Are Ageing Societies Ageing Equally? Measuring Life Expectancy and Lifespan Variation Inequalities at Older Ages

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Abstract

Socioeconomic inequalities in average life expectancy are considered to be the strongest reflection of inequalities in health and life chances but the WHO recommend that the distribution of health across all individuals also be monitored. This prompted studies into variation in age at death. Higher variation in death reflects greater heterogeneity or greater inequality. International evidence shows that the most deprived groups experience a double burden of mortality inequality: lower life expectancy and higher variation. At the national level, older ages have shown increasing variation in age at death. It is not clear if this national level trend is consistent across all socioeconomic groups. Measuring life expectancy and variation at older ages is important for understanding the extent to which ageing societies are ageing equally. We investigate life expectancy and lifespan variation changes between 1981 and 2011, at age 50, age 65 and age 75, using area-level deprivation to stratify the whole population of Scotland.

Keywords: heterogeneity in age at death, lifespan variation gap, socioeconomic inequality, inequality and ageing

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Background

Socioeconomic inequalities in life expectancy have been documented in every developed country where measurement has taken place. A gradient in life expectancy is found whether education, income, or occupation are used as a proxy measure for socioeconomic inequality with trend studies indicating that the life expectancy gap between the most and least advantaged groups has widened in developed countries (Auger, Harper and Barry 2013; Martikainen, Valkonen and Martelin 2001; Tarkiainen et al. 2012). Although inequalities in life expectancy are considered to be the strongest reflection of inequalities in health and life chances, recent attention has been paid to variation in age at death.

Higher variation in death reflects greater heterogeneity or greater inequality. It is also in line with the WHO recommendation to measure the distribution of health across all individuals (World Health Organistation 2000). National variation trends have been investigated for many countries (Seaman, Leyland and Popham 2016; Vaupel, Zhang and van Raalte 2011). In general, the desired correlation between increasing life expectancy and decreasing variation in age at death has been achieved by most countries. This is largely due to falling premature mortality rates historically outpacing falling mortality rates at older ages (Vaupel et al. 2011).

In contrast to national trends, socioeconomic trends within countries are not consistently following the desired correlation: the most deprived groups experience increasing life expectancy alongside stagnating or even increasing variation in age at death (Brønnum-Hansen 2017; van Raalte, Martikainen and Myrskylä 2014). Lower life expectancy and higher variation in age at death for the most deprived socioeconomic groups can be considered as a double burden of mortality inequality.

While increases in life expectancy come from reducing mortality rates at any age, variation in age at death decreases if there is a balance between avoiding premature deaths and avoiding older age deaths. The distribution compresses if premature mortality rates are decreased over time. The distribution expands when deaths at older ages are delayed (Vaupel et al. 2011). Therefore, increases in life expectancy could be expected to continue with increased survival at older ages but decreases in variation may be more uncertain. Increasing variation at older ages can on one hand be considered a consequence of population ageing. On the other hand, if increases at older ages are patterned by socioeconomic deprivation it may indicate that ageing is becoming an increasingly unequal process. Regardless, measuring variation has implications in terms of future planning, pensions and health care (van Raalte et al. 2014).

When looking at variation conditional upon survival to age 75 for national populations (Engelman, Canudas-Romo and Agree 2010) found the level to be stable with some small increases since 1950. Several studies have also documented socioeconomic inequalities (Sasson 2016; van Raalte et al. 2012; van Raalte et al. 2014) but these studies paid limited attention to inequalities at older ages. We consider the life expectancy gap and the lifespan variation gap conditional upon survival to age 50, age 65 and age 75 between 1981 and 2011. We use population and mortality data that covers the entire population of Scotland (c.a. 5 million) stratified by a validated measure of area-level deprivation(Carstairs and Morris 1989). The next steps of this research will involve age-and cause specific decomposition.

Data and methods

We use individual level mortality data and area-level population estimates that were obtained via a commissioned request from National Records of Scotland (National Records of Scotland), alongside the Carstairs score of area-level deprivation that is freely available to access online (Brown et al. 2014). After matching, these data were used to construct deprivation specific period life tables for each census year, for males and females separately.

Population data are for each part-postcode sector in Scotland at each census year between 1981 and 2011, ensuring the most robust population estimates available that include the whole population. There are approximately 1,010 part-postcode sectors in Scotland, with an average population size of 5,000. Population estimates obtained were stratified by single year of age and sex.

