Mortality, Work and Migration. A Consideration of Age-specific Mortality from Tuberculosis in Scotland, 1861-1901

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Urban-rural dichotomies in historical demography

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Mortality, Work and Migration

A Consideration of Age-specific Mortality from Tuberculosis in Scotland, 1861-1901

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ABSTRACT

This paper provides an examination into some of the most enduring debates regarding tuberculosis mortality during the nineteenth century: those related to gender, geographic and temporal variations. We use populations reconstructed from individual census and civil register data for the period 1861 to 1901, comparing a growing urban area with a declining rural area, both with around 20,000 inhabitants in 1861. Our analysis shows that among young adults tuberculosis was linked to excess female mortality in the urban area and excess male mortality in the rural area. We demonstrate that in the town textile workers of both genders had particularly high mortality from tuberculosis, and that the only reason for higher overall female mortality was the predominance of young women in the textile labour force. We show that the age and gender-specific pattern of mortality in the rural area is consistent with higher male than female out-migration together with return migration of those who had contracted the disease elsewhere and needed care during their lengthy illness. We argue that the observed patterns are difficult to reconcile with the 'bargaining-nutrition' account of gendered patterns in tuberculosis mortality, and that they provide little support for nutrition as a key influence on the disease. However, our findings do reinforce Andrew Hinde's recent argument that geographical patterns in sex-specific tuberculosis mortality rates were largely determined by migration patterns, and we discuss the implications of this for our understanding of the decline of the disease over the late nineteenth century.

Keywords: Cause of death, Mortality, Return migration, Scotland, Tuberculosis, Urban-rural migration

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1 INTRODUCTION

Tuberculosis was perhaps the most important, and arguably the most interesting and controversial, disease in the late nineteenth century. It was the dominant cause of death over much of the life-course, particularly during the young adult years: although mortality at these ages was lower than at other times of life, the chronic nature of tuberculosis meant that prevalence and the burden of the disease was high. Tuberculosis has also been at the centre of various unresolved debates regarding differentials and declines in mortality. Essentially these revolve around whether resistance (held to be affected by nutrition) or exposure is the key determining factor in geographical, gender and temporal variations in mortality. The arguments focus on differentials in tuberculosis mortality between women and men, on urban-rural and other geographical patterns, and on the underlying reasons for the decline in mortality in the late nineteenth century. In particular, there is disagreement about why women had higher death rates from tuberculosis than men, and whether this was due to innate female susceptibility, poorer nutrition, or differential exposure. The best-known position is that of McNay, Humphries and Klasen (2005), who argue that higher female tuberculosis rates were due to the weaker bargaining position of females within their households, resulting in lower nutrition among women. This debate is connected to geographical patterns in tuberculosis mortality, as the female disadvantage in mortality from the disease was noticeable in many agricultural areas of Britain where female labour may have been less well valued than male. The geographical patterns are far from clear-cut, however, with some rural areas having a strong male disadvantage, and other authors have suggested that high rural tuberculosis rates might be due to the return migration of those who had contracted the disease in urban places (Cronje, 1984; Hinde, 2015). Nutrition has also been implicated in the substantial decline of tuberculosis during the late nineteenth century (McKeown, 1976), and any re-assessment of the role of nutrition in affecting differentials also forces questions about the reasons for the decline of the disease.

In the British context, researchers have been prevented from resolving these debates since there are restrictions placed on access to anything but aggregate data on mortality, coupled with a conspicuous lack of information on migration. This paper provides a rare opportunity for a more detailed examination of the issues, using individual level data sets for two contrasting communities in Scotland: one urban and one rural. We demonstrate that in the urban setting tuberculosis mortality in young adulthood was associated with work in the textile industries; young women had higher risks of death because more of them worked in such occupations. In the rural area young men had higher mortality than young women, particularly from tuberculosis. We show that this is consistent with higher male migration away from the area, together with the return migration of those with the disease. These findings provide further support for the recent analysis by Hinde (2015) who argues that geographical patterns in sex-specific tuberculosis mortality were largely determined by migration patterns, rather than by differences in the nutritional condition of the population. We do not find support for the bargaining-nutrition account of why female tuberculosis rates are high, and we suggest that factors other than nutrition are likely to have underpinned the decline in tuberculosis during the late nineteenth century.

This paper starts with a brief overview of tuberculosis and the literature related to the debates regarding differentials and declines in mortality from the disease (Section 2.1). Section 2.2 then describes our data and the two study communities, giving special consideration to issues of medical certification of cause of death. It also addresses the age-structure of the communities and what our data can tell us about migration. Section 3, our main substantive section, considers mortality rates among men and women in the two communities, concentrating on the young adult age groups. After a broad overview, we consider cause-specific mortality in both communities, occupation-specific mortality in the town, and the impact of out-migration and return-migration on mortality in the rural area. We finish, in Section 4, with a discussion which considers the implications of our analysis for the debates surrounding the differentials and declines in tuberculosis mortality in the late nineteenth century.

2 BACKGROUND

2.1 TUBERCULOSIS

Tuberculosis is a bacterial infection, spread by droplet transmission and characterised by a chronic cough with bloody sputum, fever and severe weight loss. Also known as ‘consumption’ or ‘phthisis’ in

the nineteenth century, it mostly affected the lungs (when it was known as respiratory or pulmonary tuberculosis or phthisis) and could be passed from person to person. However there was also a bovine form spread by contaminated milk, and the disease could attack other parts the body. The bacillus was identified by Robert Koch in 1882 but although tuberculosis was made a notifiable disease in Britain in the 1880s and first hospitalisation and then the isolation of sufferers in sanatoria became increasingly commonplace, neither effective antibiotic treatment nor immunisation were developed until well into the twentieth century. In Britain, pulmonary tuberculosis alone accounted for over 10 per cent of all deaths in the 1860s, and nearly 20 per cent of deaths among people over the age of five (Hinde, 2015). Mortality from tuberculosis started to decline from the mid-nineteenth century in England and Wales, and from the 1870s in Scotland (Davenport, 2013), forming a major component of the overall mortality decline.[1]

Tuberculosis has always been strongly linked to poverty and overcrowding, and the role of nutrition in increasing vulnerability to death from the disease has achieved the status of accepted wisdom in the historical literature. McKeown (1976) attributed the observed declines in tuberculosis to improvements in nutrition, going on to argue that food availability, and therefore nutrition, was the key driving force in mortality decline. The nutrition-vulnerability link also underpins the 'bargaining-nutrition' account which argues that the weak position of young women within their households led to their under-nourishment, heightening their susceptibility, or diminishing their resistance, to the disease (Anderson, 1990; Humphries, 1991; Johansson, 1996; McNay et al., 2005, p. 664). This account was framed with particular reference to certain low-wage rural areas in Britain where there was little available work for women, and which also displayed excess female mortality in young adulthood. However it sits less comfortably with the existence of low-wage rural areas elsewhere in Britain which had large male excess mortality from tuberculosis (Woods & Shelton, 1997) and Hinde has argued that the nutrition part of the 'bargaining-nutrition' hypothesis should be challenged (Hinde, 2015). The causal direction of the nutrition-tuberculosis link is far from well established. One review of the literature has stated that the evidence for malnutrition leading to tuberculosis in humans is 'surprisingly thin' (Cegielski & McMurray, 2004), and another points out that this lack of evidence is connected to the 'whole complex of coincident environmental factors' associated with tuberculosis: malnutrition, poor housing, exposure to pollutants, co-morbidity and lack of access to medical treatment are often coincidental in patients (Gupta, Gupta, Atreja, Verma, & Viskvkarma, 2009). There is also a very plausible pathway from tuberculosis towards malnutrition (Gupta et al., 2009).

Further potential influences on the incidence and mortality from tuberculosis include the supposed innate biological susceptibility of women and factors related to exposure. The alleged susceptibility of women to the disease has been linked to the gender patterns of tuberculosis mortality in the nineteenth century (McNay et al., 2005, p. 668), but has not received further support in the literature and can offer little explanation of the geographical patterns or declines over time.

Exposure to the disease is a plausible influence on differentials which could act through one or more of a triumvirate of settings: home, work and treatment. The evidence related to exposure in the home has hinged on the relationships between over-crowding, housing quality, and mortality decline. Those who have examined population and housing density have found little correlation with mortality (Pooley & Pooley, 1984; Vögele, 1998), although Harris has maintained that it was plausible that improvements in British housing quality contributed to the decline in tuberculosis mortality (Harris, 2004). In terms of work, the textile industries have frequently been associated with a high tuberculosis burden, particularly for women who made up a large proportion of the workforce (Devos, 1996; Eggerickx & Tabutin, 1994). Crowded work-spaces, it has been argued, maximised transmission opportunities, with high levels of cotton dust and humidity in the textile factories providing additional risk factors (Greenlees, 2005). The workplace environment may also have been important in increasing tuberculosis mortality among men working in white collar and craft occupations in the United States, although alternatively this might have been due to men who had already contracted the disease transferring into these more sedentary occupations (Ferrie, 2003). It is possible that improving occupational conditions, particularly in the textile industry, contributed to the decline in tuberculosis over the course of the late nineteenth century (Devos, 1996). Another exposure-related candidate which may help to explain the decline in mortality from the disease is the increasing segregation of tuberculosis patients in hospitals: Newsholme found this to be the only factor which varied consistently with changes in the tuberculosis

1 McKeown's concentration on tuberculosis in his classic account of mortality decline has been frequently criticised (Guha, 1994; McKeown, 1976; Szreter, 1988), but the decline in tuberculosis mortality is nevertheless real and substantial (Davenport, 2013; Harris, 2004).

rate in a variety of European countries over the late nineteenth century, and Wilson found a tight correlation between the opening of sanatoria and the decline in tuberculosis mortality in Minnesota, USA (Newsholme, 1906; Wilson, 2005).

