Faculty of Social Sciences
University of Helsinki

DIFFERENCES IN MORTALITY AND HEALTH CARE USE BY OCCUPATION

Hanna Rinne

DOCTORAL DISSERTATION

To be presented for public discussion with the permission of the Faculty of Social Sciences of the University of Helsinki, in Festive Hall, University Language Centre, on the 7th of October, 2022 at 13 o'clock.

Helsinki 2022

Publications of the Faculty of Social Sciences 217/2022
Doctoral Program in Social Sciences
Sociology

Supervisors
Senior researcher, docent Mikko Laaksonen, Finnish Centre for Pension
Docent Veijo Notkola

Pre-examiners
Senior researcher, docent Kimmo Herttua, University of Southern Denmark
Research professor, docent Annina Ropponen, Finnish Institute of Occupational Health

Opponent
Research professor, docent Ilmo Keskimäki, Finnish institute for health and welfare

Custos
Professor Karri Silventoinen, University of Helsinki

The Faculty of Social Sciences uses the Urkund system (plagiarism recognition) to examine all doctoral dissertations.

ISBN 978-951-51-7065-1 (Paperback)
ISBN 978-951-51-7066-8 (PDF)
ISSN 2343-273X (Print)
ISSN 2343-2748 (Online)

Unigrafia
Helsinki 2022

ABSTRACT

Low socioeconomic position increases the risk of poor health. Although the long-term goal of Finnish health policy has been to reduce the health inequalities between socioeconomic groups, Finland still has large socioeconomic mortality differences compared to many other Western countries. These health inequalities and their determinants have a long research tradition at occupational class level. Previous studies have shown that high-mortality occupations are mostly manual, but there is also variation within manual occupations. By studying the differences by more detailed occupations, we can more accurately identify the risk groups and factors that affect high mortality.

In certain occupations, some of the high mortality may reflect more general socioeconomic differences. High mortality may also be related to differences in health behaviour, such as risky alcohol behaviour and the use of health care services. The use of health care services is affected by supply and demand factors, which in turn are related to health status and sociodemographic characteristics.

In order to reduce inequalities in mortality, it is important to study the determinants of high mortality in different manual occupations. Knowledge of the determinants in a specific occupation helps target effective preventive measures. The aim of this study was to identify specific manual occupations with high mortality and to examine whether the contributions of socioeconomic and occupational factors to mortality differ in these occupations. We also examined the role of alcohol-related mortality in the excess mortality in these occupations, and the use of outpatient and inpatient health services by occupational groups. The mortality of seafarers in comparison to all other employees was explored in more detail.

The study was based on longitudinal, individual-level, register-based data. In Sub-studies I–III, the study population consisted of all employees in Finland at the end of 2000. The follow-up period for mortality was 2001–2013/2015. In the fourth sub-study, which examined health care service use, the study population included all employees living in the city of Oulu. Cox proportional hazard models, negative binomial models, and logistic regression models were used in the analyses.

Men had 31 and women 11 manual occupations with high mortality (standardized mortality ratio >120) in comparison to all employees. High-mortality occupations were from every field, such as clerks, service workers, craft and metal workers, plant and machine operators, and elementary occupations.

High mortality in manual occupations was largely explained by education, income, unemployment, and industry. However, the magnitude varied in these occupations. In most of them, high mortality was partly explained by the

abovementioned characteristics, in some even fully explained, whereas in some male occupations, mortality rate even increased after the adjustments. Contrary to what might have been assumed, high income did not always protect from high mortality. An example of such an occupation is male seafarers. The manual occupations in which excess mortality remained after adjusting for socioeconomic and occupational factors were from several fields.

Almost all high-mortality manual occupations also had high mortality rates of both alcohol-related and non-alcohol-related deaths. Alcohol-related mortality mostly increased the total excess mortality among high-mortality manual occupations, but these deaths alone did not explain the differences in mortality from all employees. Similar findings regarding alcohol and smoking-related causes were made among seafarers. In some occupations with various physical and chemical risks, alcohol-related harms seemed to outweigh other major risks in the field. On the other hand, the contribution of alcohol-related deaths to total mortality in occupations with several alcohol-related risk factors was not necessarily so great.

The use of health care services by all employees was examined. Typically, manual workers made a higher number of outpatient visits to health care and non-manual occupations a lower number of visits than all employees. The gradient by occupational class was similar to that by mortality. Sociodemographic factors and health status did not explain the differences. Outpatient services are mainly well targeted, due to their higher use by high-mortality occupations. However, the use of services by manual occupations does not seem to be sufficient, as they still have a higher mortality rate. Some occupations differed from the gradient, indicating that the use of health care services seems to be affected not only by occupational hazards, but also by differences in disease identification, knowledge and attitudes towards health care, and access to occupational health services. The differences in inpatient care services were smaller than those in outpatient care. Occupation seems to have less effect on more serious illnesses.

This study provides new information on the social determinants of high mortality among manual occupations and the use of health care services by detailed occupation. In addition to broader socioeconomic characteristics, occupation is an important factor for understanding health inequalities.

Policy actions should focus on the high-mortality manual occupations identified in this study. Occupations in which socioeconomic and occupational characteristics did not explain the high mortality need special attention. Improving physical and mental working conditions would diminish not only alcohol-related but also other mortality. Health check-ups could be increased in occupations that have several known risk factors. The importance of health care services could also be emphasized to managers in companies that operate in risky sectors.

TIIVISTELMÄ

Matala sosioekonominen asema on yhteydessä huonompaan terveydentilaan. Vaikka Suomen terveyspolitiikan tavoitteena on pitkään ollut sosioekonomisten ryhmien välisten terveyserojen kaventaminen, sosioekonomiset kuolleisuuserot ovat Suomessa suuret useimpiin muihin länsimaihin verrattuna. Ammattiluokkien välisten sosioekonomisten terveyserojen ja niihin vaikuttavien tekijöiden tutkimuksella on pitkät perinteet. Korkean kuolleisuuden ammatit ovat enimmäkseen työntekijäammatteja, mutta myös työntekijäammattien välillä on vaihtelua kuolleisuudessa. Ammattien välisiä eroja tutkimalla voidaan tarkemmin paikantaa korkean kuolleisuuden riskiryhmät ja tutkia niihin vaikuttavia tekijöitä.

Korkeaan kuolleisuuteen yhteydessä olevat tekijät voivat olla erilaisia eri työntekijäammateissa. Huomattava osa ammatin korkeasta kuolleisuudesta saattaa heijastaa yleisempiä sosioekonomisia eroja tai liittyä eroihin terveyskäyttäytymisessä, esimerkiksi alkoholin käytössä. Myös terveyspalvelujen käytön eroilla voi olla vaikutusta. Terveyspalvelujen käyttöön vaikuttavat terveydentila ja sosiodemografiset tekijät, jotka ovat yhteydessä terveyspalveluiden käyttöön vaikuttaviin tarjonta- ja kysyntätekijöihin.

Kuolleisuuden eriarvoisuuden vähentämiseksi on tärkeää tutkia korkeaan kuolleisuuteen yhteydessä olevia tekijöitä eri työntekijäammateissa. Se auttaa ehkäisevien toimenpiteiden kohdentamisessa. Tämän tutkimuksen tavoitteena oli tunnistaa ne työntekijäammatit, joissa kuolleisuus on korkeaa, ja selvittää, onko näiden ammattien välillä eroja siinä, miten sosioekonomiset tekijät ja toimiala selittävät ammatin korkeaa kuolleisuutta. Tutkin myös, millainen oli alkoholikuolleisuuden vaikutus ylikuolleisuuteen näissä ammateissa. Lisäksi tutkin ammattien välisiä eroja avo- ja laitosterveyspalvelujen käytössä. Tarkastelin tarkemmin myös merenkulkijoiden kuolleisuutta.

Tutkimusaineistoina käytettiin pitkittäisiä yksilötason rekisteriaineistoja. Osatutkimuksissa I-III tutkimusväestö koostui kaikista Suomen palkansaajista vuoden 2000 lopussa. Kuolleisuuden seurantajakso oli 2001–2013/2015. Neljännessä, terveydenhuollon palveluiden käyttöä tarkastelevassa osatutkimuksessa tutkimusväestö sisälsi kaikki Oulussa asuvat palkansaajat. Menetelminä käytettiin Coxin suhteellisen vaaran mallia, negatiivista binomimallia ja logistista regressiomallia.

Tutkimuksessa havaittiin miehillä 31 ja naisilla 11 korkean kuolleisuuden työntekijäammattia (vakioitu kuolleisuussuhde >120 kaikkiin työntekijöihin verrattuna). Korkean kuolleisuuden ammatit olivat kaikilta aloilta, kuten toimistotyöntekijöitä, palvelutyöntekijöitä, rakennus- ja metallityöntekijöitä, prosessi- ja kuljetustyöntekijöitä sekä erikoistumattomia työntekijöitä.

Työntekijäammattien korkeasta kuolleisuudesta suuri osa selittyi koulutuksen, tulojen, työttömyyden ja toimialan vakioinnilla. Vakioinnin vaikutusten suuruus kuitenkin vaihteli ammattien välillä, ja kuolleisuudessa oli suuria eroja työntekijäammattien välillä myös näiden muuttujien huomioimisen jälkeen. Toisin kuin voisi olettaa, korkeat tulot eivät aina suojanneet korkealta kuolleisuudelta. Yksi esimerkki tästä oli miespuoliset merenkulkijat. Työntekijäammatit, joissa kuolleisuus pysyi korkeana sosioekonomisten tekijöiden ja toimialan vakioinnin jälkeenkin, olivat usealta eri alalta.

Alkoholikuolleisuus oli korkeaa lähes kaikissa korkean kuolleisuuden työntekijäammateissa. Kuolleisuus oli korkeaa myös alkoholiin liittymättömissä syissä. Alkoholikuolleisuus kasvatti kuolleisuutta useimmissa korkean kuolleisuuden työntekijäammateissa, mutta selitti vain osan kuolleisuuserosta kaikkiin työntekijöihin verrattuna. Samanlaisia havaintoja alkoholiin ja tupakointiin liittyvistä syistä tehtiin merenkulkijoilta. Joissakin ammateissa alkoholiin liittyvät haitat näyttäisivät ylittävän alan muut riskit. Toisaalta ammateissa, joissa oli paljon alkoholin käyttöön liittyviä riskitekijöitä, alkoholikuolleisuuden vaikutus kokonaiskuolleisuuteen ei välttämättä ollutkaan suuri.

Terveyspalveluiden käyttöä tarkasteltiin kaikilla palkansaajilla. Työntekijöillä oli enemmän ja asiantuntijoilla vähemmän käyntejä avoterveydenhoidossa kaikkiin palkansaajiin verrattuna. Sosiodemografiset tekijät ja terveydentila eivät selittäneet ammattien välisiä eroja. Avoterveydenhoitopalveluiden käyttö oli yleisempää korkean kuolleisuuden ammateissa. Vaikka palvelut näyttävät kohdentuvan pääosin hyvin, korkean kuolleisuuden työntekijäammateissa palveluiden käyttö ei vaikuta riittävältä. Jotkut ammatit kuitenkin poikkesivat tästä yleisestä linjasta. Terveyspalvelujen käyttöön näyttävät vaikuttavan paitsi ammatin riskit, myös erot esimerkiksi sairauksien tunnistamisessa, terveydenhuoltoon liittyvissä tiedoissa ja asenteissa sekä työterveyshuollon kattavuudessa. Ammattien väliset erot laitoshoitojaksoissa olivat pienempiä kuin avoterveydenhuollossa.

Tämä tutkimus tuottaa uutta tietoa työntekijäammattien korkeaan kuolleisuuteen ja ammattien terveyspalveluiden käyttöön yhteydessä olevista tekijöistä tarkalla ammattijaottelulla. Laajempien sosioekonomisten tekijöiden lisäksi ammatti on tärkeä osa terveyden eriarvoisuuden ymmärtämisessä.

Terveyseroja kaventavien toimenpiteiden tulisi kohdentua aiempaa enemmän tässä tutkimuksessa tunnistettuihin korkean kuolleisuuden työntekijäammatteihin. Ammatit, joissa sosioekonomiset ja ammattiin liittyvät tekijät eivät selittäneet korkeaa kuolleisuutta, vaativat erityistä huomiota. Fyysisten ja psyykkisten työolojen parantaminen alentaisi paitsi alkoholikuolleisuutta myös muuta kuolleisuutta. Terveystarkastuksia voitaisiin lisätä ammateissa, joissa tiedetään olevan useita riskitekijöitä. Riskialoilla toimiville työnantajille tulisi korostaa terveydenhuollon hyödyllisyyttä myös työnantajan näkökulmasta.

ACKNOWLEDGEMENTS

Even long processes are eventually completed, and so is this dissertation. I could not have done it by myself all these years.

I had the opportunity to participate in a research project called 'Occupational differences in mortality and transitions to disability pension 2001-2014: identifying straining occupations and a case study on seafarers' in Rehabilitation Foundation. The project was funded by the Finnish Work Environment Fund [grant number 115433], and the responsible researcher was Riikka Shemeikka. Sub-studies I-III were conducted as a part of this project.

Sub-study IV was a part of the Social Insurance Institution of Finland's research project 'Social and health care services and social security benefits in Oulu in 2013–2018'. The project was led by Jenni Blomgren and funded by the Social Insurance Institution of Finland.

I was able to write the articles during working hours in Rehabilitation Foundation and the Social Insurance Institution of Finland. However, I wrote the summary in my own time, which was made possible, in particular, by the COVID-19 pandemic clearing my schedule of all hobbies and social life.

I would like to thank my supervisors Mikko Laaksonen and Veijo Notkola. My deepest gratitude goes to Mikko Laaksonen. I thank him for all his support and direct, detailed comments. Without him, this dissertation would hardly have been completed. I thank Veijo Notkola for the original research idea, creating contacts with the Seafarers' Pension Fund, and a large stack of old literature on occupational mortality.

I am also grateful to my co-authors Jenni Blomgren and Riikka Shemeikka. I would like to thank Jenni Blomgren for her quick and direct comments on Sub-study IV. I thank Riikka Shemeikka for her contribution to Sub-study III.

In addition, I would like to thank Karri Silventoinen. It was an honour to be the first doctoral candidate to have him as a custos. I would like to thank my pre-examiners Kimmo Herttua and Annina Ropponen for their critical and thorough comments, which helped to improve my work in the final stages. I thank Ilmo Keskimäki for accepting the invitation to act as the opponent in my public defense and Elina Einiö for the membership of the grading committee.

I appreciate the Seafarers' Pension Fund for the collection and disclosure of the data as well as the highly knowledgeable help concerning seafaring.

I would also like to thank all participants in the Doctoral Program in Population, Health and Living Conditions (better known as the VTE seminar), headed by Professor Karri Silventoinen, and all board members, who changed many times during my long-lasting dissertation work. I enjoyed the seminar's critical, yet encouraging atmosphere. Special thanks go to Liina Junna for peer support and commenting on my summary.

I have been lucky to have such great colleagues in the Rehabilitation Foundation. Special gratitude goes to Mirkka Vuorento, Johanna Korkeamäki, Johanna Nukari, and Johanna Anttila for their friendship and support in the turbulences in working life.

In the Social Insurance Institution of Finland, I especially want to thank Sauli Jäppinen for the data management, his endless patience, and always being ready to help. I also thank all other members of the Oulu Café for peer support. The weekly meetings helped to cope with both remote work apathy and data problems.

My final thanks go to my family for all their support. Thank you to my parents for teaching me the importance of education and getting things done. Thank you to Mikko for everything, especially for putting up with me even during the bad moments and taking care of all housework. Finally, I want to thank my children Liina and Soila, who could not have cared less about my dissertation work and always took my thoughts elsewhere.

CONTENTS

LIST OF ORIGINAL PUBLICATIONS

This thesis is based on the following publications:

I Rinne Hanna, Laaksonen Mikko (2021) Manual occupations with high all-cause mortality in 2001-2015: the contribution of socio-economic and occupational characteristics. Scandinavian Journal of Public Health 49(2):237-244, https://doi.org/10.1177/1403494820960653

II Rinne Hanna, Laaksonen Mikko, Notkola Veijo (2020) High mortality in manual occupations and the role of alcohol in 2001-2015. European Journal of Public Health 30(4):788-793, https://doi.org/10.1093/eurpub/ckaa017

III Rinne Hanna, Laaksonen Mikko, Notkola Veijo, Shemeikka Riikka (2020) Mortality among seafarers: a register-based follow-up study. Occupational Medicine 70(2):119-122, https://doi.org/10.1093/occmed/kqaa002

IV Rinne Hanna, Laaksonen Mikko, Blomgren Jenni (2021) Use of outpatient and inpatient health care services by occupation – a register study of employees in Oulu, Finland. BMC Health Services Research 22:597, https://doi.org/10.1186/s12913-022-07970-y

The publications are referred to in the text by their roman numerals.

In all the sub-studies, Rinne and the other authors designed the study in collaboration: Laaksonen in Sub-studies I–IV, Notkola in Sub-studies II–III, Shemeikka in Sub-study III, and Blomgren in Sub-study IV. Rinne processed the data, conducted the statistical analyses, and wrote the manuscript draft. The other authors contributed to the interpretation of the results and the revision of the manuscripts.

ABBREVIATIONS

CI	Confidence interval
CVD	Cardiovascular disease
EU	European Union
GDPR	The General Data Protection Regulation
HILMO	Hoitoilmoitusrekisteri / Care Registers for Health Care
HR	Hazard ratio
ICD-10	International Statistical Classification of Diseases and Related Health Problems 10th Revision
ILO	International Labour Organization
IRR	Incidence rate ratio
ISCO-88	International Standard Classification of Occupations
ISCO-88(COM)	European version of the International Labour Organization's International Standard Classification of Occupations
OR	Odds ratio
PY	Person-year
RD	Rate difference
SDR	Standardized death rate
SEP	Socioeconomic position
SMR	Standardized mortality ratio

1 INTRODUCTION

People are in unequal positions in the face of death. It is well known that a low socioeconomic position (SEP), whether it is measured by occupational class, education, or income, increases the risk of death (Townsend & Davidson 1982; MacIntyre 1997; Mackenbach et al. 2008; Valkonen et al. 1990; Martikainen et al. 2001). For decades, the goal of Finnish health policy has been to reduce the health inequalities in socioeconomic groups, but socioeconomic mortality differences remain large in Finland (Mackenbach et al. 2019A).

Occupational classes can be divided into, for example, upper and lower non-manual workers and manual workers. Manual workers have higher mortality than non-manual workers. In 2001–2007 in Finland, manual workers' mortality rate per 100 000 was 358 among men and 152 among women, which was 58% higher among men and 21% higher among women than among non-manual workers (Pensola et al. 2012).

Studying these differences by detailed occupation could provide a more comprehensive picture of mortality inequalities. Several studies have found mortality differences between occupations that are termed manual occupations (Notkola et al. 1995; Pensola et al. 2012; SCB 2014; Rinne et al. 2018; Van den Borre 2018; Katikireddi et al. 2017). Although occupational safety has improved in many occupations, work environments still differ in terms of health risks such as occupational injury, exposure to toxic substances, and physical and mental job strain (Louhelainen et al. 2017; Montano 2014; TVK 2021; Raversteijn et al. 2017). As working conditions and occupational structures change over time, research occasionally needs to be repeated.

High mortality in an occupation may also be affected by risk factors other than strictly work-related ones. The factors contributing to high mortality may differ by occupation. A considerable part of high mortality in detailed manual occupations may reflect more general socioeconomic differences such as education or income. High mortality may also be related to differences in health behaviour. Alcohol consumption plays a major role in the formation of socioeconomic health inequalities. One preventive factor is health care use. Use of health care services is affected by health-related and sociodemographic factors, which in turn are related to supply and demand factors. However, few studies have focused on health care differences on a detailed occupation level.

Seafarers are an example of an occupation with exceptional working environment, several risk factors and historically high mortality. Studying seafarers' high mortality in more detailed by seafaring occupation and causes of death might help to find out prevention targets to lower their mortality.

Examining specific occupations can help more accurately identify the risk groups and factors that lead to high mortality. If high mortality could be located in only specific occupations, this would have more implications than if high mortality was in all manual occupations. To target effective prevention measures and thereby reduce mortality inequalities, it is important to study the determinants of high mortality in different manual occupations.

2 CONCEPTUAL FRAMEWORK OF THE STUDY

2.1 OCCUPATIONAL CLASS AND OCCUPATION

Occupational-based social class is one the key measures of SEP. SEP describes a person's role in society. The most commonly used SEP indicators are education, occupational-based social class, and income. Occupation is one of the determinants of SEP as it defines an occupational-based social class. It is acquired via education and provides income. Occupation is thus partly determined by education and in turn largely determines income. Occupation reflects individual characteristics such as personality, ambition, and lifestyle. Occupations differ in terms of prestige, qualifications, and rewards. Occupation reflects experiences and exposures in adulthood to, for example, work-related factors such as physical and chemical hazards, autonomy, and work stress. It affects with whom we have social interactions. (Fujishiro et al. 2010.)

Occupation is considered central to society's stratification (Krueger & Burgard 2011). Social stratification can be defined as the structural inequalities between different groupings of people. Even the classical sociology theorists were interested in occupational division. According to Marx, the two main classes were those who owned the means of production (capitalists) and those who did not (proletariat). The division was based on only economic factors. Weber's approach broadened the division to skills and prestige, which partly varied independently of class divisions. Instead of class, Weber uses the term status, which gives room for subjective evaluation. Bourdieu extended the definition of class, adding the concept of cultural capital. It refers to the behaviour, skills, tastes and preferences that one acquires through being part of a particular social class. (Wright 2005.) Although the view in this study is broader than that of Marx, I use the term occupational class for broader classification and divide it into more detailed occupations. I assume differences also exist between occupations within different classes.

There are multiple ways to measure occupation and occupation-based socioeconomic class. However, there is no clear structure or agreement on how to organize occupations on the basis of social classifications. In social science, many different measures have been used, often linked with mainstream sociological theories and concepts (Connelly et al. 2016). The operationalization of occupational classification has been widely discussed in the field of stratification studies. Three different approaches exist.

The most commonly used approach in sociological and health research is the social class scheme (Connelly et al. 2016) or big class world (Weeden & Grusky 2012), in which occupational classes are categorized on the basis of

multiple characteristics such as the skill levels of occupations, and entry into these is partly dependent on education. The classifications usually have 3–11 categories, which are not necessarily hierarchical. They are considered to share some similarities, such as levels of income, work situation, values, and lifestyles. The low degree of homogeneity within these classes has been criticized. (Connelly et al. 2016; Weeden & Grusky 2012.)

The second approach is referred to as either social stratification scales (Connelly et al. 2016) or the gradational world (Weeden & Grusky 2012). In this system, occupations are classified on a continuous scale, based on prestige, status, education, or income (Krueger & Burgard 2011). This approach, however, is criticized as highly stylized and incomplete (Weeden & Grusky 2012).

In the third approach, micro class, big occupational classes are divided into a much larger number of classes – occupations. These detailed groups are regarded as more homogenous than the larger classes, as they consist of individuals with the same level of education, income, and occupational hazards. People may already share the same beliefs, attitudes, and lifestyles when they enter into an occupation. These may be reinforced by daily interaction with each other and by sharing the same work environment. (Weeden & Grusky 2012.) According to Connelly et al. (2016) it is a 'lesser known but intellectually innovative approach'. The main advantage of this approach is that analysis on such a detailed level may reveal differences within the big classes. Critics of the micro class approach claim that first, it ignores what occupations within a class have in common and concentrates on their particularities; and second, micro classes are highly specific to time and place (Erikson et al. 2012). Detailed occupations may also be heterogenous, although some occupations are more homogenous and institutionalized than others (Connelly et al. 2016). In social stratification and mobility studies, Erikson et al. (2012) regard big classes as dominant and real enough, but they agree that the micro class approach can provide useful knowledge on other outcomes and supplement big class analysis. As a solution, Weeden and Grusky (2012) proposed using the big class and micro class approaches simultaneously.

2.2 DETERMINANTS AFFECTING MORTALITY BY OCCUPATION

The association between health and occupation is complex because occupation can be a source of both health-enhancing resources and health damaging hazards (Adler & Newman, 2002). However, employment, even with some work-related risks, is often more beneficial to health than involuntarily being outside work life (Gullberg & Vågerö 1996).

The social determinants of mortality differences by occupation, occupational class and SEP can be divided into different explanations. This

study focuses on the contribution of other socioeconomic factors and lifestyle to the mortality differences between occupations, but I briefly also introduce some other explanations. The determinants of mortality differences have been written in more detail elsewhere (for example Mackenbach 2019; Laaksonen & Silventoinen 2011).

2.2.1 MATERIALISTS OR STRUCTURAL EXPLANATIONS

The material aspects of living conditions in childhood and adulthood that are associated with SEP influence health inequalities. Poverty may lead to a lack of access to items that are regarded necessary for a decent life and that increase the risk of death. Material aspects also include the conditions under which people live: the quality and location of housing, conditions in the neighbourhood such as safety, social capital, and recreational opportunities. (Laaksonen 2011.)