Mortality data include all individual deaths that occurred in Scotland in the years centred around each census year. Each individual death record contains geographical information on place of usual residence that we used to match to population estimates and the deprivation score data.

Traditional stratification measures such as income, occupation or education are often only available for certain ages of the population meaning age truncation is required. Area-level measures of deprivation are a unique alternative that overcome this limitation as they are applicable to the entire population and are derived from routinely collective, administrative data (Kearns, Gibb and Mackay 2000). In this study we use the Carstairs score, a standardised z-score derived from four variables (overcrowding, male unemployment, no car ownership and low social class) that was constructed specifically for measuring health inequalities (Carstairs and Morris 1989).

Smoothing and extrapolation

Census population estimates obtained were available up to different open-ended age intervals; 1981 was 85+, 1991 was 90+, 2001 was 85+ and 2011 was 95+. According to the 2011 Scottish female period life table, over 45 percent of women survived to ages older than 85 (Human Mortality Database 2018) . Given the likely differences in survivorship by deprivation quintile, using an open-ended age interval of 85+ risked introducing biases in lifespan variation according to the proportions surviving to age 85. Although a mortality rate for the entire population of Scotland was available from the Human Mortality Database (HMD) up to an open-ended age interval of 110+ this could not directly be used to derive any information on socioeconomic deprivation. Instead we used the HMD smoothing method, a Kannisto logistic model, to extrapolate mortality rates to age 110+ for each year, sex, and quintile separately. We report results using an open age category of 110+. Specifically, we apply equations 64 and 65 from the HMD Methods Protocol version 6 (Wilmoth et al. 2017), but modified to use information from ages 75+ rather than 80+.

Measures of lifespan variation

We measure inequality in age at death using $e_x^\dagger$. This is the weighted average of remaining life expectancy at each age, weighted by the number of lifetable deaths at each age. It has an intuitive public health interpretation: the average number of years remaining at death and measures life years lost when a death occurs (Vaupel and Canudas Romo 2003). The high correlation between alternative indices of lifespan inequality suggests that the overall conclusions would not have

changed had an alternative measure been used (Németh 2017; van Raalte and Caswell 2013; Vaupel et al. 2011; Wilmoth and Horiuchi 1999).

Preliminary descriptive results

Figure 1 shows remaining life expectancy for ages >50 to 110+ plotted against disparity in age at death for ages>50 to 110+. It compares the most and least deprived quintile in 1981 and 2011. Three ages are highlighted: 50, 65 and 75.

