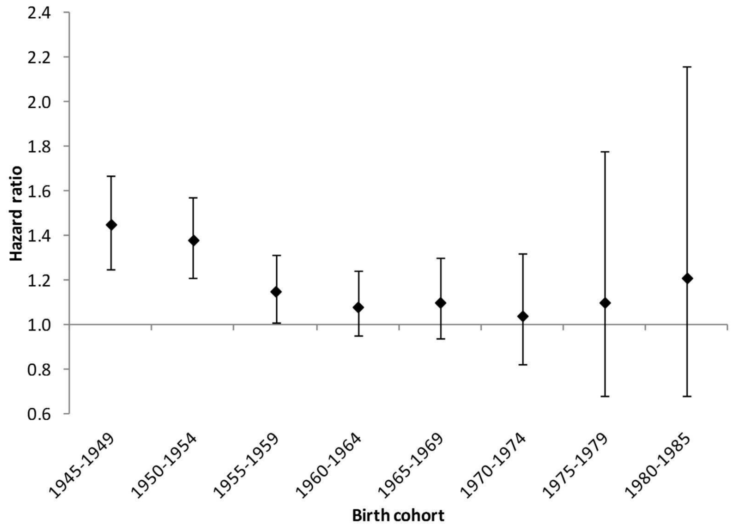

Figure 7-4 - Hazard ratios for mood disorder by birth cohort Veterans referent to non-veterans

When people with a co-morbid diagnosis of stress or PTSD were excluded, the hazard ratios were close to unity, except for the two oldest birth cohorts, where the increase in risk persisted (Figure 7-5). The evidence for a U-shaped curve was much less apparent.

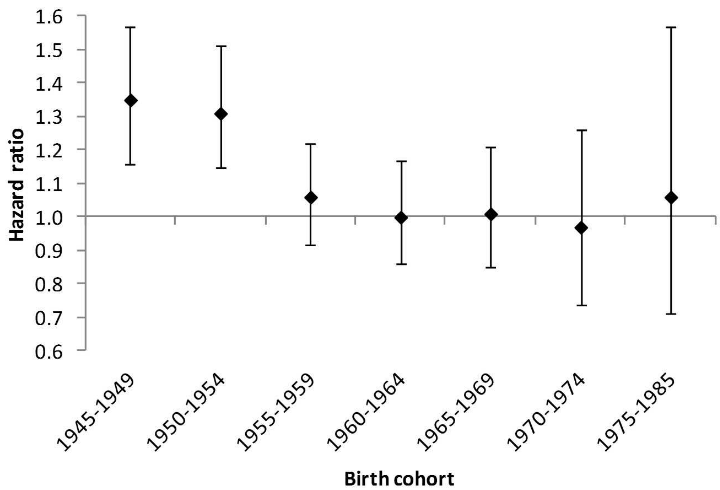

Figure 7-5 - Hazard ratios for mood disorder less PTSD, by birth cohort Veterans referent to non-veterans

The kernel density plot of mood disorder by year of birth confirmed the increased risk in older veterans (Figure 7-6).

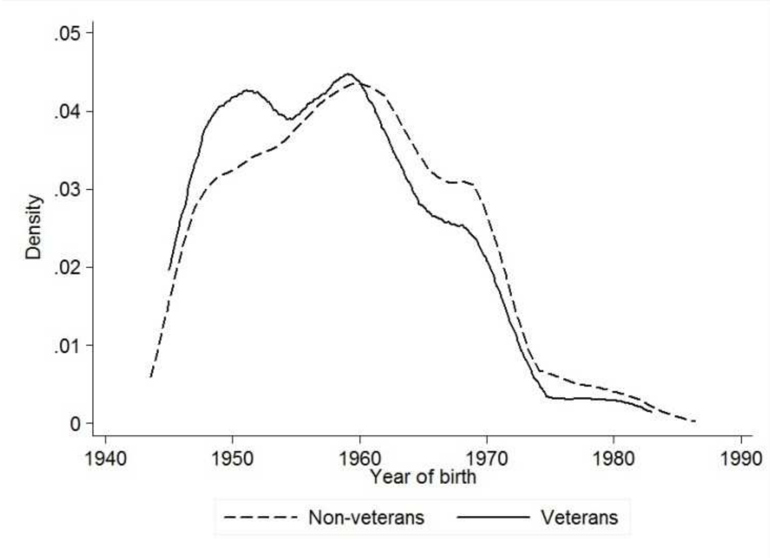

Figure 7-6 - Kernel density plot of mood disorder by year of birth Veterans and non-veterans

7.8.1.5 Length of Service

When analysed by length of service, there was a clear gradient, with those veterans who had served for the shortest length of time (Early Service Leavers) having the greatest increase in risk of any mood disorder. Veterans who had served for longest had a lower risk of mood disorder than the non-veteran population (Figure 7-7).

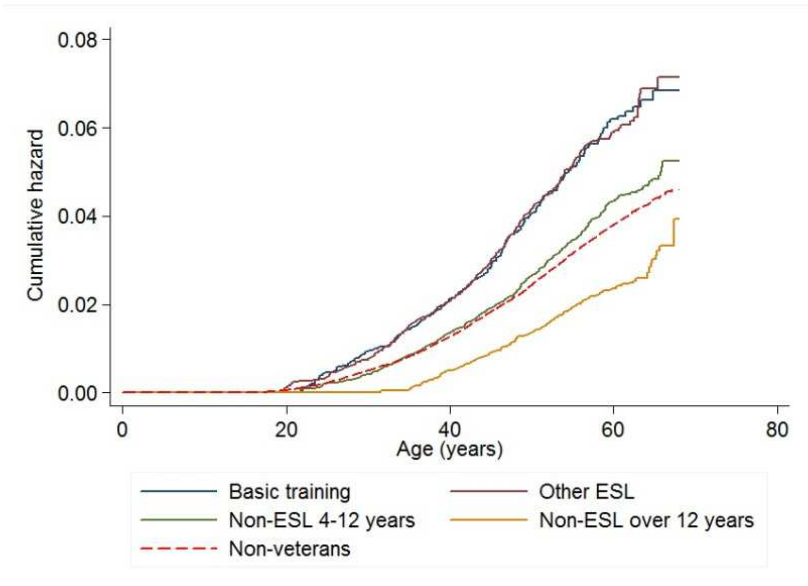

Figure 7-7 - Hazard ratios for all mood disorder by length of service Non-veterans for comparison

A detailed breakdown by length of service and birth cohort demonstrated the increased risk in all ESL, the reducing risk with longer service, the higher risk in the earlier birth cohort, and the protection enjoyed by those with the longest service (Table 7-3).

Table 7-3 - Cox proportional hazard model of the association between veteran status and mood disorder, overall and stratified by length of service and birth cohort

	Veteran cases	All Veterans *n*-56,205			Born 1945-1959 *n*=29,709			Born 1960-1985 *n*=26,496		
	n	HR	95% CI	p	HR	95% CI	p	HR	95% CI	p
Overall										
Univariate	1,578	1.22	1.15-1.29	<0.001	1.32	1.22-1.42	<0.001	1.09	1.00-1.20	0.057
Multi-variable	1,578	1.16	1.09-1.23	<0.001	1.25	1.15-1.35	<0.001	1.08	0.99-1.19	0.088
Length of service in 8 categories										
Basic training	242	1.60	1.40-1.82	<0.001	1.75	1.48-2.07	<0.001	1.50	1.22-1.85	<0.001
ESL (0-3 years)	462	1.56	1.42-1.72	<0.001	1.66	1.46-1.89	<0.001	1.51	1.31-1.76	<0.001
4-6 years	329	1.27	1.13-1.42	<0.001	1.42	1.23-1.65	<0.001	1.10	0.92-1.32	0.287
7-9 years	201	1.14	0.99-1.32	0.078	1.25	1.04-1.51	0.019	0.98	0.78-1.22	0.835
10-12 years	119	0.86	0.71-1.04	0.118	0.98	0.77-1.25	0.899	0.68	0.50-0.93	0.016
13-16 years	95	0.94	0.67-1.18	0.627	1.14	0.87-1.49	0.344	0.68	0.47-0.96	0.031
17-22 years	76	0.85	0.66-1.09	0.192	0.91	0.69-1.22	0.547	0.70	0.43-1.15	0.159
≥23 years	51	0.53	0.39-0.71	<0.001	0.59	0.43-0.81	0.001	0.31	0.12-0.74	0.009

7.8.1.6 Geographical Region

When analysed geographically, the overall increased risk of mood disorder in veterans was higher in the urban Central Belt regions than in the more rural Borders, Highlands and Islands. When cases of co-morbid PTSD were excluded, the increase in risk became non-significant in the more rural areas (Table 7-4).

Table 7-4 - Cox proportional hazard model of the association between veteran status and mood disorder, stratified by region

Region	Veteran cases *n*	Univariate			Multi-variable		
		HR	95% CI	p value	HR	95% CI	p value
All mood disorder							
Central Belt (South)	670	1.20	1.10-1.31	<0.001	1.13	1.03-1.23	0.010
Central Belt (North)	549	1.29	1.17-1.43	<0.001	1.23	1.11-1.36	<0.001
Borders, Highland & Islands	359	1.16	1.02-1.31	0.016	1.13	1.00-1.28	0.048
All mood disorder excluding co-morbid PTSD							
Central Belt (South)	561	1.14	1.03-1.25	0.009	1.08	0.98-1.18	0.124
Central Belt (North)	445	1.17	1.04-1.31	0.006	1.12	1.01-1.26	0.040
Borders, Highland & Islands	303	1.08	0.94-1.23	0.264	1.04	0.91-1.19	0.557

7.8.2 Co-Morbidity

Odds ratios comparing veterans with non-veterans for a range of co-morbidities with mood disorder were calculated and the results are summarised at Table 7-5, together with crude cumulative incidences, for people with mood disorder and overall, for each condition. The commonest physical co-morbidities with mood disorder were COPD, cardiovascular disease, diabetes and peptic ulcer. Although the crude odds ratios indicated a higher incidence in veterans compared with non-veterans for all conditions examined except for alcoholic liver disease, where there was a reduction, statistical significance was only achieved for cardiovascular disorders, alcoholic liver disease, and also for colorectal cancer although in the case of the latter, the absolute incidence in the comparison group of non-veterans with mood disorder appears very low. Among mental health conditions, 30% of veterans and 25% of non-veterans also had a diagnosis of anxiety. The difference was entirely accounted for by diagnoses of co-morbid stress or PTSD in the veterans. The only secondary outcome for which veterans had a significantly increased risk of co-morbidity with mood disorder was non-fatal self-harm. Veterans with mood disorder were at significantly reduced risk of suicide compared with non-veterans.

Table 7-5 - Risk of selected co-morbidities with mood disorder in veterans and non-veterans

	Veterans		Non-veterans		Veteran cases compared to non-veteran cases		
	Cases *n*=1,578 No. (%)	Pop. *n*=56,205 (%)	Cases *n*=4,371 No. (%)	Pop. *n*=172,741 (%)	OR	95% CI	p
Physical							
COPD	229 (14.5)	(4.3)	612 (14.0)	(4.5)	1.04	0.90-1.19	0.618
Diabetes	146 (9.3)	(3.4)	380 (8.7)	(3.3)	1.06	0.89-1.28	0.503
Any cancer	142 (9.0)	(6.4)	375 (8.6)	(6.7)	1.05	0.87-1.26	0.612
Peptic ulcer	133 (8.4)	(3.4)	305 (7.0)	(3.0)	1.21	0.99-1.47	0.059
AMI	112 (7.1)	(3.7)	221 (5.1)	(1.6)	1.40	1.13-1.75	0.003
Alcoholic liver disease	75 (4.8)	(1.2)	277 (6.3)	(1.3)	0.75	0.58-0.96	0.022
PAD	54 (3.4)	(1.2)	103 (2.4)	(0.8)	1.45	1.05-2.01	0.024
Stroke	50 (3.2)	(1.0)	95 (2.1)	(0.8)	1.46	1.04-2.04	0.028
Lung cancer	20 (1.3)	(0.8)	40 (0.9)	(0.6)	1.38	0.81-2.36	0.230
Colorectal cancer	21 (1.3)	(0.6)	24 (0.5)	(0.6)	2.42	1.35-4.34	0.002
Prostate cancer	11 (0.6)	(0.4)	15 (0.3)	(0.4)	2.03	0.93-4.41	0.068
Mental							
Anxiety	477 (30.2)	(2.5)	1102 (25.2)	(2.0)	1.20	1.10-1.31	<0.001
Stress/PTSD	269 (17.0)	(1.1)	490 (11.2)	(0.7)	1.52	1.33-1.74	<0.001
Anxiety less stress/PTSD	208 (15.9)	(1.4)	612 (15.8)	(1.3)	1.01	0.87-1.16	0.917
Psychosis	206 (13.1)	(1.0)	708 (16.2)	(1.1)	0.81	0.70-0.93	0.003
Dementia	15 (0.9)	(0.1)	24 (0.5)	(0.1)	1.73	0.91-3.29	0.090
Secondary outcomes							
Non-fatal self-harm	605 (39.3)	(2.9)	1496 (35.5)	(2.5)	1.11	1.03-1.19	0.008
Road traffic accident	358 (22.7)	(14.1)	953 (21.8)	(14.6)	1.04	0.93-1.16	0.468
Alcohol-related death	45 (2.9)	(0.6)	114 (2.6)	(0.7)	1.09	0.78-1.54	0.607
Suicide	41 (0.3)	(0.5)	160 (0.4)	(0.5)	0.71	0.51-1.00	0.045

7.8.3 Medication

Prescribing data were only available from 2009; therefore, only cases of mood disorder first recorded from 2009 onwards were examined. A total of 209/248 (84.3%) of these veterans and 696/815 (85.4%) non-veterans with mood disorder were prescribed antidepressants. The difference was non-significant, OR 0.99, 95% CI 0.93-1.05, p=0.663. A further 7 veterans and 36 non-veterans with mood disorder were prescribed an anxiolytic; analysing antidepressant and anxiolytic prescriptions together gave a similar OR, 0.97, 95% CI 0.92-1.02, p=0.227.

7.8.4 Case-Fatality

The mean follow-up from date of first admission for mood disorder to the date of death or the end of the study on 31 December 2012 was 9.94 years (range 0-31.95 years) for veterans and 9.37 years (range 0-31.89 years) for non-veterans, representing 15,685 person-years of follow-up in the veterans and 40,956 person-years in the non-veterans. There were 274 (17.4%) deaths in veterans with mood disorder, equating to 17.5 per 1,000 person-years, and 770 (17.6%) deaths in non-veterans (18.8 per 1,000 person-years). The commonest cause of death was IHD or AMI (45 (1.3%) veterans and 96 (0.9%) non-veterans).

7.9 Anxiety Including Post-Traumatic Stress Disorder

Cases were recorded as having a diagnosis of anxiety if they had received day case treatment or in-patient care for conditions coded as ICD-9 300, 308 or 309, or ICD-10 F40-F48 at any position in the record, or if any of these codes was recorded on the death certificate. These codes encompassed diagnoses of stress reaction and PTSD, ICD-9 308 and 309 and ICD-10 F43, which were able to be separately identified.

7.9.1 Incidence

7.9.1.1 Overall

Over the period of the study, 1,415 veterans had a diagnosis of anxiety compared with 3,512 non-veterans, equivalent to a cumulative incidence of 2.52% and 2.03% respectively. The increase in risk in veterans was highly statistically significant, unadjusted HR 1.41, 95% CI 1.33-1.51, p<0.001. The difference was attenuated but remained statistically significant after adjusting for deprivation, HR 1.36, 95% CI 1.27-1.45, p<0.001. The difference is shown at Figure 7-8, and demonstrates an unusual pattern with a steeper rise in the younger veterans, contrasting with non-veterans where the risk increased more gradually with age. The Cox model was therefore not reliable, and formal testing for non-proportionality of the hazards was highly significant, p<0.001. Using a landmark age of 30 years to exclude the period of rapid increase in risk in the veterans rendered the *estat phtest* test for non-proportionality of the hazards non-significant, p=0.085; the hazard ratio remained highly significant, HR 1.34, 95% CI 1.25-

1.44, p<0.001 unadjusted and HR 1.30, 95% CI 1.21-1.39, p<0.001 after adjusting for deprivation.

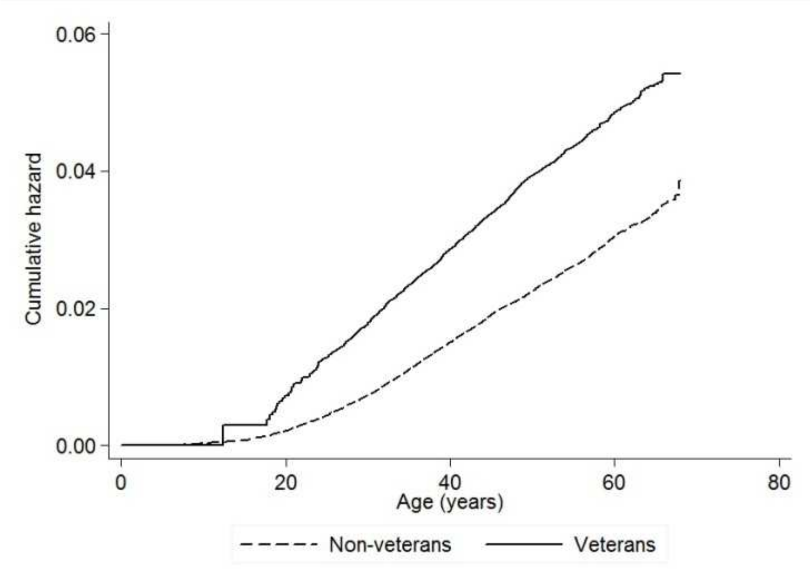

Figure 7-8 – Nelson-Aalen plot of anxiety by veteran status

Among the cases of anxiety, 630 (1.12%) veterans and 1,200 (0.69%) non-veterans had a diagnosis of stress or PTSD, equating to 44.52% of the veteran cases and 34.17% of non-veteran cases. If cases of anxiety with a diagnosis of stress or PTSD were excluded (Figure 7-9), the increased risk in veterans was reduced although it remained highly significant, unadjusted HR 1.18, 95% CI 1.09-1.28, p<0.001 and HR 1.14, 95% CI 1.05-1.24, p=0.002 after adjusting for deprivation. Testing for non-proportionality of the hazards remained highly significant, p=0.001. However, using a landmark age of 30 years to exclude the period of rapid rise in risk in veterans, the *estat phtest* test for non-proportionality of the hazards was no longer significant, p=0.061, and the increase in risk in veterans was greatly attenuated, unadjusted HR 1.12, 95%CI 1.02-1.23, p=0.014, and became non-significant after adjusting for deprivation, HR 1.08, 95% CI 0.99-1.19, p=0.085. The revised Nelson-Aalen plot at Figure 7-10 confirms that there was little difference in risk of anxiety in veterans and non-veterans aged over 30 years after excluding diagnoses of stress and PTSD.

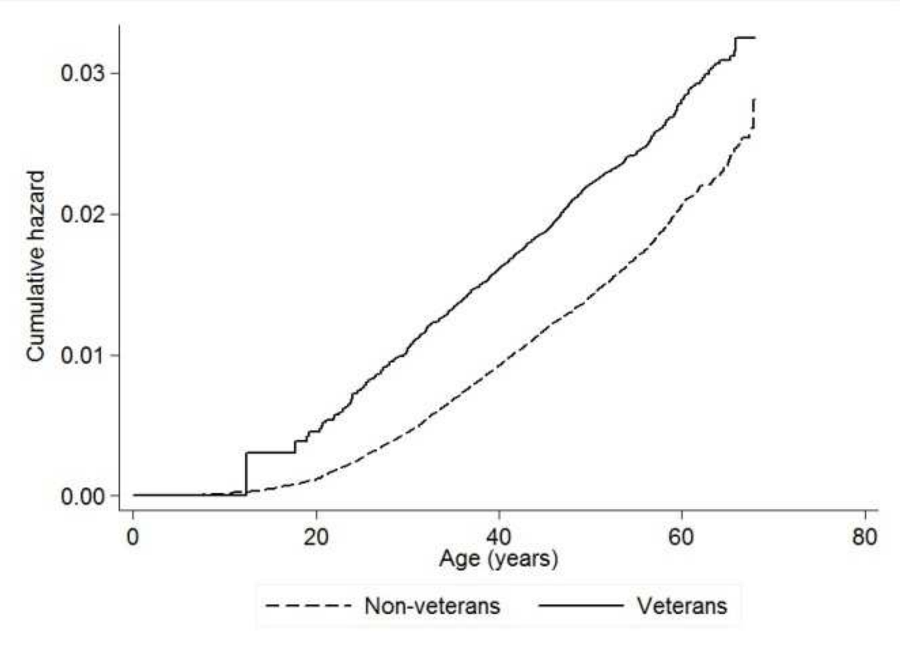

Figure 7-9 – Nelson-Aalen plot of anxiety excluding stress/PTSD by veteran status

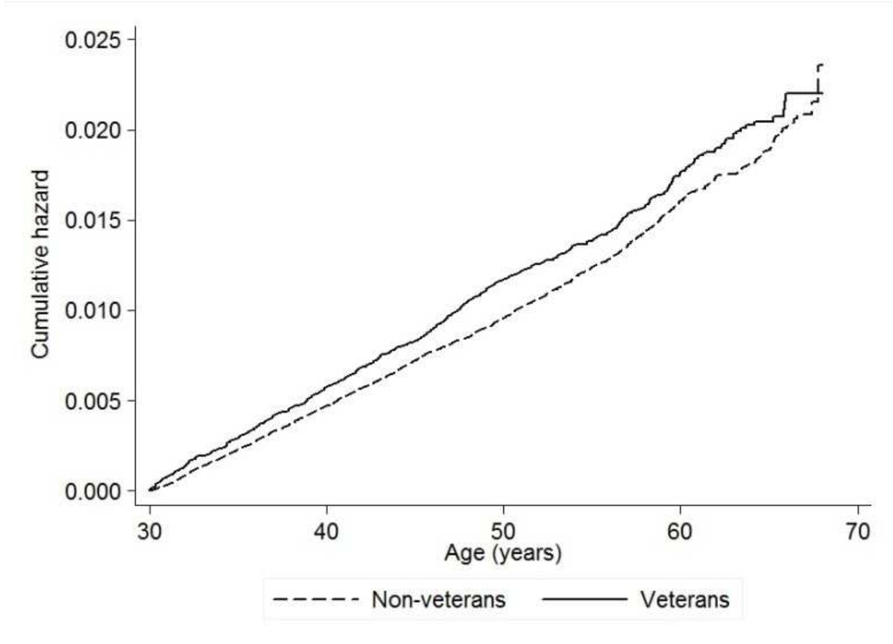

Figure 7-10 - Nelson-Aalen plot of anxiety excluding stress/PTSD by veteran status, landmark age 30 years

In both Figure 7-8 and Figure 7-9, whereas the risk of anxiety increased smoothly with age in the non-veterans, there was a step change in risk in the veterans corresponding to the youngest age for military service, which was not seen in any of the physical conditions or in mood disorder. This will be further explored in subsequent sections.

7.9.1.2 Sex

There were 139 (2.66%) cases of anxiety in veteran women compared with 566 (2.73%) in non-veteran women. The difference was not statistically significant either unadjusted, HR 1.10, 95% CI 0.90-1.33, p=0.343, or after adjusting for deprivation HR 1.07, 95% CI 0.88-1.30, p=0.472. In men, there were 1,276 (2.50%) cases in veterans and 2,946 (2.08%) cases in non-veterans. The difference was highly significant, unadjusted HR 1.48, 95% CI 1.38-1.58, p<0.001 and after adjusting for deprivation HR 1.42, 95% CI 1.32-1.52, p<0.001. Veteran women were not at statistically significantly increased risk of anxiety compared with veteran men, unadjusted HR 1.10, 95% CI 0.91-1.32, p=0.330, whilst for non-veterans, women had a greatly increased risk of anxiety compared with men, unadjusted HR 1.50, 95% CI 1.38-1.65, p<0.001. Both hazard ratios were similar after adjusting for deprivation. However, if stress and PTSD diagnoses were excluded, veteran women were at higher risk of anxiety than veteran men, unadjusted HR 1.43, 95% CI 1.15-1.79, p=0.002, similar to non-veteran women referent to men where the hazard ratio was 1.59, 95% CI 1.43, 95% CI 1.43-1.77, p<0.001. Again, the hazard ratios were little changed after adjusting for deprivation. Female veterans were at lower risk of stress or PTSD than were male veterans although the difference was not statistically significant, adjusted HR 0.75, 95% CI 0.54-1.04, p=0.081. For non-veterans, the reverse was the case, with the risk of stress or PTSD for non-veteran women being statistically significantly higher than for non-veteran men, HR 1.42, 95% CI 1.21-1.67, p<0.001.

7.9.1.3 Age

Mean age at first record of anxiety was 40.0 years (SD 10.4) for veterans and 39.4 years (SD 10.9) for non-veterans, examining men and women together. If stress and PTSD were excluded, the mean ages were slightly higher, 40.7 years (SD 11.0) for veterans and 40.4 years (SD 11.3) for non-veterans. The kernel density plot showed a similar distribution for both veterans and non-veterans (Figure 7-11), but indicated that a higher proportion of cases in non-veterans were diagnosed under the age of 40 years, whilst the reverse was the case for veterans.

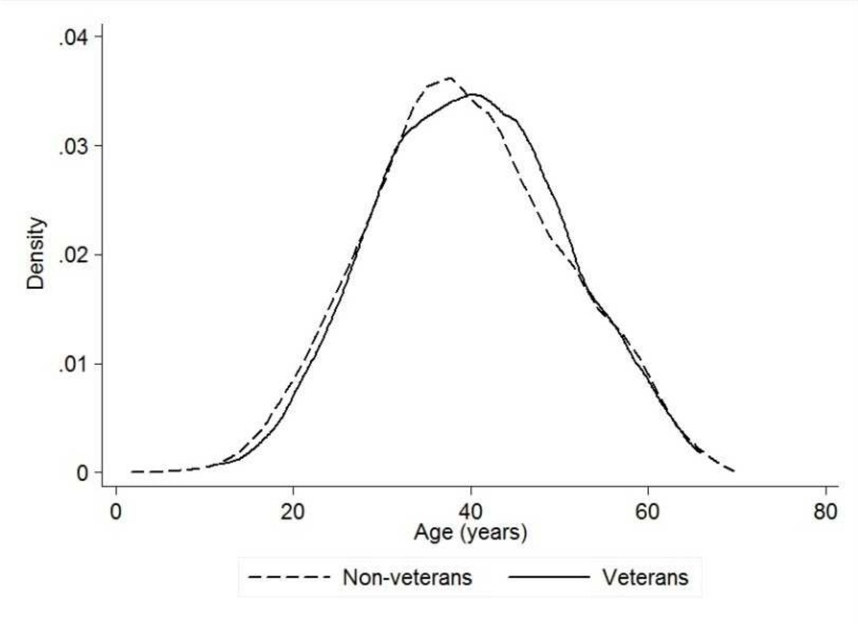

Figure 7-11 - Kernel density plot of age at first recorded episode of anxiety Veterans and non-veterans

For stress and PTSD, the kernel density plot showed a similar pattern (Figure 7-12). The mean age at presentation was 39.7 years (SD 9.7) for veterans and 38.1 years (SD 9.7) for non-veterans.

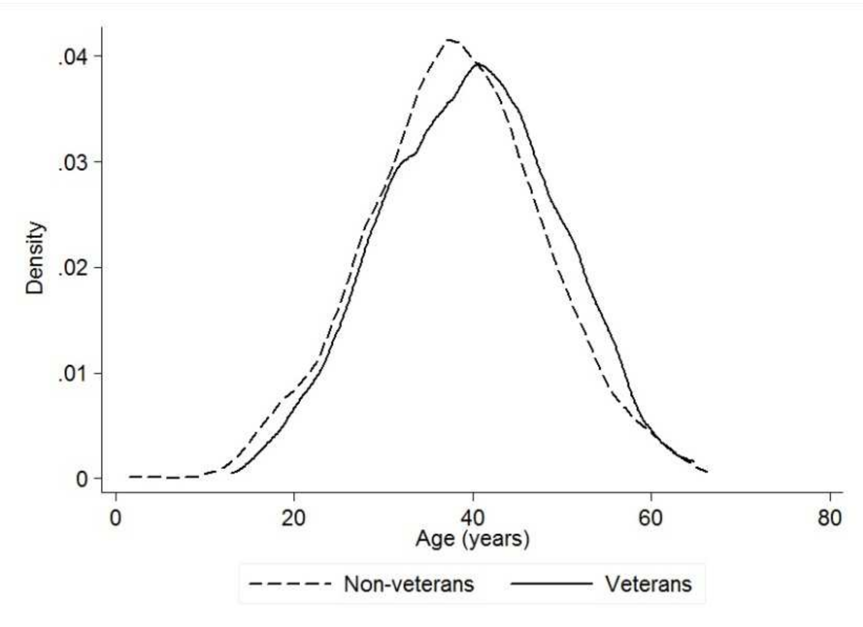

Figure 7-12 - Kernel density plot of age at first recorded episode of stress/PTSD Veterans and non-veterans

7.9.1.4 Birth Cohort

Analysis by birth cohort, for all anxiety diagnoses and examining men and women together, showed a statistically significant increase in risk for veterans in all birth cohorts but especially in veterans born from 1970 onwards (Figure 7-13).

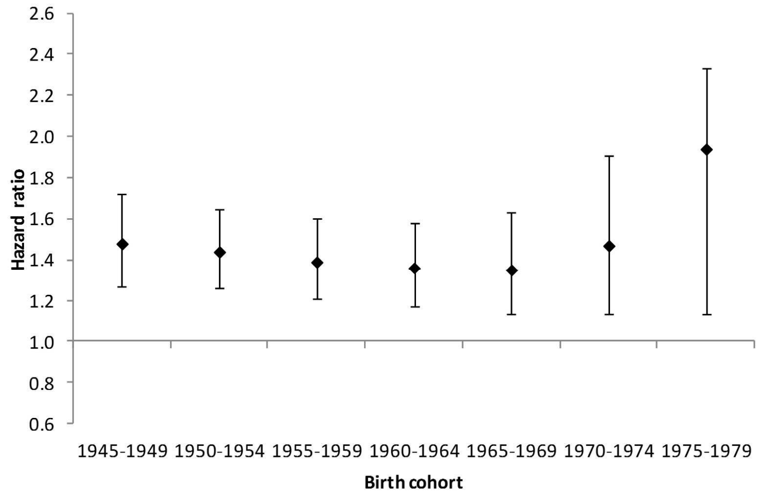

Figure 7-13 - Hazard ratios for anxiety by birth cohort Veterans referent to non-veterans

When people with stress or PTSD were excluded, there was no significant difference between veterans and non-veterans, other than in the two earliest birth cohorts (Figure 7-14). Overall, the risk in veterans relative to non-veterans decreased steadily over the period, and there was a non-significantly lower risk in veterans born from 1970 onwards, although the confidence intervals were wide.

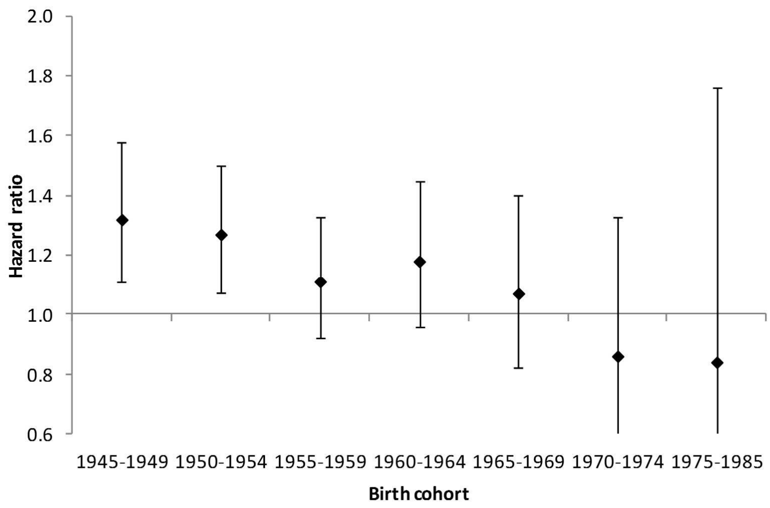

Figure 7-14 - Hazard ratios for anxiety excluding PTSD, by birth cohort Veterans referent to non-veterans

For diagnoses coded as stress or PTSD, the hazard ratios for veterans referent to non-veterans were increased for all birth cohorts, but especially for veterans born from 1970, although there were wide confidence intervals for those born from 1975 (Figure 7-15).

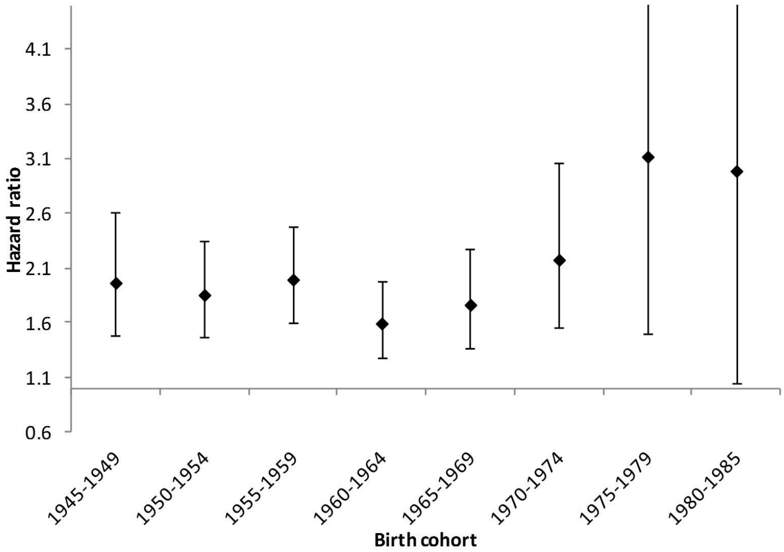

Figure 7-15 - Hazard ratios for stress and PTSD by birth cohort Veterans referent to non-veterans

Examination of the kernel density plots for incidence of anxiety less stress/PTSD, and for stress or PTSD, by year of birth revealed a markedly different pattern for the two diagnostic groups (Figure 7-16 and Figure 7-17), although the overall pattern was similar in both veterans and non-veterans. For anxiety excluding all stress/PTSD diagnoses, there was a clear excess of cases in the older veterans, whilst for stress and PTSD, there was a modest excess in veterans born in the 1950s, but for those born in the 1960s, there was an excess in the non-veterans. This parallels the dip in hazard ratios seen in the 1960s birth cohorts in Figure 7-15, and can be seen to result from an increased incidence in the non-veterans comparison group as well as a reduction in the veterans.

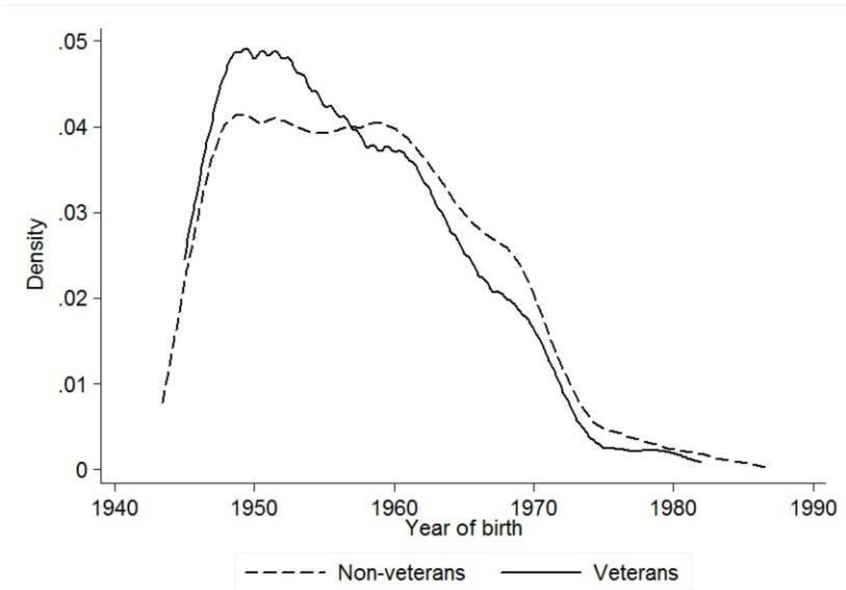

Figure 7-16 - Kernel density plot of anxiety excluding stress or PTSD, by year of birth Veterans referent to non-veterans

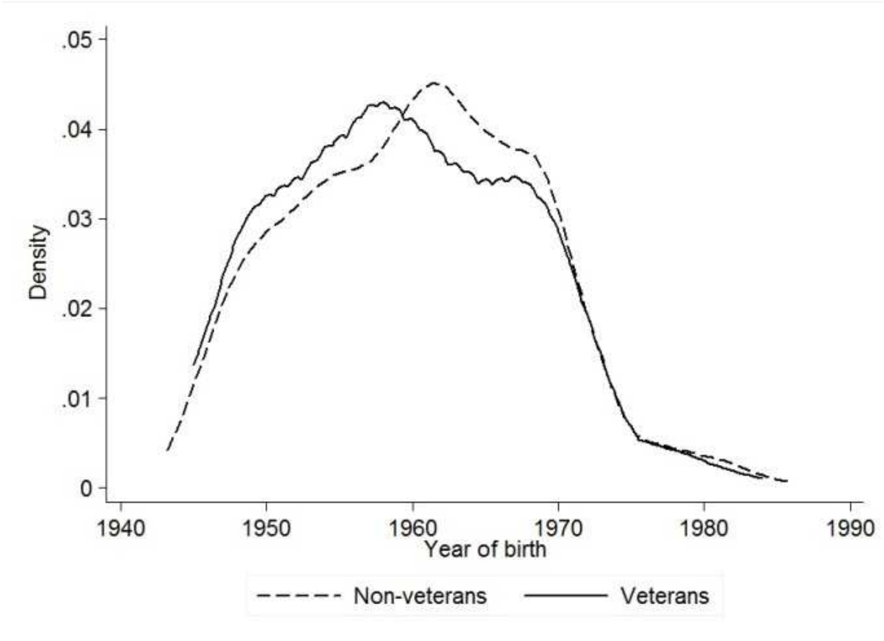

Figure 7-17 - Kernel density plot of stress or PTSD by year of birth Veterans and non-veterans

Median year of birth for veterans with stress or PTSD was 1959 (IQR 1953-1966); for anxiety excluding stress/PTSD, it was 1955 (IQR 1950-1962). The median year of birth for all veterans was 1959 (IQR 1952-1966).

7.9.1.5 Length of Service

Analysing all anxiety together, veterans showed a reducing risk with length of service, as shown at Figure 7-18. The highest risk was in Early Service Leavers, including those who had left before completing training. The risk in veterans who completed at least a minimum engagement was similar to that of non-veterans, increasing slightly in middle and older age, and the veterans with the longest service had a lower risk than the non-veterans. The median length of service was 4.2 years (IQR 1.0-9.0) for veterans with a stress/PTSD diagnosis, compared with 6.3 years (IQR 2.2-12.3) for all veterans.

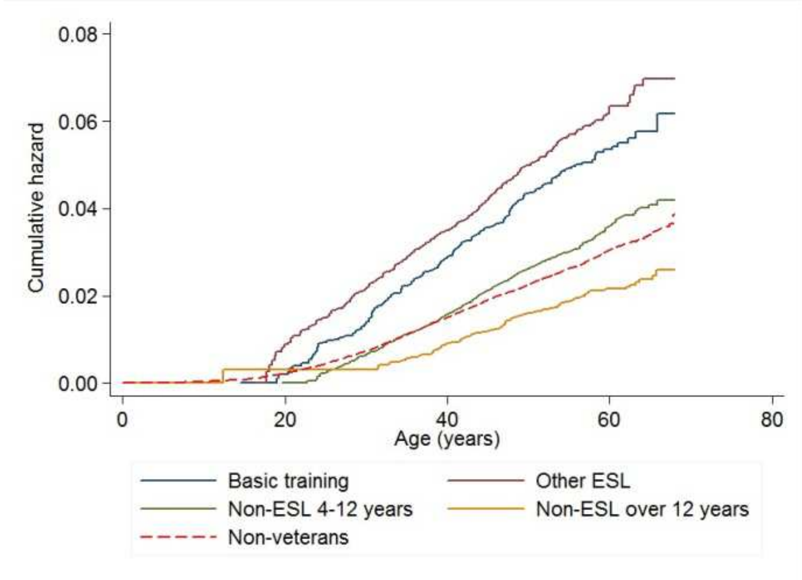

Figure 7-18 - Hazard ratios for all anxiety by length of service Non-veterans for comparison

The pattern of risk for ESL who had entered trained service showed an abrupt early rise, which contrasted sharply with the more gradual rise seen in all physical conditions, in mood disorder and in anxiety in both longer-serving veterans and non-veterans (Figure 7-18). When the data for stress and PTSD were examined by length of service, this pattern was even more marked (Figure 7-19).

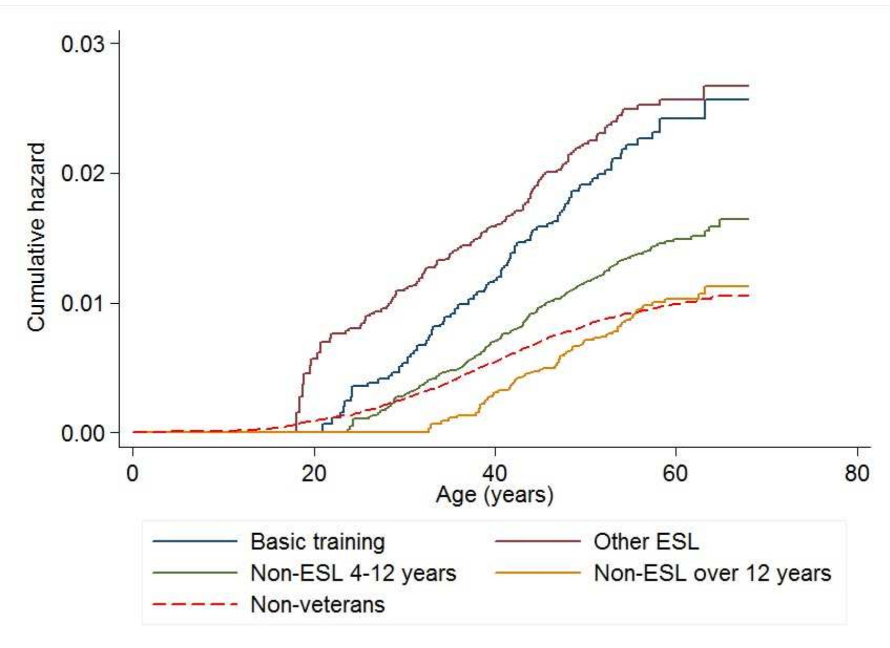

Figure 7-19 - Hazard ratios for stress and PTSD by length of service Non-veterans for comparison

Analysis by birth cohort and length of service confirmed the inverse relationship between anxiety and length of service (Table 7-6 and Table 7-7), and that the increase in risk was predominantly due to increased diagnoses of PTSD in the veterans, although those with the shortest service were at increased risk of any anxiety even after excluding stress and PTSD (Table 7-8). Fourteen veterans had a record of a stress/PTSD diagnosis predating military service; 70% of that group went on to become ESL and none completed more than 7 years' service.

Table 7-6 - Cox proportional hazard model of the association between veteran status and all anxiety, overall and stratified by length of service and birth cohort

	Veteran cases	All Veterans *n*-56,205			Born 1945-1959 *n*=29,709			Born 1960-1985 *n*=26,496		
	n	HR	95% CI	p	HR	95% CI	p	HR	95% CI	p
Overall										
Univariate	1,415	1.41	1.32-1.51	<0.001	1.43	1.32-1.56	<0.001	1.39	1.25-1.54	<0.001
Multi-variable	1,415	1.36	1.27-1.45	<0.001	1.36	1.25-1.48	<0.001	1.36	1.23-1.51	<0.001
Length of service in 8 categories										
Basic training	215	1.84	1.60-2.11	<0.001	1.87	1.56-2.23	<0.001	1.81	1.44-2.27	<0.001
ESL (0-3 years)	435	1.83	1.65-2.02	<0.001	1.83	1.61-2.09	<0.001	1.83	1.55-2.15	<0.001
4-6 years	291	1.40	1.24-1.58	<0.001	1.47	1.25-1.71	<0.001	1.31	1.07-1.60	0.010
7-9 years	182	1.38	1.18-1.60	<0.001	1.48	1.23-1.79	<0.001	1.22	0.95-1.56	0.127
10-12 years	100	0.93	0.75-1.15	0.525	1.02	0.78-1.32	0.904	0.80	0.55-1.15	0.227
13-16 years	84	1.04	0.81-1.32	0.782	0.99	0.72-1.37	0.964	1.08	0.74-1.56	0.694
17-22 years	66	0.96	0.71-1.29	0.770	0.87	0.61-1.25	0.448	1.19	0.72-1.99	0.498
≥23 years	40	0.56	0.39-0.81	0.002	0.59	0.39-0.88	0.010	0.44	0.16-1.18	0.102

Table 7-7 - Cox proportional hazard model of the association between veteran status and stress or PTSD, overall and stratified by length of service and birth cohort

	Veteran cases *n*	All Veterans *n*-56,205 HR	95% CI	p	Born 1945-1959 *n*=29,709 HR	95% CI	p	Born 1960-1985 *n*=26,496 HR	95% CI	p
Overall										
Univariate	630	1.18	1.09-1.28	<0.001	1.95	1.69-2.24	<0.001	1.80	1.55-2.08	<0.001
Multi-variable	630	1.14	1.05-1.24	0.003	1.84	1.60-2.12	<0.001	1.75	1.51-2.03	<0.001
Length of service in 8 categories										
Basic training	99	2.52	2.05-3.10	<0.001	2.72	2.06-3.60	<0.001	2.41	1.77-3.27	<0.001
ESL (0-3 years)	184	2.22	1.89-2.61	<0.001	2.26	1.81-2.84	<0.001	2.25	1.79-2.83	<0.001
4-6 years	114	1.60	1.31-1.94	<0.001	1.49	1.12-1.99	0.007	1.74	1.32-2.28	<0.001
7-9 years	85	1.90	1.522.37	<0.001	2.30	1.71-3.08	<0.001	1.48	1.05-2.10	0.025
10-12 years	48	1.33	0.98-1.81	0.068	1.35	0.89-2.08	0.158	1.28	0.81-2.00	0.280
13-16 years	47	1.84	1.33-2.52	<0.001	2.40	1.62-3.56	<0.001	1.23	0.72-2.10	0.447
17-22 years	36	1.73	1.17-2.55	0.006	1.68	1.03-2.72	0.037	1.80	0.90-3.57	0.073
≥23 years	16	0.85	0.48-1.51	0.574	0.92	0.49-1.73	0.797	0.61	0.15-2.48	0.494

Table 7-8 - Cox proportional hazard model of the association between veteran status and anxiety, excluding stress or PTSD, overall and stratified by length of service and birth cohort

	Veteran cases *n*	All Veterans *n*-56,205 HR	95% CI	p	Born 1945-1959 *n*=29,709 HR	95% CI	p	Born 1960-1985 *n*=26,496 HR	95% CI	p
Overall										
Univariate	785	1.18	1.08-1.28	<0.001	1.23	1.11-1.39	<0.001	1.07	0.93-1.25	0.324
Multi-variable	785	1.14	1.05-1.24	0.002	1.16	1.05-1.29	0.040	1.10	0.95-1.28	0.198
Length of service in 8 categories										
Basic training	116	1.47	1.22-1.78	<0.001	1.52	1.21-1.92	<0.001	1.36	0.96-1.91	0.079
ESL (0-3 years)	251	1.62	1.42-1.85	<0.001	1.66	1.41-1.95	<0.001	1.54	1.22-1.94	<0.001
4-6 years	177	1.30	1.11-1.52	0.001	1.45	1.21-1.74	<0.001	0.99	0.73-1.34	0.964
7-9 years	97	1.09	0.89-1.35	0.390	1.16	0.90-1.49	0.256	0.99	0.69-1.42	0.948
10-12 years	52	0.72	0.54-0.97	0.030	0.88	0.30-1.22	0.432	0.42	0.22-0.81	0.010
13-16 years	37	0.61	0.41-0.90	0.012	0.41	0.23-0.75	0.003	0.93	0.56-1.55	0.782
17-22 years	30	0.67	0.39-0.94	0.027	0.56	0.33-0.95	0.032	0.74	0.33-1.67	0.478
≥23 years	24	0.46	0.29-0.74	0.002	0.49	0.29-0.81	0.006	0.33	0.08-1.32	0.118

7.9.1.6 Geographical Region

There was little difference in the risk of anxiety or stress/PTSD when analysed by geographical region of residence (Table 7-9).

Table 7-9 - Cox proportional hazard model of the association between veteran status and anxiety or stress/PTSD, stratified by region

Region	Veteran cases *n*	Univariate HR	Univariate 95% CI	Univariate p value	Multi-variable HR	Multi-variable 95% CI	Multi-variable p value
All anxiety							
Central Belt (South)	613	1.47	1.33-1.62	<0.001	1.40	1.27-1.54	<0.001
Central Belt (North)	442	1.36	1.22-1.53	<0.001	1.30	1.16-1.45	<0.001
Borders, Highland & Islands	359	1.40	1.23-1.59	<0.001	1.36	1.20-1.55	<0.001
Stress or PTSD							
Central Belt (South)	266	1.82	1.56-2.12	<0.001	1.71	1.46-2.00	<0.001
Central Belt (North)	212	1.96	1.65-2.33	<0.001	1.85	1.55-2.19	<0.001
Borders, Highland & Islands	151	1.82	1.48-2.23	<0.001	1.77	1.44-2.17	<0.001

7.9.1.7 Year of Diagnosis

Because of the unusual pattern of incidence, particularly for stress/PTSD diagnoses, further examination of the data was undertaken. A kernel density plot of date of diagnosis of first episode showed a sharp peak in stress/PTSD diagnoses around 2000, in both veterans and non-veterans (Figure 7-20) which was not seen in other anxiety diagnoses, where a more even spread pertained across the years for which follow-up data were available (Figure 7-21).

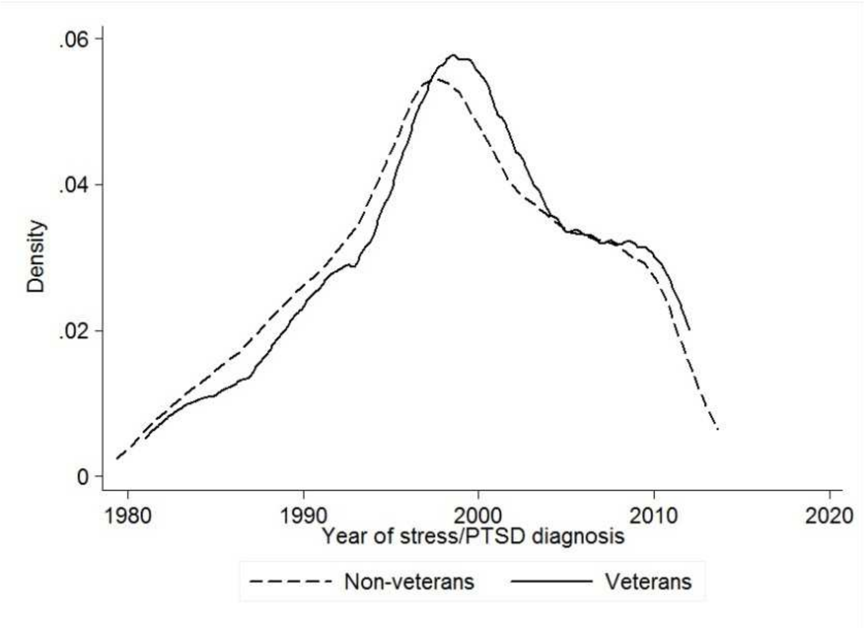

Figure 7-20 – Kernel density plot of stress/PTSD by year of diagnosis Veterans and non-veterans

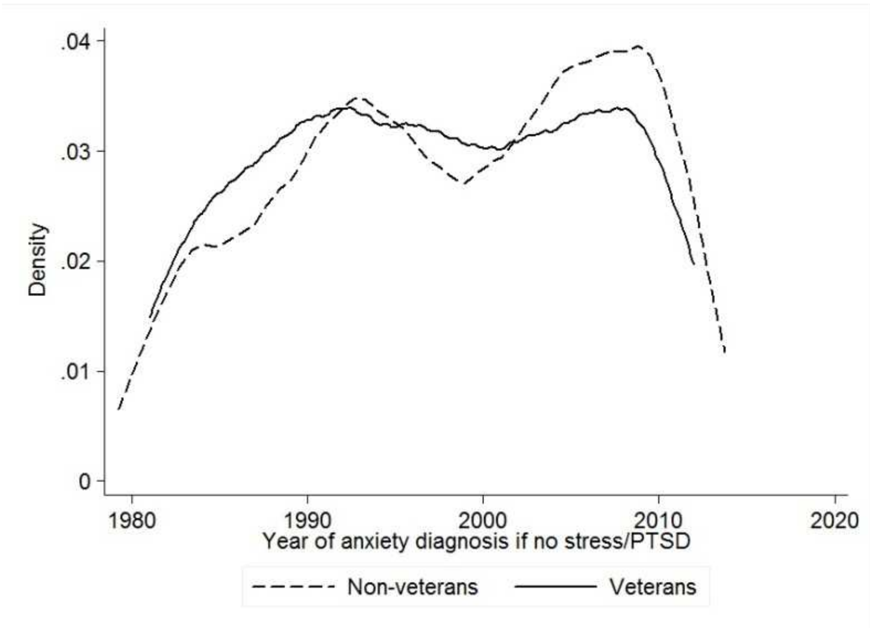

Figure 7-21 – Kernel density plot of anxiety excluding stress/PTSD, by year of diagnosis Veterans and non-veterans

A graph was therefore plotted of absolute number of stress/PTSD diagnoses in each year, for veterans and non-veterans[197]. This demonstrated a gradual rise from baseline at 1981 to 1996, followed by an abrupt increase from 1997 in both veterans and non-veterans, falling in 2001-2 to a steady state with a higher level in the veterans than non-veterans.

[197] Number of non-veteran cases divided by 3 to allow for 3:1 sample size

(Figure 7-22). The peak in veterans was substantially higher than that in non-veterans. Stratifying by grouped year of diagnosis, the Cox proportional hazard ratio confirmed this pattern of a greatly increased risk for first diagnoses occurring between 1997 and 2001 compared with all other years, adjusted HR 2.15, 95% CI 1.79-2.59, p<0.001.

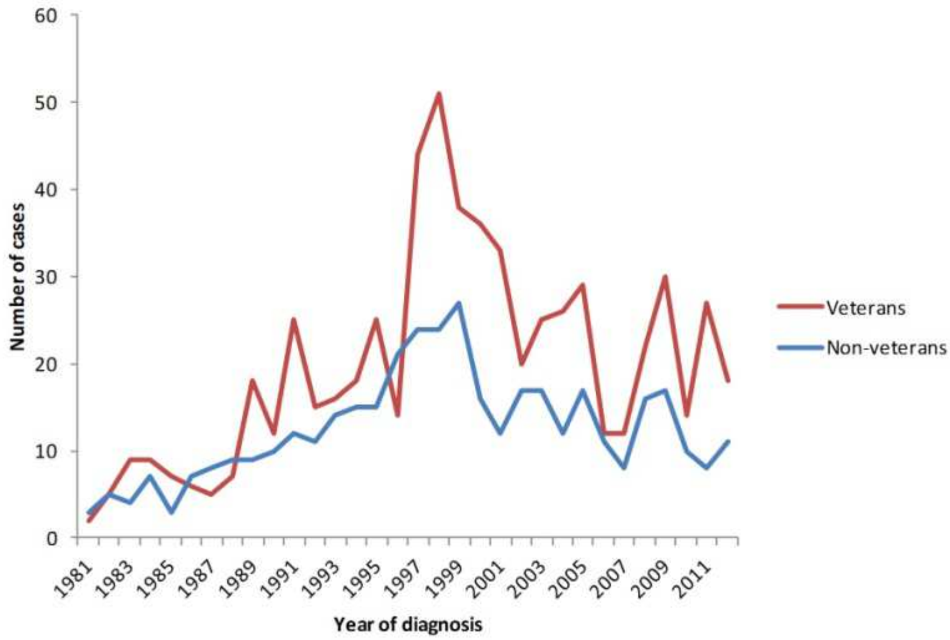

Figure 7-22 – Number of PTSD diagnoses by year
Veterans and non-veterans
Number of non-veteran cases divided by 3 to compensate for 3:1 matching of non-veterans:veterans

7.9.2 Medication

Among cases of anxiety first recorded from 2009 onwards (the start of prescribing data), 91 (47.6%) of the 191 veterans and 223 (43.5%) of the 513 non-veterans were prescribed anxiolytics. The difference was not statistically significant, OR 1.10, 95% CI 0.92-1.31, p=0.322.

7.9.3 Case-Fatality

The mean follow-up from date of first admission for any anxiety diagnosis to the date of death or the end of the study on 31 December 2012 was 13.55 years (range 0-31.94 years) for veterans and 13.15 years (range 0-31.96 years) for non-veterans, representing 19,173 person-years of follow-up among the veterans and 46,183 person-years in the non-veterans. There were 225 (15.9%) deaths among veterans with anxiety, equating to

11.7 per 1,000 person-years, and 577 (16.4%) deaths among non-veterans (12.5 per 1,000 person-years).