Naturally, occupation is strongly linked to working conditions. Chemical, physical, and biological hazards affect mortality in specific occupations. Much research has been conducted on mortality attributable to work or on occupational hazards (Krueger & Burgard 2011). The research tradition focuses on the effects of working conditions, most often on physical risks (Krueger & Burgard 2011). Adler & Newman (2002) supposed that the health effects of social environments may be even more important than those of physical environments, but there seems to be no consensus on their effects (Lahelma & Rahkonen 2017; Mackenbach 2019). Psychosocial factors can be divided into work-related and non-work-related. Stress can affect health both directly through physiological variables and indirectly through risky health behaviour (Mackenbach 2019). The most well-known model is the job strain model by Karasek (1979) and its extension (Johnson & Hall 1988), and the effort-reward imbalance model (Siegrist 1996).

Not only a person's current occupation influences health. Other socioeconomic factors such as education and income, can also affect mortality. Occupational differences may thus be due to other socioeconomic factors that contribute to mortality. Individuals in different occupational classes – but also occupations on the same skill level – can differ in terms of education and income. (Mackenbach 2019; Adler & Newman 2002; Lahelma et al. 2004.) These three dimensions of socioeconomic status represent different, but often interrelated dimensions of an individual's SEP (Lahelma et al. 2004; Hoffman et al. 2019). According to Hoffman et al. (2019) 'education can be understood as input to, occupational class as the position in, and income as output of the labour market'.

Education is normally acquired by early adulthood and therefore reflects experiences in childhood. It provides formal qualifications for occupations and is closely tied to work opportunities. It also provides knowledge, skills, and other non-material resources. Education captures differences in tastes, attitudes, and preferences. It increases sense of control. (Lahelma et al. 2004;

Lahelma & Rahkonen 2011; Hoffman et al. 2019.) On average, better-educated people have a better knowledge of their own health and the factors that affect it (Teperi & Keskimäki 2007). An educated person may also be more aware of the possibilities of the health care system, better able to navigate the system and negotiate with health care personnel (Roos & Mustard 1997).

Income contributes to material living conditions and purchasing power. It provides better resources to control one's circumstances, examples of which are housing, food, and the ability to avoid environmental hazards and pay for health care services. It offers the opportunity for health-promoting lifestyles and security. If living conditions are harsh, many immediate practical concerns may override the active and careful promotion of one's own health, including the adequate use of health care services. (Teperi & Keskimäki 2007.)

Occupation also affects the probability of becoming unemployed. The transition to inactivity can adversely affect living conditions and increase health risks through loss of income, social networks, health care coverage, and changes in health behaviour and coping styles (Roelfs et al. 2011). In addition, family type and marital status are also associated with health (Robards et al. 2021). Those who do not live alone may have better access to social, instrumental, and material support (Robards et al. 2021). Moreover, divorce and the death of a spouse are stressful life events.

2.2.2 HEALTH BEHAVIOUR

Differences in health behaviour is another possible determinant of the health inequalities between occupations. Health behaviour may be differently distributed across occupational classes and occupations. People in the same occupation may have similar health behaviours, as these are influenced not only by individual factors but also by environmental factors.

Health behaviours are influenced by many factors partly related to occupation such as psychosocial stress, health literacy, problem-solving skills, sense of control, financial resources, and social support (Pampel et al. 2010). Most adults spend most of their waking time at work, in occupations which in turn are deeply institutionalized: occupational cultures tend to develop in and reflect the environments they occupy. In other words, these occupational cultures are then affected by and affect health behaviours such as alcohol consumption, smoking, diet, physical activity, the use of health care services, and other lifestyle habits (Weeden & Grusky 2012; Ames & Janes 1992; San Jose et al. 2000). Occupational culture is likely to affect whether one responds to work-related stress through risky health behaviour. Occupational culture can change, attenuate, or reinforce an individual's behaviour (Weeden & Grusky 2012). It is thus reasonable to assume that occupational health inequalities may to some extent be due to differences in health behaviour.

Smoking is linked to many cancers (Pukkala et al. 2009) and accounts for a substantial part of socioeconomic health inequalities (Mackenbach et al. 2019B). Work-related factors such as cafeteria selection, access to food

storage, and the frequency and duration of meal breaks may affect diet. Occupational differences in working hours or occupational physical activity affect leisure-time physical activity (Kirk & Rhodes 2011). Both diet and physical activity have on impact on obesity.

Alcohol consumption is a special case of the above-mentioned health behaviours and an important cause of health inequalities. Heavy drinking is related to many diseases, both chronic and acute, such as stroke, liver cirrhosis, and upper respiratory and digestive cancer. It also increases the risk of accidents and suicide. (Rehm et al. 2010; Poikolainen 1995.)

Even though health behaviours are regarded as voluntary behaviours, occupational differences in excessive alcohol consumption are a question of inequality, because many factors beyond a person's own influence can predispose them to choosing health-endangering habits. Alcohol-related behaviours are assumed to consist of a combination of biological, psychological, and social factors. The price and availability of alcohol generally contribute to its misuse, as do specific workplace factors. According to the earlier theory of Plant (1979), the following work-related factors may contribute to alcohol risks in occupations: the availability of alcohol at work, social pressure to drink at work, separation from family or social relationships, freedom from supervision, very high or very low income levels, harassment by colleagues, strain and stress, and recruitment of people predisposed to heavy drinking. Most of these have been verified in later studies (Barrientos-Gutierrez et al. 2007; Frone & Brown 2010; Heikkilä et al. 2012; Hodgins et al. 2009; MacDonald et al. 1999; Marchand 2008; Moore et al. 2009; San Jose et al. 2000) and classified in some explanatory models (Mandell et al. 1992; Ames & Janes 1992).

It has further been suggested that alcohol consumption in general is a means of tension reduction (Cooper et al. 1992). Tension may be either work-based, for example, dangerous working conditions; or due to problems in private life such as divorce, or other adverse life events. A combination of higher stress and harmful coping strategies may lead to excess alcohol consumption (Cooper et al. 1992).

In sum, both physical and psychosocial working conditions, social norms at work and the availability of alcohol may influence the alcohol-related mortality differences among manual workers. Seafarers in particular are an occupational group with several work-related risk factors for harmful alcohol behaviour.

2.2.3 USE OF HEALTH CARE SERVICES

The use of health services can be thought of as part of health behaviour, although it also depends on other factors related to supply and demand. Because the impact of health services on socioeconomic health inequalities depends on socioeconomic differences in access to and the actual use of health services, it may vary over time and among different types of services.

Preventive services may affect incidence of diseases, and treatment services may influence recovery; both may have an impact on mortality. If preventive health care is implemented well, it may be possible to reduce health inequalities. The use of health services can also maintain or even increase socioeconomic inequalities in health if the services are more easily available to the wealthy. This is affected by how health services are targeted in quantitative and qualitative terms in each health care system. (Mackenbach 2019.)

Whereas in public health research, health care use is one of the determinants of health, in health services research, it is vice versa: health is one of the determinants of health care use (Leyland & Groenewegen 2020). In this study, we took the view of health service research and examined whether health care service use differed by occupation. However, we also compared our results to mortality studies to assess the differences in health care services use as an explanation for mortality differences.

Fairness in targeting health services means that instead of factors related to a person's background, services are targeted according to real needs. This is called horizontal equity. However, it may have several different meanings: equity in the availability of health services, equity in the use of health services, or equity in health care outcomes (Gulliford et al. 2002). Another problem is that 'the health problems of different groups are diverse, health care needs for similar health problems vary and different groups have their own priorities and values' (Gulliford et al. 2002). Equity is thus quite difficult to estimate (Gulliford et al. 2002).

People in need may often have access to these services and yet encounter difficulties in utilizing them. Andersen (1995) divided the factors influencing the use of health services into three groups: need, predisposing and enabling factors. Pechansky and Thomas' (1981) approach considered the personal, financial, and organizational barriers to service utilization. Both approaches extended access beyond service availability.

Typically, health service research divides the factors affecting the use of these services into demand for care and supply of care. Demand for health care includes not only health but also personal barriers such as perceptions of need, attitudes, beliefs, and previous experiences with health services (Gulliford et al. 2002). Occupation is clearly connected with need but attitudes and beliefs may also be shared. In addition, social norms affect demand, such as those that prevail in a family or workplace (Leyland & Groenewegen 2020). The supply of care includes service availability, financial barriers such as costs, and organizational barriers such as long waiting times (Gulliford et al. 2002). Depending on the care system, service availability may differ by occupation and thus affect the use of health care services.

The Finnish three-sector system consists of occupational, private, and public health care services. This three-channel system places people in an unequal position in terms of access to health services and can therefore affect inequalities in health. The main reason is the better availability of health services for the employed than for others. The differences between employees

should not be so prominent. Occupational health services play a major role in employee health care in Finland. All employers are obligated to arrange at least preventive occupational health services. Occupational health services is the only sector with services free of charge and provides easy access to outpatient care. Public sector outpatient services with universal coverage for all residents are organized by municipalities in health centres and are mostly funded by taxes. In the public sector, patients' co-payments are low, but access may be difficult, and gatekeeping of specialist health care is strong. The private sector's services are accessible with high co-payments. Access to specialist services is easy, and mainly provided in large cities. Inpatient care is for patients whose condition requires overnight hospitalization. It is publicly funded, and co-payments are relatively low. Hospital districts provide specialist services. In the last ten years, the number of days of inpatient care has decreased, as an increasing proportion is cared for in outpatient care (Rissanen et al. 2020).

2.2.4 SELECTION

The health selection hypothesis assumes that differences in health – or health behaviours – lead to differences in SEP. Poor health leads to lower-status occupations. Health selection can be direct or indirect. In the former, health directly affects an individual's occupation. In the latter, selection can be influenced by attitudes and behaviour, for example, which in turn influence both health and occupational choices.

Health selection can occur in adolescence and early adulthood when an illness may limit educational opportunities and thus affect occupational choices. Genetics is also likely to be associated with health inequalities, contributing to cognitive abilities and thus to an individual's SEP and health (Mackenbach 2019). Health may also influence social mobility in adulthood. Unhealthier individuals may be more likely to move into lower-status occupations. In addition, healthier individuals are more likely to be employed and remain in the workforce, whereas those with poorer health are more likely to be excluded from employment (Li & Sung 1999). This is called the healthy worker effect.

Health selection can also occur within the same occupational class level, for example, between one manual occupation and another. Occupations may differ in their hiring policies with respect to physical fitness, or certain health-related behaviours such as alcohol-related behaviour. For some occupations, people must pass a medical examination, as is the case for seafarers. Almost all occupations requiring such a health selection process are subject to an adverse health effect due to exposure to certain occupational hazards (Li & Sung 1999), such as work-related physical risks. These exposures cause the advantage of a positive health selection process to gradually disappear (Li & Sung 1999). It is assumed that in these high-risk occupations, negative health selection is greater than that in others, due to the physical requirements of the

work (Van den Borre & Deboosere 2018). Thus, health selection is assumed to be more observable in these occupations than in those with little need of physical labour (Li & Sung 1999). These selection mechanisms mean that the excess mortality related to high-risk occupations can be systematically underestimated among, for example, deck and engine crew (Gullberg & Vågerö 1996). Because those who are unable to cope with the occupation's physical or psychosocial demands may choose a less demanding occupation, there may even be high mortality in physically lighter occupations, such as among clerical workers (Moore & Hayward 1990).

2.3 THE PERSPECTIVE OF THIS STUDY

Regarding mortality, occupational epidemiology studies the relationship between workplace exposures and causes of death. Sociological and demographic research emphasizes the importance of status, focuses on the life course, and examines overall mortality. (Krueger & Burgard 2011.) According to status theories, lower occupational status (Marmot 2004) or prestige (Fujishiro et al. 2010) is associated with higher levels of stress and through this, also with mortality. According to the life course approach, an occupation's lower mortality may be caused by an individual's exposure to unfavourable conditions at different stages of life. Thus, health disadvantage is a cause of cumulative social disadvantage over the life course, and mortality is likely to be related not only to the individual's current occupation, but also to the pathways leading to it and the health risks of earlier occupations (Cambois & Laborde 2011; Moore and Hayward 1990). In sum, occupation should not be regarded as only a source of hazard exposure (Adler & Newman, 2002; Moore & Hayward 1990). In this study, I understand occupation as being broadly connected to health.

I divide big classes into micro classes, that is, occupational classes into (detailed) occupations, and I study the differences by detailed occupation within the same occupational class. At their simplest, occupations can be classified into (upper and lower) non-manual and manual workers. The term manual worker is sometimes used as a synonym for a blue-collar worker (as opposed to a white-collar worker), not including clerical workers. I use the term manual workers and include clerical workers, because they have the same skill level as blue-collar workers. Manual occupations can be divided into specialized and unspecialized, but apart from this division, manual occupations are on the same level of the occupational structure. I further divide manual workers into smaller occupational groups or fields according to their skill specialization. These subgroups I divide even further into more detailed occupations.

Many of the explanations above are likely to affect manual employees relatively equally, but there are also differences between occupations. Every single occupation has its own demands and rewards that influence health. In

this study, I focus on the all-cause mortality differences between manual occupations. I also examine the individual-level socioeconomic factors associated with mortality differences by occupation, and health behaviour, especially the contribution of alcohol-related mortality. I explore the mortality of seafarers in more detail because of their special work environment and numerous occupational hazards. This study also aimed to determine whether occupation is related to the use of health care services.

3 EMPIRICAL EVIDENCE

3.1 HIGH-MORTALITY OCCUPATIONS

3.1.1 OCCUPATIONAL CLASS

According to several studies, the lower a person's SEP, the higher their mortality, regardless of the measure of SEP. There may be more studies on income and education (Fujishiro et al. 2010), but a vast literature also considers occupational class. As the different measures of SEP measure different phenomena, they cannot be used interchangeably (Geyer et al. 2006; Hoffman et al. 2019) and therefore, I focus more on the empirical literature on occupational class and specific occupations.

In several European countries, including Finland, manual occupations have shown to have the highest level of mortality (Mackenbach et al. 2003; Mackenbach et al. 2008; Toch-Marquardt et al. 2014; Valkonen et al. 1990; Martikainen et al. 2007). However, the magnitude of these mortality inequalities varies considerably between populations. In a study in the 1990s, the mortality difference between manual and non-manual employees was greater in Finland than in Sweden, Norway, Belgium, Switzerland, France, Italy, and Spain (Machenbach et al. 2008). In a study comparing occupational class differences in 14 European countries in the early 2000s, Finland was again one of the countries in which inequalities were more pronounced than in certain European countries. A total of 51% of all deaths could have been saved if all occupational classes had had the same mortality level as that of upper non-manual workers. (Toch-Marquardt et al. 2014.)

The majority of international studies have only covered men (Mackenbach et al. 2003; Mackenbach et al. 2008; Toch-Marquardt et al. 2014). In many cases, women are excluded from analyses, as no occupation can be assigned. In addition, pensioners and the unemployed are often classified on the basis of their previous occupation, and those for whom no occupation can be found are classified on the basis of the occupation of the family reference person, this being more common for women than for men (e.g., Valkonen et al. 1990; Martikainen et al. 2007). These practices skew the results and have limited the use of occupational status in mortality studies.

3.1.2 DETAILED OCCUPATION

There is also a long tradition of studying the differences between detailed occupations. The first study on occupational mortality was a cross-sectional study in England and Wales by Farr, published in 1855 (Registrar-General 1855, reviewed by Lynge 2011). Many of the older studies (reviewed by

Johnson et al. 1999) – as well as some newer ones from the USA during the 1980s and England and Wales in 1979–2010 (e.g., Burnett et al. 1997; Coggon et al. 2010A; Harris et al. 2016) – suffer from major limitations: for example, they derived occupation from death certificates, which caused health selection problems; they had no reference population; and they only included men. In addition, the information on occupation and cause of death was not completely accurate (Harris et al. 2016).

Census-based studies became possible when the personal identification system was introduced in the Nordic countries, first in Sweden in the 1940s, and then in Finland in the 1960s (Laugesen et al. 2021). Census-based studies have the advantage of being able to reliably combine data using individuals' personal IDs, occupation from the beginning of the follow-up period, and a reference population. The earliest Nordic follow-up studies were from the 1960 censuses in Norway and Sweden and the 1970 censuses in Denmark, Finland, and Norway. A joint analysis was carried out in Norway, Sweden, Finland, and Denmark in 1971–1980 (Nordic Statistical Secretariat 1988). According to the results, the mortality of male construction workers, forestry workers and mining and quarry workers in Finland was clearly higher than that in the other Nordic countries. In all the Nordic countries, mortality was high among hotel and restaurant workers and deck and engine crew. Among women, the results were less clear. (Nordic Statistical Secretariat 1988.) Older Finnish and Nordic publications do not seem to be very well known outside the Nordic countries. This is unfortunate, as census-based occupational mortality studies provide the most comprehensive data on mortality by occupation in total national populations (Lynge 2011).

3.1.3 RECENT INTERNATIONAL STUDIES IN NORDIC COUNTRIES AND ELSEWHERE

Several studies confirm the high levels of mortality among certain manual occupations. Nordic countries share a very similar society and welfare state model, which makes results from other Nordic countries relevant. In Sweden in the 1980s, mortality was highest among ticket sellers on buses, for both sexes. Mortality was also high among cleaners, woodwork machine setters, machine-tool setters, and bookbinders (Gullberg & Vågerö 1996). In 2008–2012, the high-mortality occupations, among both men and women, were bleaching-, dyeing- and cleaning-machine operators, electrical equipment assemblers, psychiatric care attendants, home care assistants, and personal care workers (SCB 2014). The occupations with the highest mortality among men were ships' engineers, metal wheel-grinders, polishers and tool sharpeners, demonstrators and telephone salespersons, bookbinding machine operators, and newspaper and package deliverers. Women had high mortality as electronic mechanics, fitters and servicers, sewers, tellers and other counter clerks, helpers and cleaners, and assistant nurses and hospital ward assistants. (SCB 2014.) Lynge (2011) reviewed some Danish studies and found that

waiters and seamen among men, and house assistants and waiters among women were high mortality occupations in 1970–1975, and waiters and seamen in 1996–2005, whereas mortality was low among farmers. Mortality has a gradient, which widened in the last quarter of the 21st century.

Similar studies have been conducted in at least Belgium in 1991–2011 (Van den Borre 2018), England and Wales in 2001–2011 (Katikireddi et al. 2017), the USA in 1979–1989 (Johnson et al. 1999), and Canada in 1991–2001 (Mustard et al. 2010). High-mortality occupations varied slightly from country to country. The only unifying factor was that almost all the occupations with the highest mortality were classed as manual occupations. They were found in all fields of manual occupations. There were only a few clerks and agricultural and fishery workers, whereas workers in service and care, craft and related trades, and plant and machine operators were well represented, as were elementary workers.

3.1.4 FINNISH STUDIES

Table 1 presents the Finnish studies of all-cause mortality by occupation and the occupations with the highest mortality. The studies used information gathered every five years in the censuses (Nieminen 1999) and linked it with data on causes of death (Statistics Finland 2022). Since 1990, the census has been carried out entirely on a register basis, which has made it possible to produce census data on an annual basis (Nieminen 1999). However, data on occupation was not available every year until 2004. Occupational structures and classifications have changed over the years. Men have more high-mortality occupations than women. A large proportion of these are manual occupations (Sauli 1983; Marin 1986; Rantanen & Lehtinen 1991; Notkola et al. 1995; Notkola & Savela 1998; Pensola et al. 2004; Pensola et al. 2012; Rinne et al. 2018). High-mortality occupations that recur from year to year among both sexes are waiters, cleaners, building caretakers, manufacturing labourers, and other unskilled workers.

Through the ages, male miners, builders, painters, mobile plant operators, seafarers, transport labourers and freight handlers, and building construction labourers have had high mortality. Earlier, these also included forestry workers and shoemakers. Later, male home care assistants and personal care workers, welders, sheet-metal workers, paper-making plant operators, and motor vehicle drivers also came to have high mortality.

Women have a lower mortality rate and fewer high-mortality occupations, which vary slightly from year to year. Occupations that have high mortality over several periods include secretaries, telephone switchboard operators, hairdressers, metal moulders, machinery mechanics and fitters, and chemical processing plant operators.

Table 1 *Finnish studies on all-cause mortality and causes of death by occupation*

Study	Study population	Follow-up	High-risk occupations (among employees)
Sauli 1983	In an occupation in 1970 aged 35–64	1971–1975	**Both genders**: home and institutional housekeeping, building maintenance and cleaning **Men**: waiters, unskilled labourers, assistant construction workers, shoemakers and leather workers, forestry workers, miners and quarry workers, deck and engine crew, bookkeepers, painters and lacquering workers, construction workers, dock and warehouse workers, wholesale travellers and agents **Women**: hygiene and beauty treatment work, artistic and literacy work, other health care and nursing work, office clerks
Marin 1986	Labour force aged 20–64	1971–1975, 1976–1980	**Both genders**: waiters and waitresses **Men**: miners and quarry workers, deck and engine crew, forestry and log floating, dock and warehouse workers, agricultural workers, unskilled labourers, painters, restaurant and kitchen staff, textile workers, metal industry workers, machine operators, smiths, round-timber workers, insulation workers, reinforcing ironworkers, shoemakers, guards **Women**: electricians, wood workers, hairdressers, beauticians, building caretakers, cleaners, home and institutional housekeeping, graphic work
Rantanen & Lehtinen 1991	In an occupation in 1980, employees in 1985	1981–1985, 1986–1990	**Employees 1986–90** **Both genders**: building maintenance and cleaning **Men**: unskilled labourers, assistant construction workers, deck and engine crew, miners and quarry workers, forestry and log floating workers, dock and warehouse workers, painters and lacquering workers, smelting, metallurgical and foundry workers, agricultural workers, road transport workers **Women**: waiters, graphic workers, food industry workers, textile workers, hygiene and beauty treatment workers, packing and labelling workers
Notkola et al. 1995	In an occupation in 1970/1980 aged 20–64	1971–1991, 1981–1991	**Employees 1981–1991** **Both genders**: waiters and waitresses **Men**: unskilled labourers, cleaners, cooks and other kitchen staff, shoemakers and shoe repairers, deck and engine crew, stevedores and freight handlers, gardeners and park workers, hotel hall porters, unskilled construction workers, other construction workers, agricultural workers and animal caretakers, forestry and log floating workers, painters and lacquering workers, timber workers **Women**: technicians in tele-technical field, maintenance crew and supervisors, other woodwork occupations, turners, toolmakers and machine-tool setters, stationary engine and machine workers

Study	Study population	Follow-up	High-risk occupations (among employees)
Notkola & Savela 1998	Labour force (employees, entrepreneurs, unemployed) in 1990 aged 20–64	1991–1995	**Employees** **Both genders**: waiters and waitresses, unskilled labourers, cleaners, packing and labelling workers **Men**: asphalt workers, dock and warehouse workers, miners and quarry workers, assistant housebuilding workers, other sales workers, crane and hoist operators, shoemakers and leather workers, deck crew and small vessel operators, painters and lacquering workers, concrete shutterers and cement finishers, forestry and log floating workers, construction machinery operators, warehouse porters, motor vehicle and tram drivers **Women**: metal moulders, machine and motor repairers, prison guards, cannery workers, graphic workers, transport service workers, building caretakers, chemical process workers and paper-making workers, telephone switchboard operators, other clerical workers
Pensola et al. 2004	Labour force (employees, entrepreneurs, unemployed) in 1995 aged 20–64	1996–2000	**Employees** **Both genders**: other unskilled manual workers, waiters and waitresses, cleaners, packing and labelling workers **Men**: home care assistants and personal care workers, asphalt workers, laundry workers, metal plating and coating work, bookbinders, insulation workers, plywood and fibreboard workers, gardeners and park workers, unskilled construction workers, deck crew and small vessel operators, metal-processing plant operators, crane and hoist operators, stevedores and freight handlers, paper and cardboard mill workers, welders and flame cutters, warehouse workers, tool-makers, motor vehicle drivers, fitter-assemblers, electricians, sheet metal workers and structural-metal preparers **Women**: other smelting occupations, metal and foundry work, assemblers in electronics and telecommunications, hairdressers and barbers, processed food workers, chocolate and confectionery workers, office receptionists and messengers, hotel workers and undertakers, travel agency clerks and tax officials, secretaries
Pensola et al. 2012	Labour force (employees, entrepreneurs, unemployed) in 2000 aged 20–64	2001–2007	**Employees** **Both genders**: home care assistants and personal care workers, other unskilled manual workers, waiters and waitresses, cleaners, building caretakers, telephone salespersons and newspaper deliverers, wood treaters, wood-processing-plant and wood-products machine operators, transport labourers and freight handlers, other office clerks, kitchen helpers **Men**: mining and quarrying work, building finishers, sheet metal workers, manufacturing labourers, welders, bricklayers, stonemasons and concrete workers, motor vehicle drivers, plumbers and pipe fitters, porters, railway workers and ships' deck and engine crew, mobile plant operators, metal moulders, coremakers and metal-processing plant operators, blacksmiths and tool-makers, paper-pulp and paper-making plant operators **Women**: legislators and senior officials, telephone switchboard operators and emergency officers, chemical processing plant workers, authors and journalists, assistant nurses and hospital ward assistants, secretaries

Study	Study population	Follow-up	High-risk occupations (among employees)
Rinne et al. 2018	Employees in 2000 (same occupation in 1995) age 30–64	2001–2015	**Both genders**: porters, waiters and waitresses, wood treaters, wood-processing-plant and wood product machine operators, power production and industrial robot operators, printing-, binding- and paper-product machine operators, cleaners, building caretakers, other unskilled manual workers, manufacturing labourers, transport labourers and freight handlers **Men**: building finishers, building workers, home care assistants and personal care workers, baked goods and fruit processing machine operators, mechanical machinery assemblers, mobile plant operators, paper-pulp and paper-making plant operators, miners and quarry workers, motor vehicle drivers, special needs nurses and social work assistants, metal moulders and coremakers and metal processing plant operators, chemical processing plant workers, railway workers and ships' deck and engine crew, metal- and mineral product machine operators, sheet metal workers, mail carriers and sorting clerks, food products machine operators, blacksmiths and tool-makers, welders, plumbers and pipe fitters, locomotive engine drivers, rubber- and plastic product machine operators, guards **Women**: electrical engineering technicians, electrical- and electronic-equipment assemblers, precision, glass and ceramics workers, managers of small enterprises, authors and journalists, telephone switchboard operators and emergency officers, assistant office clerks, assistant nurses and hospital ward assistants, payroll accounting and insurance clerks

3.2 CONTRIBUTION OF OTHER SOCIOECONOMIC FACTORS TO MORTALITY DIFFERENCES

The increased risk of all-cause mortality in certain occupations could be partly explained by other SEP measures. For example, manual workers are typically less educated than non-manual workers, and if low education leads to increased mortality by some other mechanism, such as worse health literacy, this can affect the association seen between occupation and mortality. In manual occupations, income is also typically low, although dangerous working conditions may be compensated by higher earnings (Raversteijn et al. 2013). An adjustment by other SEP measures is advisable to minimize their confounding effect. However, outside the Nordic countries it is unusual to have data on education, income, and occupational class in the same study (Geyer et. al 2006) and even more unusual to also have detailed information on occupation. Thus, SEP is rarely controlled in studies of occupational mortality differences.