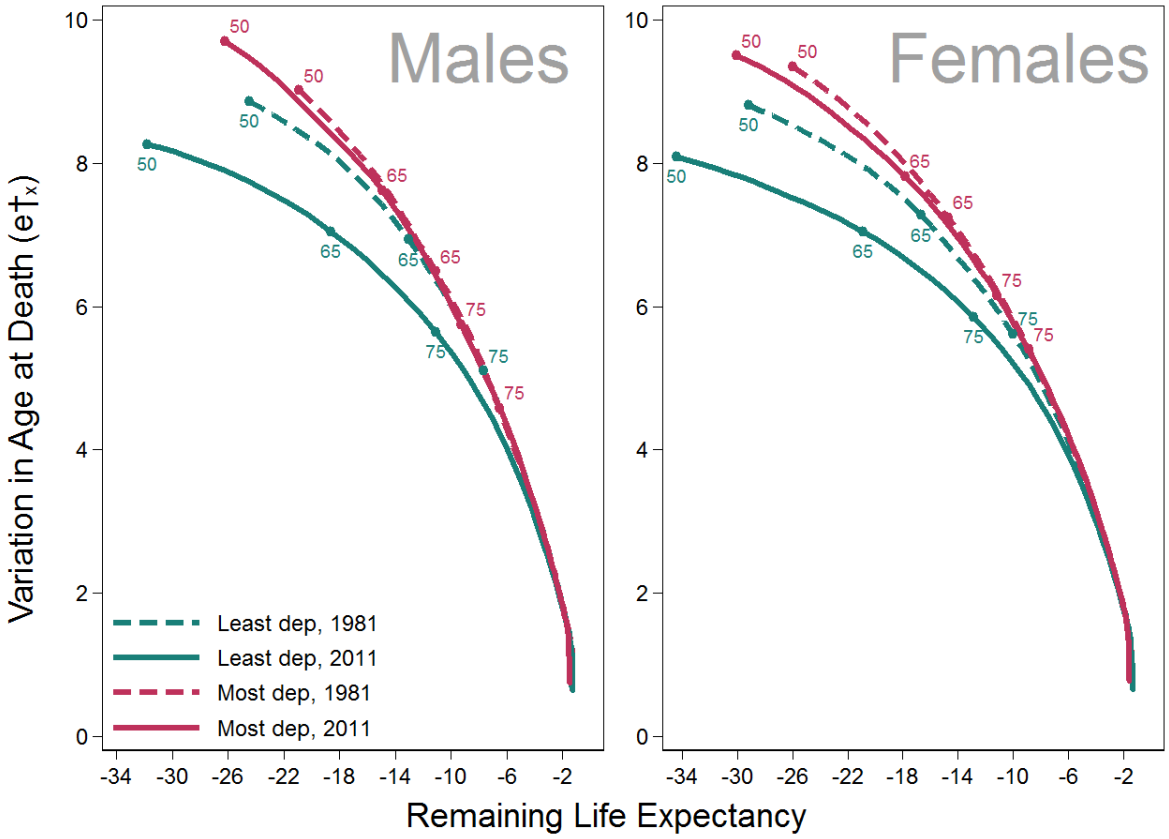

Figure 1 Relationship between remaining life expectancy and variation in age at death conditional upon survival to ages >50, for most and least deprived quintile.

The overall patterns for males and females are similar but females have slightly higher remaining life expectancy and slightly lower variation in age at death. The most striking finding in this figure is the change between 1981 and 2011 for the least deprived quintile that is not present for the most deprived quintile. Between 1981 and 2011, we see that remaining life expectancy for the least deprived quintile has increased more than for the most deprived. Variation has decreased for those age 50 from the least deprived, stayed constant for those age 65 and has slightly increased for those age 75. This generally indicates increased longevity and decreasing inequality between individuals for the least deprived. This is in contrast to the least deprived where variation in 2011 is consistently higher across all ages than it was in 1981.

Discussion

Our initial results show that that ageing is an unequal process between socioeconomic groups *and* within socioeconomic groups. Life expectancy has increased for older ages across all socioeconomic groups but within in the context of higher absolute life expectancy and greater relative gains for the least deprived. Variation does not show the same systematic gains. Variation in age at death has increased at older ages for the most deprived but stayed fairly constant for the least deprived. This means that older individuals from the most deprived quintile experience increasing uncertainty in age at death. This finding builds upon an earlier study which showed a small expansion of life span inequalities among older ages at the national level (Engelman et al. 2010) but we demonstrate that this expansion of inequalities to be greater in magnitude for the most deprived in Scotland.

Variation partly reflects the fact that survival improvements at older ages have risen (Rau et al. 2008; Wilmoth et al. 2000). Whether improved survival at extreme old age is positive or negative attribute of population health depends on whether additional life years are lived in good or bad health. Engelman et al. (2010) argue that the mortality composition of a population may be changed and health disparities delayed to older ages if increased survival rates result in a more diverse population and an increasing number of frail members of the population. Societies need to meet the needs of an ageing population and measuring variation inequalities can help to inform social policies. For example, increasing variation has implications at the individual and at the societal level in terms of increased uncertainty surrounding pension planning and healthcare needs (van Raalte et al. 2014). Our study indicates that increased uncertainty is burdened by the most vulnerable older individuals who may be at greater risk of pension poverty. This is a particular concern in Scotland where pensioner poverty is higher than the UK average (Social Meterics Commission 2018). Increasing variation in age at death has implications for estimating the level of resources an ageing population will likely need and reveals inequalities that are hidden behind average life expectancy.

Research outlook

The next steps of this project will decompose life expectancy and lifespan variation into the age and cause specific contributions using a method of continuous change (Horiuchi, Wilmoth and Pletcher 2008). We will carry out the following decompositions (i) the change in life expectancy for the most and for the least deprived quintile (ii) the change in lifespan variation for the most and for the least deprived quintile (iii) the life expectancy gap between the most and the least deprived quintile and (iv) the lifespan variation gap between the most and least deprived quintile. This will help to better understand the reasons why we find life expectancy and lifespan variation inequalities at older ages.

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