For stress and PTSD, the mean follow-up from date of first admission to the date of death or the end of the study on 31 December 2012 was 12.24 years (range 0-31.22 years) for veterans and 12.70 years (range 0-31.83 years) for non-veterans, representing 7,711 person-years of follow-up in the veterans and 15,240 person-years in the non-veterans. There were 89 (14.1%) deaths among veterans with stress or PTSD, equating to 11.5 per 1,000 person-years, and 199 (16.6%) deaths among non-veterans (13.1 per 1,000 person-years).

The commonest causes of death for people with a diagnosis of anxiety were AMI and lung cancer in veterans, and AMI, alcoholic liver disease and lung cancer in non-veterans. In non-veterans with stress or PTSD, the commonest causes of death were suicide, alcoholic liver disease and AMI, whilst for veterans no single cause of death predominated apart from 7 cases of AMI (7.9% of deaths in veterans with stress/PTSD).

7.9.4 Commentary – Mood Disorder and Anxiety

7.9.4.1 Main Findings

The data for mood disorder in veterans were unremarkable. There was a modest increase in the overall hazard ratio for veterans compared with non-veterans, which was reduced after adjusting for deprivation and still further reduced when co-morbid stress or PTSD were excluded. Analysis by birth cohort showed the increase in risk to be entirely confined to the two oldest birth cohorts, 1945-1949 and 1950-1954. When analysed by length of service, the two ESL categories[198] showed an increased risk of mood disorder compared with all non-veterans. Veterans with between 4 and 12 years service had a similar risk to non-veterans, whereas those with longer service showed a reduction in risk. Mood disorder was significantly correlated with a higher risk of COPD, cardiovascular disease, peptic ulcer, diabetes and non-fatal self-harm in both veterans and non-veterans, but the risk was higher in veterans. There was also an association with risk of colorectal cancer in veterans but as the absolute number of cases was small, this may have been a spurious finding.

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[198] Failed to complete basic training, and trained but left prior to completing minimum engagement

In contrast to mood disorder, the data on anxiety, stress and PTSD revealed a high degree of complexity. Overall, veterans were more likely to be admitted with an anxiety or stress/PTSD diagnosis than non-veterans, but the excess risk has changed over time. Stress and PTSD diagnoses accounted for most of the excess. Birth cohort analysis showed a risk of stress/PTSD in veterans approximately double that for non-veterans in those born 1945-1959. The subsequent 2 five-year groups (covering 1960-1969) exhibited a smaller increase in risk, but this was predominantly due to a higher incidence of stress and PTSD in non-veterans born in those years rather than a reduction in incidence in the veterans. The excess risk in veterans then increased, with the greatest increase being in those born 1975-1979. Examination by year of diagnosis revealed a striking pattern with a marked increase in the years 1997-2001 in both veterans and non-veterans, although it was higher in the veterans. This period did not coincide with any major military deployment. Furthermore, when analysed by length of service, the greatest increase in risk was in those who had not completed initial training and therefore could not have experienced combat.

When examined by age at diagnosis, there was an abrupt increase in risk which coincided with the age of commencement of military service and which did not match the pattern of any other condition, mental or physical. Further analysis showed that this was predominantly due to cases of stress or PTSD occurring in ESL who had completed training. In the birth cohort analysis, there was an elevated risk of any anxiety across all birth cohorts, but it was highest in the two youngest cohorts, born 1970 onwards. However, if stress/PTSD diagnoses were excluded, the pattern became similar to that seen in many other diagnoses, physical and mental, with increased risk in the two oldest cohorts (born prior to 1955), hazard ratios close to unity for those born in the 1960s and a non-significant reduction in risk in veterans in the youngest birth cohorts. By contrast, for stress and PTSD, there was a strongly elevated risk in veterans across all birth cohorts, with a relative dip in those born in the 1960s, and the highest risk was in the most recent birth cohorts. Veterans with stress or PTSD were younger on average than those with anxiety excluding stress/PTSD.

7.9.4.2 Previous Studies

There has been much research on PTSD in military personnel in the last 30 years, predominantly focussing on the effects of deployment and combat. Initial research on Vietnam veterans was followed by comprehensive studies of both US and UK military personnel and a consistent picture of the risk factors is emerging, as summarised by Jones et al. These include lower rank, having a combat role, having left service, having had a serious accident, and having experienced major childhood adversity, with having left service making the greatest contribution to risk. The authors noted that a possible reason for the latter could have been increased willingness to admit to symptoms after leaving service. Deployment status is not independently associated with risk of PTSD (Jones et al. 2013). There has been limited work on PTSD in UK veterans, the most comprehensive studies having been conducted by Brewin et al. as part of a Ministry of Defence funded study. The researchers were give access to over 100 veterans in receipt of war pensions for both psychological and physical disorders, and to their in-service medical and administrative records. They were able to examine risk factors for both immediate-onset (within 6 months of the traumatic event) and delayed-onset PTSD (more than 6 months after the event), access to medical care and treatment in-service and history of disciplinary offences. In an important series of papers, they reported that 25% of those later diagnosed with delayed-onset PTSD had experienced some symptoms prior to the occurrence of the in-service traumatic event, and that those with delayed-onset PTSD were significantly more likely than those without PTSD to have experienced a severe life stressor (most commonly personal health or relationship problems) in the 12 months prior to onset (Andrews et al. 2009). Those who had first experienced psychological symptoms whilst in service (60% of all the sample of veterans who had received a diagnosis of PTSD) were highly likely (81% of cases) to have received medical care and treatment in-service, half of such health contacts having been initiated after being prompted by senior officers or diagnosed after injury. This contradicted the widely-held belief that service personnel are reluctant to seek help in service for psychological problems. The researchers also found that most of the diagnoses of PTSD were made in the 1990s (32/46) compared with just 2 diagnoses in the 1980s and 6 in the period 2000-2005 (Brewin et al. 2012a). This pattern is consistent with the pattern of PTSD diagnoses observed in the Scottish Veterans dataset.

Brewin et al. also examined the medical and administrative records of veterans who developed PTSD after discharge to explore possible objective predictors. They found no difference in history of presentation to the medical services with psychological symptoms in comparison with the control group of veterans who did not have PTSD (war pensioners with physical conditions). However, the delayed PTSD group had record of a significantly greater number of disciplinary offences, which predated the trauma exposure. The predominant offences were absence without leave and dishonesty; violent offences and drunkenness were no more frequent than in the controls. The authors cautioned that the excess of prior disciplinary action for dishonesty could be associated with an increased rate of malingering for secondary gain in those presenting post-service with delayed-onset PTSD, whilst noting that validation was provided by the independent assessment of the diagnosis for war pensions purposes in the study sample (Brewin et al. 2012b).

7.9.4.3 Risk Factors for Post-Traumatic Stress Disorder

The military experience of the veterans represented in the Scottish Veterans dataset collectively spanned the years 1960 (as junior soldiers) through to 2012, and encompassed periods of intense operational activity as well as periods when training and military exercises predominated. It took place against a background of socio-economic change in the wider community, both during the veterans' time in service and beyond it as they adjusted to veteran status, whilst the socio-economic setting also impacted on the non-veteran comparison group. The following discussion therefore endeavours to interpret the findings holistically, considering not just the risk of exposure to traumatic events but also background factors which may have increased susceptibility to PTSD.

The criteria for a diagnosis of PTSD include experiencing or witnessing a traumatic event involving death or serious injury and resulting in fear, helplessness or horror, followed by persistent re-experiencing of the event, numbing or avoidance of stimuli, increased arousal and clinical distress or impaired social functioning (American Psychiatric Association 1994). The DMS-IV criteria for PTSD are listed at Appendix 8. There are gender differences in susceptibility, with women being more likely to develop PTSD than men following assault, but not following other types of traumatic event (Stein et al. 2000). Estimates of the prevalence of PTSD in the community vary widely; Breslau cites a lifetime prevalence of about 1 in 12 of the adult population, or 15-24% of those exposed to a traumatic event. Exposure to violent crime or accidental death was associated with a current prevalence rate of 7-11% (Breslau 2001). Koenen et al. demonstrated that susceptibility to PTSD was increased by early childhood factors including family adversity, family history of mental health difficulties and low SES, using a longitudinal birth cohort study (Koenen et al. 2007). Schoedl et al. found that early childhood traumatic events (death of a family member or close friend, sexual abuse, physical or emotional abuse) were strongly correlated with the development of adult PTSD, providing support for the hypothesis that childhood events sensitise to adult traumatic stress (Schoedl et al. 2013). Brown et al. reviewed the literature on early childhood risk factors for a range of mental health disorders in adulthood and found that separation from a parent, death of a parent and parental divorce were all associated with increased risk of anxiety and panic disorder (Brown and Harris 1993).

In military personnel, risk factors for PTSD have been extensively studied since the Vietnam War, as noted above. UK studies have failed to show that operational deployment *per se* increases the prevalence of PTSD (Iversen et al. 2009) although having a combat role is a risk factor. The proportion of serving personnel who experience combat has been discussed at Section 7.4. A factitious history of combat also occurs; Frueh et al. found objective evidence of combat in only 41% of US Vietnam veterans seeking treatment for combat-related PTSD. Those who had no record of combat were paradoxically more likely to report witnessing or committing battlefield atrocities than those who had been in combat, as noted at Section 7.4, and a small number had no record of service in Vietnam, or even in the military. Whilst acknowledging that many veterans do suffer severe symptoms, the authors recommended careful evaluation of all those presenting with combat-related mental health problems (Frueh et al. 2005), consistent with Brewin et al.'s observations on possible malingering in association with a history of dishonesty (Brewin et al. 2012b). In a commentary on Frueh's paper, Wessely noted the need to examine 'war stories' "for what is said . . and for what is unsaid". He questioned why there was a reluctance to examine the stories of Vietnam veterans, noting *inter alia* a fear of being seen to do other than accept the narratives at face value (Wessely 2005). In a study of over 8,000 deployed and non-deployed UK personnel analysed together, Jones et al. demonstrated that a history of childhood adversity was highly significant, OR 3.3, 95% CI 2.1-50. A combat role was associated with an increased risk of PTSD in the same study, OR 2.7, 95% CI 1.9-3.9, but the authors concluded that vulnerability factors such as childhood adversity may be at least as important as combat. They recommended that healthcare providers should explore factors unrelated to deployment, and those which may have occurred pre-service, as part of their clinical management of cases (Jones et al. 2013).

The criteria for selection of the veterans' cohort for the Scottish Veterans study provide assurance that the histories of military service are valid (Section 2.2.2.3). However, in seeking to explain the higher risk of PTSD consistently observed in the dataset across a wide-ranging group of veterans, which included those who had not experienced combat nor indeed even completed initial training, it is essential to have confidence that the diagnoses are also valid. Although the mental healthcare and secondary care origin of the diagnoses suggests a greater assurance of validity than, for example, self-reported survey data, the possibility cannot be excluded that eliciting a history of military service may have introduced a degree of diagnostic bias on the part of civilian healthcare providers, perhaps coupled with a reluctance to explore deeply the antecedent military, pre-service and post-service history (Frueh et al. 2005, Wessely 2005, Dobbs 2009). Alternatively, a short period of military service may act as an enabler, such that an individual affected by trauma, albeit not necessarily arising from military exposure, feels more able to admit to symptoms. Other aspects of overdiagnosis are explored at Section 7.9.4.8. This is a complex area and further studies would be needed to test this hypothesis in relation to the Scottish Veterans dataset.

7.9.4.4 The 1960s Birth Cohorts

The finding of an increased rate of PTSD in non-veterans born in the 1960s, which reduced the excess risk among veterans in the same birth cohorts, was unexpected. The 1960s represented a period of social and political turmoil in the UK. The then Prime Minister Harold Macmillan's positive economic assessment of the late 1950s was rapidly followed by a wage freeze in 1961 in the face of rising inflation. National income declined despite measures to boost the economy, and there was widespread public disillusionment[199]. Racial tension was beginning to emerge, there were rising numbers of industrial disputes and, towards the end of the decade, widespread student unrest.

[199] 'The British Political Scene in the 1960s' http://www.leeds.ac.uk/politics/cbl/brit/scene.htm accessed 23 Oct 2014

Women were entering the labour force in increasing numbers[200], altering both family dynamics and the potential for women to live independently. Divorces rose rapidly throughout the decade, from 24,000 in 1960 to 119,000 in 1972[201]. It is plausible that economic hardship, the relatively new concept of working mothers, and families going through the trauma of divorce, provided the stressful background which sensitised children born and growing up in that decade to later mental ill-health.

Children who were born from 1958 to 1970 entered the labour market between 1974 and 1986, or later for those who continued in full-time education. Government data show rising unemployment throughout that period, from 2.6% in 1974 to a peak of 13% of the eligible workforce by 1982 (Denman and McDonald 1996). For those leaving school, the key data are youth employment figures. Reliable pre-1992 figures for youth unemployment are unavailable but the rate has recently been shown to be double the general population rate in most European countries[202]. If that holds true for the 1970s, school leavers were highly likely to face unemployment, and the Armed Forces, which were recruiting heavily in the face of intense operational activity in Northern Ireland, would have provided a welcome employment opportunity.

Evidence from the Scottish Veterans Health Study has demonstrated that although veterans born in the 1960s continued to have a higher risk of later stress and PTSD than non-veterans, the relative increase was smaller. One obvious difference between the two groups is employment history; by definition, all the veterans went into employment, whereas some of the non-veterans would have been unemployed. Both veterans and non-veterans may be equally likely to have experienced early childhood stressors such as family breakdown, paternal involvement in industrial unrest and economic hardship. It is therefore plausible that at a time of high youth unemployment, joining the Armed Forces was beneficial to mental health and, in particular, afforded a degree of protection against later development of stress/PTSD, even in the presence of adverse early childhood

[200] 'Sixties Britain: A social and cultural revolution?' http://www.nationalarchives.gov.uk/education/topics/sixties-britain.htm accessed 23 Oct 2014

[201] Divorce data from the Office for National Statistics, London

[202] 'G20 Labour Ministers must focus on young jobseekers' http://www.oecd.org/newsroom/g20labourministersmustfocusonyoungjobseekers.htm accessed 23 Oct 2014

events. This benefit could, however, be negated by becoming ESL and entering or re-entering the unemployment pool.

7.9.4.5 Peak in New Diagnoses 1996-2002

There was an unexpected peak in diagnoses of stress or PTSD, in both veterans and non-veterans, beginning after 1996 and ceasing by 2002. There is a strong temporal relationship with a major legal action by military veterans against the Ministry of Defence (MOD), alleging that the MOD had been negligent in failing to take measures to prevent, detect or treat the development of psychiatric illness in general and PTSD in particular (McGeorge et al. 2006). Judgment was given in May 2003 when the High Court in London ruled, in a test case involving 18 of the veterans, that the MOD had not been negligent. The case had lasted over a year and incurred an estimated £20 million in legal costs. It had been preceded by a single case in 1994 when a Falklands veteran, employing the freedom to take legal action against the MOD which had then only recently been granted with the repeal of Section 10 of the Crown Proceedings Act 1947, commenced a civil claim in negligence against the MOD, including for PTSD which, he alleged, he had developed after service in the Falkland Islands in 1982. The case was settled out of court and compensation of £100,000 was paid, without admission of liability (Beggs 1994). Nonetheless this case appears to have paved the way for the subsequent action, and active case-finding by legal firms followed, accompanied by widespread publicity, culminating in October 1999 in the establishment by a legal firm of a formal group of post-1987 veterans (predominantly Gulf, Bosnia and Northern Ireland veterans) who would form the nucleus of the eventual class action[203].

At the same time, PTSD was becoming more widely discussed in the UK, having originally been thought to be specific to the US and Vietnam veterans. Jones et al. noted that as late as 1986, ‘post traumatic syndrome’ received only scant acknowledgment in the *Oxford Textbook of Psychiatry* (Jones and Wessely 2007) despite the inclusion of PTSD in DSM-III from 1980. The number of dated webpages (many are undated and therefore not included) returned by a Google search for <PTSD>, by calendar year, provided an indication of growing public interest in PTSD. Superimposing this additional information

[203] Military Post-Traumatic Stress Disorder Group 2 Newsletter. May 2000. Linder Myers, Manchester.

on Figure 7-22 sheds light on a possible factor underpinning the rapid rise in PTSD diagnoses (Figure 7-23).

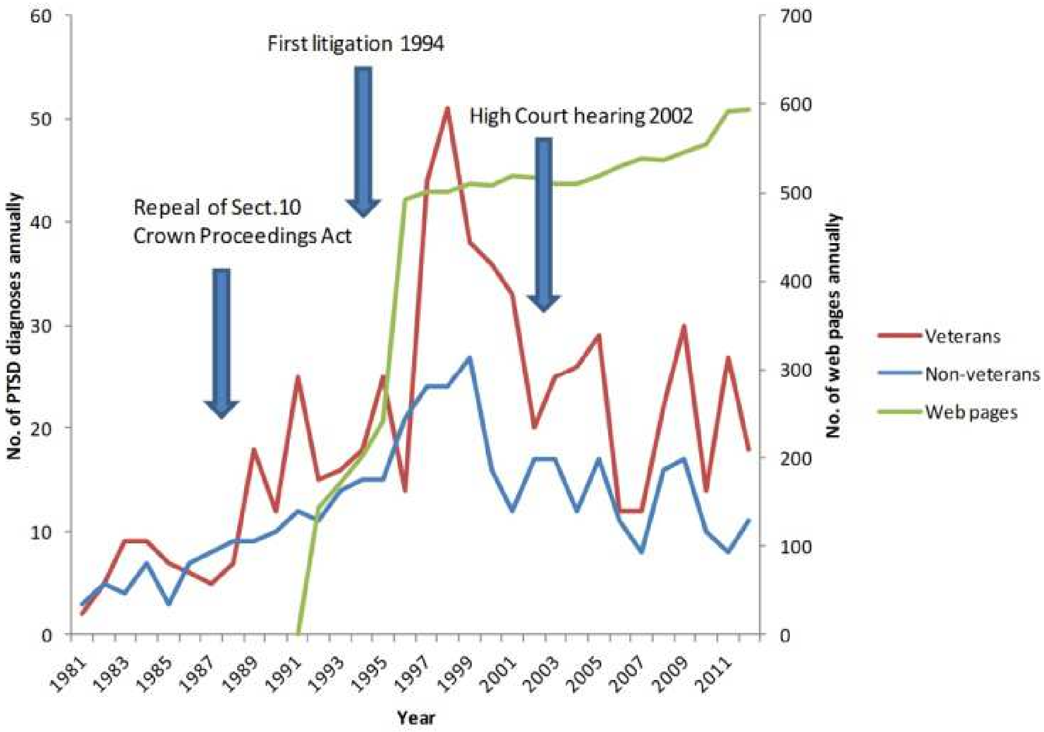

Figure 7-23 - PTSD diagnoses by year, with key events
Number of non-veteran cases divided by 3 to compensate for 3:1 matching of non-veterans:veterans

Modelling the frequency of occurrence of the phrase 'post traumatic stress disorder' in printed books published between 1975 and 2008, using the Google Ngram Viewer[204] application, similarly produced a good fit with the rising number of PTSD diagnoses from 1980 and the steeper rise from 1995 when plotted as a composite graph with Figure 7-22, as shown in Figure 7-24.

[204] An n-gram is a contiguous sequence of words or other linguistic units. N-gram models are used in statistical methods in linguistics; the Google Ngram Viewer determines the frequency of specified search terms in a database of over 5 million books published to 2008 and returns the result in graphical format. Information from http://en.wikipedia.org/wiki/Google_Ngram_Viewer and http://en.wikipedia.org/wiki/N-gram accessed 1 May 2015.

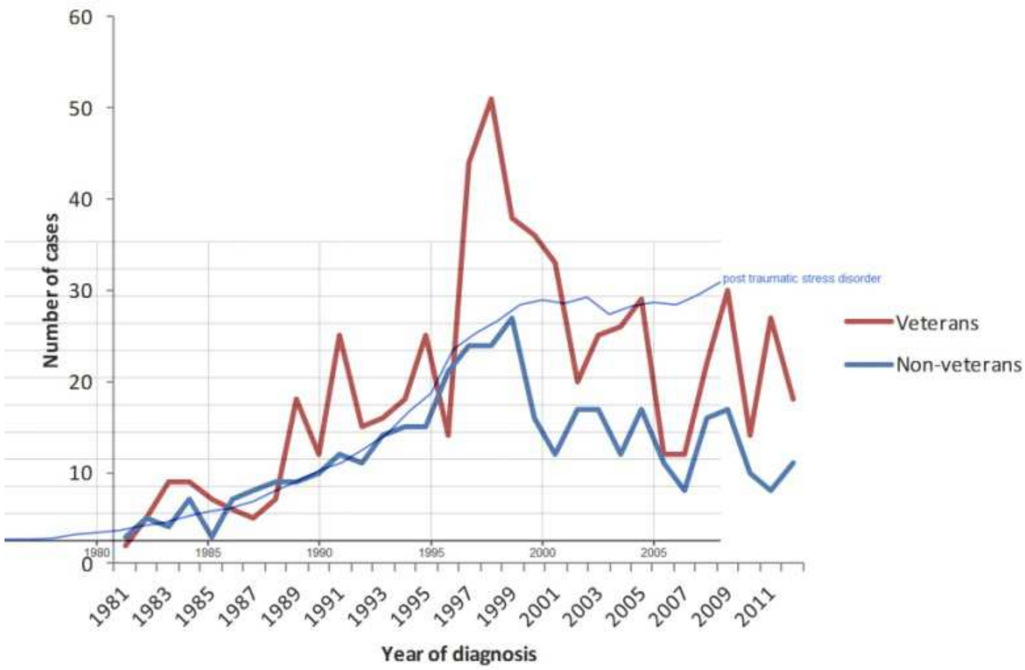

Figure 7-24 - PTSD diagnoses per year, with frequency of phrase in printed books
Light blue line denotes frequency of "post traumatic stress disorder"
Number of non-veteran cases divided by 3 to compensate
for 3:1 matching of non-veterans:veterans

The sharp increase may therefore reflect a growing public (and medical) awareness of PTSD in the mid-1990s, perhaps in part stimulated by interest in, and case-finding for, the emerging MOD class action. This may have impacted not only on military veterans but also diffused into the wider community. The later reduction in number of diagnoses may be a consequence of the High Court judgement but, as it appears to have commenced before judgment was given, it is perhaps more likely to reflect 'diagnostic saturation', a previously hidden population of PTSD sufferers having been encouraged to come forward for treatment by the growing awareness of the condition. The flow of cases may have then returned to a 'steady state' following presentation for treatment of the 'hidden iceberg'[205] of cases. This hypothesis is supported by an analysis of veteran cases presenting during 1996-2001 by year of entry to service (Figure 7-25). This shows that there are peaks (circled in red) corresponding to those who would have been young soldiers during the Aden, early Northern Ireland, Falklands and first Gulf campaigns, and who may have previously been unaware that help was available.

[205] The concept of the 'clinical iceberg' was first described by Last in 1963 to draw attention to the burden of covert disease in a community, and hence provide a measure of what today is known as unmet need. Last, J. M. (1963) 'The iceberg:'completing the clinical picture'in general practice', *Lancet,* 282(7297), 28-31.

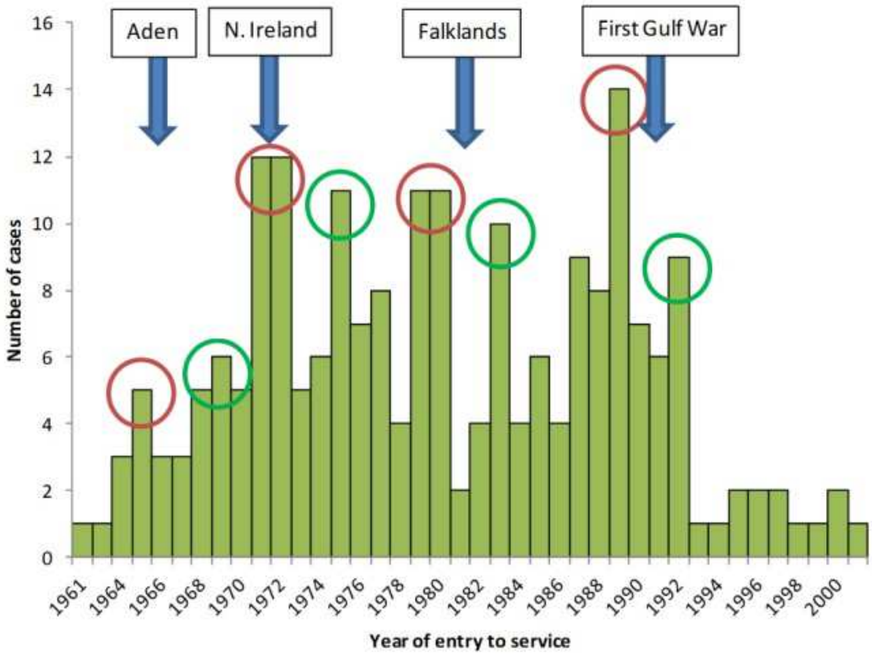

Figure 7-25 - New cases of stress or PTSD in veterans diagnosed 1996-2001 by year of recruitment

The constant feature of peaks occurring in personnel who joined shortly *after* each campaign (circled in green) cannot readily be explained by this hypothesis however, and it is likely that there are other explanations which remain unidentified.

Analysis of the veterans whose PTSD was diagnosed 1996-2001 by length of service showed that 84 (38.9%) failed to complete their initial engagement, and 42 (19.4%) left prior to completing initial training. The latter showed no clear relationship to any year of entry to service. However, 20% of the group had over 10 years' service, representing a small but important area of unmet need.

7.9.4.6 Early Service Leavers

The finding of an increased risk in those with the shortest service mirrors the results of the study of ESL by Buckman et al., who found an age-adjusted odds ratio for probable PTSD of 2.32, 95% CI 1.21-4.45 (Buckman et al. 2013) in ESL. This is similar to the adjusted HR of 2.20, 95% CI 1.92-2.53 for severe stress or PTSD in ESL in the Scottish Veterans cohort. The finding that the greatest excess risk for stress/PTSD occurs in those with the shortest service, and especially in those who have not completed initial training and who by definition could not have seen operational service, raises questions about both causation and diagnostic validity. Whilst Buckman et al.'s definition of ESL included all those left before completion of their initial engagement, and thus some may have seen combat, stratification by length of service in the Scottish Veterans study has showed that within the ESL group, the highest increase in risk occurred in those who had not completed initial training. In the controlled conditions of recruit training, it is implausible that this group will have experienced a traumatic event in service which meets the precursor requirements for a later diagnosis of PTSD. The only exception may be the very small number who witnessed a serious accident during training, but it is highly unlikely that this explains the doubling of risk of PTSD seen in ESL.

The finding that the youngest soldiers were at greatest risk from adverse mental health outcomes has been described from the US Civil War onwards (Pizarro et al. 2006, Pitman 2006). Whilst it is understandable that they may be most affected by the experience of combat, the Scottish Veterans study may be the first to demonstrate that they are at increased risk even in the absence of combat. This raises the question of whether civilian healthcare providers are more likely to make a diagnosis of PTSD in military veterans who present with mental health disorders or, conversely, whether PTSD is under-recognised in the non-veteran community. Whilst over-diagnosis in veterans (Dobbs 2009, McNally 2003, Rosen and Taylor 2007, McHugh and Treisman 2007) is a possible explanation, and is discussed further at Section 7.9.4.8, it is also plausible that those who are most likely to leave early include a disproportionate number of people who are at high risk of PTSD as a result of adverse pre-service events; this will be considered more fully at Section 7.14.5 and Section 8.3.1.

Unemployment may also be an important factor, both in the non-veterans who entered the labour market in the 1970s and early 1980s, and in the ESL veterans. The latter have been shown in a study by the National Audit Office to be almost three times as likely to face unemployment on leaving the Armed Forces as all leavers taken together (National Audit Office 2007). Most studies on unemployment and PTSD have been of a *post hoc* nature, examining whether people with PTSD are more likely to be unemployed, for example in the study by Prigerson et al. (Prigerson et al. 2001). The reverse may also be true; people who have a long history of unemployment, especially in adolescence or early adult life, may be more susceptible to PTSD, the unemployed state itself acting as a predisposing stressor. Few studies have specifically examined the role of unemployment as a risk factor rather than a consequence. Bryant et al. examined patients who had sustained a traumatic brain injury (TBI) and found that being unemployed was a predictor for the degree of PTSD severity (Bryant et al. 2000). Epigenetic factors may also be involved. Koenen et al. found that the association between the *5-HTTLPR* genotype, which had previously been shown to increase levels of depression and suicidality in the presence of life stressors, and PTSD, was moderated by social environmental factors such as unemployment and crime (Koenen et al. 2010, Koenen et al. 2009).

7.9.4.7 Age at Presentation

Whilst acute onset PTSD follows shortly after exposure to a traumatic event and can therefore occur at any age, delayed onset PTSD is more complex. According to the ex-Services mental health charity Combat Stress, veterans typically delay 14 years from leaving the Service before presenting with mental health problems relating to service (Busuttil 2010); a formal audit by Combat Stress reported an average of 14.1 years (Fletcher 2007). Around 75% of those presenting to Combat Stress have PTSD as a primary diagnosis (Combat Stress 2014). The mean age at admission with stress/PTSD in Scottish veterans was 39.7 years, whilst the mean age at entry to the Armed Forces was 19.5 years. The mean length of service for those with a stress/PTSD diagnosis was 6.1 years, giving a mean age at exit from the Armed Forces of 25.6 years. The mean interval from leaving the Services to admission with PTSD was therefore 14.1 years, identical to the Combat Stress quoted figure. The mean age at admission with stress/PTSD for non-veterans was similar at 38.1 years. Kessler et al. reviewed the recent literature on age of onset of common mental health disorders, focussing on data from the WHO World Mental Health surveys, and reported that the group of anxiety disorders encompassing panic disorder, generalised anxiety disorder and PTSD had a median age of onset of 25-53 years. The authors noted a lack of previous studies on age of onset of PTSD (Kessler et al. 2007). Thus, the presentation an average of 14.1 years after leaving the Services may simply represent the typical age at which symptoms of severe stress or PTSD present, and may not be a reflection of disadvantage, under-diagnosis or delayed diagnosis in veterans as is commonly suggested.

7.9.4.8 Overdiagnosis

Overdiagnosis of PTSD by civilian healthcare providers who accept a stated history of trauma during service without further enquiry is recognised; many authors attest to the problems both of overdiagnosis and even of malingering or giving a factitious history of service (Frueh et al. 2005, Brewin et al. 2012a, Wessely 2005, McNally 2003, Dobbs 2009). In a remarkable study of 103 people with major depression who were examined for both PTSD and traumatic experiences, the prevalence of symptoms meeting the other DSM-IV criteria for PTSD[206] was identical (78%) in both those who had experienced trauma and those who had not. The authors suggest that the symptom cluster currently attributed to PTSD may be a non-specific group of symptoms widely observed in patients with mood and anxiety disorders, regardless of trauma history (Bodkin et al. 2007).

Overdiagnosis is misdiagnosis, and it is unhelpful to the patient as it results in suboptimal care. As recommended by Wessely, and by Jones et al., history taking should be as thorough in suspected PTSD as in any other clinical condition, and should not be biased by implicit acceptance of the initial statements (Wessely 2005, Jones et al. 2013). A history of having been in the Special Forces or Parachute Regiment, or "not being allowed to talk about" experiences should be regarded as a 'red flag', and advice from military sources should be sought if doubt remains as factitious claims of military experience are common ("military Munchhausen") (Baggaley 1998). Mild traumatic brain injury (mTBI) is also an important confounder; the long-term symptoms can be similar to those of PTSD and indeed the diagnoses may co-exist if the circumstances of the injury were psychologically traumatic. Head injury is common in military personnel, not only in combat but also in sport and road traffic accidents, and there is emerging evidence that some cases classified as PTSD are in fact chronic traumatic encephalopathy (CTE) due to previous episodes of mTBI (Shively and Perl 2012). Again, misclassification is not in the veteran's interests as it is likely to lead to inappropriate management.

[206] ie excluding having experienced or witnessed a life-threatening event

7.10 Psychosis

Psychosis was defined as ICD-9 code 295 or ICD-10 code F20-F29, at any position in the record.

7.10.1 Incidence

7.10.1.1 Overall

During the period of follow-up, there were 537 (0.95%) cases of psychosis in veterans leading to hospital admission, attendance as a day-case or death, compared with 1,967 (1.08%) cases in non-veterans. Despite the lower odds ratio for cumulative incidence, OR 0.88, 95% CI 0.80-0.97, p=0.011, the Cox model showed a statistically significant increase in risk in veterans, HR 1.13, 95% CI 1.02-1.25, p=0.016 unadjusted (Figure 7-26). However, this became non-significant after adjusting for deprivation, HR 1.06, 95% CI 0.96-1.17, p=0.246. Testing for non-proportionality of the hazards was non-significant, p=0.158. If cases of co-morbid stress or PTSD were excluded, there was no significant difference in either the unadjusted or adjusted model, HR 1.09, 95% CI 0.98-1.21, p=0.106 and HR 1.03, 95% CI 0.92-1.14, p=0.643 respectively.

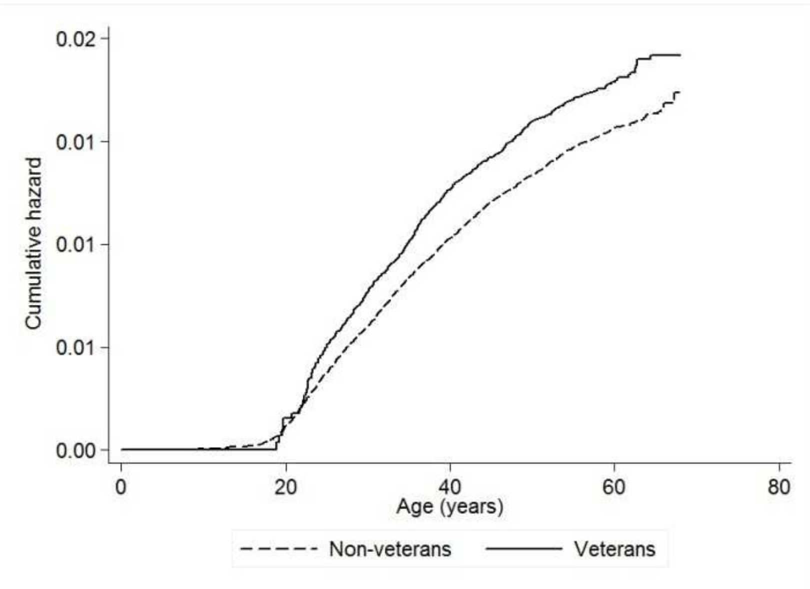

Figure 7-26 - Nelson-Aalen plot of psychosis by veteran status

7.10.1.2 Sex

Among the veterans, 48 (0.92%) women developed psychosis compared with 489 (0.96%) men. The difference was not statistically significant, HR 0.88, 95% CI 0.64-1.21, p=0.436.

In non-veterans, psychosis was significantly less common in women. There were 149 (0.72%) cases in non-veteran women compared with 1,718 (1.13%) cases in non-veteran men, HR 0.65, 95% CI 0.55-0.76, p<0.001.

7.10.1.3 Age

Veterans were older than non-veterans on average at first recorded episode of psychosis, mean 37.4 years (SD 9.9) for veterans and 35.5 years (SD 10.3) for non-veterans. The kernel density plot revealed a moderately different pattern in the two groups, with a lower proportion of cases in the younger age-groups in veterans but more in the older age-groups (Figure 7-27).

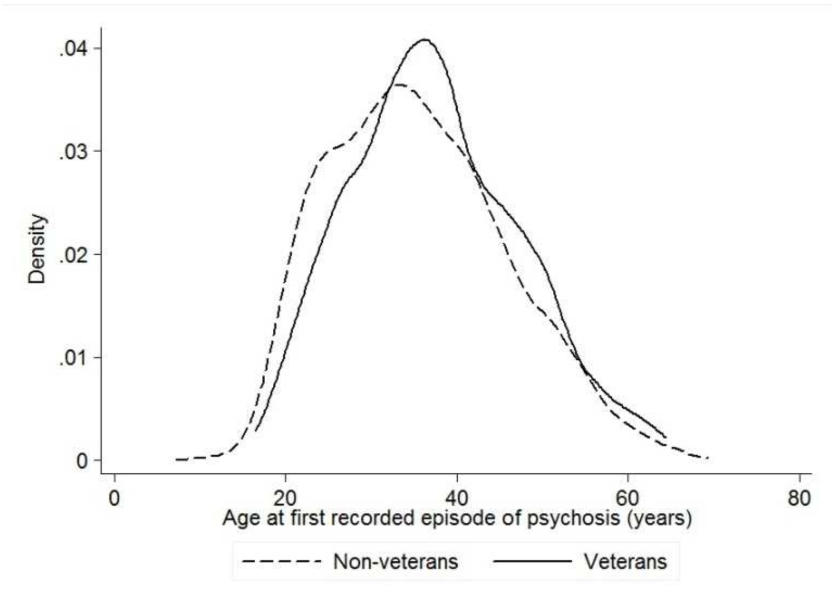

Figure 7-27 - Kernel density plot of age at first recorded episode of psychosis

7.10.1.4 Birth Cohort

Examination of the hazard ratios by birth cohort showed that the increase in risk in veterans was confined to the two oldest groups, birth years 1945-1949 and 1950-1954 (Figure 7-28). There was no difference in risk for any birth cohort from 1955 onwards.

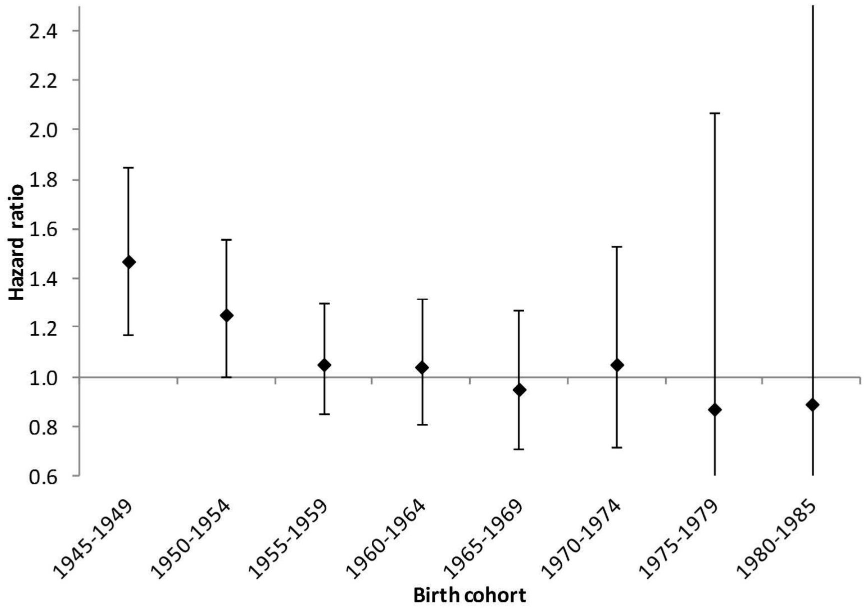

Figure 7-28 - Hazard ratios for psychosis by birth cohort
Veterans referent to non-veterans

7.10.1.5 Length of Service

Analysis by length of service showed that the increase in risk of psychosis in veterans was confined to Early Service Leavers. Those who had served between 4 and 12 years had a similar risk to non-veterans, whilst the risk was reduced in those with over 12 years' service (Figure 7-29).

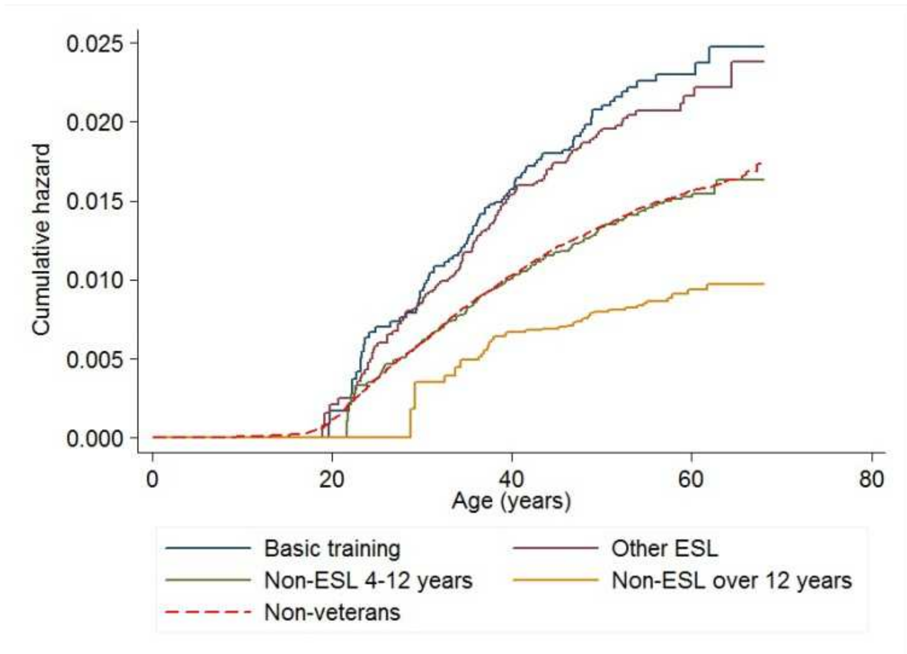

Figure 7-29 - Hazard ratios for psychosis by length of service
All non-veterans for reference

More detailed analysis confirmed the increased risk in ESL and higher risk in the earlier birth years (Table 7-10).

Table 7-10 - Cox proportional hazard model of the association between veteran status and psychosis, overall and stratified by length of service and birth cohort

	Veteran cases	All Veterans *n*-56,205			Born 1945-1959 *n*=29,709			Born 1960-1985 *n*=26,496		
	n	HR	95% CI	p	HR	95% CI	p	HR	95% CI	p
Overall										
Univariate	537	1.13	1.02-1.25	0.016	1.25	1.08-1.39	0.002	1.00	0.85-1.17	0.976
Multivariable	537	1.06	0.96-1.17	0.246	1.11	0.98-1.26	0.106	0.98	0.83-1.15	0.784
Length of service in 8 categories										
Basic training	92	1.53	1.24-1.90	<0.001	1.58	1.19-2.08	0.001	1.46	1.04-2.04	0.029
ESL (0-3 years)	188	1.51	1.29-1.76	<0.001	1.66	1.36-2.02	<0.001	1.29	1.01-1.66	0.046
4-6 years	121	1.20	0.99-1.45	0.056	1.22	0.96-1.56	0.105	1.16	0.86-1.56	0.325
7-9 years	53	0.79	0.59-1.05	0.109	0.92	0.65-1.31	0.638	0.62	0.37-1.02	0.057
10-12 years	34	0.72	0.50-1.04	0.077	1.00	0.67-1.49	0.998	0.30	0.13-0.73	0.008
13-16 years	24	0.76	0.49-1.17	0.215	0.81	0.47-1.41	0.461	0.71	0.35-1.42	0.330
17-22 years	16	0.61	0.34-1.10	0.106	0.83	0.46-1.51	0.540	*	*	*
≥23 years	<10	0.29	0.12-0.71	0.006	0.35	0.15-0.85	0.020	*	*	*

Cases: Figures <10 in subgroups suppressed to minimise risk of disclosure * = no cases

7.10.2 Co-Morbidity

Six (1.12%) veterans with psychosis also had a diagnosis of hepatitis C, an indicator of possible drug abuse, compared with 37 (1.98%) non-veterans. The odds ratio of 0.56 did not achieve statistical significance, 95% CI 0.24-1.33, p=0.082, owing to low statistical power. Nineteen (3.53%) veterans with a diagnosis of psychosis were also recorded as having alcoholic liver disease, compared with 76 (4.07%) non-veterans. The lower risk in veterans was not statistically significant, OR 0.87, 95% CI 0.53-1.42, p=0.576. Veterans with a diagnosis of psychosis were more likely than non-veterans to also have COPD, 62 (11.54%) and 149 (7.98%) respectively. The difference was statistically significant, OR 1.45, 95% CI 1.09-1.91, p=0.010.

7.10.3 Case-Fatality

The mean follow-up from date of first admission for psychosis to the date of death or the end of the study was 15.55 years (range 0-31.98 years) for veterans and 15.28 years (range 0-31.98 years) for non-veterans, representing 8,350 person-years of follow-up in the veterans and 28,528 person-years in the non-veterans. There were 116 (21.6%) deaths in veterans with psychosis, equating to 13.9 per 1,000 person-years, and 412 (22.07%) deaths in non-veterans (14.4 per 1,000 person-years).

The commonest cause of death, in both veterans and non-veterans, was IHD/AMI. Other notable causes of death were lung cancer, suicide and alcoholic liver disease, the latter two more commonly in non-veterans than in veterans. Thirteen (4.89%) of the veterans who died from suicide had a previous diagnosis of psychosis, compared with 78 (8.49%) of the non-veterans, OR 0.57, 95% CI 0.32-1.01, p=0.050. For alcoholic liver disease, there were 2 (0.89%) deaths in veterans with psychosis, compared with 26 (3.64%) in non-veterans, OR 0.24, 95% CI 0.06-1.02, p=0.034.

7.10.4 Commentary

Only Early Service Leavers were at increased risk of psychosis compared with non-veterans, and the risk was higher in ESL in the oldest birth cohorts. No veterans who completed at least a minimum engagement had an increased risk of psychosis and, on detailed breakdown by length of service, there was a reduction in risk in all those who had served for more than 6 years, whether significant or non-significant. Data for hepatitis C co-morbidity suggested that psychosis was less likely to be associated with drug abuse in veterans than in non-veterans. Veterans were older at first record of psychosis than non-veterans, suggesting that the recruit selection process had screened out those who would develop psychosis early, but was less likely to identify those with the potential to develop the disease later. Co-morbid COPD, and deaths from IHD and lung cancer, indicate that those who develop psychosis may be more likely to smoke, but veterans may be especially more likely to do so than non-veterans because of their probable higher overall prevalence of smoking. Veterans with a diagnosis of psychosis were also less likely than non-veterans to die as a result of alcoholic liver disease or suicide. The findings indicate that factors which may be early precursors of psychosis may underlie the reasons for early discharge in some ESL, but that military service is not causative.

Although there is a discrepancy between the odds ratio for the crude cumulative incidence of psychosis, which was lower in veterans than in non-veterans, and the Cox proportional hazard ratio which showed an increased risk in veterans, the results are both correct and legitimate. The discrepancy arises because the odds ratio ignores censoring, which in this study occurred on death or the end of follow-up, whereas the Cox modelling method takes censoring into account. This can sometimes result in an apparent difference in the direction of effect.

7.11 Dementia

Dementia was defined as ICD-9 code 290 or 331.0, or ICD-10 code G30 or F00-F03, at any position in the record.

7.11.1 Incidence

7.11.1.1 Overall

Over the period of follow-up, 66 (0.12%) veterans and 191 (0.11%) non-veterans had a diagnosis of dementia of sufficient severity to require in-patient or day-case care, or to result in death. The difference was not statistically significant, either in the unadjusted model or after adjusting for deprivation, HR 1.06, 95% CI 0.80-1.40, p=0.673 and HR 1.01, 95% CI 0.76-1.33, p=0.972 respectively. The Nelson-Aalen plot confirmed no difference in risk overall (Figure 7-30).

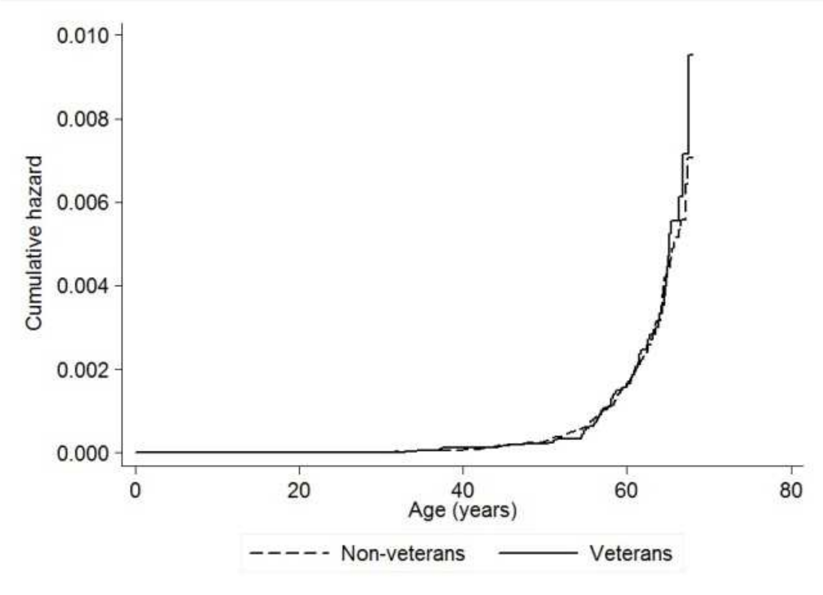

Figure 7-30 - Nelson-Aalen plot of dementia by veteran status

7.11.1.2 Sex

There were 8 cases of dementia in veteran women (12.12% of all dementia in veterans), compared with 21 in non-veteran women (10.99% of dementia in non-veterans). The increase in risk, comparing veteran women with non-veteran women, was not statistically significant, unadjusted HR 1.54, 95% CI 0.68-3.49, p=0.295. Veteran women were more likely to have a diagnosis of dementia than veteran men, unadjusted HR 1.76, 95% CI 0.84-3.69, p=0.134, although the difference was non-significant owing to small numbers. The increase in non-veteran women referent to non-veteran men was much smaller, unadjusted HR 1.14, 95% CI 0.72-1.80, p=0.570.

7.11.1.3 Age

The mean age at onset of dementia was 56.0 years (SD 8.6) for veterans and 55.9 years (SD 8.5) for non-veterans.

7.11.1.4 Birth Cohort

Analysing men and women together, there were no significant differences in risk of dementia for any birth cohort (Figure 7-1).

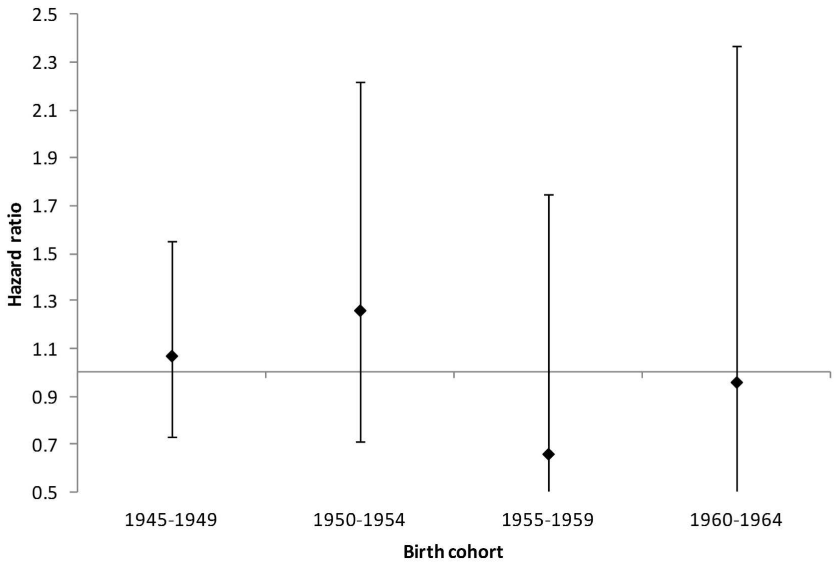

Figure 7-31 – Hazard ratios for dementia by birth cohort
Veterans referent to non-veterans

7.11.1.5 Length of Service

There was no consistent pattern of increased or decreased risk of dementia in veterans for any length of service (Figure 7-32).

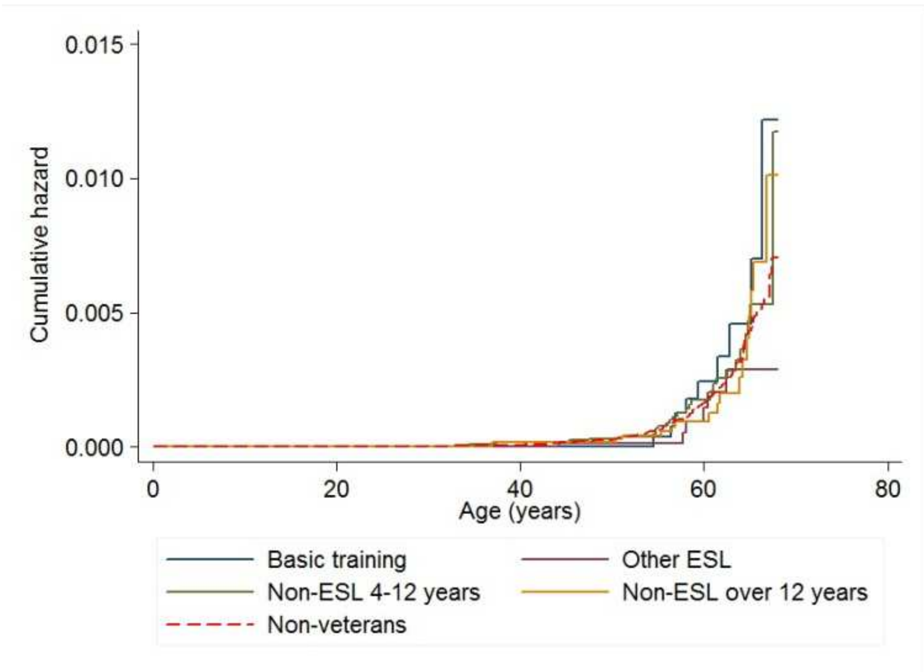

Figure 7-32 – Hazard ratios for dementia by length of service
Non-veterans for comparison

7.11.2 Dementia and Post-Traumatic Stress Disorder

Four veterans with dementia had a diagnosis of PTSD (6.1% of veterans with dementia) compared with 7 non-veterans (3.7%). The odds ratio of 1.65 was not statistically significant, 95% CI 0.50-5.47, p=0.407, although it was numerically similar to the highly significant odds ratio of 1.61, 95%CI 1.46-1.78, p<0.001 for PTSD in veterans without dementia compared with non-veterans without dementia.

7.11.3 Case-Fatality

The mean follow-up from date of first admission with dementia to the date of death or the end of the study on 31 December 2012 was 4.04 years (range 0-22.58 years) for veterans and 2.87 years (range 0-24.96 years) for non-veterans, representing 267 person-years of follow-up in the veterans and 548 person-years in the non-veterans. There were 28 (42.4%) deaths in veterans with dementia, equating to 105.0 per 1,000 person-years, and 91 (47.6%) deaths in non-veterans (166.0 per 1,000 person-years).

For the veterans, there was no predominant cause of death. In non-veterans, dementia was most often given as the cause of death (11 cases) but 6 cases were also recorded as having Down's syndrome, and 5 each as Huntingdon's disease and Parkinson's disease. Down's syndrome would have precluded military service. Two veterans and four non-veterans with dementia died from 'pneumonitis due to solids and liquids' (ICD-10 J690), presumed to be due to aspiration.

7.11.4 Commentary

Dementia is a disease of old age. The mean age of 56 years in this study is much lower than the peak age of onset for dementia in the community; with the oldest of the cohort aged only 67 years at the end of follow-up, the majority of cases of dementia recorded will have been premature. The UK prevalence at age 30-59 years is 0.16% in men and 0.09% in women, and at age 60-64 years, 1.58% in men and 0.47% in women. It is not until age 75 years and above that the prevalence in women exceeds that in men[207]. Launer et al. found female gender, older age, low levels of education and current smoking

[207] Data from Alzheimer's Research UK http://www.alzheimersresearchuk.org/dementia-statistics accessed 27 Oct 2014 derived from the European Community Concerted Action on the Epidemiology and prevention of dementia (EURODEm) study.

(especially in men) to be associated with dementia (Launer et al. 1999) but overall, the risk factors are poorly understood. Concerns have been expressed that PTSD predisposes to dementia. In a study of 181,000 US veterans aged 55 years and over (mean 69 years), Yaffe et al. found that those with PTSD were twice as likely to develop dementia, unadjusted HR 2.31, 95% CI 2.24-2.39 and HR 1.77, 95% CI 1.70-1.85 after adjusting for demographic factors and co-morbidities (Yaffe et al. 2010). This finding was confirmed by Qureshi et al. (Qureshi et al. 2010), whilst an association with having been a prisoner of war has also been demonstrated (Meziab et al. 2014). The Scottish Veterans Health Study provides reassurance, not only that the risk of dementia in veterans does not currently differ from that in the wider community, but also that having PTSD does not confer additional risk of dementia. A major limitation is that the cohort had not reached the age at which the incidence of dementia peaks by the end of follow-up; future changes in the pattern of risk as the cohort ages cannot be ruled out.

7.12 Suicide

Deaths were categorised as suicide if the cause of death was recorded as ICD-9 code E950-E959 or E850-E989, or ICD-10 code X60-X84, Y10-Y34, Y87.0 or Y87.2, and if both a date of self-harm/suicide and a date of death were recorded. 'Suicide' was used in the medical sense of death as a result of probable self-harm, and not in the legal sense; thus some cases categorised as 'suicide' may have been legally categorised as 'intentional self-harm' or 'events of undetermined intent'[208].

7.12.1 Incidence

7.12.1.1 Overall

There were 267 deaths from suicide in veterans (0.48% of all veterans) during the period of follow-up, compared with 918 (0.53%) in non-veterans, representing 7.6% of all deaths in veterans compared with 8.4% of all non-veteran deaths. There was no statistically

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[208] The difference arises from whether intent can be clearly established, and whether it is known that the individual intended to kill themselves or merely intended to harm themselves without necessarily wishing for a fatal outcome; or whether intent cannot be determined. For statistical purposes, it is conventional to combine these categories. Information from http://www.gro-scotland.gov.uk/statistics/theme/vital-events/deaths/suicides/definition-of-stats/index.html accessed 27 Oct 2014.