It is more difficult to see how occupational exposure and segregation could explain the persistent geographic differences in Britain. Nineteenth-century British observers viewed tuberculosis as mainly an urban disease (Cronjé, 1984), but excess female mortality across Europe, connected with tuberculosis, has generally been depicted as a rural phenomenon (Alter, Manfredini, & Nystedt, 2004; Janssens, Messelinka, & Need, 2010; Tabutin & Willems, 1998). Detailed analysis for Britain showed that both the lowest and the highest rates of tuberculosis mortality could be seen in rural areas and that some of the places in Britain with the highest mortality from the disease, including West Wales, had excess male mortality (Hinde, 2015; Woods & Shelton, 1997). Any plausible explanation of the geographical patterns in tuberculosis has to be able to explain these complicated patterns, and one such possibility is connected to the selective return home of rural-urban migrants who had contracted the disease (Cronjé, 1984; Hinde, 2015). The chronic nature of tuberculosis means that migrants of rural origin who contracted the disease in an urban area had time to return home to receive care before also dying there. These deaths will have increased the numerators of rural death rates, but the lower likelihood of healthy migrants returning mean that denominators will not have increased proportionately. For nineteenth-century Britain, Hinde has demonstrated that gender-specific migration and the return migration of the chronically ill can plausibly explain sex-specific mortality from tuberculosis, but he argues that a firmer conclusion needs detailed local studies of particular areas with distinctive phthisis mortality regimes and individual level data yielding more information on migration (Hinde, 2015). This paper provides just such a detailed study of young adult mortality in an urban area and a contrasting rural area, in order to address the inter-connected issues of urban-rural patterns and gender differentials when considering mortality from tuberculosis. Our urban area, the town of Kilmarnock, contained a thriving textile industry and our rural area, the Isle of Skye, was subject to substantial out-migration, particularly of young men, allowing us to consider the roles of occupational exposure and migration in shaping observed rates, which we contrast with alternative explanations for cross-sectional differences, and comment on the implications for our understanding of declines in tuberculosis mortality.

2.2 THE STUDY COMMUNITIES AND THEIR DATA SOURCES

Our study focuses on two contrasting Scottish communities, the town of Kilmarnock and the remote, rural, Isle of Skye, over the period from 1861 to 1901. A data source consisting of linked census enumerators' books and entries from the civil registers of births, marriages and deaths was used to calculate mortality rates for age, sex and occupation specific groups.

2.2.1 THE DATA

Usually in the United Kingdom, records from the civil registers of vital events have to be purchased individually from the Offices of the Registrars General. This makes any study of deaths within a community an extremely expensive enterprise. However, as part of two research grants – an ESRC funded project, 'Determining the demography of Victorian Scotland through record linkage' (grant RES-000-23-0128) and a Wellcome Trust Award, 'Doctors, deaths, diagnoses and data: a comparative study of the medical certification of cause of death in nineteenth century Scotland' (082200/Z/07/Z) – we were granted special permission by the General Register Office for Scotland to transcribe the details contained on each birth, marriage and death entry recorded in the civil registers of the Isle of Skye and the town of Kilmarnock between 1861 and 1901.

In addition to the civil register material we also transcribed the details of all individuals recorded in the census enumerators' books relating to the two communities for all five decennial censuses from 1861 to 1901. The censuses record each individual's name, address, age, marital status, relationship to head of household, occupation and birthplace. The different demographic events and census entries relating to each individual were linked together to create both 'individual' and 'family' histories (Reid, Davies, & Garrett, 2006). Although we have no records of actual moves, absences from a census allow us to identify individuals and families who had left either Skye or Kilmarnock since the previous census. We can identify new arrivals in a similar way. Unfortunately if an individual or a family moved both in and then out again between censuses we are only aware of their presence if they experienced a birth, a marriage or a death while they were resident. Similarly the temporary absence of those who both moved away and returned between censuses is hard to detect.

In this paper we make particular use of the information contained in the civil registers of deaths which contain the name of the deceased, the names of their parents and their spouse, if any, and note the date, time, place and cause of death. They also state whether the cause of death was certified by a qualified doctor, was reported by a lay person, or had been referred to the Procurator Fiscal, the Scottish equivalent of a coroner.[2] The majority of the mortality rates we calculate in this paper use all relevant deaths of those who died in one of our communities (whether or not they have been linked to individuals in the censuses). Populations at risk are calculated by interpolation between censuses.

2.2.2 THE COMMUNITIES

As indicated above, the availability of data means that Scotland is the only part of the British Isles for which this sort of dataset can currently be constructed. Within Scotland, we chose to work on Skye and Kilmarnock for two reasons. The first was their relatively distinct geographic boundaries. Skye is an entire island, and in the nineteenth century it was necessary to take a ferry to get there, so its boundaries are precisely defined. Compared to many of Scotland's major urban areas at the time, Kilmarnock's boundaries were also very clear, as the town was encompassed by rural Ayrshire and did not coalesce into neighbouring urban areas over time. Clear boundaries allow demographic rates to be calculated reasonably accurately, as the registration of events in neighbouring areas should not be a major problem. They also make the identification of migrants more certain and therefore the calculations concerning migration more robust. The locations of these two places within Scotland are shown in Figure 1.

Figure 1 *The locations of Skye, Inverness-shire and Kilmarnock, Ayrshire within Scotland*

Source: This map was drawn with data provided with the support of the ESRC and JISC and uses boundary material which is copyright of the Crown, the Post Office and the ED-LINE consortium.

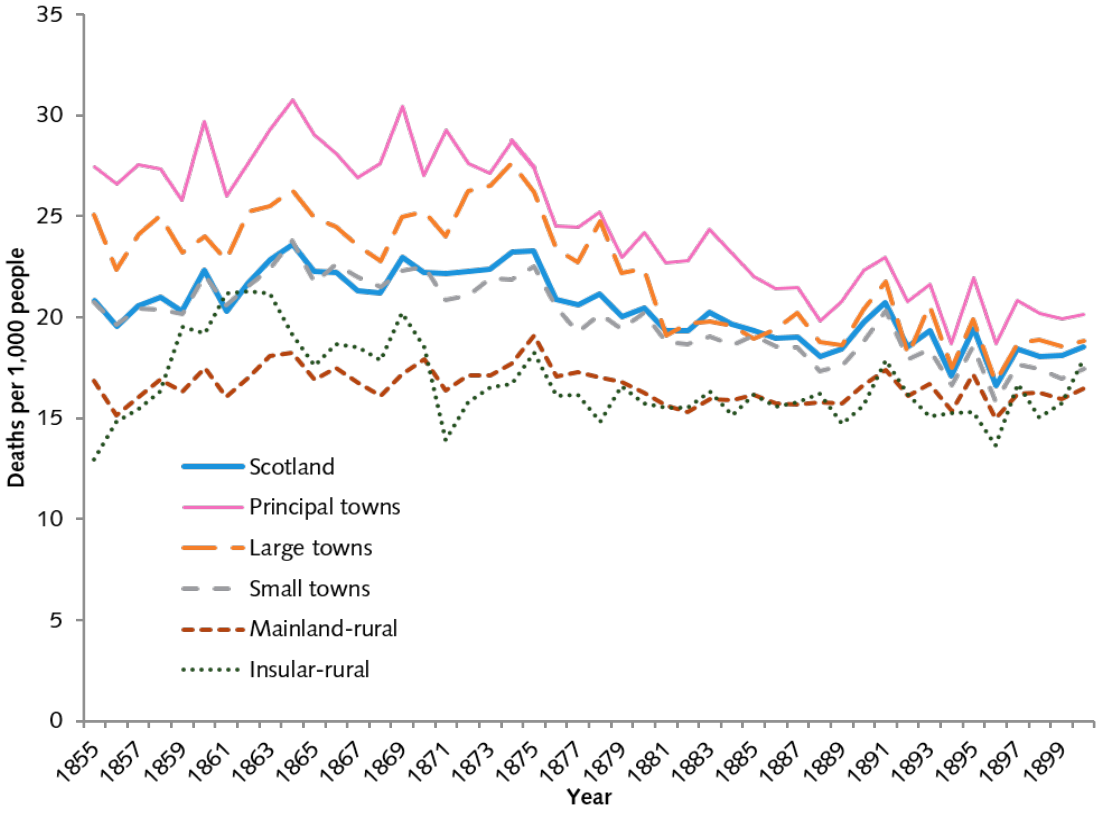
Note: The Registration District of Kilmarnock has been circled to increase its visibility.