Some studies on occupational class level (Hoffmann et al. 2019; Geyer et al. 2006) have estimated the total and net effects of education, occupational class, and income on mutual adjustments and found the total effects to be larger than the net effects. However, all the SEP dimensions have had their own net effect on mortality, the by income gradient being the steepest (Hoffman et al. 2019; Geyer et al. 2006). One Finnish study estimated changes in the total and independent effects of occupational class and education on mortality over 30 years and found that the effects of occupational class on mortality that were independent of education had increased between 1971 and 2000 (Martikainen et al. 2007).

Some studies using detailed occupations have controlled for one factor at a time. A Swedish study found a connection between education and occupation, but occupation also had an independent effect beyond education (SCB 2014). In Finnish studies, separately controlling for education (Rinne et al. 2018) and income (Pensola et al. 2012; Rinne et al. 2018) had little effect on the association between occupation and mortality among women and some effect among men.

Other factors might also contribute to occupational mortality differences, such as unemployment (Martikainen 1990; Roelfs et al. 2011; Pensola & Notkola 2012), living arrangements and marital status (Koskinen et al. 2007), language (Sipilä & Martikainen 2009), and industry (Kokkinen et al. 2014). These are seldom controlled for on a detailed occupational level. Pulido et al. (2017) studied all-cause mortality by occupation and adjusted for age, sex, immigration, marital status, area, education, and material wealth indicators. In the first age- and sex-adjusted model, 16 of 18 occupations had higher mortality than teachers, and in the fully adjusted model the respective figure was seven occupations. These occupational categories included unskilled construction workers, mineworkers/fish workers/sailors, small catering/accommodation companies' managers and protective service

workers. The study had various limitations: the occupational classification had only 18 classes, men and women were not studied separately, and there was no information on income. Johnson et al. (1999) estimated the mortality risk for specific occupations in the USA after adjusting for race, income, and education. They found that the mortality differences in the four occupational classes were almost completely explained, whereas the important differences remained by detailed occupation (69 groups for men and 32 groups for women). When race, income and education was controlled for, high-risk occupations among men were office workers, construction craft workers, construction labourers, and food service workers, and among women, waitresses and protective service and private household workers.

3.3 CONTRIBUTION OF ALCOHOL-RELATED DEATHS TO MORTALITY DIFFERENCES

Excessive alcohol consumption is a key cause of health inequalities. Alcohol-related mortality rates are higher among lower SEP measured by occupational class, income, and education in several European countries, especially in Finland (Mackenbach et al. 2015; Mäkelä 1999; Mäkelä et al. 2015; Probst et al. 2014). Here I focus on the results by occupational class. Alcohol-related mortality is more common among manual workers than non-manual workers (Hemström 2002; Mäkelä et al. 1997; Probst et al. 2014; Mackenbach et al. 2015; Herttua et al. 2008; Mäkelä & Paljärvi 2008). Inequalities in alcohol-related mortality are higher than in all-cause mortality, and the relative differences are larger among men than among women (Hemström 2002; Probst et al. 2014; Mäkelä et al. 1997).

There are also differences among manual workers. According to studies from the 1980s to the 2010s, in Finland and other Western countries (Sweden, England & Wales, Belgium, Spain, USA), alcohol-related mortality and hospitalization were high among waiters, bartenders, and cooks and kitchen assistants. Many construction and metal workers, as well as drivers and seafarers, had high alcohol-related mortality. Elementary occupations, such as cleaners and transport labourers and freight handlers, also had high alcohol-related mortality. Some studies have also found high mortality among office workers and male care workers. (Coggon et al. 2010B; Hemmingsson et al. 1997B; Hemmingsson & Ringbäck Weitoft 2001; Romeri et al. 2007; Kaila-Kangas et al. 2016; Pensola et al. 2004; Pulido et al. 2017; Van den Borre 2018.) The limitations of some earlier studies include no reference population (Coggon et al. 2010B), missing occupations among women (Romeri et al. 2007), occupation from the date of death or last full-time occupation (Romeri et al. 2007; Coggon et al. 2010B), men and women in combined analyses (Pulido et al. 2017) and not very detailed occupational classification (Pulido et al. 2017). Despite different study designs, periods, and populations, some high-risk occupations remain the same.

The occupational differences may be due to differences in work-related risk factors that are connected to heavy drinking, such as workplace social norms, hazardous physical working conditions, low work control, and easy access to alcohol (Barrientos-Gutierrez et al. 2007; Frone & Brown 2010; MacDonald et al. 1999; Hodgins et al. 2009; Hemmingsson & Ringbäck Weitoft 2001; Moore et al. 2009; San Jose et al. 2000; Zhang et al. 2003; Roche et al. 2015; Plant 1978; Hemmingsson et al. 1997B; Romeri 2007; Heikkilä et al. 2012; Niedhammer et al. 1998; Marchand 2008; Thompson & Pirmohamed 2021). A combination of several risk factors increases the risk (Olkinuora 1984; Martin et al. 1996).

Alcohol-related mortality may largely explain the occupational differences in total mortality. In a Finnish study by occupational class, the contribution of alcohol-related mortality to relative differences accounted for 14% (men) and 4% (women) of the excess all-cause mortality among manual workers in comparison to upper non-manual workers (Mäkelä et al. 1997). The differences in life expectancy were 24% and 9% among men and women, respectively (Mäkelä et al. 1997). In a study of 12 European countries and 35–64-year-old men, the percentage of four alcohol-related causes that account for the absolute inequality in total mortality between manual and non-manual employees was the highest (24%) in Finland (Mackenbach et al. 2015). In Sweden, the contribution to the absolute difference between manual workers and upper non-manual workers was 16% among men and 6% among women (Hemström 2002). The contribution of alcohol to total mortality varies considerably according to age and gender: it is greater among men than among women and among younger than older individuals (Mäkelä et al. 1997; Hemström 2002).

A Finnish study of occupational alcohol-related risks found that alcohol-related morbidity and mortality combined would have been 31% lower among men and 20% lower among women if all the occupational groups had been at the same risk level as professionals (Kaila-Kangas et al. 2016). Pulido et al. (2017) found larger disparities between industries and occupations in alcohol-related mortality than in total mortality. Their results suggest that alcohol consumption plays a relevant role in all-cause mortality disparities in occupations. However, the contribution of the role of alcohol to mortality in a specific occupation remains unknown.

3.4 USE OF HEALTH CARE SERVICES

Health care is divided into outpatient and inpatient care services. In Finland, the use of outpatient health care services in different sectors is distributed differently according to SEP (Blomgren & Virta 2020; Häkkinen & Alha 2006; Häkkinen & Nguyen 2010; Martelin et al. 2012; Virtanen et al. 2006). Outpatient primary health care is either equally distributed or distributed in favour of the less advantaged, whereas special health care tends to favour the

more advantaged. Similar differences have been observed in other countries, for example, in Sweden (Agerholm et al. 2012). Most studies have used income as a measure of SEP (Agerholm et al. 2012; Häkkinen & Nguyen 2010); some have also used education (Blomgren & Virta 2020; Häkkinen & Alha 2006) or employment status (Virtanen et al. 2006).

Only a few studies have used occupational-based SEP. According to studies in Western countries with different health care systems, outpatient health care service use is distributed differently among occupational classes. Primary health care use is more common among lower occupational classes (Garrido-Cumbrera et al. 2010; Redigor et al. 2008; Palència et al. 2011), but some studies have found no difference (Hansen et al. 2012; La Parra-Casado et al. 2018; Korda et al. 2009) or no clear socioeconomic pattern (Blomgren & Virta 2020; Lostao et al. 2011). Specialized care is more common among higher occupational classes (Garrido-Cumbrera et al. 2010; Korda et al. 2009; Lostao et al. 2011; Palència et al. 2011; Redigor et al. 2008). These contradictory results may have several reasons. Some studies have used the occupational class of the head of the household, and others have used self-rated social status of one's occupation. Some have included the unemployed and the retired and used their last occupation or counted them as separated groups. All studies have adjusted for need using self-rated health, chronic diseases or both, but only a few have also used other covariates such as education, income or marital status. To our knowledge, the differences between outpatient health care service use in detailed occupations have not been widely studied.

Inpatient health care services have also most often been examined using income (Keskimäki 2003; Manderbacka et al. 2008; Manderbacka et al. 2014; Manderbacka et al. 2015). The lower the income group, the higher the risk. Some studies of inpatient care services have used occupational class and detailed occupation. Studies using occupational class have found an increased need-adjusted risk of inpatient care services among lower socioeconomic classes (La Parra-Casado et al. 2018; Palència et al. 2011) or higher socioeconomic classes (Lostao et al. 2011), while others have found no difference (Garrido-Cumbrera et al. 2010; Keskimäki et al. 1995; Redigor et al. 2008). At a more detailed occupational level, one Finnish study conducted in 1996 found that occupations with heavy manual work and difficult working conditions were at a higher risk of having to use inpatient care services. These were, for example, welders and flame cutters, paper-making plant operators, and cleaners (Kaila-Kangas et al. 1999). Other studies have found significant differences between the six largest occupations and between industries (Varje et al. 2014; Kokkinen et al. 2014). Of the studied occupations, nurses had the highest incidence of inpatient care service use, and teachers had the lowest (Varje et al. 2014).

The Finnish health care policy is based on ideas of universality and equity, which claim that health services should be distributed according to need and not SEP. Still, Finland ranked poorly in the international comparisons of equal allocation of health services (van Doorslaer & Masseria 2004; Devaux & de

Looper 2012). Inequality in Finland is largely related to the structure of the three-sector system of occupational, private, and public health care. Inequality of access is the most notable between employees and the rest of the population. It is mandatory for employers to arrange preventive occupational health services for employees. However, occupational health services in small enterprises, which are typical in construction, land transport, accommodation, and food service sectors are often inadequate (Virtanen & Husman 2010), as they also often are for fixed-term employees (Lappalainen et al. 2016). However, most employers also provide curative care. Abundant supply increases the use of services (Räsänen et al. 2014). The options for occupational health services are the public and the private sector. The public sector has long waiting times due to the weak economic situation of municipalities and a shortage of doctors (Rissanen et al. 2020), whereas in the private sector, access is easy for those who can afford it. Public sector visits were more common among manual workers and private sector visits were more common among upper non-manual employees, also after adjusting for need and other socioeconomic factors (Blomgren & Virta 2020).

3.5 CASE STUDY: SEAFARERS

Seafarers are an exceptional occupational group because of the many occupational hazards in their work. Working conditions on board differ from those ashore. They encounter many ship-related environmental stress factors such as ship motion, noise, vibration, UV light, adverse weather conditions, and hazardous substances (Forsell et al. 2016; Oldenburg et al. 2010). Seafarers also face many psychological stress factors on board such as long separations from their families, loneliness, extremely long and irregular working hours, constantly changing crews, and poor sleep quality (Carotenuto et al. 2012; Forsell et al. 2016; Iversen 2012; Oldenburg et al. 2009; Mellbye & Carter 2017). Working on board also means spending leisure time on board, isolated from the rest of society and its services. Maintaining a healthy lifestyle is more demanding on board, with limited recreation opportunities. Indeed, seafarers have high levels of smoking and obesity and they lack physical exercise (Nittari et al. 2019; Pougnet et al 2013; Pougnet et al. 2014; Oldenburg 2014; Hjarnoe & Lappin 2013). Alcohol drinking has been common in general but also on board (Pougnet et al. 2014). However, it may have decreased due to stricter regulations (Ala-Pöllänen 2017; Stoll et al. 2020). Seafaring has gone through many changes in recent decades, such as reduced crew sizes, shortening turnaround times, automation, and higher qualification standards. These changes have placed additional demands on remaining crew (Bloor et al. 2000; Busk & Härmälä 2016; Oldelburg 2014). Such difficult conditions make working on board more demanding than working ashore.

In cases of emergency, all personnel on board have to be able to participate in rescue operations. Access to health care is also limited on board. These

mean that the requirements for seafarers' health and work ability are high (IMO 2011). Seafarers are therefore biennially required to undergo medical examinations, which may lead to selecting out of seafaring on the basis of occupational health and work ability.

Due to occupational hazards, seafarers are at a high risk of mortality, especially deck and engine crew (Marin 1986; Notkola et al. 1995; Pensola et al. 2004; Borgan & Kristofersen 1986; Gullberg & Vågerö 1996; Hemmingsson et al. 1997A; SCB 2014; Hansen & Pedersen 1996). Seafarers are at excess risk of accidents and violence as a cause of death (Hansen & Pedersen 1996; Hansen & Jensen 1998; Oldenburg et al 2016; Notkola et al. 1995). Risk of suicide is also high (Hansen & Jensen 1998; Hansen & Pedersen 1996; Roberts et al. 2010; 2013; Mellbye & Carter 2017). The risk of accidents, including fatal ones, is declining. However, the pattern for disease is less clear. (Carter 2011.) Seafarers have a high cancer incidence rate (Pukkala et al. 2009; Kaerlev et al. 2005; Ugelvig Petersen et al. 2018), but the mortality rate of cardiovascular disease (CVD) is not particularly high (Hansen & Pedersen 1996; Hansen & Jensen 1998; Roberts & Jaremin 2010; Eriksson et al. 2020). Historically, the mortality rates of infectious diseases have been very high, but these have decreased over the years (Roberts & Carter 2016). However, seafarers are at a high risk of alcohol-related morbidity and mortality (Hemmingsson et al. 1997B; Coggon et al. 2010B; Kaila-Kangas et al. 2016; Kaerlev et al. 2007; 2005; Hansen & Pedersen 1996).

Working conditions on board differ depending on occupation and the general type of vessel. Health characteristics are unevenly distributed between occupations (Poulsen et al. 2014; Roberts & Jaremin 2010; Notkola et al. 1995; Roberts et al. 2010; Oldenburg et al. 2010; Mellbye & Carter 2017). Mortality from CVD, respiratory diseases and suicide are higher among crew than among officers (Roberts et al. 2010; Notkola et al. 1995). The engine crew is a particularly high-risk, whereas deck personnel suffer many fatal occupational accidents (Oldenburg et al. 2010; Notkola et al. 1995).

The demographic characteristics of seafarers may obscure the association between seafaring and mortality. However, hardly any studies have taken these characteristics into account. Most have only examined male deck and engine personnel (Borgan & Kristofersen 1986; Gullberg & Vågerö 1996; SCB 2014; Marin 1986; Notkola et al. 1995; Pensola et al. 2004). These 'traditional' seafaring occupations are uncommon among women. To our knowledge, only a few previous follow-up studies have examined mortality among female seafarers (Hansen & Jensen 1998; Eriksson et al 2020), or included the catering department (Hansen & Jensen 1998; Hansen & Pedersen 1996; Eriksson et al 2020).

3.6 SUMMARY OF PREVIOUS FINDINGS AND GAPS IDENTIFIED IN RESEARCH

Some Nordic register-based research has been conducted on the differences between mortality in detailed occupations, and with almost equal quality data, some research has also been carried out in other Western countries. Based on these studies, most high-mortality occupations are classified as manual occupations.

Much research has examined how controlling for other SEP measures, such as education and income, affects mortality differences according to occupational class level. Only a few such studies have focused on the detailed occupational level. The increased risk of all-cause mortality in certain occupations could be partly explained by other SEP measures. However, it is unusual to have data on education and income and detailed information on occupation in the same study. Thus, studies of occupational mortality differences rarely control for SEP.

The occupations with high alcohol-related mortality are for the most part manual. Alcohol-related mortality is known to contribute to differences in total mortality by occupational class but the extent to which it contributes to the high mortality of an occupation and whether occupations differ in this respect is not known.

Seafarers are an exceptional occupational group with many occupational hazards. Earlier studies have almost exclusively examined the mortality of men in traditional seafaring occupations due to overall small numbers of female seafarers. There is thus a need to study female seafarers and catering staff. Different seafaring occupations have different kind of risks. Therefore, it is important to also investigate mortality separately in different seafaring occupations. The industry has undergone many changes in recent decades, hence new research is needed.

Studies of health care services use by occupational class and detailed occupation are rare and the results are partly controversial. Some studies have included both outpatient and inpatient health care services, but these studies have only used the occupational class level. Most studies have adjusted for need, but controlling for other covariates is rare. Most earlier studies have been surveys; register-based studies, which are more reliable than self-reported data, are lacking.

Up-to-date research on the mortality differences among manual workers is needed. Knowledge on the role of other socioeconomic factors in these differences and on whether the differences are related to alcohol consumption is also lacking. It would be interesting to study whether knowledge of a specific occupational group, for example seafarers, could be increased, as more detailed information about this occupational group is available. A study of health care service use at the detailed occupational level could help define its effect on health inequalities.

4 AIMS OF THE STUDY

The general aim of this study was to examine mortality and the use of health care services by detailed occupation rather than occupational class. The focus was on manual occupations with high mortality rates. The study also sought explanations for this high mortality. Not only health but also alcohol-related behaviour, and the use of health care services depend partly on people's personal factors and partly on the social context and shared circumstances of the occupations.

The first aim was to identify manual occupations with high mortality and find explanations for this high mortality. High mortality in a specific occupation may be due to other SEP measures such as education and income. Differences in alcohol-related behaviour may explain occupational mortality differences. Differences between the health care service use of occupations, as well as explanations for these differences, have seldom been studied. We attempted to fill this gap. We studied not only manual occupations but also all other occupational classes, because so few studies have been conducted on the topic. We specifically concentrated on the mortality of seafarers, who have an unparalleled work environment, and use the unique register-based data on Finnish seafarers.

The specific research questions of the study were:

1. Which manual occupations have high mortality? (Sub-study II)
2. Can the high mortality of manual occupations be explained by education, income, unemployment, or industry, and do these effects vary among different manual occupations with a high risk of mortality? (Sub-study I)
3. Does the role of alcohol differ in the excess mortality in these occupations? (Sub-study II)
4. Does mortality by cause of death differ between seafarers and other employees in Finland, does seafarers' mortality vary in different seafaring occupations and can these differences be explained by sociodemographic factors such as language, family type, education, or income? (Sub-study III)
5. Does the use of outpatient and inpatient health services differ by occupational class and by detailed occupation, and are the differences explained by sociodemographic factors and health status? (Sub-study IV)

5 DATA AND METHODS

5.1 STUDY POPULATION AND FOLLOW-UP

In all the sub-studies, we used longitudinal, individual-level register-based data (Table 2).

In Sub-studies I and II, the study population consisted of all employees aged 30–64 living in Finland at the end of 2000. The study population was obtained from Statistics Finland. Information from the registers of Statistics Finland was linked together via the participants' unique personal identity numbers. The study population's mortality was followed from 1 January 2001 to 31 December 2015. A participant was censored at their time of death, at the time they were lost to follow-up, or at the end of the follow-up. To study high-mortality manual occupations, we selected manual occupations with a standardized mortality ratio (SMR) of at least 120 and which was statistically significantly higher than that of all employees, and with at least 15 000 person-years. We examined men and women separately. The whole cohort consisted of 1 539 941 individuals, 22 477 812 person-years and 78 029 deaths.

In Sub-study III, the study population was derived from the data files of the Seafarers' Pension Fund, which is the authorized pension provider that provides statutory earnings-related pension for seafarers working under the Finnish flag. We included all seafarers who had at least five cumulative years of employment as a seafarer before the follow-up, lived in Finland, and were aged 25–64 at the end of 2000 (N=6 429, 67% men). The reference population was obtained from Statistics Finland. It included all other employees aged 25–64 at the end of 2000 (N=1 721 553), except for those who had a work history as a seafarer in the registers of the Finnish Centre for Pensions. Information from various registers (the Seafarers' Pension Fund, Statistics Finland, and the Finnish Centre for Pensions) was linked together via the participants' unique personal identity numbers. The mortality of the study population was followed from 1 January 2001 to 31 December 2013. A participant was censored at their time of death, at the time they were lost to follow-up, or at the end of the follow-up. During the follow-up period from 2001 to 2013, the seafarers' cohort had 81 035 person-years and 382 deaths.

In Sub-study IV, the study population consisted of all 25–64-year-old employees living in the city of Oulu at the end of 2017. We restricted the analysis to those who were employees at the end of 2017, who had worked for more than six months in 2018, and who lived in Oulu for the whole of 2018 (N = 61 848). The individual-level register data of their sociodemographic background and their use of social and health services and benefits were linked from several registers: the City of Oulu, The Social Insurance Institution of Finland, the Finnish Institute for Health and Welfare, the Finnish Centre for Pensions, four large occupational health care providers, Statistics Finland, and

the Finnish Tax Administration (see Blomgren & Jäppinen 2020). We followed their health care service use during 2018. The data were collected as part of a research project which examined the use of services and social security benefits of the inhabitants of Oulu (Blomgren & Jäppinen 2020). The dataset included individual-level information that is not commonly available in registers, such as comprehensive information on the use of occupational health care services.

Table 2 *Main characteristics of Sub-studies I–IV.*

	Sub-study I	**Sub-study II**	**Sub-study III**	**Sub-study IV**
Data sources	Statistics Finland	Statistics Finland	Statistics Finland, Seafarers' Pension Fund, Finnish Centre for Pensions	City of Oulu, The Social Insurance Institution of Finland, Finnish Institute for Health and Welfare, Finnish Centre for Pensions, four occupational health care companies, Statistics Finland, Finnish Tax Administration
Type of data	Register	Register	Register	Register
Target population	Manual employees with high mortality	Manual employees with high mortality	Seafarers	All employees in Oulu
Reference population	All employees	All employees	All employees	All employees
N / PY	N 1 539 941 PY 22 477 812	N 1 539 941 PY 22 477 812	N 6 429 seafarers N 1 721 553 other employees	N 61 848
Age range (years)	30–64	30–64	25–64	25–64
Follow-up	2001–2015	2001–2015	2001–2013	2018
Outcome	Mortality	Mortality, alcohol-related mortality	Mortality	Use of outpatient and inpatient health care services
Covariates of main interest	Education, income, unemployment, industry	None	Language, family type, education, income	Education, income, marital status, entitlements to special reimbursement for medicine, sickness absence
Methods	SDR, Cox proportional hazard model	SMR	SDR, SMR, Cox proportional hazard model	Negative binomial regression model, logistic regression model

5.2 MEASUREMENTS

5.2.1 OCCUPATION

In Sub-studies I and II, occupation at the end of 2000 with a five-digit level was derived from Statistics Finland. It was classified according to Finland's national Classification of Occupations 2001 (Statistics Finland 2001). With a few exceptions, the classification is based on the four-digit level of the EU's Classification of Occupations ISCO-88(COM) (Elias & Birch 1994), which is the European version of the International Labour Organization's International Standard Classification of Occupations (ISCO-88) (ILO 1990; ILO 2004; Elias 1997). Finnish national circumstances are taken into account by adding five-digit occupations (Statistics Finland 2001). The classification considers the skill required by the job or the skill of an employee. It has two dimensions: skill level and skill specialization. The codes are internationally comparable and enable analysis by both occupational class and detailed occupation.