Information on Fatal Accident Inquiry (the Scottish equivalent of a Coroner's Inquest) determinations was not available in the linked dataset.

significant overall difference in risk, unadjusted HR 1.03, 95% CI 0.90-1.18, p=0.661. The findings remained non-significant after adjusting for deprivation, HR 0.99, 95% CI 0.86-1.13. p=0.872. Testing for non-proportionality of the hazards was non-significant, p=0.106.

7.12.1.2 Sex

There was a statistically significant interaction with sex, p=0.007. There were 16 cases of suicide in veteran women (0.3% of all veteran women and 8.6% of deaths in this group), compared with 30 in non-veteran women (0.1% of all non-veteran women and 4.0% of deaths). Whilst the adjusted Cox proportional hazard ratio for male veterans compared with non-veterans was 0.94, 95% CI 0.81-1.08, p=0.363, for women it was 2.44, 95% CI 1.32-4.51, p=0.005. When women were compared with men, non-veteran women were at much lower risk than non-veteran men, adjusted HR 0.28, 95% CI 0.19-0.40, p<0.001, but there was no statistically significant difference for veteran women compared with veteran men, adjusted HR 0.71, 95% CI 0.43-1.18, p=0.192. The mean age at death from suicide for veteran men was 44 years, compared with 41 years for non-veterans, whilst for women it was 49 years for veterans compared with 39 years for non-veterans (Figure 7-34). All the veteran women who died as a result of suicide joined the Services prior to 1991, half had left the Services after 3 years or less and none had served for more than 11 years. Three-quarters were living in the two most deprived SES quintiles.

7.12.1.3 Age

The mean age at death from suicide was 43.5 years (SD 8.1) in veterans compared with 40.6 years (SD 9.7) in non-veterans. There were only 2 deaths from suicide in veterans aged under 25 years, out of 11 total deaths in this age-group (18%), compared with 39/163 deaths (24%) in non-veterans under 25 years. The risk was reduced in veterans under 25 years compared with non-veterans, but was not statistically significant, HR 0.43, 95% CI 0.06-3.17, p=0.407 in the univariate model, HR 0.47, 95% CI 0.06-3.45, p=0.456 after adjusting for deprivation. The Nelson-Aalen plot demonstrated a lower risk in veterans at younger ages, catching up with the risk in non-veterans in older age, a pattern which was confirmed by the kernel density plot which showed a lower proportion of suicides in veterans at younger ages, particularly in women veterans (Figure 7-33 and Figure 7-34).

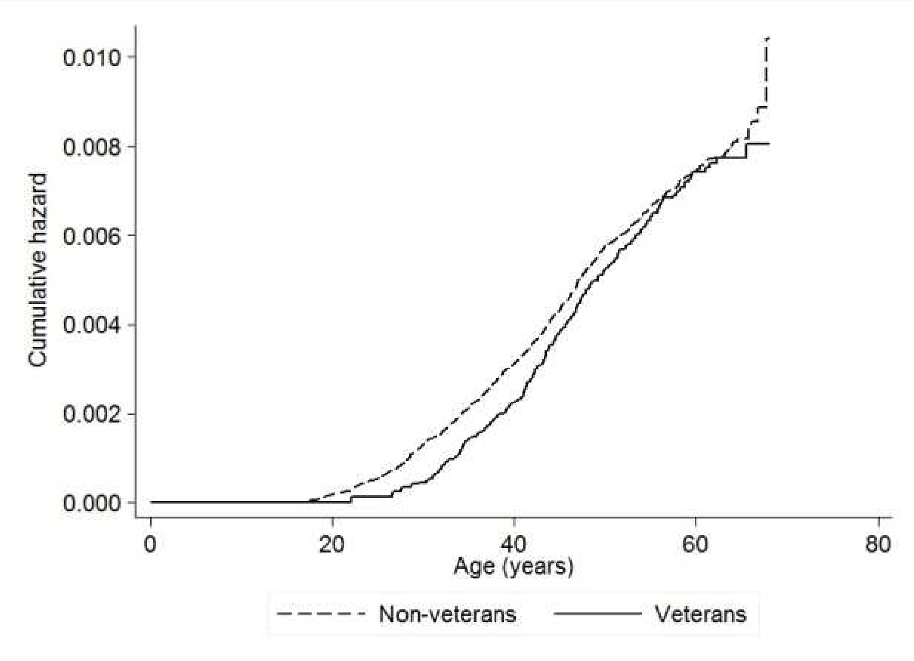

Figure 7-33 - Nelson-Aalen plot of suicide by veteran status

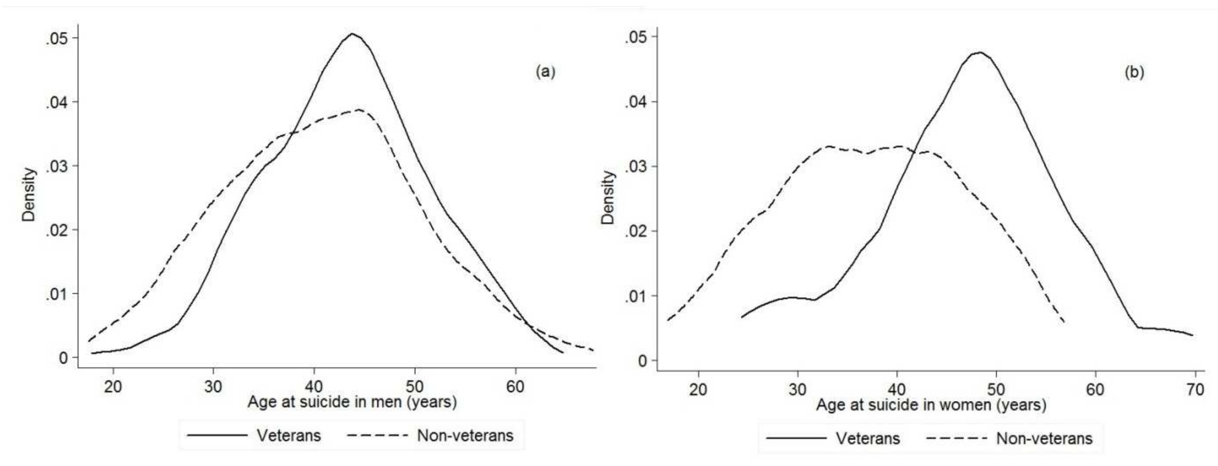

Figure 7-34 - Kernel density plot of age at suicide in men and women Veterans and non-veterans

7.12.1.4 Birth Cohort

Examining both sexes together, testing for interaction with birth cohort was highly significant, p=0.003. Analysis of risk in 5-year birth cohorts showed a significantly increased risk only in the 1950-1954 cohort, adjusted HR 1.44, 95% CI 1.06-1.97, p=0.021. There was a non-significant increase in risk in the 1945-1949 birth cohort and a non-significant decrease in risk in all birth cohorts from 1960 onwards (Figure 7-35).

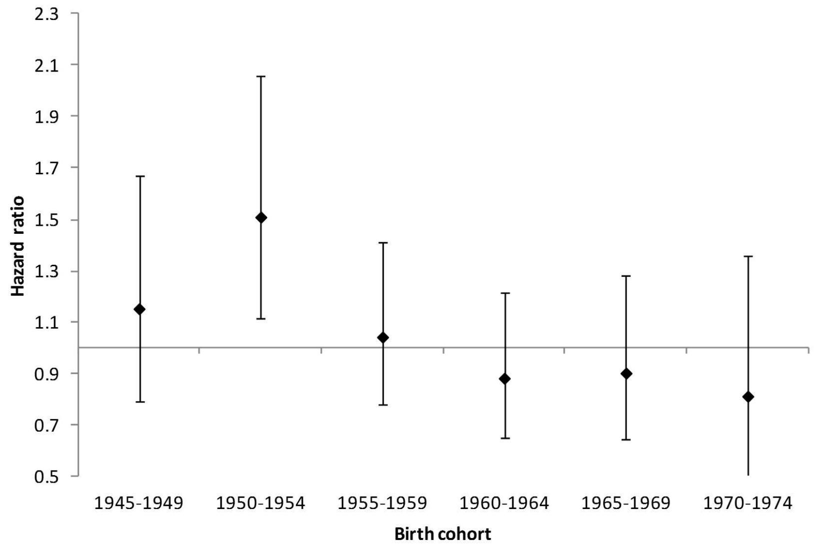

Figure 7-35 - Hazard ratios for suicide by birth cohort Veterans referent to non-veterans

7.12.1.5 Length of Service

There was little difference in the risk of suicide in veterans for any length of service, compared with the overall risk in non-veterans, apart from a slight increase in risk in older Early Service Leavers and a slight reduction in risk in older veterans with over 12 years' service (Figure 7-36).

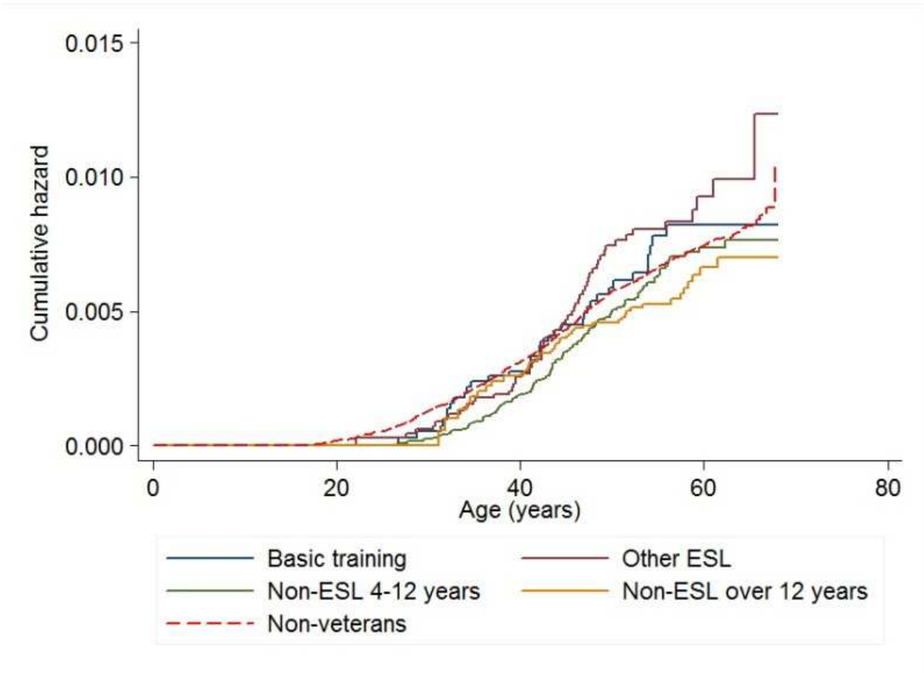

Figure 7-36 - Hazard ratios for suicide by length of service Non-veterans for comparison

7.12.1.6 Rates

Rates of suicide per 100,000 person-years of follow-up, for men and women together, confirmed that veterans aged under 40 years were not at increased risk compared with non-veterans, but that there was a modest increase in risk in the oldest age-groups. The overall rate for male and female veterans together was 21.2 per 100,000 person-years, compared with 17.0 for non-veterans, whilst for those under 40 years of age, the rate was 14.3 for veterans compared with 13.9 for non-veterans. The overall suicide rate in Early Service Leaver veterans was intermediate between that of non-veterans and veterans, but when analysed by age-group, their rate was lower than both veterans and non-veterans in all but the oldest age-group (50 years and over). The highest rates were seen in people aged from 40 to under 50 years, in both veterans and non-veterans. Veterans aged over 40 years had a higher rate than non-veterans (Table 7-11). However, plotting absolute number of suicides by year of birth showed little difference between veterans and non-veterans, for people aged over 40 years at death, apart from a small excess in veterans born in the early 1950s (Figure 7-37).

Table 7-11 - Rates of suicide per 100,000 person-years at risk, by veteran status

	All veterans *n*=56,205		Veterans up to 3 years service (Early Service Leavers) *n*=17,884[209]		Non-veterans *n*=172,741	
Age	**Number**	**Rate**	**Number**	**Rate**	**Number**	**Rate**
All ages	267	21.2	173	19.8	918	17.0
<30 years	<10	5.2	<10	4.4	144	10.1
30-<40 years	73	18.2	47	17.2	286	18.4
40-<50 years	127	30.6	79	26.2	348	26.6
≥50 years	56	20.2	41	20.0	140	16.9

Cases: Figures <10 in subgroups suppressed to minimise risk of disclosure

[209] Using a 3-year definition of ESL rather than 2.5 years

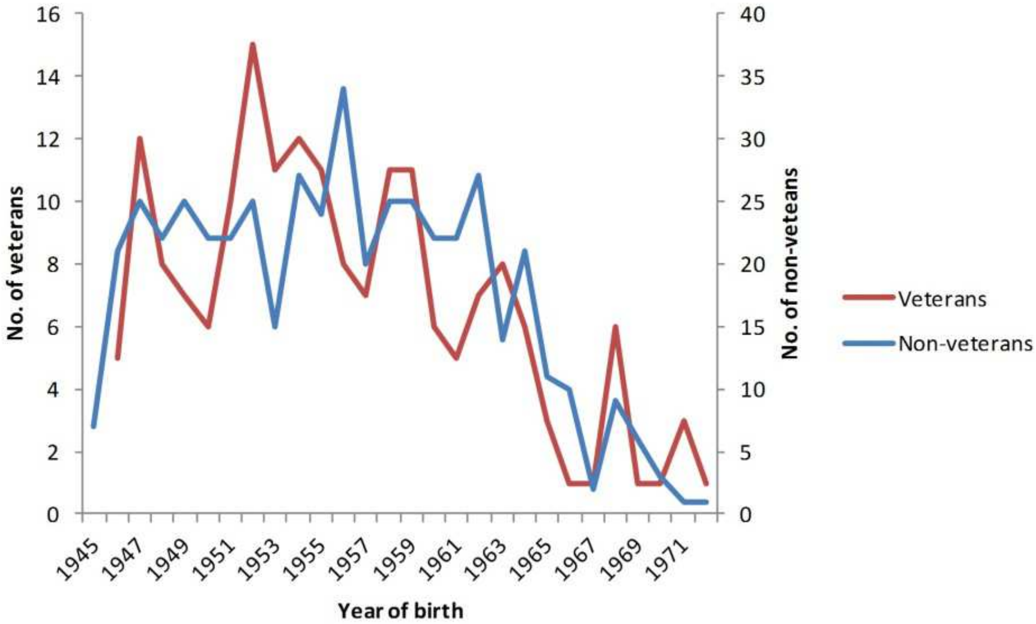

Figure 7-37 - Number of suicides over age 40 years, by year of birth Veterans and non-veterans

Cox proportional hazard analysis showed all differences to be non-significant, unadjusted HR 0.89, 95% CI 0.70-1.13, p=0.332 for age 20 to under 40 years; HR 1.08, 95% CI 0.89-1.32, p=0.418 for age 40 to under 50 years; and HR 1.12, 95% CI 0.84-1.49 for age 50 years and above. The results were similar after adjusting for deprivation.

7.12.2 Co-Morbidity

Co-morbidities with suicide in veterans and non-veterans, for selected conditions, are summarised at Table 7-12.

Table 7-12 - Co-morbidities with suicide for selected conditions
Crude overall cumulative incidence for comparison

	Veterans		Non-veterans		Veterans referent to non-veterans		
	Cases *n*=267 No. (%)	Pop. *n*=56,205 (%)	Cases *n*=918 No. (%)	Pop. *n*=172,741 (%)	OR	95% CI	p
Physical							
Peptic ulcer	18 (6.7)	(3.4)	40 (4.3)	(3.0)	1.55	0.90-2.65	0.112
COPD	11 (4.1)	(4.3)	37 (4.0)	(4.5)	1.02	0.53-1.98	0.948
Diabetes	8 (3.0)	(3.4)	22 (2.4)	(3.3)	1.25	0.56-2.78	0.583
Any cancer	8 (3.0)	(6.4)	20 (2.2)	(6.7)	1.38	0.61-3.09	0.439
AMI	5 (1.9)	(3.7)	15 (1.6)	(3.0)	1.15	0.42-3.12	0.790
Alcoholic liver disease	5 (1.9)	(1.2)	22 (2.4)	(1.3)	0.78	0.30-2.04	0.614
Hepatitis C	4 (1.5)	(0.2)	18 (2.0)	(0.4)	0.76	0.26-2.24	0.622
Mental							
Any mental health disorder	70 (26.2)	(5.0)	247 (26.9)	(4.5)	0.97	0.78-1.22	0.823
Any mental health disorder excluding PTSD	60 (22.5)	(3.9)	201 (21.8)	(3.8)	1.02	0.0-1.32	0.841
Mood disorder	41 (15.4)	(2.8)	160 (17.4)	(2.6)	0.88	0.64-1.21	0.427
Anxiety	33 (12.4)	(2.5)	94 (10.2)	(2.0)	1.21	0.83-1.75	0.324
Stress/PTSD	10 (3.7)	(1.1)	46 (5.0)	(0.7)	0.75	0.38-1.46	0.391
Anxiety less stress/PTSD	23 (8.9)	(1.4)	48 (5.5)	(1.3)	1.63	1.01-2.62	0.046
Psychosis	13 (4.9)	(1.0)	78 (8.5)	(1.1)	0.57	0.32-1.01	0.050

An increased risk of suicide has been reported in association with a number of medical conditions including malignant neoplasms, peptic ulcer and multiple sclerosis, although there is no conclusive evidence for an association with cardiovascular disease (Harris et al. 1994). Other researchers have also reported an increased association with peptic ulcer, whether or not treated surgically (Bahmanyar et al. 2009, Viskum 1975). The finding that the most common physical co-morbidity was peptic ulcer, in both veterans and non-veterans, is consistent with these earlier reports. The number of suicides in people with a previous diagnosis of hepatitis C or alcoholic liver disease was also increased, although less for veterans than for non-veterans. For COPD, it was similar to the proportion in the whole cohort, whilst for those with diabetes, cardiovascular disease or any cancer the proportion of suicides was lower than in the overall cohort, stratified by veteran status, for both veterans and non-veterans. Suicide was less likely to be associated with stress or PTSD in veterans than in non-veterans, although the difference did not achieve statistical significance.

7.12.3 Commentary

Despite the recent publication of a number of high-quality studies on suicide risk in veterans, there remains no clear consensus as to their risk (Miller et al. 2009). Kaplan reported a doubling of risk in the general US male veteran population compared with non-veterans based on data from the 1986-1994 National Health Interview Survey (NHIS) (Kaplan et al. 2006), whilst LeardMann found no increase in risk associated with military-specific variables in the US military Millennium Cohort Study population followed up from 2001 to 2008, although suicide risk was independently associated with male sex and mental disorders (LeardMann et al. 2013). Kapur examined suicides in a retrospective cohort of 233,803 veterans who had left the UK Armed Forces between 1996 and 2005 and found that the overall rate of suicide was no higher than in the general population, but that there was an increased risk in those aged under 25 years. For veterans aged 30-49 years, the age-specific rates were lower than in the general population (Kapur et al. 2008). A recent report on deaths in UK veterans of the 1982 Falklands conflict showed an overall reduction in risk of suicide/open verdict deaths compared with the general population (standardised mortality ratio 65, 95% CI 53-80), which was similar to the risk of suicide reported in UK military personnel followed up since the 1991 Gulf conflict (standardised mortality ratio 76, 95% CI 66-88) (Defence Statistics (Health) 2013, Defence Statistics (Health) 2014a).

Overall, there was no significant difference in risk of suicide between veterans and non-veterans in the Scottish Veterans Health Study. Women veterans were at increased risk compared with non-veteran women but not when compared with veteran men. When analysed by birth cohort, only veterans in the 1950-1954 birth cohort showed a significantly increased risk compared with non-veterans, which persisted after adjusting for deprivation. Veterans born after 1960 showed a non-significant decrease in risk. Veterans aged under 40 years were at lower risk of suicide than civilians but the risk increased in the 5th decade until there was no difference in risk in older age.

The finding of an incidence of suicide of 21.2 per 100,000 person-years in veterans is broadly comparable to the age-standardised rate for men of 21.8 (95% CI 20.5-23.1) in the general Scottish population in 2009-10. The rate for women in the general Scottish population was much lower at 7.3 (95% CI 6.6-8.0) (ISD Scotland 2012). The UK-wide rates in 2011 were 18.2 per 100,000 person-years for men and 5.6 per 100,000 person-years for women (Scowcroft 2013). For non-veterans, there were 17.0 suicides per 100,000 person-years in the Scottish Veterans study, somewhat lower than the Scotland-wide rates for 2009-2010. By comparison, in the US, Miller et al. reported a rate of 18.9 per 100,000 person-years in veterans in a prospective study of 500,000 middle-aged and elderly male veterans enrolled in the US Cancer Prevention Study II, compared with 21.7 per 100,000 in non-veterans (Miller et al. 2009).

In the Scottish Veterans study, the highest incidence for both veterans and non-veterans was in the 5th decade. This is similar to the 2012 UK-wide national data (Scowcroft 2013), and also accords with the 2010 Scottish data (ISD Scotland 2012). However, it is likely that the age profile has changed over time during the long follow-up period. The overall incidence of suicide in Early Service Leavers was intermediate between the incidence for all veterans and for non-veterans, but the only increase was confined to the oldest. ESL are of particular concern as they have been shown to be at higher risk of mental health problems (Buckman et al. 2013) but no previous studies on their long-term suicide risk have been identified. The Scottish Veterans Health Study showed no increase in risk in ESL other than in those aged over 50 years; the suicide risk of ESL was similar to that of non-veterans in the under-50s, rising to that of all veterans in the over-50s.

Men are at consistently higher risk of suicide than women throughout the developed world (Moller-Leimkuhler 2003), and in Scotland the ratio was 3:1 in 2009-10 (ISD Scotland 2012). Rates fell in England and Wales during the two World Wars, especially in middle aged and older men (Thomas and Gunnell 2010). In the Scottish Veterans study, the rate for all veterans (of whom 90% were male) of 21.2 per 100,000 person-years was similar to the rate for males in Scotland of 21.8 per 100,000. Owing to small numbers, it was not possible to analyse male and female veterans separately by person-years at risk but the Cox proportional hazard ratio showed that the female veterans experienced a risk closer to that of male veterans, and significantly higher than non-veteran women. This may be consistent with the findings of Woodhead et al. who reported a significant association between veteran status and suicidal ideation in women, adjusted OR 2.82, 95% CI 1.13-7.03, although there was no significant increase in male veterans (Woodhead et al. 2011a). Other studies have shown a mixed picture. A US study found no difference in suicide rates between women who had deployed to Vietnam compared with those who did not deploy, and their SMR for suicide was similar to that for US women overall (Thomas et al. 1991). McCarthy et al. examined suicide among US veterans receiving care from the Veterans Health Administration and found that both men and women had higher rates than the general population but the relative risk was especially high for women. In women, the risk was highest in those aged 50-59 years, SMR 2.36, 95% CI 1.22-3.38 although the sex and age adjusted crude suicide rate for female veterans was lower at 9.76 than that of 38.46 for male veterans (McCarthy et al. 2009). Veterans Health Administration patients are not typical of the US veterans population as they are generally drawn from the more deprived end of the socio-economic spectrum; the authors also noted that their population encompassed some non-veterans who were included in the analysis. A follow-up of US Persian Gulf veterans to 1993 found a non-significantly higher rate of suicide in women who had deployed in comparison with non-deployed veteran women (SMR 1.81, 95% CI 0.90-3.24) and also in non-deployed women compared with women in the general US population, SMR 1.22, 95% CI 0.68-2.00. The increased rates of suicide in women accorded with an increase in other external causes of death (Kang and Bullman 1996). It is likely that women serving in the Armed Forces exhibit increased risk-taking behaviours compared with the general population, as do men, and this may modify their gender-specific risk of suicide to a more 'male' risk. Nonetheless, in the present study, the increased risk appears to be limited to those who joined prior to 1992 and therefore served in the women's corps; women who joined the Armed Forces from 1992 onwards served alongside men, following a change in employment policy, with no distinction as to role for land forces apart from the ongoing prohibition on women serving on the front line in a combat role. The reasons for this change in risk pattern for suicide in women veterans require further investigation, as does the differing age profile.

7.13 Non-Fatal Self-Harm

Non-fatal self-harm was defined as the occurrence of ICD-9 code E950-E959 or E850-E989, or ICD-10 code X60-X84, Y87.0, Y10-Y34 or Y87.2, at any position in the record other than the death certificate, excluding any individual classified as suicide in Section 7.12, and excluding anyone whose date of death was recorded as the same as the date of self-harm or suicide. This definition therefore excludes anyone with an episode of non-fatal self-harm who later died as a result of suicide (see Section 7.13.3).

7.13.1 Incidence

7.13.1.1 Overall

A record of acute or psychiatric hospital admission for non-fatal self-harm was common, occurring in 1,620 (2.90%) veterans and 4,212 (2.45%) non-veterans. The increase in risk of non-fatal self-harm in veterans was statistically significant, unadjusted HR 1.27, 95% CI 1.21-1.35, p<0.001, and HR 1.20, 95% CI 1.14-1.27, p<0.001 after adjusting for deprivation. Testing for non-proportionality of the hazards was non-significant, p=0.124. The Nelson-Aalen plot showed a pattern of changing risk with age, with a steep increase in risk in the youngest veterans and a further increase in older middle age (Figure 7-38).

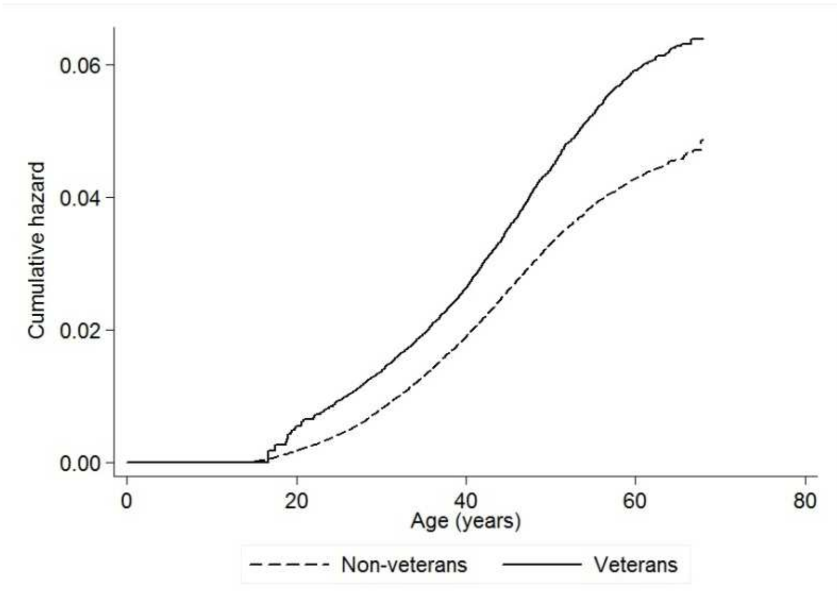

Figure 7-38 - Nelson-Aalen plot of non-fatal self-harm by veteran status

7.13.1.2 Sex

There was a history of non-fatal self-harm in 170 female veterans and 691 female non-veterans, equating to 3.25% of veteran women and 3.34% of non-veteran women. The cumulative incidence for veteran men was 2.84% (1,450 cases) compared with 2.32% (3,521 cases) for non-veteran men. The Cox model demonstrated a moderately increased risk of non-fatal self-harm in women when veterans were compared with non-veterans, although it did not achieve statistical significance, unadjusted HR 1.18, 95% CI 0.99-1.39, p=0.058 and HR 1.14, 95% CI 0.97-1.35, p=0.116 after adjusting for deprivation, but for men the risk was highly significantly increased, unadjusted HR 1.29, 95% CI 1.22-1.37, p<0.001, adjusted HR 1.22, 95% CI 1.15-1.29, p<0.001.

For veterans, the hazard ratios for non-fatal self-harm in women referent to men were 1.11, 95% CI 0.95-1.30, p=0.206 unadjusted and 1.18, 95% CI 1.01-1.38, p=0.039 adjusted for deprivation, whilst for non-veterans the corresponding hazard ratios were 1.29, 95% CI 1.19-1.40, p<0.001 and 1.36, 95% CI 1.26-1.48, p<0.001.

7.13.1.3 Age

The mean age at first episode of non-fatal self-harm resulting in acute or psychiatric hospital admission was 41.6 years (SD 9.6) for veterans, compared with 39.6 years (SD 9.7) for non-veterans. The mean age at non-fatal self-harm in Early Service Leavers who failed to complete training was 41.5 years (SD 9.5), similar to the mean age for all veterans. The kernel density plot showed no difference in age distribution between veterans and non-veterans other than a shift to the right in veterans (Figure 7-39).

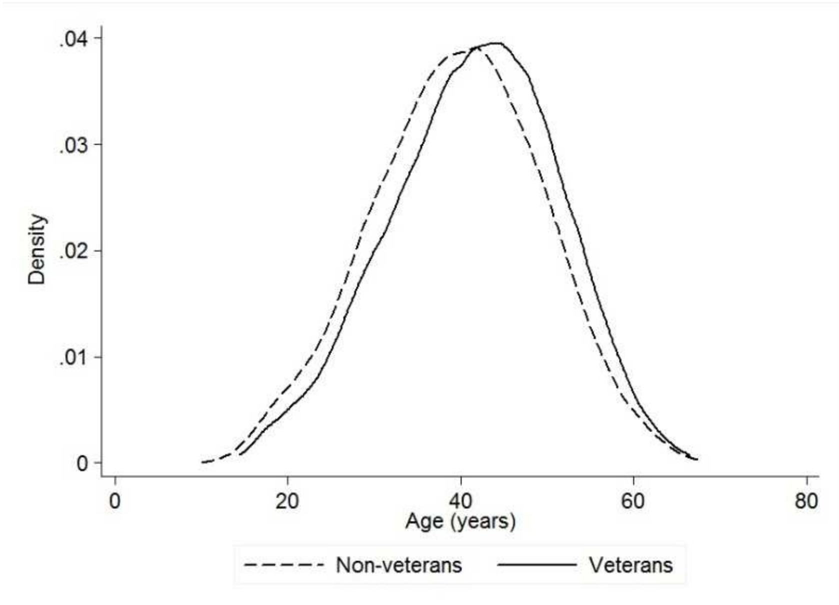

Figure 7-39 - Kernel density plot of age at first episode of non-fatal self-harm by veteran status

Women were younger than men at first episode of non-fatal self-harm, for both veterans and non-veterans (Table 7-13).

Table 7-13 - Age at first episode of non-fatal self-harm

	Veterans *n*=1,620			Non-veterans *n*=4,212		
	Cases	Mean (years)	SD	Cases	Mean (years)	SD
Men	1,450	41.9	9.5	3,521	40.1	9.5
Women	170	38.9	10.1	691	37.5	10.7

7.13.1.4 Birth Cohort

Analysis by birth cohort showed a U-shaped curve; the oldest veterans were at increased risk of non-fatal self-harm, the hazard ratio then reducing steadily and becoming non-significantly different from unity for veterans born from 1965 to 1979. The pattern then reversed, with an increase in risk in the youngest veterans; based on 55 cases in veterans and 184 in non-veterans in the 1980-1985 birth cohort (Figure 7-40).

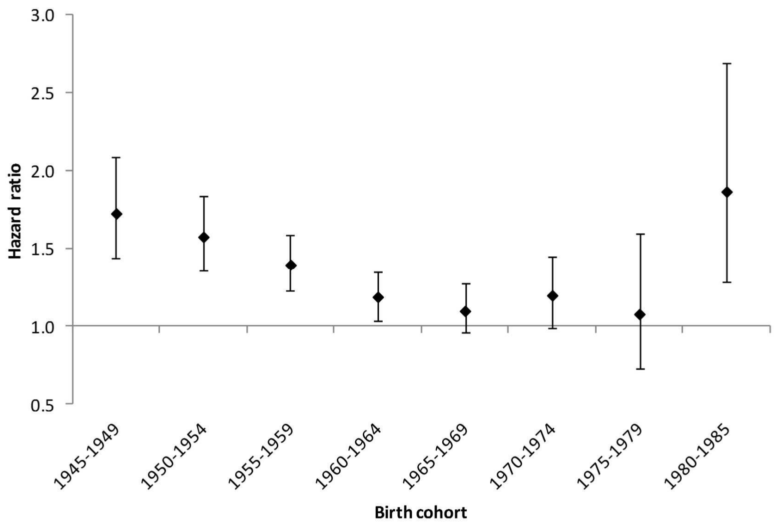

Figure 7-40 - Hazard ratios for non-fatal self-harm by birth cohort Veterans referent to non-veterans

7.13.1.5 Length of Service

Subgroup analysis by length of service showed the excess risk of non-fatal self-harm to be confined to Early Service Leavers, with the highest risk in those who did not complete initial training, except for a group of older (over 50 years of age) veterans with between 4 and 12 years' service. The risk in veterans with over 12 years' service was lower than that in all non-veterans taken together (Figure 7-41).

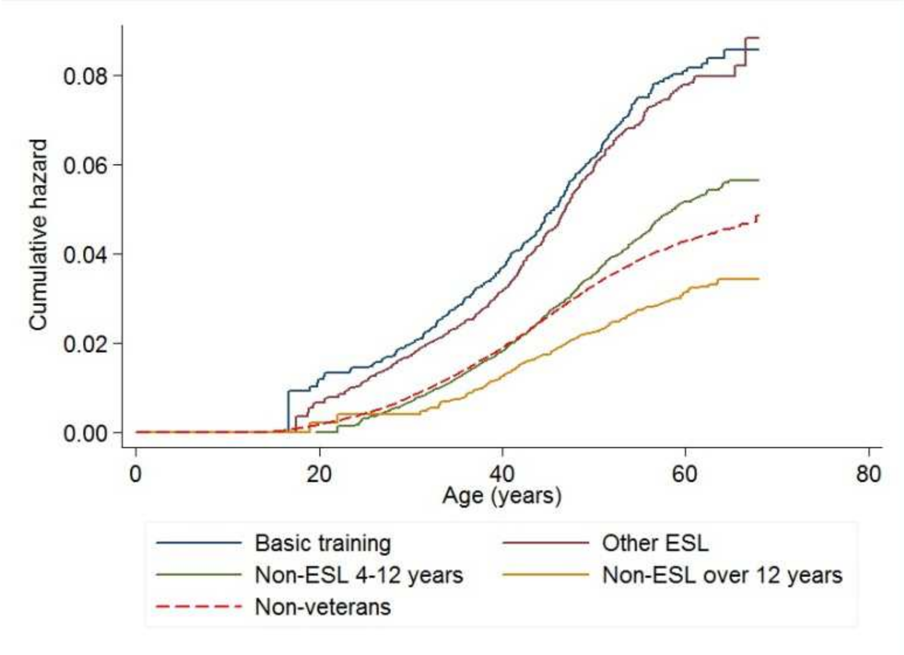

Figure 7-41 - Hazard ratios for non-fatal self-harm by length of service Non-veterans for comparison

Detailed breakdown by length of service and birth cohort confirmed the highest risk to be in those who did not complete initial training, and also demonstrated a reducing risk in the later birth cohorts (1960 onwards), with a significantly lower risk in those with 10 years' service and over (Table 7-14). The excess risk in older veterans was limited to those with under 10 years' service.

Table 7-14 - Cox proportional hazard model of the association between veteran status and non-fatal self-harm, overall and stratified by length of service and birth cohort

	Veteran cases	All Veterans *n*-56,205			Born 1945-1959 *n*=29,709			Born 1960-1985 *n*=26,496		
	n	HR	95% CI	p	HR	95% CI	p	HR	95% CI	p
Overall										
Univariate	1,620	1.34	1.26-1.42	<0.001	1.55	1.42-1.69	<0.001	1.19	1.10-1.30	<0.001
Multi-variable	1,620	1.26	1.18-1.33	<0.001	1.43	1.31-1.56	<0.001	1.17	1.08-1.27	<0.001
Length of service in 8 categories										
Basic training	259	1.69	1.50-1.91	<0.001	2.08	1.76-2.45	<0.001	1.52	1.28-1.80	<0.001
ESL (0-3 years)	480	1.59	1.46-1.74	<0.001	1.92	1.69-2.18	<0.001	1.45	1.28-1.65	<0.001
4-6 years	345	1.33	1.20-1.47	<0.001	1.58	1.36-1.83	<0.001	1.19	1.03-1.37	0.018
7-9 years	211	1.19	1.04-1.36	0.008	1.57	1.31-1.88	<0.001	0.89	0.73-1.08	0.249
10-12 years	128	0.97	0.82-1.14	0.690	1.17	0.93-1.47	0.190	0.77	0.60-0.99	0.044
13-16 years	94	0.97	0.79-1.18	0.740	1.21	0.92-1.58	0.179	0.71	0.53-0.96	0.026
17-22 years	67	0.89	0.70-1.14	0.362	0.87	0.64-1.18	0.358	0.96	0.65-1.41	0.818
≥23 years	31	0.40	0.28-0.57	<0.001	0.41	0.28-0.62	<0.001	0.38	0.18-0.80	0.011

Examination of the data for the 1980-1985 birth cohort showed that, of the veterans who had a recorded episode of non-fatal self-harm, 60% were Early Service Leavers, 81% had served for four years or less and none had more than 9 years' service.

7.13.2 Co-Morbidity

Co-morbidities were examined for the same conditions as in Section 7.12.2, and the results are summarised at Table 7-15.

Table 7-15 - Co-morbidities with non-fatal self-harm
Crude overall incidence for comparison

	Veterans		Non-veterans		Veterans referent to non-veterans		
	Cases *n*=1,620 No. (%)	Pop. *n*=56,205 (%)	Cases *n*=4,212 No. (%)	Pop. *n*=172,741 (%)	OR	95% CI	p
Physical							
Peptic ulcer	128 (7.9)	(3.4)	310 (7.4)	(3.0)	1.07	0.88-1.31	0.482
COPD	209 (12.9)	(4.3)	558 (13.2)	(4.5)	0.97	0.84-1.13	0.726
Diabetes	112 (6.9)	(3.4)	234 (5.6)	(3.3)	1.24	1.00-1.55	0.049
Any cancer	134 (8.3)	(6.4)	290 (6.9)	(6.7)	1.20	0.99-1.46	0.068
AMI	86 (5.3)	(3.7)	183 (4.3)	(3.0)	1.22	0.95-1.57	0.116
Alcoholic liver disease	91 (5.6)	(1.2)	281 (6.7)	(1.3)	0.84	0.67-1.06	0.140
Hepatitis C	25 (1.5)	(0.2)	134 (3.2)	(0.4)	0.49	0.32-0.74	<0.001
Lung cancer	27 (1.7)	(0.8)	33 (0.8)	(0.6)	2.13	1.28-3.53	0.002
Mental							
Any mental health disorder	811 (50.1)	(5.0)	1955 (46.4)	(4.5)	1.08	1.02-1.14	0.013
Any mental health disorder less PTSD	536 (33.1)	(3.9)	1451 (34.4)	(3.8)	0.96	0.89-1.04	0325
Mood disorder	604 (37.3)	(2.8)	1491 (35.4)	(2.6)	1.05	0.98-1.14	0.179
Anxiety	404 (24.9)	(2.5)	893 (21.2)	(2.0)	1.18	1.06-1.30	0.002
Stress/PTSD	275 (16.9)	(1.1)	504(11.9)	(0.7)	1.42	1.24-1.62	<0.001
Anxiety less stress/PTSD	129 (9.6)	(1.4)	389 (10.5)	(1.3)	0.91	0.76-1.10	0.351
Psychosis	123 (7.6)	(1.0)	371 (8.8)	(1.1)	0.86	0.71-1.05	0.135

The pattern differs markedly from that seen for suicide (Table 7-12). Whilst the association with peptic ulcer was similar, COPD was much more strongly associated with non-fatal self-harm than with suicide. There was also an increased risk of lung cancer in both veterans and non-veterans who self-harmed; the magnitude of the association was greater in veterans[210]. Diabetes, AMI and alcoholic liver disease were also associated with an increased risk of non-fatal self-harm, in both veterans and non-veterans. An increased association with any cancer was only seen in veterans. The increase in risk of co-morbid hepatitis C was similar to that for suicide, for both veterans and non-veterans, although overall, veterans had a lower risk of hepatitis C co-morbidity than did non-veterans. Otherwise, apart from a marginally significant increased risk of diabetes, there were no significant differences in the pattern of co-morbidity for physical disorders between veterans and non-veterans.

[210] No veterans, and only one non-veteran, with a diagnosis of lung cancer died as a result of suicide

As expected, mental health disorders were strongly associated with non-fatal self-harm; 50% of veterans and 46% of non-veterans who had a non-fatal self-harm episode also had a record of in-patient or day case admission for a mental health condition. Any difference between veterans and non-veterans arose solely in respect of co-morbid diagnoses of stress or PTSD.

7.13.3 Case-Fatality

The mean follow-up from date of first record of non-fatal self-harm to the date of death or the end of the study was 9.74 years (range 0-23.61 years) for veterans and 9.49 years (range 0-28.23 years) for non-veterans, representing 15,799 person-years of follow-up in the veterans and 39,972 person-years in the non-veterans. There were 206 (12.7%) deaths in veterans with a history of non-fatal self-harm, equating to 13.1 per 1,000 person-years, and 540 (12.8%) deaths in non-veterans (13.5 per 1,000 person-years).

The definition of non-fatal self-harm used in this study excluded anyone who died as a result of suicide; it was not possible to determine how many deaths from suicide followed an earlier separate episode of self-harm because of the difficulty of ruling out a late fatal outcome of the initial episode of self-harm. The commonest non-suicide cause of death in veterans with a history of self-harm was myocardial infarction; in non-veterans, it was alcoholic liver disease.

7.13.4 Commentary

Non-fatal self-harm covers a wide spectrum of behaviours and psychopathology, from hair-pulling and self-hitting through to parasuicide or major mutilation such as enucleation of an eye, and from an impulsive urge to cause oneself pain through to psychotic delusional states (Pattison and Kahan 1983, Skegg 2005). Risk factors include young age, female sex, adverse childhood experiences, depression, anxiety, substance abuse, impulsivity and intoxication, whilst good social support, religious affiliation and an optimistic outlook are protective (Skegg 2005). Generalisations based on epidemiological data are therefore problematic, other than in identifying broad patterns of risk.

The Scottish Veterans Health Study provided no evidence that military service predisposes to non-fatal self-harm of sufficient severity to result in secondary care admission. Although the overall risk was statistically significantly increased in veterans, this was entirely accounted for by an increased risk in Early Service Leavers, especially in the older birth cohorts, and in older veterans with less than 10 years' service. The risk reduced with increasing length of service, and veterans with the longest service were at reduced risk compared with non-veterans. The highest risk was in those ESL who had not completed initial training, but their mean age at first recorded episode was not consistent with a causal role for their brief period of military service; it is implausible that less than 20 weeks' service should result in a self-harm episode 20 or more years later. Rather, it is suggested that the evidence points to a vulnerable personality in which the tendency to self-harm is but one component of the overall picture of unsuitability for military service, thus supporting Larson et al.'s theoretical model of initial military training as a *de facto* extension to the screening process for suitability for military service (Larson et al. 2008). This is further discussed at Section 8.3.1.3. The pattern of increased risk in ESL is consistent with the findings of Woodhead et al., who reported a strong association between ESL status[211] and a history of self-harm, OR 12.38, 95% CI 1.56-98.2 (Woodhead et al. 2011a). The finding of an increased risk in the most recent (1980-1985) birth cohort, also predominantly among ESL, cannot readily be explained. The risk should be monitored to establish whether the pattern changes as the cohort ages. As with a number of other conditions, veteran women showed a pattern of risk closer to that of veteran men, in contrast to non-veteran women who were at significantly increased risk compared with non-veteran men.

Examination of co-morbidities suggests that alcohol and drugs (using alcoholic liver disease and hepatitis C as proxies) may be less important as risk factors for self-harm in veterans than in the non-veteran community. Smoking-related disease appears to be strongly associated with non-fatal self-harm, with increased risk of both COPD and lung cancer, in both veterans and non-veterans but with a higher risk in the veterans, which is consistent with the higher rates of smoking-related disease in veterans described in Chapters 4 to 6.

[211] Defined as less than 4 years' service

7.14 Chapter Summary and Interpretation

7.14.1 Overview

The mental health of veterans has received an unprecedented level of interest since the start of hostilities in the Persian Gulf in 1991. A Google search for <veterans mental health> returned over 64 million pages, whilst the same search on Google Scholar returned 492,000 articles, books and citations. There is a widespread public perception that mental health problems are the most important veterans' health issue. Data from the Scottish Veterans Health Study provide a more reassuring picture in respect of mental health, whilst highlighting other less widely recognised issues. Of more concern is the identification of a number of unexpected high-risk groups, including older ESL veterans, and, as identified at Section 6.7.2, people who may have served in Northern Ireland in the first two years of that campaign, especially if they were older at entry to service. Since they have not hitherto been recognised, some may not be receiving care appropriate to their needs. The extraordinary pattern of presentation of stress and PTSD in the late 1990s may demonstrate the impact of increased publicity on the emergence of a 'hidden iceberg' of unmet need; there may yet be other 'icebergs' of unidentified and unmet need which could come to light in the future.

The Scottish Veterans Health Study has demonstrated some remarkably consistent patterns of mental health disorder in the veterans' community. These will be examined individually and their implications considered.

7.14.2 Birth Cohort

There was a consistent pattern of higher risk for veterans in the earlier birth cohorts, compared with non-veterans, for:

- mood disorder
- anxiety excluding stress/PTSD
- psychosis
- suicide
- non-fatal self-harm

For risk of dementia, there was little variation with birth cohort, whilst for stress and PTSD, there was an initially increased level of risk which dipped slightly in the 1960-1964 birth cohort and then rose in successive cohorts, reaching a peak in those born between 1975 and 1979 and remaining at a similar level in the most recent (1980-1985) cohort. There was also an increase in non-fatal self-harm in the 1980-1985 birth cohort, reversing the trend in earlier cohorts. For the later birth cohorts, the hazard ratios dropped non-significantly below unity, indicating a reduced risk in veterans compared with non-veterans, for:

- anxiety excluding stress/PTSD
- psychosis
- suicide

with a significant decrease in the latter for the 1960-1964 birth cohort. The hazard ratios by birth cohort for mental health conditions, except dementia, are summarised graphically at Figure 7-42.

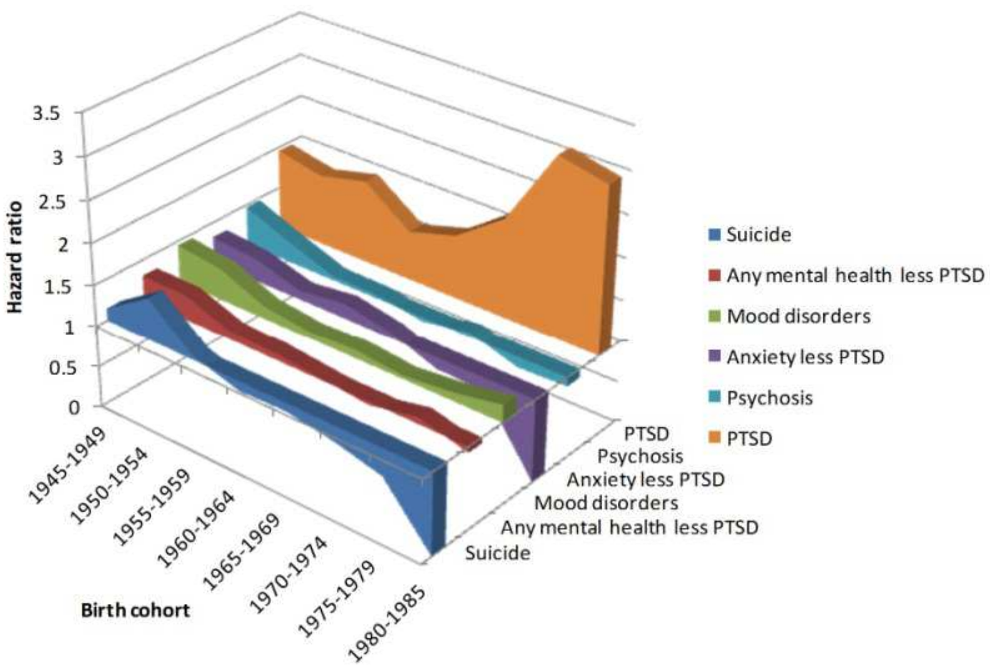

Figure 7-42 - 3D plot of mental health hazard ratios in veterans by birth cohort and diagnosis, referent to non-veterans

The pattern of risk by birth cohort for mood disorder, anxiety excluding stress/PTSD, psychosis and suicide closely mirrored the pattern seen in cardiovascular disease and smoking-related cancers, although the reduction in risk in the more recent birth cohorts was not as great. In view of the associations between smoking and mental health disorders discussed at Sections 7.4.3 to 7.4.3.1, it is therefore possible that the higher levels of smoking in the Armed Forces discussed in previous chapters had an adverse impact on mental health, and that lower rates of smoking in serving personnel have contributed to the substantial reduction in the risk of most mental health disorders in younger veterans, although reverse causality[212] cannot be excluded.

The rise in risk of stress and PTSD in those born from 1975 onwards has been examined in detail at Section 7.9.4 and it is likely that the explanation is complex. Figure 7-25 demonstrates a clear relationship with operational deployment shortly after entry to service, and this accords with studies by the King's Centre for Military Health Research showing that combat troops experience a rate of PTSD approximately double that seen in personnel who have not had a combat role (MacManus et al. 2014). However, combat does not appear to explain the whole of the excess. Overdiagnosis may also be a factor, as discussed in Section 7.9.4.8, but the finding that the highest risk was in those Early Service Leavers who had not completed initial training clearly establishes the role of pre-service factors, which operate irrespective of birth cohort (Table 7-7).

7.14.3 Age

Mean age at first record of mental health disorder, by veteran status, is summarised at Table 7-16.

[212] ie heavier smoking as a consequence of mental distress

Table 7-16 - Age at first record of mental health disorder by veteran status

Diagnosis	Non-veterans *n*=172,741 Mean (SD) years	All veterans *n*=56,205 Mean (SD) years	All non-ESL veterans *n*=38,052 Mean (SD) years	ESL veterans *n*=14,713 Mean (SD) years	Failed initial training *n*=5,823 Mean (SD) years
Any mental health disorder	39.8 (11.0)	40.8 (10.5)	42.1 (10.1)	39.2 (10.7)	39.7 (10.6)
Anxiety	39.4 (10.9)	40.0 (10.4)	41.2 (10.2)	38.8 (10.6)	39.3 (10.1)
Anxiety less stress/PTSD	40.4 (11.3)	40.7 (11.0)	41.6 (10.8)	39.8 (10.9)	39.6 (10.7)
Stress/PTSD	38.1 (9.7)	39.7 (9.7)	41.0 (9.3)	38.2 (10.2)	39.7 (9.6)
Mood	42.5 (10.1)	43.6 (9.6)	44.4 (9.4)	42.5 (9.8)	42.7 (9.9)
Psychosis	35.5 (10.3)	37.4 (9.9)	39.0 (9.4)	35.7 (10.0)	36.3 (10.1)
Dementia	55.9 (8.5)	56.5 (8.6)	56.1 (9.7)	58.9 (5.2)	60.1 (4.1)
Suicide	40.5 (9.7)	43.4 (8.1)	43.9 (7.6)	42.7 (8.3)	42.0 (8.4)
Non-fatal self-harm	39.6 (9.7)	41.6 (9.6)	42.2 (9.5)	40.9 (9.8)	41.5 (9.5)

For all disorders apart from psychosis and dementia, the first recorded episode of sufficient severity to warrant admission or day-case care occurred at a mean age of around 40 years, irrespective of veteran status. Veterans were generally slightly older than non-veterans at presentation, and non-ESL veterans especially so. Early Service Leavers generally exhibited a similar mean age to non-veterans, providing further evidence that many of the mental health problems of ESL result from factors external to military service, rather than having been influenced by their short period of service. Non-ESL veterans who developed psychosis were much older than non-veterans, whilst ESL veterans were of similar age to non-veterans, suggesting that early features of psychosis may have contributed to premature discharge from service in this latter group. For suicide and non-fatal self-harm, all veterans including ESL were older on average than non-veterans, suggesting that there may have been some protective (or delaying) effect from even a short period of service. The older age at presentation with dementia in ESL, compared with both non-veterans and non-ESL veterans, cannot readily be explained.

Overall, there was no evidence that military service hastened the onset of mental health disorder; on the contrary, veterans tended to be older at presentation. It may be argued that this provides evidence of delayed diagnosis owing to veterans concealing their mental health condition and presenting later. However, Brewin et al.'s study (Brewin et al. 2012a), in which 81% of veterans with mental health problems whose symptoms had started during service had received appropriate care during their service, provides no support for the validity of this widely-quoted anecdote.

The mean age at presentation also sheds light on another widely-quoted statistic, as discussed at Section 7.9.4.7. Although the ex-Services mental health charity Combat Stress states that veterans delay 14 years from leaving the Service before presenting with mental health problems relating to service (Busuttil 2010), data from the Scottish Veterans Study suggest that the presentation around 14-15 years after leaving the Services may simply represent the typical age at which significant mental health disorders present, and is similar to, or slightly older than, the age at which such problems present in non-veterans.

7.14.4 Sex

The risk of mental health disorder in veterans referent to non-veterans, by diagnosis and sex, is summarised at Table 7-17 to Table 7-19, for all veterans, ESL veterans and non-ESL veterans respectively.

Table 7-17- Cox proportional hazard model of the association between veteran status and risk of mental health disorder by sex: all veterans referent to all non-veterans

		Veteran cases *n*	Univariate			Multi-variable		
			HR	95% CI	p value	HR	95% CI	p value
Any MHD[213]	Men	2,518	1.30	1.24-1.37	<0.001	1.24	1.19-1.30	<0.001
	Women	276	1.08	0.94-1.24	0.278	1.06	0.92-1.21	0.429
Any MHD less PTSD	Men	1,929	1.18	1.12-1.24	<0.001	1.13	1.07-1.19	<0.001
	Women	235	1.07	0.92-1.24	0.379	1.05	0.90-1.22	0.530
Mood	Men	1,401	1.26	1.18-1.34	<0.001	1.20	1.13-1.28	<0.001
	Women	177	1.05	0.88-1.24	0.604	1.02	0.87-1.21	0.775
Mood less PTSD	Men	1,158	1.17	1.09-1.25	<0.001	1.12	1.04-1.20	0.002
	Women	151	1.00	0.83-1.20	0.997	0.98	0.82-1.18	0.845
Anxiety	Men	1,276	1.48	1.38-1.58	<0.001	1.42	1.32-1.52	<0.001
	Women	139	1.10	0.90-1.33	0.343	1.07	0.88-1.30	0.472
Anxiety less PTSD	Men	687	1.21	1.11-1.32	<0.001	1.17	1.07-1.28	<0.001
	Women	98	1.10	0.87-1.38	0.442	1.07	0.85-1.35	0.552
Stress/PTSD	Men	589	1.98	1.78-2.20	<0.001	1.88	1.69-2.09	<0.001
	Women	41	1.07	0.75-1.53	<0.703	1.04	0.73-1.49	0.815
Psychosis	Men	489	1.10	0.99-1.22	0.068	1.03	0.93-1.14	0.557
	Women	48	1.45	1.02-2.06	0.035	1.41	0.99-1.99	0.052
Dementia	Men	58	1.00	0.40-1.35	0.986	0.96	0.71-1.30	0.810
	Women	<10	1.54	0.68-3.49	0.295	1.50	0.66-3.39	0.329

Cases: Figures <10 in subgroups suppressed to minimise risk of disclosure

[213] MHD = mental health disorder

Table 7-18 - Cox proportional hazard model of the association between veteran status and risk of mental health disorder by sex: ESL veterans referent to all non-veterans

		Veteran cases	Univariate			Multi-variable		
		n	HR	95% CI	p value	HR	95% CI	p value
Any MHD	Men	916	1.68	1.57-1.81	<0.001	1.54	1.43-1.65	<0.001
	Women	147	1.41	1.18-1.67	<0.001	1.32	1.11-1.57	<0.002
Any MHD less PTSD	Men	702	1.53	1.41-1.65	<0.001	1.40	1.29-1.51	<0.001
	Women	126	1.40	1.16-1.69	<0.001	1.33	1.10-1.60	0.003
Mood	Men	501	1.66	1.51-1.82	<0.001	1.50	1.37-1.65	<0.001
	Women	92	1.30	1.05-1.62	0.019	1.23	0.98-1.53	0.069
Mood less PTSD	Men	410	1.52	1.38-1.69	<0.001	1.38	1.24-1.53	<0.001
	Women	77	1.21	0.96-1.54	0.111	1.15	0.90-1.46	0.253
Anxiety	Men	477	1.97	1.78-2.17	<0.001	1.82	1.65-2.01	<0.001
	Women	74	1.45	1.13-1.85	0.003	1.35	1.06-1.73	0.016
Anxiety less PTSD	Men	263	1.67	1.46-1.90	<0.001	1.56	1.37-1.78	<0.001
	Women	53	1.47	1.10-1.97	0.009	1.39	1.04-1.86	0.026
Stress/PTSD	Men	214	2.51	2.16-2.92	<0.001	2.28	1.95-2.65	<0.001
	Women	21	1.35	0.84-2.15	0.209	1.23	0.77-1.96	0.380
Psychosis	Men	199	1.42	1.22-1.65	<0.001	1.26	1.09-1.47	0.003
	Women	26	1.99	1.30-3.05	0.002	1.83	1.19-2.80	0.006
Dementia	Men	10	0.74	0.39-1.38	0.333	0.68	0.36-1.29	0.236
	Women	<10	1.97	0.74-5.23	0.173	1.87	0.70-4.97	0.209

Cases: Figures <10 in subgroups suppressed to minimise risk of disclosure

Table 7-19 - Cox proportional hazard model of the association between veteran status and risk of mental health disorder by sex: non-ESL veterans referent to all non-veterans

		Veteran cases	Univariate			Multi-variable		
		n	HR	95% CI	p value	HR	95% CI	p value
Any MHD	Men	1,417	1.09	1.03-1.16	0.003	1.07	1.01-1.14	0.029
	Women	109	0.83	0.67-1.03	0.089	0.85	0.68-1.05	0.126
Any MHD less PTSD	Men	1,088	0.99	0.93-1.06	0.879	0.97	0.91-1.04	0.425
	Women	91	0.80	0.63-1.01	0.065	0.82	0.65-1.03	0.089
Mood	Men	802	1.06	0.98-1.15	0.146	1.04	0.96-1.12	0.365
	Women	72	0.85	0.66-1.10	0.227	0.87	0.67-1.12	0.286
Mood less PTSD	Men	672	1.00	0.92-1.09	0.915	0.98	0.90-1.07	0.693
	Women	62	0.83	0.63-1.09	0.182	0.84	0.64-1.11	0.224
Anxiety	Men	710	1.22	1.11-1.33	<0.001	1.19	1.09-1.30	<0.001
	Women	55	0.84	0.62-1.13	0.265	0.86	0.64-1.16	0.326
Anxiety less PTSD	Men	381	0.98	0.87-1.10	0.759	0.96	0.86-1.08	0.543
	Women	37	0.79	0.54-1.14	0.206	0.80	0.55-1.16	0.240
Stress/PTSD	Men	329	1.66	1.45-1.89	<0.001	1.61	1.41-1.84	<0.001
	Women	18	0.95	0.56-1.58	0.830	0.97	0.58-1.63	0.921
Psychosis	Men	239	0.86	0.74-0.99	0.034	0.83	0.72-0.95	0.009
	Women	18	1.01	0.58-1.76	0.958	1.05	0.60-1.82	0.863
Dementia	Men	43	1.05	0.75-1.47	0.794	1.01	0.72-1.43	0.937
	Women	<10	1.36	0.41-4.57	0.614	1.36	0.41-4.56	0.618

Cases: Figures <10 in subgroups suppressed to minimise risk of disclosure

When all veterans were considered together, male veterans had a statistically significantly higher risk than male non-veterans for all mental health disorders apart from psychosis and dementia, where their risk did not differ from non-veteran men. For veteran women, the pattern was reversed; there was no significant difference in risk for any mental health disorder apart from psychosis and dementia, where they were at increased risk compared with non-veteran women (Table 7-17).