The second, and more important, reason for choosing Skye and Kilmarnock was because they exemplify Scotland's highest and lowest mortality experiences in the second half of the nineteenth century. Scotland, like many other countries, displayed a large urban mortality penalty which had been established prior to industrialisation. Figure 2 shows death rates published by the Registrar General for

2 Deaths which were sudden or unexplained were referred to the Procurator Fiscal, particularly if foul play was suspected. The Procurator Fiscal would then hold an inquest to determine the circumstances of death and the cause which would then be entered into the death register. Numbers of such deaths were very small in both of our places and the great majority resulted from accidents or acts of violence.

Scotland (RGS) for a five-fold spatial classification: principal towns (towns or cities with at least 25,000 inhabitants), large towns (10,000 to 24,999 inhabitants), small towns (2,000 to 9,999 inhabitants), mainland-rural districts, and insular-rural districts (Registrar General for Scotland 1875, p. xi).[3] There is a clear mortality gradient from the largest towns where mortality was highest to rural districts where it was lowest. Although the gradient diminished from the mid-1870s, it was still present at the turn of the new century. The convergence between mortality in the towns and in the countryside was entirely due to more rapid declines in the more populous areas. Both the mainland-rural and the insular-rural areas exhibited consistently low mortality rates across the second half of the nineteenth century (although those in the islands suffered a period of elevated mortality in the 1860s), but they experienced little in the way of mortality decline. Skye was thus chosen to represent Scotland's 'insular-rural' populations. Kilmarnock, which was designated as a 'principal town' in 1881, represents conditions in Scotland's larger urban areas.

Figure 2 *Crude Death Rate: Scotland and selected types of district, 1855-1901*



Source: 46th Detailed Annual Report of the Registrar General for Scotland. HMSO Cd. 1258, 1902. p x.

Note: There were 8 principal towns in 1855-80, 9 in 1881-91, 11 in 1892-1900 and 15 in 1901-10.

In 1861 Skye still had a considerable population of around 20,000, but a decline in numbers had already set in and by 1901 it had only about 15,000 inhabitants. The island was remote but relatively accessible from the mainland. Its economy was dominated by crofting and fishing but people increasingly left the island to seek other types of employment elsewhere. Kilmarnock, in contrast, had a burgeoning and varied economy including cotton mills, carpet weaving, scotch-bonnet making, mining, railway construction, carriage building, tobacco works, printing and cheese making. Levels of female labour force participation were high and it attracted considerable in-migration, its population growing from about 23,000 in 1861 to about 33,000 in 1901.

3 The series starts in 1855 when civil registration of deaths was introduced. Although this five-fold classification was only introduced in 1871, the Registrar General re-amalgamated deaths and populations for smaller units to calculate a time series going back to 1855. The Registrar General of Scotland's Annual Reports and Detailed Annual Reports covering the period 1855-1919 may be consulted via the histpop.org website.

Before we can begin to analyse rates and influences on tuberculosis mortality in these communities, we must consider two pertinent factors. The first is medical certification of cause of death: if the proportion of deaths certified by a doctor differed between Kilmarnock and Skye this might affect the recording of cause of deaths, and thus death rates from particular causes. The second is the contrasting age and sex structures of the two populations which provide an insight into migration into and out of the communities.

2.2.3 MEDICAL CERTIFICATION

When considering causes of death in town and country, both in Scotland and elsewhere, it is very important to be sensitive to the legal and medical issues surrounding the registration of deaths and the certification of causes of death. From the inception of civil registration in 1855, it was the responsibility of a relative or neighbour to register a death with the local registrar. Because a death certificate was necessary for burial, it is likely that almost all deaths were registered. Cause of death was different: a doctor who had seen the deceased during their last illness was supposed to provide a medical certificate stating the cause of death, and this (together with the name of the certifying doctor) was transferred into the death register by the registrar. If no medical certificate was forthcoming, a cause offered by the person who registered the death was written into the register. Although it was a legal requirement in Scotland for a doctor to provide a medical certificate, this was impossible if no doctor had attended the patient and levels of medical certification varied dramatically between towns where doctors were in easy reach, and rural areas where the distance between a patient and their doctor must often have been a considerable deterrent to the seeking, and sometimes the provision, of medical assistance during illness.

The vast majority of deaths in Kilmarnock were medically certified in the nineteenth century: over 95 per cent of the deaths of young people and adults were certified, although the percentage amongst infants and the elderly was slightly lower. On Skye the situation was very different: fewer than 20 per cent of deaths were certified by a doctor during the early 1860s and although this figure rose to around 60 per cent amongst older children and adults by the 1890s, barely 20 per cent of infant deaths were certified in the latter decade. There were more registrars than doctors on the island in the second half of the nineteenth century, so distance was less of a deterrent to registration than it was to certification. Furthermore, registration was free whereas a doctor would have had to be paid.

When comparing mortality between communities, it is important to acknowledge the varying degrees to which causes of death were medically certified, because the ranges of cause of death offered by doctors and lay informants differed markedly. The two groups described certain causes which clearly relate to the same condition quite differently. For example 'bronchitis' was a common term offered by doctors, but 'cold' and 'asthma' appear to have been preferred by relatives of the deceased. Some terms might have been more commonly reported by lay people because they dominated causes of death among the very old and very young for whom doctors were rarely summoned: examples include 'old age' and most infectious diseases and fevers. The case is less clear-cut for other causes: for example, doctors were much more likely to offer a heart condition as a cause of death, but it is difficult to tell whether this was because medical help was more likely to have been summoned to people with heart conditions, or because lay people were less likely to make such a diagnosis. Perhaps the most important diagnostic difference is that doctors rarely admitted ignorance of what had killed their patient; but the cause of death was 'not known' on 40 per cent of instances where the cause of death was offered by a relative or other lay informant. Further information on the certification of death and implications for the analysis of cause of death patterns can be found in Reid and Garrett (2012) Reid, Garrett, Dibben and Williamson (2015), Reid, Garrett, Williamson and Dibben (2016) and Reid and Garrett (2018).

When comparing causes of death between different places it is therefore important to consider whether the populations had similar access to a doctor and which categories of cause of death might be underestimated because of cases where the cause of death was reported as 'not known'. Although people on Skye had less access to a doctor, the impact on tuberculosis recording is relatively small because even on Skye medical attendance was highest for the age groups in which most tuberculosis deaths occurred. In addition the fact that tuberculosis was a common disease with distinctive symptoms means that both doctors and relatives could easily identify it (Guha, 1994; Woods and Shelton, 2000). To minimise the effect of doctors and lay informants using different terms (doctors mostly attributing

deaths to 'phthisis', whereas lay people generally offered 'consumption') we use broad cause of death groups which combine the causes offered by both lay people and doctors for the same conditions.

Most analyses of tuberculosis concentrate on the pulmonary form of the disease: in Britain the published cause of death series present pulmonary tuberculosis and abdominal (bovine) tuberculosis separately, and indicate that the pulmonary form was far more common. However the causes of death on the individual death certificates that we used in our research for this paper suggest that the distinction was less clear-cut (see also Padiak (2009), who argues that tuberculosis 'is likely the most problematic cause of death that is routinely encountered'). While some deaths were identified as pulmonary or abdominal (*tabes mesenterica*) forms of the disease, many were attributed simply to tuberculosis, and it seems that the clerks at the General Register Office allocated all of these to pulmonary tuberculosis. For this reason our analysis combines all forms of the disease.

2.2.4 AGE AND SEX STRUCTURE OF THE POPULATION

In the absence of specific information about migratory movements, the age and sex structure of populations can provide an insight into net migration. Figure 3 shows age pyramids for Kilmarnock and Skye in 1861 and 1901: numbers of men in 10 year age groups are given on the left of the vertical axes and numbers of women on the right. Because the census provides the birth-place of each person, we can also identify those who have moved into a particular community since birth. It is clear that a significant proportion of Kilmarnock's population were in-migrants: in 1901 incomers formed a particularly large proportion of the younger adults of both sexes, and also of their children. It is much more difficult, of course, to observe out-migrants in the same way, but discontinuities or short-falls from a smooth age pattern in a particular pyramid can suggest where there had been outmigration within a particular age group or sex. The pyramids for Skye show this clearly: the pyramid for 1861 has fewer young adult males in their 20s and 30s than adult females, which clearly indicates greater outmigration among young men than among young women. Despite the considerable population loss, there is still evidence of some in-migration to the island, although this was at a much lower scale than in-migration to Kilmarnock.