The distinction between manual and non-manual occupations was made according to the occupational classification, which has ten major groups: 0) armed forces, 1) legislators, senior officials and managers, 2) professionals, 3) technicians and associate professionals, 4) clerks, 5) service and care workers, and shop and market sales workers, 6) skilled agricultural and fishery workers, 7) craft and related trade workers, 8) plant and machine operators and assemblers, and 9) elementary occupations. Groups 4–9 belong to manual workers, and Groups 4–8 belong to the same skill level, whereas Group 9 consist of elementary occupations with simple and routine tasks.

These major groups can in turn be divided into sub-major groups, sub-major groups into minor groups, and minor groups into more detailed occupations. The most detailed level in use in the Finnish classification goes up to a three- to five-digit level.

We coded occupations into 156 categories, which consisted of non-overlapping job groups. We mainly used occupational classification at the four-digit level. Of the 156 occupations, 90 belonged to manual occupations.

In Sub-study III, the data on seafaring occupations were obtained from the data files of the Seafarers' Pension Fund. Information on seafarers' occupations in 2000 was based on the classification of the Finnish Transport Safety Agency. The original 166 occupations were classified, for men, into deck officers (20%), deck crew (18%), engine officers (15%), engine crew (11%), galley (11%), restaurant (11%) and other employees (14%) including hotel personnel, and those in sales, entertainment and other services. The classifications for women were sailor (3%), galley employee (27%), restaurant employee (40%), and other (30%).

In Sub-study IV, occupation was classified using the national Classification of Occupations 2010 (Statistics Finland 2011), which is based on the ISCO-08 compiled by the International Labour Organization (ILO) (ILO 2012). The ISCO-08 conceptual model has not fundamentally changed from the ISCO-88

model, but there are significant differences in the treatment of some occupations. Some occupations have even been moved from one major group to another. (ILO 2012.) The EU has no separate version. The Finnish occupational classification of 2010 follows the structure of the ISCO-08 up to the four-digit level, with a few exceptions. The five-digit level of the classification is a national addition. (Statistics Finland 2011.) We used the one-digit level, excluding armed forces. We also selected the 20 largest occupations at two-digit level, separately for men and women.

5.2.2 MORTALITY

The mortality data with primary and contributing causes of death was derived from the Statistics Finland register on causes of death (ICD-10) (Lahti & Penttilä 2001; Statistics Finland 1996). The information on cause of death is based on the death certificates issued by medical doctors after clinical examination or by coroners.

In Sub-study I we studied all-cause mortality. In Sub-studies II and III, we also studied alcohol-related and non-alcohol-related deaths. A death was defined as alcohol-related if the primary or contributing causes of death were mental and behavioural disorders due to use of alcohol (F10), degeneration of the nervous system due to alcohol (G312), alcohol-induced epileptic seizure (G4051), alcoholic polyneuropathy (G621), alcoholic cardiomyopathy (I426), alcoholic gastritis (K292), alcoholic liver disease (K70, K852, K860, K8600), or accidental alcohol intoxication (X45). All remaining deaths were defined as non-alcohol related.

Among seafarers (Sub-study III), we classified the primary causes of death as follows: neoplasms (C00-D48), lung cancer (C32-C34), diseases of the circulatory system (I00-I425, I427-I99), ischaemic heart disease (I20-I25), cerebrovascular disease (I60-I69), diseases of the respiratory system (J00-J64, J66-J99), diabetes (E10-E14, including contributing causes), alcohol-related diseases (F10, G312, G4051, G621, I426, K292, K70, K852, K860, K8600), other diseases, accidents and violence (V01-Y89), suicide (X60-X84, Y87.0), accidental poisoning by alcohol (X45) and other accidents and violence.

5.2.3 USE OF HEALTH CARE SERVICES

In Sub-study IV, we examined the use of outpatient and inpatient health care services in 2018. The use of outpatient care was derived from several registers. Data on occupational health care services were derived from the four largest occupational health care providers in Oulu, estimated to cover over 90% of occupational health care customers (Hujanen & Mikkola 2016). Data on public sector outpatient primary health care were obtained from the registers of the City of Oulu and data on specialized health care from the Care Registers for Health Care (HILMO). Data on private sector outpatient visits were obtained

from The Social Insurance Institution of Finland. We summed the number of face-to-face visit days to a doctor or nurse in 2018 from all three sectors. We did not include dental health care visits.

Data on inpatient care came from the registers of the City of Oulu and HILMO. They include admission dates from both primary and specialized care. They cover both the public and private sector (Arajärvi et al. 2018). These data cover hospital visits adequately and the visits are recorded accurately (Sund 2012).

5.2.4 EXPLANATORY FACTORS

Most of the background variables were derived from the registers of Statistics Finland. In Sub-studies I and III, the information was mostly from the end of 2000 and in Sub-study IV from the end of or during 2017.

Age at the end of 2000/2017 was classified into five-year age groups.

Education (Sub-studies I, III and IV) was based on the highest completed degree or certificate. Those with primary-level education had completed up to nine years of education, those with secondary education 11–12 years, and those with tertiary education at least 13 years.

Income (Sub-studies I, III and IV) was based on the data on income subject to state taxation. It consisted of wages and salaries, entrepreneurial income, and other income such as unemployment benefits and other social security benefits. In Sub-studies II and III, income was classified into thirds and in Sub-study into quartiles, separately for men and women because of their different income distribution.

Unemployment months (Sub-study I) from 1999 and 2000 were summarized.

Language (Sub-study III) was classified into Finnish, Swedish and other.

Family type (Sub-study III) was classified into four groups: 1) living alone, 2) spouse, no children, 3) spouse with children and 4) single father/mother with children. Spouse covered married, co-habiting and in a registered partnership.

Marital status (Sub-study IV) was classified into married, unmarried, and separated/widowed. It was obtained from the registers of The Social Insurance Institution of Finland.

The information on industry (Sub-study I) was coded into 18 main categories according to Standard Industrial Classification 1995 (Statistics Finland 1999).

The entitlements to special reimbursement for medicine expenses (Sub-study IV) can be paid for the costs of medicines for severe and long-term diseases (Kastarinen 2020), and the information is often used as a proxy of chronic diseases (Saastamoinen et al. 2012). Persons were classified as having at least one chronic disease if they were entitled to this reimbursement in 2017.

Sickness absence (Sub-study IV) was measured by sickness allowance paid by The Social Insurance Institution of Finland. Sickness allowance is paid as

compensation for loss of income due to incapacity to work. It is granted on the basis of a medical certificate after a ten-day waiting period. We summarized the sickness allowance days in 2017 and categorized them into 0, 1–60 and 61–365 days. The information on entitlements and sickness allowance was obtained from the registers of The Social Insurance Institution of Finland.

5.3 STATISTICAL METHODS

Men and women were analysed separately because of the different occupational distribution and the different level of mortality between the sexes. All analyses used Stata (StataCorp 2015).

In order to investigate the level of mortality in Sub-studies I and III, directly age-adjusted standardized death rates (SDR per 100 000 person-years) and their 95% confidence intervals (CI) were calculated, using all employed as the standard population.

In Sub-studies II and III, indirectly age standardized mortality ratios (SMR) and their 95% confidence intervals (CI) were calculated to compare the mortality of high-risk occupations to that of all employees. In Sub-study III, we also calculated SMR by causes of death and by seafaring occupation. The SMR for an occupational cohort is the ratio of the total number of observed deaths in the occupation to the number of expected deaths from age-specific reference rates multiplied by 100. If the ratio is higher than 100, the number of deaths is higher than expected in a situation in which the age-specific death rates would be the same as that of the total population. We calculated the reference rates for all the five-year age groups by dividing the number of deaths by person-years in a specific age group. Expected deaths were calculated by multiplying the total number of participants in the occupation by the death rates of all employees in the corresponding age group and summing up all the values for each age group. (Armitage et al. 2005.)

$$SMR = \frac{d}{\sum(M_x p_x)} \times 100$$

d = number of deaths in the occupation

M_x = death rate of all employees in the age group x

p_x = total number of person-years in the occupation in the age group x

SMR is the weighted mean over the separate age groups, i.e., the ratio of the observed death rates in the occupation to those in the standard population, that is, all employees. The weights depend on the age distribution of the occupation. This means that the SMRs calculated for several occupations are not strictly comparable, as they have been calculated using different weights.

(Armitage et al. 2005.) According to Julious et al. (2001), SMR should only be used to compare mortality from different causes within a single population. However, in our study, age distributions did not vary substantially by occupation. SMR is often used in the analysis of occupational cohorts (Armitage et al. 2005, Lynge 2011), also recently in Nordic countries, where the data allow directly standardized methods (Pensola et al. 2012; Pukkala et al. 2009; SCB 2014). SMR enables comparison of all employees. The SMR is favoured when the number of deaths is small (Sauli 1983). Another advantage of using SMR is that the variance of indirectly standardized rates is lower than that of directly standardized rates (Julious et al. 2001; Court & Cheng 1995). SMRs are also quite robust in terms of violations of the assumption of proportionality (Court & Cheng 1995). The CIs were calculated using the quadratic approximation of the Poisson log likelihood for the log-rate parameter. The log scale is preferred because of the skewed distribution of SMR (Julious et al. 2001).

We used two different methods to estimate the contribution of different causes of death to total mortality. In Sub-study II, the contribution of alcohol-related mortality to relative excess mortality was obtained by comparing the excess mortality in all deaths to that in deaths not related to alcohol. We calculated the proportion rate difference (RD) (Mäkelä et al. 1997).

$$RD = \frac{(SMR_{all} - 100) - (SMR_{non-alcohol-related} - 100)}{SMR_{all} - 100} \times 100$$

In Sub-study III, we compared the absolute differences between the mortality of seafarers and that of other employees by cause of death. The contribution of cause-specific deaths to excess mortality is estimated from the difference in SDR of total and cause-specific deaths (Hemström 2002).

$$difference\ in\ SDR = \frac{C_S - C_E}{T_S - T_E} \times 100$$

C = cause-specific mortality rate

T = total mortality rate

S = seafarers

E = other employees

The Cox proportional hazard regression models with hazard ratios (HR) and their 95% CIs were used to estimate the association between occupation and mortality in Sub-studies I and III (Armitage et al. 2005). Time to death was measured in days, as a continuous variable. In Sub-study I, we adjusted for education, income and unemployment, and after this, industry. In Sub-

study III, we adjusted for language, family type, education, and income. We studied the effect of the explanatory factors by comparing the adjusted models to Model 1, using the formula:

$$\frac{HR_{model1} - HR_{modelx}}{HR_{model1} - 1} \times 100$$

We used negative binomial regression with incidence rate ratios (IRR) to analyse the number of visits to outpatient care services in Sub-study IV. Negative binomial regression can be used for over-dispersed count data, that is, when the conditional variance exceeds the conditional mean. Hospitalization was measured as a dichotomous variable and studied using a logistic regression model with odds ratios (OR). In both cases, we fit the models with age and then adjusted for sociodemographic factors (education, income, marital status) and health status (special reimbursement entitlements for medicine expenses and sickness absence) and calculated the 95% CIs.

5.4 ETHICAL APPROVAL AND CONSIDERATIONS

The material comprised information classified as sensitive in the Finnish Data Protection Act (1050/2018), as it concerned a person's state of health, illness, or disability. The processing of this information is permitted for scientific research purposes. The research complied with the EU's General Data Protection Regulation (GDPR) (2016/679) and with good scientific practice (TENK 2012) and ethical guidelines (TENK 2019). Informed consent was not required, because the data were register based. The data providers removed all identification codes from the combined material and pseudonymized the data.

For Sub-studies I–III, we obtained ethical approval from the ethical committee of the Rehabilitation Foundation, and permission to use the data from Statistics Finland, for Sub-study III also from Seafarers' Pension Fund and Finnish Centre for Pensions. The data were used with Statistics Finland's remote access system. For Sub-study IV, the data were accessed with the permission of the City of Oulu, The Social Insurance Institution of Finland, the Finnish Institute for Health and Welfare, the Finnish Centre for Pensions, Statistics Finland, and the Finnish Tax Administration.

6 RESULTS

6.1 HIGH-MORTALITY MANUAL OCCUPATIONS (SUB-STUDIES I AND II)

Men had 31 and women 11 high-mortality manual occupations (SMR>120).

Among men, most of the occupations with high mortality belonged to building and metal workers, stationary plant operators, drivers, and elementary occupations. The occupation with the highest mortality among men was building construction labourers (SMR 180) (Table 3). Other high-mortality occupations were some clerks, waiters and bartenders, care workers, and farmer's locums.

Among women, half of the high-mortality occupations belonged to elementary occupations (Table 4). Mortality was highest among building caretakers (SMR 155). High-mortality occupations also included three clerical occupations, waitresses and bartenders, chemical processing plant operators, and bleaching-, dyeing- and cleaning-machine operators.

Six of the high-mortality occupations were the same among men and women. These were waiters/waitresses and bartenders, cleaners, building caretakers, newspaper and advertisement deliverers, manufacturing labourers, and transport labourers and freight handlers. Most of these were elementary occupations.

Table 3 *Number of persons and deaths, standardized death rates (SDR per 100 000 person-years), standardized mortality ratios (SMR) and their 95% confidence intervals in 31 high-mortality manual occupations among men.*

Occupation	Code*	N	Deaths	SDR	SMR	95% CI
Clerks						
Porters (office)	41422	3096	324	646	137	(122-152)
Assistant office clerks	4190	3711	276	634	129	(114-145)
Service, care, shop, and market sales workers						
Waiters, waitresses and bartenders	5123	3303	222	708	147	(129-168)
Practical nurses	5132	4193	284	592	123	(110-138)
Home care assistants, personal care workers	5133	2627	377	772	156	(141-173)
Skilled agricultural and fishery workers						
Farmer's locums	6123	1774	122	620	132	(111-158)
Craft and related trade workers						
Builders	7121	8606	753	695	147	(137-158)
Bricklayers and stonemasons	7122	1691	129	585	121	(102-144)
Other building frame workers	7129	1966	196	688	144	(125-165)
Insulation workers	7134	1506	149	750	158	(134-185)
Glaziers	7135	1064	77	661	141	(113-176)
Plumbers and pipe fitters	7136	9015	799	603	126	(118-135)
Painters	7141	5761	531	702	146	(134-159)
Metal moulders and coremakers	7211	1551	134	617	132	(111-156)
Welders and flame cutters	7212	10338	839	573	120	(112-129)
Sheet-metal workers	7213	8868	757	602	126	(117-135)
Plant and machine operators and assemblers						
Metal processing plant operators	812	3956	321	579	121	(108-135)
Wood processing plant operators	8141	4306	369	642	136	(122-150)
Paper-making plant operators	8143	5625	447	594	125	(114-137)
Motor vehicle drivers	832	39751	3416	625	130	(126-135)
Earth-moving plant operators	8332	6596	641	665	139	(129-150)
Crane and hoist operators	8333	1336	125	647	131	(110-156)
Lifting-truck operators	8334	3373	319	619	128	(115-143)
Ships' deck and engine crews	8340	1304	138	677	145	(123-171)
Elementary occupations						
Cleaners	91322	3508	326	760	162	(146-181)
Building caretakers	9141	15219	1514	613	127	(121-133)
Newspaper and advertisement deliverers	9151	1841	152	594	125	(107-147)
Construction and maintenance labourers	9312	3773	393	706	149	(135-165)
Building construction labourers	9313	3243	397	859	180	(163-199)
Manufacturing labourers	9320	4096	355	655	136	(122-150)
Transport labourers and freight handlers	9330	17551	1459	629	132	(125-139)
All employees		756792		478	100	

*Classification of Occupations 2001 (Statistics Finland 2001)

Table 4 *Number of persons and deaths, standardized death rates (SDR per 100 000 person-years), standardized mortality ratios (SMR) and their 95% confidence intervals in 11 high-mortality manual occupations among women.*

Occupation	Code*	N	Deaths	SDR	SMR	95% CI
Clerks						
Word-processors	4112	1999	90	302	131	(107-161)
Library and filing clerks	4141	3639	170	298	130	(111-151)
Telephone switchboard operators	42231	3686	189	328	143	(124-165)
Service, care, shop, and market sales workers						
Waitresses and bartenders	5123	11528	484	322	141	(129-154)
Plant and machine operators and assemblers						
Chemical processing plant operators	8150	1780	93	313	138	(113-169)
Bleaching-, dyeing- and cleaning-machine operators	8264	2368	119	295	125	(104-149)
Elementary occupations						
Cleaners	91322	35014	1972	318	134	(128-140)
Building caretakers	9141	2849	198	366	155	(135-179)
Newspaper and advertisement deliverers	9151	2357	114	297	124	(104-150)
Manufacturing labourers	9320	4678	232	304	133	(117-151)
Transport labourers and freight handlers	9330	5356	259	304	130	(115-147)
All employees		783140		230	100	

*Classification of Occupations 2001 (Statistics Finland 2001)

6.2 CONTRIBUTION OF SOCIOECONOMIC AND OCCUPATIONAL FACTORS TO HIGH MORTALITY AMONG MANUAL OCCUPATIONS (SUB-STUDY I)

Among men, the extent to which adjusting for education, income, unemployment and industry explained the high mortality in a specific occupation varied greatly (from -38% to 145%) (Table 5). Among clerks, controlling for socioeconomic characteristics explained the excess mortality in comparison to all employees. The same applied to service, care, shop, and market sales workers, excluding waiters and bartenders. Overall, industry had only a small effect in studied occupations, apart from farmer's locums. Socioeconomic factors explained their high mortality but controlling for industry returned the level to near the original level. Among craft and related trade workers, the effect of adjustments was quite large overall. However, in some occupations, excess mortality remained significantly high; for example, among plumbers and pipe fitters, painters, metal moulders and coremakers, and sheet-metal workers. Plant and machine operators and assemblers included the occupations least affected by the adjustments. Among paper-making plant operators, the adjustment of income and unemployment even increased the risk. The effect was also relatively low among metal-processing plant operators and ships' deck and engine crews. Elementary occupations' excess mortality was partly explained by socioeconomic characteristics and industry. Only among building caretakers and newspaper and advertisement deliverers was excess mortality fully explained. After adjusting for socioeconomic and occupational characteristics, mortality was statistically significantly high in 17 of the 31 occupations.

Among women, the variation in the effects of adjusting for education, income, unemployment, and industry was smaller than that among men (Table 6). The contribution was the highest among newspaper and advertisement deliverers (86%) and the lowest among word processors (9%). Among clerks, the effect of the adjustments was quite low overall due to their higher education. Among waitresses and bartenders, the adjustments explained half of the excess mortality. The effect varied from 32% to 86% among plant and machine operators and assemblers and elementary occupations. After the adjustments, mortality was still statistically higher than average in all 11 occupations, apart from bleaching-, dyeing- and cleaning-machine operators, and newspaper and advertisement deliverers.

Table 5 *Adjusted hazard ratios (HR) and 95% confidence intervals (CI) and change (%) compared to age-adjusted model for all-cause mortality in 31 high-mortality manual occupations among men.*

	Age-adjusted model		Full model		
Occupation*	**HR**	**95% CI**	**HR**	**95% CI**	**%**
Clerks					
Porters (office)	**1.37**	(1.22-1.52)	1.10	(0.99-1.23)	73
Assistant office clerks	**1.30**	(1.15-1.46)	1.10	(0.98-1.24)	67
Service, care, shop, and market sales workers					
Waiters and bartenders	**1.50**	(1.31-1.71)	**1.18**	(1.01-1.38)	64
Practical nurses	**1.25**	(1.12-1.41)	1.09	(0.96-1.23)	64
Home care assistants, personal care workers	**1.52**	(1.37-1.68)	1.10	(0.99-1.23)	81
Skilled agricultural and fishery workers					
Farmer's locums	**1.33**	(1.11-1.59)	**1.25**	(1.04-1.51)	24
Craft and related trade workers					
Builders	**1.51**	(1.40-1.62)	1.04	(0.97-1.12)	92
Bricklayers and stonemasons	**1.22**	(1.03-1.45)	0.90	(0.76-1.08)	145
Other building frame workers	**1.45**	(1.26-1.67)	1.11	(0.97-1.28)	76
Insulation workers	**1.60**	(1.36-1.88)	1.17	(0.99-1.37)	72
Glaziers	**1.43**	(1.15-1.79)	1.17	(0.94-1.46)	60
Plumbers and pipe fitters	**1.28**	(1.19-1.37)	**1.08**	(1.01-1.16)	71
Painters	**1.48**	(1.36-1.62)	**1.14**	(1.04-1.24)	71
Metal moulders and coremakers	**1.33**	(1.12-1.58)	**1.23**	(1.04-1.46)	30
Welders and flame cutters	**1.22**	(1.14-1.30)	1.06	(0.99-1.14)	73
Sheet-metal workers	**1.28**	(1.19-1.37)	**1.14**	(1.06-1.22)	50
Plant and machine operators and assemblers					
Metal processing plant operators	**1.22**	(1.09-1.36)	**1.22**	(1.09-1.36)	0
Wood processing plant operators	**1.37**	(1.23-1.51)	**1.15**	(1.03-1.27)	59
Paper-making plant operators	**1.26**	(1.15-1.39)	**1.36**	(1.24-1.50)	-38
Motor vehicle drivers	**1.33**	(1.28-1.38)	**1.06**	(1.01-1.10)	82
Earth-moving plant operators	**1.40**	(1.29-1.51)	1.06	(0.98-1.15)	85
Crane and hoist operators	**1.32**	(1.11-1.57)	1.09	(0.92-1.30)	72
Lifting-truck operators	**1.29**	(1.16-1.44)	**1.16**	(1.04-1.30)	45
Ships' deck and engine crews	**1.46**	(1.24-1.73)	**1.35**	(1.14-1.59)	24
Elementary occupations					
Cleaners	**1.65**	(1.48-1.84)	**1.28**	(1.14-1.42)	57
Building caretakers	**1.27**	(1.20-1.33)	1.01	(0.96-1.07)	96
Newspaper and advertisement deliverers	**1.25**	(1.06-1.46)	0.98	(0.84-1.16)	108
Construction and maintenance labourers	**1.52**	(1.38-1.68)	**1.10**	(1.00-1.22)	81
Building construction labourers	**1.83**	(1.66-2.02)	**1.19**	(1.08-1.31)	77
Manufacturing labourers	**1.36**	(1.23-1.51)	**1.20**	(1.08-1.33)	44
Transport labourers and freight handlers	**1.33**	(1.26-1.40)	**1.17**	(1.11-1.23)	48

Age-adjusted model: HRs adjusted for age

Full model: HRs adjusted for age, education, income, unemployment and industry

*The reference group for a specific occupation was all other employees, excluding this particular occupation.

Table 6 *Adjusted hazard ratios (HR) and 95% confidence intervals (CI) and change (%) compared to age-adjusted model for all-cause mortality in 11 high-mortality manual occupations among women.*

	Age-adjusted model		Full model		
Occupation*	**HR**	**95% CI**	**HR**	**95% CI**	**%**
Clerks					
Word processors	**1.33**	(1.08-1.63)	**1.30**	(1.05-1.59)	9
Library and filing clerks	**1.30**	(1.12-1.52)	**1.20**	(1.03-1.40)	33
Telephone switchboard operators	**1.43**	(1.24-1.65)	**1.32**	(1.14-1.52)	26
Service, care, shop, and market sales workers					
Waitresses and bartenders	**1.43**	(1.30-1.56)	**1.20**	(1.08-1.33)	53
Plant and machine operators and assemblers					
Chemical processing plant operators	**1.37**	(1.12-1.68)	**1.25**	(1.02-1.53)	32
Bleaching-, dyeing- and cleaning-machine operators	**1.24**	(1.04-1.48)	1.06	(0.89-1.28)	75
Elementary occupations					
Cleaners	**1.36**	(1.30-1.42)	**1.11**	(1.06-1.17)	69
Building caretakers	**1.53**	(1.33-1.76)	**1.28**	(1.11-1.48)	47
Newspaper and advertisement deliverers	**1.22**	(1.02-1.47)	1.03	(0.85-1.24)	86
Manufacturing labourers	**1.34**	(1.17-1.52)	**1.21**	(1.06-1.38)	38
Transport labourers and freight handlers	**1.30**	(1.15-1.47)	**1.18**	(1.04-1.33)	40

Age-adjusted model: HRs adjusted for age

Full model: HRs adjusted for age, education, income, unemployment and industry

*The reference group for a specific occupation was all other employees, excluding this particular occupation.