Stratification by ESL status revealed that this accounted for the majority of the differences observed. When only ESL veterans were considered (Table 7-18), both male and female veterans were at increased risk of all mental health disorders compared with non-veteran men and women respectively, with the exception of dementia where veteran men were at non-significantly decreased risk compared with non-veteran men.

Non-ESL veterans, who had served at least their minimum term of engagement, showed no significant differences from non-veterans for either men or women, apart from stress/PTSD where veteran men were at highly significantly increased risk compared with non-veteran men, and psychosis where veteran men were at significantly reduced risk.

The greatly increased risk of psychosis in ESL veteran women suggests the possibility of a female personality type that is attracted to military service but quickly proves unsuitable. The higher risk of dementia in female veterans including those with longer service, albeit non-significantly, cannot be readily explained.

The hazard ratios for women referent to men, for both veterans and non-veterans separately, are presented at Table 7-20 and enable comparison with the crude female:male ratios for all Scottish mental health admissions (Table 7-1).

Table 7-20 - Cox proportional hazard model of the association between sex (female referent to male) and risk of mental health disorder in veterans and non-veterans

			Univariate			Multi-variable	
		HR	95% CI	p value	HR	95% CI	p value
Any MHD	Veterans	1.11	0.97-1.26	0.130	1.16	1.02-1.33	0.020
	Non-veterans	1.34	1.26-1.42	<0.001	1.39	1.31-1.48	<0.001
Any MHD less PTSD	Veterans	1.23	1.06-1.41	0.005	1.29	1.22-1.49	<0.001
	Non-veterans	1.34	1.25-1.43	<0.001	1.39	1.30-1.49	<0.001
Mood	Veterans	1.32	1.12-1.55	0.001	1.39	1.18-1.63	<0.001
	Non-veterans	1.61	1.49-1.75	<0.001	1.67	1.55-1.81	<0.001
Anxiety	Veterans	1.10	0.91-1.32	0.330	1.15	0.96-1.38	0.133
	Non-veterans	1.50	1.38-1.65	<0.001	1.56	1.43-1.71	<0.001
Anxiety less PTSD	Veterans	1.43	1.15-1.79	0.002	1.50	1.20-1.87	<0.001
	Non-veterans	1.59	1.43-1.77	<0.001	1.64	1.47-1.83	<0.001
PTSD	Veterans	0.71	0.51-0.98	0.038	0.75	0.54-1.04	0.081
	Non-veterans	1.35	1.16-1.59	<0.001	1.42	1.21-1.67	<0.001
Psychosis	Veterans	0.88	0.64-1.21	0.436	0.95	0.69-1.31	0.760
	Non-veterans	0.65	0.55-0.76	<0.001	0.69	0.58-0.81	<0.001
Dementia	Veterans	1.76	0.83-3.69	0.134	1.81	0.86-3.80	0.117
	Non-veterans	1.14	0.72-1.79	0.570	1.15	0.73-1.81	0.542

There were notable differences in the female:male ratios for all mental health disorders between veterans and non-veterans. For all diagnoses except dementia, the ratios for veterans were closer to unity than they were for non-veterans, indicating that veteran women exhibited a more 'male' pattern of mental health than non-veteran women.

There was a similar pattern for the major mental-health related outcomes of suicide and non-fatal self-harm, with women veteran exhibiting a risk pattern closer to that of male veterans (Table 7-21).

Table 7-21 - Cox proportional hazard model of the association between sex (female referent to male) and risk of major mental health outcomes in veterans and non-veterans

		Univariate			Multi-variable		
		HR	95% CI	p value	HR	95% CI	p value
Suicide	Veterans	0.68	0.41-1.12	0.136	0.71	0.43-1.18	0.192
	Non-veterans	0.27	0.18-0.39	<0.001	0.28	0.19-0.40	<0.001
Non-fatal self-harm	Veterans	1.10	0.95-1.30	0.209	1.18	1.01-1.38	0.039
	Non-veterans	1.29	0.19-1.40	<0.001	1.36	1.26-1.48	<0.001

7.14.5 Length of Service

For all mental health disorders except dementia, there was a consistent pattern of greatest increase in risk in Early Service Leavers, and the increase was highest in women ESL who had not completed training. Veterans with 4-12 years' service showed a similar risk to all non-veterans for anxiety excluding stress/PTSD, mood disorders[214], and psychosis, and a slightly higher risk for stress/PTSD; the risk was reduced in those with over 12 years' service. For dementia, there was no difference in risk for any length of service. There were no differences in risk of suicide with length of service. Non-fatal self-harm showed a similar pattern to mood disorder[215]. Analysis of data from the Scottish Veterans Health Study thus provides no evidence that military service is damaging to mental health in the long term, for most people; if it was, longer exposure (longer service) would be expected to be associated with poorer mental health. The reverse is the case, which is consistent not only with a healthy worker effect but also with a concomitant 'less

[214] Although there was a slight increase in risk of mood disorder in people with 4-12 years' service over the age of 50 years

[215] Including the slight increase in risk in veterans over age 50 years

healthy leaver' effect. The concept of the 'less healthy leaver' as the counterpart to the 'healthy worker' will be explored in depth at Section 8.3.1 and subsections.

7.14.6 Co-Morbidity

The data also provide an important insight into physical co-morbidities with mental health disorders. Whilst the cardiovascular associations with mental health disorders are well recognised (Section 7.5.1), associations with diseases of the gastro-intestinal tract are perhaps less so.

The finding of a strong association between mental health disorders and peptic ulcer disease was unexpected. A total of 8.1% of veterans and 6.7% of non-veterans with any mental health disease also had a history of peptic ulcer, compared with 3.4% of veterans and 3.0% of non-veterans in the whole study population. Whilst the association with alcoholic liver disease was especially strong in this group, the increase remained after excluding these cases, with 7.4% of veterans and 6.0% of non-veterans with mental health problems (and no alcoholic liver disease) affected.

Prior to the discovery of the role of *Helicobacter pylori* in peptic ulceration, 'stress' was considered to be an important predisposing factor but it was largely discounted once *H. pylori* was identified as a causal agent. Nonetheless, there remains some interest in the role of stress in gastro-intestinal disease, especially in relation to the role of cytokines and allostatic load mechanisms (Mayer 2000). Genetic factors may also be important but their role in relation to mental health disorders remains unclear (Soll et al. 2008, Grabe et al. 2010).

Goodwin and Stein found an increased risk of self-reported peptic ulcer in association with generalised anxiety disorder, OR 2.8, 95% CI 1.4-5.7, $p<0.001$, after adjusting for confounders (Goodwin and Stein 2002). Depression, maladjustment and hostility were found to be prospectively associated with peptic ulcer in a longitudinal study in the US (Levenstein et al. 1997). There are stronger reported associations between peptic ulcer and suicide, alcoholism and other major psychiatric outcomes, even after successful surgical treatment of the ulcer disease (Knop and Fischer 1981, Bahmanyar et al. 2009, Viskum 1975).

The association between peptic ulcer disease and adverse mental health outcomes has been clearly demonstrated in the Scottish Veterans Health Study, for both veterans and non-veterans. That the increase is higher in veterans than in non-veterans may be explained by higher rates of smoking in the veterans. What is not clear is the direction of causality, and this cannot be determined from the current dataset as both peptic ulcer disease and mental health disorders are usually chronic conditions with varying degrees of severity; the date of admission may be many years after the date of onset of either condition.

7.14.7 Developing the Hypothesis

Data on cardiovascular disease, cancer and other physical conditions have supported smoking as an important influence on veterans' health, and also provided evidence that alcohol may have had an impact on the health of some of the veterans with the shortest service, although only if they had completed recruit training. Analysis of the data on mental health outcomes demonstrates that for the majority of veterans, military service has been associated with favourable long-term outcomes, with the poorest mental health generally being associated with the shortest service, whilst co-morbidities have demonstrated possible associated risk factors. The analysis of mental health-related outcomes has therefore provided further corroborative evidence for the postulated dominant factors influencing veterans' health: smoking, alcohol, early birth cohort, and short service/ESL status. Protective factors are longer service and more recent birth cohort.

7.14.8 Key Points

- 95% of veterans had no recorded major mental health diagnosis during the period of follow-up.

- Major mental health events were more common in veterans overall than non-veterans, but only if stress and PTSD were included.

- The greatest mental health burden occurred in Early Service Leavers, and especially in those who did not complete training.

- Veterans who had completed at least the minimum engagement were not at increased risk of adverse mental health outcomes compared with non-veterans.

- Longer service was associated with better long-term mental health. The risk of adverse mental health events decreased with increasing length of service, for all conditions and outcomes except dementia and suicide (where there was no length of service effect). The risk was similar to non-veterans for people with 4-12 years' service, and service over 12 years was protective.

- After excluding stress/PTSD diagnoses, veterans were not at increased risk of adverse mental health outcomes compared with non-veterans.

- There was an increased risk of stress/PTSD for all age groups and birth cohorts.

- The increased risk of stress/PTSD was highest in Early Service Leavers who did not complete training.

- Stress/PTSD diagnoses were clustered in the period 1997-2002, in both veterans and non-veterans although the incidence was higher in veterans.

- The excess risk of stress/PTSD in veterans is likely to be explained by:
    - Pre-service factors in ESL
    - In-service exposure to trauma in combat troops
    - Overdiagnosis, including:
        - 'Diagnostic bias' by healthcare providers
        - Misdiagnosis of mTBI
        - Factitious history of exposure to trauma ('Military Munchhausen')

- ESL veterans were at increased risk of all mental health disorders except dementia. The increase in risk was generally higher for ESL in the earlier birth cohorts, suggesting later improvement to recruit selection.

- Veterans were at reduced risk of psychosis overall, compared with non-veterans.

- The counterpart of the 'healthy worker effect' is the 'less healthy leaver effect'.
- Overall, veterans were at no greater risk of suicide than non-veterans.
- ESL were not at increased risk of suicide compared with age, sex and geographically matched non-veterans.
- Veteran women exhibited a risk profile which more closely resembled that of veteran men, for all mental health diagnoses and outcomes except dementia. This was especially marked for suicide.
- No suicides were recorded for veteran women who joined for service after disbandment of the women's services in 1991.
- Non-fatal self-harm was more common in veterans than non-veterans, but the increase was confined to ESL and a subgroup of non-ESL veterans aged over 50 years with less than 10 years' service.
- Cardiovascular disease was strongly associated with mental health disorder, in both veterans and non-veterans.
- The risk of peptic ulcer was increased in both veterans and non-veterans with mental disorders, but the increase was greater in veterans.
- The pattern of risk by birth cohort in veterans, for all mental health outcomes except stress/PTSD and dementia, referent to non-veterans, closely mirrors the pattern seen in smoking-related cardiovascular and malignant disease, suggesting an association between smoking and adverse mental health outcomes.
- Smoking may be an independent risk factor for mental health disorder.

Chapter 8: Conclusion

8.1 Introduction

The aim of the Scottish Veterans Health Study was to determine whether the health of military veterans differed from that of people who had never served and, if differences were found, to identify the magnitude, nature and effect modifiers for those differences.

As the study progressed, a number of consistent themes associated with poorer veterans' health began to emerge. These themes included smoking-related illness, people who left service after a very short period of time, people born in the late 1940s and early 1950s, alcohol-related illness, and mental health, although in the case of the latter two, a complexity emerged which had not been previously described. Perhaps the most important, and unexpected, outcome was the development of an understanding of the nature of the veteran population as a cohort of 'occupational leavers', the earliest of whom represented those who were least suited to military employment and in whom mental health problems predominated, as will be discussed at Section 8.3.1.3.

Those who left service earliest (the Early Service Leavers or ESL), often after only a few weeks and before completing training, have been shown to be at increased risk compared with both non-veterans and longer-serving veterans for cardiovascular disease (Section 4.9.1.2), smoking-related cancer (Sections 5.8.1.4 and 5.12.1.4), alcohol-related cancer (Section 5.12.2), post-traumatic stress disorder (Section 7.9.4.6), peptic ulcer (Section 6.12.2.5), diabetes (Section 6.13.2.5)[216], and road traffic accident (Section 6.14.2.4). By contrast, veterans with the longest service have been shown to have a reduced risk of cardiovascular disease, mental health disorders, COPD, and alcohol-related death, in comparison with non-veterans, whilst their risk of most cancers, road traffic accident and suicide did not differ from that of non-veterans. These results do not point to an occupational aetiology for most of the conditions of *a priori* interest which were examined in the Scottish Veterans Health Study. Rather, it suggests that where the risk differed, the majority of the difference may be explained by a stratification of the veterans according to their pre- and post-service health risk factors and consequent health potential, and by their lifestyle choices; notwithstanding that some of

[216] Within the limitations of the data as discussed at Section 6.13.1.

those choices may have been influenced by military service and culture. There was clear evidence of the positive benefits of military service for a number of conditions, where longer-serving people have been shown to enjoy better outcomes than non-veterans. By contrast, the poorer outcomes seen in ESL cannot be explained by military service, especially for those conditions such as PTSD where the greatest increase in risk was found in those who did not complete training. For the majority of recruits[217], it is implausible that a short period of service in the strictly controlled environment of a training unit has damaged their long-term health potential; it is far more likely that behavioural risk factors and adverse pre-service events not only contributed to their long-term health risks, but also predisposed to their likelihood of early discharge from service. For a small number of conditions, including some of the less common malignancies, there was some evidence pointing to an occupational association, but further research is needed in these areas.

8.1.1 Research Questions

The research questions to be addressed in this thesis were:

- Do military veterans have better or worse long-term health outcomes (physical or mental) than people who have never served?
- Are there specific conditions which are associated with military service, and is there evidence of causality?
- Are some sub-groups of veterans at greater risk than others?
- Are there any trends over time?
- What is the overall impact of military service on health?

8.2 Summary of Principal Results

The study has revealed a high degree of complexity in the long-term health risks faced by veterans. The results of the analysis which form the basis to the answers to the research questions are multi-dimensional, and are summarised in the following tables (Table 8-1 to Table 8-5).

[217] With the exception of the small number who sustained a significant service-related injury or illness, or who witnessed an exceptionally traumatic incident, during training

Table 8-1 summarises the net long-term impact on health of military service, by condition, showing where the health of veterans was found to differ significantly from that of non-veterans overall, and where no difference was found. Although it is a useful summary, and provides a pointer to the conditions of *a priori* interest where there was a net increased or decreased risk, it is too superficial, especially for the conditions where no difference was found, as important details were revealed on subgroup analysis.

Table 8-1 - Statistically significant differences in health risk overall
Veterans referent to non-veterans

Increased risk	No significant difference	Decreased risk
All cardiovascular disease	All cancer	Mesothelioma
AMI	Prostate cancer	Hepatitis C
Stroke	Testicular cancer	
PAD	Cervical cancer	
Lung cancer	Breast cancer (F)	
Smoking-related cancer (less lung)[1]	Renal cancer	
Oropharyngeal/laryngeal cancer	Colorectal cancer	
Oesophageal cancer	Pancreatic cancer	
Peptic ulcer	Intracranial cancer	
Motor neuron disease	Malignant melanoma	
Road traffic accident	Non-melanoma skin cancer	
All mental health[2]	Leukaemia (all types)	
Mood disorder (M)	Lymphohaematopoietic malignancy (all)	
Anxiety	Tuberculosis	
Stress/PTSD	COPD	
Non-fatal self-harm	Alcoholic liver disease	
	Alcohol-related death	
	Mood disorder (F)	
	Psychosis	
	Dementia	
	Suicide	

AMI: Acute myocardial infarction; PAD: Peripheral arterial disease; COPD; Chronic obstructive pulmonary disease; PTSD: Post-traumatic stress disorder; M: Male; F: Female

[1]Smoking-related cancer (less lung): Oropharynx/larynx, oesophagus, stomach, kidney, bladder

[2]All mental health: Anxiety including stress/PTSD, mood disorder, psychosis

Subgroup analysis by birth cohort clearly demonstrated the increased risk of cardiovascular disease, smoking-related ill-health, alcohol-related problems and mental health disorder faced by older veterans, born between 1945 and 1954, who served predominantly in the 1960s and 1970s. The results, in Table 8-2, which highlights only the birth cohort experiencing the maximum statistically significant difference for each condition, showed that there was little significant increase in risk for any condition in the younger generations when compared with their age and sex matched non-veteran peers, other than for motor neuron disease, bladder cancer and pancreatic cancer in specific birth cohorts and some mental health disorders in the youngest cohort. For the majority of individual cancers apart from those related to smoking, there was no increased risk in any birth cohort, indicating that there was no trend over time[218] which differed from that experienced by the wider population. For cancer overall, the youngest veterans demonstrated a reduced risk compared with non-veterans.

In order to provide further clarification, the birth cohort table was expanded to highlight all differences in excess of 10%, whether or not achieving statistical significance (Table 8-3 and Table 8-4). These tables confirmed the increased risk of smoking-related disease, alcohol-related disease and mental health disorder in the veterans born prior to 1960, the increased risk of mental health disorder[219] across all birth cohorts and the reduced risk of some cancers and hepatitis C across all birth cohorts. Table 8-3 and Table 8-4 also powerfully illustrate trends in the falling number of conditions for which the hazard ratios were increased, and the rising number for which they were reduced, with successive birth cohorts, providing a clear demonstration of the overall improvement in the health of veterans compared with non-veterans over time.

[218] See Appendix 12 for further analysis of trends over time

[219] Predominantly due to increased risk of stress/PTSD, as discussed in Chapter 8

Table 8-2 - Maximum statistically significant difference in health risk by birth cohort Veterans referent to non-veterans

1945-1949	1950-1954	1955-1959	1960-1964	1965-1985
Increased risk				
AMI Oropharyngeal/ laryngeal cancer Smoking-related cancer (less lung)[1] Oesophageal cancer Hepatitis B COPD Alcoholic liver disease Alcohol-related death All mental health[2] Anxiety less PTSD Mood disorder Psychosis Non-fatal self-harm	Stroke PAD All CVD Lung cancer Smoking-related cancer (less lung)[1] Stomach cancer Peptic ulcer All mental health[2] Suicide	Motor neuron disease	Bladder cancer Pancreatic cancer Road traffic accident	Stress/PTSD Anxiety Non-fatal self-harm
Decreased risk				
Mesothelioma Non-Hodgkin lymphoma			Hepatitis B Hepatitis C Alcoholic liver disease Alcohol-related death	All cancer Hepatitis C COPD
No significant effect in any birth cohort				
Prostate cancer Testicular cancer Cervical cancer Breast cancer (F) Ovarian cancer Intracranial cancer Renal cancer Liver cancer Colorectal cancer Malignant melanoma Non-melanoma skin cancer Hodgkin lymphoma Leukaemia (all types) Lymphohaematopoietic malignancy (all) Tuberculosis Multiple sclerosis RTA death Dementia				

AMI: Acute myocardial infarction; PAD: Peripheral arterial disease; CVD: Cardiovascular disease; COPD: Chronic obstructive pulmonary disease; PTSD: Post-traumatic stress disorder; RTA: Road traffic accident; M: Male; F: Female

[1] Smoking-related cancer (less lung): Oropharyngeal/laryngeal, oesophageal, stomach, renal, bladder
[2] All mental health: Anxiety including stress/PTSD, mood disorder, psychosis
Smoking-related cancer (less lung) and hepatitis C each appear in two columns as there was a similar level of statistically significant increase in risk in two birth cohorts

Table 8-3 - Any increase in health risk >10% by birth cohort (significant and non-significant) Veterans referent to non-veterans

1945-1949	1950-1954	1955-1959	1960-1964	1965-1985
AMI Stroke PAD All CVD Lung cancer Oropharyngeal/ laryngeal cancer Oesophageal cancer Smoking-related cancer (less lung)[1] Testicular cancer Cervical cancer Renal cancer Bladder cancer Stomach cancer Peptic ulcer Tuberculosis Hepatitis B COPD Alcoholic liver disease Alcohol-related death Motor neuron disease Road traffic accident RTA death All mental health[2] Stress/PTSD Anxiety Anxiety less PTSD Mood disorder Psychosis Suicide Self-harm	AMI Stroke PAD All CVD Lung cancer Oropharyngeal/ laryngeal cancer Oesophageal cancer Smoking-related cancer (less lung)[1] Ovarian cancer Renal cancer Bladder cancer Stomach cancer Peptic ulcer Hepatitis B COPD Road traffic accident All mental health[2] Stress/PTSD Anxiety Anxiety less PTSD Mood disorder Psychosis Dementia Suicide Self-harm	AMI PAD All CVD Lung cancer Cervical cancer Bladder cancer Colorectal cancer Mesothelioma Hodgkin lymphoma Peptic ulcer Motor neuron disease Multiple sclerosis Road traffic accident All mental health[2] Stress/PTSD Anxiety Anxiety less PTSD Mood disorder Self-harm	PAD Breast cancer (F) Ovarian cancer Bladder cancer Pancreatic cancer Hodgkin lymphoma Peptic ulcer Road traffic accident All mental health[2] Stress/PTSD Anxiety Anxiety less PTSD Self-harm	Breast cancer (F) Ovarian cancer Malignant melanoma Leukaemia Motor neuron disease All mental health[2] Stress/PTSD Anxiety

AMI: Acute myocardial infarction; PAD: Peripheral arterial disease; CVD: Cardiovascular disease; COPD: Chronic obstructive pulmonary disease; PTSD: Post-traumatic stress disorder; RTA: Road traffic accident; M: Male; F: Female

[1] Smoking-related cancer (less lung) : Oropharynx/larynx, oesophagus, stomach, kidney, bladder
[2] All mental health: Anxiety including stress/PTSD, mood disorder, psychosis

Table 8-4 - Any decrease in health risk >10% by birth cohort (significant and non-significant) Veterans referent to non-veterans

1945-1949	1950-1954	1955-1959	1960-1964	1965-1985
Intracranial cancer Liver cancer Malignant melanoma Mesothelioma Non-Hodgkin lymphoma Lymphohaematopoietic malignancy (all) Hepatitis C	Testicular cancer Cervical cancer Liver cancer Colorectal cancer Pancreatic cancer Malignant melanoma Non-melanoma skin cancer Mesothelioma Tuberculosis Hepatitis C Motor neuron disease Multiple sclerosis	Prostate cancer Ovarian cancer Intracranial cancer Stomach cancer Liver cancer Malignant melanoma Leukaemia Tuberculosis Hepatitis B Hepatitis C Alcoholic liver disease Alcohol-related death RTA death Dementia	Cervical cancer Stomach cancer Colorectal cancer Non-melanoma skin cancer Mesothelioma Tuberculosis Hepatitis B Hepatitis C COPD Alcoholic liver disease Alcohol-related death Motor neuron disease Dementia Suicide	AMI Stroke All CVD All cancer Lung cancer Cervical cancer Renal cancer Bladder cancer Stomach cancer Liver cancer Colorectal cancer Pancreatic cancer Non-melanoma skin cancer Non-Hodgkin lymphoma Peptic ulcer Tuberculosis Hepatitis B Hepatitis C COPD Alcoholic liver disease Alcohol-related death Multiple sclerosis Anxiety less PTSD Psychosis Suicide

AMI: Acute myocardial infarction; PAD: Peripheral arterial disease; CVD: Cardiovascular disease; COPD: Chronic obstructive pulmonary disease; PTSD: Post-traumatic stress disorder; RTA: Road traffic accident; M: Male; F: Female

Subgroup analysis by length of service provided an indication of the likelihood of attributability of specific outcomes to military service. It is highly implausible that conditions which were most common in those with the shortest service had an occupational causation; conversely, an increased risk in those with longer service suggests an association with military service, although not necessarily causal. Table 8-5 shows that smoking-related disease and mental health disorder were commonest among those who did not complete training, whilst alcohol-related disorders and some respiratory and cardiovascular disease (which could have been related to smoking) were most common in Early Service Leavers who completed training but were discharged before completing the minimum term of service. Smoking and alcohol-related cancers were also prominent in those who left with between four and 12 years' service, and who are therefore likely to have reached no higher than corporal (or equivalent) rank. A peak risk of bladder cancer in the 1960-1964 birth cohort also particularly affected this group, indicating a possible occupational association. The increased risk of testicular cancer in veterans with 13-22 years' service also suggests an occupational association, although the higher risk of breast cancer in longer-serving women is likely to reflect lower parity, or nulliparity, during the period prior to 1991 when servicewomen were not permitted to remain in service beyond 12 weeks of pregnancy, and those who opted for a long military career had to forgo childbearing. Veterans with the longest service, who are most likely to have been officers or reached senior non-commissioned rank (and therefore *inter alia* to have had the highest levels of educational attainment), have been shown to have reduced risks of cardiovascular disease, smoking-related disease, alcohol-related death and mental health disorder compared with matched non-veterans.

Table 8-5 - Maximum statistically significant difference in health risk by length of service Veterans by sub-group referent to all non-veterans

ESL Basic training	ESL < 3 years	4-12 years	13-22 years	23 years & over
Increased risk				
Stroke PAD All CVD Lung cancer Peptic ulcer Motor neuron disease Road traffic accident All mental health[2] Stress/PTSD Anxiety Mood disorder Psychosis Self-harm	AMI Renal cancer COPD Alcoholic liver disease Alcohol-related death Anxiety less PTSD	Oropharyngeal/ laryngeal cancer Smoking-related cancer (less lung)[1] Bladder cancer	Testicular cancer Breast cancer (F)	
Decreased risk				
		Non-Hodgkin lymphoma	Peptic ulcer	Stroke All CVD COPD Alcohol-related death All mental health[2] Anxiety Anxiety less PTSD Mood disorder Psychosis Self-harm
No significant difference for any length of service				
Any cancer Prostate cancer Intracranial cancer Liver cancer Colorectal cancer Malignant melanoma Non-melanoma skin cancer Hodgkin lymphoma Leukaemia Lymphohaematopoietic malignancy (all) Multiple sclerosis Dementia Suicide				

AMI: Acute myocardial infarction; PAD: Peripheral arterial disease; CVD: Cardiovascular disease; COPD: Chronic obstructive pulmonary disease; PTSD: Post-traumatic stress disorder; RTA: Road traffic accident; M: male; F: Female

[1] Smoking-related cancer (less lung) : Oropharynx/larynx, oesophagus, stomach, kidney, bladder
[2] All mental health: Anxiety including stress/PTSD, mood disorder, psychosis

Insufficient numbers for subgroup analysis by length of service: Cervical cancer, ovarian cancer, oesophageal cancer, stomach cancer, pancreatic cancer, mesothelioma, tuberculosis, hepatitis B, hepatitis C, RTA death

8.3 Discussion

As demonstrated in the preceding sections, the main areas in which the health of veterans differed from that of non-veterans were smoking- and alcohol-related conditions, and mental health, whilst the most important effect modifiers were birth cohort and, within the veteran group, length of service.

8.3.1 Length of Service

8.3.1.1 'Healthy Workers' and 'Healthy Warriors'

The association between continued employment and reduced mortality has long been recognised. The term 'healthy worker effect' was introduced by McMichael et al. in 1974 (McMichael et al. 1974), and later defined by him as

> "the consistent tendency of the actively employed to have a more favorable [*sic*] mortality experience than the population at large." (McMichael 1976).

The effect of length of employment on the healthy worker effect (Kolstad and Olsen 1999) is especially important in studies on UK veterans, where 'veteran' status is conferred after only one day's service and, until recently, around 60% of soldiers served for 3 years or less. The healthy worker effect is strongest in those occupations which are the most physically demanding (Li and Sung 1999), so it is of particular relevance to studies of the long-term health of military personnel. It is therefore likely that the health worker effect is a factor in the generally better long-term health of longer-serving veterans.

The existence of a number of major military research datasets (predominantly in the US) has made the military/veterans population particularly suitable for studies on the healthy worker effect. In 1986, data from an earlier study of US veterans[220] were re-examined to assess the magnitude, persistence and constancy of the healthy worker effect. This study concluded that the overall effect on mortality for all causes was a reduction of 27%, and that it would be inappropriate to conclude that no occupational hazard existed if the

[220] The Dorn Study, which was initiated in 1954 to follow approximately 293,600 veterans who had served in the US military between 1917 and 1940 and who held Government life insurance policies (Sterling and Weinkam 1986). A primary aim of the study had been to collect information on smoking although this aspect of the study was later discredited as the smoking data were found to be unreliable.

standardised mortality ratio (SMR) was found to be not statistically significantly different from 1.0. To exclude a hazard where the healthy worker effect applied, the authors recommended that confidence intervals for SMR should exclude 0.73 (Sterling and Weinkam 1986). There was a small but consistent weakening of the SMR with age (0.63 at age 40-44 years and 0.78 at age 80-84 years for all-cause mortality), other than for accidental death and upper gastro-intestinal tract cancer where there was an inverse relationship with age. For respiratory cancers, the SMRs exceeded 1.0 in the veterans aged over 75 years, which could be interpreted as a negative healthy worker effect. The interpretation of changes in the healthy worker effect with age remains controversial (Li and Sung 1999) but has important implications for studies which compare the long-term health experience of veterans with that of the general population.

A review of the health of US veterans from the first Gulf conflict and controls who had not served in the Gulf (Kang and Bullman 1996) found that both cohorts exhibited overall mortality rates significantly lower than the general population (SMR 0.44 (95% CI 0.42-0.47) for Gulf veterans and SMR 0.38 (95% CI 0.36-0.40) for non-Gulf veterans), contradicting popular belief at that time. The authors termed this the 'healthy soldier effect', attributing it to initial physical screening to exclude those suffering from pre-existing conditions; the requirement to maintain a certain standard of physical well-being during service; and better access to medical care both during and after service. An Australian study examined around 100,000 veterans of the Korean War and Vietnam War era and found a complex picture although deaths other than from external causes were generally lower than in the general population for up to 20 years, before rising to the wider population rate. This pattern was seen most clearly in deaths from circulatory disease, and cancer (all sites), although after 20 years of follow-up, mortality from all cancers and lung cancer exceeded the general population rate. There were marked differences between the Korean and Vietnam-era cohorts, and between regular and national service personnel. The authors noted the complexity of the 'healthy soldier effect' and cautioned against use of a standard correction factor (Waller and McGuire 2011). McLaughlin et al. conducted a systematic review of 12 studies on the 'healthy soldier effect' meeting their inclusion criteria and concluded that the pooled all-cause SMR for deployed personnel relative to the general population was 0.76 (95% CI 0.65-0.89) but there were wide variations in cause-specific SMR (McLaughlin et al. 2008).

A commentary in 1998 noted the importance of continuing good health as a prerequisite to remaining in service (Haley 1998) but, importantly, introduced the term 'healthy warrior' with the specific aim of

> "designat[ing] the selection bias from systematic differences in the health of military personnel who are deployed to a war zone and those who are not deployed due to the selective withholding of chronically ill soldiers from deployment",

representing a subtle but important change of meaning from the original 'healthy worker effect'. However, by 2008 the term 'healthy warrior effect' was being used predominantly to refer to psychiatric diagnoses (Larson et al. 2008), as demonstrated in a definition published two years later (Manos 2010) which described it as the effect

> "wherein those with mental illness are more likely to be screened out during the initial months of training and pre-deployment".

This represented a major departure from the original concept of the healthy worker effect, and may be problematic in the context of military epidemiology as it is a source of confusion.

8.3.1.2 The Early Service Leaver

The inclusiveness of the definition of 'veteran' means that it encompasses those who leave before completing the minimum term of service. The term Early Service Leaver encompasses both those who fail to complete initial training, and therefore have never been exposed to deployment or combat, and those who complete training but leave prematurely, prior to finishing the minimum term of engagement, who may have experienced deployment and possibly combat.

Recent data show that around 34% of those who join as recruits are discharged prior to completing initial training, and a further 17% complete training but leave before the end of the minimum engagement[221]. Not all ESL leave for a reason likely to be associated with adverse long-term health outcomes; the term ESL encompasses a highly heterogeneous group of people and there are many reasons for failure to enter trained service. Recruits are permitted to take free discharge ('discharge as of right') between 4 weeks and 3

[221] Forces in Mind Trust. *The Transition Mapping Study* (2013). See also Appendix 9.

months from enlistment if they realise that they have made a mistake in choosing to join the Armed Forces. Others are discharged for disciplinary reasons, which may include theft[222], violence[223], drug abuse[224] or absence without leave. Medical discharge during recruit training is common, accounting for 25% of all failures to complete initial training[225]. Some of this group have been injured or become ill in training, whilst others have a medical history which subsequently comes to light under the rigours of training. A similar proportion is discharged 'Services no longer required'; although this encompasses a wide range of issues, a major contributor has historically been being found 'temperamentally unsuitable for service' (Deu et al. 2004). Some recruits simply fail to meet the high standard of physical fitness required, whilst others experience an unexpected change in family circumstances.

Figure 8-1 summarises outcomes from initial training in Army recruits 2010-2013[225]. Around 6% of those discharged (23% of all those who leave for medical reasons) have been found, after joining, to have failed to declare pertinent medical history which would have precluded enlistment.

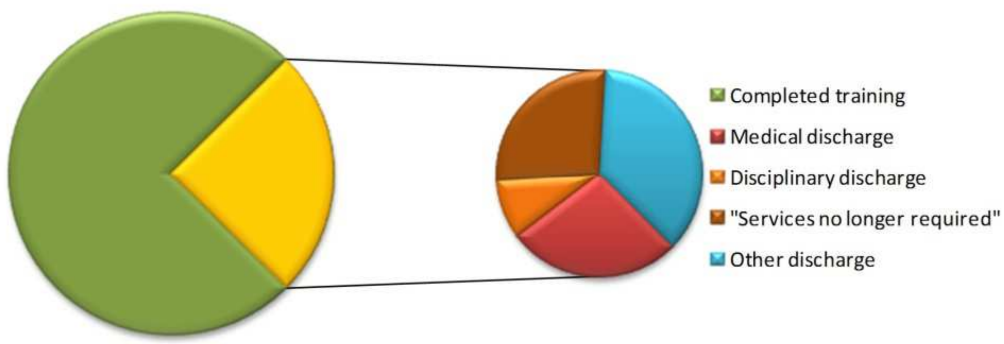

Figure 8-1 - Outcome of Recruit Training (Army)

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[222] For example, stealing from a fellow recruit's locker in the barrack-room

[223] For example, fighting with another soldier or a civilian whilst off-duty

[224] The Armed Forces have a zero-tolerance policy in respect of drug abuse and all serving personnel are subject to random drug testing in accordance with the Compulsory Drug Testing (CDT) programme. In most cases, a positive test leads to disciplinary discharge, whilst being found unlawfully in possession of controlled drugs may incur a custodial sentence. Drug misuse education is provided, and both medical and welfare support are available, including confidential services for those who wish to seek help. Personnel Services 2 (Army) (2004) *Alcohol and Drugs - the facts (AC64243),* Upavon: Ministry of Defence.

[225] Figures obtained from the Army Medical Directorate

The Scottish Veterans Health Study has demonstrated that for a number of conditions, including cardiovascular disease, lung cancer, peptic ulcer, mental ill-health and alcohol-related outcomes, the highest risk was seen in ESL, the veterans who had served for the shortest time. In the case of alcohol-related outcomes, only veterans who had completed training were at increased risk; those who left before completing training were at no greater risk than non-veterans, whereas for certain other conditions, those who left before completing training exhibited the highest risk. In this latter group, deployment could be excluded with confidence and factors directly related to service are highly unlikely to have been causal. Although ESL may not have experienced some of the service-related threats to health, they have not spent long enough in service to benefit fully from the protection afforded by the healthy worker effect.

8.3.1.3 The 'Less Healthy Leaver' Effect

In their 2008 paper on the 'healthy warrior effect' (Section 8.3.1.1), Larson et al. postulated a selection effect which continues to take place beyond the initial recruit selection process and into early service, which they expressed as "if this is true, then basic training acts somewhat as a de facto psychological screening process . . " (Larson et al. 2008). This concept was further developed by Manos in defining the 'healthy warrior effect' as the effect "wherein those with mental illness are more likely to be screened out during the initial months of training and pre-deployment" (Manos 2010).

Although screening for physical suitability for service is now firmly based on validated principles (Appendix 3, Section A3.3.1), effective screening of recruits for mental robustness has proved difficult to implement, and is limited to assessment at interview by experienced recruit selection staff and mental health assessment by the examining medical officer. Jones et al. conducted an historical review of screening for psychological disability or vulnerability from World War 1 onwards and found that the sensitivity and specificity of screening was low; many of those identified as vulnerable would go on to become good soldiers, whilst screening to identify those who would not complete training yielded results of variable predictive accuracy and risked a negative impact on manpower by excluding those who would succeed. Studies during World War 2 provided no reassurance that screening could reduce psychological casualties (Jones et al. 2003). In a questionnaire-based longitudinal cohort study of UK personnel deployed to the Iraq war, Rona et al. concluded there was little evidence to support pre-deployment psychological screening to prevent mental disorders, as both positive and negative predictive values were low (Rona et al. 2006). Although childhood vulnerability, encompassing both family relationship issues and externalising behaviours, is common and has been shown to be a risk factor for later poor mental health in military personnel, as in the wider population, there is no evidence that it is feasible to prospectively identify individuals at risk of a poor outcome (Iversen et al. 2007).

It is therefore inevitable that each intake of recruits includes a number of people who are either vulnerable to mental health disorders, have latent mental health conditions which have not yet become manifest, or have deliberately concealed a mental health history. Although the recent introduction of scrutiny of the primary care record may help to minimise the latter, it cannot pick up those cases which are known only to the independent sector or which have not yet presented. The stress of cultural readjustment which is an intrinsic concomitant of recruit training will inevitably cause some of these latent or concealed problems to become manifest, leading in most cases to early medical or administrative discharge or, if resulting in the recruit displaying conduct disorders, going absent without leave or misusing drugs, disciplinary discharge. Larson's interpretation of this process, as early service (including recruit training) acting as a *de facto* extension to the screening process for suitability to service (Larson et al. 2008), would predict that those with expressed or latent mental health problems are disproportionately over-represented in the pool of early leavers, whilst at the same time reducing the level of latent mental ill-health in the residual still-serving population. Those who are discharged for disciplinary reasons may be especially likely to develop later mental health problems; Kim-Cohen et al., in a follow-back of a longitudinal cohort, found a history of juvenile conduct or behavioural disorder in 25%-60% of adults with mental health disorders (Kim-Cohen et al. 2003). The pattern of risk of mental ill-health by length of service identified in the Scottish Veterans Health Study supports this theoretical explanatory framework.

The findings of the Scottish Veterans Health Study in respect of the association between length of service and long-term mental health are therefore consistent not only with Larson et al.'s hypothesis that recruit training and the early years of service act as a *de facto* extension to the recruit entry screening process (Larson et al. 2008) by identifying those who prove mentally or behaviourally unsuited to service, but also with Rona et al.'s conclusion that effective pre-service screening for mental health disorders in military personnel is problematic (Rona et al. 2006). Selective discharge of those who prove to be unsuited to service takes place throughout the ESL period but is predominantly skewed towards the early months of service. This 'multilayered selection process' has been described by Hyams (Hyams 2006). This process of, in effect, stratification of the pool of recruits by future health risk parallels fractional crystallisation in igneous petrology[226]; its interpreted application to the stratification of the health potential of veterans by length of service is illustrated at Figure 8-2. Those who complete the initial term of engagement have demonstrated a 'healthy warrior effect', as 'survivors', and may be predicted to show a reducing propensity to mental health problems.

The findings in respect of physical conditions examined in the Scottish Veterans study are also supported by this hypothetical explanatory framework. Furthermore, since poor mental health is known to be associated with a wide range of lifestyle-related health risk factors including smoking and alcohol misuse, and is also associated with increased risk of cardiovascular disease and other smoking-related ill-health, it is inevitable that this group of veterans will also demonstrate the highest risk for these conditions. No such effect is seen with, for example, risk of colorectal cancer in ESL, nor does the hypothesis predict an effect since a latent propensity to colorectal cancer would not become manifest early in service or impact on the ability to complete recruit training.

It is therefore concluded that the 'survivors' (from an occupational perspective) demonstrate a healthy worker effect whilst those who become veterans after a very short period of service, having failed to adapt to the rigours of training and service life, form a cohort of 'less healthy leavers' whose long-term health experience has been demonstrated to be less favourable. This long-term effect is consistent with Iversen et al.'s observation in relation to Gulf War and Era control veterans that "Those who are well, remain well, those who are symptomatic [for mental health problems], remain symptomatic."(Iversen et al. 2005) . In addition to carrying a greater burden of pre-existing threats to health such as childhood adversity, ESL have also served for too short a

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[226] Fractional crystallisation is the process whereby the chemical composition of a magma is progressively altered during cooling by sequential crystallisation (and hence removal from the melt) of those minerals having the highest melting points (O'Hara and Mathews 1981, Smith 2005).

period to have benefited from in-service health promotion, unlike their longer-serving colleagues.

The poorer long-term health outcomes of Early Service Leavers therefore simply represent the inverse or counterpart of the 'healthy worker effect' – a 'less healthy leaver effect', in which those who have had to leave an employment for health-related reasons, or for behavioural reasons which may be associated with later mental health disorder, are more likely to experience poorer health in the longer term. These leavers constitute a group who would not normally be monitored or studied since, for most employments, they are lost to follow-up. Labelled as veterans, traceable on some data systems and included in cohort studies, service leavers are unique in this respect. This hypothesis is also consistent with, and explains, the results of Jones et al.'s study of 8,261 UK military personnel which demonstrated, in a multiple logistic regression analysis, that having left service was the greatest contributor to risk of possible PTSD; other factors being low rank, a history of accident and major childhood adversity. The authors suggested that a possible reason may have been a greater willingness to seek care after discharge (Jones et al. 2013); the Scottish Veterans study has indicated that the 'health composition' of the pool of early leavers is skewed by selective discharge of those who, by virtue of their pre-existing health risk burden, are least suited to service and therefore represents a 'less healthy leaver' effect. The unique feature of these 'less healthy leavers', who form an inverse counterpart to the longer-serving 'healthy workers' (illustrated graphically at Figure 8-2), is that their designation as 'veterans' from their first day of service meant that they are identifiable within the community, and their health is therefore more 'visible' than is the health of people who leave other occupations after only a short time.

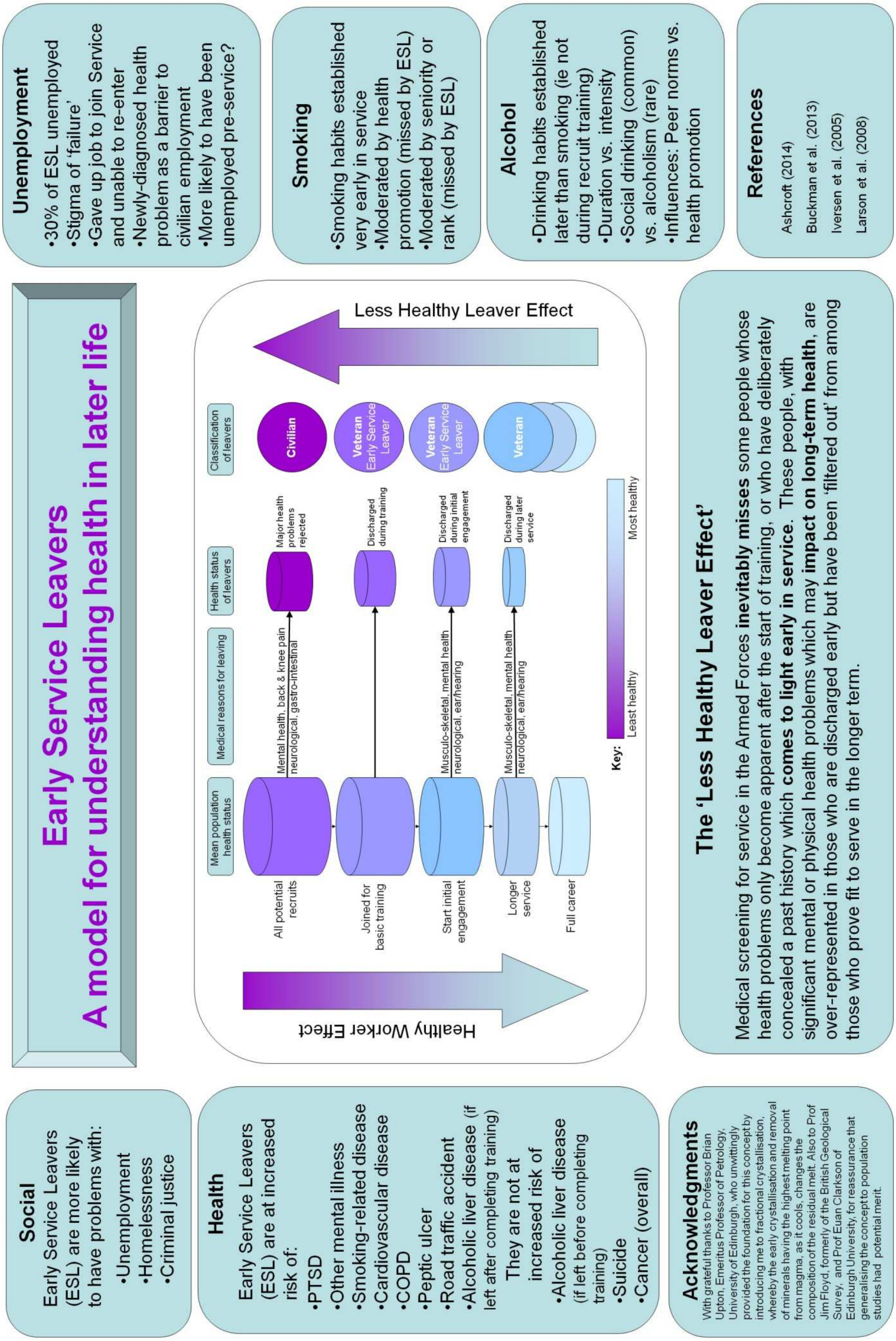

Figure 8-2 - The 'Less Healthy Leaver' Effect

8.3.1.4 The Longer-Serving Veteran

The longest-serving veterans demonstrated a reduced risk of all cardiovascular disease, all mental health disorders except dementia, peptic ulcer, COPD and alcohol-related death compared with all non-veterans. This pattern is consistent with a healthy worker effect, and *inter alia* suggests that smoking and alcohol misuse are less prevalent in these longer-serving individuals, although it provides no information about the direction of 'causality'.

8.3.1.5 Post-Service Employment

The adverse effect on health of early termination of employment is not specific to the military; in a study of nuclear industry workers, those who left after less than two years employment (including those whose employment was terminated) experienced 15% higher overall mortality than those with longer employment. The greatest differences were in diseases of the circulatory system (14.4% higher in early leavers), malignant neoplasms of the liver and pancreas (119.6% and 30.0% higher respectively, although based on small numbers of observed cases) and deaths due to accidents, violence and poisoning (45.3% higher). Few of the early leavers, and none of those in the excess mortality group, had experienced high occupational radiation doses (Gilbert and Marks 1979). A study in Finland showed that the highest mortality rate was experienced by those who retired aged less than 65 years (SMR 130), whilst those who remained in the same occupation throughout the 10 year period of the study had an SMR of 80. However, changing occupation was not detrimental to health and the SMR for this group was 70 (Vinni and Hakama 1980). On the basis of this study, it may be postulated that leaving the Armed Forces *per se* should not be damaging to health as long as the individual moves into new employment. However, becoming an ESL is itself a risk factor for post-service unemployment (Ashcroft 2014). The nature of post-service employment may also bring specific health risks which may impact on the long-term health of the veteran; for example, working in the emergency services may increase the risk of PTSD (Clohessy and Ehlers 1999) which is unrelated to military service.

8.3.2 Smoking

Tobacco smoking is responsible for around 100,000 deaths per year in the UK, equivalent to 23-27% of all deaths in men and 11-12% in women, and is a major preventable cause of death and morbidity (Allender et al. 2009, Twigg 2004). It has been causally linked to a wide range of diseases including lung cancer, oropharyngeal cancer, stomach, bladder and other cancers, cardiovascular disease including myocardial infarction, leukaemia, cervical cancer in women (US Department of Health 2004), COPD, and peptic ulceration (Allender et al. 2009). Exposure to environmental tobacco smoke (ETS) increases the risk of CHD and lung cancer in healthy non-smokers (US Department of Health 2006). The percentage of deaths in England attributable to smoking, for selected diseases, is shown at Table 8-6. There is evidence for a possible protective effect of smoking for a small number of diseases including malignant melanoma and endometrial cancer (Grant 2008, Lesko et al. 1985).

Table 8-6 - Percentage of deaths attributable to smoking, by disease
Adapted from (Twigg 2004)

Disease	Men	Women	Men & Women
Lung cancer	91%	80%	87%
COPD	87%	84%	86%
Upper respiratory cancer	77%	58%	73%
Oesophageal cancer	70%	72%	71%
Peptic ulcer	54%	58%	56%
Ischaemic heart disease (age 35-64)	46%	42%	45%
Cerebrovascular disease (age 35-64)	39%	42%	43%
Pancreatic cancer	26%	31%	29%
Kidney cancer	42%	7%	28%
Stomach cancer	35%	12%	27%
Leukaemia (myeloid)	19%	12%	16%

In one of the largest studies of cancer in veterans ever conducted, McLaughlin et al. followed up a cohort of US veterans for 26 years, accumulating over 3 million person-years of data, and found that all-cause death rates were 70% higher in current smokers than in non-smokers. Relative risks for cancer mortality were calculated for two periods, 1954-1969 and 1970-1980, and the findings are summarised at Table 8-7 (McLaughlin et al. 1995).

Table 8-7 - Relative risks for cancer mortality in US veterans; current smokers referent to non-smokers
Adapted from (McLaughlin et al. 1995)

Cancer site	1954-1969		1970-1980	
	RR	95% CI	RR	95% CI
All sites	2.2	2.1-2.3	2.0	1.9-2.1
Pharynx	14.4	5.8-35.7	13.4	4.1-43.6
Larynx	11.9	5.2-27.2	17.8	5.5-57.5
Lung	11.7	10.1-13.7	11.6	9.7-13.7
Oesophagus	6.3	3.9-10.1	2.6	1.7-4.0
Oral	4.3	2.6-7.0	2.2	1.1-4.1
Bladder	2.2	1.8-2.7	2.3	1.8-2.8
Liver	2.2	1.6-3.1	1.2	0.8-1.9
Pancreas	1.7	1.5-2.1	1.6	1.3-1.9
Stomach	1.5	1.3-1.8	1.2	1.0-1.5
Kidney	1.4	1.1-1.9	1.7	1.2-2.3
Skin	1.4	0.9-2.1	1.1	0.8-1.7
Prostate	1.3	1.1-1.5	1.1	1.0-1.2
Rectum	1.2	1.0-1.5	2.0	1.5-2.8
Colon	1.1	1.0-1.3	1.4	1.2-1.6
Brain	1.1	0.9-1.4	1.0	0.7-1.5
Hodgkin lymphoma	1.8	1.2-2.7	0.9	0.4-1.7
Leukaemia	1.6	1.3-1.9	1.1	0.9-1.3
Non-Hodgkin lymphoma	1.1	0.9-1.4	0.9	0.6-1.2
Multiple myeloma	0.8	0.6-1.1	1.2	0.8-1.7

The Scottish Veterans Health Study has demonstrated that veterans were at increased risk of a wide range of smoking-related diseases; AMI, stroke, PAD, lung cancer, oropharyngeal and laryngeal cancer, oesophageal cancer, stomach cancer, COPD and peptic ulcer. The overall increase in risk was generally around 20%, providing a good match to the 20% higher rates of smoking by Service personnel, compared with civilians, described by military researchers (Richards and Crowdy 1961, Lewthwaite and Graham 1992). The hazard ratios by birth cohort and diagnosis are summarised graphically at Figure 8-3 and show a consistent pattern, other than for smoking-related cancers excluding lung[227], where the failure of the hazard ratio to drop below unity in the later birth cohorts is likely to reflect the role of additional risk factors other than smoking in this group of diseases. Reductions in the risk of smoking-related disease in later birth cohorts closely match the reduction in smoking prevalence in the Armed Forces over time (Figure A4-7).

[227] Stomach, oesophagus, oropharynx and larynx, bladder and kidney

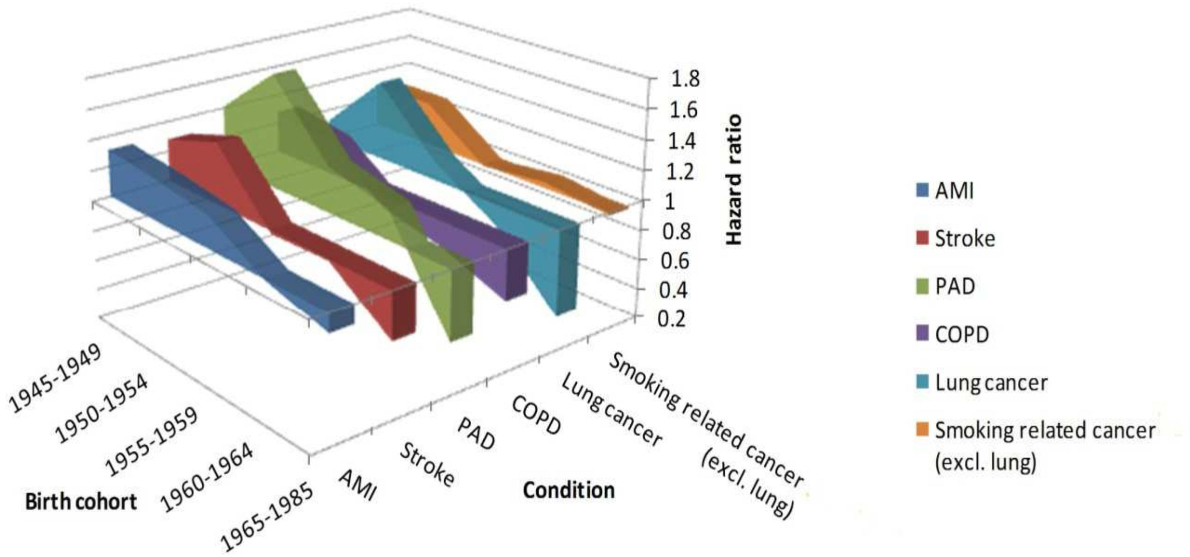

Figure 8-3 - 3D plot of hazard ratios for smoking-related disease in veterans by diagnosis, referent to non-veterans

The finding of the highest risk for COPD in ESL who completed training, compared with those who left prior to completing training, is consistent with the pattern seen in oropharyngeal and laryngeal cancer (Table 5-5) and contrasts with the pattern in lung cancer and cardiovascular disease where those who did not complete training exhibited the highest risk (Table 4-5 and Table 5-4). This finding suggests that an additional risk factor is operating in these veterans beyond smoking; heavy alcohol intake, as suggested by Sisson (Sisson 2007) is a good fit, for the reasons discussed at Section 5.9.3.

There is a long history of military smoking, as described in Appendix 4. Smoking status is related to rank, which in turn is broadly related to seniority and length of service, as discussed at Appendix 3, Sections A3.3.1 and A3.3.3. Lodge has shown that the prevalence of never-smoking increased from 35% in the most junior ranks (private to lance-corporal and equivalent[228]) to 67% in field and staff officers (major to colonel and equivalent[229]) (Lodge 1991) (Figure 8-4). It is likely that educational attainment, which is known to be inversely associated with smoking prevalence (Gilman et al. 2008) and is also

[228] NATO rank OR3 and below

[229] NATO rank OF4 and above

an important determinant of potential for promotion, accounts for much of the variation[230].