Figure 3, part 1 *Age pyramids for Kilmarnock and Skye, 1861 and 1901*

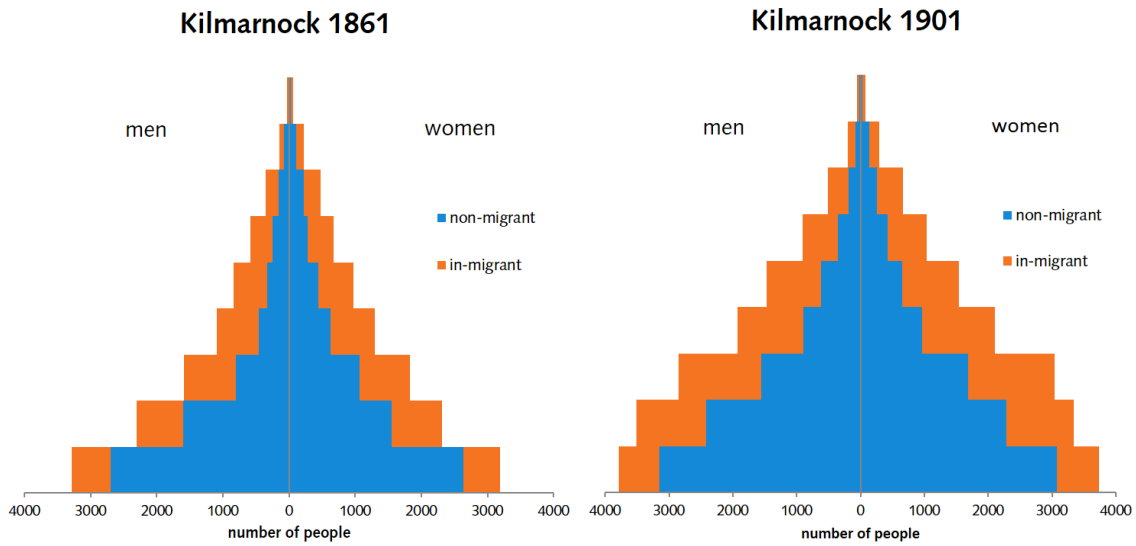
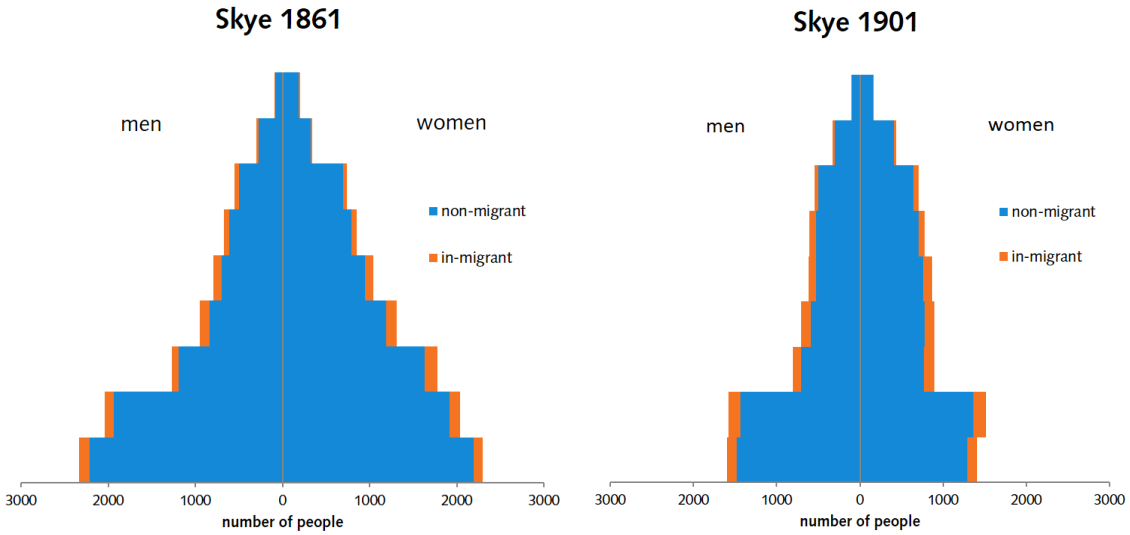


Figure 3, part 2 *Age pyramids for Kilmarnock and Skye, 1861 and 1901*



Source: Demography of Victorian Scotland dataset.

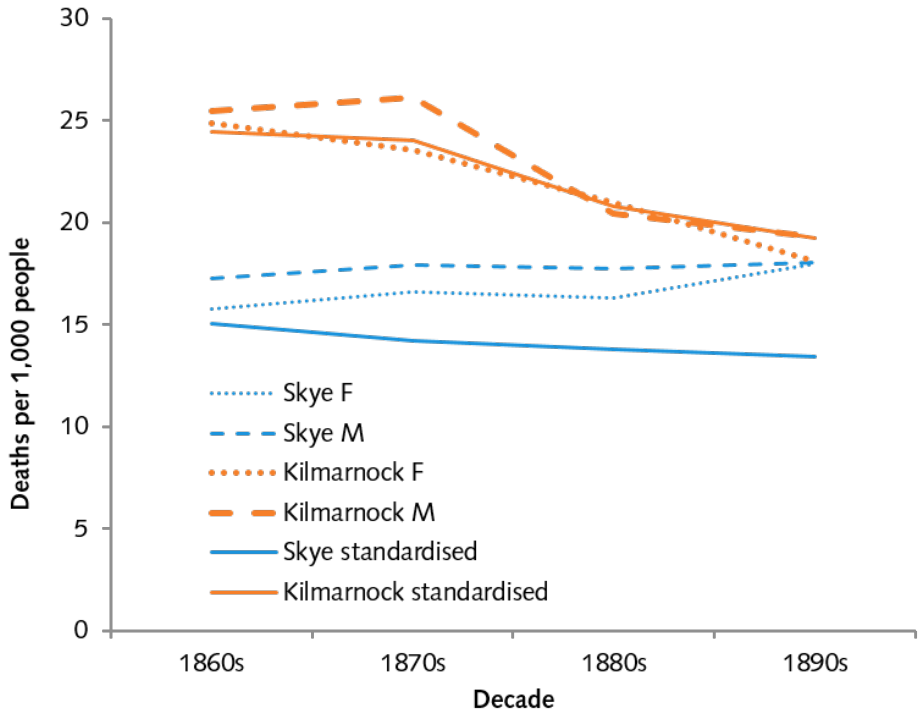
Note: A very small number of respondents on Skye gave a place of birth that could not be identified. These individuals have been included in the 'Skye born' category due to similarities in their age structure.

The 1861 pyramid for Skye is still broadly triangular in shape, typical of nineteenth century European populations, but by 1901 the situation was very different: outmigration had dramatically altered the age-structure of the population. There were still slightly more young adult women than men on the island, but there were far fewer people of both sexes in their 20s, 30s and 40s than would normally be expected. As well as showing the extent of migration off the island, the changing shape of the pyramids has important implications when considering mortality, as the population remaining on Skye included an increasing proportion of old people, who would necessarily have had higher rates of mortality. Any comparisons of mortality between urban Kilmarnock and rural Skye which use crude measures and do not take account of age structure are therefore likely to be distorted.

3 MORTALITY PATTERNS

To provide a background to our examination of gender-specific mortality rates among young adults, we start by showing crude and standardised mortality rates for both Skye and Kilmarnock (Figure 4). Although these are shown for decades rather than annually, they clearly confirm that these two communities exemplify Scotland's national rural and urban mortality patterns, although it is noticeable that Skye did not share in the mortality peak prominent in the country's insular-rural districts as a whole in the 1860s. The gap between Kilmarnock's urban and Skye's rural mortality is particularly high in the 1860s and 1870s but converged by the end of the period. Crude mortality on the island even increased a little over time, but this is largely a function of the changing age structure of the Skye population; the standardised rates were falling. The move towards convergence was therefore not nearly as strong as the unstandardized figures suggest, and a significant urban mortality penalty persisted even in the 1890s. Figure 4 also indicates that mortality rates for males were persistently above those for females. Overall mortality was dominated by deaths in the age groups where mortality rates were highest (infancy, early childhood and old age), and it was in these age groups that the urban and male penalties were also highest. The next sections show that the situation in adolescence and early adulthood, where mortality was dominated by tuberculosis, showed noticeable departures from this pattern.

Figure 4 *Mortality rates in Skye and Kilmarnock, 1860s-1890s: crude rates for each sex and rates standardised for age and sex structure*



Source: Demography of Victorian Scotland dataset.