6.3 THE ROLE OF ALCOHOL IN HIGH MORTALITY AMONG MANUAL OCCUPATIONS (SUB-STUDY II)

Alcohol-related mortality constituted 27% of all-cause mortality among men aged 30–64 in manual occupations and 12% among women. The proportions were one percentage point lower among all employees.

Among men, almost all (24 of 31) high-mortality manual occupations also had high alcohol-related mortality (Table 7). In some occupations, excess alcohol-related mortality was not statistically significant, despite high SMR. Only among farmer's locums was alcohol-related mortality near the average (SMR 96). Mortality that was not related to alcohol was higher than the average in almost all occupations. The contribution of alcohol-related mortality to excess all-cause mortality was the highest among welders and flame cutters (50%), and bricklayers and stonemasons (48%). In 15 of the 31 occupations, the contribution of alcohol-related mortality was over 10%. These included many craft and related workers and elementary occupations, but also assistant office clerks, waiters and bartenders, practical nurses, and paper-making plant operators. In some occupations, the effect was negative, the lowest being among farmer's locums (-50%). In these occupations, relative mortality was higher without the equalizing effect of low alcohol-related mortality. The effect was also negative among some traffic workers.

Among women, the risk of death due to alcohol-related mortality was statistically significantly higher than the average in six occupations of the 11 high all-cause mortality occupations (Table 8). These occupations were library and filing clerks, waitresses and bartenders, cleaners, building caretakers, manufacturing labourers and transport labourers and freight handlers. The five last mentioned also had high alcohol-related mortality among men. All 11 occupations were also at a higher risk of death when alcohol-related deaths were excluded. The contribution of alcohol-related mortality to excess all-cause mortality was 10% or more in the six occupations with high alcohol-related mortality. It was the highest among building caretakers (15%). Among chemical processing-plant operators and word processors, excess mortality increased by 10% after excluding alcohol-related mortality.

Table 7 *Age standardized mortality ratios (SMR) due to all-cause mortality, alcohol-related mortality and mortality excluding alcohol-related deaths and excess mortality accounted for by alcohol (rate difference RD and proportion) in 31 high-mortality manual occupations among men.*

Occupation	All causes SMR	Alcohol-related SMR	All causes excluding alcohol-related SMR	Excess mortality due to alcohol RD	(%)
Clerks					
Porters (office)	**137**	**142**	**135**	2	5
Assistant office clerks	**129**	**147**	**122**	7	24
Service, care, shop, and market sales workers					
Waiters and bartenders	**147**	**165**	**139**	8	17
Practical nurses	**123**	**134**	**119**	4	17
Home care assistants, personal care workers	**156**	**148**	**159**	-3	-5
Skilled agricultural and fishery workers					
Farmer's locums	**132**	96	**148**	-16	-50
Craft and related trade workers					
Builders	**147**	**178**	**135**	12	26
Bricklayers and stonemasons	**121**	**147**	111	10	48
Other building frame workers	**144**	**139**	**145**	-1	-2
Insulation workers	**158**	**205**	**140**	18	31
Glaziers	**141**	132	**145**	-4	-10
Plumbers and pipe fitters	**126**	**156**	**116**	10	38
Painters	**146**	**152**	**144**	2	4
Metal moulders and coremakers	**132**	123	**135**	-3	-9
Welders and flame cutters	**120**	**148**	**110**	10	50
Sheet-metal workers	**126**	**141**	**120**	6	23
Plant and machine operators and assemblers					
Metal processing plant operators	**121**	123	**120**	1	5
Wood processing plant operators	**136**	**137**	**135**	1	3
Paper-making plant operators	**125**	**146**	**116**	9	36
Motor vehicle drivers	**130**	**124**	**133**	-3	-10
Earth-moving plant operators	**139**	**148**	**136**	3	8
Crane and hoist operators	**131**	115	**137**	-6	-19
Lifting-truck operators	**128**	**142**	**124**	4	14
Ships' deck and engine crews	**145**	131	**150**	-5	-11
Elementary occupations					
Cleaners	**162**	**180**	**156**	6	10
Building caretakers	**127**	**141**	**122**	5	19
Newspaper and advertisement deliverers and messengers	**125**	123	**126**	-1	-4
Construction and maintenance labourers	**149**	**175**	**140**	9	18
Building construction labourers	**180**	**239**	**160**	20	25
Manufacturing labourers	**136**	**148**	**131**	5	14
Transport labourers and freight handlers	**132**	**130**	**132**	0	0

Coefficients in bold differ statistically significantly from the reference group (all male employees).

Table 8 *Age standardized mortality ratios (SMR) due to all-cause mortality, alcohol-related mortality, and mortality excluding alcohol-related deaths and excess mortality accounted for by alcohol (rate difference RD and proportion) in 11 high-mortality manual occupations among women.*

Occupation	All causes SMR	Alcohol-related SMR	All causes excluding alcohol-related SMR	Excess mortality due to alcohol RD	(%)
Clerks					
Word processors	**131**	114	**134**	-3	-10
Library and filing clerks	**130**	**153**	**127**	3	10
Telephone switchboard operators	**143**	148	**142**	1	2
Service, care, shop, and market sales workers					
Waitresses and bartenders	**141**	**181**	**136**	5	12
Plant and machine operators and assemblers					
Chemical processing plant operators	**138**	110	**141**	-3	-8
Bleaching-, dyeing- and cleaning-machine operators	**125**	111	**126**	-1	-4
Elementary occupations					
Cleaners	**134**	**169**	**130**	4	12
Building caretakers	**155**	**232**	**147**	8	15
Newspaper and advertisement deliverers and messengers	**124**	128	**124**	0	0
Manufacturing labourers	**133**	**162**	**129**	4	12
Transport labourers and freight handlers	**130**	**155**	**127**	3	10

Coefficients in bold differ statistically significantly from the reference group (all female employees).

6.4 MORTALITY OF SEAFARERS (SUB-STUDY III)

The risk of death among seafarers was 1.3 times higher than that among all employees (SDR men 530, women 230) (Table 9). Men were at a higher risk of death from diseases (SMR 128), and accidents and violence (SMR 135). The risk of death was higher than average in many causes: neoplasm overall (SMR 132) and lung cancer in particular (SMR 151), diseases of the respiratory system (SMR 256) and alcohol-related diseases (SMR 172). In contrast, there were no differences in mortality due to diseases of the circulatory system, diabetes, or suicides in comparison to those among all employees. Among women, excess mortality due to diseases (SMR 126) did not quite reach statistical significance. Mortality due to accidents and violence was at the same level as that of all employees (SMR 99). Women were at a higher risk of death from lung cancer (SMR 365) and alcohol-related diseases (SMR 262).

We also examined whether seafarers' excess all-cause mortality and mortality due to alcohol-related and other than alcohol-related causes could be explained by language, family type, education, and income (Graphic 1). For men, the adjustments even increased excess mortality, mainly because of the higher income of seafarers. For women, it was only possible to examine all-cause mortality. The excess risk of mortality among female seafarers was attenuated by the adjustments.

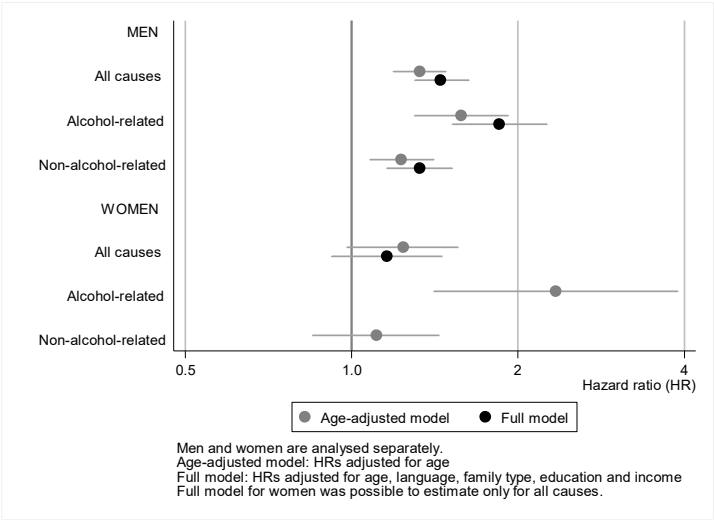
We also examined the differences between different seafaring occupations (Graphic 2). Among men, deck and engine crew as well as galley crew were at a higher risk of death than deck officers, which was the occupation with the lowest mortality and was at same level as that of all employees. Among women, galley crew seemed to have higher mortality than restaurant crew and other employees. Controlling for sociodemographic factors diminished the risk.

Table 9 *Standardized mortality ratios (SMR) and their 95% confidence intervals (CI) by cause of death among Finnish male and female seafarers aged 25–64 compared to that among all employees, 2001–2013.*

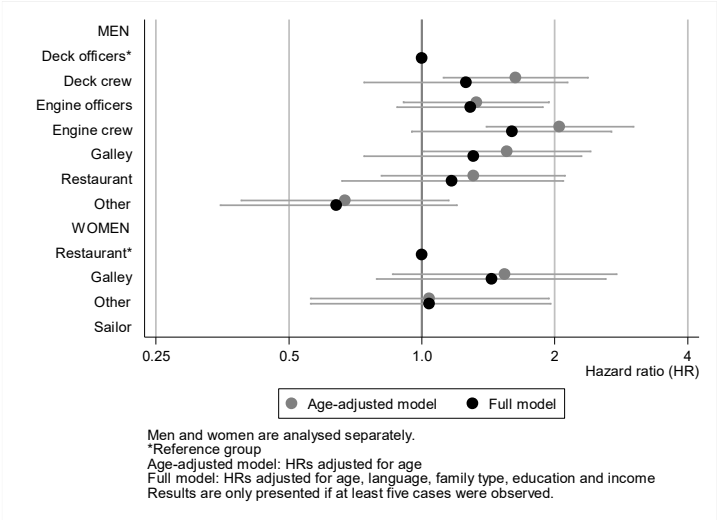
Cause of death (ICD-10)	Men		Women	
	SMR	95% CI	SMR	95% CI
All causes	**132**	(118-147)	125	(99-157)
All diseases (A00-R99)	**128**	(113-145)	126	(99-161)
Neoplasms (C00-D48)	**132**	(108-161)	123	(90-168)
Lung cancer (C32-C34)	**151**	(104-221)	**365**	(220-606)
Circulatory system diseases (I00-I425, I427-I99)	116	(93-144)	75	(36-158)
Ischaemic heart diseases (I20-I25)	120	(91-158)		
Cerebrovascular diseases (I60-I69)	93	(50-172)		
Diseases of the respiratory system (J00-J64, J66-J99)	**256**	(149-441)		
Diabetes (inc. contributing) (E10-E14)	99	(60-161)		
Alcohol-related diseases (F10, G312, G4051, G621, I426, K292, K70, K852, K860, K8600)	**172**	(126-233)	**262**	(131-525)
Other diseases	62	(32-120)	157	(79-315)
Accidents and violence (V01-Y89)	**135**	(104-174)	99	(44-220)
Suicide (X60-X84, Y87.0)	107	(66-175)		
Accidental poisoning by alcohol (X45)	**192**	(113-324)		
Other accidents and violence	134	(93-193)		

Results are only presented if at least five cases were observed.

Coefficients in bold differ statistically significantly from the reference groups (all male/female employees).



Graphic 1 *Adjusted hazard ratios and their 95% confidence intervals for all-cause, alcohol-related, and non-alcohol-related mortality among Finnish male and female seafarers aged 25–64 compared to that of all other employees, 2001–2013 (log scale).*



Graphic 2 *Adjusted hazard ratios and their 95% confidence intervals for all-cause mortality among Finnish male and female seafarers aged 25–64 by occupation, 2001–2013 (log scale).*

6.5 USE OF HEALTH CARE SERVICES (SUB-STUDY IV)

6.5.1 MEN

Male employees made an average of 3.8 visits to a doctor or a nurse in outpatient health care services in 2018. Clerical support workers had the highest number of visits (4.4), managers and professionals the lowest (3.3). After adjustment for sociodemographic factors and health status, the use of outpatient health care services was less common than the average among managers and professionals (Table 10). Technicians and associate professionals used outpatient care services slightly more frequently than average, especially health associate professionals. Clerical support workers still made the most visits. Service and sales workers made more visits on average than the average employee, but by the detailed occupation personal service workers and protective service workers made even more. Skilled agricultural, forestry and fishery workers did not differ from the average employee. Craft and related trade workers used outpatient care services more often, especially metal, machinery and related trade workers. Plant and machine operators and assemblers made more visits than average, but visits among detailed occupations varied: stationary plant and machine operators used outpatient care services more frequently, and drivers and mobile plant operators less frequently. In elementary occupations, the use of outpatient health services was on the average level, but among these, labourers in mining, construction, manufacturing, and transport made more visits than average.

Among all male employees, 6.8% had used inpatient health care services in 2018. By occupational group, inpatient care was more common among plant and machine workers and assemblers, and less common among professionals. After adjustments, higher use only remained significant among plant and machine workers and assemblers. By detailed occupation, the adjusted risk of inpatient care was higher than average among health associate professionals and stationary plant and machine operators.

6.5.2 WOMEN

Female employees made an average of 5.7 visits to outpatient health care services during 2018. Elementary occupations made the most visits (6.4), and skilled agricultural, forestry and fishery workers the least (4.0). After all adjustments, managers and professionals made a lower, and technicians and associate professionals a slightly higher number of visits than average (Table 11). There was some variation among manual workers. Clerical support workers used outpatient care services more frequently, especially customer service clerks. Service and sales workers did not differ from the average employee, but variation by detailed occupation was substantial: the use of outpatient health care services was less common than average among personal service workers and more common among sales workers. Skilled agricultural,

forestry and fishery workers did not differ from all employees, whereas craft and related trade workers made less visits than average. Among plant and machine operators and assemblers, the use of outpatient health services was at the same level as that among all employees. However, stationary plant and machine operators used outpatient care services more frequently than all the other occupations studied. Elementary occupations' use did not differ from that of all employees.

On average, 8.4% of female employees had used inpatient health care services in 2018. The adjusted results by occupational group and detailed occupation were very similar to those among men. After adjustments, use was high among health associate professionals and stationary plant and machine operators.

Overall, controlling for sociodemographic factors and health status only slightly attenuated the estimates in most occupations.

Table 10 *Use of outpatient and inpatient health care services by occupational group and occupation among male employees in Oulu in 2018.*

Occupational group (1-digit level)/ Occupation (2-digit level)*	Outpatient care (IRR)		Inpatient care (OR)	
	Age-adj. model	Full model	Age-adj. model	Full model
All employees	1.00	1.00	1.00	1.00
1 Managers	**0.80**	**0.86**	0.90	0.96
13 Production and specialized services managers	**0.85**	**0.91**	0.92	0.97
2 Professionals	**0.87**	**0.91**	**0.89**	0.94
21 Science and engineering professionals	**0.80**	**0.84**	**0.88**	0.94
22 Health professionals	0.97	0.98	0.94	0.95
23 Teaching professionals	**0.85**	**0.88**	1.06	1.10
24 Business and administration professionals	0.95	0.97	0.80	0.82
25 Information and communications technology professionals	0.96	0.98	**0.83**	0.88
3 Technicians and associate professionals	**1.04**	**1.03**	1.01	1.01
31 Science and engineering associate professionals	0.99	0.97	0.94	0.95
32 Health associate professionals	**1.25**	**1.16**	**1.47**	**1.38**
33 Business and administration associate professionals	**1.06**	**1.08**	0.96	0.98
34 Legal, social, cultural, and related associate professionals	1.03	1.01	1.18	1.15
4 Clerical support workers	**1.17**	**1.12**	1.16	1.10
5 Service and sales workers	**1.08**	**1.08**	1.13	1.09
51 Personal service workers	0.98	1.01	1.22	1.20
52 Sales workers	1.00	1.03	1.04	1.03
53 Personal care workers	**1.26**	**1.22**	1.24	1.15
54 Protective services workers	**1.30**	**1.25**	1.15	1.05
6 Skilled agricultural, forestry and fishery workers	1.02	0.99	0.86	0.80
7 Craft and related trade workers	**1.13**	**1.09**	1.04	1.00
71 Building and related trade workers, excluding electricians	**1.12**	**1.09**	0.97	0.92
72 Metal, machinery, and related trade workers	**1.27**	**1.23**	1.18	1.14
74 Electrical and electronic trade workers	1.04	1.00	0.97	0.95
8 Plant and machine operators, and assemblers	**1.11**	**1.05**	**1.24**	**1.15**
81 Stationary plant and machine operators	**1.36**	**1.28**	**1.39**	**1.27**
83 Drivers and mobile plant operators	0.98	**0.93**	**1.18**	1.11
9 Elementary occupations	**1.10**	1.07	0.83	0.78
93 Labourers in mining, construction, manufacturing, and transport	**1.30**	**1.23**	0.82	0.75

*Classification of Occupations 2010 (Statistics Finland 2011)

Age-adjusted model: occupational group/occupation + age

Full model: occupational group/occupation + age + education + income + marital status + chronic diseases + sickness absence

Coefficients in bold differ statistically significantly from the reference group (all male employees).

Table 11 *Use of outpatient and inpatient health care services by occupational group and occupation among female employees in Oulu in 2018.*

Occupational group (1-digit level)/ Occupation (2-digit level)*	Outpatient care (IRR)		Inpatient care (OR)	
	Age-adj. model	Full model	Age-adj. model	Full model
All employees	1.00	1.00	1.00	1.00
1 Managers	**0.81**	**0.90**	0.78	0.82
2 Professionals	**0.88**	**0.95**	**0.88**	0.93
21 Science and engineering professionals	**0.81**	**0.88**	1.01	1.11
22 Health professionals	**0.82**	**0.90**	0.88	0.92
23 Teaching professionals	**0.89**	**0.95**	**0.89**	0.95
24 Business and administration professionals	**0.88**	0.95	0.87	0.92
25 Information and communications technology professionals	0.95	1.00	1.00	1.05
26 Legal, social, and cultural professionals	1.00	1.06	**0.72**	**0.74**
3 Technicians and associate professionals	**1.05**	**1.04**	1.06	1.05
31 Science and engineering associate professionals	1.05	**1.13**	1.18	1.25
32 Health associate professionals	**1.06**	**1.04**	**1.16**	**1.13**
33 Business and administration associate professionals	1.04	**1.04**	**0.86**	0.89
34 Legal, social, cultural, and related associate professionals	1.03	0.99	**1.20**	1.16
4 Clerical support workers	**1.09**	**1.07**	1.03	1.04
41 General and keyboard clerks	1.07	1.03	1.13	1.12
42 Customer services clerks	**1.15**	**1.14**	1.03	1.04
43 Numerical and material recording clerks	1.06	1.07	0.99	1.02
44 Other clerical support workers	1.04	1.04	0.84	0.86
5 Service and sales workers	**1.07**	1.01	1.06	1.01
51 Personal service workers	**0.93**	**0.92**	1.05	1.06
52 Sales workers	1.10	**1.08**	0.88	0.88
53 Personal care workers	1.09	0.99	**1.18**	1.07
6 Skilled agricultural, forestry and fishery workers	**0.74**	0.79	0.99	1.12
7 Craft and related trade workers	**0.76**	**0.77**	0.85	0.88
8 Plant and machine operators, and assemblers	**1.09**	1.05	**1.45**	**1.41**
81 Stationary plant and machine operators	**1.25**	**1.21**	**1.60**	**1.54**
9 Elementary occupations	**1.10**	1.03	1.06	0.99
91 Cleaners and helpers	**1.11**	1.04	1.07	0.99
94 Food preparation assistants	1.00	0.94	1.14	1.07

*Classification of Occupations 2010 (Statistics Finland 2011)

Age-adjusted model: occupational group/occupation + age

Full model: occupational group/occupation + age + education + income + marital status + chronic diseases + sickness absence

Coefficients in bold differ statistically significantly from the reference group (all female employees).

7 DISCUSSION

7.1 SUMMARY OF MAIN FINDINGS

We identified 31 high-mortality manual occupations among male and 11 among female employees. Among men, most of the high-mortality occupations were craft and related trade workers, plant and machine operators and assemblers, and elementary occupations. Among women, nearly half were elementary occupations. Due to the gendered occupational structure, men and women had relatively few common high-mortality occupations. Furthermore, seafarer's mortality was 1.3 times higher than that of all employees.

The contribution of socioeconomic and occupational characteristics to total mortality varied between manual occupations. In most occupations, high mortality was partly explained by these characteristics, in some even fully explained. However, nearly every field included occupations in which excess mortality remained high after adjustments. In some male occupations, mortality rate even increased after adjustments. This was also true for male seafarers. In contrast, among women, seafarers' excess mortality was attenuated by controlling for sociodemographic factors. The mortality differences between the seafaring occupations were no more statistically significant after controlling for sociodemographic factors.

Almost all high-mortality manual occupations also had high mortality in alcohol-related deaths. High-mortality occupations also typically had high mortality in non-alcohol-related deaths. However, relative alcohol-related mortality was generally higher than relative mortality for other causes; therefore, alcohol-related mortality further increased excess mortality. In some occupations, the contribution was reverse, as excess mortality from non-alcohol-related causes was higher than that from alcohol-related causes. Although previous research has suggested high alcohol mortality in the occupation, this did not necessarily mean that alcohol-related mortality made a high contribution to total mortality. Among seafarers, the risk was especially high for alcohol-related mortality and lung cancer, but the risk for circulatory system diseases was on the average level.

Some differences between occupational classes in the use of health care services among employees were not explained by sociodemographic factors or health status. There were also differences among the use of health care services of detailed occupations belonging to the same field. Principally, manual workers made higher use and non-manual occupations made lower use than that of all employees. However, some occupations differed from this general line, for example male drivers and female personal service workers had low visit rates. Both outpatient and inpatient care services were more commonly used than average by both sexes among health associate professionals and

stationary plant and machine operators. Compared to mortality rates, it seems that high mortality does not always mean a high number of visits and vice versa.

7.2 DISCUSSION OF MAIN FINDINGS

7.2.1 HIGH-MORTALITY OCCUPATIONS

In earlier studies (Sauli 1983; Marin 1986; Notkola et al. 1995; Notkola & Savela 1998; Pensola ym. 2004; Pensola et al. 2012; Rinne et al. 2018; SCB 2014), almost all high mortality occupations have belonged to manual occupations, and thus focusing on these was justified. Occupations at the highest risk of occupational diseases (TTL 2021), work accidents (TVK 2021) and exposure to chemical agents (Louhelainen et a. 2017), and those with the highest prevalence of job strain (Wieclaw et al. 2008) were also manual.

The 31 high-mortality manual occupations among men and the 11 among women were from several fields. Women have also had fewer high-mortality occupations than men in earlier studies (Sauli 1983; Marin 1986; Notkola et al. 1995; Notkola & Savela 1998; Pensola ym. 2004; Pensola et al. 2012; Rinne et al. 2018; SCB 2014). Mortality is more evenly distributed between occupations among women than among men.

The large number of elementary occupations among high-mortality occupations was expected, because of the lower skill level and probably lower level of education, income, and job security in these occupations. Mortality has also been high in elementary occupations in earlier studies in Finland (Sauli 1983; Notkola & Savela 1998; Pensola et al. 2004) and elsewhere, particularly among men (van den Borre 2018; Katikireddi et al. 2017). In a Swedish study, the number of elementary occupations was surprisingly low (SCB 2014). Men had quite many high mortality occupations among craft and related trade workers, and plant and machine operators and assemblers, as in earlier Finnish studies (Marin 1986; Notkola & Savela 1998; Pensola et al. 2004). In contrast, the high mortality among clerical workers and male care workers was somewhat surprising, because of their lower level of occupational risk. Previous studies have found some clerical workers to have high mortality (Notkola & Savela 1998; Pensola et al. 2004; SCB 2014), as well as male care workers (Pensola et al. 2004), but not female (Sauli 1982; Notkola & Savela 1998; Pensola et al. 2004).

Exact comparison with Finnish studies from the 1990s (Notkola & Savela 1998; Pensola et al. 2004) is slightly difficult, as occupational classification has changed. For men, a large proportion of high-risk occupations were the same as in our study, whereas for women they varied more. In all the studies, occupations with high mortality included cleaners, waiters, and manufacturing labourers; and among men also drivers, deck and engine crew, and many elementary occupations. The results among men reflect the stability

of the Finnish occupational structure and working conditions, whereas the results among women are more random due to the lower number of deaths.

The results are easier to compare with those of the Swedish study (SCB 2014) because the occupational classification is the same. In the Swedish study, the high-mortality occupations were, with the exception of one, also manual occupations, but similar occupations to those in our study were surprisingly few, most of them being plant and machine operators and assemblers. Their shorter follow-up period or differences in occupational structure, working conditions or health behaviour (Connelly et al. 2016) may partly explain these differences.