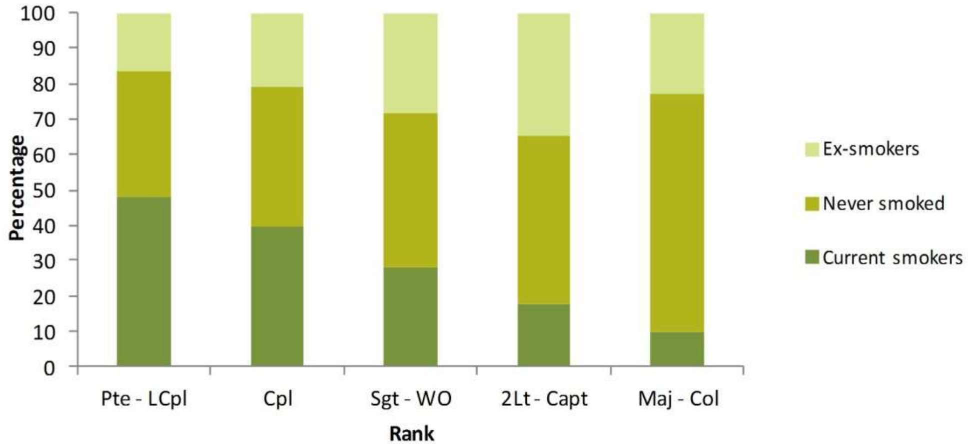

Figure 8-4 - Prevalence of current, former and never-smoking by current rank (1989)
Adapted from (Lodge 1989)

Over the period of service of the veterans included in the study, the prevalence of military smoking has fallen from around 70% to under 30% (Appendix 4, Figure A4-7), although it remains higher than in civilians. The increased risk of smoking-related disease which was observed, predominantly affecting the oldest veterans, who served in the 1960s and 1970s, is consistent with this picture of military smoking.

8.3.3 Alcohol

Whilst alcohol is widely consumed for social and recreational purposes, alcohol misuse accounted for 38,724 discharges from acute general hospitals in Scotland in 2011-12 and played a part in 1,080 deaths in 2012, the highest rates being in men aged 50-54 (ISD Scotland 2014). Ezzati et al. have placed alcohol as the third highest contributor to the burden of disease in developed countries, after tobacco and high blood pressure and ahead of high cholesterol and high BMI (Ezzati et al. 2002). Health effects of alcohol consumption include acute intoxication (which may result in accidental injury or death including road traffic accidents), as well as long-term effects wholly attributable to alcohol such as alcoholic cirrhosis of the liver, alcoholic gastritis, alcoholic pancreatitis,

[230] Although whether the association between educational attainment and smoking is causal or indirect is a matter of debate. Gilman, S. E., Martin, L. T., Abrams, D. B., Kawachi, I., Kubzansky, L., Loucks, E. B., Rende, R., Rudd, R. and Buka, S. L. (2008) 'Educational attainment and cigarette smoking: a causal association?', *International Journal of Epidemiology,* 37(3), 615-624.

alcoholic polyneuropathy and psychiatric disorders such as alcoholic psychosis and alcohol dependence (World Health Organization 2004). Alcohol dependence often coexists with other mental health conditions. In other diseases, alcohol plays a contributory role although the attributable fraction varies between countries and cultures. Conditions in which alcohol has a well-established contributory role include cancers of the oropharynx, oesophagus, liver, and female breast. There is weaker evidence of an association with cancers of the stomach, pancreas, colon and rectum, prostate, ovary, endometrium and bladder (World Health Organization 2004). Alcohol in moderation has a protective effect on the cardiovascular system but this reverses with heavy drinking (World Health Organization 2014).

A number of studies have shown that military personnel drink more heavily than their civilian peers (Jones and Fear 2011), and that veterans are more likely to develop alcohol-related health problems than those who have never served, although the latter studies have been predominantly conducted among veterans of specific conflicts such as Vietnam (Jordan et al. 1991). Patterns of drinking in the Armed Forces in the late 20th century are further examined in Appendix 4.

The observed results on alcohol-related harms (alcoholic liver disease, alcohol-related death, oropharyngeal and laryngeal cancer and oesophageal cancer) are consistent with no increase in drinking patterns during recruit training (Appendix 4, Section A4.2.3), followed by an increase as the recruit commences adult trained service which quickly moderates if the individual progresses in seniority. There is evidence to suggest vulnerability to alcohol misuse in specific groups, for example those who were older at entry and who joined at a time of high operational intensity in Northern Ireland (Section 6.6.1.5). There is also evidence of an overall fall in risk of alcohol-related harm with successive birth cohorts, suggesting a reducing ‘culture of drinking’ within the Armed Forces over time.

8.3.4 The Early Birth Cohorts

There was a consistent pattern of increased risk of cardiovascular disease and other smoking-related disease, alcohol-related outcomes and mental health disorders in veterans in the 1945-1949 and 1950-1954 birth cohorts, who generally served in the

1960s and early 1970s. The reasons for their poorer outcomes are likely to be multi-factorial. This group is known from earlier studies to have had a higher prevalence of in-service smoking than later-serving people (Lewthwaite and Graham 1992). They also served prior to the introduction of widespread health promotion within the Armed Forces, at a time when risky health behaviour, especially in relation to alcohol[337], was commonplace. Many would have experienced deployment, either to Aden or Northern Ireland, at a time of intense operational activity. As the oldest group in the study, they are also most likely to have experienced weakening of any healthy worker effect (Li and Sung 1999). What cannot be determined is whether the pattern of risk observed in the Scottish Veterans Health Study will change as the younger birth cohorts age; examination of trends over time for hypothetical earlier end-points to the study (Appendix 10) suggests that improvement is more likely than worsening.

8.4 Key Points

8.4.1 Occupational Epidemiology

- Veterans represent a unique and diverse cohort of 'occupational leavers', with occupations ranging from unskilled and untrained to highly skilled professionals, and lengths of 'employment' ranging from one day to in excess of 40 years.

- No other group of 'occupational leavers' (for example police, nurses, teachers, builders), including those who leave before completing training, is able to be followed up in the same way as veterans, with the exception of specific groups who are monitored long-term following exposure to a hazard, such as radiation workers.

- The ability to monitor veterans gives visibility to a 'less healthy leaver effect', the inverse of the 'healthy worker effect', whereby those who leave earliest are inevitably at the highest risk of poor long-term health outcomes.

8.4.2 Length of Service

- In general, Early Service Leavers had the poorest long-term health outcomes; this can largely be explained by a 'less healthy leaver' effect; those who have medical or behavioural problems, or latent mental health problems, which may in turn predispose to later long-term health problems, are more likely to be discharged early.

- Military service *per se* is highly unlikely to play a causal role in the poorer long-term health of veterans who leave earliest, especially in those who left before completion of training. Pre-service and post-service factors are likely to have been a major determinant of the health of these veterans.

- In general, longer military service was associated with better long-term health.

8.4.3 Smoking

- The well-documented high rates of military smoking in the 1960s and 1970s appear to have left their mark on the long-term health of veterans, with increased rates of all smoking-related diseases. Although no data were available on smoking status in the cohort members, the relationship to previously-documented rates of in-service smoking appears clear.

- The risk has reduced over time, and veterans born after 1960, who joined the Services from the late 1970s, demonstrated a lower risk of many smoking-related diseases than non-veterans. Since serving personnel continue to smoke more than civilians, although at much lower levels than hitherto, it is likely that better fitness and nutrition have contributed to the lower risk.

- The risk of smoking-related disease was highest in Early Service Leavers, including those who did not complete training. The evidence supports adoption of increased levels of smoking very early in service, as reported in other studies.

- The risk of smoking-related disease reduced with longer service, providing evidence for the effectiveness of military health promotion. Higher educational level, which is recognised to be associated with lower rates of smoking, in those who go on to achieve higher rank was also likely to be a contributory factor.

- There may also have been an association between high rates of smoking and adverse mental health outcomes.

- Lack of data on smoking prevalence in the cohort has limited the robustness of the interpretation. Further studies utilising linkage to other datasets which included data on smoking would provide confirmation.

8.4.4 Alcohol

- Veterans were not at increased risk of alcoholism overall (as measured by risk of alcoholic liver disease), and were at reduced risk when post-service social deprivation was taken into consideration.

- There was evidence of increased risk of alcohol-related disorder in veterans born before 1950, but those born from 1965 onwards were at reduced risk.

- There was an increased risk of alcoholic liver disease and alcohol-related death in ESL who had completed training.

- ESL who left before completing training were not at increased risk of alcohol-related adverse outcomes. It is likely that strict control of exposure to alcohol during recruit training prevented the development of service-related heavy drinking patterns.

- Using oropharyngeal and laryngeal cancer as a proxy measure, there is some evidence that would support heavy social drinking to harmful levels, not amounting to alcoholism, in veterans who completed training and served for 10 years or less. Most are likely to have been discharged in the rank of corporal (and equivalent) and below.

- Heavy drinking may also be a risk factor underpinning the finding of the highest risk of COPD in ESL veterans who had completed training.

- Lack of data on alcohol consumption in the cohort has limited the robustness of the interpretation.

8.4.5 Age at Recruitment

- ESL who failed to complete training had the highest median age at recruitment.

- Younger age at entry to the Armed Forces was associated with completing longer service.

- Age at recruitment did not influence risk of later adverse health outcomes except for road traffic accident, which was more common amongst those who were youngest at entry, and for alcoholic liver disease which was non-significantly increased in those who were older at recruitment during early operations in Northern Ireland (see below).

- Although the Scottish Veterans study included no data on civilian employment history, it is plausible that a history of unemployment or job loss may be relevant not only to the decision to join the Armed Forces at an older age, but also may have been a risk factor for failure to settle into Service life.

8.4.6 Military Training

- There was an increased risk of alcohol misuse disorders in people who had been recruited at a time when they were highly likely to have deployed directly from training to a novel military situation[231], for which a mature training package had not yet been developed. The risk was highest in those who were older than average at entry to the Services.

- The increased risk disappeared in those who joined later in the operation, suggesting that good training and preparation for deployment and combat could protect against adverse long-term health outcomes, even with continuing operational deployment.

[231] The findings were clearest for those who joined in 1970 and 1971, at the start of Operation BANNER (military operations in Northern Ireland)

8.4.7 Mental Health Disorders

- Overall, veterans were at increased risk of all mental health disorders except dementia, but subgroup analysis showed a complex pattern with the increase predominantly seen in the oldest veterans and those with the shortest service.

- If PTSD was excluded, veterans were not at increased risk of other mental health disorders overall.

- Veterans were not at increased risk of suicide overall.

- Veterans were at increased risk of non-fatal self-harm, but the increased risk was confined to ESL and to older (age 50 years upwards) veterans with under 10 years' service.

8.4.8 Post Traumatic Stress Disorder

- There is evidence to suggest a 'hidden iceberg' of combat-related PTSD which came to light in the late 1990s, possibly as a consequence of publicity about the condition during the Falkland veterans' court action (1997-2002).

- There is evidence of a similar (although smaller) 'iceberg effect' in non-veterans at the same time.

- Once the 'iceberg' had passed, the risk of PTSD in veterans remained higher than in non-veterans.

- Although some of the ongoing increased risk in veterans is likely to have been accounted for by the increased risk associated with combat reported in other studies, other factors such as over-diagnosis and factitious symptoms cannot be ruled out.

- The high risk in ESL veterans who had not completed training cannot be explained by combat, and is most likely to result from factors external to service.

8.4.9 Women

- The enforced nulliparity of longer-serving women prior to 1991 appears to have resulted in increased risks of breast, and possibly ovarian, cancer although other factors cannot be ruled out without further studies.

- There is evidence, although not reaching statistical significance, that the early introduction of cervical cytological screening in the Armed Forces may have had a beneficial impact on the risk of cervical cancer in women born after 1958.

- For a number of conditions, particularly suicide and some mental health disorders, the health profile of women veterans was closer to that of veteran men than of non-veteran women.

- For the majority of conditions, women veterans were shown not to be at increased risk compared with non-veteran women, although the smaller number of women in the cohort, reflecting the gender balance in the Armed Forces, had the effect of reducing the statistical power of the female subgroup in the analyses.

8.5 Responses to Research Questions

The responses to the research questions can therefore be summarised:

Research Question	Key Findings
Do military veterans have better or worse long-term health outcomes (physical or mental) than people who have never served?	The long-term health of veterans demonstrated a high level of heterogeneity, although consistent patterns were evident. Just as there is no typical 'veteran', so there was no typical 'health outcome'. For some veterans, and some conditions, the outcomes were worse; for others, the reverse was the case, whilst for the remainder, no differences were identified.
Are there specific conditions which are associated with military service, and is there evidence of causality?	There was evidence of a possible causal occupational association for only a very small number of conditions; bladder cancer, pancreatic cancer, and testicular cancer. Further studies are recommended. Increased risks of breast and ovarian cancer in some subgroups of women veterans are likely to have an indirect, non-causal association with service. The data for stress/PTSD have yielded a complex picture, the interpretation of which is at best speculative, and further analysis is recommended.

Are some sub-groups of veterans at greater risk than others?	The highest risks were faced by Early Service Leavers, particularly those who did not complete training, and the oldest veterans. Longer-serving veterans and those in the more recent birth cohorts generally enjoyed better health than their non-veteran counterparts.
Are there any trends over time?	There was evidence of an overall improvement in veterans' health, both relative to non-veterans and absolute, especially for smoking-related and alcohol-related problems. Veterans born after 1960 generally demonstrated better health than those born in the 1940s and 1950s.
What is the overall impact of military service on health?	Longest service was associated with the best long-term health; thus it is concluded that military service has an overall positive impact on health. Leaving service early was associated with poorer health, although the association is unlikely to be causal.
SUMMARY: What might explain the findings?	**i. Early Service Leavers**. It is likely that the long-term health outcomes of those who left earliest were in large part determined by pre-service (and possibly post-service) factors. ESL represent a 'less healthy leaver' cohort which is the counterpart to the 'healthy worker effect' in those who serve for longer. **ii. Military health promotion.** The improving health of veterans compared with non-veterans in the more recent birth cohorts, and especially in those born from 1960 onwards, may largely be explained by the increasing emphasis on health promotion in Defence policy since the late 1970s. **iii. Smoking.** Smoking initiation (or restarting) is known from other studies to occur soon after entry to service, and longer service is associated with lower prevalence of smoking. Smoking prevalence in serving personnel has declined, especially since the late 1970s. This is consistent with the observed risks of smoking-related disease, which were highest in ESL, lowest in the longest-serving and reduced in veterans born after 1960 who commenced service in the late 1970s. **iv. Alcohol.** Evidence of alcoholism or very high alcohol consumption was confined to ESL who had completed training. It is likely that the controlled environment of the recruit training establishments did not permit the development of patterns of alcohol misuse in those who left before completing training. By contrast, there was some evidence of harmful alcohol use, not amounting to alcoholism, in those with shorter service who are unlikely to have progressed beyond the junior ranks. **v. Mental Health**. Veterans with the shortest service (ESL who did not complete training) were at highest risk. It is implausible that military service was causal, and it is more likely that pre-service factors are responsible. An unusual pattern of presentation of PTSD in the late 1990s may reflect the uncovering of a 'hidden iceberg'. If PTSD diagnoses were excluded, the majority of the differences between veterans' and non-veterans' mental health disappeared.

8.5.1 Hypothesis

The null hypothesis, at the commencement of this study of a novel dataset, was that there is no difference in the long-term health experience of veterans, compared with people who have never served. It has been demonstrated that this does not hold true. The final revised hypothesis is:

> The predominant negative influences on veterans' health are those arising from pre-service and lifestyle factors, whilst longer military service generally has a positive effect on health.

8.6 Implications of the Study

8.6.1 Recommendations for Further Research

8.6.1.1 Bladder Cancer

Bladder cancer demonstrated the strongest evidence for an occupationally-associated outcome in the Scottish Veterans study, with statistically significant elevated risks for veterans who had served for between four and 16 years, especially affecting the 1960-1964 birth cohort. Whilst smoking is a risk factor for bladder cancer, this birth cohort did not demonstrate an elevated risk of the major smoking-related cancer, lung cancer. Furthermore, they joined the Armed Forces after smoking rates had started to fall so they would not be expected to demonstrate the highest incidence of bladder cancer if this was smoking-related. Potentially relevant candidate military exposures include fuels, solvents, and service in Kenya involving risk of infection with schistosomiasis. Currently, the Ministry of Defence does not consider bladder cancer to be causally related to military service (Section 5.21.3); data from the Scottish Veterans study suggest otherwise, which may have implications for service disability compensation payments to affected veterans. More importantly, for the purpose of secondary prevention, veterans of the 1960-1964 birth cohort have not yet reached the peak age for bladder cancer; if an occupational association is confirmed, there may be justification to raise awareness amongst veterans or primary care practitioners, or to even to recommend periodic screening in the highest-risk group, in order to ensure prompt access to treatment and prevent unnecessary deaths. Associations with military trade, chemical exposures, and overseas service should therefore be explored by means of a nested case control study. Subject to approval by a relevant ethics body, the importance of this finding may justify breaking the pseudo-anonymisation code to identify affected individuals. Longer follow-up is also needed as the cohort has not yet reached the peak incidence for bladder cancer; the observed pattern may change as the cohort ages.

8.6.1.2 Pancreatic Cancer

A similar pattern of significantly elevated risk of pancreatic cancer in veterans was evident in the same 1960-1964 birth cohort, although there were insufficient numbers of cases to permit analysis by length of service. As an association between pancreatic cancer and occupational exposure to pesticides and polycyclic aromatic hydrocarbons has been described in the literature (Section 5.16.4), and as the increase in risk occurred in the same birth cohort as that for bladder cancer, further exploration by means of a nested case control study should take place.

8.6.1.3 Testicular Cancer

Although not achieving statistical significance, the results in respect of testicular cancer, showing a small increase in risk with longer service and possibly some clustering by year of entry, add weight to published reports indicating that there may be some military association (Section 5.32.3). A nested case control study to examine occupational histories and explore patterns of risk is indicated.

8.6.1.4 Ovarian cancer

The data for ovarian cancer indicate a statistically significant increase in risk in servicewomen born after 1960 who joined for service up to 1991. As cases are still being diagnosed (the most recent being in 2009, with the study follow-up having continued to 2012), and the cohort remains within the at-risk age group, a nested case control study to examine risk factors is recommended in order to determine whether there is a specific group at higher risk for whom secondary prevention (advice or possibly even screening) may be appropriate.

8.6.1.5 Women's Health

The Scottish Veterans Health Study has provided a rich source of data on the long-term health of servicewomen compared with women who have never served, and some important observations have been made, including the generally better mental health enjoyed by women veterans compared with veteran men. For some conditions, the veteran women's health risk profile was closer to that of veteran men than to non-veteran women, although for others such as multiple sclerosis, the higher risk in veteran women compared with men reflected the pattern of risk observed in non-veterans. In the light of various MOD initiatives to extend the role of servicewomen since 1991, and the importance of monitoring any health implications resulting from such changes, there is scope to conduct more in-depth research into the health of women veterans, either using the Scottish Veterans dataset or as separate studies.

8.6.1.6 Mental Health

The Scottish Veterans Health Study has provided an overview of long-term mental health outcomes in veterans compared with non-veterans and has revealed a high level of complexity, as described in Chapter 7. There is scope for much additional research, including developing and exploiting linkages to other datasets which are already being used to examine mental health such as that maintained by the King's Centre for Military Health Research.

8.6.1.7 Motor Neuron Disease

The Scottish Veterans Health Study has added to the small body of evidence, predominantly from the USA, demonstrating an increased risk in military veterans, but evidence for causal associations remains elusive in this rare disease. A nested case control study would help to identify potential occupational risk factors. As additional data linkage capability becomes available in other nations' health services, so additional retrospective and case control studies should be undertaken. Because of the rarity of the condition, it is unlikely that new prospective cohort studies would yield useful results in a reasonable timeframe.

8.6.1.8 Leukaemia

In view of the increased risk of leukaemia in younger veterans (born from 1965) compared with non-veterans, which almost reached statistical significance despite small numbers, further studies should be undertaken as the subgroup ages in order to monitor longer-term trends.

8.6.1.9 Data Linkage

Potential linkages to other study populations which may overlap with the Scottish Veterans group should be explored, as noted at Section 8.6.1.6 above, in order to provide information on service-specific factors such as trade and risk exposures, and on lifestyle factors such as smoking, alcohol consumption and obesity. Potentially suitable study populations include the Scottish Health Survey maintained by the Scottish Government, the Gulf and Era Health cohorts maintained by the King's Centre for Military Health Research, King's College, London and the Service Leavers database maintained by Defence Statistics (Health).

8.6.1.10 Follow-up

The Scottish Veterans Health Study has demonstrated the feasibility and utility of examining veterans' health using routinely collected linked data. The findings represent the picture as at the end of 2012, but this may change as the cohort ages. It would be valuable to continue to monitor the cohort by repeating the data analysis, for example at five or 10 year intervals, refreshing it with people who have newly left the Armed Forces and appropriate controls.

There would be utility in adding a question on military service to routine health surveillance instruments such as the Scottish Health Survey in order to facilitate routine monitoring of veterans' health.

8.6.2 Recommendations for Policy

8.6.2.1 Definition of a Veteran

Much of the long-term increase in risk of ill-health in veterans arises in Early Service Leavers, and especially in those who did not complete training. The Scottish Veterans

Health Study has provided evidence that the early weeks and months of training and service act as a *de facto* extension to the screening of recruits for suitability on entry, especially in respect of psychological factors (Larson et al. 2008), and other studies have shown that it is unlikely that the screening process can be greatly improved in this respect (Jones et al. 2003, Rona et al. 2006). Thus it is those with the poorest health potential, especially in respect of mental health, who leave earliest, as discussed at Section 7.14.5 and Section 8.3.1.3. The current UK definition of a veteran recognises the commitment to serve the Nation and, if necessary, to make the ultimate sacrifice but, paradoxically, the early weeks of training include a period when the recruit may opt to be discharged of all obligations ('discharge as of right' or DAOR) without penalty. It is recommended that consideration be given by the MOD to reviewing the designation of a 'veteran', with a view to examining whether entitlement to such designation should commence on the first day after expiration of the period of DAOR entitlement or, alternatively, at the conclusion of initial training.

8.6.2.2 Age at Entry

The incidental finding that those who were oldest at entry were more likely to become ESL[232], whilst those who joined at the earliest ages were more likely to go on to longer service, has important implications in the light of current concerns about 'junior entry'[233], which have been driven by societal objections to 'child soldiers'. Further research[234] is indicated to examine the long-term occupational outcomes of recruitment by age at entry, in order to provide an evidence base for any policy change and minimise the risk of inadvertently reducing the number of recruits who have the best career outcomes whilst increasing the number who are most likely to fail. It would be inappropriate for this pathway to service to be phased out if there is evidence that the overall long-term outcomes are beneficial to both the Armed Forces and the individual. The MOD should consider commissioning such a study in order to inform future recruitment policy and minimise the number of those recruited whose service is terminated prematurely.

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[232] This finding from the Scottish Veterans data was fully supported by a retrospective analysis of a specific group of recruits (Appendix 10)

[233] At age 16 or 17 years, in an educational capacity, as discussed at Section 3.2.3

[234] By human resource planners or sociologists; there is no requirement for this to be led by epidemiologists

8.6.2.3 'Less Healthy Leaver Effect'

The concept of the 'less healthy leaver' was a novel finding. Although constrained, by definition, to those occupational groups in which the early leavers can be identified, it has wider utility in occupational health studies in understanding the reasons why early leavers may experience poorer long-term outcomes, and thus may avoid the risk of inappropriate attribution of blame for ill-health to the former employer. Wider adoption of the concept is recommended.

8.6.3 Recommendations for Service Provision

8.6.3.1 Smoking Cessation

With nearly 2,400 (4%) veterans in the study population affected by COPD of sufficient severity to warrant secondary care admission, over 3,000 (5%) affected by cardiovascular disease and almost 450 (just under 1%) diagnosed with lung cancer, the long-term consequences of the high prevalence of military smoking described by Major-General Crowdy and his fellow military occupational and public health physicians in the 1960s and beyond (Richards and Crowdy 1961, Crowdy and Sowden 1975) have been shown to have left a legacy of smoking-related ill-health. Even in the oldest veterans, smoking cessation is likely to result in improved life expectancy (Taylor Jr et al. 2002, Doll et al. 2004) and reduced healthcare costs and morbidity (Barendregt et al. 1997, Connolly 2000). It is therefore highly likely that targeting smoking cessation services towards veterans would be of benefit. Although these services should first and foremost be delivered by primary care practitioners and through community services such as pharmacies, services aimed specifically at veterans, recognising the social and occupational environment which originally encouraged them to smoke, may result in improved uptake. In view of the association between smoking, mental health disorder and smoking-related disease which is widely recognised in the literature, and which has been demonstrated in the Scottish Veterans study, the NHS should consider piloting a smoking cessation initiative through an established veterans' mental health service such as Veterans First Point[235]. Innovative ways of reaching older veterans should also be explored, in consultation with the veterans' charities.

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[235] The NHS Lothian 'one stop shop' for veterans' mental health.

8.6.3.2 Mental Health

Since the first reports of Gulf War-related ill-health in the mid 1990s, there has been an unprecedented level of public interest in the mental health consequences of military service. Following the publication of Dr Andrew Murrison's report[236] into provision of mental health services for serving personnel and veterans, substantial NHS resources have been committed to veterans' mental health. Many veterans' charities are also dedicated to, or include, the provision of mental health support for veterans; the best known is Combat Stress (formerly the Ex-Services Mental Welfare Society). In consequence, there is not only a widespread public perception that mental health is the only area in which veterans' health differs from that of non-veterans, but also an erroneous perception that mental ill-health is widespread in the ex-service community (Ashcroft 2014).

The Scottish Veterans Health Study has demonstrated that there is indeed a substantial level of mental ill-health (at the level of severity encompassed by the study) in the veterans' community. However, mental health disorders are also common in the wider community, and the majority of veterans are not at any greater risk than non-veterans in this respect. Veterans who were at increased risk were those who left earliest, and especially those who left prior to completing training. Furthermore, the bulk of any excess risk rested with diagnoses of severe stress and PTSD and, if these diagnoses were excluded, there was little or no excess risk other than in the oldest birth cohort. Overall, long-term mental health has been shown to improve with longer service. Thus, the perception amongst both the public and healthcare providers that most veterans' mental ill-health is combat-related, and the configuring of services predominantly to meet this perceived need, is inappropriate. Whilst accepting that there are some veterans who have experienced severe combat-related psychological trauma, and who may benefit from targeted services, the majority of mental health needs, especially in ESL veterans, are likely to arise from factors external to service. It is important that this is recognised in careful history-taking, as highlighted by Wessely (Wessely 2005); inappropriate blanket attribution of mental ill-health in middle age to a short period spent in recruit training as

[236] Murrison A. Fighting Fit: A mental health plan for servicemen [*sic*] and veterans. Ministry of Defence (2010).

a teenager is unhelpful to the affected individual, to the Armed Forces and to society as a whole.

The recognition that military service may facilitate uncovering a mental health problem, thereby acting as a pathway to care, is important (Section 7.9.4.3). In-service health promotion aimed at encouraging personnel to seek support for mental health problems, the 'legitimisation' of mental health disorder as a socially acceptable consequence of combat, and the availability of services aimed at veterans, may act as an enabler to encourage those who have served and can claim veteran status to come forward and seek care. However, a relatively small proportion of these mental health problems will be due to combat, and hence it is equally important that healthcare providers and veterans' charities do not routinely assume that military service has a causal role. Nor should veterans feel compelled to present a 'war story' in order to obtain support. Both care providers and veterans should be encouraged to recognise, and publicise, that the entitlement to mental health support as a veteran is not confined to service-attributable conditions; this will lead to better diagnosis and, ultimately, to more effective care.

8.6.4 The Armed Forces Covenant

The Armed Forces Covenant recognises the moral obligation of the nation towards members of the Armed Forces, their families and veterans, collectively termed the Armed Forces Community. It has two underpinning principals; that the Armed Forces Community should not experience disadvantage compared with other citizens in the provision of public and commercial services, and that special consideration may be appropriate in some cases including for those who have been injured. The Covenant is supported at a local level by Community Covenants and Corporate Covenants.

The Scottish Veterans' Health Study has found no evidence that veterans experience disadvantage in accessing healthcare, which would have been expected to result in poorer outcomes such as higher mortality, or shorter survival in treatable conditions. However, veterans have been clearly demonstrated to be at higher risk of certain conditions than non-veterans. For those conditions which have been recognised as being causally related to military service, the existing War Pensions[237] and Armed Forces Compensation Schemes[238] ensure access to financial support. Priority access to healthcare may also be available where authorised. However, the Scottish Veterans Health Study has clearly identified that other conditions which are not generally recognised as service-attributable, for example smoking-related disease, may also be causally related, the circumstances of military service having not only increased the prevalence of smoking(Appendix 4), but also resulted in the widespread exposure of non-smokers to environmental tobacco smoke, especially prior to the implementation of current policy on smoke-free areas. The evidence to support a link between military service and motor neuron disease has also been strengthened (Section 6.5.6). The Independent Medical Advisory Group, which advises the MOD on the conditions for which compensation may be payable, is recommended to take note of the findings of the Scottish Veterans Health Study in assessing whether eligibility for compensation should be extended to other conditions, on the basis of 'special consideration' as defined in the Armed Forces Covenant.

8.7 Strengths and Limitations of this Thesis

8.7.1 Strengths

The strengths of this study were:

- The ability to use a large retrospective cohort, covering the whole of Scotland and over 40 years of births and 50 years of military service.
- The ability to link demographic, health and vital records.
- The availability of follow-up data on health events occurring over a period of up to 30 years, extending up to 50 years after leaving military service.
- Inclusion within the cohort of a wide range of lengths of military service, ranging from one day to over 40 years, and the ability to measure length of service.

[237] The Naval, Military and Air Forces Etc. (Disablement and Death) Service Pensions Order 2006. SI 2006 No. 606.

[238] Armed Forces and Reserve Forces (Compensation Scheme) Order 2005. SI 2005 No. 439.

- Inclusion of a wide range of military experience within the cohort, ranging from people who did not complete training to those with probable multiple periods of operational deployment, and including representatives of a wide range of trades and professional groups.

- Inclusion of both community-living and institution-living veterans, as well as any homeless veterans who had a secondary care admission or who had died, since the data were drawn from NHS secondary care and national vital records.

- Near-completeness of the SMR secondary care, cancer registration and mental health data and death data for Scotland.

- The ability to match or adjust for confounders such as sex, geographical region and deprivation.

8.7.2 Limitations

The main limitations of the study were:

- Possible loss to follow-up of subjects due to migration away from Scotland, for which no data are available. This would have had the effect of weakening any observed differences if migration was higher in veterans, or strengthening it if veterans were less likely than non-veterans to move away. Losses to migration within the cohort cannot be quantified but it is unlikely that veterans and non-veterans differ greatly in this respect. The assumption has therefore been made that there is no systematic difference between veterans and non-veterans in the likelihood of migration.

- The lack of any follow-up data prior to 1 January 1981. As the oldest of the cohort were only aged 36 years at that date, few are likely to have been diagnosed with any of the long-term conditions identified as being of *a priori* interest by the earliest follow-up date; the impact has been assessed as minimal.

- For the veterans, it was not possible to link to in-service health records and thus any health events experienced during service will not have been captured.

However, any conditions requiring ongoing follow-up would have been captured on first presentation for NHS care following discharge and therefore important loss of information was considered to be unlikely.

- With no occupational data available, it was not possible to estimate the contribution of toxic hazard exposure, overseas service, hours of work or shift work to the findings. Combat exposure could only be inferred from period of service and military campaign history. This limited the extent to which causality could be assessed, and has been reflected in the Discussion and Interpretation for individual conditions.

- With no linkage to MOD records, it was necessary to infer ESL and trainee/trained status on the basis of length of service, and pragmatic definitions of 2.5 years for the minimum commitment and 0.4 years for the duration of basic training were chosen. Because of changes in the length of training and the minimum commitment over the period of the study, this is likely to have been incorrect for a number of individuals, resulting in the exclusion of some people who were ESL. Any effect will have been to underestimate observed differences. The alternative of defining a longer period as the minimum commitment, for the purposes of assessing ESL status, would have included many people who completed the full earlier three-year commitment, and would have acted as a confounder in the analysis of the impact of early departure.

- As the data were derived from NHS hospital records and death certificates, no data were available on personal lifestyle risk factors such as smoking, obesity, exercise levels, alcohol intake or drug misuse. This limited the range of analyses that could be undertaken. It was possible to make assumptions at a population level from published research on obesity, smoking and alcohol in serving personnel, although generally this only covered recent service, other than in respect of smoking where good data exist from the 1960s onwards. Availability of individual-level lifestyle data would have facilitated in-depth exploration of the reasons underpinning the observed differences in health outcomes between veterans and non-veterans.

- Prescribing data were only available for 2009-2012, and only for psychotropic drugs and addiction treatment. This limited the scope of the analyses which could be undertaken.

- Veterans with Reserve service only could not be identified from NHS records and would have been included amongst the non-veterans. Any effect would have been to underestimate observed differences between veterans and non-veterans.

- No information was available on the service to which a veteran had belonged (Army, Royal Navy, Royal Marines or Royal Air Force). This limited the utility of direct comparisons with service-specific studies on health behaviour in serving personnel, in interpretation of the findings in respect of veterans.

- No ethnicity data were available; however the ethnic minority population in Scotland is small and it is unlikely that the ethnic mix of Scottish veterans differed markedly from the wider population; hence the impact on the study findings is likely to have been minimal.

- Postcode data, which determined the SIMD quintile, reflected the last recorded NHS registration and thus could not be assumed to provide information on childhood deprivation. This meant that it was not possible to assess the contribution of childhood adversity to the findings.

- For rare conditions which had been identified by stakeholders as being of *a priori* interest, the small number of cases provided insufficient statistical power to demonstrate a statistically significant difference, especially on subgroup analysis. As the study population comprised a 100% sample of all eligible veterans, there was no scope to increase the statistical power. Although adjustment of the subgroup boundaries provided some compensation, this was achieved at the expense of loss of detail in the analyses.

- In comparing 48 diseases and secondary outcomes, the problem of multiple comparisons arises; with a rejection level of 0.05, it is possible that several of the results which demonstrated a significant difference between veterans and non-veterans had arisen by chance, resulting in a type 1 error (wrongly rejecting the null hypothesis). In order to minimise this risk, corroborative evidence was sought where possible, for example consistency between findings in conditions having a shared aetiology, or consistency with the findings of other independent studies. Plausibility of the results was also assessed, where possible, and anomalous findings were highlighted. Some of the unexpected findings in rare conditions in the Scottish Veterans Health Study (for example pancreatic cancer, ovarian cancer) may be explained by chance; where this was considered possible, recommendations have been made for additional in-depth studies.

8.8 Concluding Remarks

The early stages of this study bore a resemblance to mapping hitherto unexplored territory but, as the analysis progressed, a picture of the complexity and multi-dimensional nature of veterans' health began to emerge[239]. It was not a picture of minds torn by combat, or of health ruined by alcohol, but one which reflected the unique and hitherto unrecognised dynamics of military occupational health and the veteran population, the social milieu from which many soldiers are drawn, and the lifestyle choices to which those who serve in the Armed Forces may be attracted.

The dominant overall picture to emerge was that veterans' long-term health improved with longer service. For some conditions, military service made no difference; veterans were no more or less likely than non-veterans to experience a diagnosis of, for example, colorectal cancer or prostate cancer. But for many of the conditions where rates did differ, the increase in risk was highest in the Early Service Leavers, those who left service prior to completing the minimum term of engagement. The highest risks were often found in those who failed to complete initial training, many of whom were discharged within a few days or weeks of commencement of service. Those with the longest service exhibited a reduction in risk of some conditions compared with non-veterans.

This pattern of 'inverse dose effect' cannot be reconciled with military service as a causative factor. Instead, it points to the early period of service acting as a continuation

[239] "It is a common observation that the progress of any science is marked by periods of slow accumulation of facts and ideas and periods, when, owing to some new point of view, the accumulated material suddenly fits into place and the whole subject is revolutionised." Anderson, JA. 'The Recent Trend of Military Hygiene', Proceedings of the Royal Society of Medicine (1924) 29-42.

of the selection process, screening out those who, despite having passed the selection tests, were in fact unsuited to service. Whilst people who leave after a longer period of service are most likely to be leaving at the end of their engagement, in a planned and prepared move, those who leave early are going 'for a reason', and may be leaving abruptly or unexpectedly, voluntarily or otherwise. Medical, disciplinary or family problems predominate in this subgroup. It might therefore be anticipated that their long-term health outcomes would prove less favourable. A numerically large group, they are capable of making a major contribution to the overall picture of veterans' health, and it was only when the veterans were stratified by subgroup that the true picture could be elucidated. The removal of those with the poorest health potential from the pool of longer serving veterans progressively improves the long-term health outlook of those who remain in service. For a small number of conditions, there is some evidence that there may be an occupational association, which may be causal or indirect; further studies to either confirm or refute these findings are needed.

This thesis has identified conditions where subgroups of veterans are at increased risk and may be able to benefit from targeted interventions; conditions where further research may identify at-risk groups for whom prompt intervention or focussed screening programmes may be life-saving; and conditions which are of no greater concern in the veterans' population than in people who have never served; as well as trends over time which demonstrate *inter alia* the impact of social change and in-service health promotion. It is hoped that it will thereby improve the understanding of veterans' health issues, and will provide a sound scientific basis for the development of targeted, cost-effective services for veterans. If it supports the Armed Forces Covenant[6] by leading to improved health outcomes for veterans who are at risk of health inequalities compared with their non-veteran counterparts, and in better resource allocation for health and welfare services, it will have achieved its aim.

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Appendix 1 - Background

A1.1 Historical Evolution of the Modern Armed Forces

Prior to the 17th century, Britain's military capability comprised locally-recruited militia and irregulars, constituted on an *ad hoc* basis to meet emerging threats to security which were likely to require the deployment of force. The modern British Army has its origins in the New Model Army which was instigated by Cromwell in 1645. Although the New Model Army was disbanded after the Restoration of the monarchy in 1660, the requirement to maintain stability in the light of ongoing foreign conflict dictated that it was quickly succeeded by a new Standing Army under the command of Cromwell's former commander General Monck. The New Model Army and its successor represented a movement towards a dedicated profession of arms, albeit initially largely manned by pressed men who had been inveigled into service through drink, deception or coercion.

A1.1.1 Invaliding

Enlistment was for an unlimited period, and was to remain so until the 19th century[240]. Release was achievable only in death, or through becoming permanently medically unfit to serve. This latter required a disability of some severity, as the military surgeon Henry Marshall (1775-1851) records in his seminal book, *On the Enlisting, Discharging and Pensioning of Soldiers*, that

> "From the restoration of Charles II (1660) to a comparatively late date, a portion of the British forces consisted of 'invalids'. The men of these corps or companies were soldiers partially disabled by wounds, or veterans who, from old age and length of service, were rendered incapable of the duties of an active campaign, but who were still judged fit enough for garrison duty." (Marshall 1840)

This draconian policy persisted into the 19th century; a War Office memorandum of 30th July 1830 rules,

[240] "A soldier cannot be allowed, as a servant or labourer might be, to quit the service in which he is engaged as soon as it becomes irksome to him, nor can he be sent away because he is disobedient, irregular, unwilling to learn, or that he insults, and strikes, those that he is bound to respect and obey. He must be constrained to serve the state according to his engagements, and must be taught, and must be forced to learn how to serve in his station of soldier." Duke of Wellington (1769-1852) quoted in Marshall, H. (1840) *On the Enlisting, Discharging and Pensioning of Soldiers,* Philadelphia: Waldie.

> "A soldier is not to be discharged on account of disability, unless the existence thereof is satisfactorily ascertained and the infirmity is calculated to render the man permanently unfit for military service."

Nonetheless, King Charles II had recognised a need to provide for infirm veterans and, on 22nd December 1681, the Royal Warrant was signed authorising the building of the Royal Hospital Chelsea, believed to have been modelled on the Hôtel des Invalides established by Louis XIV in Paris. The first in-pensioners were admitted in 1692. All discharges of soldiers for medical reasons were under the control of the Royal Hospital Chelsea or its counterpart in Dublin, Kilmainham Hospital (Figure A1-1). Soldiers who were recommended for discharge after examination at one of those two institutions were granted a pension for life and were admitted either as in-pensioners or as out-pensioners. As this was the only route to achieving a pension at the end of military service, malingering (the feigning of ill-health) was rife and extreme, encompassing the deliberate self-infliction of injuries including fractures or even blindness and graphically described by Marshall (Marshall 1840). Thus, in the late 17th century, the only veterans were the medically unfit, and they were provided for by either the Royal Hospital Chelsea or by Kilmainham.

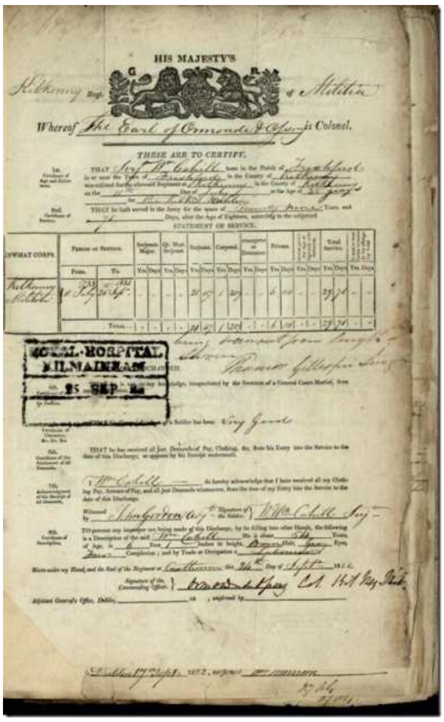

Figure A1-1 - Discharge certificate, Kilmainham Hospital
Sgt Wm. Cahill, discharged 1822, "worn out from length of service"

A1.1.2 Emergence of the 'Veteran'

As time went on, it became clear that not all would remain in service for life. The ending of the Nine Years' War[241] saw the British Government financially unable to support a large army which was no longer needed for campaign service, and a number of regiments were disbanded. Officers could be placed on half-pay[242], but there was no such option for the enlisted men and they were discharged. After years of service, many knew no other trade and would have struggled to cope in the civilian world. Many would have become a 'charge on the parish'. Those who were disabled would be supported by the parish in which they had enlisted in accordance with earlier legislation[243]. But for many, there would have been little support other than to try and claim relief from their parish of settlement as paupers, or to beg on the streets. The societally dislocated veteran was born.

There was to be little improvement in the lot of the veteran for many years. William Wordsworth's poem "The Discharged Soldier" (1798) (Annex A) perhaps typifies the public perception, if not necessarily the reality, of the veteran. Wordsworth's veteran is believed to have been discharged after service in the West Indies, a campaign which cost the lives of many thousands of British soldiers, predominantly from yellow fever. The poignant description of the gaunt figure may reflect chronic ill-health as a result of tropical service, or could represent an early depiction of post-traumatic stress disorder. Other authors took similar themes[244]. The broadside ballad "The Poor Discharged

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[241] Also known as the War of the Palatine Succession (1688-1697), a complex conflict between France and the other European nations including Britain and Ireland.

[242] The half-pay system was introduced in 1697 and provided a mechanism whereby officers were able to return to civilian employment, whilst retaining a liability to be recalled for service should hostilities break out in the future.

[243] "And forasmuch as it is found more needful than it was in the making of the said Acts [*Act for the Necessary Relief of Soldiers and Mariners*, passed in 1593 and updated in 1603] to provide Relief and Maintenance to Soldiers and Mariners that have lost their limbs, and disabled their Bodies in the Defence and Service of her Majesty and the State, in respect the Number of the said Soldiers is so much the greater, by how much her Majesty's just and honourable defensive Wars are increased. To the End therefore that the said Soldiers may reap the Fruits of their good Deservings and others may be encouraged to perform the like Endeavours. Be it enacted…That from and after the said Feast of Easter next, every Parish within this Realm of England and Wales shall be charged to pay a weekly Sum of Money towards the Relief of Sick, Hurt and Maimed Soldiers and Mariners."

[244] See Keane,P. J. '*Coleridge's Submerged Politics: The Ancient Mariner and Robinson Crusoe'.* Univ. of Missouri Press 1944, p.159.

Soldier", published in Scotland and reproduced at Annex B[245], provides evidence that a similar situation pertained north of the Border[246]. At a time when the Press generally reported fact rather than opinion, it was left to the creative authors of the day to provide social commentary and influence public opinion.

A1.2 Military Health

At the inception of the Standing Army (Section A1.1), background morbidity and mortality rates in the civilian community were high, and occupational ill-health and injury were common. The principles of public health had been established by such early pioneers of health as Hippocrates[247], and the health of Roman soldiers appears to have been a matter of importance (Prioreschi 1996), but by the early modern period, it seems probable that protecting the health of soldiers received little attention at a time when recruitment was at best coercive and casualties could be readily replaced. The earliest study of military health in the Western world is believed to have been Sir John Pringle's *Observations on Diseases of the Army*, first published in 1756 (Pringle 1764). In common with other works of the period, the study was qualitative; indeed, the science of statistics (and even the word 'statistics') was not introduced into the United Kingdom until 1786, when Sir John Sinclair (1754-1835) imported the concept from Germany and utilised it as the basis for his Statistical Account of Scotland (1791-1799)[248]. It was not until the early 19th century that quantitative data on the health of soldiers began to be collected by the early military epidemiologists such as Marshall (Blanco 1970) and Sir James McGrigor (1771-1858)

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[245] National Library of Scotland http://digital.nls.uk/broadsides/broadside.cfm/id/16857/transcript/1 accessed 1 July 2014.

[246] The fourth verse "But before in rags I'd fly some roguery I must try/I'll break an arm or blind an eye, some blunt for to decoy/Then I'll go through the town, with my medal hanging down/Saying for glory and renown, help the poor soldier boy." provides evidence for the malingering described in Marshall, H. (1840) *On the Enlisting, Discharging and Pensioning of Soldiers,* Philadelphia: Waldie.

[247] Hippocrates, *On Airs, Waters, and Place*s. c.400BCE.

[248] "Many people were at first surprised at my using the words "statistical" and "statistics", as it was supposed that some in our own language might have expressed the same meaning. But in the course of a very extensive tour through the northern parts of Europe, which I happened to take in 1786, I found that in Germany they were engaged in a species of political enquiry to which they had given the name "statistics," and though I apply a different meaning to that word—for by "statistical" is meant in Germany an inquiry for the purposes of ascertaining the political strength of a country or questions respecting matters of state—whereas the idea I annex to the term is an inquiry into the state of a country, for the purpose of ascertaining the quantum of happiness enjoyed by its inhabitants, and the means of its future improvement; but as I thought that a new word might attract more public attention, I resolved on adopting it, and I hope it is now completely naturalised and incorporated with our language." (Statistical Account of Scotland Vol XX p. xiii)

(Chichester 1893), although analysis had to wait for the work of Alexander Tulloch (1803-1864) and Thomas Graham Balfour (1813-1891) in the late 1830s (Tulloch 1838). These latter two officers were tasked by Parliament to prepare an assessment of the health of troops overseas (Tulloch 1847), which resulted in the publication of a series of 'Blue Books' detailing their findings. The deleterious effect of prolonged overseas service could no longer be overlooked by the Government and the policy of extended overseas tours of duty, hitherto thought to confer benefit through becoming 'seasoned' to the climate and conditions, was rescinded in favour of shorter periods of service, thus representing the first use of epidemiological evidence to influence military policy. Thereafter, military health statistics have been published on a regular basis[249], with only brief interruptions during wartime.

A1.2.1 Veterans' Health

Historically, the health of veterans received even less attention than that of serving personnel, at least until after the First World War when the scale of returning servicemen dictated a radically changed approach to the care of veterans. Over 7 million returned to find that the 'land fit for heroes' promised by Prime Minister David Lloyd George[250] had become, in the face of the emerging deep recession of the 1920s, an empty promise. Between 1.6 and 2.2 million of them had been wounded, although many had been able to recover from their injuries to return to the fighting. Among the returnees were 41,000 who had lost one or more limbs (Stewart and Jain 1999), and countless more bore the scars, both physical and mental, of the 'war to end all wars[251]'. It was at this time that organisations such as the Royal British Legion and Erskine Hospital (the Princess Louise Scottish Hospital of Limbless Sailors and Soldiers) came to provide much-needed support, the latter having opened in 1916 to meet the needs of the growing number of amputees (Figure A1-2).

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[249] The '*Army Medical Department Statistical, Sanitary, and Medical Report*' was first published in 1861, for the year 1860, and continues in publication to date, now entitled '*Director General Army Medical Services Annual Report on the Health of the Army*'. The author of this thesis was its editor 1999-2008.

[250] Election speech 1918

[251] A phrase often attributed to the author HG Wells, although the title of his book was '*The War That Will End Wars*' (pub. Frank & Cecil Palmer 1914)

Figure A1-2 - World War 1 military amputees wearing the 'hospital uniform' of blue suit and red tie
(image source: Imperial War Museum)

The Second World War, only two decades later, added to the number of disabled veterans, and by the 50th anniversary of Erskine in 1966, Scotland had 11,000 disabled war pensioners from the First World War and 40,000 from the Second World War and later conflicts[252]. In 2011, there were 14,000 recipients of War Disability Pensions resident in Scotland[253]. The legacies of Northern Ireland, Bosnia, Kosovo and the recent conflicts in Iraq and Afghanistan mean that the need to provide support to disabled veterans will continue for the foreseeable future. Nor is conflict the only cause of long-term disability; road traffic accidents, both on and off duty, have taken a major toll of military life and limb[254]. Although the Scottish Veterans Health Study does not encompass information on combat casualties, data on road traffic accidents after leaving service are presented at Section 6.14. Furthermore, the pattern of support needed is changing; as progress is made in prosthetic limb technology and rehabilitation, so younger veterans are better able to self-care in the community even after major life-changing injury (Figure A1-3). However, as they age, so their care needs are likely to be much higher than those of the general ageing population, and they may also be at increased risk of other adverse outcomes such as cardiovascular disease (Naschitz and Lenger 2008). An association

[252] Figures from Erskine http://www.rememberingscotlandatwar.org.uk/Accessible/Exhibition/170/The-history-of-Erskine accessed 25 April 2014.

[253] 2011 figure extracted from data provided to charities and local authorities by the Service Personnel and Veterans Agency.

[254] Defence Statistics (Health) (2014b) *Annual UK Regular Armed Forces Land Transport Accident Deaths 1 January 2009 - 31 December 2013*, Abbeywood: Ministry of Defence.

between post-traumatic stress disorder (PTSD) and dementia has also been postulated (Qureshi et al. 2010, Yaffe et al. 2010). Already, the veteran care providers are reconfiguring to provide dementia services for ageing veterans, one ex-Service charity having estimated a demand for nursing care for 40,000 veterans with dementia in the UK by 2020[255]. Dementia in the Scottish Veterans cohort has been examined in Section 7.11, with particular reference to co-morbid PTSD.

Image has been
removed due to
Copyright restrictions

Figure A1-3 - Royal Marine triple amputee Mark Ormerod (injured in Afghanistan), with his family

A1.3 Historical Aspects of Specific Conditions

A1.3.1 Cardiovascular Disease

'Disease of the heart' was first recorded as a problem in the UK Armed Forces at the time of the Crimean War (1854-1856)[256] (Jones 2006), and by 1866 it had become a major cause of discharge on medical grounds (Maclean 1867). 'Soldiers' Heart'[257] remained problematic for the British Army throughout the Boer War (1899-1902) and the First World War (1914-1918), when disorders of the heart constituted the third commonest

[255] http://starandgarter.org/dementia-care-past-present/ accessed 27 June 2014.

[256] The medical reports for the Crimean War record the deaths of 45 soldiers from "palpitatio" [*sic*] and a further 62 who were invalided to England with the same diagnosis.

[257] 'Soldier's heart', also known as disordered action of the heart (DAH), da Costa's syndrome, effort syndrome, irritable heart, neurocirculatory asthenia and many other synonyms, has puzzled military clinicians and historians for a century and a half. Characterised by chest pains, palpitations and shortness of breath and originally ascribed to cardiac disease, it was later considered to be a functional disorder; in modern times, similar symptoms have been classified as panic attack or panic disorder (DSM-IV).

reason for invaliding after wounds and diseases of the chest (Bergman and Miller 2000). Precise diagnosis was problematic in the late 19th and early 20th centuries and the majority of patients medically discharged for 'heart disease' in 1918, for example, were classified as having either 'disordered action of the heart'[257] or 'valvular disease of the heart'[258] (Lewis 1918). However, despite the short-term impact on effective military manpower, there was little early evidence of long-term cardiac morbidity following discharge; a postal survey showed that less than 1% of those so discharged had developed overt cardiac disease after 5 years (Grant 1925).

CHD does not appear to have been an important military problem until the 1960s; only 28 cases were admitted to the Queen Alexandra Military Hospital in London, which was then the main referral hospital for the Army, between 1958 and 1961 (O'Brien 1961). The number of cases rose rapidly during the 1960s, mirroring the pattern in the civilian world (Dalen et al. 2014) and by the mid-1970s a coronary care unit had been established at the Cambridge Military Hospital, Aldershot[259] to manage the increasing number of cases in the military population. The demographic profile of the Armed Forces meant that CHD was predominantly a problem affecting senior officers and non-commissioned officers, although some younger soldiers were affected. Lynch reported 294 deaths of serving soldiers from IHD between 1968 and 1977 (Lynch 1980). The mean age at death was 41 years but 101 cases (34.4%) were under 35 years of age. Sudden cardiac death[260] in previously healthy individuals in this relatively young and otherwise fit population was of great concern, both to their peers[261] and to medical policy-makers[262].

Around 1990, cardiovascular mortality in soldiers fell quite abruptly over a period of about 5 years from an annual average of 16.0 per 100,000 in 1973-1990 to 4.8 per 100,000 in 1994-2011 (Bergman et al. 2014b)(Figure A1-4). Whilst the deaths were predominantly from CHD during the early period (Lynch and Oelman 1981), in recent

[258] Although some cases of 'valvular disease of the heart' were undoubtedly rheumatic in nature, modern re-examination of case files indicates that others had a functional origin. Jones, E., Hodgins-Vermaas, R., McCartney, H., Everitt, B., Beech, C., Poynter, D., Palmer, I., Hyams, K. and Wessely, S. (2002) 'Post-combat syndromes from the Boer war to the Gulf war: a cluster analysis of their nature and attribution', *British Medical Journal,* Feb 9(7333), 321-324.

[259] Author's personal recollection, as a medical house officer at the Cambridge Military Hospital 1976-1977

[260] Predominantly due to acute coronary artery occlusion in Lynch's study

[261] Author's personal recollection

[262] Graham, J.T. Pers. comm. (2014)

years the majority of in-service cardiac deaths have been the result of structural cardiac abnormalities and arrhythmias (Vanezis et al. 2011). This welcome reduction in coronary deaths amongst serving personnel has never been explained, although it is consistent with the fall in prevalence of coronary atherosclerosis reported at autopsy in US soldiers killed in conflict, from 77% in the Korean War (1951-1953), to 45% in the Vietnam War (1968-1978), falling further to 8.5% in Iraq and Afghanistan (2001-2011) (Dalen et al. 2014) . There is no evidence that a change in UK Armed Forces selection policy excluded more individuals from service who were at high risk from CHD; in a series of 3,886 candidates medically examined for service between 1980 and 1990, only three were rejected for cardiovascular causes, of whom one had hypertrophic cardiomyopathy and one had symptomatic mitral valve prolapse (Dignan 1992).

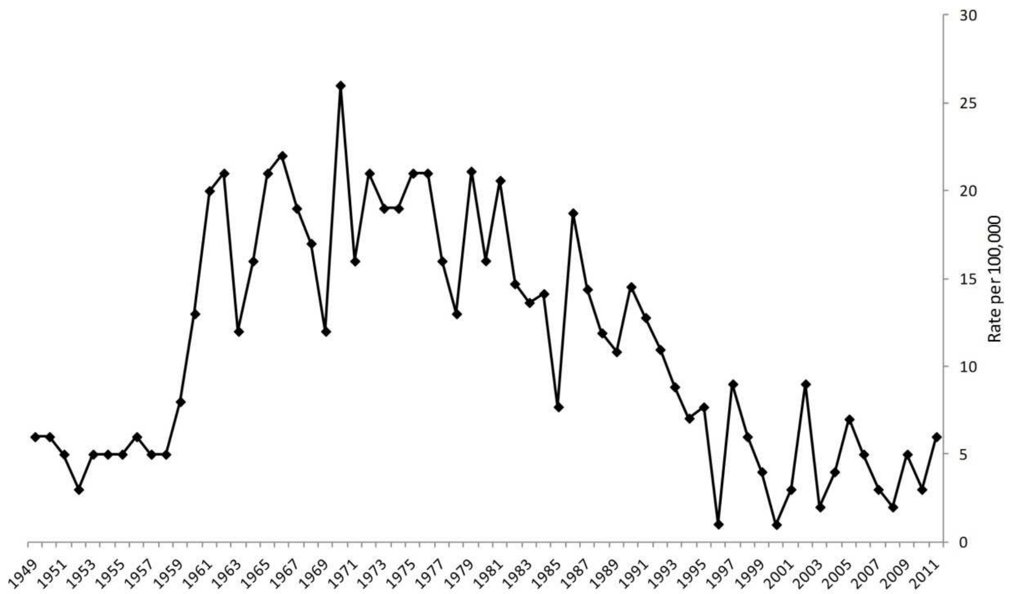

Figure A1-4 - Army cardiovascular deaths 1949-2011
Collated from historical published MOD data sources

A1.3.2 Cancer

Concerns about the risk of cancer arising from military service are of relatively recent origin, becoming widespread only after Doll's and Bradford Hill's research on the association between lung cancer and smoking (Doll and Hill 1950) highlighted the role of external agents in the aetiology of cancer. Soon afterwards, a paper appeared postulating that exposure to mustard gas in World War 1 servicemen was a risk factor for the later development of lung cancer (Case and Lea 1955); the complete absence of references suggests that the paper was breaking new ground. The paper's findings were not supported by later research (Norman 1975) but, by then, the role of external agents in the genesis of cancer had been firmly established. The Vietnam War saw the use of novel compounds such as the Agent Orange defoliant (Frumkin 2003) and, whilst risk assessment is now routine for known military occupational hazards, as discussed at Appendix A3.3.5.5, the risks encountered in warfare are by their nature unpredictable. Personal lifestyle choices such as smoking, alcohol (Bagnardi et al. 2001), diet (La Vecchia 2004), and multiple sexual partners (Goyal et al. 2012) during service may also influence the risk of cancer in the veteran population.