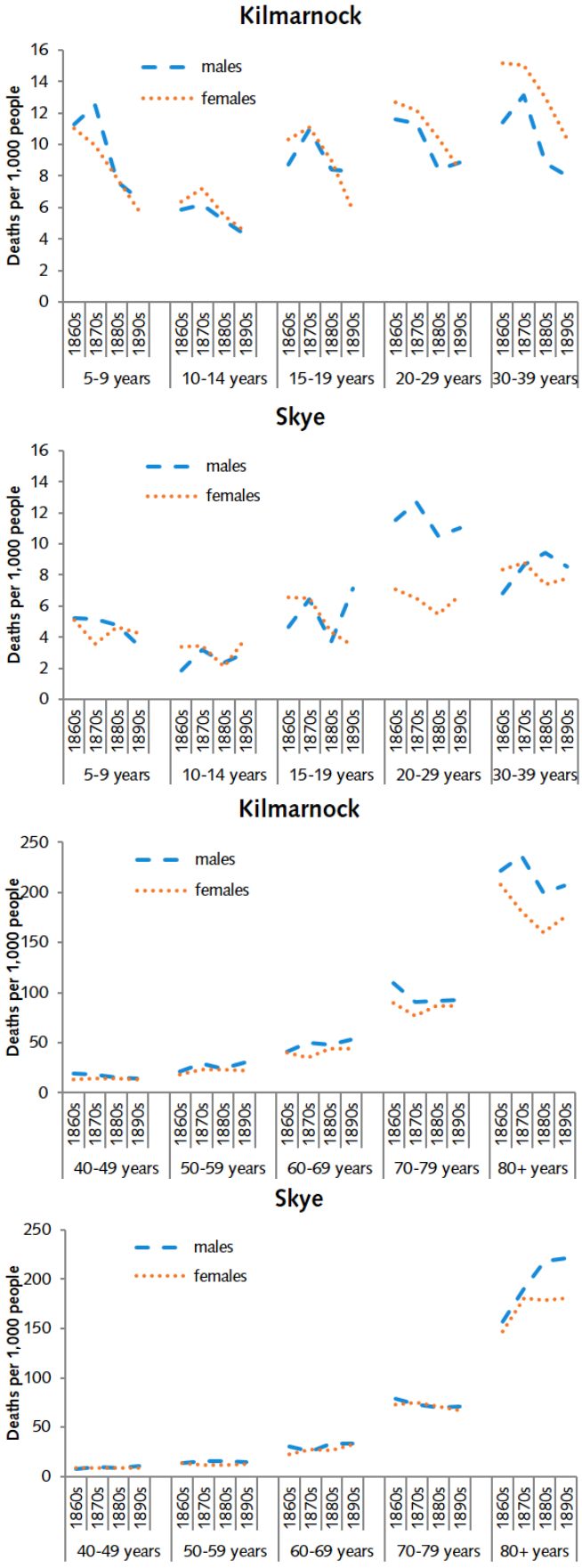
Note: Standardised mortality rates take account of differences in the age and sex structures of the two populations by applying the mortality rates observed for each age group and sex in each place to the same population, in this case the population of Kilmarnock in 1861.

3.1 AGE- AND SEX-SPECIFIC MORTALITY IN ADOLESCENCE AND ADULTHOOD

The urban mortality penalty is clearly visible in childhood and young adulthood. Figure 5 shows rates for age groups from 5-9 years onward for comparison. Among children mortality rates were significantly higher in Kilmarnock than on Skye although, as is usual, the actual risk of death amongst young people was very low. The rates rose again in early adulthood, and it was in this age group that our urban-rural comparators began to diverge from the expected picture. In the nineteenth century the general pattern of mortality was one where the reproductive age group (generally taken to be 20-49) was the only age group where the risk of death was greater for women than for men. This pattern can certainly be seen clearly in Kilmarnock, at least amongst those aged 20-29 and 30-39. The additional risk of death amongst women is generally assumed to be related to the risks associated with giving birth, but it may also have been linked to the poor nutritional condition of young women (Humphries, 1991; McNay et al., 2005).

It is therefore surprising that young men on Skye, particularly those in their 20s, had higher mortality than young women during the last four decades of the nineteenth century. This was also true for those in their 30s during the last two decades. Mortality rates for men in their 20s on Skye were so high that they exceeded those of their peers in Kilmarnock: among these men there appears to have been a rural, rather than an urban, mortality penalty. The lower two graphs of Figure 5 suggests, however, that the normal pattern of higher male and higher urban mortality returned for the age groups over 40 years of age, at least in our two study communities.

Figure 5 *Age- and sex-specific mortality rates: Skye and Kilmarnock, 1860s-1890s*

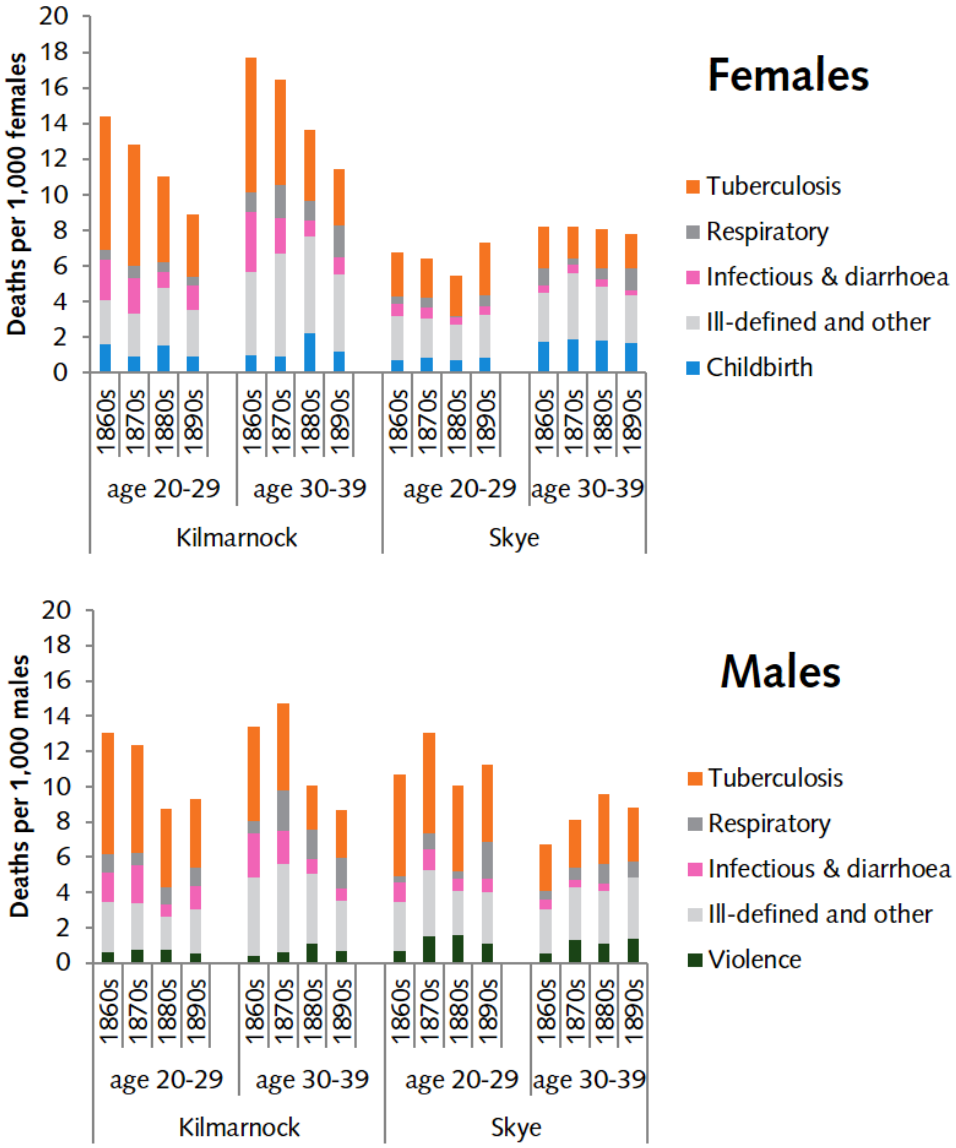


Source: Demography of Victorian Scotland dataset.

3.2 CAUSE-SPECIFIC MORTALITY AMONG YOUNG ADULTS

Figure 6 shows mortality rates for young adult men and women in Skye and Kilmarnock for five broad groups of causes of death. Four of the groups are the same for both sexes, and the fifth represents groups of causes of particular importance to either women or men. For men this was violence, which includes accidents, and for women it was childbirth, which might be considered the most obvious candidate to blame for higher female mortality. Although the great majority of births were accomplished without the loss of life of the mother, in the second half of the nineteenth century in England and Wales around one in every 200 to 250 birth events was associated with the mother's death; a maternal mortality rate (MMR) of four to five deaths per thousand births (Galley & Reid, 2014; Woods & Shelton, 1997, p. 115). In Scotland the rate was a little higher, and rose to a peak of one in every 150 births (an MMR of up to six maternal deaths per thousand births) in the early 1930s. The cause-specific mortality rates in Figure 6 are given per 1,000 women rather than per 1,000 birth events, but prevailing patterns of marriage and fertility meant that, in Scotland in the second half of the nineteenth century, out of 1,000 women in the child-bearing ages, one woman would be expected to die in childbirth each year.

Figure 6 *Cause-specific mortality rates among young adults in Skye and Kilmarnock, 1860s to 1890s*



Source: Demography of Victorian Scotland dataset.