Seafaring is still a high-risk occupation, as shown in many earlier Finnish and international studies, even if seafarers' excess mortality has decreased over time according to Swedish and Danish studies (Eriksson et al. 2020; Ugelvig Petersen et al. 2020). Although working conditions have improved, seafarers still have several risk factors, such as noise, risk of accidents and whole-body vibration, exposure to carcinogens from different oils, and psychosocial stressors. Limited or postponed access to health care may determine the severity of outcomes in cases of emergency.

7.2.2 CONTRIBUTION OF SOCIOECONOMIC AND OCCUPATIONAL FACTORS

Occupational differences in mortality may reflect more general socioeconomic characteristics. Even occupations of the same skill level may differ by education, income, and the likelihood of unemployment. These differences may also be due to differences in the common physical or social environment of the industry. It might have been assumed that adjusting for education, income, and unemployment would have explained at least part of the excess mortality among manual occupations. After all, manual occupations are basically united by lower educational requirements and income. Education brings knowledge and income material resources. Studies by occupational class have supported this assumption: mortality differences have been partly explained but occupational class still has its own net effect after adjustment for other socioeconomic factors (Martikainen et al. 2007; Geyer et al. 2006; Hoffman et al. 2019).

In most occupations, high mortality was partly explained by these factors, and in some even fully explained. Such occupations were clerks, care workers, construction workers and mobile plant operators among men, and bleaching-, dyeing- and cleaning-machine operators among women, and newspaper and advertisement deliverers among both sexes. In the occupations in which mortality was high among both sexes, the contributions were equal for men and for women. However, there were gender differences in different fields. High occupational mortality was explained more often among men than among women. Earlier studies have shown that at occupational class level, unemployment (Roelfs et al. 2011), education and income have a stronger

impact on men (Hoffman et al. 2019), possibly via risky alcohol behaviour, which is especially common in the lower income groups (Tarkiainen et al. 2015).

Some exceptions also emerged. Men had one high-risk occupation – paper-making plant operators – whose mortality rate even increased after adjusting for income and unemployment. Thus, high income and low unemployment do not always guarantee a low mortality rate. The results were somewhat similar among metal-processing plant operators. In these occupations, dangerous working conditions may be compensated by higher earnings (Raversteijn et al. 2013). Although income provides better resources and enables health-promoting lifestyles (Teperi & Keskimäki 2007), in the masculine occupational culture, behavioural patterns may be inclined towards unhealthy lifestyles as strategies for coping with stress, such as excessive alcohol consumption (Turtiainen & Väänänen 2012).

The combination of high mortality and high earnings also applied to male seafarers, whose mortality risk increased after adjustments for language, family type, education, and income in comparison to other employees. It seems that sociodemographic characteristics, especially income, protect them to some extent from the factors in seafaring that increase mortality. Among women, the risk attenuated so that the difference was no longer statistically significant. A different occupational structure may play a role in explaining these gender differences. All occupations share the same occupational culture and health behaviour such as general smoking (Pougnet et al. 2014) on board, but some have a more dangerous micro-working environment. The risk of death was highest among male engine and deck crew, as well as male and female galley personnel. Our results regarding men are consistent with both earlier (SCB 2014; Notkola & Savela 1998) and recent (Eriksson et al. 2020; Ugelvig Petersen et al. 2020) studies. Engine personnel are exposed to, for example, noise and carcinogens from different oils (Forsell et al. 2016). Deck crew, on the other hand, have the highest rate of occupational accidents (Hansen et al. 2002). Although the differences between seafaring occupations were not statistically significant after adjustments, there was some indication of excess risk among male engine crew and female galley crew.

Among women, in many manual occupations, part of excess mortality was explained as expected. Among clerks, one occupation had higher education than the average employee, but lower income and higher unemployment. It is possible that those with poorer health already at a younger age, but also the highly educated with poor health, may be selected for lower-rank office jobs. Physical risks are generally thought to explain mortality differences more than psychosocial risks (Lahelma & Rahkonen 2017), but the latter are assumed to better explain female clerks' unexplained excess mortality (Adler & Newman 2002). Their psychosocial work risks (Niedhammer et al. 2008; Wieclaw et al. 2008) could be one cause of their higher CVD mortality (Rinne et al. 2018). Perhaps being at the bottom of the hierarchy creates an extra burden (Marmot 2004). The number of office workers also fell sharply during the follow-up

period (Statistics Finland 2021), which may have meant that some became unemployed and the workload of the remaining workers increased.

The high impact of socioeconomic factors on mortality among elementary workers is understandable, as these occupations do not require high education and the salary is low. Among most of them, however, mortality remained high after adjustments. Many of these occupations are physically demanding, but they also have psychosocial work-related risks (Wieclaw et al. 2008). During the follow-up period, they may also have more unemployment periods and other stressful life situations outside of work life. In addition, the life course approach may apply, as long-term exposure to low social position increases mortality risk (Ervasti et al. 2019).

Industry measures cultural and environmental factors independently of occupation. It is certainly different to work as a cleaner in a kindergarten than in a factory. According to initial expectations, industry's impact on mortality differences may have been more diverse than that of socioeconomic factors. Not all high-mortality occupations are necessarily in a high-mortality industry. After socioeconomic factors had been adjusted for, the adjustment for industry did not have much of an impact. The biggest exception was farmers' locums, who operate in the low-mortality industry. The impact of the environment may not extend to them because of their substitutory role.

In conclusion, the high mortality of most occupations was not explained by other socioeconomic factors or industry. The effect of socioeconomic factors was smaller among women than among men. However, there were differences between occupations, and in this respect, manual occupations are not a unified group.

7.2.3 THE ROLE OF ALCOHOL-RELATED MORTALITY

One explanation for the mortality difference between occupations is health behaviour, which includes risky alcohol-related behaviour. Previous studies have listed occupations with high alcohol-related mortality, but the contribution of alcohol to total mortality has only been calculated at the occupational class level (Mäkelä et al. 1997; Hemström 2002). At this level, the contribution of alcohol to total mortality was greater among men than among women (Mäkelä et al. 1997; Hemström 2002). In this study by detailed occupation, the contribution of alcohol-related mortality to total mortality among men varied more than that among women. However, alcohol-related mortality in the high-risk occupations that were the same among men and women made a very similar contribution to total mortality.

Several occupations had high alcohol-related mortality. High-mortality occupations also had higher than average non-alcohol-related mortality. Excessive alcohol consumption may be used to recover from heavy physical and psychosocial working conditions (San Jose et al 2000; Heikkilä et al. 2012). Thus, harmful working conditions have double harmful consequences: they can cause poor health directly but also indirectly via unhealthy behaviour.

In some occupations, such as among male craft and related trade workers, alcohol-related harms would seem to outweigh other major risks in the field. This sector can be regarded as having an alcohol-friendly culture. In previous studies, many construction and metal workers (Kaila-Kangas et al. 2016; Thompson & Pirmohamed 2021) have had high alcohol-related mortality. The masculine occupational culture that Turtiainen & Väänänen (2012) observed while studying the masculinity of metal workers in the post-WWII era may still prevail. In this kind of culture, unhealthy behaviour such as excessive alcohol consumption may more likely be used as coping strategies to deal with stress.

On the other hand, the situation was not the same in all heavy occupations. Among plant and machine operators and assemblers, the contribution of alcohol was negative among women and very low among men, meaning that their relative mortality from alcohol-related causes was lower than from other causes. Like the construction industry, they face many physical and chemical risks. High alcohol consumption does not necessarily mean that the contribution of alcohol to all-cause mortality is high if the occupation also has many other risks. The industry may be lacking an equally strong pro-alcohol culture. The exception to this is male paper-making plant operators.

I would have assumed a higher contribution of alcohol-related mortality among waiters and bartenders. They have several alcohol-related risk factors such as easy access to alcohol, alcohol-friendly workplace norms and culture (Moore et al. 2009), and high alcohol-related mortality (Coggon et al. 2010B; Hemmingsson et al. 1997B; Romeri et al. 2007; Kaila-Kangas et al. 2016; Pensola et al. 2004). It has even been said that 'Publicans' and bar staffs' risk of alcohol-related disease could be regarded as a true occupational hazard' (Coggon et al. 2010B). According to this study, it is not the only hazard they face. Other risks were active and passive smoking (Reijula et al. 2015), fast work pace, lack of autonomy, high physical load, irregular working hours, threats by clients, and exposure to noise (EFILWC 2004).

Selection may explain the substantial proportion of alcohol-related mortality among elementary occupations. Risky use of alcohol in late adolescence might also lead to a lower educational level (Hemmingsson et al. 1999), which in turn only qualifies individuals for elementary occupations. Heavy drinkers may have difficulties obtaining employment, and may have ended up in low-standard jobs with hazardous conditions (San Jose et al. 2000), regardless of their education. Elementary workers may be more vulnerable to the effects of alcohol because of the cumulative effects of other adverse life events and stressors such as family issues and personal characteristics (Marchand 2008; Zhang & Snizek 2003), adverse circumstances in childhood and adolescence (Hemmingsson et al. 1999), or unemployment. According to the alcohol harm paradox, socioeconomic differences in alcohol consumption are moderate, but drinking patterns are more harmful among manual workers (Mäkelä et al. 2015; Sydén & Landberg 2017) and the consequences of alcohol-related behaviour are more severe even if drinking habits are similar (Mäkelä & Paljärvi 2008; Peña 2021).

Among seafarers, alcohol-related causes made up half of total excess mortality. Seafaring occupations have several risk factors for risky use of alcohol, such as social norms supporting or tolerating workplace drinking, frequency of after-work socializing with co-workers, hazardous physical working conditions, and mental or physical stress. In small, closed communities, drinking habits can easily be transmitted to others. We also found a high alcohol-related risk among women, contradictory to Danish studies (Kaerlev et al. 2005; Hansen & Pedersen 1996; Hansen & Jensen 1998; Kaerlev et al. 2007). Women in male-dominant occupations are under particular stress in their work life, as they may have to deal with gender discrimination (Mellbye & Carter 2017) or harassment (Forsell et al. 2016) at sea, and this stress is possibly relieved by increased alcohol consumption. Women may encounter a double burden in male-dominated occupations: stress due to being in the minority (Kanter 1977) and an adverse peer effect (Barclay 2013). Female seafarers work in occupations that also have high alcohol-related mortality on shore (Rinne et al. 2018). The alcohol policies on ships differ by company, type of ship, and the nature of the cargo (Ala-Pöllänen 2017). The mandatory limits for alcohol consumption on board came into force at the beginning of 2012 (ITF 2010). It would be interesting to see whether women have reduced their drinking more than men after the regulations, as women are generally more likely to engage in positive health behaviours than men.

In this study, we analysed alcohol-related mortality as an example of a lifestyle factor that contributes to mortality inequalities, as alcohol-related deaths play a major role in mortality inequalities (Martikainen et al. 2014). However, there were also other lifestyle differences between occupations (Shaikh et al. 2015). The accumulation of hazardous lifestyles is particularly harmful. Many high-mortality occupations identified in this study are also at a high risk of other lifestyle-related deaths such as mortality due to diabetes and lung cancer (Rinne et al. 2018). As in Sweden (Forsell et al. 2022), the risk of lung cancer was high among seafarers, especially among women. Seafarers' higher levels of smoking are the main explanation for this (Haldorsen et al. 2004). These occupations thus have wider-ranging health behaviour problems.

7.2.4 USE OF HEALTH CARE SERVICES

One aim of the Finnish health care policy is to reduce health inequalities. The root causes of socioeconomic health inequalities lay elsewhere, but one way of influencing the health inequalities between occupations is through equitable access to and use of health services. This study provided information on the use of health care services. This information helps us assess its contribution to the development of health inequalities between occupations. We assumed that the effect of a three-sector health care system would not be so central among employees.

Principally, manual workers made more outpatient visits, and non-manual occupations made less visits than all employees. The gradient was similar to that of mortality. However, some occupations differed from this general pattern: for example, male drivers and female personal service workers had low visit rates. There was no equivalent gradient in inpatient care. Occupation seemed to have a smaller effect on more serious illnesses. A small proportion of the differences attenuated when sociodemographic factors and health status were controlled for. Both outpatient and inpatient care services were more common than average for both sexes among health associate professionals and stationary plant and machine operators.

The findings of earlier studies of outpatient and inpatient care services by occupational class have been controversial, and mostly only health-related factors have been controlled for. Hardly any studies by detailed occupation have been conducted.

The use of health services might be affected not only by occupational hazards, but also by differences in disease identification, health behaviour, knowledge and attitudes towards health care, and coverage of occupational health services.

Outpatient services are mainly well targeted if assessed by the result that use is higher in high-mortality occupations. Higher physical and psychosocial work-related risks presumably increase the number of visits. Many high-use occupational groups, such as stationary plant and machine operators and male building and metal workers, have many work-related physical risk factors and a high mortality rate. Psychosocial factors may explain the greater use among, for example, clerical support workers.

However, the use of services among manual occupations does not seem to be sufficient, as they still have a higher mortality rate. Manual occupations may have poorer health literacy and information about services as well as a weaker ability to navigate the system. It may also be that not everyone is interested in health or health behaviour. More severe conditions require more visits and are more likely to lead to a higher death rate. Manual workers might also more often have communication problems with a doctor or a nurse, which leads to poor-quality services (Roos & Mustard 1997; Valtonen 2007; Willems et al. 2005) and high levels of health care use (Gulliford et al. 2002).

The importance of one's own disease identification, knowledge, and activity, as well as knowledge of the system may be reflected in the higher use of outpatient and inpatient care services among male and female health associate professionals. Men may also be affected by the peer effect: exposure to feminine culture to treat themselves (Buscariolli et al. 2018). Other studies have also observed high use of inpatient care services in health care occupations (Varje et al. 2014; Kokkinen et al. 2014), however, mortality and disability retirement rates have mainly been low (Rinne et al. 2018).

Comprehensive, individual-level information on diagnosis or reasons to visit health care services is not available in Finland; therefore, it is not possible to examine them at the occupational level. In occupational health care, the

number of medical treatment visits was three times higher than the number of health check-ups in 2018 in Finland (Kela 2020). In public sector primary care, the most common reasons for outpatient visits to a doctor among the general population were acute upper respiratory infections, hypertension, and back pain, but these data are not comprehensive (THL 2019).

Some employer practices may artificially increase the number of visits among manual occupations in particular. Manual workers often need a sick leave certificate from a doctor or nurse earlier than non-manual employees, 23% even from the first day of sickness (Sutela et al. 2019). In addition, many manual employees work in jobs that have a high risk of illness or accidents and are thus required to attend mandatory periodic medical examinations (Koskinen 2005). We can expect the healthy worker effect to be the strongest in these occupations, and example of which is seafaring (Bloor et al. 2000; Hansen & Pedersen 1996). Seafarers are required to undergo medical examinations every other year to safeguard their own as well as other crew members' health and safety. Medical examinations may cause selection out of seafaring occupations on the basis of occupational health and work ability. For example, symptomatic ischemic heart disease, heart failure, and chronic obstructive pulmonary disease prevent working on board (STM 2019). Seafarers have limited access to health care on board. In addition, they need to be able to participate in rescue operations. This places high demands on their health and work ability (IMO 2011). Medical examinations also have shortcomings, because the occupational health care system of seafarers is scattered in Finland (Miilunpalo & Visuri 2015).

High-mortality occupations in which occupational health care is known to be deficient or non-existent made lower use of health care services. This may indicate the importance of the availability of services. Despite the mandatory nature of occupational health care, it is often deficient in small enterprises, which are typical in construction, land transport, accommodation, and food service activities (Virtanen & Husman 2010). This may explain the low visit rates of male drivers and female personal service workers, such as waiters and hairdressers. Other sectors may not compensate for their lack of occupational health care, because the public sector has long waiting times and the private sector requires extra payment.

Overall, the differences between occupations in their use of health care services are due to several different factors related to supply and demand.

7.3 METHODOLOGICAL CONSIDERATIONS

Our register-based data included all employees in Finland for the mortality studies (Sub-studies I–III). The unique data, including visits to all three health care sectors, covered all employees in one city (Sub-study IV). We were able to link the information from several registers using the personal identity

numbers. Each dataset also included extensive information about the individual's characteristics, such as education and income.

Our data contained detailed information on occupation for each individual (Sub-studies I–IV). We were able to include women as they were registered by their own occupation. Many earlier studies have only covered men. As recommend (Connelly et al. 2016), we used well-documented occupational classification. The occupation data were from the beginning of the follow-up period. Earlier and later occupations and their exposures also affect an individual's mortality (Moore & Hayward 1990; Cambois & Laborde 2011). Ignoring earlier occupations might result in an underestimation of mortality in hazardous occupations and an overestimation in low-risk occupations if those in high-risk occupations move to low-risk occupations. Longer exposures to more physically demanding occupations are associated with increased risks of mortality, regardless of the most recent occupation. (Moore & Hayward 1990; Cambois & Laborde 2011.) Despite the comprehensive registers in Finland, annual information on occupation has only been available since 2004. Before that, the data were only available every five years. However, occupation at one time point seems to provide a suitable picture of mortality. When the results were compared to those of a study that used the same data and follow-up, but whose study population consisted of only people employed in the same occupation in 1995 and 2000 (Rinne et al. 2018), high-mortality occupations were the same as in this study, with a few exceptions. Moreover, in earlier studies, the results were very similar when occupation was recorded at two time points (Notkola et al. 1995) or when the high mortality occupations of the employed and unemployed were compared (Pensola & Notkola 2012). Other researchers such as Pukkala et al. (2009) have come to the same conclusion.

The long follow-up period of 13–15 years in mortality studies ensured that we did not underestimate mortality due to diseases that have a longer latency time, such as cancer. Alcohol-related causes may be underrepresented in the data because of the stigma attached to them (Probst et al. 2014). However, the quality and coverage of Finnish alcohol-related cause-of-death data is better than that in many other countries (Mäkelä 1998). Long follow-up periods also have some disadvantages. The effect of occupation may attenuate over the course of time. Occupation may change during the follow-up period, or an individual may become unemployed or retire to disability or old age pension. Unemployment is strongly associated with all-cause mortality via causal and selection mechanisms (Roelfs et al. 2011). The unemployed are also at a multiple risk of dying from alcohol in comparison to the employed (Herttua et al. 2008). Variation in all-cause and alcohol-related mortality may thus also reflect factors related to differences in unemployment rates during the follow-up. The number of employees in the follow-up decreased among, for example, clerical support workers (Statistics Finland 2021). In addition, the impact of unemployment on mortality may vary (Pensola & Notkola 2012). Those outside the workforce are also likely to have poorer access to health care

services due to restricted access to occupational health services, and their lower income may mean they cannot afford visits to the private sector. The unemployed make less visits to the doctor than the employed (Virtanen et al. 2006). There are also differences between occupations in terms of disability retirement (Pajunen et al. 1994-1995; Pensola et al. 2010; Rinne et al. 2018).

I adjusted several background factors. According to one assessment, in some cases, adjustment of other SEP variables may lead to biased results in the study of occupational cancer (Richiardi et al. 2008). Controlling for education and income is usual when studying mortality inequalities between occupational classes. We also adjusted for unemployment, as it has shown to be linked to mortality and unemployment varies greatly between occupations. Whether the adjustment for industry was necessary may be questioned. Industry describes the environment in which a person operates in their occupation. Some occupations may mainly operate in only one industry, for example construction occupations, but this is not true for all occupations. In my opinion, it was sensible to adjust for the wider environment, because occupations do not work in a vacuum.

Our alcohol-related deaths covered only 100% alcohol-related causes: these diseases would not have occurred without alcohol consumption. In addition, many diseases, mainly chronic, non-communicable and infectious, are partially attributable to alcohol or have significant relations to alcohol (Rehm et al. 2010). These causes were not included in our alcohol-related deaths but in non-alcohol-related causes. Using the attributable fraction approach, of alcohol-related deaths, 43% were 100% alcohol attributable and the rest partially attributable deaths in Finland in 2018 (Stockwell et al. 2019). Thus, the proportion of alcohol-related deaths is likely to be slightly underestimated and correspondingly, the proportion of non-alcohol deaths overestimated. On the other hand, contributory causes were also included, unlike in some other studies. There is no standardized definition of which causes belong to alcohol-related deaths (Hemström 2002). Other studies have used similar definitions (Tarkiainen et al. 2015; Pulido et al. 2017; Herttua 2010).

Unfortunately, our data did not contain any information on occupational exposures and health-related behaviour in specific occupations. This kind of information is acquired via surveys.

Our seafarers' data were unique in that they covered all seafarers living in Finland and working under the Finnish flag and had very detailed information on the seafaring occupation. Unlike earlier studies, we were able to also include women and catering personnel. The data did not include seafarers working under the Finnish flag who did not live in Finland. Seafarers on passenger ships may also live in Sweden or Estonia. Cargo ships today also have foreign crews, who do not belong to the Finnish pension system and do not live in Finland, and Finnish shipping companies may have ships under foreign flags. Our data also lacked those seafarers who live in Finland but work under other flag states. Many Ålanders may work under the Swedish flag, for

instance. To avoid bias, Li & Sung (1999) urge taking as a reference population other employed people who have entered and remained in the workforce through an equivalent selection process. Seafarers have health-related restrictions for employment. However, as the maritime experts did not come up with a population similar to that of seafarers, we were able to compare the seafaring occupations to each other.

Our Oulu data contained comprehensive registers of health care service use. Data on health care use is often self-reported (Lueckmann et al. 2021), even in the Finnish context (eg. Häkkinen & Alha 2006; Virtanen et al. 2006), because register data lack occupational health services. We had register data covering all three health care sectors: public, private and occupational health services. The data also adequately covered inpatient care (Sund 2012). The operating environments of the regions differ, and the service structures reflect previous decisions (Rissanen et al. 2020). Oulu differed from the whole of Finland with its slightly younger and more highly educated population and higher unemployment rate (Blomgren & Jäppinen 2020). The selection of services, such as student health care, occupational health services and the private sector, is wider in large cities, including Oulu. Because Oulu does not seem to differ in any systematic way from the whole country or from other large cities, Blomgren and Jäppinen (2020) estimated that based on the Oulu data, we can make broader generalizations regarding the use of health care services and the factors related to it in different population groups.

7.4 POLICY IMPLICATIONS

Policies should focus on the 31 high-mortality occupations among men and the 11 among women identified in this study. Occupations require special attention when 1) socioeconomic and occupational characteristics do not explain high mortality, 2) their alcohol-related mortality contribution is high, and 3) health care services use is low despite the occupation's high mortality. Practically nothing can be done about the occupational division in society (unlike, for example, income disparities), because different occupations are essential. However, the harmful aspects of occupations can still always be reduced, and work autonomy increased.

The workplace is a relevant setting for prevention and intervention programmes (Hodgins et al. 2009; Roman & Blum 2002). Because lifestyles are also affected by the environment, measures to reduce alcohol consumption cannot be only individual based. Circumstances must allow for a healthy lifestyle. More important than learning stress-coping skills is reducing the stressors and structures that sustain alcohol consumption. Managers can lead by example, limiting their harmful alcohol consumption. A good start is for a company to make a drug and alcohol abuse prevention plan (TTL 2013). Improving physical and mental working conditions could also have a diminishing effect on non-alcohol-related mortality. For seafarers, successful

lifestyle changes have required interventions addressing working and living conditions on board such as psychosocial issues, and active participation of shipping companies (Baygi et al. 2020). The impact of reduced alcohol prices has been greatest in the lower socioeconomic groups (Herttua et al. 2008; Mäkelä et al. 2015).

Although some high-risk occupations make many health care visits, they also have a high mortality risk. Health check-ups could be increased, especially in occupations in which several risk factors are known to exist and in which the number of health care visits is thought to be lower due to an unmet need for health services. Health literacy skills and knowledge of services in these occupations could be increased through education and providing easier access to health services. The challenge is for small companies with limited occupational health care or, in the worst case, no occupational health care at all. For managers of companies operating in risk sectors, the usefulness of healthcare could also be emphasized from the perspective of the employer. Opportunities for occupational health care are limited if employers are reluctant to cooperate and if they attempt to solve structural problems as individual problems.

8 CONCLUSIONS

Socioeconomic differences and the mechanisms behind them have been extensively studied. Permanent differences in mortality have been observed between occupational classes but also between occupations – and still, very little previous research has examined the causes of these differences at the detailed occupation level. Studying differences by detailed occupation provides a more specific picture of mortality inequalities and helps us understand their causes.

The focus of this study was on manual occupations with high mortality. We studied the determinants of mortality in these occupations: the contribution of socioeconomic and occupational characteristics, as well as the role of alcohol-related mortality. We paid particular attention to the mortality of seafarers. We also examined the differences between occupations' health care service use.