Long-term follow-up studies on the health of the 20,000 British service personnel[263] who were involved in nuclear test programmes in the 1950s and 1960s programme provide an insight into long-term cancer risks in military personnel, and subsequently veterans, through the inclusion of unexposed military control subjects. The first study, a case-control study of over 22,000 participants and a similar number of military controls, was conducted by Doll et al. at Oxford University and the results were published in 1988 (Darby et al. 1988). Among the cancers, increased rates were found for leukaemia (SMR 113) and multiple myeloma (SMR 111) when compared with national rates, although the incidence of these conditions in the controls was much lower than national rates. For prostate and renal cancer, nuclear test participants exhibited lower rates than the controls. Smoking-related cancers were lower in the test participants than in the military controls and the authors suggested that this group may have been more responsive to health education.

At follow-up ten years later, any excess risk of leukaemia or myeloma relative to either controls or national rates had disappeared. Neither all-cause mortality nor cancer mortality differed between participants and controls, and all were lower than national rates, although a modest increase in risk of leukaemia was found after excluding chronic lymphocytic leukaemia[264] (RR 1.83, 95% CI 1.15-2.17) (Muirhead et al. 2003a). The MOD

[263] Only a small number of women participated in the tests; they have been excluded from the main follow-up studies (Muirhead, C. R., Bingham, D., Haylock, R. G. E., O'Hagan, J. A., Goodill, A. A., Berridge, G. L. C., English, M. A., Hunter, N. and Kendall, G. M. (2003b) *Mortality and Cancer Incidence 1952-1998 in UK Participants in the UK Atmospheric Nuclear Weapons Tests and Experimental Programmes* London: National Radiological Protection Board.)

[264] Chronic lymphocytic leukaemia is not generally considered to be of radiogenic origin, although this is disputed by some researchers. See Richardson, D. B., Wing, S., Schroeder, J., Schmitz-Feuerhake, I. and Hoffmann, W. (2005) 'Ionizing radiation and chronic lymphocytic leukemia', *Environmental Health Perspectives,* 113(1), 1-5.

acknowledges that myelodysplastic syndromes, acute myeloid leukaemia and chronic myeloid leukaemia may be a consequence of occupational exposure to ionising radiation (Bowen 2008, Vickers 2008).

A health needs audit of a 3% self-selected sample of the surviving nuclear test veterans was conducted on behalf of the Ministry of Defence in 2011. The majority of these veterans were over 70 years of age (average 74 years, range 65-91 years). Of the 633 survey respondents, 46 (7%) were resident in Scotland. Information on health conditions was provided by 574 respondents; 283 (49%) reported 'ever having had' cancer, of whom the problem was currently active in 152 and 'resolved' in 46%. Cancer was reported as the fourth most prevalent condition after musculoskeletal disorders, heart/circulatory disorders and digestive/dental disorders. Most cancers (63%) had developed after the age of 65. A breakdown by ICD code showed that urological cancers were most common (49 active cases, 32% of active cancers) whilst skin cancers were the most common 'resolved' cancers (94 cases, 33%). Haematological cancers accounted for 17 (11%) active and 23 (8%) resolved cases. There were only 3 active cases of lung cancer (3%), no doubt reflecting the high mortality of this condition although 7 cases (2%) were self-declared as 'resolved' (Miles et al. 2011). Major limitations of this study, as acknowledged by the authors, are the use of a non-random sample, self-declared health information, the lack of correlation with individual radiation dosage and the lack of a comparison group.

A1.3.2.1 Gulf War

With the outbreak of the 1991 Gulf War, and the subsequent military operation which commenced in 2003, there was renewed concern about the risk of cancer posed to military personnel by occupational exposure to chemical weapons, radiation and other potential carcinogens. Smoke from burning oil wells caused widespread atmospheric pollution, and pesticides were widely used (Blanck et al. 1995), whilst for a small number of individuals, the aftermath of the use of depleted uranium munitions resulted in the inhalation of depleted uranium dust or contamination of wounds with depleted uranium shrapnel (Fetter and von Hippel 2000, Dyer 2001). It was believed that large quantities of weapons of mass destruction (chemical and/or biological (Betts 1998)) had been stockpiled although none was ever found and the earlier intelligence reports were later refuted. The Gulf cohort and a matched 'Era' cohort of military personnel who served at the same time have been carefully followed up and no excess cancer risk has emerged (Macfarlane et al. 2003). These studies continue although there have been no recent publications.

A1.3.3 Mental Health

The modern reader may be forgiven for thinking that mental health disorders in military personnel are a recent phenomenon; that shell-shock began with the First World War (Myers 1915); or that post-traumatic stress disorder (PTSD) began with the Vietnam War[265]. History recounts otherwise. Both Crocq and Bentley provide comprehensive historical accounts of 'fright in battle', from Biblical times[266], through the Epic of Gilgamesh and the European wars of past centuries up to the present day. The Greek historian Herodotus described an uninjured soldier losing his sight during the battle of Marathon (490 BCE) when a fellow soldier was killed alongside him. Sir Walter Scott may have alluded to combat-related PTSD in his epic poem "The Lady of the Lake"[267]. Even Myers' seminal description of shell-shock was predated by observations made during the French Revolution (1792-1800) and the Napoleonic wars (1800-1815) that soldiers collapsed into protracted stupor after shells brushed past them, despite being physically uninjured. In a civilian setting, the diarist Samuel Pepys wrote of being "terrified in the nights . . . with dreams of fire and falling down of houses" after witnessing the Great Fire of London in 1666 (Crocq and Crocq 2000, Bentley 1991). The diagnostic terminology has changed over the years; it is likely that the psychopathology remains the same. What has

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[265] Bloom S.L., 'The Lost is Found: Post-traumatic Stress Disorder' in Shalev, A. Y., Yehuda, R. and McFarlane, A. C. (2000) *International handbook of human response to trauma,* New York, Boston, Dordrecht, London, Moscow: Kluwer Academic/Plenum Publishers. Bloom describes how the earlier removal of the diagnosis of 'traumatic war neurosis' from the Diagnostic and Statistical Manual of Mental Disorders (DSM) left traumatised Vietnam veterans who faced criminal justice with no defence. After concerted action by pressure groups and academics, the Committee on Reactive Disorders, part of the DSM-III Task Force charged with determining the content of the new version of that publication, agreed to include a category of 'post-traumatic stress disorder'. The DSM-III was published in 1980 and a new terminology entered the diagnostic lexicon.

[266] "When thou goest out to battle against thine enemies, and seest horses, and chariots, and a people more than thou, be not afraid of them . . .And it shall be, when ye are come nigh unto the battle, that the priest shall approach and speak unto the people, And shall say unto them . . . let not your hearts faint, fear not, and do not tremble, neither be ye terrified because of them; . . . And the officers shall speak further unto the people, and they shall say, What man is there that is fearful and fainthearted? let him go and return unto his house, lest his brethren's heart faint as well as his heart." Deuteronomy Chap. 20 v.1-9 (excerpts) King James Version

[267] "Soldier, rest! thy warfare o'er/Sleep the sleep that knows not breaking/Dream of battled fields no more/Days of danger, nights of waking." The Lady of the Lake: Canto 1. Scott W. (1810)

also changed is the boundary between ‘normality’ and ‘mental health disorder’. In an era when any psychiatric diagnosis equated to ‘madness’, and the only treatments involved incarceration in an asylum, only the most severe disturbances of mood or psyche were classified as mental health disorders. In recent years, there has been a shifting of the boundary such that many of the grief reactions and other reactive phenomena are now regarded as mental health problems. Jones and Wessely have also drawn attention, in consideration of theories of mental breakdown in war, to the shift in the frame of reference from the group, or ‘herd’, to the individual (Jones and Wessely 2007). Cultural perceptions and norms are also important; one culture’s religious asceticism may be another’s profound depressive illness (Obeyesekere 1985).

Appendix 1 Annex A - The Discharged Soldier

by William Wordsworth

No living thing appeared in earth or air,
And, save the flowing water's peaceful voice,
Sound there was none–but, lo! an uncouth shape,
Shown by a sudden turning of the road,
So near that, slipping back into the shade
Of a thick hawthorn, I could mark him well,
Myself unseen. He was of stature tall,
A span above man's common measure, tall,
Stiff, lank, and upright; a more meagre man
Was never seen before by night or day.
Long were his arms, pallid his hands; his mouth
Looked ghastly in the moonlight: from behind,
A mile-stone propped him; I could also ken
That he was clothed in military garb,
Though faded, yet entire. Companionless,
No dog attending, by no staff sustained,
He stood, and in his very dress appeared
A desolation, a simplicity,
To which the trappings of a gaudy world
Make a strange back-ground. From his lips, ere long,
Issued low muttered sounds, as if of pain
Or some uneasy thought; yet still his form
Kept the same awful steadiness–at his feet
His shadow lay, and moved not. From self-blame
Not wholly free, I watched him thus; at length
Subduing my heart's specious cowardice,
I left the shady nook where I had stood
And hailed him. Slowly from his resting-place
He rose, and with a lean and wasted arm
In measured gesture lifted to his head
Returned my salutation; then resumed
His station as before; and when I asked
His history, the veteran, in reply,
Was neither slow nor eager; but, unmoved,
And with a quiet uncomplaining voice,
A stately air of mild indifference,
He told in few plain words a soldier's tale–
That in the Tropic Islands he had served,
Whence he had landed scarcely three weeks past;
That on his landing he had been dismissed,
And now was travelling towards his native home.
This heard, I said, in pity, "Come with me."
He stooped, and straightway from the ground took up
An oaken staff by me yet unobserved–

A staff which must have dropped from his slack hand
And lay till now neglected in the grass.
Though weak his step and cautious, he appeared
To travel without pain, and I beheld,
With an astonishment but ill suppressed,
His ghostly figure moving at my side;
Nor could I, while we journeyed thus, forbear
To turn from present hardships to the past,
And speak of war, battle, and pestilence,
Sprinkling this talk with questions, better spared,
On what he might himself have seen or felt.
He all the while was in demeanour calm,
Concise in answer; solemn and sublime
He might have seemed, but that in all he said
There was a strange half-absence, as of one
Knowing too well the importance of his theme,
But feeling it no longer. Our discourse
Soon ended, and together on we passed
In silence through a wood gloomy and still.
Up-turning, then, along an open field,
We reached a cottage. At the door I knocked,
And earnestly to charitable care
Commended him as a poor friendless man,
Belated and by sickness overcome.
Assured that now the traveller would repose
In comfort, I entreated that henceforth
He would not linger in the public ways,
But ask for timely furtherance and help
Such as his state required. At this reproof,
With the same ghastly mildness in his look,
He said, "My trust is in the God of Heaven,
And in the eye of him who passes me!"

The cottage door was speedily unbarred,
And now the soldier touched his hat once more
With his lean hand, and in a faltering voice,
Whose tone bespake reviving interests
Till then unfelt, he thanked me; I returned
The farewell blessing of the patient man,
And so we parted. Back I cast a look,
And lingered near the door a little space,
Then sought with quiet heart my distant home.

Appendix 1 Annex B – Ballad

217

THE POOR

Discharged Soldier.

Gather round me, one an'all, great and small, short and tall,
Till you hear the sad down fall of the poor soldier boy.
That has fought by land and sea, night and day far away,
For thirteenpence a day, says the poor soldier boy.

But after all I've done and the battles I have won.
In place of march I got the run, which does me sore annoy.
With my old red coat all tore. and my bones both bruised & sore,
I'm left starving on the shore, says the poor soldier boy,

The next thing I've to tell, mark it well. what befel,
My old shirt I had to sell, says the poor soldier boy,
For hunger I can't bear, I declare, and I swear,
For bread I'd sell my hair, says the poor soldier boy.

But before in rags I'd fly some roguery I must try,
I'll break an arm or blind an eye, some blunt for to decoy,
Then I'll go through the town, with my medal hanging down,
Saying, for glory and renown, help the poor soldier boy.

When I was at Waterloo, I tell to you it is true,
My old red coat was new, says the poor soldier boy,
And likewise at Cabul I smashed many in the skull,
But his belly it was full says the poor soldier boy.

At Vitoria and the Nile, I cut them rank and file,
I never thought awhile that they'd make me such a toy,
As to turn me away, without one penny in the day.
After smashing China, clear the way, says the poor soldier boy.

It's when this bill was passed, we were cast, very fast,
We're all begging now at last, says the poor soldier boy.
We are going about like Jews, without hats, shirts or shoes,
For to live upon strange news, says the poor soldier boy.

Now we can stand at ease, at any corner that we please,
Into every tavern gaze, for to comfort us with joy,
Where we'll see bread and meat on each plate, that we could eat,
But our blunt was out of date, says the poor soldier boy.

Now very long ago, you must know, it was so,
Off to India I did go, says the poor soldier boy,
And fought the black men there, I declare, and I swear,
Without either dread or fear, says the poor soldier boy.

But after the campain I was sent back again,
Some were kilt, and more were lame but it mattered not a toy,
They'd no penison give to I, live or die, I might fly,
To the devil or Buckleroy. says the poor soldier boy.

So now to end my theme, I'm to blame for the same,
I wish I had been slain, says the poor soldier boy.
When I took a delight to go and fight. out of spite,
Away off to the Sikhs, says the poor soldier boy.

But all for my vallantry, in that glorious victory.
See what they've done to me. and how they did destroy,
They sent me for to wait at the mendiciy gate.
To get skilly on a plate, says the poor soldier boy.

Source: http://deriv.nls.uk/dcn6/7441/74417178.6.pdf

Appendix 2 - Demographic Profile of the Armed Forces

A2.1 Serving Military Population

A2.1.1 Size

The size of the UK military population is sensitive to a number of factors including political will, conflict and economic conditions and, over the course of the 20th and early 21st centuries, has ranged between 180,000 and 4.9 million (Figure A2-1). During periods of high operational intensity (especially during the two World Wars), conscripts predominated; since 1962, the Armed Forces have comprised solely volunteers.

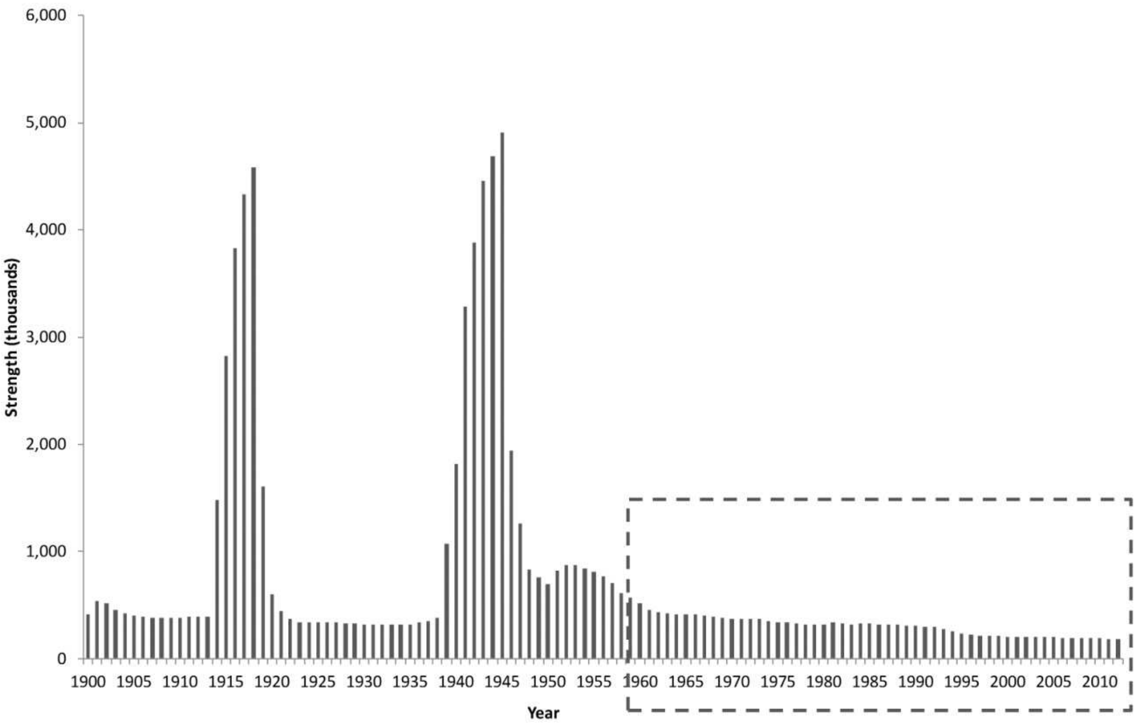

Figure A2-1 - Number of serving personnel 1900-2012[268]
The dashed rectangle represents the period covered by the Scottish Veterans Health Study (see Figure A2-2)

Over the period covered by the Scottish Veterans Health Study, the number of serving personnel fell from 521,100 (992 per 100,000 population) in 1960 to 179,800 (285 per 100,000 population) in 2012, equating to a reduction in size of 65%.

[268] Derived from data obtained from http://www.ukpublicspending.co.uk/downchart_ukgs.php?chart=30-total&year=1900_2011&units=p&state=UK#copypaste accessed 4 November 2013, and Defence Personnel Statistics SN/SG/02183. House of Commons Library (2014).

The early part of the fall was due to a gradual downsizing following the discharge of the remaining Second World War soldiers and the ending of National Service, as well as changes in Government Defence policy[269]; as early as 1976, the serving population had fallen by 35% to 336,600 (600 per 100,000 population)[270]. A major manpower reduction exercise in 1993-94, known as 'Options for Change', reduced the Armed Forces to close to its present size (Figure A2-2). Each episode of downsizing has contributed further to the pool of veterans.

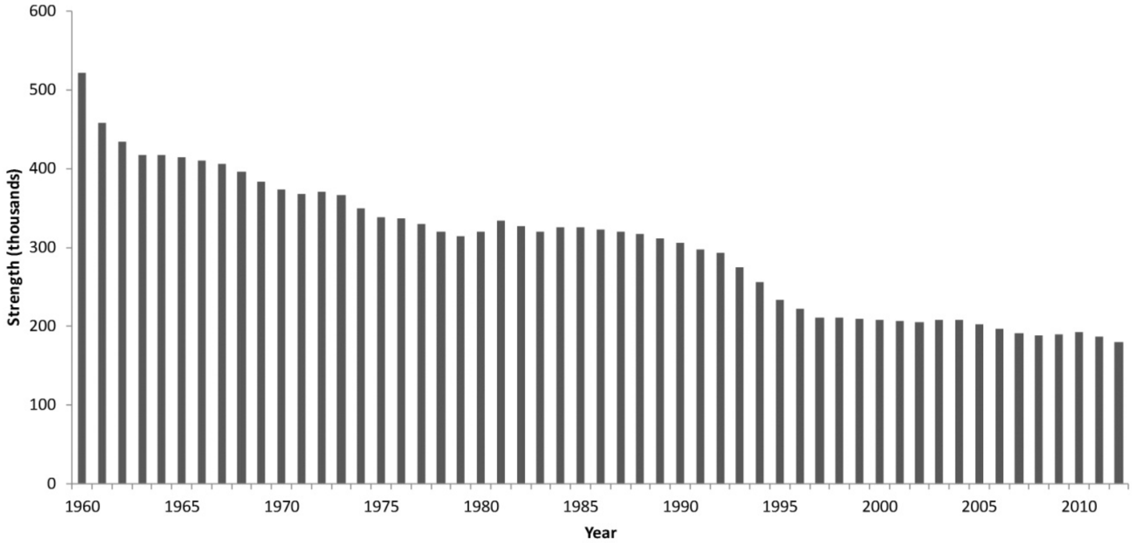

Figure A2-2 - Number of serving personnel 1960-2012[268]

A2.2 Veteran Community[271]

A2.2.1 Size

The number of serving personnel is a matter of public record, since provision must be made annually by Parliament for payment of the military wage bill and other costs[272]. In contrast, the number of veterans can only be inferred from the number who have served, less estimated deaths and migrations, since only a subset of veterans receives a pension

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[269] As a result of the 1957 Sandys review and the 1965-1968 Healey reviews.

[270] Figures from Defence Analytical Services and Advice (DASA) and the Institute for Fiscal Studies http://www.ukpublicspending.co.uk

[271] For the purposes of this study, the term 'veteran community' refers only to individuals who have served in the Armed Forces, notwithstanding that the popular usage of the term has recently been extended to encompass family members. In the Royal British Legion reports, the term 'ex-Service community' is used to encompass veterans and their families.

[272] Defence Estimates, presented annually to Parliament

and no central record of other veterans is maintained[273]. Recruitment of a soldier will potentially contribute to the pool of veterans for 70 years or more, even if he or she only serves for a single day. In 2005 the Royal British Legion (RBL) commissioned a major study into the demography of the veterans' population and concluded that there was a total of 4.8 million veterans residing in the UK (Compass Partnership 2006). The study was based on a face to face survey of 6,000 UK adults in the general population, and thus must be regarded as an estimate. However, it has been widely used for planning purposes. From this, it has been estimated that 400,000 veterans are resident in Scotland, and this figure is used by the Scottish Government as a basis for policy development. Almost 60% of the veterans surveyed had been discharged more than 40 years earlier. The average length of service was 6 years, with 75% having served for between 2 and 10 years and only 16% serving longer than 10 years. This is broadly comparable with a study of US veterans of the Vietnam era which found that 12% had served for less than 2 years, 70% for between 2 and 4 years and 18% had served for longer than 4 years (Watanabe and Kang 1995); the demographic characteristics of the Scottish Veterans Health Study cohort have been described in Chapter 3. Sixty percent of the veterans in the RBL study were aged 65 years and over, and it was forecast that the total number of veterans would fall to 4.2 million in 2010, 3.6 million in 2015 and 3.1 million in 2020, with the number of younger veterans (aged 55 and under) remaining relatively constant. Half the veterans had served in the Army, a quarter in the Royal Air Force and only 11% in the Royal Navy or Royal Marines. Fifteen per cent had been Reservists. A higher percentage of veterans was in the lowest socio-economic group[274] compared with the general population (26% versus 18%). The RBL commissioned a new survey 9 years later, in 2014, in order to monitor trends and inform the needs assessment for a veteran population which was perceived to be ageing (Compass Partnership 2014).

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[273] The Ministry of Defence now maintains a database of service leavers (Regular service only) compiled from a number of sources including archived personnel records, exit data and medical records. As at 2009, it comprised 1.44 million records dating from 1979 (Navy), 1972 (Army) and 1968 (RAF). This compares with the figure of 4.8 million veterans estimated by the Royal British Legion to be living in the UK at that time. Sources: *Estimating the proportion of prisoners in England and Wales who are ex-Armed Forces; a data matching exercise carried out by the MOD in collaboration with the MoJ.* Ministry of Defence (2010) and The Royal British Legion *General Election Manifesto* (2009) http://www.britishlegion.org.uk/media/205299/manifesto-veterans.pdf accessed 6 February 2014

[274] The RBL study defined the lowest socio-economic group as people who were entirely dependent on the State long-term, through old age, sickness, or unemployment in excess of 6 months. The category also included casual workers with no regular income.

The results, based on a survey of 20,698 people interviewed using TNS[275] CAPI[276] Omnibus methodology, of whom 1,120 (5.41%) were veterans, demonstrated that the veterans' population had reduced by 42% to 2.83 million in the interval between the two surveys, a substantially greater reduction than had been forecast. It is unclear whether this was due to inaccuracies in either survey or to a greater loss from the pool of veterans. Of the adults included in the survey, 9.7% were resident in Scotland. Although the figures for the devolved nations did not differentiate between veterans and family members, the assumption that the same proportions hold good across the UK gives a figure of 274,000 veterans resident in Scotland as at 2014. Forty six percent of veterans were aged over 75 years, compared with 28% in 2005 and 10% of the current UK population; 62% of veterans were aged over 65 years. The major changes in demographic profile were largely explained by ageing and death within the large Second World War and National Service veteran populations. Whilst these studies are an important source of demographic data, there are important methodological limitations. No tests of statistical significance have been presented. The inclusion of the spouses and dependent children of veterans in the term 'ex-Service community' makes it difficult to assess the impact of military service, other than in those instances where specific data have been given for veterans, limiting the value of this potentially important data source.

[275]TNS Global http://www.tnsglobal.com/uk/omnibus accessed 13 January 2015

[276] CAPI = Computer Assisted Personal Interviewing

Appendix 3 - Influences on Veterans' Health

A3.1 Introduction

This Appendix examines risk factors potentially influencing veterans' health, military health promotion, and military occupational health care. Tobacco and alcohol are considered separately in Appendix 4.

As noted in Chapter 1, veterans' health results from the combination of biological, social, psychological, occupational and environmental factors operating along the life-course. The factors can be usefully considered in terms of the pre-service, in-service and post-service stages of a veteran's life, and are presented under these headings, with particular emphasis on the in-service influences. These include both occupational factors related to military employment, and non-occupational factors which may nonetheless be influenced by service.

A3.2 Pre-Service

The majority of recruits join the Armed Forces at age 17-19 years, although younger people may enter as 'juniors' or 'apprentices', in a predominantly educational and training role (see Section 3.2.3), and others are older at recruitment, especially if to be commissioned as officers, having already undergone further education or professional training, or having chosen to enter the Armed Forces following job loss and unemployment. Therefore, the predominant pre-service factors influencing health are those operating during childhood and adolescence such as socio-economic deprivation, educational attainment, exposure to adverse childhood events, and early unemployment. Lifestyle risk factors such as nutrition, exercise levels and the early adoption of smoking and alcohol use may also act as pre-service influences on long-term health.

As early as 1840, Marshall recognised that adverse pre-service factors could have a major impact on adaptation to military life:

> "Agricultural labourers generally enter the army in consequence of some family difficulty or discord, or some scrape in which they are involved, or from want of work . . . Recruits who are enlisted in the manufacturing districts and

> large towns are frequently idle and dissolute, and require all the means in the power of their officers to correct the intemperate and vicious habits in which they have indulged, and to enforce subordination."[277]

Education, childhood adversity and socio-economic factors will be discussed here.

A3.2.1 Education

A survey of educational attainment in Scottish recruits in the early 19th century[278] showed that 7-10% were unable to read or write, and 20% were unable to sign their name. Two centuries later, the educational level of recruits continues to cause concern, as reported by the House of Commons Defence Committee[279]. The minimum entry level varies with the role to be undertaken, some roles requiring professional qualifications; at the lower end of the scale, in 2012, 3.5% of Army recruits had a reading age of only 7 years whilst 39% had the reading skills of an 11-year old[280]. Educational programmes are integrated into military training to ensure that a minimum standard of literacy and numeracy of Level 3 is achieved during service, and support programmes are in place for those with specific learning difficulties such as dyslexia[281], although those who are discharged prematurely may not have served for long enough to benefit from these programmes. Today, the majority of officer entrants have at least a bachelor's degree, although that was not the case in earlier years. Education is given a high priority, both in-service and in preparation for, and following, discharge to civilian life[282].

A3.2.2 Adverse Childhood Experiences

Adverse childhood experiences include physical or sexual abuse; parental separation, unemployment, alcohol or drugs; being sent away from home, neglect or captivity; and witnessing injury. In a school-based study of US adolescents, parental separation was the commonest adverse experience, reported by 27.5% of respondents, but 14.2% reported

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[277] Marshall, H. (1840) *On the Enlisting, Discharging and Pensioning of Soldiers,* Philadelphia: Waldie. p.5

[278] Ibid. p.8

[279] House of Commons Defence Committee (2013) *The Armed Forces Covenant in Action? Part 4: Education of Service Personnel*, London: The Stationery Office Ltd.

[280] Ibid.

[281] Ibid.

[282] The MOD's Enhanced Learning Credit scheme provides financial support for education for service leavers following completion of a qualifying period of service (4 or 8 years, the period determining the level of award), to be taken up within 10 years of leaving the Armed Forces.

parental drink problems or drug-taking, and 7.8% reported sexual abuse (Schilling et al. 2008). The association between childhood adversity and poor long-term mental health outcomes has been extensively documented (Brown and Harris 1993, Kessler et al. 1997), and Thomas et al. have shown that physical and verbal abuse and poor parenting are risk factors for obesity at age 45 years, which in turn increases the risk of type 2 diabetes (Thomas et al. 2008). Employing a holistic ecobiodevelopmental framework, Shonkoff et al. postulated that the roots of many adult diseases lay in toxic stress arising from childhood adversity (Shonkoff et al. 2012). The authors suggested that adolescents with a history of multiple adverse childhood experiences were more likely to adopt unhealthy behaviours such as smoking and drinking alcohol, as a coping mechanism. Iversen et al. studied self-reported childhood adversity in a randomly-selected cohort of serving male UK military personnel and found that whilst 24% of the 10,272 study participants reported no or one positive response to the 16 vulnerability questions, another 24% reported 6 or more positive responses, and 76% had at least 2 vulnerability markers. Higher vulnerability counts were associated with younger age, lower educational attainment, lower rank and being in the Army, and were associated with all adverse health outcomes examined[283]. There was also a highly significant association between poor family relationships (home environment) and reported exposure to trauma (Iversen et al. 2007). Brodsky et al. noted that personality traits such as impulsivity and risk-taking are likely to be associated with childhood trauma (Brodsky et al. 2001); these traits are also likely to be over-represented in those who opt for a military career (Bray et al. 2009).

A3.2.3 Socio-Economic Status

Chen et al. reviewed the literature on the impact of socio-economic status (SES) on childhood health and found that lower status was associated with poorer health, including all-cause mortality, mortality for respiratory disorders, and morbidity from a wide range of chronic conditions. The relationship was stronger at younger ages in respect of childhood injury, and stronger in adolescence for smoking. Low income was also associated with higher blood lead levels in children (Chen et al. 2002), which may in turn be associated with adverse health and behavioural outcomes (Muntner et al. 2005, Needleman et al. 1996). It is plausible that an elevated baseline blood/bone lead level as

[283] General psychological ill-health, PTSD, self-harming, heavy drinking, smoking, fatigue, fair or poor general health

a result of childhood exposure may increase the risk of harmful levels being attained through subsequent occupational exposure, although no longitudinal studies have been identified; risks to military personnel arising from occupational exposure to lead are described at Section A3.3.5.13.

A3.3 In Service

When assessed against the model of the determinants of health developed by Acheson (Figure A3-1) (Acheson 1998), service in the Armed Forces should theoretically confer many benefits, at least whilst service continues. Serving military personnel are in full employment, provided with a secure work environment, food, housing, sanitation, education and a dedicated healthcare service. They receive health promotion to address modifiable lifestyle factors, and both they and their families are part of a close-knit social and community network. Whilst periods of operational deployment may introduce austerity, the principles of Army Health established in the mid-19th century (Parkes 1864) ensure that a high priority is given to health protection in order to control avoidable risks to health.

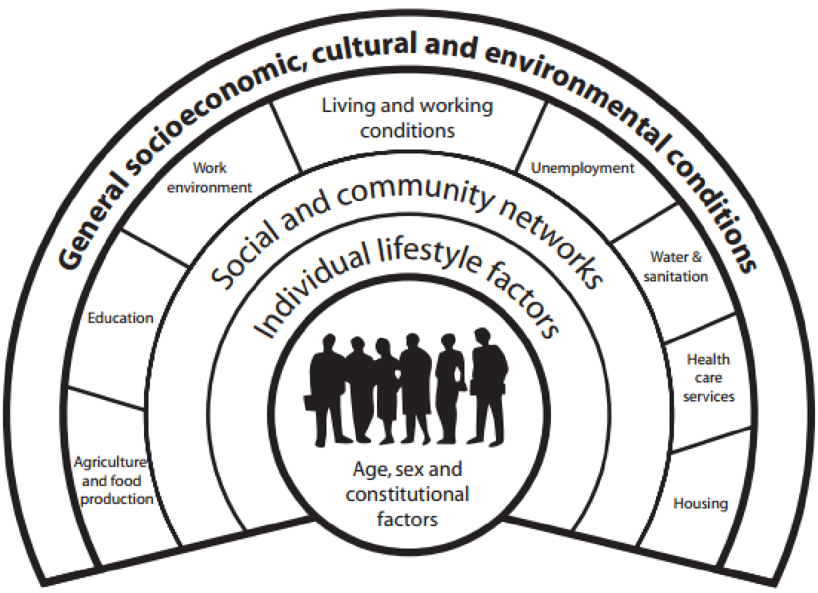

Figure A3-1 - Determinants of Health
(Acheson 1998)

Nonetheless, military service brings threats to long-term health, from both occupational and social or lifestyle factors. A consideration of both threats and benefits forms the basis of an understanding of the military influences on veterans' health.

A3.3.1 Recruit Selection

All recruits are medically examined prior to acceptance for military service[284]. The recruit selection process has changed over the long period encompassed by this study, from a relatively crude exclusion of those with gross problems in the 1960s through to the more recent scientifically validated battery of physical tests and medical examinations based on modern occupational health screening (Bilzon et al. 2002, Wilkinson et al. 2005). The aim has been to minimise 'recruit wastage'[285] through injury (Blacker et al. 2008), although losses due to concealed conditions such as asthma (Dickinson 1988) remain common. Specialist medical opinion may be sought in cases where there is doubt as to fitness for service.

A3.3.2 Rank

All service personnel commence at the lowest rank, in one of two strata as either a private soldier or equivalent[286] for 'other rank' service, or as an officer cadet[287] leading to commissioning as an officer[288]. This differs from some civilian occupations such as the Civil Service, where starting grade or rank is determined by qualifications and experience, and entry at a senior grade is possible for the best qualified[289]. Promotion through the ranks is on merit, and may be conditional on successful completion of specific courses of instruction, education or professional training. Advancement from other rank to officer is

[284] In accordance with the procedural manual JSP 950, formerly JSP 346

[285] Early discharge, which results in loss of a recruit to future trained service since 'vacancies' occurring after the commencement of training cannot later be filled

[286] Private soldier, able seaman, airman or equivalent, equating to NATO rank OR1 or OR2.

[287] 'Officer cadet' is a courtesy title for an officer in training, but equates in rank to private soldier.

[288] Initially as second lieutenant, sub lieutenant, pilot officer or equivalent, equating to NATO rank OF1. Officer entrants do not receive The Queen's Commission until completion of training. Selection for officer entry is dependent on passing a battery of tests of leadership, initiative, skills and knowledge. Most officer entrants have a bachelor's degree.

[289] A notable exception is made in the case of doctors, who are eligible to enter the Armed Forces at the rank of captain (Army) or equivalent (NATO rank OF3) on full registration.

possible, for those who prove most able[290]. The timescale for promotion varies greatly but a typical example[291] for the Army is shown at Table A3-1:

Table A3-1 - Example of rank progression over time - Army

Rank	Average time to progress to rank	% likelihood of promotion to that rank
Private	N/A	
Lance corporal	4.3 years	37.7%
Corporal	8.3 years	72.0%
Sergeant	12.8 years	70.7%
Staff Sergeant	15.7 years	80.1%
Warrant Officer Class 2	17.5 years	77.1%
Warrant Officer Class 1	18.8 years	33.1%

The jump in likelihood of promotion to corporal is a result of the selective discharge of most of the people who have not shown the potential to progress by the end of their initial engagement, whilst the relatively small percentage who achieve warrant officer class 1[292] rank reflects the highly selective nature of promotion on merit to this most senior non-commissioned rank.

Questionnaire-based military or veteran studies often include a question on rank, either current or highest achieved. Rank has been consistently linked to health outcomes in many studies of serving personnel and veterans, with higher rank being associated with better long-term health (Ismail et al. 2000, Fear et al. 2009, Keehn 1974, Seltzer and Jablon 1977).

A3.3.3 Length of Service

Length of service and rank are generally correlated, although there is wide variation and no exact formula can be derived. Length of service therefore provides a rough proxy for rank. Maclean and Edwards surmise that the protective effect of officer rank found in their study stems in part from length of service, officers generally having served for longer than enlisted men (MacLean and Edwards 2010). It may be argued that length of service is a more sensitive measure of the 'occupational' health effects of service, as opposed to

[290] Commissioning 'from the ranks' normally takes place either early in the career, for those who are identified early as having exceptional talent, or at a senior level (normally warrant officer rank) for those who have served for around 20 years.

[291] Drawn up by an employment consultant in support of a claim for loss of earnings due to medical discharge http://www.keithcarter.co.uk/ArmedServices/ accessed 23 July 2014

[292] Regimental Sergeant Major and equivalent, the most senior non-commissioned rank

the health effects of seniority-related factors such as job strain (Fear et al. 2009), and therefore more appropriate to a study of veterans' health. Nonetheless, despite the obvious advantages of examining length of service, few studies of long-term health have utilised this measure.

The minimum term of service for the Army is currently[293] 4 years for those who join over the age of 18 years, although the initial engagement is 12 years, with an option to leave after the minimum term or, alternatively, to continue for 24 or even 30 years. For the Royal Air Force, the minimum term is the longer of 4 years or 3 years after completion of training, whilst for the Royal Navy it is the longer of 4 years or 3.5 years from completion of training. The minimum term of service for the Army was 3 years until 1999. Army and Royal Navy personnel must give one year's notice to leave on completion of their minimum term; Royal Air Force personnel must give 18 months notice[294]. There have been many changes; in the past, fixed terms of 3, 6 and 9 years have been offered, and compulsory redundancy has been applied when it has been necessary to adjust the size or composition of the Armed Forces. Thus, no single definition of minimum length of engagement is possible, although it has never been less than three years during the period of the study. Those who leave prior to completing the minimum term of service are termed Early Service Leavers (ESL) by the Ministry of Defence**Error! Bookmark not efined.**. The impact of premature separation from service has been discussed at Section 8.3.1.2.

A3.3.4 Military Health Promotion

In an organisation whose primary aim is war-fighting, and which is widely perceived as carrying a significant risk of death or injury, the concepts of military health promotion, occupational health and safety may seem a contradiction in terms. However, to the military commander, the success of a campaign is in large part determined by the

[293] As at 2014

[294] '*Terms of Service in the UK Armed Forces*'. ForcesWatch briefing paper (2011) http://www.parliament.uk/documents/joint-committees/human-rights/Briefing_from_Forces_Watch_Terms_of_service.pdf accessed 23 July 2014

strength (both numerical and physical) of the military manpower[295] which can be brought to bear[296]. Whilst some military hazards are unavoidable (albeit that their consequences may be minimised by good planning, tactics, training and equipment), preventable injury and disease represent an 'own goal' which can only reduce the chance of a successful campaign. There is a perception that, in the past, military health policy was primarily focussed on the immediate need to maintain military effectiveness, and that it is only in recent years that it began to encompass concern for long-term health. However, any attempt to be critical of the Armed Forces for not seizing the health promotion initiative earlier must recognise the timescale for evolution of health promotion in the civilian world. It was not until 1976 that the UK Department of Health published its vision for health promotion, '*Prevention and Health: Everybody's Business*' (Department of Health and Social Security 1976), modelled on the groundbreaking Canadian Lalonde Report published in 1974, '*A New Perspective on the Health of Canadians*' (Berridge et al. 2011). The latter report proposed pragmatically, in the absence of a body of scientific evidence of effective public health intervention, that the principles to be followed in health education should be:

- It is better to be slim than fat
- The excessive use of medication is to be avoided
- It is better not to smoke cigarettes
- Exercise and fitness are better than sedentary living and lack of fitness
- Alcohol is a danger to health, particularly when driving a car
- Mood-modifying drugs are a danger to health unless controlled by a physician
- Tranquillity is better than excess stress
- The less polluted the air is, the healthier it is
- The less polluted the water is, the healthier it is (Lalonde 1974)

Intentionally or otherwise, these principles would underpin the emerging Defence health promotion policy from the late 1970s onwards. The Basic Fitness Test, a test of cardio-respiratory function based on a timed run, was introduced in 1978, supporting the principle of exercise and fitness (Ministry of Defence 1978), and by 1987 there was clear

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[295] The gendered conventional term 'military manpower' no doubt reflects the male dominance of the fighting role, women not being permitted to serve in the front line of UK troops in predominantly war-fighting roles.

[296] Joint Doctrine Publication 0-01. *British Defence Doctrine*. 4th Ed. Ministry of Defence (2011).

evidence that the triad of nutrition, physical fitness and obesity prevention "figure[d] prominently in the health care programme for soldiers" (Crowdy 1987).

A3.3.5 Military Occupational Health

Military 'preventive medicine'[297] has long encompassed a component which would today be termed occupational health. Today, that component is delivered by military specialist occupational physicians, environmental health practitioners and by all military commanders, the latter having a statutory responsibility for the health and safety of the personnel under their command[298]. Furthermore there are both legal and moral obligations to minimise avoidable risks, which are binding on the Armed Forces, notwithstanding that the Armed Forces held Crown immunity from prosecution until the repeal of Section 10 of the Crown Proceedings Act 1947 in 1987 (See Section 5.4.1 and footnotes 94 to 96).

The Armed Forces constitute a highly heterogeneous occupational group, comprising a wide range of trades and professions ranging from infantry soldiers to consultant surgeons, from ships' cooks to senior policymakers, and from police officers to fast jet pilots. For service personnel, living conditions may also be occupationally determined, whether the shared barrack-room of the junior soldier, the comfortable suburban married quarter or the austere tented accommodation of operational deployment, although when not on deployed operations or training, many married and cohabiting personnel opt to live in their own privately owned or rented accommodation. Furthermore, the risks have changed over the long period of this study, in consequence of changes in technology, legislation, societal norms and operational imperatives. Armed Forces occupational health issues therefore encompass diverse risk factors, and a blanket generalisation of these issues to encompass 'all veterans' is inappropriate. Nonetheless, some commonly encountered military occupational factors can be identified which are associated with long-term health effects; these will be discussed in detail in the following sections. Personal and lifestyle factors which may impact on later health, and which may

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[297] The term 'Preventive Medicine' was introduced as a short form of 'Army Community and Occupational Medicine' when 'Community Medicine' displaced 'Public Health' in civilian terminology. Crowdy, J. (1987) 'Pointers from the past: a critical analysis of the teaching of preventive medicine principally in the military environment', *Journal of Public Health,* 9(3), 274-278. In its modern military usage, it encompasses Public Health, Occupational Health and Environmental Health.

[298] Health & Safety at Work etc Act 1974. The Act does not apply to military operations overseas.

be modified by military service, will also be discussed. Consideration of these determinants of health forms the basis for the interpretation of the effects of military service on veterans' health in Chapters 4-7.

A3.3.5.1 Physical Activity

The recognition that exercise was beneficial to health can be traced back to Classical times, in the writings of Hippocrates and Galen (Berryman 2010). However, in the 19th century British Army, Parkes noted that the chief exertion which the infantry soldier was called upon to perform comprised drill or carrying weights[299]. He attested to the value of 'training' to increase 'breathing power [and] muscular action' and noted that such training would strengthen the heart (Parkes 1864), presaging the promotion of cardiorespiratory fitness a century later with the introduction of the 'Fit to Fight' programme (Ministry of Defence 1978). The role of physical exercise in modifying disease risk has been widely described in the literature, and has been highlighted in the discussion of specific disease outcomes in Chapters 4-7. Physical training and activity is now an integral part of military life, with sport (both on and off duty) providing both a competitive element and relaxation. Training and overuse injuries are a potential threat (Hopkins 1992, Bergman 1993). Those who have to restrict activity in consequence of in-service injury may fail to show the health benefits of exercise, but the direction of causality may be difficult to establish since soldiers who are less fit have been shown to be more likely to sustain injury (Knapik et al. 1993). Although all military personnel have a duty to maintain their physical fitness[300], exercise levels are likely to vary with role; as in civilian life, those in clerical or administrative roles are likely to be less physically active than people in 'manual'-type employments (eg infantry soldiers), unless they take part in leisure sport.

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[299] Parkes stated that the weight of a soldier's equipment, without blankets and rations, was around 60 lb. He estimated that with this load, a soldier could march 20 miles in a day occasionally, or 12 miles in a day repeatedly for a long time. A media report in 2010 noted that soldiers of the Royal Marines and Parachute Regiment carried loads of 80lb during the 1982 Falklands campaign; by 2009, infantry soldiers in Afghanistan were carrying around 145lb, in temperatures of up to 50 deg C. Source: http://www.express.co.uk/news/uk/188986/British-soldiers-suffer-injuries-from-too-heavy-weights accessed 9 April 2015

[300] As described in FOI2014/01133/13/04/72991 dated 23 June 2014, available at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/322922/PFA_failure.pdf accessed 27 January 2015.

A3.3.5.2 Nutrition and Obesity

Inappropriate nutrition may result in overweight or obesity, which is a major contributor to the long-term risk of ill-health. Diseases recognised as having an association with high body mass index include hypertension, coronary heart disease, stroke, type 2 diabetes, pulmonary hypertension, sleep apnoea (which is itself associated with increased risk of myocardial infarction and stroke), some cancers, non-alcoholic liver disease and osteoarthritis (Kopelman 2007). Central (abdominal) adiposity is especially associated with cardiovascular risk (Lee et al. 2008). Among regular drinkers, alcohol intake may make a substantial contribution to overall energy intake. Beer-drinking in men is associated with increased waist circumference, which is itself associated with increased cardiovascular risk, although the cardiovascular effect is diminished after adjusting for overall weight gain (Schutze et al. 2009). However, physical fitness is protective against increased cardiovascular risk in those who are overweight and obese (McAuley et al. 2010).

The diet of Armed Forces personnel has long been important to military planners. Even before the health implications of diet were recognised, the provision of rations to a military force required careful logistic planning; procurement, transportation, storage and preparation of food all had to be incorporated in operational plans. By the mid 18th century, the importance of the military diet in the prevention of disease was recognised (Pringle 1764)[301] and, a century later, the Professor of Military Hygiene drew attention to the undesirability of obesity (Parkes 1864). Today, the MOD's nutritional policy is set by the Expert Panel on Armed Forces Feeding (EPAFF), whose overarching aim is to educate Service personnel about nutrition and healthy eating[302]. For personnel living in barracks or on operations, food is normally prepared and served in central catering facilities (dining rooms or messes). A modest charge is made for food, except for recruits and personnel deployed on operations. Military health promotion initiatives in recent years have endeavoured to inculcate a culture of healthy eating (Edwards and Thomson 1987) and weight management in military personnel in an attempt not only to improve fitness during service but also to protect health in later life. 'Healthy choices' are available

[301] "Section IV. *How to prevent Diseases arising from improper Diet*"

[302] MOD Public Service Agreement Autumn Performance Report 2008-09. Annex A: Public Accounts Committee Recommendations (Thirteenth Report (2006/07) Smarter Food Procurement in the Public Sector)

today, although in the past, fried and energy-dense foods were the traditional mainstay of military catering. With the majority of military personnel aged under 25 years, the effectiveness of 'healthy eating' promotion has been tempered by the known difficulties in effecting health behaviour change in young people (Gibbons and Gerrard 1995).

Although the height and weight of recruits was routinely recorded (Rosenbaum and Crowdy 1992), no data on in-service obesity were available until recently, when a study demonstrated that serving military personnel under the age of 35 years had a lower prevalence of obesity than civilians, although there were no differences in older personnel (Fear et al. 2011). A US study examined data from the 2003 Behavioral Risk Factors Surveillance Study (BRFSS) dataset and found that veterans were more likely to be overweight or obese than non-veterans; only 26.7% of veterans accessing VA services, and 27.4% of those who did not use the VA, were of normal weight compared with 40.5% of non-veterans (Nelson 2006). No papers on the prevalence of obesity in UK veterans have been identified. No trend data for weight in UK veterans are therefore available although since the weight of recruits has increased over time (Rosenbaum and Crowdy 1992) and there is a national trend towards increasing body mass (Rennie and Jebb 2005), it is likely that the prevalence of overweight and obesity in veterans has increased over the period covered by the Scottish Veterans Health Study.

A3.3.5.3 Job Strain

The UK Health and Safety Executive (HSE) defines work-related stress as:

> "The adverse reaction people have to excessive pressure or other types of demands placed on them at work"

recognising that although stress itself is not pathological, prolonged or 'excessive' stress may predispose to ill-health[303]. However, the term 'stress' is somewhat imprecise, its meaning varying according to culture and context. By contrast, the term 'job strain' is more precisely defined. The Karasek-Theorell job strain model comprises two components; job demands (required speed and difficulty of work) and decision latitude (control over skill use, time allocation and organisational decisions) (Theorell and Karasek

[303] Source: Health & Safety Executive http://www.hse.gov.uk/stress/furtheradvice/whatisstress.htm accessed 27 June 2014.

1996). Job strain is generated by a combination of high job demand and low job control. The Whitehall II Study demonstrated that job strain increases the risk of CHD, with both high job demand and low decision latitude increasing risk (Kuper and Marmot 2003), whilst the relationship between job strain and psychological ill-health or well-being is more complex (Van der Doef and Maes 1999). By contrast, a systematic review of 57 studies meeting the inclusion criteria covering the years 1960-2001, by an Expert Working Group of the National Heart Foundation of Australia, found no strong or consistent evidence for an association between CHD and work stressors, although there was good evidence for an association with depression and social isolation, independently of smoking, hypercholesterolaemia and hypertension (Bunker et al. 2003).

Fear et al. examined mental health in relation to job strain and rank in the UK Armed Forces using standard survey instruments including PCL-C[304], GHQ-12[305] and AUDIT[339], and found that job control was lowest in the most junior ranks and highest in commissioned officers, and job demand was lowest in junior ranks and highest in commissioned officers. Thus the group with the lowest job control also had the lowest job demand. Mental ill-health was positively correlated with low job control, high job demand and low rank, although the odds ratios for increased risk were not significant for PCL-C[304] (for post-traumatic stress disorder (PTSD)) or severe AUDIT score (for alcohol misuse) in relation to job demand, and those who reported high job control had a lower rate of severe alcohol problems. The authors concluded that rank should be regarded as a causal factor rather than a confounder, and that military jobs which were perceived to be worthwhile and reasonably demanding may benefit health (Fear et al. 2009). The authors noted that only one other study had examined job strain in a military population (Ippolito et al. 2005), using GHQ-12; their results were consistent with the findings from that earlier study.

A3.3.5.4 Hours of Work

Military personnel are expected to be available for duty at all times, although the interpretation of this overarching statement in respect of non-deployed service has changed in recent years in order to comply with the European Working Time Directive

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[304]Post-traumatic stress disorder (PTSD) CheckList – Civilian version

[305] General Health Questionnaire-12

when not on operations[306]. Many military roles involve shift work or night duty, including not only catering, medical or telecommunications work but also guard duty and participation in night training exercises. A meta-analysis of 12 studies demonstrated a small but significant trend of increasing health symptoms, both physical and mental, with longer hours of work, and also noted an increased risk of both injury and suicide with longer working hours (Sparks et al. 1997). Shift work is also associated with adverse health effects such as anxiety, depression, cardiovascular and possibly gastro-intestinal disorders. There is a wide range of individual tolerance to shift work (Harrington 2001). Breast cancer in women has been linked to night work involving exposure to light (Davis et al. 2001), and rotating shift work has been linked to risk of both breast and colorectal cancer in women (Schernhammer et al. 2003, Schernhammer et al. 2001) and prostate cancer in men (Conlon et al. 2007).

A3.3.5.5 Physical Environment

Aspects of the physical environment which may impact on the health of serving personnel and veterans include climatic factors (heat, cold, solar radiation), noise, electromagnetic radiation and ionising radiation. Military personnel may also be exposed to a wide range of hazardous agents in the course of their duties, including fuels, lead, asbestos, pesticides, chemical warfare agents, industrial chemicals and the smoke from explosives, propellants, flares and white phosphorus, as well as from the destruction of industry and infrastructure. Although risk assessment is now routine for known military occupational hazards in accordance with UK national legislation[307] and codes of practice[308], many veterans included in the study served prior to the introduction of exposure controls. Furthermore, the nature of warfare inevitably gives rise to unexpected hazard exposures.

A3.3.5.6 Climatic Factors

The most ubiquitous environmental risk factors relevant to military populations arise from climate, many service personnel spending a considerable proportion of their military working lives out of doors. Since the 18th century, members of the British Armed Forces have spent prolonged periods overseas in hot, sunny regions. Historically, the major

[306] Hansard HL Deb 18 October 1999 vol 605 cc737-8

[307] eg Health and Safety at Work etc. Act 1974

[308] eg Control of Substances Hazardous to Health Regulations 2002

problems they faced were tropical diseases; between 1819 and 1836 the mortality rate for British troops in West Africa exceeded 48% per annum (Curtin 1961), mainly due to malaria and yellow fever. Whilst hygiene, immunisation and other health protection measures have largely controlled the risks of communicable disease, environmental factors remain a concern. In particular, exposure to solar ultraviolet radiation carries a risk of skin cancer, and many who were required to do heavy outdoor manual work, including those who were prisoners of war in the Far East, had no possibility of protecting themselves (Figure A3-2). Even today, those serving in the Gulf and Afghanistan may be exposed to strong incident sunlight both when working out of doors and during off-duty time (Section A3.3.5.5), notwithstanding an increased awareness of the hazards.

Figure A3-2 – Soldiers manning a gun in the Radfan, 1967 showing sunburn on backs and shoulders
[image source: Lt Richard Grevatte-Ball]

Exposure to solar radiation is associated with increased risk of both malignant melanoma and non-melanoma skin cancer (Diepgen and Mahler 2002). The authors report a paradoxically lower risk of melanoma in outdoor workers compared with indoor workers. There is also evidence that sun exposure is associated with a reduction in risk of some cancers, including breast cancer in light-skinned women (John et al. 2007) and prostate cancer in men, probably mediated through vitamin D (John et al. 2005). An inverse relationship has been found between risk of melanoma and smoking (Freedman et al. 2003) although two large cohort studies found the effect to be confined to men (Song et al. 2012). It has been postulated that the skin ageing effect of smoking prevents the development of melanoma (Grant 2008).

Although military uniform is worn and, most recently, in Iraq and Afghanistan the use of combat body armour has resulted in only minimal exposure of the skin to solar radiation (Figure A3-3), in the past many men worked stripped to the waist in hot climates (Figure A3-2), and even today most personnel take the opportunity to reduce the burden of uniform during off-duty time (Figure A3-4). Sunscreen is provided, and sunburn is considered to be a 'self-inflicted wound' and therefore subject to disciplinary action[309]; thus a pattern of 'chronic occupational exposure' is more likely than a pattern of intermittent sunburn.

Image has been removed due to
Copyright restrictions

Figure A3-3 - Combat uniform and body armour as worn in Afghanistan 2010

Image has been removed due to
Copyright restrictions

Figure A3-4 - Off-duty soldiers relaxing in Afghanistan

[309] Army Act 1955 3 & 4 Eliz. Ch. 18 Sect. 42 or Sect. 69 and subsequent legislation. In practice, disciplinary action for sunburn would rarely be invoked.

Although recent years have seen campaigns in Iraq and Afghanistan, service in hot or tropical climates was more common in the past when military bases were maintained throughout the world and many personnel served 2-year tours in Singapore, Malaya, Hong Kong, Cyprus, Malta, Gibraltar, Nepal, the Caribbean and many parts of Africa. The map illustrates British Army deployments since 1950, with the peak number deployed at any one time (Figure A3-5), and demonstrates the ongoing potential for occupational sun exposure, which may influence the risk of some cancers.

Figure A3-5 - British Army global deployment map 1950-2010
© Garry Walton. Used with permission

A3.3.5.7 High-Frequency Electromagnetic Radiation

Military personnel may be exposed to high-frequency electromagnetic radiation from communications equipment or radar installations, particularly if working in occupations such as signalling (telecommunications) or if employed as an electronics technician. Furthermore, most infantry soldiers and many others use high-frequency radio equipment for communication on the battlefield, the radio antenna normally being positioned close to the operator's head. In a comprehensive review of the epidemiological evidence for cancer risk as a result of exposure to radio frequency emissions, Elwood concluded that the epidemiological evidence fell short of that required to conclude that such radiation was carcinogenic, although he acknowledged inconsistent results and methodological limitations (Elwood 2003). One study in military personnel found a reduced risk of cancer mortality in personnel exposure to high levels of radar waves (Groves et al. 2002). Most recently, concerns about the carcinogenic potential of radio frequency emissions have centred around mobile phone use. A review of epidemiological studies on the health risks of mobile phone use identified 33 papers; 25 studies related to brain tumours, whilst others examined the risk of salivary gland tumours, uveal melanoma, non-Hodgkin lymphoma, facial nerve tumour, and testicular cancer. Overall, there was a statistically significant increase in risk of glioma and a non-significant increase in risk of acoustic neuroma and meningioma. However, numerous methodological inadequacies were noted, and the author cautioned that longer follow-up would be needed to assess the magnitude of any effect. No conclusions could be drawn for any of the cancers other than brain (Kundi 2009).