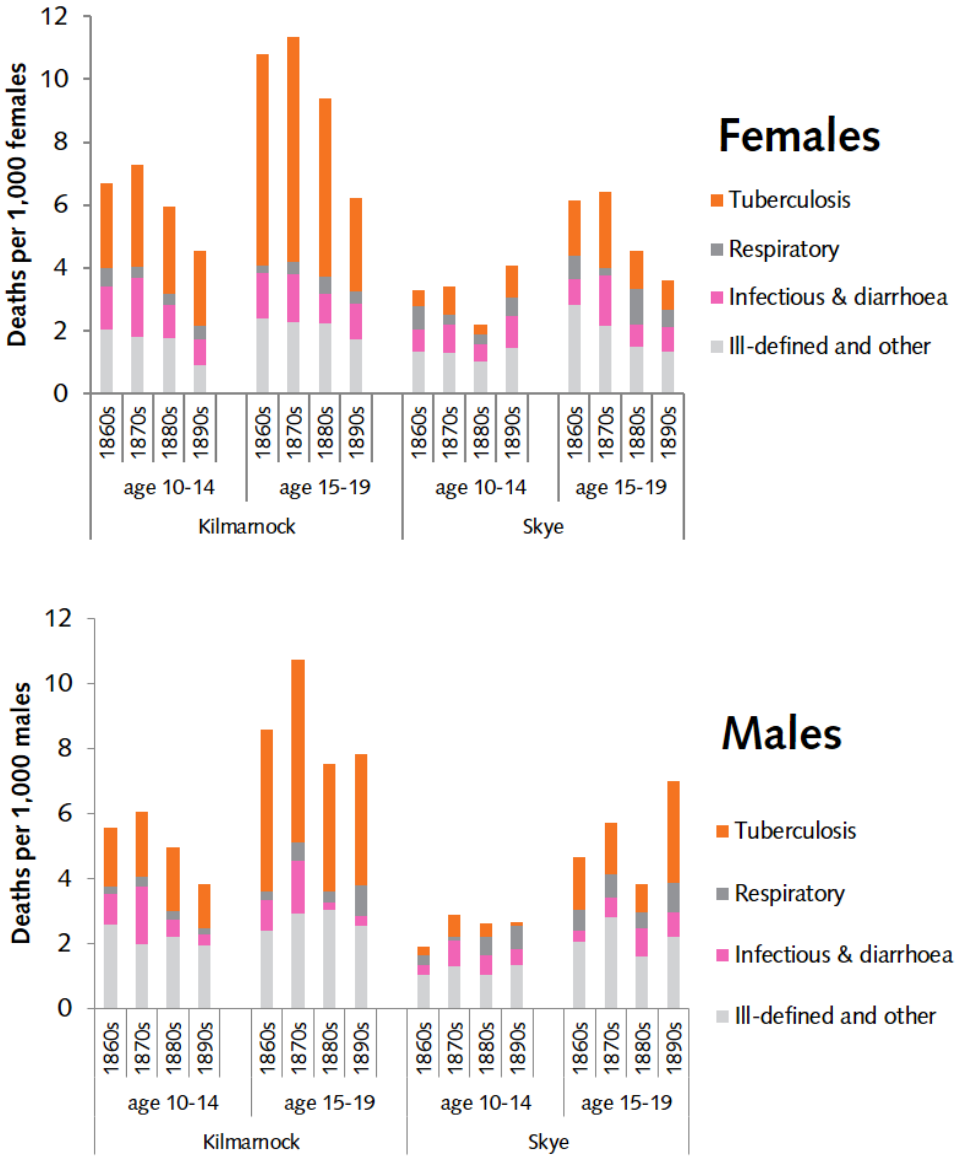
Figure 6 indicates that maternal mortality cannot entirely explain the excess female mortality seen in Kilmarnock. There was no clear trend in the number of deaths due to childbirth per 1,000 women either in Kilmarnock or on Skye over the second half of the nineteenth century. In Kilmarnock the rate was 1.19 deaths per 1,000 women in their twenties and 1.36 deaths per 1,000 women in their thirties. On Skye, where the average age of marriage was rather later, the risk of death due to childbirth was lower, at 0.75 per 1,000 women, amongst those in their twenties, but higher for those in their thirties at 1.80 per 1,000. When both age groups are combined the risk of death from childbirth was very similar in both communities; about 1.25 deaths per 1,000 women. It is clear that this can neither explain why female mortality was higher in Kilmarnock than on Skye, nor does it make more than a small contribution towards pushing mortality among females higher than that among males in Kilmarnock. At this point it is pertinent to remember the caveats concerning the recording of causes of death and medical certification. Lower rates of medical certification on Skye might lead us to suppose that maternal mortality was under-recorded, with some deaths in childbirth relegated to the 'not known' category. In fact, a detailed examination of those women who could be linked to the births of their children reveals that although this did happen on Skye, the problem was far more severe in Kilmarnock, where doctors were more likely to 'hide' maternal deaths by attributing them to precise proximate causes (such as heart-failure, apoplexy, peritonitis, septicaemia, or infectious disease) while failing to mention childbirth (Reid & Garrett, 2018). When maternal mortality rates were calculated as including all deaths from direct or indirect causes following childbirth, they were about 30 per cent higher on Skye and approximately 130 per cent higher in Kilmarnock than they had initially seemed (Reid & Garrett, 2018). The real risk of death from childbirth for women in Kilmarnock was therefore actually higher than it was on Skye, and large enough to explain the excess female mortality amongst young adults in Kilmarnock. On Skye, despite the additional risks for women of death during childbirth, young adult women actually had a lower risk of mortality than men of the same age. The differences in maternal mortality were not, however, large enough to explain the higher female mortality in Kilmarnock than on Skye, nor the decline in this difference over time.

The single most significant disease pushing Kilmarnock's female mortality rates higher than those on Skye was tuberculosis. For women in their twenties and thirties, the evidence is unequivocal: far more women died of tuberculosis in Kilmarnock than on Skye, particularly in the 1860s and 1870s. Female death rates from this cause, and indeed from all causes, showed little change over time on the island, but were declining rapidly in the town. It is notable, however, that male death rates from tuberculosis were higher than those for females on Skye and by the end of the period they were also higher than male tuberculosis death rates in Kilmarnock. Death rates from 'ill-defined and other' causes were also higher in Kilmarnock so it is not plausible that under-recording of cause of death was responsible for lower mortality from tuberculosis on Skye.

Figure 7 shows cause-specific mortality rates for 10-14 and 15-19 year olds. Neither maternal mortality nor violence were high enough to show separately in these diagrams and the few deaths from these causes are therefore included with the 'ill-defined and other' category.[4] Tuberculosis mortality in these age groups was considerably higher in Kilmarnock than on Skye, and this was particularly marked among 15-19 year olds of both sexes. In the town there was a strong female disadvantage in the tuberculosis rates, particularly amongst those in their late teens at the beginning of the period, while in the rural area the rate of tuberculosis deaths amongst 15-19 year olds shifted from being higher amongst girls in the 1860s to being higher amongst boys by the end of the century. The presence of a cotton manufacturing industry in Kilmarnock allows us to investigate whether textile workers were particularly vulnerable to tuberculosis, and to see if this can explain the higher mortality in Kilmarnock.

4 Very few women were married or gave birth in their teens in Scotland in the late nineteenth century, and although the risk of mortality for a teenage mother was probably higher than among a more physically mature woman, this cannot explain the presence of female excess mortality amongst teenagers in both Kilmarnock and Skye in the early part of our period.

Figure 7 *Cause-specific mortality among adolescents in Skye and Kilmarnock, 1860s to 1890s*



Source: Demography of Victorian Scotland dataset.

Table 1 examines tuberculosis mortality rates for broad occupational groups within Kilmarnock. Among young women in the town, particularly those in their late teens, the main source of paid labour was textile manufacture. There were also sizable numbers of young women working in textile finishing industries such as dressmaking and scotch-bonnet making. Textile manufacturing and finishing also employed young men, and the 'textiles, dress and shoe' category used in Table 1 includes shoemakers and carpet-makers, who were both more likely to have been male than female. Outside of textiles, the town's young men had access to a far greater range of occupations than young women, and could be found working in railway and railway-wagon construction, metal working, mining and engineering. The table considers mortality rates amongst late adolescents (aged 15-19), the age group with both the highest tuberculosis mortality rates and higher rates of formal employment than in younger teenage years.[5] The table also shows those in their 20s and 30s who are combined together to offer larger numbers of working women. Deaths are allocated to occupational categories, according to the occupation of the deceased given on the death certificates, so it is possible that some 'not occupied' men and women had been invalided out of work, while others may have been selected into a less physically demanding occupation.

5 70 per cent of girls aged 15-19 returned a formal occupation in the 1881 census, while only 17 per cent of those aged 10-14 did the same.