The contribution of socioeconomic factors varied by occupation, whereas the effect of industry was generally small, irrespective of occupation. In most high-risk occupations, excess mortality was partly explained, but in some occupations, the mortality rate was even higher after adjustments. It might have been assumed that the effect of adjustment for education, income and unemployment would vary by occupation, but that it would reduce the mortality risk in general. High incomes are usually associated with low mortality, but in some occupations this did not apply. High income alone did not reduce mortality if the environment was not supported by other factors such as healthy lifestyle. Only in some high-mortality occupations could excess mortality be fully explained.

We analysed alcohol-related mortality as an example of lifestyle factors that contribute to the mortality differences between occupations, as alcohol-related deaths play a major role in mortality inequalities. In previous studies at the occupational class level, alcohol-related mortality has partly explained the excess mortality among manual workers. Instead, by detailed occupation, the contribution of alcohol-related mortality to total excess mortality varied greatly, and this variation was greater among men than women. In some occupations, alcohol-related harms seemed to outweigh other major risks in the field. On the other hand, high alcohol-related mortality in an occupation does not necessarily mean that the contribution of alcohol to mortality is high if the occupation has several other risks.

The effects of health care on health inequalities are generally thought to be of minor importance. In this study, the aim was not to examine the effects of health services on mortality differences, but to examine occupational differences in the use of health care services, which is a step in the right direction. Previous information on the differences between service use in occupations has been scarce and contradictory, but the most likely assumption

based on past information has been that manual workers use more services than others. At the occupational class level, health services and mortality have a similar gradient, but by detailed occupation it varies, due to health skills and the availability of services. High-mortality occupations generally use health services more than other occupations, although apparently not enough, because there are still differences in mortality. The combination of high occupational risks, poor health behaviour, and poor access to health care services can lead to a situation in which health services are only used at a severe stage of a disease.

The national health and social services reform entered into force on 1 July 2021. However, on 1 January 2023, the responsibility for organizing health, social and rescue services will be transferred from municipalities and hospital districts to newly established 'well-being service counties'. Their aim will be to ensure equal access to services and to reduce inequalities in well-being and health. The effects of the reform on occupational differences in the use of health services need to be studied. To improve health equity, further research is needed on the effects of the three-sector health care system on the differences in health care services use by occupation and on occupational differences in the use of health care services by diagnosis. More information is also needed on the type of services, such as whether they are used for preventive or curative health care. Studies of the differences by occupation should be extended to cover sickness absence and participation in rehabilitation with extensive national data. In addition to the differences, their determinants should be clarified. This also applies to disability pensions, in which differences between occupations have been observed.

Further studies on mortality could examine the effect of previous work history and changes during the follow-up period on occupations' mortality rates. It is also important to examine the determinants of high mortality in occupations in which high mortality is not explained by other socioeconomic factors. Regarding alcohol-related mortality, it would be interesting to examine whether the contribution of other socioeconomic characteristics to alcohol-related mortality would be the same as their contribution to total mortality, and whether the tightening of alcohol restrictions has affected the level of alcohol-related mortality among seafarers.

As work life is changing, research on the differences in health and mortality between occupations should continue in the future. The positive developments in work life include more diverse work tasks and better opportunities for influence, but the negative ones include increased time pressure, mental strain, the threat of violence, and psychosocial symptoms (Sutela et al. 2019). Changes are not the same in all occupations. When agricultural and manufacturing jobs decline, the relative importance of physical and environmental hazards also decline, whereas the rise of the service sector increases the importance of psychosocial factors (Krueger & Burgard 2011). Other structural changes are the rising educational level and the ageing of employees. A rising education level in an occupation can reduce mortality, for

example through better lifestyles, and increase the use of health care services. The ageing of the population in turn may lead to a shortage of workers in some occupations. It also creates pressure to raise the retirement age.

This study provided new insights into the social determinants of high mortality among manual occupations and the use of health care services by detailed occupation. The results showed that findings at the occupational class level do not always hold for detailed occupation, and even occupations within the same field can differ in this respect. In addition to broader sociodemographic characteristics, occupation is an important factor for understanding health inequalities. Knowing the determinants in a specific occupation helps us target effective preventive measures. Improving working conditions would diminish mortality not only from non-alcohol-related but also from alcohol-related causes if high alcohol-related mortality was related to hazardous working conditions. It is also important to create an environment that supports healthy lifestyles. Changing the health culture of an occupation could reduce alcohol consumption, but it may also lead to earlier access to health services. Employers play a major role in this development. Focusing well-targeted, preventive measures on high-risk occupations would not only reduce mortality in these particular occupations but perhaps also decrease the overall mortality level and reduce mortality inequalities.

REFERENCES

Adler NE, Newman K (2002) Socioeconomic disparities in health: Pathways and policies. Health affairs 21(2):60-76.

Agerholm J, Bruce D, Ponce De Leon A, Burström A (2013) Socioeconomic differences in healthcare utilization, with and without adjustment for need: An example from Stockholm, Sweden. Scandinavian Journal of Public Health 41:328-325.

Ala-Pöllänen A (2017) Happy ship? Etnografinen tutkimus suomalaisista ja filippiiniläisistä merimiehistä suomalaisilla rahtilaivoilla. Akateeminen väitöskirja. Kansatieteellinen arkisto 57. Suomen muinaismuistoyhdistys, Helsinki.

Ames GM, Janes CA (1992) A cultural approach to conceptualizing alcohol and the workplace. Alcohol Health and Research World 16:112-119.

Andersen R (1995) Revisiting the behavioral model and access to medical care: Does it matter? Journal of Health and Social Behaviour 36:1-10.

Arajärvi M, Häkkinen P, Järvelin J, Mölläri K, Saukkonen SM, Väyrynen R (2018) Hilmo-opas 2019. Ohjaus 7. Terveyden ja hyvinvoinnin laitos, Helsinki.

Armitage P, Berry G, Matthews JNS (2005) Statistical Methods in Medical Research. Fourth edition. Blackwell Science, London, UK.

Barclay KJ (2013) Sex composition of the workplace and mortality risk. Journal of Biosocial Science 45(6):807-821.

Barrientos-Gutierrez T, Gimeno D, Mangione TW, Harrist RB, Amick BC (2007) Drinking social norms and drinking behaviours: a multilevel analysis of 137 workgroups in 16 workers. Occupational and Environmental Medicine 64:602-608.

Baygi F, Djalalinia S, Qorbani M, Dejman M, Bo Nielsen J (2020) Lifestyle interventions in the maritime settings: a systematic review. Environmental Health and Preventive Medicine 25:10.

Blomgren J, Jäppinen S (2020) Social and health care services and social security benefits in Oulu in 2013–2018. Basic description of data [In Finnish with English abstract]. Working papers 154. Kela, Helsinki.

Blomgren J, Virta L (2020) Socioeconomic differences in use of public, occupational and private health care: A register-linkage study of a working-age population in Finland. PLoS ONE 15(4):e0231792.

Bloor M, Thomas M, Lane T (2000) Health risks in the global shipping industry: an overwiev. Health, risks and society 2(3):329-340.

Borgan J-K, Kristofersen LB (1986) Dødelighet I yrken og socioøkonomiske gruppen 1970-1980. Statistisk Sentralbyrå, Oslo.

Burnett C, Maurer J, Dosemeci M (1997) Mortality by occupation, industry, and cause of death. 24 Reporting states, 1984–1988. U.S. department of health and human services, Cincinnati, Ohio, USA.

Buscariolli A, Kouvonen A, Kokkinen L, Halonen JI, Koskinen A, Väänänen A (2018) Human service work, gender and antidepressant use: a nationwide register-based 19-year follow-up of 752 683 women and men. Occupational and Environmental Medicine 75:401-406.

Busk H, Härmälä V (2016) Katsaus kauppamerenkulun tilanteeseen Suomessa. PTT raportteja 252. Pellervon taloustutkimus, Helsinki.

Cambois E, Laborde C (2011) Occupational mobility and mortality in France. Links confirmed for men, emergent for women. Population-E 66(2):333-360.

Carotenuto A, Molino I, Fasanaro AM, Amenta F (2012) Psychological stress in seafarers: a review. International Maritime Health 63(4):188–194.

Carter T (2011) Mapping the knowledge base for maritime health: 3 illness and injury in seafarers. International Maritime Health 62(4):224-235.

Coggon D, Harris EC, Brown T, Rice S, Palmer KT (2010A) Work-related mortality in England and Wales, 1979–2000. Occupational and Environmental Medicine 67:816-822.

Coggon D, Harris EC, Brown T, Rice S, Palmer KT (2010B) Occupation and mortality related to alcohol, drugs and sexual habits. Occupational Medicine 60:348-353.

Connelly R, Gayle V, Lambert PS (2016) A review of occupation-based social classifications for social survey research. Methodological Innovations 9:1-14.

Cooper M, Russell M, Skinner J, Frone M, Mudar P (1992) Stress and alcohol use: Moderating effects of gender, coping, and alcohol expectancies. Journal of Abnormal Psychology 101(1):139-152.

Court BV, Cheng KK (1995) Pros and cons of standardised mortality ratios. Lancet 346(8987):1432.

Data Protection Act 1050/2018. Available from: https://www.finlex.fi/fi/laki/ajantasa/2018/20181050; English translation available from: https://www.finlex.fi/en/laki/kaannokset/2018/en20181050.pdf

Devaux M, de Looper M (2012) Income-related inequalities in health service utilization in 19 OECD countries, 2008–2009. OECD Publishing, Paris.

Elias P, Birch M (1994) ISCO 88(com). A Guide for Users. Establisment of community-wide occupational statistics. Institute for Employment Research. University of Warwick, Warwick.

EFILWC (2004) EU hotel and restaurant sector: Work and employment conditions. European Foundation for the Improvement of Living and Working Conditions, Dublin.

Elias P (1997) Occupational Classification (ISCO-88): Concepts, Methods, Reliability, Validity and Cross-National Comparability. OECD Labour Market and Social Policy Occasional Papers 20. OECD Publishing, Paris.

Erikson R, Goldthorpe J, Hällsten M (2012) No way back up from ratcheting down? A critique of the 'microclass' approach to the analysis of social mobility. Acta Sociologica 55(3): 211-229.

Eriksson HP, Forsell K, Andersson E (2020) Mortality from cardiovascular disease in a cohort of Swedish seafarers. International Archives of Occupational and Environmental Health 93:345-353.

Ervasti J, Pietiläinen O, Rahkonen O, Lahelma E, Kouvonen A, Lallukka T, Mänty M (2019) Long-term exposure to heavy physical work, disability pension due to musculoskeletal disorders and all-cause mortality: 20-year follow-up – introducing Helsinki Health Study job exposure matrix. International Archives of Occupational and Environmental Health 92(3):337-345.

Forsell K, Eriksson H, Järvholm B, Lundh M, Andersson E, Nilsson R (2016) Work environment and safety climate in the Swedish merchant fleet. International Archives of Occupational and Environmental Health 90(2):161-168.

Forsell K, Eriksson H, Järvholm B, Lundh M, Andersson E, Nilsson R (2022) Cancer incidence in a cohort of Swedish merchant seafarers between 1985 and 2011. International Archives of Occupational and Environmental Health. Published online 8 Jan 2022.

Frone MR, Brown AL (2010) Workplace substance-use norms as predictors of employee substance use and impairment: A survey of U.S. workers. Journal of Studies on Alcohol and Drugs 71:526-534.

Fujishiro K, Xu J, Gong F (2010) What does "occupation" represent as an indicator of socioeconomic status?: Exploring occupational prestige and health. Social Science and Medicine 71:2100-2107.

Garrido-Cumbrera M, Borrell C, Palència L, Espelt A, Rodríguez-Sanz M, Pasarín MI, Kunst A (2010) Social class inequalities in the utilization of health care and preventive services in Spain, a country with a national health system. International Journal of Health Services 40(3):525-542.

General Data Protection Regulation of the European Union. Regulation (EU) 2016/679 of the European Parliament and of the Council. Available from: https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:32016R0679

Geyer S, Hemström Ö, Peter R, Vågerö D (2006) Education, income and occupational class cannot be used interchangeably in social epedimiology. Empiral evidence against a common practice. Journal of Epedemiology and Community Health 60:804-810.

Gullberg A, Vågerö D (1996) Yrke och dödlighet under 1980-talet. EpC-rapport 1996:3. Socialstyrelsen och Stockholms universitet, Stockholm.

Gulliford M, Figueroa-Munoz J, Morgan M, Hughes D, Gibson B, Beech R, Hudson M (2002) What does 'access to health care' mean? Journal of Health Services Research & Policy 7:186-188.

Haldorsen T, Andersen A, Boffetta P (2004) Smoking-adjusted incidence of lung cancer by occupation among Norwegian men. Cancer Causes and Control 15:139-147.

Hansen HL, Nielsen D, Frydenberg M (2002) Occupational accidents aboard merchant ships. Occupational and Environmental Medicine 59:85-91.

Hansen HL, Pedersen G (1996) Influence of occupational accidents and deaths related to lifestyle on mortality among merchant seafarers. International Journal of Epidemiology 25(6):1237-1243.

Hansen HL, Jensen J (1998) Female seafarers adopt high risk lifestyle of male seafarers. Occupational and Environmental Medicine 55:49-51.

Hansen AH, Halvorsen PA, Ringberg U, Førde OH (2012) Socio-economic inequalities in health care utilisation in Norway: a population based cross-sectional survey. BMC Health Services Research 12:336.

Harris EC, Palmer KT, Cox V, Darnton A, Osman J, Coggon D (2016) Trends in mortality from occupational hazards among men in England and Wales during 1979–2010. Occupational and Environmental Medicine 73(6):385-393.

Heikkilä K, Nyberg ST, Fransson EI… Kivimäki M (2012) Job strain and alcohol intake: a collaborative meta-analysis of individual-participant data from 140 000 men and women. PloS ONE 7(7):e40101.

Hemmingsson T, Lundberg I, Nilsson R, Allebeck P (1997A) Health-related selection to seafaring occupations and its effects on morbidity and mortality. American Journal of Industrial Medicine 31:662-668.

Hemmigsson T, Lundberg I, Romelsjö A, Alfredsson L (1997B) Alcoholism in social classes and occupations in Sweden. International Journal of Epidemiology 26(3):584-591.

Hemmingsson T, Lundberg I, Diderichsen F (1999) The roles of social class of origin, achieved social class and intergenerational social mobility in explaining social-class inequalities in alcoholism among young men. Social Science and Medicine 49:1051-1059.

Hemmingsson Tomas, Ringbäck Weitoft Gunilla (2001) Alcohol-related hospital utilization and mortality in different occupations in Sweden in 1991–1995. Scandinavian Journal of Work, Environment & Health 27(6):412-419.

Hemström Ö (2002) Alcohol-related deaths contribute to socioeconomic differentials in mortality in Sweden. European Journal of Public Health 12:254-262.

Herttua K, Mäkelä P, Martikainen P (2008) Changes in alcohol-related mortality and its socioeconomic differences after a large reduction in alcohol prices: a natural experiment based on register data. American Journal of Epidemiology 168(10):1110-1118.

Herttua K (2010) The effects of the 2004 reduction in the price of alcohol on alcohol-related harm in Finland: A natural experiment based on register data. Finnish Yearbook of Population Research, XLV 2010 Supplement. The Population Research Institute, Helsinki.

Hjarnoe L, Leppin A (2013) A risky occupation? (Un)healthy lifestyle behaviors among Danish seafarers. Health Promotion International 29(4):720-729.

Hodgins DC, Williams R, Munro G (2009) Workplace responsibility, stress, alcohol availability and norms as predictors of alcohol consumption-related problems among employed workers. Substance Use & Misuse 44:2062-2079.

Hoffman R, Kröger H, Tarkiainen L, Martikainen P (2019) Dimensions of social stratification and their relation to mortality: A comparison across gender and life course periods in Finland. Social Indicators Research 145(1):349-365.

Hujanen T, Mikkola H (2016) Työterveyshuollon kustannuskehitys. Suomen Lääkärilehti 71:1537-1540.

Häkkinen U, Alha P (2006) Avohoitopalvelut. In Häkkinen U, Alha P (eds.) Terveyspalvelujen käyttö ja sen väestöryhmittäiset erot. Terveys 2000 - tutkimus. Kansanterveyslaitoksen julkaisuja B 10, Helsinki, p. 32-43.

Häkkinen U, Nguyen L (2010) Rikas käy edelleen lääkärissä köyhää enemmän. Optimi 2. Available from: http://www.julkari.fi/handle/ 10024/114521

ILO (1990) International standard classification of occupations: ISCO-88. International Labour Office, Geneva.

ILO (2004) ISCO-88. International standard classification of occupations. Available from: https://www.ilo.org/public/english/bureau/stat/isco/isco88/index.htm

ILO (2012) International standard classification of occupations. ISCO-08. Volume 1. Structure, group definitions and correspondence tables. International Labour Office, Geneva.

IMO (2011) International convention on standards of training, certification and watchkeeping for seafarers. International Maritime Organization, London.

ITF (2010) STCW: a guide for seafarers. Taking into account the 2010 Manila amendments. International Transport Workers' Federation, London.

Iversen RTB (2012) The mental health of seafarers. International Maritime Healt 63(2):89-89.

Johnson JV, Hall EM (1988) Job strain, work place social support, and cardiovascular disease: a cross-sectional study of a random sample of the Swedish working population. American Journal of Public Health 78(19):1336-1342.

Johnson N, Sorlie PD, Backlund E (1999) The Impact of specific occupation on mortality in the U.S. national longitudinal mortality study. Demography 36(3):355-367.

Julious SA, Nicholl J, George S (2001) Why do we continue to use standardized mortality ratios for small area comparisons? Journal of Public Health Medicine 2(1):40-46.

Kaerlev L, Hansen J, Hansen HL, Nielsen PS (2005) Cancer incidence among Danish seafarers: a population based cohort study. Occupational and Environmental Medicine 62:761-765.

Kaerlev L, Dahl S, Nielsen PS, Olsen J, Hannerz H, Jensen A, Tüchsen F (2007) Hospital contacts for chronic diseases among Danish seafarers and fisherman: a population-based cohort study. Scandinavian Journal of Public Health 35:481-489.

Kaila-Kangas L, Notkola V, Mutanen P, Keskimäki I, Leino-Arjas P (1999) Sairaalapalvelujen käyttö ammattiryhmittäin Suomessa vuonna 1996. Työterveyslaitos, Stakes, Tilastokeskus, Helsinki.

Kaila-Kangas L, Koskinen A, Pensola T, Mäkelä P, Leino-Arjas P (2016) Alcohol-induced morbidity and mortality by occupation: a population-based follow-up study of working Finns. European Journal of Public Health 26(1):116-122.

Kanter RM (1977) Men and women of the corporation. Basic Books, New York.

Karasek RA (1979) Job demands, job decision latitude and mental strain: implications for job redesign. Administrative Science Quarterly 24:285-307.

Kastarinen H (2020) Hyvän B-lausunnon resepti lääkekorvausasiassa. Duodecim 136:1585-1589.

Katikireddi SV, Leyland AH, McKee M, Ralston K, Stuckler D (2017) Patterns of mortality by occupation in the UK, 1991-2011: a comparative analysis of linked census and mortality records. Lancet Public Health 2:e501-12.

Kela (2019) Kelan työterveyshuoltotilasto. SVT. Sosiaaliturva. Kela, Helsinki

Keskimäki I, Salinto M, Aro S (1995) Socioeconomic equity in Finnish hospital care in relation to need. Social Science & Medicine 41(3):425-431.

Keskimäki I (2003) How did Finland's economic recession in the early 1990s affect socio-economic equity in use of hospital care? Social Science & Medicine 56:1517-1530.

Kirk MA, Rhodes RE (2011) Occupation correlates of adults' participation in leisure-time physical activity: a systematic review. American Journal of Preventive Medicine 40(4):476-485.

Kokkinen L, Kouvonen A, Koskinen A, Varje P, Väänänen A (2014) Differences in hospitalizations between employment industries, Finland 1976 to 2010. Annals of Epidemiology 24:598-605.

Korda RJ, Banks E, Clements MS, Young AF. Is inequity undermining Australia's 'universal' health care system? Socio-economic inequalities in

the use of specialist medical and non-medical ambulatory health care (2009) Australian and New Zealand Journal of Public Health 33:458-65.

Koskinen S (2005) Työntekijän pakollinen terveystarkastus – milloin ja miksi? Työterveyslääkäri 23(1):92-95.

Koskinen S, Joutsenniemi K, Martelin T, Martikainen P (2007) Mortality differences according to living arrangements. International Journal of Epidemiology 36:1255-1264.

Krueger PM, Burgard SA (2011) Chapter 13. Work, occupation, income and mortality. In Rogers RG, Crimmins EM (eds.) International handbook of adult mortality. International Handbooks of Population 2, Springer Science+Business Media B.V., p. 263-288.

La Parra-Casado D, Mosquera PA, Vives-Cases C, San Sebastian M (2018) Socioeconomic inequalities in the use of healthcare services: Comparison between the Roma and general populations in Spain. International Journal of Environmental Research and Public Health 15:121.

Laaksonen M (2011) Aineelliset ja taloudellinen tekijät. In Laaksonen M, Silventoinen K (eds.) Sosiaaliepidemiologia. Gaudeamus, Helsinki, p. 177-194.

Lahelma E, Martikainen P, Laaksonen M, Aittomäki A (2004) Pathways between socioeconomic determinants of health. Journal of Epedemiology and Community Health 58:327-332.

Lahelma E, Rahkonen O (2011) Sosioekonominen asema. In Laaksonen M, Silventoinen K (eds.) Sosiaaliepidemiologia. Gaudeamus, Helsinki, p. 41-59

Lahelma E, Rahkonen O (2017) Sosiaalinen rakenne ja terveys. In Karvonen S, Kestilä L, Mäki-Opas T (eds.) Terveyssosiologian linjoja. Gaudeamus, Helsinki, p-19-39.

Lahti RA, Penttilä A (2001) The validity of death certificates: routine validation of death certification and its effects on mortality statistics. Forensic Science International 115:15-32.

Lappalainen K, Aminoff M, Hakulinen H, Hirvonen M, Räsänen K, Sauni R, Stengård J (2016) Työterveyshuolto Suomessa vuonna 2015 ja kehitystrendi 2000–2015. Työterveyslaitos, Helsinki.

Laugesen K, Ludvigsson JF, Schmidt M, Gissler M, Valdimarsdottir UA, Lunde A, Sørensen HT (2021) Nordic health registry-based research: A review of health care systems and key registers. Clinical Epidemiology 13:533-554.

Leyland AH, Groenewegen PP (2020) Multilevel modelling for public health and health services research. Health in context. Springer Open, Cham, Switzerland.

Li CY, Sung FC (1999) A review of the healthy worker effect in occupational epidemiology. Occupational Medicine 49:225-229.

Lostao L, Redigor E, Gimeno D, Netuveli G, Blane D (2011) Socioeconomic patterns in health services use in Great Britain and Spain before and after the health system reforms of the 1990s. Health Place 17(3):830-835.

Louhelainen K, Uuksulainen A, Mikkola J, Hyytinen E-R, Karjalainen A, Priha E, Santonen T (2017) Kemikaaliriskien hallinta kuntoon. Rekisteritietoon perustuva selvitys kemikaaleille altistavista riskitöistä ja -ammateista. Työterveyslaitos, Helsinki.

Lueckman SL, Hoebel J, Roick J, Markert J, Spallek J, von dem Knesebeck O, Richter M (2021) Socioeconomic inequalities in primary-care and specialist physician visits: a systematic review. International Journal for Equity in Health 20:58.

Lynge E (2011) Occupational mortality. Scandinavian Journal of Public Health 39(Suppl 7):153-157.

Macdonald S, Wells S, Wild TC (1999) Occupational risk factors associated with alcohol and drug problems. American Journal of Drug and Alcohol Abuse 25(2):351-369.

Macintyre S (1997) The Black report and beyond. What are the issues? Social Science & Medicine 44:723-745.

Mackenbach JP, Bos V, Andersen O, Cardano M, Costa G, Harding S, Reid A, Hemström Ö, Valkonen T, Kunst A (2003) Widening socioeconomic inequalities in mortality in six European countries. International Journal of Epidemiology 32(5):830-837.

Mackenbach JP, Stirbu I, Roskam A-J, Schaap MM, Menvielle G, Leinsalu M, Kunst AE (2008) Socioeconomic inequalities in health in 22 European countries. The New England Journal of Medicine 358:2468-81.

Mackenbach JP, Kulhánová I, Bopp M, Borrell C, Deboosere P, Kovács K, Looman C, Leinsalu M, Mäkelä P, Martikainen P, Menvielle G, Rodríguez-Sanz M, Rychtaříková J, de Gelder R (2015) Inequalities in alcohol-related mortality in 17 European countries: a retrospective analysis of mortality registers. PLoS Med 12(12):e1001909.