A3.3.5.8 Ionising Radiation

Only those exposures which affect a large number of people are likely to contribute to the overall picture of veterans' health. Over 20,000 British service personnel were involved in one or more of the 21 nuclear tests which were carried out by Britain between 1952 and 1958; many of them continued to participate in radiation tests conducted by the United States through to 1967 (Gardner 1988), and the possibility of their being at increased risk of cancer has given rise to concern, as described at Section A1.3.2. A wide range of cancers has been examined for epidemiological evidence of an association with low dose radiation exposure, although confounding has proved difficult to eliminate and much uncertainty remains. An association with leukaemia[310] is accepted, but the evidence in respect of solid tumours is conflicting (Dauer et al. 2010). Studies on aircrew have demonstrated an association between increased exposure to natural radiation and both melanoma and non-melanoma skin cancer (Pukkala et al. 2002), and breast cancer in women (Rafnsson et al. 2001), whilst Henshaw et al. have demonstrated an association between domestic radon exposure and both acute myeloid leukaemia and malignant melanoma (Henshaw et al. 1990). Only about 10% or 2,000 men involved in the nuclear tests were exposed to measurable levels of radiation (Ministry of Defence 2008), although this figure is disputed by the veterans themselves. Of these, it is likely that no

[310] Excluding chronic lymphocytic leukaemia

more than 200 (10%) were from Scotland[311]; an audit of the nuclear test veterans' health needs conducted on behalf of the Ministry of Defence in 2011, when their average age was 74 years, found 46 (7%) of the respondents to be living in Scotland (Miles et al. 2011). Despite the large number of personnel present at the tests, the contribution of this group to the Scottish Veterans Health Study cohort, none of whom reached adult service until 1963, is therefore likely to be minimal, and no other notable radiation exposure to British military personnel has taken place since the ending of the nuclear test series. The only occupational radiation exposures are likely to have occurred in personnel such as nuclear submarine maintenance engineers, radiographers, dentists and dental technicians; all are routinely monitored in accordance with standard occupational health surveillance practice and legislation. Potential consequences of the military use of depleted uranium (see Section A1.3.2.1) have received much publicity[312], including from pressure groups[313]. The main target organs are the kidney, giving rise to impairment of renal function, which may be reversible, and the lung which is susceptible to radiation damage, including lung cancer, following inhalation of depleted uranium dust (World Health Organization 2001). Increased body levels of radiation arising from contact with depleted uranium munitions[314] have been found only in surviving crew members of vehicles which were hit by such a weapon (Ballantyne 2008); the number of serving personnel and veterans so affected is small.

A3.3.5.9 Benzene

Benzene is an aromatic hydrocarbon which is a component of crude oil and petroleum, and also occurs in tobacco smoke. It is both haematotoxic and carcinogenic (Atkinson 2009). Cancers associated with exposure to benzene include lung, leukaemia, malignant lymphoma and multiple myeloma (Aksoy 1980). Long-term follow-up of a UK historical cohort who were occupationally exposed to benzene in the 1960s or earlier, in a wide

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[311] Approximately 10% of the Armed Forces are recruited from Scotland; it is assumed that there was no systematic difference in the likelihood of Scottish soldiers being exposed to radiation

[312] "Is an armament sickening US soldiers?" Military on NBC News (2006) http://www.nbcnews.com/id/14321787/ns/us_news-military/t/armament-sickening-us-soldiers/#.VNM8qS6Qzb4 accessed 5 February 2015

[313] For example, the Campaign Against Depleted Uranium http://www.cadu.org.uk accessed 5 February 2015

[314] First used by NATO forces on military operations in the early 1990s. Source: http://en.wikipedia.org/wiki/Depleted_uranium accessed 16 February 2015.

range of industries, and whose NHS records had been flagged at the request of the Medical Research Council, demonstrated significantly increased SMRs for lung cancer, lip cancer and cancers of uncertain origin, although there was no excess mortality from leukaemia (Sorahan et al. 2005). Military personnel are most likely to be exposed to benzene through vehicle fumes (Section A3.3.5.13) or tobacco smoke (Section A4.1.3).

Those who drive or work with vehicles are exposed to benzene vapour whilst refuelling or carrying out vehicle maintenance, and aviation ground crew are also at risk of exposure. Benzene is a component of both petrol (gasoline) and military aviation fuel, whilst diesel fuel contains a smaller proportion of benzene than petrol. Benzene is a known human carcinogen (Egeghy et al. 2003), and exposure is also a risk factor for leukaemia (Austin et al. 1988), especially in the presence of tobacco smoke (Korte et al. 2000). The MOD recognises that myelodysplastic syndromes and acute myeloid leukaemia may be a consequence of occupational exposure to benzene, whilst noting the association with cigarette smoking (which has in turn been attributed to the benzene component of tobacco smoke) (Bowen 2008). Lymphohaematopoietic malignancies are examined at Section 5.25.

A3.3.5.10 Polycyclic Aromatic Hydrocarbons

Polycyclic aromatic hydrocarbons (PAH) are widespread environmental pollutants which vary in their level of toxicity but, importantly, workplace exposure is linked to some cancers of occupational origin. Common sources of exposure include tobacco smoke, cooked food, urban air pollution and drinking water, coal tar and mineral oils, and inhalation of organic solvents. Occupational exposure is associated with an increased risk of lung and bladder cancer, whilst dermal exposure increases the risk of skin cancer (Boffetta et al. 1997). Elevated levels of soil contamination with PAH have been reported in the vicinity of military installations (Baran et al. 2004, Halsall et al. 1997), suggesting that some military personnel may be at increased risk; exposure to solvents and oils is common in a number of military trades, as in civilian industry.

A3.3.5.11 Asbestos

Asbestos is the generic term for a set of six fibrous silicate minerals[315] which were formerly widely used for their thermal resistance properties. Inhalation of asbestos fibres is now known to be associated with lung cancer, mesothelioma of the pleura, and asbestosis (O'Reilly et al. 2007), and its use has been restricted or subject to stringent controls. Smoking increases the risk of asbestos-related lung cancer; the two carcinogens are believed to act synergistically, leading to a multiplicative effect (Saracci 1977), although other authors have questioned the reliability of the data underpinning the multiplicative hypothesis and propose an additive model (Liddell 2001). Asbestos was widely used in military engineering and naval shipbuilding until the early 1980s. Its fireproof properties made it ideal for insulation to protect personnel from thermal injury, particularly in armoured vehicles. By the time the health risks associated with asbestos became widely recognised, many Service personnel had been exposed. Asbestosis and mesothelioma are conditions for which a War Disability Pension may be awarded (Jenkins 2008b).

A3.3.5.12 Talc

Metamorphism of certain asbestos minerals, chiefly serpentine and amphibole, in the presence of water and carbon dioxide results in the formation of talc, a hydrated silicate in which the fibrous structure of the original minerals is converted to a platy (foliated) structure. Talc is extremely soft and is a major constituent of soapstone. It is readily ground to a fine, soft powder which is widely used as a cosmetic (talcum powder) and as a lubricant. Because it is formed from asbestos and therefore co-exists with it if incompletely metamorphosed, talc may be contaminated with asbestos (Rohl 1974). Since 1976, measures have been in place to ensure that cosmetic-grade talc (although not industrial talc) is free from asbestos.

Talc has long been widely used by military personnel of both genders for personal hygiene, especially for care of the feet to prevent blistering and the groin/perineum to prevent chafing. It was supplied in green-painted metal tins, known as 'Foot and Body Powder' (Figure A3-6), through to the late 1970s, and was provided free of charge as a

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[315] Chrysotile or 'white asbestos' (a member of the serpentine group) and the amphibole group (amosite ('brown asbestos'), crocidolite ('blue asbestos'), tremolite, actinolite and anthophyllite)

routine 'issue' item. After it was discontinued, many personnel opted to use a proprietary antifungal dusting powder as this could be obtained free of charge from unit medical centres for treatment of dermatophytosis[316].

Figure A3-6 - Military issue tins of 'Foot & Body Powder'
showing changes in pack design over time
The most recent (behind) was a re-labelled cosmetic talc

A review of the epidemiological evidence found no evidence of an increased risk of lung cancer in heavily-exposed workers (talc millers and talc miners) that could not be attributed to confounding by exposure to radon or quartz particles, provided that asbestiform minerals were absent (Wild 2006). However, in the presence of tremolite and other asbestos minerals, there was a significant excess lung cancer mortality in both miners and millers as well as in pottery workers, leading the International Agency for Research on Cancer (IARC) to conclude in 1987 that there was sufficient evidence of human carcinogenicity for talc containing asbestiform fibres (IARC 1987).

No studies have been found which have examined whether pre-1976 military issued talc contained asbestos fibres, although since it was a common contaminant at that time, it seems likely. Accordingly, some samples were obtained by the author and examined using both plane and crossed polarised light microscopy[317]. This revealed a poor-quality talc with sharp and irregular particles of a wide range of sizes, but no fibres of asbestiform appearance (Figure A3-7). However Rohl has noted that light microscopy alone is

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[316] Author's personal recollection, as an Army GP. Dermatophytosis ('athlete's foot', 'jock itch' and other fungal infections) is almost universal in service personnel as a consequence of shared showers and changing rooms.

[317] Thanks are due to the Curator of Mineralogy, Hunterian Museum, University of Glasgow for providing laboratory facilities to examine the specimens.

insufficient to exclude or quantify the presence of asbestos in talc, and that transmission electron microscopy is more satisfactory (Rohl 1974). Owing to resource limitations, which did not permit access to electron microscopy, it was possible therefore neither to exclude nor confirm the presence of asbestos in the samples.

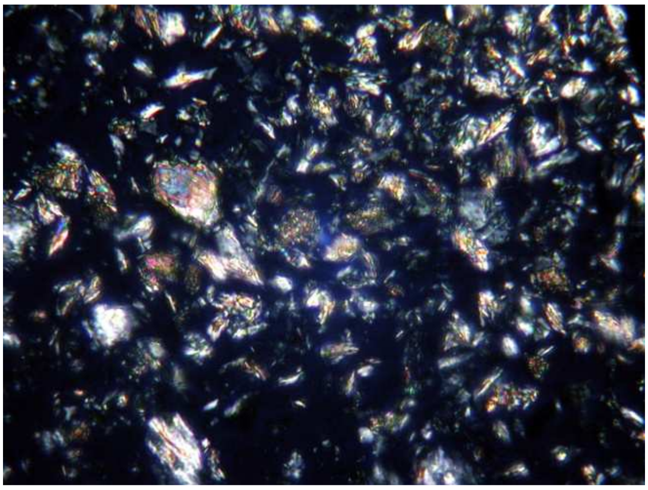

Figure A3-7 - Microscopy of military issue talc
Crossed polarisers. Field of view approx. 2.5mm

There is consistent evidence of an association between ovarian cancer in women and use of talc on the perineum (Wu et al. 2009), as has been discussed at Section 5.36.4. The increased risk was restricted to women who started using talcum powder before 1975 and the authors note that other studies (although not all) had found an increased risk for use in the 1960s and 1970s, although it remains unclear whether the risk arises from asbestos contamination or from the talc particles themselves. No evidence has been found concerning perineal use of military-issued talc in UK servicewomen, although as it was widely recommended for prevention of chafing, it is probable that some would have used it.

A3.3.5.13 Lead

Prior to the withdrawal of leaded petrol, inhalation of vehicle fumes also carried a risk of exposure to lead, in addition to carbon monoxide and particulates. Brown noted that military personnel were likely to be exposed to vehicle exhaust fumes to a greater degree than that normally experienced by the general public (Brown 1983). On exercises, military vehicles often halt in relatively enclosed surroundings such as a wooded area to provide camouflage and concealment, and are commonly draped with netting or vegetation which provides additional protection but further increases the local concentration of exhaust gases, engines being kept running in order to provide electrical power and heat (Figure A3-8). Personnel are also exposed when travelling in military vehicles such as Land Rovers and trucks which normally have an open, canvas-covered passenger compartment, giving rise to far greater exposure of passengers to exhaust fumes than would occur in a conventional form of land transport. Much military travel takes place in convoy, one vehicle following another, which further increases the exposure of passengers to fumes emitted by the vehicle in front. From 1985 the British Army began to convert its ageing petrol-engine Land Rover fleet to the diesel-engine 90/110/Defender model[318], purchasing around 20,000 of the new vehicles by 1994. The petrol Bedford RL 3-ton truck had already been phased out in favour of the diesel Bedford MK 4-tonne truck by 1977, and so by 1994 at the latest, military personnel were no longer exposed to leaded fuels or high concentrations of benzene vapour, consequent on an overall upgrading of the fleet and an emerging standardisation of all military vehicles on diesel in order to maximise interoperability. However, it is now accepted that diesel exhaust fumes may also have adverse health effects including respiratory disease, and the International Agency for Research on Cancer (IARC) has recently recognised sufficient evidence to classify diesel exhaust as a cause of lung cancer, and limited evidence to associate it with an increased risk of bladder cancer (Benbrahim-Tallaa et al. 2012, Lipsett and Campleman 1999, Boffetta and Silverman 2001).

Figure A3-8 - Mark 1 Land Rover and Bedford RL vehicles Stanford Training Area 1967[319]

[318] Information provided by the Archivist, Royal Logistic Corps Museum, Deepcut, Surrey

[319] http://www.873.org.uk/camps-and-exercises.htm accessed 17 July 2014

Munitions are a further source of lead exposure in military personnel, as all are required to undertake weapon training on at least an annual basis, even if working in a support role. A cartridge or round (small arms) or a shell (field guns) comprises a projectile and a casing containing the propellant and a primer (or detonator), the major difference being one of scale. Detonation of the primer, normally by impact, ignites the propellant which generates a large volume of gas, expelling the projectile along the barrel of the weapon at high velocity. Many projectiles, especially for small arms, are based on lead as its mass contributes to the aerodynamic qualities of the projectile as well as increasing its penetrating power on impact. In the modern high-velocity rifle bullet, a lead core is encased in a copper jacket which mechanically isolates the lead and reduces fouling of the barrel of the weapon. Ammunition intended for low-velocity weapons such as the .22 rifle, often used on indoor firing ranges for practice, is not jacketed. Airborne lead may be generated by direct vaporisation from the surface of the projectile during firing, by disintegration of the projectile on impact or by explosive vaporisation of the primer which is often composed of lead azide[320], lead styphnate or other lead compounds (Figure A3-9). Individuals may be at risk through direct inhalation of vaporised lead, or through ingestion of lead from contaminated surfaces. The soil of many former battlefield sites is heavily contaminated with lead and other heavy metals such as arsenic and cadmium from corroded fragments of artillery ammunition (Meerschman et al. 2010), as is the environment close to former ammunition factories (Figure A3-10).

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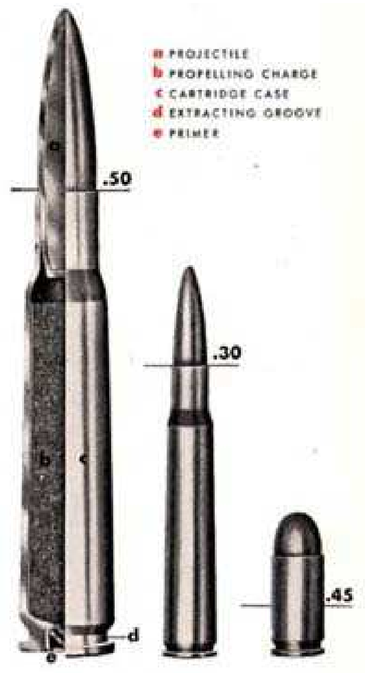
[320] Lead azide was introduced in 1944 as a substitute for the highly toxic mercury fulminate.



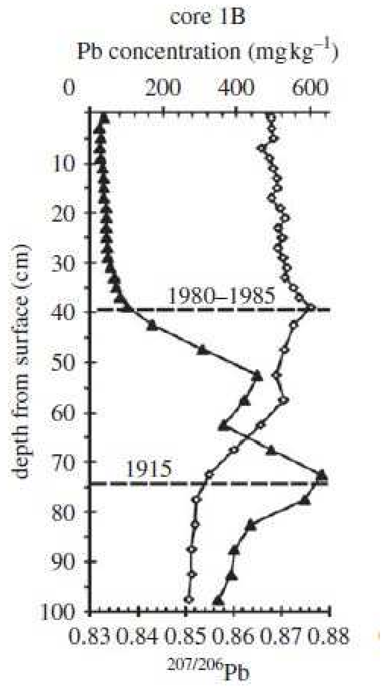


Figure A3-9 – Small arms bullets Lead may be present in the projectile (a) and the primer (e)[321]

Figure A3-10 - Lead in the River Clyde sediments, showing peak at 1915[322]

The Army Physiological Research Establishment (APRE) conducted a survey of indoor firing ranges in 1981 which demonstrated significant levels of airborne lead at some locations and, in due course, exposure controls and monitoring were introduced. Elevated blood lead levels were demonstrated in Royal Artillery soldiers in the early 1980s (Brown 1983), but routine monitoring of military personnel is not carried out and no other data have been located, although some records of occupationally-exposed personnel are held by the Institute of Naval Medicine, Alverstoke (Capleton et al. 2001). Whilst high levels of lead produce symptoms of acute toxicity, chronic low-grade exposure is associated with chronic kidney disease, peripheral arterial disease (PAD) and hypertension (Muntner et al. 2005). The role of lead in cardiovascular disease is

[321] http://pwencycl.kgbudge.com/S/m/Small_Arms.htm accessed 17 July 2014

[322] Adapted from Vane, C. H., Chenery, S. R., Harrison, I., Kim, A. W., Moss-Hayes, V. and Jones, D. G. (2011) 'Chemical signatures of the Anthropocene in the Clyde estuary, UK: sediment-hosted Pb, 207/206Pb, total petroleum hydrocarbon, polyaromatic hydrocarbon and polychlorinated biphenyl pollution records', *Philosophical Transactions of the Royal Society A: Mathematical, Physical and Engineering Sciences,* 369(1938), 1085-1111. Major contributors to lead pollution in the River Clyde were the munitions works of the National Filling Factory (World War 1) and the Royal Ordnance Factory (World War 2) at Bishopton, Renfrewshire. The smaller peak corresponds to World War 2 manufacture, whilst the line peaking at 1980-1985, representing lead having a different isotope ratio from that used in munitions, reflects lead derived from petrol. Figure 2-14 © The Royal Society 2011. Reproduced by permission of the Royal Society.

controversial, but a systematic review demonstrated sufficient evidence to support a causal relationship for hypertension, with positive but non-statistically significant associations for CHD and stroke (Navas-Acien et al. 2007).

A3.4 Post-Service

For those who have served for a number of years, transition from serving to veteran status represents a change in an individual's life on a par with leaving school or university, or with divorce. Former lifestyle, environment, friends and occupation are left behind and a new identity must be assumed. Nonetheless, transition is often hardest for those with the shortest service (McDermott 2009). The process of transition has been comprehensively mapped by Lord Ashcroft (Ashcroft 2014), in a major independent study commissioned by the UK Government, whilst a model of reverse culture shock has been proposed to explain the apparent paradox of the inverse relationship between length of service and transition difficulty (Bergman et al. 2014a).

The relationship between mortality in work and mortality after retirement, in relation to socio-economic factors, was explored by Marmot et al. in a 25-year follow-up to the Whitehall longitudinal study of civil servants. The authors found that the association between previous employment grade and mortality (lower grades experiencing significantly higher mortality) declined after retirement but that the effect of socio-economic status increased with age (Marmot and Shipley 1996). For the Scottish Veterans Health Study, this finding suggests that if a protective effect of higher rank [as measured by longer service] was identified, as has been demonstrated by Seltzer and Jablon in their study of US Army veterans (Seltzer and Jablon 1977), it should attenuate over time, becoming less marked in the older birth cohorts in whom more time has elapsed since leaving service, whilst the harmful effect of deprivation should become greater. This may partially explain the poorer health outcomes observed in older veterans.

A3.4.1 Lifestyle and Family

Although family accommodation ('quarters') is provided for service personnel who are married, the demands of service life, spouses' careers, children's education and operational deployment mean that for many, conventional family life is at best intermittent, and long periods may be spent living in barracks or in temporary accommodation on deployment, where the military lifestyle influences the behavioural determinants of health such as smoking, alcohol, nutrition and exercise. Many families meanwhile opt to live in private civilian accommodation, perhaps to accommodate children's schooling in a preferred location, or the non-serving spouse's employment. The end of a military career may therefore mean the first opportunity for service personnel to enjoy a stable life with family members, except for those who opt for a post-service career in, for example, an offshore industry. The impact on the determinants of health within the family group is likely to be mixed, for example with the new veteran being more likely to adopt the nutritional patterns of the civilian world, whilst family members may be more likely to be exposed to environmental tobacco smoke.

The success of transition to life as a new veteran is strongly dependent on social networks (Hatch et al. 2013). Family breakdown may therefore have a particularly negative impact on the new veteran. There is evidence from the US that military personnel tend to marry earlier than civilians, but also that they are more likely to divorce (Hogan and Seifert 2009). Figures from the Office for National Statistics (England & Wales) show an estimated 42% of all marriages ending in divorce; there are around 10,000 divorces in Scotland annually, compared with around 30,000 marriages. No data on divorce in UK veterans have been located, but it may be surmised that rates are no lower, and may be higher, than the general population.

A3.4.2 Employment

There are conflicting reports on the employment status of veterans. In a study in 2005, Iversen et al. reported that the majority did well after leaving and 87.5% were in full-time employment. Being married, achieving higher rank and having been deployed to the Gulf were associated with a higher probability of being employed, whilst veterans who had poorer mental health in service[323] were less likely to be employed than those with no evidence of mental health problems (Iversen et al. 2005). At the same time, the first Royal British Legion (RBL) survey showed that the profile of the working status of non-retired members of the ex-Service community was close to that of the wider population (Compass Partnership 2006), whilst the follow-up survey showed higher levels of

[323] As measured by GHQ caseness

unemployment and economic inactivity (Compass Partnership 2014). However, the datasets are not fully comparable as the RBL 'ex-Service community' includes not only veterans but also partners and dependent children. Post-service employment may have an independent effect on the health of the veteran; for example working in the civilian emergency services may increase the risk of PTSD (Clohessy and Ehlers 1999), whilst shipyard employment may be associated with poor respiratory health owing to exposure to welding fumes and, in the past, asbestos (Ferris and Heimann 1976).

A3.4.3 Geography

There are major spatial inequalities in health within the wider community in Scotland (Macintyre 2007), and it may be postulated that the health of veterans may be influenced by where they choose to live post-service. There were no data on where veterans lived until 2011, when the Service Personnel and Veterans Agency of the Ministry of Defence (MOD) released aggregated and anonymised postcode data on recipients of Armed Forces pensions, initially to local authorities and ex-service charities[324]. At the same time, the feasibility study for the Scottish Veterans Health Study was in progress and the opportunity was taken to map the veterans in each dataset. The resulting maps (reproduced at Appendix 5), which were distributed to stakeholders[325], showed a high level of agreement on the location of veterans; there was a clear tendency for the veterans to be clustered around the major military bases (Figure 3-2), perhaps reflecting post-service employment as a civilian on the base, a desire to remain close to former colleagues and maintain contact with in-service social networks, or maintenance of stability for spouses' employment or children's education. The geographical breakdown of the cohort is described at Section 3.2.4.

[324] Now available at https://www.gov.uk/government/statistics/location-of-armed-forces-pension-and-compensation-recipients last accessed 15 January 2015

[325] http://servicepersonnelandveteransagency.blogspot.co.uk/2011/10/new-map-to-help-services-to-veterans.html last accessed 15 January 2015

Appendix 4 - Tobacco, Alcohol and the Armed Forces

A4.1 Tobacco

A4.1.1 Historical Background

There is evidence of smoking by soldiers from at least as early as the beginning of the 17th century.[326] Many authors attest to the role of the Crimean War (1854-1856) in introducing soldiers to smoking through the ready availability of cheap tobacco (Starr 1984, Tate 2000), although many would already have been smokers of clay pipes, fragile and impractical on the battlefield, who readily embraced the convenience of the cigarette, copied from Turkish and Egyptian troops. The change from pipe to cigarette is important in respect of the health effects of smoking. Soldiers accustomed to smoking a clay pipe with a long, cool stem in which the volatile agents condensed would have had minimal nicotine intake (Dixon 1927) compared with that from the shorter cigarette, made from dark, strong, alkaline Turkish tobacco. This may have been a factor in the development of the 'palpitations' which were first described in soldiers during the Crimean War. It was a returning soldier and Crimean War veteran, Robert Peacock Gloag (Figure A4-1), who was one of the UK's first manufacturers of cigarettes, producing tissue-paper wrapped "Sweet Threes" (Figure A4-2) at his factory in London (Figure A4-3).

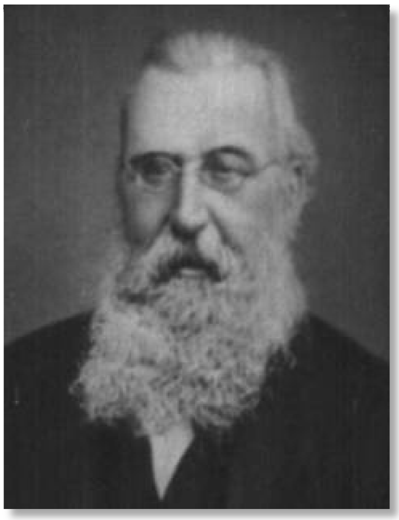


Figure A4-1 – Robert Peacock Gloag (1825-1891)

Figure A4-2 – "Sweet Threes" cigarettes

[326] A character in a play by Chapman (c. 1559-1634) written in 1606 makes reference to tobacco as "the gentleman's saint and the soldier's idol". Smoking by soldiers is described both at the trial of King Charles I and at the funeral of Oliver Cromwell.

Figure A4-3 - Gloag's first cigarette factory

The automation of cigarette manufacture in the 1880s led to intense commercial efforts to boost the popularity of smoking. Historical data show that in 1900, about one-third of all tobacco in the UK was smoked as cigarettes, but by 1914 this had risen to just under half (Doll and Hill 1950). Bhabutta has shown how support for 'cigarettes for the troops' during the First World War by the tobacco industry, Government, the public and even charities served not only to take up the enhanced production capacity but also to create an ongoing demand throughout the lifetime of those who had served and had become addicted (Bhabutta 1995). In the course of that conflict, the majority of men aged 17-50 years (estimated at 8.7 million from official records) served in the Forces[327] and were exposed to the relentless pressure of Service life and the provision of tobacco in military rations and as gifts from family, friends and a well-meaning public (Figure A4-4)[328]. These factors combined to achieve a smoking rate in First World War soldiers estimated at around 96%. No data on civilian smoking prevalence prior to or during the First World

[327] The male population of England & Wales aged 10-39 in 1911 was 9.0 million, compared with 7.7 million for those aged 20-49 (ie the same cohort) in 1921. Data from '*1921 Census of England and Wales, General Report with Appendices*', Table 33. http://www.visionofbritain.org.uk/census/table_page.jsp?tab_id=EW1921GEN_M33&show=DB accessed 15 Jul 2014.

[328] Princess Mary's Gift Fund Boxes were first provided to troops at Christmas 1914, as a result of public donations of money on the initiative of the 17-year old daughter of King George V. They contained a pipe, a tinder lighter, 1 oz tobacco and 20 cigarettes. Boxes for non-smokers (comprising only 4% of the total issued) contained sweets, a bullet pencil and a writing case. All boxes contained a Christmas card and a photograph of Princess Mary. The boxes were made of brass, notwithstanding a severe shortage of that metal caused by the sinking of the ship *RMS Lusitania* in May 1915, part of whose cargo comprised 45 tons of brass strip to manufacture the boxes. Almost half a million gift boxes were distributed initially, containing 45,000 lb tobacco and 13 million cigarettes; distribution continued throughout the war, bringing the final total to over 2.6 million. Information from the Imperial War Museum http://archive.iwm.org.uk/server/show/ConWebDoc.994/setPaginate/No accessed 27 Aug 2014, http://www.iwm.org.uk/history/princess-mary-gift-fund-1914-box-and-contents accessed 29 May 2015, and other sources.

War have been identified, and as the men who did not serve were most likely to be those who were medically unfit, a valid civilian comparator is unachievable although it may be surmised that the prevalence of smoking was lower in civilians.

Figure A4-4 - Princess Mary's Gift Fund Box of tobacco products
Reproduced on a Royal Mail postage stamp commemorating
the centenary of the outbreak of World War 1
© Stamp Design Royal Mail Group Ltd 2014

At the start of the Second World War in 1939, the younger First World War veterans were called up to serve for a second time[329]. In contrast to a volunteer Army which recruits the majority of its entrants at age 17-18, a conscript Army recruits from a wide age range and many entrants are mature adults. Unlike the First World War which saw many soldiers start smoking cigarettes for the first time after joining up, most Second World War soldiers were already cigarette smokers, as implicit from figures for cigarette marketing drawn up by the statistician Richard Stone[330] (Stone 1945), having either started to smoke themselves during the First World War or grown up in a smoking household and started smoking as adolescents and young men.

A4.1.2 Factors Underpinning Military Smoking

In an unpublished thesis, Hodgson used a qualitative study to explore the reasons why soldiers smoke. She found that stress was a major factor, but that the stress arose not from operational factors but from low job control and high job demand, as graphically described by one respondent:

[329] Including Field Marshall Bernard Montgomery (1887-1976), who was commissioned as a Second Lieutenant in 1908. He was seriously wounded in 1914 but recovered and took part in a number of major campaigns, finishing the First World War in the rank of Lieutenant Colonel.

[330] In 1938, estimated total annual tobacco consumption in the UK was 201.1 million pounds weight (p.318), and 90% of males and 33% of females aged 16 and over were smokers (p.320). Stone, R. (1945) 'The Analysis of Market Demand', *Journal of the Royal Statistical Society,* 108(3/4), 286-391.

> "You could try and get on with the job, but when you are given twelve other jobs to get on with at the same time but then you've got people nagging in your ear. Then you'll do one thing and they'll say, right change that round, do it this way instead . . . so things get changed round all the time and you go back on yourself and that's when you start losing your temper."

Shared living conditions, separation from family and girlfriends and lack of free time were other issues noted. Smoking a cigarette provided a highly valued few moments in which to regain self-control, a form of 'time out' which was not only recognised but endorsed by the military in the form of the 'smoke break' (Hodgson 1997).

Another aspect was related to the author by a veteran, who described the bonding effect of sharing a packet of cigarettes during his first few days of recruit training.

> "You accepted one, because you wanted to be part of the group. Then you had to buy a packet of cigarettes, so that you had some to share round."

The estimate that regular smoking may be initiated by as few as 3-4 cigarettes (Russell 1990) is consistent with a high rate of smoking initiation (or re-starting) in the early days of recruit training.

A4.1.3 Prevalence of Military Smoking

The prevalence of smoking was not formally studied in British soldiers prior to 1959 (Richards and Crowdy 1961) but an impression of a high prevalence in the late Victorian period can be gained from a report by Brigade Surgeon Veale which showed that in a sample of 100 soldiers treated for 'palpitations', 87% smoked and a further 2% chewed tobacco (Veale 1880). A prevalence of smoking approaching 100% may be inferred from a paper reporting a study conducted at the Military Heart Hospital, Hampstead which noted among the 20 cases reported (soldiers aged between 17-32 years complaining of undue breathlessness on exertion) that:

> "all were smokers . . they were consecutive cases and were not selected because smoking was presumed to be a . . factor".

Similarly for the healthy controls, "all were smokers". The authors noted that most of the patients and controls began smoking between the ages of 15-18 years and only two of the 30 (6.7%) began smoking after enlistment (Parkinson and Koefod 1917). Richards and

Crowdy studied Army junior soldiers in 1959 and found that the prevalence of regular smoking ranged from 51-58% at age 15 years to 79-80% at age 18-19 years, with the greatest increase taking place during the 16th year. The authors compared smoking rates in junior soldiers (aged 15-19 years) in 1959 with civilian rates quoted by the Tobacco Manufacturers' Standing Committee and found an excess of 17-20% in the soldiers (Richards and Crowdy 1961). The UK Defence Dental Agency conducted a survey of 10,500 military personnel who enlisted in 1998-9 as part of a major MOD smoking cessation initiative, and found that 45% of the Army personnel smoked on enlistment, compared with 34% for the Royal Navy and 31% for the Royal Air Force. At the conclusion of the initiative in 2007, the prevalence of smoking across all 3 Services had dropped to 28.4% (Army Health Unit 2008) and measures such as active promotion of smoking cessation by military primary care practices, and an annual Armed Forces No Smoking Day (Figure A4-5), were embedded in military culture.

Figure A4-5 - Armed Forces No Smoking Day poster

Recent cuts to funding have led to major reductions in the military smoking cessation programme (Bhabutta, pers. comm.), and there is evidence that smoking rates are rising again (see Section A4.1.4).

A4.1.4 Long-Term Trends

The heterogeneity of the data means that it is problematic to show trends in smoking prevalence in the Armed Forces over time, but a synthesis of various sources[331] is shown at Figure A4-6 and demonstrates falling rates from 1969-2004.

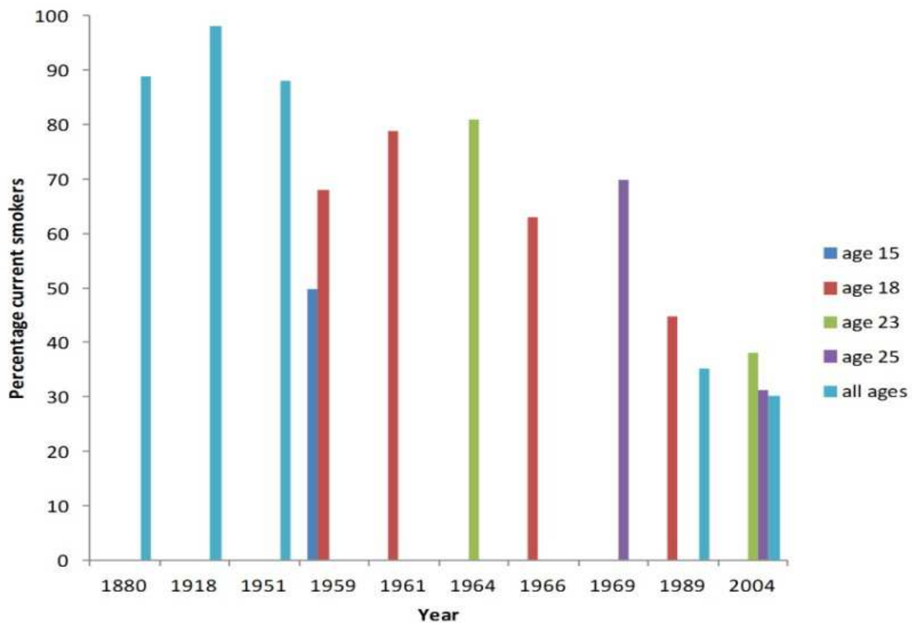


Figure A4-6 – Trends in military smoking by year and age
Compiled from various sources

The International Smoking Statistics (ISS) Web Edition[332] provides historical data on smoking rates by country, and from those it has been possible to construct a composite graph comparing British military smoking rates with UK civilian rates. Assuming that all military smokers use cigarettes, Crowdy's estimate of a 17-20% excess in soldiers appears validated (Figure A4-7). The excess has persisted over time, the reduction in military smoking prevalence lagging behind that in civilians.

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[331]Veale, H. (1880) 'On palpitation of the heart in soldiers' in *Army Medical Report for the Year 1880*, London: Eyre & Spottiswoode.

Lewis, T. (1918) *The Soldier's Heart and the Effort Syndrome,* London: Shaw & Sons.

Richards, H. J. A. and Crowdy, J. P. (1961) 'Smoking habits of young soldiers', *British Journal of Social & Preventive Medicine,* 15, 84-88.

Lodge, L. H. (1991) 'Tri-service Health Questionnaire - 1989', *Journal of the Royal Army Medical Corps,* 137(2), 80-83.

Lewthwaite, C. J. and Graham, J. T. (1992) 'The smoking habits of young soldiers', ibid.138, 67-71.

[332] http://www.pnlee.co.uk/ISS.htm last accessed 26 June 2014

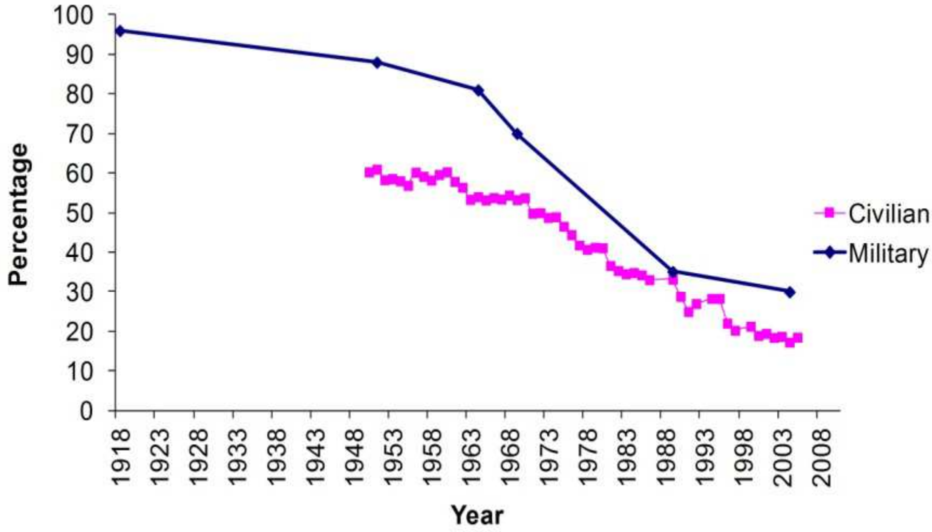

Figure A4-7 – Military and civilian smoking prevalence, by year
Male cigarette smokers
Compiled from various sources

Unfortunately there is evidence of increasing military smoking prevalence in connection with recent operational deployments, a study in medical personnel deployed to Iraq in 2003 showing a rate of 29% pre-deployment, rising to 38% after six weeks. Boredom, social factors and stress were reported to be reasons for starting to smoke on operations, with some people restarting after previously quitting successfully. Mean daily cigarette consumption also increased in those who were already smokers (Boos and Croft 2004).

A4.2 Alcohol

A4.2.1 Historical Background

The early use of alcohol by the military may have mirrored its use in the wider community, predominantly as a drink which was generally safer than water. In the absence of facilities for purifying drinking water when in the field, it was recommended that wine or spirits be added to render it wholesome (Monro 1780). Prior to 1800, soldiers were provided with beer as part of their daily ration of food and drink. This was usually ‘small beer’, a low-alcohol beverage which would have had little potential for intoxication or misuse. Sailors received a ration of one gallon of beer per day, but this was gradually replaced by a daily half-pint of rum (taken diluted 1:4 with water) following the British conquest of Jamaica in 1655. The naval rum ration was not discontinued until 1970. The Army permitted rum to be issued as a stimulant in arduous conditions on the authorisation of a medical officer, a practice which continued to recent times[333]. From 1800 the daily ration of beer was replaced by a monetary allowance of one penny per day for 'beer money' with which it was to be purchased locally, thus absolving the Army from the need to transport bulky stocks of beer. 'Beer money' was eventually subsumed into soldiers' pay in 1873. The provision of 'beer money' encouraged soldiers to frequent local taverns, and alcohol misuse became especially problematic during the 19th century although there are many earlier accounts of soldiers having become intoxicated after discovering a supply of alcohol, and it is alleged to have played a decisive part in the outcome of a number of battles, including the Battle of Bannockburn.

The Crimean War led to a rise in alcohol misuse by soldiers, graphically described in *The Times* newspaper[334]. There was public outrage, led by the newspapers, but little action resulted. A commentator in the *Glasgow Herald* of 21 December 1855 attributed the problem to:

> "a person who is totally unaccustomed to the use of money . . . finds his pockets full, and is at the same time surrounded by temptation in its manifold forms".

A letter in *The Times* of 9 November 1855 from 'An Englishman' attributed much of the blame to the availability of spirits and called for coffee, tea and beer to replace the issue of spirits, noting that the health of officers in the Indian Army had greatly improved since they had become accustomed to drink bitter ale rather than wines or spirits. *The Times* reported that 2.28% of the Army had been imprisoned on account of drunkenness in 1867 and a Major Edwardes noted that:

> "Owing to increased pay, the vice of drunkenness has again been prevalent".

[333] The author personally recollects authorising the issue of a 'rum ration' by the Quartermaster on a winter exercise in Germany in the late 1970s.

[334] "The tavern-booths of Old Kadikoi [*near Balaklava*] were crowded with drinkers, and rang with oaths, obscenity, and brawls." *The Times*, 9 November 1855

Although fewer Scottish soldiers were imprisoned for drunkenness than English (1.33% in 1867 compared with 2.23%), the wider Scottish population was not immune to the long-term effects of alcohol. *The Times*[335] noted that:

> "In the hospitals of Edinburgh and Glasgow there is hardly a patient without a deceased [*sic*] liver. Even the stout Highlander becomes prematurely old, and neither comes up to the southern idea of his stature nor completes the allotted period of life under the incessant attack of this insidious foe."

A4.2.2 Military Alcohol Use in the Late 20th Century

Military health promotion throughout service strongly discourages excessive use of alcohol, and has been given particular emphasis during the late 20th century with the introduction of a Defence-wide health strategy. However, for many soldiers during the 1960s, 1970s and early 1980s, heavy alcohol use was an accepted, and indeed valued, social and recreational activity, especially in Germany and other overseas localities where both its tax-free status and the overseas living allowances paid to Service personnel meant that cost did not limit consumption. Other than on the operational tours of duty in Northern Ireland from 1969 onwards, the military routine was predominantly based around training, military exercises and sport. The social milieu in which off-duty leisure time was spent revolved around bars – NAAFI[336], Sergeants' Mess or Officers' Mess depending on rank. Alcohol was a powerful social lubricant and there was a macho bravado associated with extreme over-indulgence[337].

In the late 1970s and early 1980s the military drinking culture began to change as part of a general transition to a fitness-orientated culture (see Section A3.3.4). Over a period of around 20 years, drunkenness, and especially lunchtime drinking, changed from being almost *de rigeur* to being almost taboo, as continuing operational activity in Northern

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[335] 9 November 1855

[336] Navy, Army and Air Force Institute, provider of 'club' facilities to military personnel not entitled to use a Mess.

[337] As typically described in an ex-service 'blog' website at http://raoc.websitetoolbox.com/post?id=6097617&trail=25 (accessed 27 June 2014). "I am still amazed at how much and how often we drank in BAOR [*British Army of the Rhine, ie Germany*] in the '70's. . . BAOR is the only place I served where we drank 7 days a week, lunchtimes and evenings." "I think it was an occupational hazard. Everyone drank in the Army in the 70's 80's 90's. They don't touch it now on operations. Good move in my opinion. I wish there was less of a drinking culture when I served." One contributor notes the lack of an English-language television service for troops serving in Germany in 1978 as a reason for a 'party'.

Ireland followed by the Falklands, the Balkans and the Middle East reduced the long periods of inactivity associated with a predominantly Cold War-orientated Force, and especially as the Armed Forces became aware of the problems of heavy drinking and began to implement health promotion strategies. Army policy and regulations discouraged heavy drinking off-duty and it remained an offence to be drunk, whether or not required for duty[338] (Bergman et al. 2015b), but it may be argued that the most powerful driver was peer example and pressure; the societal drinking 'norm' is the most likely pattern to be followed, especially in younger people and in a group-orientated culture such as the Armed Forces (Dielman et al. 1987, Selnow and Crano 1986).

There is considerable interest in alcohol behaviour in relation to current and recent operations (Bergman et al. 2015b). One study has showed an increase in heavy drinking behaviour (>20 units per week) between the Gulf War (1991) and the Iraq War (2003), irrespective of deployment history, in both men and women (Rona et al. 2007). In personnel who deployed to Iraq in 2003 (Operation TELIC 1), heavy drinking (defined by the authors as an AUDIT[339] score of 16 or higher) was more likely in those who deployed with their parent unit; had medium to high unit comradeship; had poor unit leadership; and had problems at home during and after deployment. No individual combat exposures reached statistical significance as a risk factor for heavy drinking although there was a trend towards more time spent in a forward area. The authors noted the lack of previous research on the association between comradeship and alcohol use (Browne et al. 2008).

A4.2.3 Alcohol and Recruits

The drinking of alcohol during recruit training has generally been subject to strict controls, as part of the induction of a culture of military discipline and the general restriction of freedom which accompanies the early weeks in uniform. A formal statement of this policy has proved impossible to obtain; a Freedom of Information request to the MOD[340] for details of the policy in recruit training units which pertained between 1960 and 2006 produced only a 'Discipline and Standards Paper' for the Army, issued in 1993, setting out the expected standards of behaviour in this respect by all personnel and highlighting the

[338] Army Act 1955. 3 & 4 Eliz. 2 Ch. 18 Sect. 43, superseded by the Armed Forces Act 2006 Sect. 20

[339] Alcohol Use Disorders Identification Tool

[340] MOD response FOI2014/07782 dated 6 January 2015

difference between social drinking and harmful or drunken behaviour[341]. The current policy[342], issued in 2006, places a responsibility on Commanding Officers to conduct an 'estimate' (essentially, a risk assessment) and set policy appropriate to their unit.

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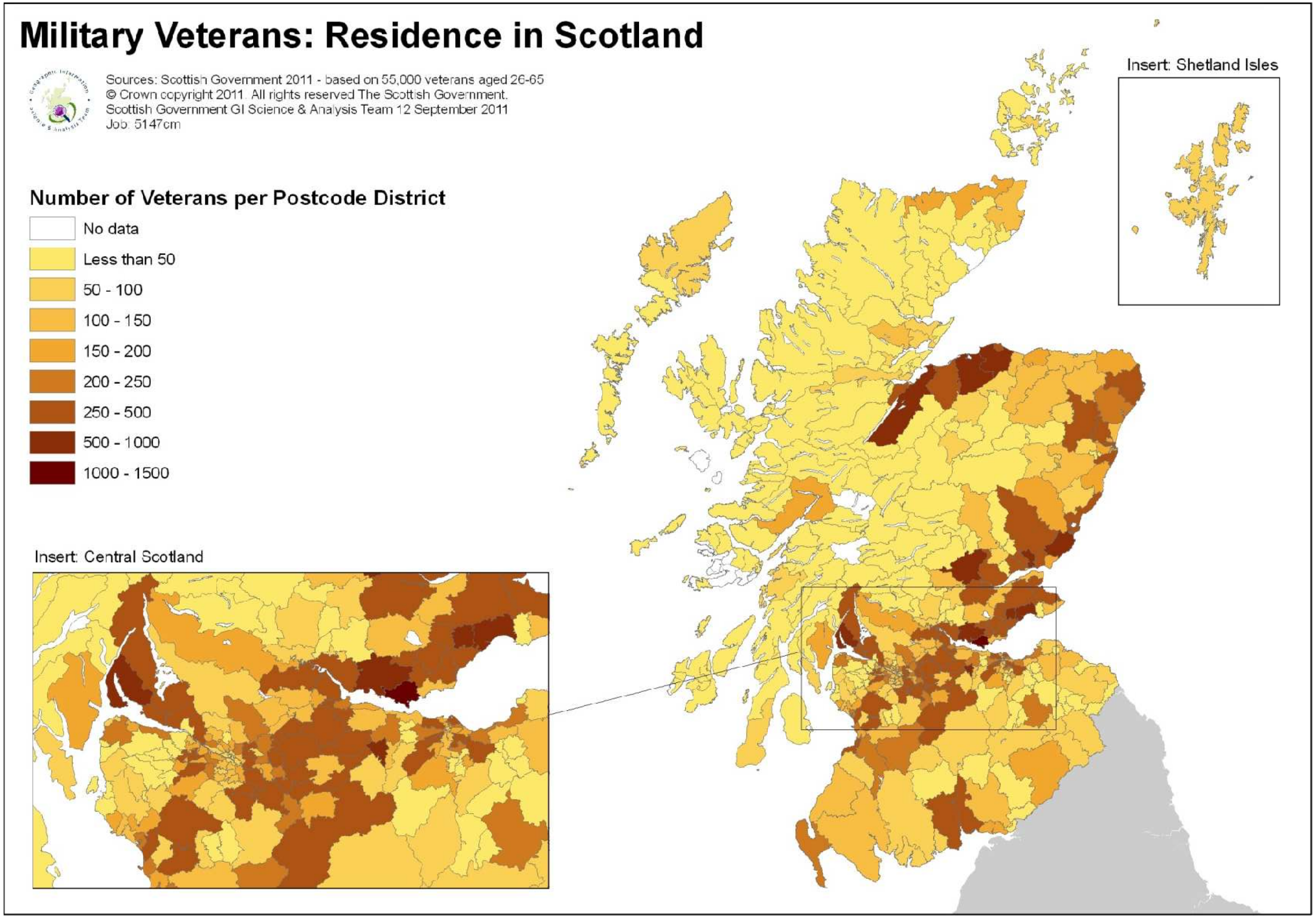
[341] '*The Military Ethos*', paras 17-20, issued under cover of D/AG/4/5/1 dated 21 October 1993.

[342] AGAI Vol 2 Chap 64

Appendix 5 – Maps


Military Veterans: Residence in Scotland
Sources: Scottish Government 2011 - based on 55,000 veterans aged 26-65
© Crown copyright 2011. All rights reserved The Scottish Government.
Scottish Government GI Science & Analysis Team 12 September 2011
Job: 5147cm
Number of Veterans per Postcode District
No data
Less than 50
50 - 100
100 - 150
150 - 200
200 - 250
250 - 500
500 - 1000
1000 - 1500
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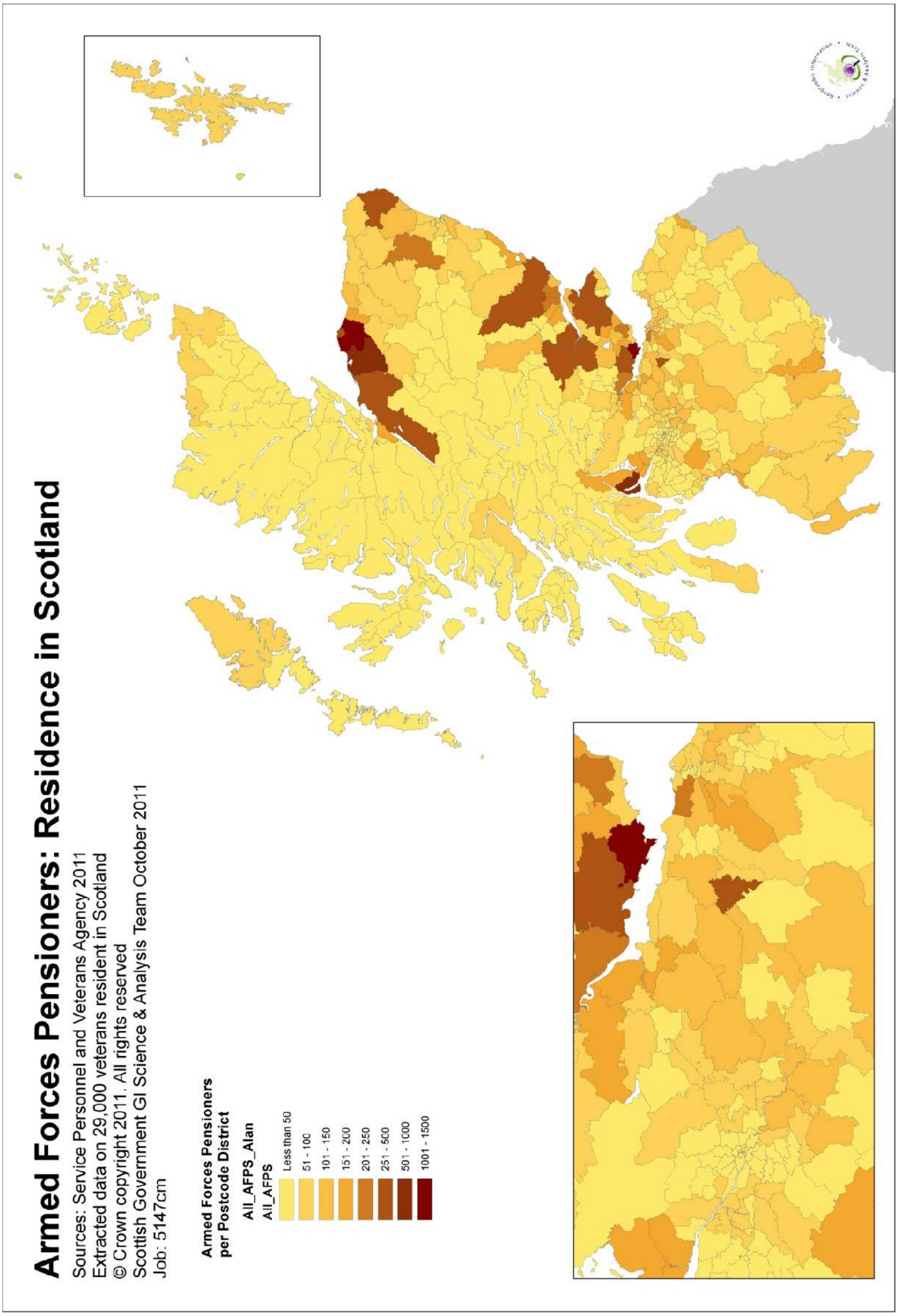
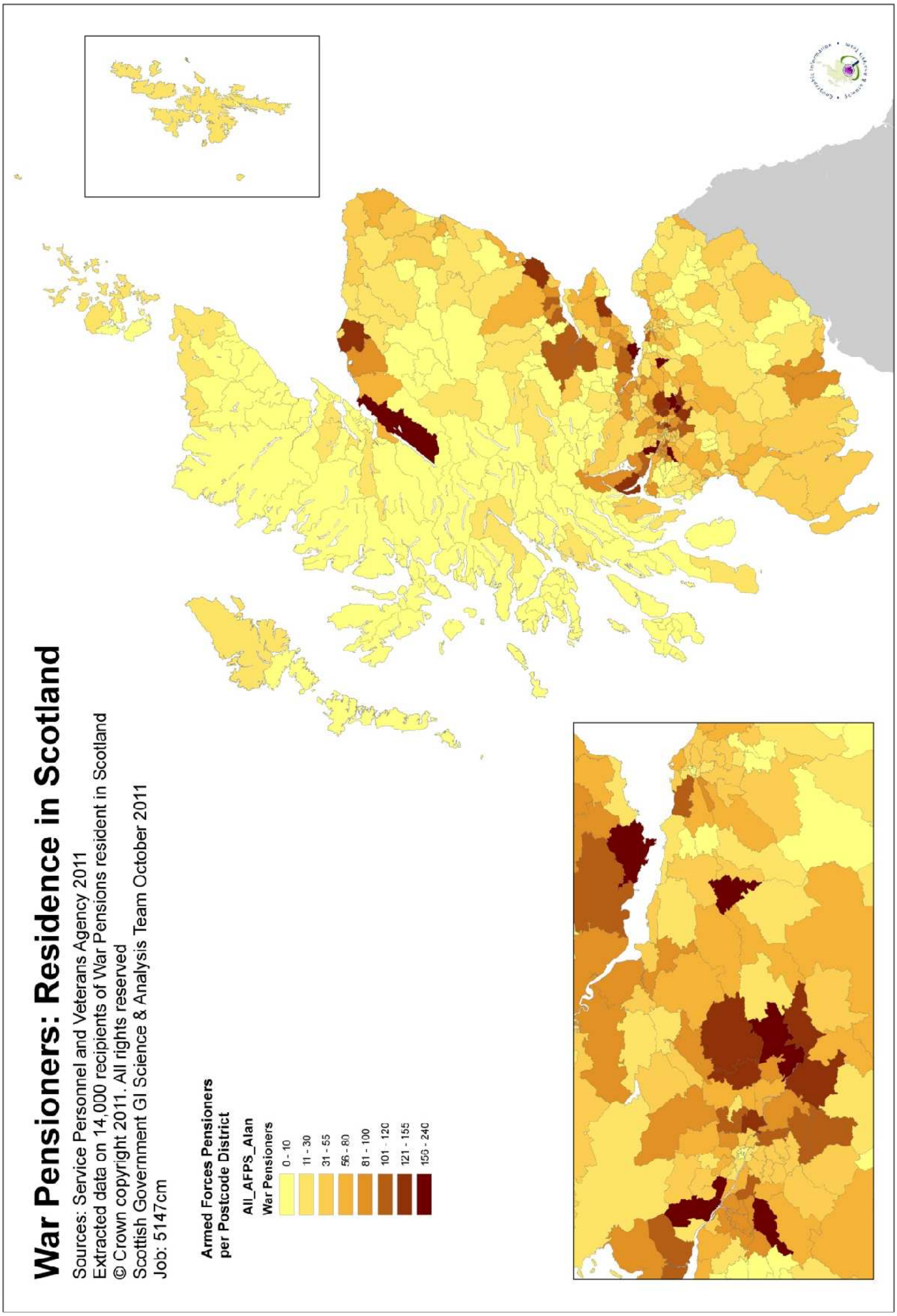
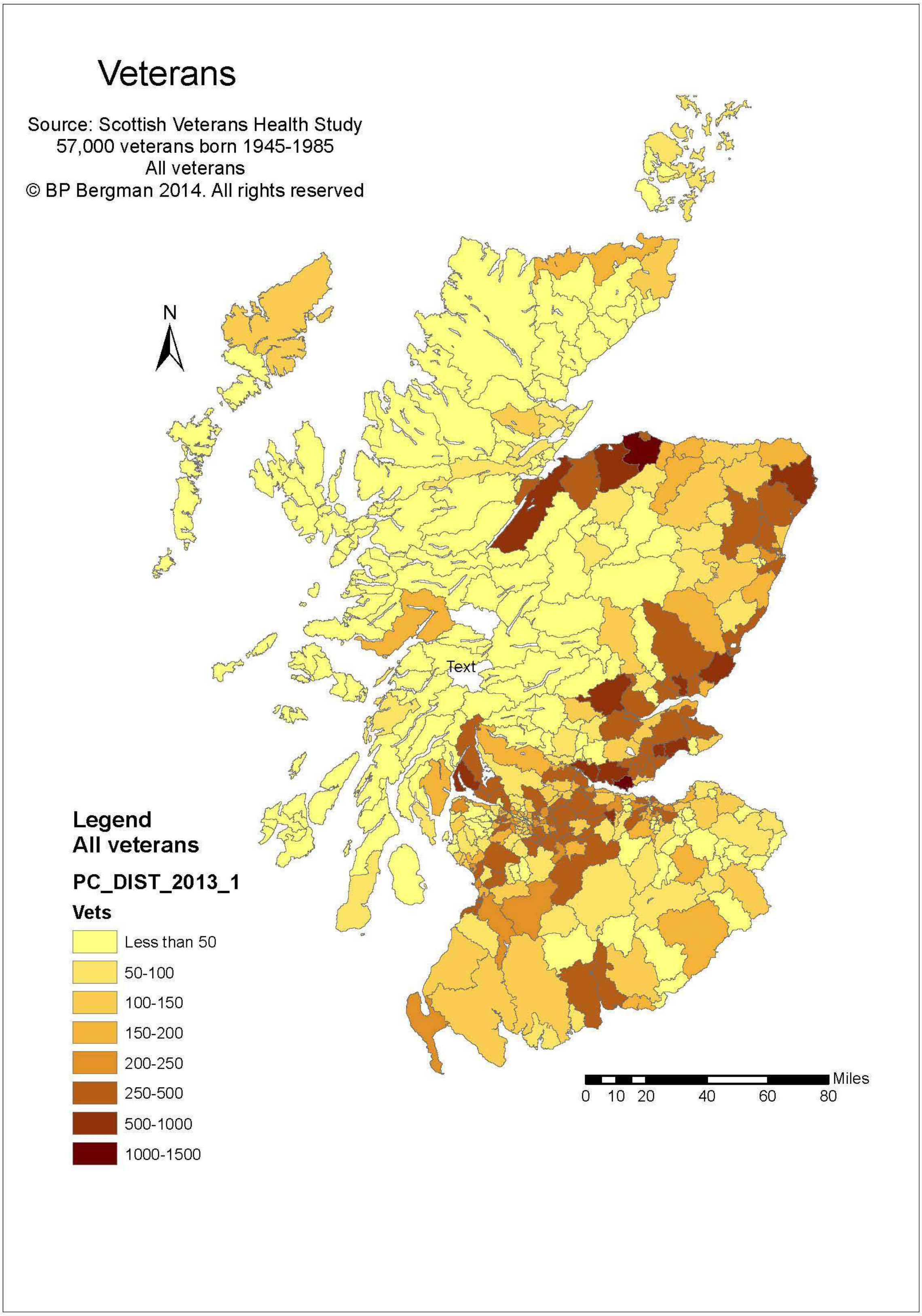
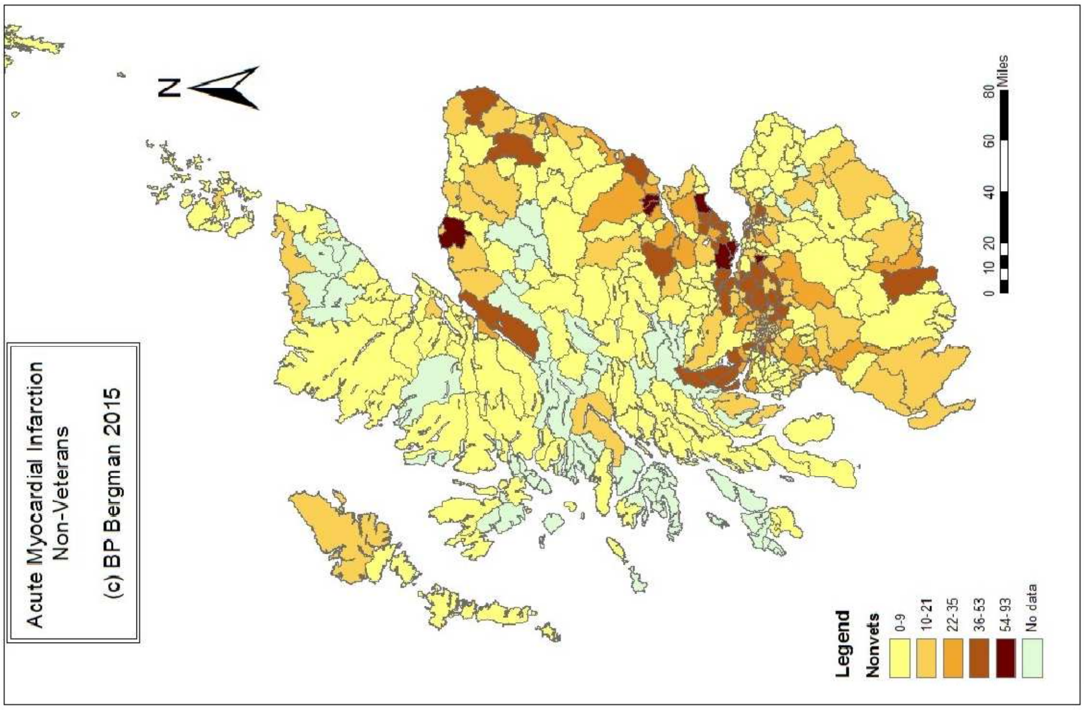
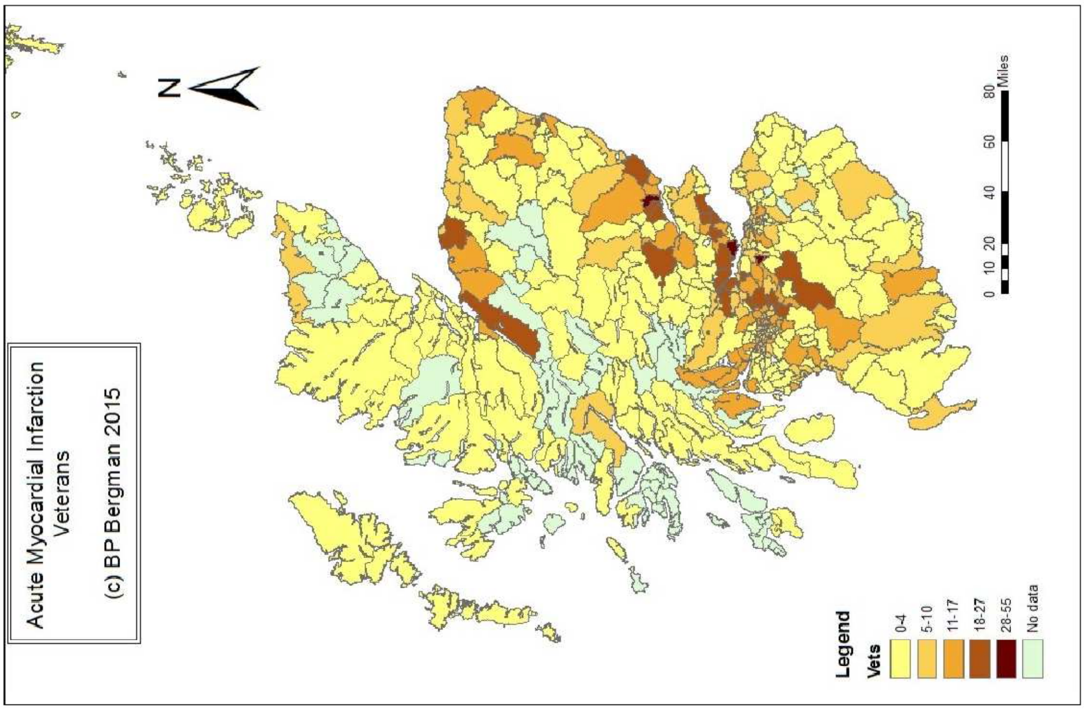
Insert: Shetland Isles