Table 1 *Mortality rates from tuberculosis among young men and women working in particular occupational groups, Kilmarnock 1861-1901*

	women 15-19			women 20-39		
	Nº of TB deaths	TB deaths per 1,000 people	% of population	Nº of TB deaths	TB deaths per 1,000 people	% of population
textiles, dress & shoes	210	5.47	45.5	275	6.09	22.3
service	21	2.39	10.4	42	1.93	10.7
other	31	2.57	14.3	121	4.42	13.6
not occupied	170	6.79	29.7	608	5.64	53.4
ALL	*432*	*5.13*	*100*	*1046*	*5.17*	*100*
ALL: Without TB penalty for textiles		*3.80*	*100*		*4.80*	*100*
	men 15-19			men 20-39		
	Nº of TB deaths	TB deaths per 1,000 people	% of population	Nº of TB deaths	TB deaths per 1,000 people	% of population
textiles, dress & shoes	44	10.09	5.3	142	8.20	7.5
agriculture	1	0.83	1.5	24	5.17	2.0
white collar	36	9.00	4.8	84	10.61	3.4
sales	14	7.00	2.4	40	6.10	2.8
mining	16	4.21	4.6	19	1.46	5.6
other	211	4.65	54.9	760	4.54	72.3
not occupied	44	2.01	26.5	38	2.61	6.3
ALL	*366*	*4.43*	*100*	*1107*	*4.78*	*100*
ALL: Without TB penalty for textiles		*4.14*	*100*		*4.51*	*100*

Source: Demography of Victorian Scotland dataset.

Notes: The population working in each occupation group has been approximated using the 1881 census.
'Without TB penalty for textiles' applies the mortality rates for other occupations to textile workers.

It is clear that women working in textiles in Kilmarnock suffered higher mortality rates than the town's female average, and significantly higher rates than women working in other forms of employment. It was, however the 30 per cent of adolescent women 'not in formal employment' who suffered the worst mortality rates of any female occupational category, suggesting that this group included girls who had left, or been unable to join, the labour market because they had contracted the disease. The same effect may have been at work among women in their 20s and 30s, but was more muted because women in this age group had alternative reasons to drop out of the work-force: marriage and child-bearing. Unexpectedly, we found that boys and young men working in Kilmarnock's textile industry had even higher mortality rates than their female counterparts. Male clerks and those in other white collar occupations also had particularly high rates, but young men 'not in formal employment' had low rates. As suggested by Ferrie (2003), it is possible that instead of giving up work entirely young men who contracted tuberculosis changed to more sedentary office jobs, which would not have been an option for women at this time. It is also possible that when men gave up work through ill-health, their former occupation was more likely to have been recorded on their death certificate than those of young women.

Textile work thus appears to have carried a mortality penalty in Kilmarnock, as in other parts of Europe (Devos, 1996; Eggerickx & Tabutin, 1994). However it is not yet clear whether this was sufficient to produce the gender differences in mortality in Kilmarnock or to account for Kilmarnock's mortality penalty over Skye in these age groups. Included in Table 1 are hypothetical mortality rates from

tuberculosis for each age and sex group, calculated on the assumption that there was no additional mortality penalty attached to textile work (see '*All: Without TB penalty for textiles*' rows in Table 1). To create these figures we assumed that textile workers suffered the (lower) tuberculosis mortality rates of the 'other' occupation group. We chose not to use the mortality of the 'unoccupied' for this exercise due to the possibility of the chronically ill being selected into this category. Comparing the rates in the table for 15-19 year olds, we can see that although female textile workers were less likely to have died of tuberculosis than male textile workers (5.47 per 1,000 *vs*. 10.09 per 1,000), the large proportion of females working in textiles (45.5 per cent *vs*. 5.3 per cent) was sufficient to create the higher overall female tuberculosis mortality rates observed in this age group.

The gender differential in tuberculosis was also present in the 20-39 age group, although the difference was small, as the female rate was higher and the male rate lower than the figures for those in their late teens. Death rates from tuberculosis may have been exacerbated by pregnancy and childbirth amongst women in their 20s and 30s age group and, as we have seen above, doctors may have 'failed to mention' that a woman was pregnant or had recently given birth on her death certificate. This may account for the higher rates of tuberculosis mortality among women working in textiles and in other occupations in their 20s and 30s than those in their teens. It is notable that amongst domestic servants, who would have been much less likely to be married and at risk of pregnancy, the rate of mortality in the older age group was lower than it was for those in their late teens.

Our evidence does therefore reveal a textile-related tuberculosis penalty, and suggests, perhaps surprisingly, that this was higher for men than for women. It is possible that textile mills, and maybe also the offices where young male clerks were crowded together, were breeding grounds for tuberculosis and other infectious diseases: working in close proximity would have increased exposure and eased transmission from person to person. Specific practices such as the 'kissing' of shuttles may have increased transmission (Greenlees, 2005) and the presence of fibres or dust in the air and high humidity are likely to have increased vulnerability to lung infections (British Parliamentary Papers, 1889). Females do not appear to have been any more vulnerable to tuberculosis than men, but they were much more likely to have been employed in textiles, at least in Kilmarnock, and it was this that elevated their chances of dying from the disease, not their inherent biology or their nutritional status. It would be an interesting exercise to calculate cause-specific mortality rates for a town where male textile work was more prevalent than female, or the rates of employment in the textile industry were more evenly balanced than in Kilmarnock, to see whether this changed the nature of any 'textile penalty' observed.

3.3 SEX-SPECIFIC MORTALITY AND MIGRATION AMONG YOUNG ADULTS: SKYE

There remains the conundrum of why males on Skye had mortality rates which were both higher than those of females on Skye, and of males in Kilmarnock. There were no textile factories on Skye and little white-collar work. Instead, the most common occupational trajectory for a young man was to start off as a fisherman, before taking over the family croft in later life, or moving off the island to find employment elsewhere. Fishing was a dangerous occupation, carrying a high risk of drowning, and although male rates of death due to violence (the majority of which were drownings) on Skye were both higher than those for women on the island and higher than those among men in Kilmarnock, the effect is too small to make more than a small dent in the excess mortality amongst men in their twenties on Skye.

One possible answer to the puzzle is connected to migration (Hinde, 2015). The population pyramids shown in Figure 3 indicated that there was considerable out-migration from Skye, particularly among young men and increasingly among young women too. This could have affected mortality in a number of ways. Out-migrants tended, on average, to be healthier than those who did not migrate (Ruggles, 1992) and therefore people remaining in a community were likely to have suffered higher rates of mortality than if no migration had happened. If more men migrated, male mortality rates in the community of origin will have been elevated more than female rates. Moreover out-migrants who developed a chronic disease such as tuberculosis may have returned home to be cared for by relatives. It is also possible that some ill individuals moved to rural areas, such as Skye, thinking that such places might offer respite from their condition. This additional selection of particularly ill return- or in-migrants, may have acted to increase mortality rates even further. As Boyle and Norman (2009) have pointed out, William Farr noted as long ago as 1864 that health-selective migration could affect

place-specific morbidity and mortality rates, and in 1871 Welton also commented that migration could have a 'profound' effect on local mortality rates. Recent studies in Africa, such as those of Levira, Todd and Masanja (2014) and Ginsburg et al. (2016) have also highlighted the inter-relationship between migration and mortality, especially in the context of HIV/AIDS; a disease which, like tuberculosis, can take a long time to reach a fatal conclusion.

Unfortunately 'return migrants' are virtually invisible in the census enumerators' books, as they reported that they were born on Skye. However our record linkage allowed us to identify those individuals in the death registers of Skye who had died in the year after a census was taken, but who had not been living (and were therefore not enumerated) on the island on census day itself. To provide illustrative examples, we have traced the migratory paths of two such young people using additional sources.[6] Our first example is Betsy M. who died on Skye, aged 26, from 'phthisis pulmonalis' of 'unknown duration' in October 1881. Her death certificate states that she was the daughter of John M. and Marion R.[7] She was recorded as living with her mother and her siblings in the 1861 and 1871 census returns for Skye, but she was not present on the island when the 1881 census was taken. Instead she was living as a servant in, ironically, a doctor's house in Govan in Scotland's industrial central belt. Betsy must have returned home sometime between the census and her death. Her employer may have recommended the move for the sake of her health; or perhaps fearing infection he 'let her go' from her position. Alternatively, being ill, Betsy wanted to go home to be cared for by her mother. Whatever the case, a chronic disease such as tuberculosis would have allowed Betsy time to travel back to Skye. Had she succumbed to an acute disease, such as appendicitis, measles or pneumonia, her death would most likely have been registered in Govan. The second example of a young person returning to Skye to die was John F., who was born on Skye in 1868, to Donald F. and Catherine M. Catherine died from a brain fever in 1870 and in the 1871 census John was living with his father in his paternal grandparents' house, and he was still there in 1881, although by that year his father had moved off the island. By the spring of 1891 he had joined his father and stepmother in Greenock near Glasgow, and was working as an engine fitter. His grandfather was still living on Skye with John's aunt, her husband and their growing family. John was back on Skye by November of 1891, however, when he died aged 23 in the village where his grandfather lived. His uncle by marriage registered his death as being due to tuberculosis of four months duration. Whether intentionally or not John had returned 'home' to die. The deaths of these two young return-migrants both added to the toll of young adult deaths on the island, even though they were not present amongst the young people who had been counted in the census whose numbers form the denominator for the mortality rates. The cases of Betsy and John form examples of the effect of return migration, but are not sufficient on their own to demonstrate a significant effect on mortality rates.