Mackenbach JP, Valverde JR, Bopp M, Brønnum-Hansen H, Costa G, Deboosere P, Kalediene R, Kovács K, Leinsalu M, Martikainen P, Menvielle G, Rodriguez-Sanz M, Nusselder WJ (2019A) Progress against inequalities in mortality: register based study of 15 European countries between 1990 and 2015. European Journal of Epidemiology 34:1131-1142.

Mackenbach JP, Valverde JR, Bopp M, Brønnum-Hansen H, Deboosere P, Kalediene R, Kovács K, Leinsalu M, Martikainen P, Menvielle G, Regidor E, Nusselder WJ (2019B) Determinants of inequalities in life expectancy: an international comparative study of eight risk factors. Lancet Public Health 4:e529-37.

Mackenbach JP (2019) Health inequalities. Persistence and change in European welfare states. Oxford University Press, Oxford, UK.

Mandell W, Eaton WW, Anthony JC, Garrison R (1992) Alcoholism and Occupations: a review and analysis of 104 occupations. Alcoholism: Clinical and Experimental Research 16(4):734-746.

Manderbacka K, Arffman M, Leyland A, McCallum A, Keskimäki I (2008) Change and persistence in healthcare inequalities: access to elective surgery in Finland in 1992–2003. Scandinavian Journal of Public Health 37:131-138.

Manderbacka K, Arffman M, Keskimäki I (2014) Has socioeconomic equity increased in somatic specialist care: a register-based cohort study from Finland in 1995–2010. BMC Health Services Research 24(14):430.

Manderbacka K, Järvelin J, Arffman M, Rättö H, Häkkinen U, Keskimäki I (2015) National and regional trends in equity within specialised health care in Finland in 2002–2010. Scandinavian Journal of Public Health 43:514-517.

Marchand A (2008) Alcohol use and misuse: What are the contributions of occupation and work organization conditions? BMC Public Health 8:333.

Marin R (1986) Ammattikuolleisuus 1971–80. Tutkimuksia Nro 129. Tilastokeskus, Helsinki.

Marmot MG (2004) Status syndrome. Bloomsbury, London.

Martelin T, Karvonen S, Linnanmäki E, Prättälä R, Koskinen S (2012) Terveyden, toimintakyvyn ja niihin vaikuttavien tekijöiden vaihtelu

koulutuksen ja asuinalueen mukaan. In Koskinen S, Lundqvist A, Ristiluoma N (eds.) Terveys, toimintakyky ja hyvinvointi Suomessa. Raportti 68. Terveyden ja hyvinvoinnin laitos, Helsinki, p. 202-210.

Martikainen P (1990) Unemployment and mortality among Finnish men, 1981–5. BMJ 301(6749):407-411.

Martikainen P, Mäkelä P, Koskinen S, Valkonen T (2001) Income differences in mortality: a register-based follow-up study of three million men and women. International Journal of Epidemiology 30(6):1397-1405.

Martikainen P, Blomgren J, Valkonen T (2007) Change in the total and independent effects of education and occupational social class on mortality: analyses of all Finnish men and women in the period 1971–2000. Journal of Epedemiology and Community Health 61(6):499-505.

Martikainen P, Mäkelä P, Peltonen R, Myrskylä M (2014) Income differences in life expectancy: the changing contribution of harmful consumption of alcohol and smoking. Epidemiology 25:182-190.

Martin JK, Roman PM, Blum TC (1996) Job stress, drinking networks and social support at work: a comprehensive model of employees' problem drinking behaviors. The Sociological Quarterly 37(4):579-599.

Mellbye A, Carter T (2017) Seafarers' depression and suicide. International Maritime Healt 68:108-114.

Miilunpalo P, Visuri S (2015) Varustamoiden työterveyshuollon nykytila ja kehittämistarpeet. Työterveyslaitos, Turku.

Montano D (2014) Chemical and biological work-related risks across occupations in Europe: a review. Journal of Occupational Medicine and Toxicology 9:28.

Moore DE, Hayward MD (1990) Occupational careers and mortality of elderly men. Demography 27(1):31-53.

Moore RS, Cunradi CB, Duke MR, Ames GM (2009) Dimensions of problem drinking among young adult restaurant workers. The American Journal of Drug and Alcohol Abuse 35:329-333.

Mustard CA, Bielecky A, Etches J, Wilkins R, Tjepkema M, Amick BC, Smith PM, Aronson KJ (2010) Avoidable mortality for causes amenable to medical care, by occupation in Canada, 1991–2001. Canadian Journal of Public Health 101(6):500-506.

Mäkelä P, Valkonen T, Martikainen P (1997) Contribution of deaths related alcohol use to socioeconomic varitation in mortality: register based follow up study. BMJ 315:211-216.

Mäkelä P (1998) Alcohol-related mortality by age and sex and its impact on life expectancy: estimates based on the Finnish death register. European Journal of Public Health 8:43-51.

Mäkelä P (1999) Alcohol-related mortality as a function of socio-economic status. Addiction 94:867-886.

Mäkelä P, Paljärvi T (2008) Do consequences of a given pattern of drinking vary by socioeconomic status? A mortality and hospitalization follow-up for alcohol-related causes of the Finnish Drinking Habits Surveys. Journal of Epidemiology and Community Health 62:728-733.

Mäkelä P, Herttua K, Martikainen P (2015) The socioeconomic differences in alcohol-related harm and the effects of alcohol prices on them: a summary of evidence from Finland. Alcohol and Alcoholism 50(6):661-669.

Niedhammer I, Goldberg M, Leclerc A, David S, Bugel I, Landre M-F (1998) Psychosocial work environment and cardiovascular risk factors in an

occupational cohort in France. Journal of Epidemiology and Community Health 52(2):93-100.

Niedhammer I, Chastang J-F, David S, Kelleher C (2008) The contribution of occupational factors to social inequalities in health: findings from the national French SUMER survey. Social Science & Medicine 67:1870-1881.

Nieminen M (1999) Väestötilastoja 250 vuotta. Katsaus väestötilaston historiaan vuosina 1749–1999. Väestö 1999:8. SVT. Tilastokeskus, Helsinki.

Nittari G, Tomassoni D, Di Canio M, Traini E, Pirillo I, Minciacchi A, Amenta F (2019) Overweigh among seafarers working on board merchant ships. BMC Public Health 19:45.

Nordic Statistical Secretariat (1988) Occupational mortality in the Nordic countries 1971–1980. Statistical Reports of the Nordic Countries. No. 49. Nordic Statistical Secretariat, Copenhagen.

Notkola V, Pajunen A, Leino-Arjas P (1995) Telineet, tehdas vai toimisto – tutkimus ammattiryhmittäisestä kuolleisuudesta ja työkyvyttömyydestä. SVT Terveys 1995:4. Tilastokeskus, Helsinki.

Notkola V, Savela S (1998) Ammattiryhmittäinen kuolleisuus Suomessa 1991–1995. Työterveyslaitos, Tilastokeskus, Helsinki.

Oldenburg M, Jensen H-J, Latza U, Bau X (2009) Seafaring stressors aboard merchant and passenger ships. International Journal of Public Health 54:96-105.

Oldenburg M, Baur X, Schlaich C (2010) Occupational risks and challenges of seafaring. Journal of Occupational Health 52(5):249-256.

Oldenburg M (2014) Risk of cardiovascular diseases in seafarers. International Maritime Healt 65:53-57.

Oldenburg M, Herzog J, Harth V (2016) Seafarer deaths at sea: a German mortality study. Occupational Medicine (Lond) 66:135-137.

Olkinuora M (1984) Alcoholism and occupation. Scandinavian Journal of Occupational Health 10(6):511-515.

Pajunen A, Notkola V, Leino-Arjas P (1994–1995) Disability by occupation in Finland 1986–1990. Yearbook of Population Research in Finland 32:70-79.

Palència L, Espelt A, Rodríguez-Sanz M, Rocha KB, Pasarín MI, Borrell C (2013) Trends in social class inequalities in the use of health care services within the Spanish National Health System, 1993–2006. European Journal of Health Economics 14(2):211-219.

Pampel FC, Krueger PM, Denney JT (2010) Socioeconomic disparities in health behaviors. Annual Review of Sociology 36:349-370.

Pechansky R, Thomas W (1981) The concept of access. Medical Care 19:127-140.

Peña S (2021) Socioeconomic differences in alcohol use, disorders and harm: Exploring the alcohol harm paradox. Academic dissertation. Faculty of Medicine University of Helsinki, Finnish Institute for Health and Welfare, Helsinki.

Pensola T, Ahonen H, Notkola V (2004) Ammatit ja kuolleisuus. Työllisten ja työttömien ammattiryhmittäinen kuolleisuus 1996–2000. Kuntoutussäätiö, Tilastokeskus, Helsinki.

Pensola T, Gould R, Polvinen A (2010) Ammatit ja työkyvyttömyyseläkkeet. Masennukseen, muihin mielenterveyden häiriöihin sekä tuki- ja liikuntaelinten sairauksiin perustuvat eläkkeet. Sosiaali- ja terveysministeriön selvityksiä 2010:16, Helsinki.

Pensola T & Notkola V (2012) Mortality of unemployed men and women in relation to their former occupation in Finland in 1996–2000. In Kieselbach J & Mannila S (eds.) Persistent unemployment and precarious work: Research and policy issues. VS Verlag für Sozialwissenschaften, Wiesbaden.

Pensola T, Shemeikka R, Kesseli K, Laihiala T, Rinne H, Notkola V (2012) Palkansaaja, yrittäjä, työtön. Kuolleisuus Suomessa 2001–2007. Kuntoutussäätiö tutkimuksia 84. Kuntoutussäätiö, Helsinki.

Plant MA (1977) Alcoholism and occupation: a review. British Journal of Addiction 72: 309-316.

Plant M (1978) Occupation and alcoholims: cause or effect? A controlled study of recruits to the drink trade. International Journal of Addictions 13(4):605-626.

Plant M (1979) Occupations, drinking patterns and alcohol related problems: conclusions from a follow up study. British Journal of Addiction 74:267-273.

Poikolainen K (1995) Alcohol and mortality: a review. Journal of Clinical Epidemiology 48(4):455-465.

Pougnet R, Pougner L, Lodde B, Canals-Pol ML, Jegaden D, Lucas D, Dewitte J-D (2013) Cardiovascular risk factors in seamen and fishermen: review of literature. International Maritime Healt 64(3):107-113.

Pougnet R, Pougner L, Lodde B, Canals L, Bell S, Lucas D, Dewitte J-D (2014) Consumption of addictive substances in mariners. International Maritime Healt 65(4):199-204.

Poulsen TR, Hermann B, Henrik LH, Riis Jepsen J (2014): Health of Danish seafarers and fisherman 1970–2010: What have register-based studies found? Review article. Scandinavian Journal of Public Health 42(6):534-545.

Probst C, Roerecke M, Behrendt S, Rehm J (2014) Socioeconomic differences in alcohol-attributable mortality compared to all-cause mortality: a systematic review and meta-analysis. International Journal of Epidemiology 43(4):1314-1327.

Pukkala et al. (2009) Occupation and cancer – follow-up of 15 million people in five Nordic countries. Acta Oncologica (48):646-790.

Pulido J, Vallejo F, Alonso-López I, Redigor E, Villar F, de la Fuente L, Domingo-Salvany A, Barrio G (2017) Directly alcohol-attributable mortality by industry and occupation in a Spanish census cohort of economically active population. Drug and Alcohol Dependence 180:93-102.

Rantanen J, Lehtinen S (eds.) (1991) Työympäristö ja työterveys Suomessa. Komiteanmietintö 43. Työolokomitean liiteselvitys. Työterveyslaitoksen katsauksia 199. Helsinki.

Raversteijn B, van Kippersluis H, van Doorslaer E (2013) The contribution of occupation to health inequality. Research Economic Inequality 21:311-332.

Raversteijn B, van Kippersluis H, van Doorslaer E (2017) The wear and tear on health: What is the role of occupation? Health Economics 27:e69-e86.

Redigor E, Martínez D, Calle ME, Astasio P, Ortega P, Domínguez V (2008) Socioeconomic patterns in the use of public and private health services and equity in health care. BMC Health Services Research 8:183.

Registrar-General (1855) Fourteenth annual report on births, deaths, and marriages in England. HMSO, London.

Rehm J, Baliunas D, Guilherme LG, Borges GL, Graham K, Irving H, Kehoe T, Parry CD, Patra J, Popova S, Poznyak V, Roerecke M, Room R, Samokhvalov AV, Taylor B (2010) The relation between different dimensions of alcohol consumption and burden of disease: an overview. Addiction 105:817-43.

Reijula J, Kjaerheim K, Lynge E, Martinsen JI, Reijula K, Sparén P, Tryggvadottir L, Weiderpass E, Pukkala E (2015) Cancer incidence among waiters: 45 years of follow-up in five Nordic countries. Scandinavian Journal of Public Health 43:204-211.

Richiardi L, Barone-Adesi F, Merletti F, Pearce N (2008) Using directed acyclic graphs to consider adjustment for socioeconomic status in occupational cancer studies. Journal of Epidemiology and Community Health 62(7):e14.

Rinne H, Parkkinen M, Shemeikka R, Ilomäki T, Notkola V (2018) Kuolleisuus ja työkyvyttömyyseläkkeelle siirtyminen palkansaajilla ammateittain Suomessa 2001–2015. Kuntoutussäätiön tutkimuksia 90. Kuntoutusäätiö, Helsinki.

Rissanen P, Parhiala K, Hetemaa T, Kekkonen R, Knape N, Ridanpää H, Rintala E, Sihvo S, Suomela T, Kannisto R (2020) Sosiaali- ja terveyspalvelut Suomessa 2018. Asiantuntija-arvio. Päätösten tueksi 2/2020. Terveyden ja hyvinvoinnin laitos, Helsinki.

Robards J, Evandrou M, Falkingham J, Vlachantoni A (2012) Marital status, health and mortality. Maturitas 73(4):295-299.

Roberts SE, Jaremin B, Chalasani P, Rodgers SE (2010) Suicides among seafarers in UK merchant shipping, 1919–2005. Occupational Medicine 60:54-61.

Roberts SE, Jaremin B (2010) Cardiovascular disease mortality in British merchant shipping and among British seafarers ashore in Britain. International Maritime Healt 61(3):107-116.

Roberts SE, Jaremin B, Lloyd K (2013) High-risk occupations for suicide. Psychological Medicine 43: 1231-1240.

Roberts SE, Carter T (2016) British merchant seafarers 1900–2010: A history of extreme risks of mortality from infectious disease. Travel Medicine and Infectious Disease 14:499-504.

Roche AM, Lee NK, Battams S, Fischer JA, Cameron J, McEntee A (2015) Alcohol use among workers in male-dominated industries: A systematic review of risk factors. Safety Science 78:124-141.

Roelfs DJ, Shor E, Davidson KW, Schwartz JE (2011) Losing life and livelihood: a systematic review and meta-analysis of unemployment and all-cause mortality. Social Science & Medicine 72(6):840-854.

Roman PM, Blum TC (2002) The workplace and alcohol problem prevention. Alcohol Research & Health 26:49-57.

Romeri E, Baker A, Griffiths C (2007) Alcohol-related deaths by occupation, England and Wales 2001–05. Health Statistics Quarterly 35:6-12.

Roos N, Mustard CA (1997) Variation in health and health care use by socioeconomic status in Winnipeg, Canada: Does the system work well? Yes and no. The Millbank Quarterly 75/1997:89-111.

Räsänen K, Heikkinen J, Myllykangas M (2014) Työterveyshuollon sairaanhoitopalvelujen käyttö vaihtelee tarjonnan mukaan. Suomen Lääkärilehti 18:1325-1330.

Saastamoinen L, Aaltonen K, Maljanen T, Tuominen U, Martikainen J (2012) Health registers as a source of data for research and policy making. Dosis 28:199-205.

Sauli H (1983) Ammatti ja kuolleisuus 1971–75. Kuolleisuus. Tutkimuksia N:o 54. Tilastokeskus, Helsinki.

San Jose B, van der Mheen H, van Oesr JA et al. (2000) Adverse working conditions and alcohol use in men and women. Alcoholism: Clinical and Experimental Research 24:1207-13.

SCB (2014) Yrke och dödlighet 2008–2012. Demografiska rapporter 2014:3. Statistiska centralbyrån, Stockholm.

Shaikh RA, Sikora A, Siahpush M, Singh GP (2015) Occupational variations in obesity, smoking, heavy drinking, and non-adherence to physical activity recommendations: findings from the 2010 National Health Interview Survey. Am J Ind Med 58(1):77-87.

Siegrist J (1996) Adverse health effects of high-effort/low-reward conditions. Journal of Occupational Health Psychology 1:27-41.

Sipilä P, Martikainen P (2009) Language-group mortality differentials in Finland in 1988–2004: assessment of the contribution of cause of death, sex and age. European Journal of Public Health 19(5):492-498.

StataCorp (2015) Stata Statistical Software: Release 14. College Station, StataCorp LP, TX.

Statistics Finland (1999) Standard Industrial Classification 1995. Available from: https://www2.stat.fi/en/luokitukset/toimiala/toimiala_1_20000101/

Statistics Finland (1996) Tilastokeskuksen 54-luokkainen kuolemansyyluokitus. Available from: https://www.stat.fi/meta/luokitukset/kuolinsyyt/ 061-1996/index.html

Statistics Finland (2001) Classification of Occupations 2001. Available from: https://www2.tilastokeskus.fi/fi/luokitukset/ammatti/ammatti_1_20010101/

Statistics Finland (2011) Classification of occupations 2010. Available from: https://www.tilastokeskus.fi/en/luokitukset/ammatti/ammatti_1_20100101/

Statistics Finland (2021) Employment. Available from: https://www.stat.fi/en/statistics/ tyokay

Statistics Finland (2022) Causes of death. Available from: https://www.stat.fi/en/statistics/ksyyt

STM (2019) Laivaväen tarkastusohjeet. Sosiaali- ja terveysministeriön opas. Sosiaali- ja terveysministeriön julkaisuja 2019:18, Helsinki.

Stockwell T, Sherk A, Sorge J, Norström T, Angus C, Chikritzhs T, Churchill S, Holmes J, Meier P, Naimi T, Ramstedt M, Simpura J (2019) Finnish alcohol policy at the crossroads: The health, safety and economic consequences of alternative systems to manage the retail sale of alcohol. A report prepared for the Finnish alcohol monopoly, Alko. Canadian Institute for Substance Use Research, University of Victoria, BC, Canada.

Stoll E, Püschel K, Harth V, Oldenburg M (2020) Prevalence of alcohol consumption among seafarers and fishermen. International Maritime Health 71(4):265-274.

Sund R (2012) Quality of the Finnish hospital discharge register: a systematic review. Scandinavian Journal of Public Health 40:505-515.

Sutela H, Pärnänen A, Keyriläinen M (2019) Digiajan työelämä – Työolotutkimuksen tuloksia 1977–2018. Tilastokeskus, Helsinki.

Sydén L, Landberg J (2017) The contribution of alcohol use and other lifestyle factors to socioeconomic differences in all-cause mortality in a Swedish cohort. Drug and Alcohol Review 36(5):691-700.

Tarkiainen L, Martikainen P, Laaksonen M (2015) The contribution of education, social class and economic activity to the income-mortality association in alcohol-related and other mortality in Finland in 1988–2012. Addiction 111(3): 456-464.

TENK (2012) Hyvä tieteellinen käytäntö ja sen loukkausepäilyjen käsitteleminen Suomessa. Tutkimuseettisen neuvottelukunnan ohje 2012. Available from: https://tenk.fi/sites/tenk.fi/files/HTK_ohje_2012.pdf

TENK (2019) Ihmiseen kohdistuvan tutkimuksen eettiset periaatteet ja ihmistieteiden eettinen ennakkoarviointi Suomessa. Tutkimuseettisen neuvottelukunnan julkaisuja 3, Helsinki. Available from: https://www.tenk.fi/sites/tenk.fi/files/Ihmistieteiden_eettisen_ennakkoarvioinnin_ohje_2019.pdf

Teperi J, Keskimäki I (2007) Terveyspalvelujen kohdentumisen oikeudenmukaisuus. In Saari J, Yeung AB (eds.) Oikeudenmukaisuus hyvinvointivaltiossa. Gaudeamus, Helsinki, p. 274-291.

THL (2019) Perusterveydenhuollon ja suun terveydenhuollon avokäynnit 2018. Tilastoraportti 8/2019. Terveyden ja hyvinvoinnin laitos, Helsinki.

Thompson A, Pirmohamed M (2021) Associated between occupation and heavy alcohol consumption in UK adults aged 40–69 years: a cross-sectional study using the UK Biobank. BMC Public Health 21:190.

Toch-Marquardt M, Menvielle G, Eikemo T, Kulhánová I, Kulic MC, Bopp M, Esnaola S, Jasilionis D, Mäki N, Martikainen P, Redigor E, Lundberg O, Mackenbach J, Euro-GBD-SE consortium (2014) Occupational class inequalities in all-cause and cause-specific mortality among middle-aged men in 14 European populations during the early 2000s. PLoS One 9(9):e108072.

Townsend P, Davidson N (1982) Inequalities in health: The Black Report. Penquin, London.

TTL (2013) Päihdeohjelmaopas – malli päihdeohjelman tekemiseen työpaikalla. Työterveyslaitos, Helsinki.

TTL (2021) Recognized occupational diseases in the working-age population. Work-life knowledge service. Published 12.3.2019, updated 17.3.2021. Available from: https://www.tyoelamatieto.fi/#/en/dashboards/occupational-diseases

Turtiainen J, Väänänen A (2012) Men of Steel? The Masculinity of Metal Industry Workers in Finland after World War II. Journal of Social History 46:449-72.

TVK (2021) Työtapaturmia sattui vuonna 2020 ennätyksellisen vähän. Tapaturmavakuutuksen analyyseja 12.2.2021. Available from: https://www.tvk.fi/document175732/5A7B54E3F108ADB4D240E0F4E7CCE0AB8F99C6B394181BC756170E0C22802362

Ugelvig Petersen K, Volk J, Kaerlev L, Lyngbeck Hansen H, Hansen J (2018) Cancer incidence among merchant seafarers: an extended follow-up of a Danish cohort. Occupational and Environmental Medicine 75:582-585.

Ugelvig Petersen K, Lyngbeck Hansen H, Kaerlev L, Hansen J (2020) Turning the tide: reducing mortality among Danish merchant seafarers. Occupational and Environmental Medicine 77:761-768.

Valkonen T, Martelin T, Rimpelä A (1990) Eriarvoisuus kuoleman edessä. Sosioekonomiset kuolleisuuserot Suomessa 1971–85. Tutkimuksia 172. Tilastokeskus, Helsinki.

Valtonen H (2007) Oikeudenmukaisuus ja terveyspalvelujen kohdentaminen. Teoksessa Saari J, Yeung AB (eds.) Oikeudenmukaisuus hyvinvointivaltiossa. Gaudeamus, Helsinki, p. 97-114.

Van den Borre L, Deboosere P (2018) Investigating self-reported health by occupational group after a 10-year lag: results from the total Belgian workforce. Archives of Public Health 76:68.

Van den Borre L (2018) Occupation, health & mortality: a longitudinal study of the Belgian workforce: Doctoral dissertation. VUBPRESS, Brussels.

van Doorslaer E, Masseria C (2004) Income-Related Inequality in the Use of Medical Care in 21 OECD countries. OECD Health Working Papers no.14.

Varje P, Kokkinen L, Kouvonen A, Koskinen A, Väänänen A (2014) Occupational groups and main causes of hospitalization. A longitudinal multicohort study of the Finnish working-age population, 1976 to 2010. Journal of Occupational and Environmental Medicine 56(8):886-891.

Weeden KA, Grusky DB (2012) The three worlds of inequality. American Journal of Sociology 117(6): 1723-1785.

Wieclaw J, Agerbo E, Mortensen PB, Burr H, Tuchsen F, Bonde JP (2008) Psychosocial working conditions and the risk of depression and anxiety disorders in the Danish workforce. BMC Public Health 8:280.

Willems S, De Maesschalck S, Deveugele M, Derese A, De Maeseneer J (2005) Socio-economic status of the patient and doctor-patient communication: does it make a difference? Patient Education and Counseling 56(2):139-146.

Virtanen S, Husman P (2010) Sosioekonomiset terveyserot. In: Kauppinen T, Hanhela R, Kandolin I, Karjalainen A, Kasvio A, Perkiö-Mäkelä M, Priha E, Toikkanen J, Viluksela M (eds). Työ ja terveys Suomessa 2009. Finnish Institute of Occupational Health, Helsinki, p. 147-152.

Virtanen P, Kivimäki M, Vahtera J, Koskenvuo M (2006) Employment status and differences in the one-year coverage of physician visits: different needs or unequal access to services? BMC Health Services Research 6:123.

Wright EO (2005) Approaches to Class Analysis. Cambridge University Press, Cambridge.

Zhang Z, & Snizek WE (2003) Occupation, job characteristics, and the use of alcohol and other drugs. Social Behavior and Personality: An International Journal 31(4):395–412.