Armed Forces Pensioners: Residence in Scotland
Sources: Service Personnel and Veterans Agency 2011
Extracted data on 29,000 veterans resident in Scotland
© Crown copyright 2011. All rights reserved
Scottish Government GI Science & Analysis Team October 2011
Job: 5147cm
Armed Forces Pensioners
per Postcode District
All_AFPS_Alan
All_AFPS
Less than 50
51 - 100
101 - 150
151 - 200
201 - 250
251 - 500
501 - 1000
1001 - 1500


War Pensioners: Residence in Scotland
Sources: Service Personnel and Veterans Agency 2011
Extracted data on 14,000 recipients of War Pensions resident in Scotland
© Crown copyright 2011. All rights reserved
Scottish Government GI Science & Analysis Team October 2011
Job: 5147cm
Armed Forces Pensioners
per Postcode District
All_AFPS_Alan
War Pensioners
0 - 10
11 - 30
31 - 55
56 - 80
81 - 100
101 - 120
121 - 155
156 - 240


Veterans
Source: Scottish Veterans Health Study
57,000 veterans born 1945-1985
All veterans
© BP Bergman 2014. All rights reserved
N
Text
Legend
All veterans
PC_DIST_2013_1
Vets
Less than 50
50-100
100-150
150-200
200-250
250-500
500-1000
1000-1500
Miles
0 10 20 40 60 80


Acute Myocardial Infarction
Non-Veterans
(c) BP Bergman 2015
N
Legend
Nonvets
0-9
10-21
22-35
36-53
54-93
No data
0 10 20 40 60 80 Miles


Acute Myocardial Infarction
Veterans
(c) BP Bergman 2015
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Vets
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5-10
11-17
18-27
28-55
No data
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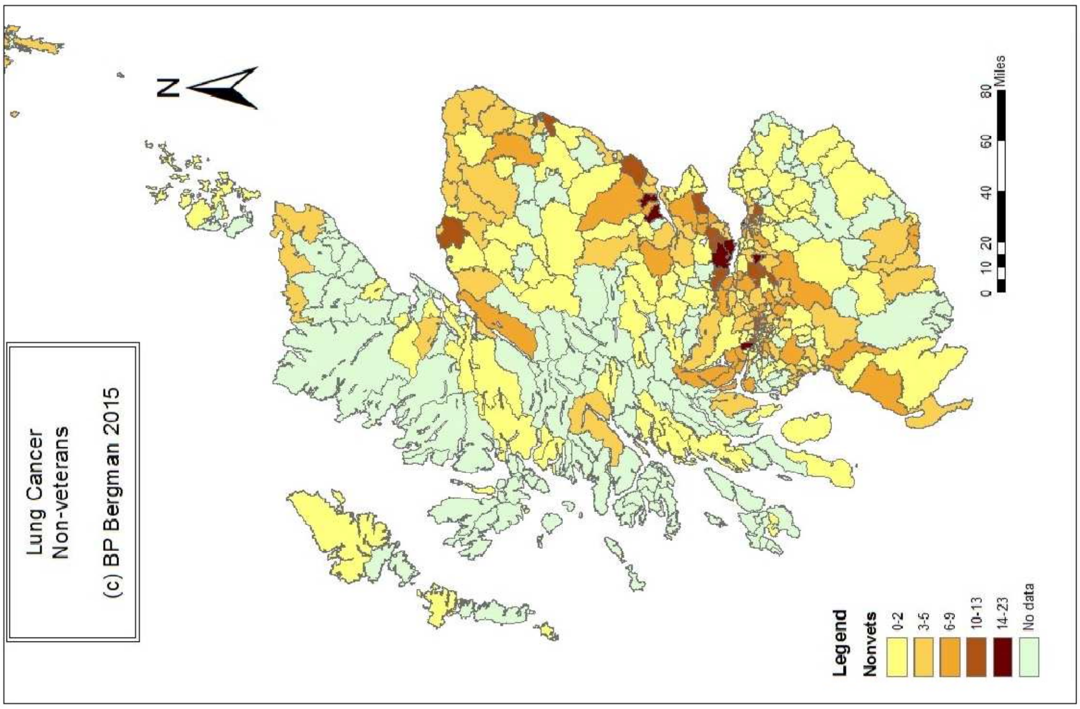
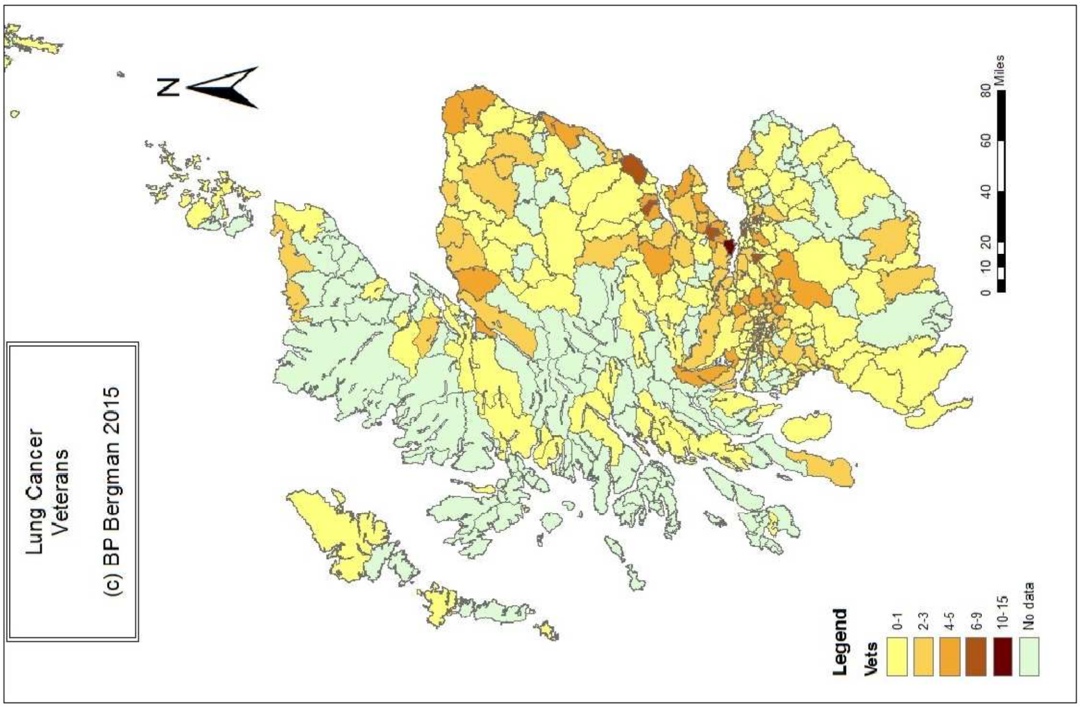

Lung Cancer
Non-veterans
(c) BP Bergman 2015
N
0 10 20 40 60 80 Miles
Legend
Nonvets
0-2
3-5
6-9
10-13
14-23
No data


Lung Cancer
Veterans
(c) BP Bergman 2015
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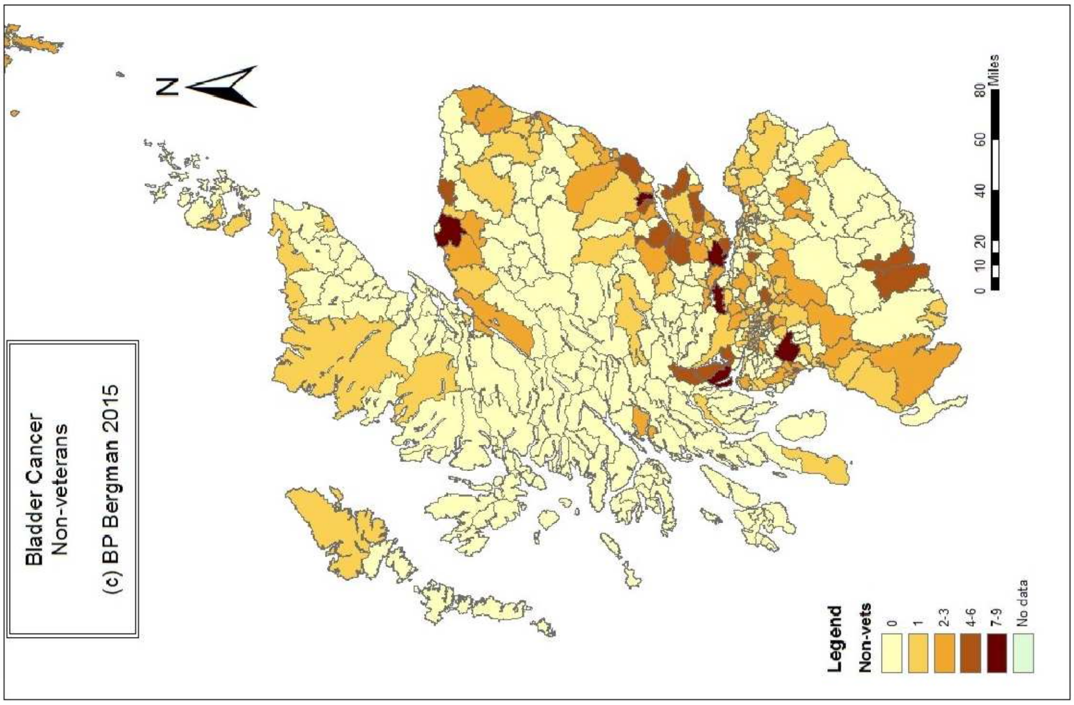
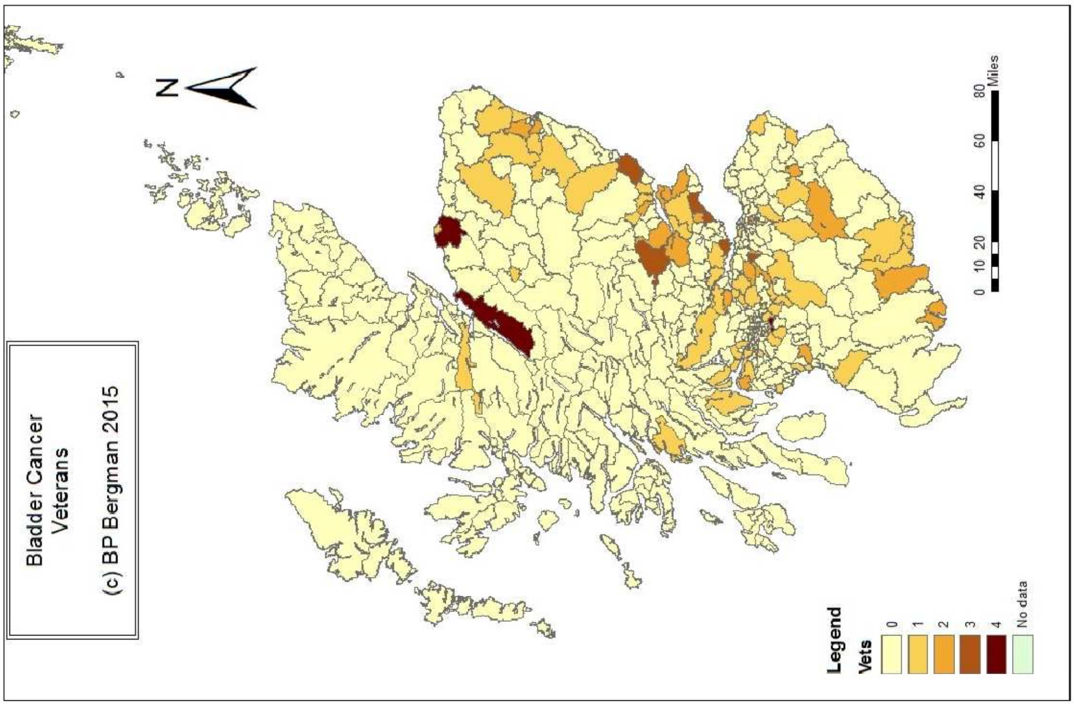
0 10 20 40 60 80 Miles
Legend
Vets
0-1
2-3
4-5
6-9
10-15
No data


Bladder Cancer
Non-veterans
(c) BP Bergman 2015
N
0 10 20 40 60 80 Miles
Legend
Non-vets
0
1
2-3
4-6
7-9
No data


Bladder Cancer
Veterans
(c) BP Bergman 2015
N
0 10 20 40 60 80 Miles
Legend
Vets
0
1
2
3
4
No data

Appendix 6 - Variables

Table A6-1 - Variables in original data file as supplied

Variable name	Description
PatientID	Anonymous patient ID
vet_flag	Veteran flag (0=non-veteran, 1=veteran)
dobirth	Date of birth (Format YYYYMMDD)
sex	Sex (1=Male, 2=Female)
HBRES	Health board of residence (most recent recorded)
scsimd2012quintile	SIMD 2012 Scotland Quintile (1=Most deprived, 5=Least deprived)
hbsimd2012quintile	SIMD 2012 Health Board Quintile (1=Most deprived, 5=Least deprived)
date_entered_MS	Date entered military service (Format YYYYMMDD)
date_left_MS	Date left military service (Format YYYYMMDD)
death_flag	Death flag (0=alive, 1=dead)
Date_of_death	Date of death (Format YYYYMMDD)
Cause_of_death	Cause of death (ICD9/ICD10)
AMI	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_AMI	Date of first specified diagnosis (Format YYYYMMDD)
stroke	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_stroke	Date of first specified diagnosis (Format YYYYMMDD)
PAD	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_PAD	Date of first specified diagnosis (Format YYYYMMDD)
cancer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_cancer	Date of first specified diagnosis (Format YYYYMMDD)
oesoph_cancer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_oesoph_cancer	Date of first specified diagnosis (Format YYYYMMDD)
stomach_cancer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_stomach_cancer	Date of first specified diagnosis (Format YYYYMMDD)
sml_intest_cancer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_sml_intest_cancer	Date of first specified diagnosis (Format YYYYMMDD)
colorectal_cancer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_colorectal_cancer	Date of first specified diagnosis (Format YYYYMMDD)
liver_cancer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_liver_cancer	Date of first specified diagnosis (Format YYYYMMDD)
pancreatic_cancer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)

Date1st_pancreatic_cancer	Date of first specified diagnosis (Format YYYYMMDD)
lung_cancer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_lung_cancer	Date of first specified diagnosis (Format YYYYMMDD)
breast_cancer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_breast_cancer	Date of first specified diagnosis (Format YYYYMMDD)
cervical_cancer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_cervical_cancer	Date of first specified diagnosis (Format YYYYMMDD)
uterine_cancer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
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Date1st_ovarian_cancer	Date of first specified diagnosis (Format YYYYMMDD)
prostate_cancer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_prostate_cancer	Date of first specified diagnosis (Format YYYYMMDD)
testicular_cancer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_testicular_cancer	Date of first specified diagnosis (Format YYYYMMDD)
renal_cancer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_renal_cancer	Date of first specified diagnosis (Format YYYYMMDD)
bladder_cancer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_bladder_cancer	Date of first specified diagnosis (Format YYYYMMDD)
hodgkins_disease	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_hodgkins_disease	Date of first specified diagnosis (Format YYYYMMDD)
nonhodgkins_lymphoma	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_nonhodgkins_lymphoma	Date of first specified diagnosis (Format YYYYMMDD)
leukaemia	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_leukaemia	Date of first specified diagnosis (Format YYYYMMDD)
malignant_melanoma	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_malignant_melanoma	Date of first specified diagnosis (Format YYYYMMDD)
intracranial_cancer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_intracranial_cancer	Date of first specified diagnosis (Format YYYYMMDD)
dementia	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_dementia	Date of first specified diagnosis (Format YYYYMMDD)
psychosis	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_psychosis	Date of first specified diagnosis (Format YYYYMMDD)
mood_disorder	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_mood_disorder	Date of first specified diagnosis (Format YYYYMMDD)

anxiety	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_anxiety	Date of first specified diagnosis (Format YYYYMMDD)
stress_PTSD	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_stress_PTSD	Date of first specified diagnosis (Format YYYYMMDD)
COPD_asthma	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_COPD_asthma	Date of first specified diagnosis (Format YYYYMMDD)
alco_liver_disease	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_alco_liver_disease	Date of first specified diagnosis (Format YYYYMMDD)
liver_disease	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_liver_disease	Date of first specified diagnosis (Format YYYYMMDD)
road_traffic_accident	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_road_traffic_accident	Date of first specified diagnosis (Format YYYYMMDD)
poisoning	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_poisoning	Date of first specified diagnosis (Format YYYYMMDD)
trauma	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_trauma	Date of first specified diagnosis (Format YYYYMMDD)
tuberculosis	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_tuberculosis	Date of first specified diagnosis (Format YYYYMMDD)
hepatitis_B	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_hepatitis_B	Date of first specified diagnosis (Format YYYYMMDD)
hepatitis_C	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_hepatitis_C	Date of first specified diagnosis (Format YYYYMMDD)
peptic_ulcer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_peptic_ulcer	Date of first specified diagnosis (Format YYYYMMDD)
oropharynx_larynx_cancer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_oropharynx_larynx_cancer	Date of first specified diagnosis (Format YYYYMMDD)
non_melanoma_skin_cancer	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_non_melanoma_skin_cancer	Date of first specified diagnosis (Format YYYYMMDD)
mesothelioma	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_mesothelioma	Date of first specified diagnosis (Format YYYYMMDD)
multiple_sclerosis	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_multiple_sclerosis	Date of first specified diagnosis (Format YYYYMMDD)
motor_neuron_disease	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_motor_neuron_disease	Date of first specified diagnosis (Format YYYYMMDD)

diabetes	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_diabetes	Date of first specified diagnosis (Format YYYYMMDD)
renal_disease	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_renal_disease	Date of first specified diagnosis (Format YYYYMMDD)
GU_disease	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_GU_disease	Date of first specified diagnosis (Format YYYYMMDD)
self_harm_suicide	Flag for specified diagnosis (0=no diagnosis, 1=recorded diagnosis)
Date1st_self_harm_suicide	Date of first specified diagnosis (Format YYYYMMDD)
antidepressants	Flag for specified prescription (0=no prescription, 1=recorded prescription)
Date1st_antidepressants	Paid date of first specified prescription (Format YYYYMM)
anxiolytics	Flag for specified prescription (0=no prescription, 1=recorded prescription)
Date1st_anxiolytics	Paid date of first specified prescription (Format YYYYMM)
anti_psychotics	Flag for specified prescription (0=no prescription, 1=recorded prescription)
Date1st_anti_psychotics	Paid date of first specified prescription (Format YYYYMM)
NRT	Flag for specified prescription (0=no prescription, 1=recorded prescription)
Date1st_NRT	Paid date of first specified prescription (Format YYYYMM)
antabuse	Flag for specified prescription (0=no prescription, 1=recorded prescription)
Date1st_antabuse	Paid date of first specified prescription (Format YYYYMM)

Table A6-2 – Additional calculated variables

Variable name	Description
age_rec	Age at recruitment (years)
age_rec_int	Age at recruitment rounded to nearest integer
los	Length of service (years)
losint	Length of service rounded to nearest integer
yob	Year of birth (Format YYYY)
yo_rec	Year of recruitment (Format YYYY)
yo_death	Year of death (Format YYYY)
age_death	Age at death (years)
agenow	Age at end of study if still alive (years)
latest_age	Age at death or censoring (years)
start_age	Age at entry to follow-up (years)
start_date	Date of entry to follow-up
risk_marker	Dummy binary variable 0/1
pc_id	Postcode ID (from GIS OBJECTID field)
latest_date	Date of death or censoring
hbres_nhscr	Updated health board of residence
scsimd2012quintile_NHSCR*	Final update to SIMD Scotland quintile
hbsimd2012quintile_NHSCR*	Final update to SIMD health board quintile
pcid_nhscr*	Final update to Postcode ID field
hbres06_update	Health board post-2006
hbres_update_1*	Health board pre-2006

The ‘updated’ variables mark successive iterations to achieve completeness of data in respect of postcode, health board and SIMD; variables designated with an asterisk represent the most complete versions, which were used in the final data analysis.

Appendix 7 – ICD Codes used in Data Fields

Data field	ICD10 codes	ICD9 codes	Location
Acute myocardial infarction	I21	410	SMR1/SMR4/SMR6 any position or death certificate any position
Stroke	I61-I64 I60	430, 431, 432, 434, 436	SMR1/SMR4/SMR6 any position or death certificate any position
Peripheral arterial disease	I702 I73-I79	443.9, 440.2	SMR1/SMR4/SMR6 any position or death certificate any position
Any cancer	C00-C97 D00-D09	140-239 less 210-229	SMR1/SMR4/SMR6 any position or death certificate any position
Oesophageal cancer	C15	150	SMR1/SMR4/SMR6 any position or death certificate any position
Stomach cancer	C16	151	SMR1/SMR4/SMR6 any position or death certificate any position
Small intestine cancer	C17	152	SMR1/SMR4/SMR6 any position or death certificate any position
Colorectal cancer	C18-C21	153-154	SMR1/SMR4/SMR6 any position or death certificate any position
Liver cancer	C22	155	SMR1/SMR4/SMR6 any position or death certificate any position
Pancreatic cancer	C25	157	SMR1/SMR4/SMR6 any position or death certificate any position
Lung cancer	C33 & C34	162	SMR1/SMR4/SMR6 any position or death certificate any position
Breast cancer	C50	174-175	SMR1/SMR4/SMR6 any position or death certificate any position
Cervical cancer	C53	180	SMR1/SMR4/SMR6 any position or death certificate any position
Uterine cancer	C54 & C55	182	SMR1/SMR4/SMR6 any position or death certificate any position
Ovarian cancer	C56	183	SMR1/SMR4/SMR6 any position or death certificate any position
Prostate cancer	C61	185	SMR1/SMR4/SMR6 any position or death certificate any position
Testicular cancer	C62	186	SMR1/SMR4/SMR6 any position or death certificate any position
Renal cancer	C64 & C65	189.0 & 189.1	SMR1/SMR4/SMR6 any position or death certificate any position
Bladder cancer	C67	188	SMR1/SMR4/SMR6 any position or death certificate any position
Hodgkin lymphoma	C81	201	SMR1/SMR4/SMR6 any position or death certificate any position
Non-Hodgkin lymphoma	C82-C85	200, 202	SMR1/SMR4/SMR6 any position or death certificate any position
Leukaemia	C90-C95	203-208	SMR1/SMR4/SMR6 any position or death certificate any position
Malignant melanoma	C43	172	SMR1/SMR4/SMR6 any position or death certificate any position
Intracranial cancer	C71	191	SMR1/SMR4/SMR6 any position or death certificate any position
Dementia	G30, F00-F03	290, 331.0	SMR1/SMR4/SMR6 any position or death certificate any position
Schizophrenia/ psychosis	F20-F29	295	SMR1/SMR4/SMR6 any position or death certificate any position

Data field	ICD10 codes	ICD9 codes	Location
Mood disorders	F30-F39	296	SMR1/SMR4/SMR6 any position or death certificate any position
Anxiety	F40-F48	300, 308-309	SMR1/SMR4/SMR6 any position or death certificate any position
Stress/PTSD	F43	300, 308-309	SMR1/SMR4/SMR6 any position or death certificate any position
COPD/asthma	J40-J46	490-496 less 494 & 495	SMR1/SMR4/SMR6 any position or death certificate any position
Alcoholic liver disease	K70	571.0, 571.1, 571.2	SMR1/SMR4/SMR6 any position or death certificate any position
All liver disease	K70-K77	570-573	SMR1/SMR4/SMR6 any position or death certificate any position
Road traffic accident	V00-V99	E809-E819, E820-E825	SMR1/SMR4/SMR6 any position or death certificate any position
Poisoning	T36-T50 T51-T65	E850-E858 E860-E869 960-989.4	SMR1/SMR4/SMR6 any position or death certificate any position
Trauma	S00-S99,T00-T32	E880-E888 E890-E929 800-957	SMR1/SMR4/SMR6 any position or death certificate any position
Tuberculosis	A15-A19	010-018	SMR1/SMR4/SMR6 any position or death certificate any position
Hepatitis B	B16, B18.0-B18.1	070.2-070.3	SMR1/SMR4/SMR6 any position or death certificate any position
Hepatitis C	B17.1,B18.2	070.7, 070.4, 070.5	SMR1/SMR4/SMR6 any position or death certificate any position
Peptic ulcer	K25-K27	531-533	SMR1/SMR4/SMR6 any position or death certificate any position
Oropharynx/larynx cancer	C00-C14, C32	140-149, 161	SMR1/SMR4/SMR6 any position or death certificate any position
Non-melanoma skin cancer	C44	173	SMR1/SMR4/SMR6 any position or death certificate any position
Mesothelioma	C38.4, C45	163	SMR1/SMR4/SMR6 any position or death certificate any position
Multiple sclerosis	G35	340	SMR1/SMR4/SMR6 any position or death certificate any position
Motor neuron disease	G12.2	335.2	SMR1/SMR4/SMR6 any position or death certificate any position
Diabetes	E10-E14	250	SMR1/SMR4/SMR6 any position or death certificate any position
Renal disease	N00-N08, N10-N23, N26-N39,	580-589 590-593	SMR1/SMR4/SMR6 any position or death certificate any position
Genitourinary disease	N40-N51, N70-N77, N80-N98	597-599 600-608 614-629	SMR1/SMR4/SMR6 any position or death certificate any position
Self-harm/suicide	X60-X84, Y87.0, Y10-Y34, Y87.2	E950-E959, E980-E989	SMR1/SMR4/SMR6 any position or death certificate any position

Appendix 8 – PTSD Criteria

DMS-IV Criteria for Diagnosis of Post-Traumatic Stress Disorder

A history of exposure to a traumatic event meeting two criteria and symptoms from each of three symptom clusters: intrusive recollections, avoidant/numbing symptoms, and hyper-arousal symptoms. A fifth criterion concerns duration of symptoms and a sixth assesses functioning.

Criterion A: Stressor

The person has been exposed to a traumatic event in which both of the following have been present:

- The person has experienced, witnessed, or been confronted with an event or events that involve actual or threatened death or serious injury, or a threat to the physical integrity of oneself or others.

- The person's response involved intense fear, helplessness, or horror. Note: in children, it may be expressed instead by disorganized or agitated behaviour.

Criterion B: Intrusive recollection

The traumatic event is persistently re-experienced in at least one of the following ways:

- Recurrent and intrusive distressing recollections of the event, including images, thoughts, or perceptions. Note: in young children, repetitive play may occur in which themes or aspects of the trauma are expressed.

- Recurrent distressing dreams of the event. Note: in children, there may be frightening dreams without recognizable content

- Acting or feeling as if the traumatic event were recurring (includes a sense of reliving the experience, illusions, hallucinations, and dissociative flashback episodes, including those that occur upon awakening or when intoxicated). Note: in children, trauma-specific re-enactment may occur.

- Intense psychological distress at exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event.

- Physiologic reactivity upon exposure to internal or external cues that symbolize or resemble an aspect of the traumatic event

Criterion C: Avoidant/numbing

Persistent avoidance of stimuli associated with the trauma and numbing of general responsiveness (not present before the trauma), as indicated by at least three of the following:

- Efforts to avoid thoughts, feelings, or conversations associated with the trauma

- Efforts to avoid activities, places, or people that arouse recollections of the trauma

- Inability to recall an important aspect of the trauma

- Markedly diminished interest or participation in significant activities

- Feeling of detachment or estrangement from others

- Restricted range of affect (e.g., unable to have loving feelings)

- Sense of foreshortened future (e.g., does not expect to have a career, marriage, children, or a normal life span)

Criterion D: Hyper-arousal

Persistent symptoms of increasing arousal (not present before the trauma), indicated by at least two of the following:

- Difficulty falling or staying asleep

- Irritability or outbursts of anger

- Difficulty concentrating

- Hyper-vigilance

- Exaggerated startle response

Criterion E: Duration

Duration of the disturbance (symptoms in B, C, and D) is more than one month.

Criterion F: Functional significance

The disturbance causes clinically significant distress or impairment in social, occupational, or other important areas of functioning.

Specify if:

- **Acute:** if duration of symptoms is less than three months
- **Chronic:** if duration of symptoms is three months or more

Specify if:

- **With or without delay onset:** Onset of symptoms at least six months after the stressor

Appendix 9 – The Soldiers' Story: 480 Platoon

Qualitative data derived from soldiers' personal narrative can be a rich source of background information, enabling quantitative data to be contextualised, and aiding interpretation. On 11 January 1982, 41 recruits entered the Depot (training unit) of the Parachute Regiment for the first time. Their story was to become the subject of a BBC documentary series, The Paras[343], and a book[344]. In an era before the Data Protection Acts, and when individual consent could be subordinated to 'organisational' authorisation, the book encompasses much personal information and is a valuable source of material on personal aspirations, pre-service employment and, for those who were to become Early Service Leavers (ESL), reasons for leaving. In some cases, later follow-up has been provided by media reports and websites, including online discussion forums[345].

The platoon entered service close to the mid-point of the Scottish Veterans Health Study, the veterans' cohort having entered service between 1960 and 2012; members of the platoon were aged between 47 and 55 years at the end of the Scottish Veterans study. Although there was little overlap between the cohorts[346], the experiences of 480 Platoon provide a rare detailed insight into the life of a recruit during the study period.

Detailed biographical data are provided in the book on 39 of the 41 recruits, including names[347] and dates of birth. The other two recruits were from Ireland and little information on them is given; they are only referred to as 'the Irishmen'. Neither finished training; one went absent without leave (AWOL) whilst the other took voluntary 'discharge as of right' (DAOR). Of the remainder, 21 went on the join the Parachute Regiment and four joined other Army regiments; one was still in hospital at the end of follow-up. Thirteen (33%) left as ESL without finishing training. Ten of the recruits were

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343 First broadcast in 1983 and now available online as part of the BBC Four Army Collection http://www.bbc.co.uk/programmes/p00hjtqj (last accessed 30 December 2014)

344 Hilton F. The Paras. BBC (1983).

345 The author has a personal interest in 480 Platoon, having been Regimental Medical Officer at the Parachute Regiment Depot during the making of the documentary. All material presented in this Appendix is taken directly from, or derived from, publicly-available sources, either printed or online.

346 Only one member of 480 Platoon has been identified as a probable member of the Scottish Veterans cohort, based on dates of birth. The discrepancy may be due to inaccuracies in the biographical data as presented in the book, or to individuals having settled outside Scotland after leaving the Army.

347 Names of those believed to be still living have been withheld from this Appendix.

Scottish, of whom only 20% became ESL although this was stated to be unusual, the Scots generally (according to the Training Officer) having a poorer record of completing training.

Although unemployment was high in 1982, and four of the recruits had been unemployed for over a year, none gave this as his reason for wanting to join the Army. ‘Adventure’, ‘travel’ and ‘learning a trade’ were commonly given as reasons. Few had joined ‘on impulse’, and some had been required to wait over a year between their initial enquiry and the commencement of training. Perhaps surprisingly, most faced opposition to their enlistment from their parents, although 50% had a close relative (father, brother or uncle) who had served[348]. Of the four long-term unemployed, two completed training and entered the Parachute Regiment, and the other two became ESL (one AWOL and one of the Irishmen). One of those who had been unemployed, but successfully completed training, was discharged for theft after three years’ service; after discharge, he had a number of convictions for dishonesty before being jailed for 9 months, some 14 years after leaving the Army, for stalking a former girlfriend. He had been unemployed for most of the time since leaving the Army[349] although at his trial, he claimed to have been working for the police and the Ministry of Defence.

Eight of the recruits had been members of the Territorial Army (TA) or Army Cadet Force. This was generally perceived as disadvantageous, as it led to higher expectations being placed upon the recruit by the training staff:

> “It laid him open to charges of complacency, to knowing it all, to thinking he could take an easy ride just because he’d done some of the training before. This was not, of course, how he saw it. He was giving of his best.”

> “Clearly serving in the TA was no passport to success in the regular army. . . If anything, being in the TA seemed to be a positive disadvantage. It both raised the army’s expectations and somehow annoyed them at your presumption. Either you were accused of knowing it all . . or knowing nothing. . . Either way you came off badly, and had the contempt of your colleagues thrown in.”

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[348] In 1982, National Service had finished only 20 years earlier, so many recruits would have been the children or nephews of National Servicemen

[349] http://www.thefreelibrary.com/Jail+for+hulking+Para+in+stalker+terror%3B+TV+weirdo+spied+on+his+ex.-a064967085 and http://www.heraldscotland.com/sport/spl/aberdeen/former-para-jailed-for-stalking-1.219830 accessed 6 January 2015

Older recruits also had higher expectations placed upon them. One had been 'backsquadded'[350] because of injury and had been at the Depot for some time:

> "[The Sergeant] arrived to see how Section 1 was getting on. They were lucky having [the backsquadded soldier], he told them. He could help them out with any problems, show them how things were done. [The soldier] rather resented this suggestion. It was [the Sergeant's] job to teach recruits, not his. He had enough to do looking after himself."

He did not complete training and was later discharged Services No Longer Required (SNLR)[351].

The mean age at entry was 20.5 years, range 17.9-25.2 years. There was an inverse relationship between age at entry and likelihood of becoming ESL before completing training. Of those aged 20 years and over at entry, 35.3% failed to complete training, compared with 31.8% for those joining under 20 years of age. However, of those aged 18 years or less at entry, only 9.1% failed to complete training. Mean age at discharge for all ESL was 20.6 years, but those who opted for DAOR were older, mean 21.2 years.

Five recruits (12.2% of all recruits and 38.5% of all ESL) were discharged for medical reasons as a result of undeclared pre-existing conditions; two with asthma, two with knee problems and one with hypertension. A further recruit was discharged as 'temperamentally unsuitable' for service, a category which is only awarded following psychiatric assessment. The condition of the recruit discharged for hypertension had been detected at his initial pre-service medical examination, but it was not deemed sufficiently severe to preclude service until reviewed by a specialist when he joined for training, 16 months later. With no civilian job to go back to, he was bitterly disappointed, angry and resentful.

Not all who became ESL had cogent reasons for leaving, as illustrated in this account of an interview between the Company Commander and one of the recruits:

> "So what was the matter then? Why had he suddenly decided he wanted to leave? [He] could not find a satisfactory answer to that one. He just didn't like it. No, he wasn't homesick. He didn't think he'd enjoy the training, that's all.

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[350] Held back from an earlier group

[351] A category which may be used for misdemeanours not requiring formal disciplinary procedures

> And that was that. Right turn and fall out, in a shuffling, civvy sort of way. . . Oddly enough, [he] had come from Corporal Slater's[352] section too. But unlike [the soldier with hypertension], he couldn't wait to hand his kit in. . . . It was an interesting illustration of how one man's promised land could be another man's desert."

Others were more explicit:

> "He thought it was great . . He planned to stick it out to the end. Not like a couple in his section he could name and another couple in the section next door. Had enough, they had. Couldn't stand the bull[353] and the runs. They had come to symbolise all the physical effort and the pain they had to conquer if they wanted to stay the course."

Relationships with friends back home also changed. On the recruits' first weekend's leave,

> "They saw their girls, their parents and their friends – some of whom, they discovered, were less friendly now they were in the Paras. Becoming a soldier was rather like becoming a policeman. It tended to isolate you from your civvy peers, put you on the other side of the fence . . If that was how their friends felt, then they would just have to get on with it. At least, that was what the ones who planned to stay in the army thought. Those who had been having doubts on that score merely found their friends' attitude further justification for what they already had in mind. Get out. Admit it wasn't their scene. . . Anyone could make a mistake. It wasn't their fault they couldn't stay the pace, or stand the life."

Commentary

The soldiers' narrative reveals the complexity of predicting the long-term health risks likely to be experienced by veterans, and especially by ESL. In this small sample, some left with asthma or knee problems. One had hypertension, which may have been a precursor to later cardiovascular disease. None experienced a psychologically traumatic event, although many realised that they did not have the aptitude for military life. They have, however, clearly illustrated the way in which early training acts as a *de facto* extension to the recruit selection process, as postulated by Larson et al. (Larson et al. 2008) It may be

[352] Cpl Slater was unpopular as a section commander, "a fairly hard taskmaster, who was not liberal with his praise", although he commanded great respect, and especially won admiration for his skills as a field soldier. Eight weeks into training, only two recruits were left in his section, the remainder having been discharged, gone AWOL or been injured. Cpl (later Sgt) Slater went on to join the SAS and was killed on 2 December 1984 in Northern Ireland, in an operation for which he was posthumously awarded the Military Medal.

[353] Over-zealous polishing

argued that this is inevitable, and that there is no reasonable alternative; it is difficult to envisage a more appropriate battery of selection tests which could be applied before entry. It is inconceivable that 'not enjoying' military life is a health risk *per se*; rather, it is likely that the decision to leave early precludes recruits from benefiting from the military 'healthy worker' effect and from in-service health promotion and, instead, returns them to the civilian environment whence they came, perhaps with the added disadvantages of now being 'different', of having failed in the eyes of family and peers (Bergman et al. 2014a), and of becoming unemployed.

Appendix 10 - Trends over Time

The data analysis for the Scottish Veterans Health Study represented a snapshot as at the end of follow-up on 31 December 2012. It was possible that, had follow-up ended earlier, a different picture might have emerged. Accordingly, a series of graphs was constructed (Figure A10-1 to Figure A10-8) to illustrate the changing hazard ratios over time, for a number of representative conditions, for notional follow-up end points at two-yearly intervals from the start of the linked data in 1981. In the case of conditions having a later onset where there were no cases in the early years, or where a later landmark age had been defined, the analysis ran from the year of presentation of the earliest cases eligible for inclusion.

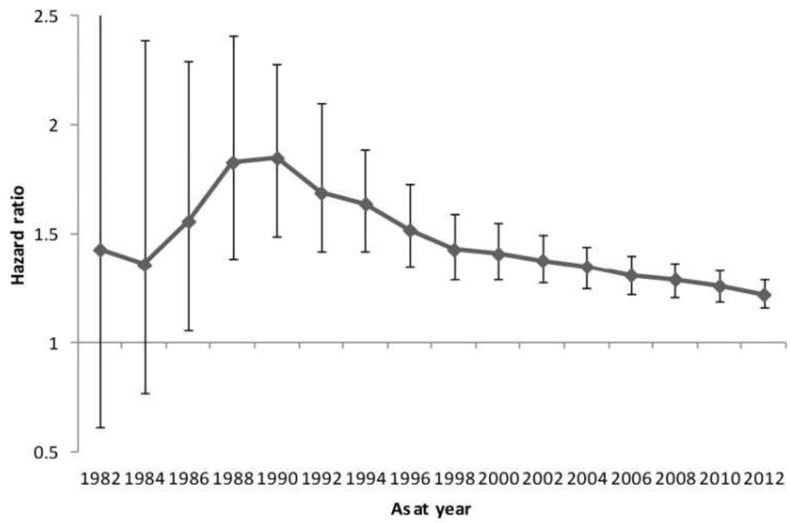

Figure A10-1 - AMI - hazard ratios for earlier endpoints by year Veterans referent to non-veterans

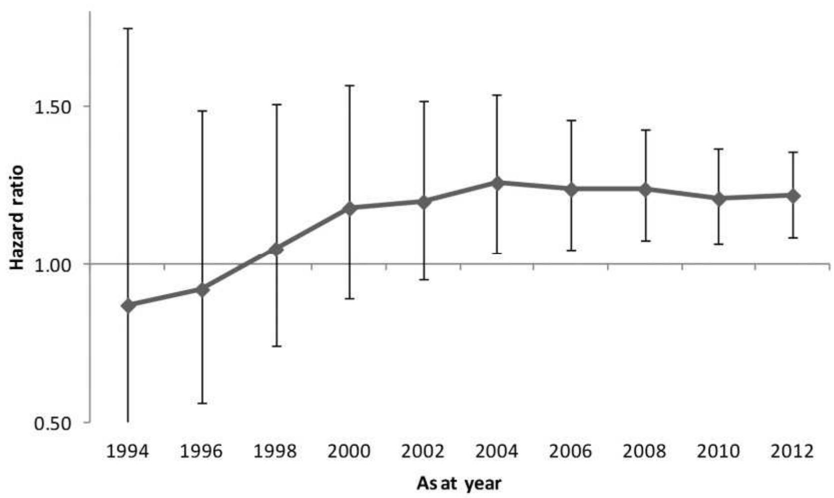

Figure A10-2 – Lung cancer - hazard ratios for earlier endpoints by year Veterans referent to non-veterans

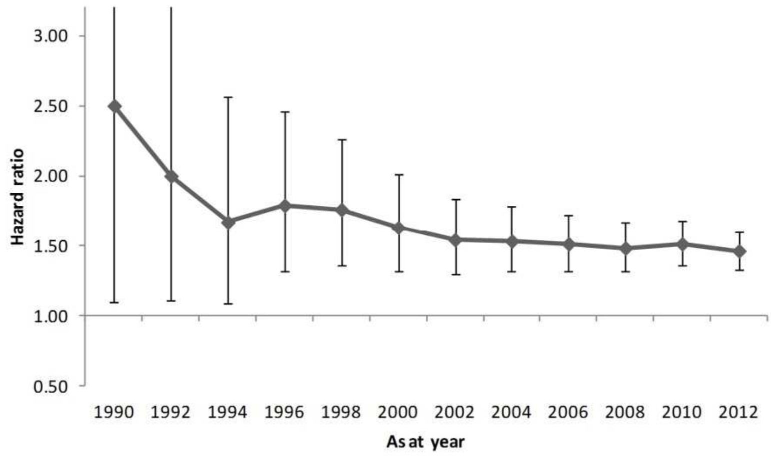

Figure A10-3 - PAD - hazard ratios for earlier endpoints by year Veterans referent to non-veterans

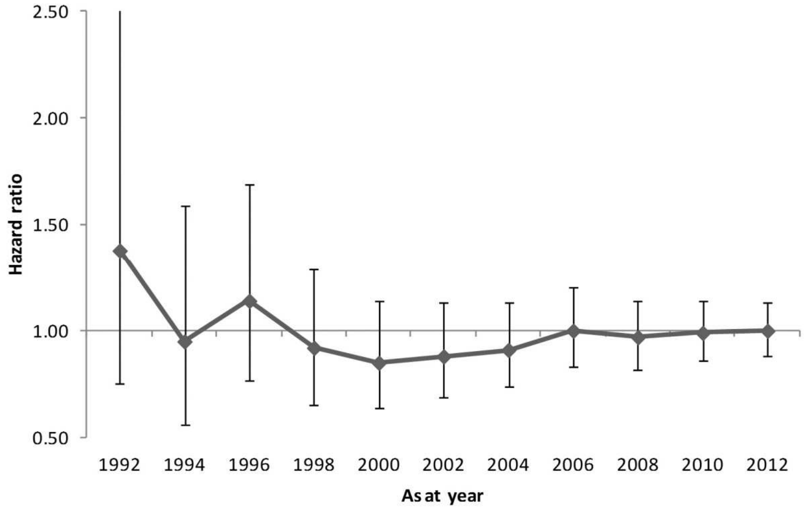

Figure A10-4 - Colorectal cancer - hazard ratios for earlier endpoints by year Veterans referent to non-veterans

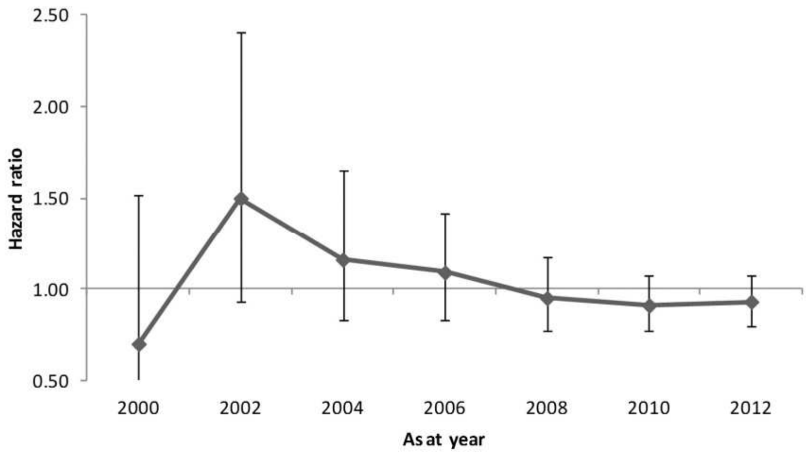

Figure A10-5 - Prostate cancer - hazard ratios for earlier endpoints by year Veterans referent to non-veterans

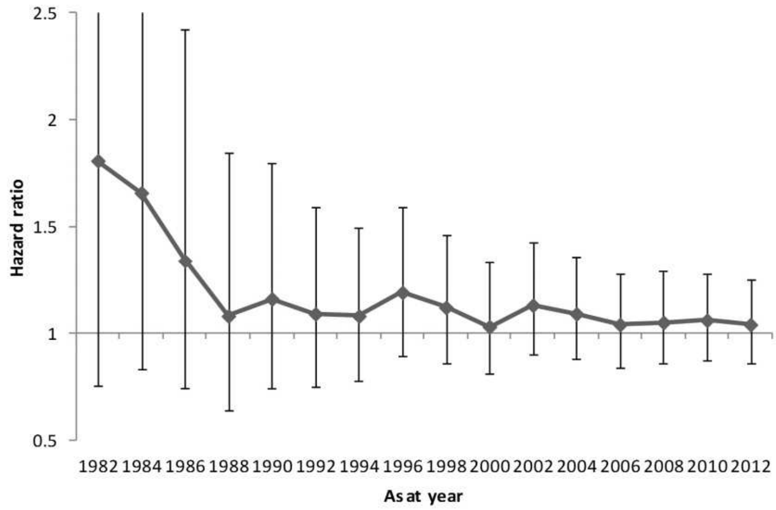

Figure A10-6 - Testicular cancer - hazard ratios for earlier endpoints by year Veterans referent to non-veterans

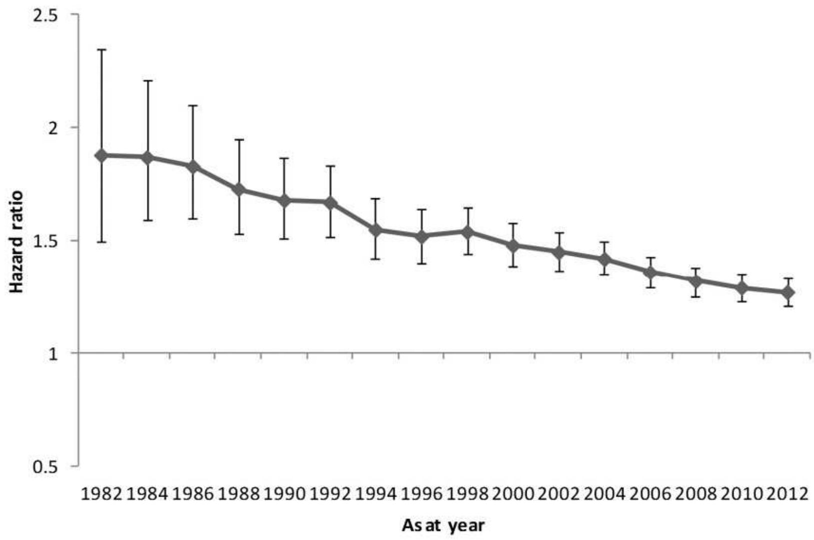

Figure A10-7 – Any mental health disorder - hazard ratios for earlier endpoints by year Veterans referent to non-veterans

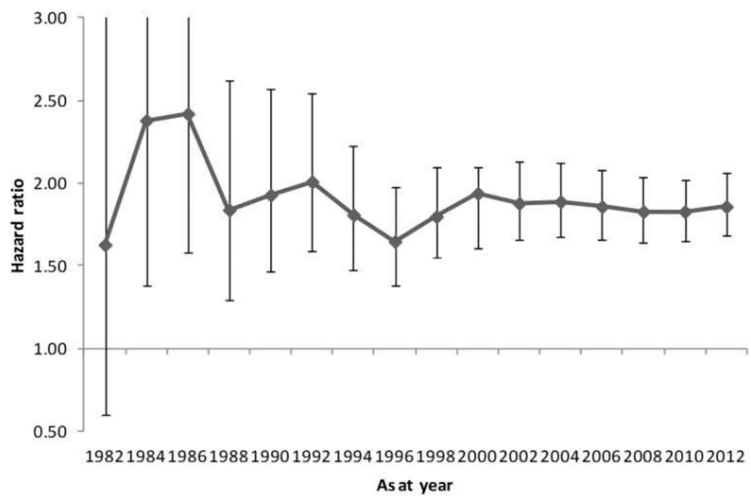

Figure A10-8 – Stress/PTSD - hazard ratios for earlier endpoints by year Veterans referent to non-veterans

For the early years, there was considerable fluctuation in the hazard ratios, accompanied by wide confidence intervals; the cohort was still young and the number of cases few. Once the 'steady state' was reached, the graphs provide an indication of trends in risk and thus *inter alia* may help to inform the needs assessment for future veterans' services. For some conditions, the improving health of veterans is making a clear impact. For example, the increased risk of AMI is decreasing steadily and, if the trend is maintained, it is likely that within 10 years, veterans will be at no greater risk of AMI than non-veterans. By contrast, in the late 1980s the excess risk in veterans was much higher than it is now, echoing the pattern that was reported in serving personnel and illustrated at Figure A1-4. The elevated risks of lung cancer and PAD in veterans show little sign of falling, perhaps reflecting the longer-term course of these other smoking-related conditions.

The graphs confirm no significant difference in risk between veterans and non-veterans in respect of colorectal cancer and prostate cancer at any time during the follow-up period, once the steady state had been reached. For the later years of follow-up, there is a similar pattern in testicular cancer although there is a non-significant indication of increased risk of testicular cancer in the early part of the period which is consistent with the non-significant elevation in risk which was observed in the 1945-1949 birth cohort.

The overall increase in risk of any mental health condition is decreasing steadily, albeit slowly; however, the graph for stress/PTSD shows that the increase in risk in veterans compared with non-veterans would have been broadly similar at any point over the period of follow-up. It is difficult to assess the significance of the early increase around 1984-1986, shortly after the Falklands campaign (1982), as the confidence intervals are wide, and overlap with later years.

Overall, analysis of changes over time confirms the gradually improving health of veterans, except for those smoking-related conditions which have a long lead time, and also further illustrates those conditions in which veterans' health does not differ from that of non-veterans.

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