We have not been able to trace the full migration paths of all migrants who left and returned to Skye. Instead, to explore the effect of return migration on mortality rates on the island, we designed a series of 'thought experiments' in which we made various assumptions regarding tuberculosis mortality and migration. These are illustrated in Figure 8, where the solid lines show the observed all-cause mortality rates among men and women aged 20-29 and 30-39 on Skye. These were cohorts which had been strongly depleted by migration, and we posited that some of their excess mortality could have been due to either a) out-migration of the healthy (who would not have died had they stayed), b) return migration of former residents who had picked up tuberculosis whilst away or, possibly, c) the in-migration of ill individuals who were not native to Skye. As already mentioned, tuberculosis was characterised by a long period of illness prior to death – the typical length of last illness of those dying from tuberculosis on Skye was 18 months to 2 years – giving sufferers time to travel home to their family for care, a choice that might have appealed particularly to relatively young, single individuals.[8]

6 These two individuals have been traced using Scotlandspeople.gov.uk. The ScotlandsPeople website is more than a genealogical website as it is maintained by 'the National Records of Scotland, a non-ministerial department of the Scottish Government' and is the 'official Scottish Government site for searching government records and archives'. See https://www.scotlandspeople.gov.uk/about-us.

7 Surnames have been omitted for reasons of confidentiality. Note that in the Scottish civil registers of death the maiden surname of the deceased's mother is given, hence why Betsy's parents have different surname initials.

8 The length of last illness was provided on death certificates, although it was not uniformly provided and at times was rather imprecise so a precise calculation is not possible. However, the values for tuberculosis are generally given in months or years rather than days or weeks.

Amongst those in their 20s such individuals were more likely to be male, given the later age at which men married, and the greater proportion of young men amongst the out-migrants.

Our first thought experiment considered what mortality might have been like if no-one had migrated away from Skye. We took mid-decade cohorts aged 10-19 (D1) and 'survived' them forward, applying the average of mortality rates of 10-19 year olds and 20-29 year olds to obtain the mid-decade cohort of 20-29 year olds in the following decade (D2) and 30-39 year olds in the decade after that (D3).[9] For example, we took the 10-19 year olds in the mid-1860s and survived them on to the mid-1870s. We then made the assumption that the deaths observed on Skye to that age group over the following decade included all the deaths occurring in that particular cohort. To put it another way, we were assuming that out-migrants were so healthy that none of them died off the island and therefore all deaths in the target cohort were captured by the deaths occurring on the island. We then recalculated the mortality rate by dividing the number of individuals in the 'survived' cohort into the number of deaths from all causes occurring to that cohort on Skye. This produced the new 'no migration' death rates shown in Figure 8. The assumption that out-migrants were so healthy that none would have died off the island is implausible, but it does indicate the bounds of possibility.[10] The 'no migration' lines in Figure 8 indicate that 'healthy migrants' could potentially have had a large effect, raising apparent mortality rates for both men and women on the island but particularly for men. Higher levels of male than female out-migration cannot entirely explain the excess male mortality experienced by those remaining on Skye, however. Higher male mortality might be explained, as we have suggested, by a greater tendency for sick men than sick women to return to the island for nursing care.[11]

Figure 8 *Young adult mortality rates under various assumptions about migration and tuberculosis, Skye 1860s to 1890s*

Source: Demography of Victorian Scotland dataset.

9 We decided not to use cohorts aged 0-9 as these are often slightly smaller possibly due to under-enumeration and possibly due to the return migration of young adults bringing children born elsewhere – this explains why the 20-29 rates are only for 1870s on and 30-39s only for 1880s on.

10 Also, if many of the migrants were seasonal migrants, away at the time of the census, the assumption is less extreme, as they would have been on Skye contributing to deaths for the greater part of the year although not contributing to population denominators.

11 It is also possible that females migrating to the island from elsewhere for the first time were more healthy than male in-migrants, or that men who came were more likely to be in occupations which carried a higher direct or indirect risk of death, such as those associated with the sea. These possibilities need further exploration, but our data do not allow us to do this at present.

Given that death rates observed on Skye may have included deaths from tuberculosis amongst return migrants, our second thought experiment explored the effect of 'unhealthy return migration'. We assumed that if people had not migrated away from Skye then they would not have been able to contract tuberculosis, and we therefore applied only non-tuberculosis deaths on Skye to the relevant 'survived' age groups. The results are shown as the 'no migration, no TB' lines in Figure 8. Although this too is an unrealistic assumption, representing one extreme scenario, it is the only scenario in Figure 8 which returns the ratio of male to female mortality among people aged 30-39 on Skye to levels we might expect (i.e. higher female mortality). Men in their twenties still ran a greater risk of dying than women in the same age group, but this scenario has reduced this risk to a level which is more easily explained by the dangers encountered in the fishing industry.

Young men were more likely to migrate away from Skye than young women, and were also more likely to move for employment reasons than for marriage. This means that it is probable that a greater number of men, and particularly young single men, would have returned to seek care from their families when they contracted tuberculosis, further elevating the disparity in mortality between the sexes amongst young adults on the island. Further research is needed, however, to test this supposition.

4 DISCUSSION AND CONCLUSIONS

In this paper we have explored age and sex differentials in mortality in both an urban and a rural community in late nineteenth century Scotland and demonstrated that factors quite divorced from the disease environment can have a marked impact on mortality differentials between certain groups. Different patterns of employment and migration amongst males and females, and between different age groups have been shown to contribute to variations in mortality.

As expected, urban mortality was higher in most age groups, but by focusing our examination on gender differences in the teenage and early adult age groups, where mortality rates are typically low, we first demonstrated that, although men and boys working in the textile industry in Kilmarnock were more susceptible to tuberculosis, the strongly female nature of textile employment in the town meant that more girls in the community were exposed to the hazards of the mills and this meant that tuberculosis mortality rates were higher among young women than among young men. This finding has implications for the debates on female excess mortality from tuberculosis: in particular it provides no support for the theory that young women were inherently more vulnerable to the disease. Instead it suggests that all those working in textile manufacture, along with those in clerical occupations, ran a greater risk of developing tuberculosis, probably as a result of a combination of increased exposure and greater opportunities for transmission.

We have also been able to tease out the differential effects of migration, notably return migration, on gender-specific mortality in rural areas, particularly in relation to tuberculosis. We have shown that it is plausible that selective out-migration of healthy people, coupled with return migration of the chronically ill, inflated mortality in rural areas from causes such as tuberculosis. Mortality rates from more acute diseases would have been less affected as sufferers would have had less opportunity, and possibly inclination, to migrate. Furthermore we observed that this can produce strong sex differentials in mortality in communities where migration is more common among one sex than the other. There is a strongly gendered geography of tuberculosis mortality in England and Wales (see Woods & Shelton, 1997, Map 22, p. 106) and our findings add credibility to the suggestion that places which experienced higher out-migration of a particular sex were more likely to experience higher mortality rates from all causes, due to the loss of healthy out-migrants, and from tuberculosis in particular, because return migrants were often disproportionately unhealthy (Hinde, 2015).

It is worth considering the implications for the 'bargaining nutrition' explanation for excess female mortality from tuberculosis. This holds that women (particularly in rural areas) occupied a weaker position within the household than their menfolk, leading to poorer nutrition and raised susceptibility (Humphries, 1991; Johansson, 1996; McNay et al., 2005). We have shown that it was women earning a good salary in the textile mills who suffered most from the disease: such women were unlikely to be in a poor bargaining position in the household. Their excess mortality is more plausibly explained by higher exposure and associated environmental risk factors in the textile industry. The fact that

male textile workers suffered death rates at least as high as women lends weight to this suggestion. Excess male mortality on Skye among young adults is also inconsistent with the 'bargaining nutrition' account, as it is difficult to argue that the bargaining position of men was so adversely affected in a rural community where most of the paid labour opportunities were restricted to men. The combination of sex-selective migration and return migration of the ill proves a much more plausible explanation for the gendered mortality patterns on Skye, as well as the more general geography of tuberculosis in Britain (Hinde, 2015).

If our argument that tuberculosis mortality was affected more by exposure than by nutrition is upheld, where does that leave McKeown's theory of mortality decline? Wilson (2005) has argued that McKeown ignored a careful contemporary analysis by Arthur Newsholme (1906) who proposed that the increasing use of isolation facilities had had a major impact on the decline of tuberculosis. The findings we have presented would certainly support Newsholme's argument. The string of industrial legislation which led to the gradual improvement of conditions in textile mills and other crowded workplaces may also have played a role in urban mortality decline (Devos, 1996). How then might we explain declines in tuberculosis mortality in rural places as well as urban? Segregation of those diagnosed with the disease could have affected rural as well as urban areas if sufferers were hospitalised rather than returning to their family homes to be cared for: they would therefore have been less likely to inflate the mortality rates of rural areas. Possibly, as transport links improved, an increasing proportion of the population were exposed to the organism causing the disease and therefore those from rural communities became less susceptible. Perhaps the organism experienced an exogenous decline in virulence as Woods and Shelton (1997, p. 114) have suggested. Much remains to be discovered from the geography of death, and the effects of the movement of healthy and unhealthy individuals of various ages and sexes may yet come to be seen as important as housing, nutrition and social inequalities, the 'more usual suspects', where the causes of mortality differentials were concerned.

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