The Geography of a rapid rise in elderly mortality in England and Wales, 2014-15

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Abstract

Since at least the early 1900s almost all affluent nations in the world have continually experienced improvements in human longevity. Using ONS mid-year population and deaths estimates for Local Authorities for England and Wales, we show that these improvements have recently reversed. We estimate that in England and Wales there were 39,074 more deaths in the year to July 2015 as compared to the year to July 2014 (32,208 of these were of individuals aged 80+). We demonstrate that these increases occurred almost everywhere geographically; in poor and affluent areas, in rural and urban areas. The implications of our findings are profound given what has come before them, combined with the current political climate of austerity.

Keywords

England and Wales; mortality; health geography; epidemiology; elderly.

Highlights

- 2015 saw rising mortality rates for all ages but especially the elderly
- We estimate an additional 39,074 deaths compared to the year before
- There is little geographical pattern to the relative changes in mortality rates
- Few explanations we tested seem to explain these increases

Introduction

One of the great successes globally since the early 1900s has been the continued improvement of human longevity (Oeppen & Vaupel 2002; Leon 2011). For example, life expectancy at birth in England and Wales has increased by 28 years over the last 100 years (i.e. from 51 in 1910/12 to 79 in 2010/12) (ONS 2014). Developed countries passed through the epidemiological transition where their disease profiles moved away from the majority of deaths being due to infectious diseases towards chronic illnesses being the most likely precursor to mortality (Omran 1971). While medical improvements have helped to treat ill health and disease, improvements in population health have been largely driven by better sanitation, education and general rising standards of living (Woolf et al. 2007). As a result, age-specific mortality rates have been falling consistently throughout the 20th Century and beyond in all affluent countries (Minton et al. 2013).

The 2008 Great Recession saw worldwide economic decline on a scale not observed in the UK (and many other countries) since the Great Depression that began in 1929. Many governments (including that of the UK) responded by cutting the size of the state under the assumption that lower public expenditure would lower public debt, leading to lower taxation (especially corporation tax) and hence increase economic growth. Other countries such as Finland, France, Denmark, Norway, Sweden and Japan increased the proportion of their GDP spent on public services to mitigate the effects of GDP falling (see Figure 2 in Author 2016). The resulting changes to society in those countries that chose to cut public spending the most were all encompassing, affecting everyone (although some more than others). The only country to cut spending more than the UK was Ireland which consequently again experienced high rates of emigration (Dorling 2016a). While primarily it has been the

services mainly used by poorer individuals that were cut most severely, wider cuts to the NHS (Dunn et al. 2016) and adult social care (ADASS 2016) have broader impacts which may negatively impact on population health.

The current evidence base on what the impact the 2008 Great Recession and subsequent period of austerity has had on population health is very small (this is partly due to the recent nature of the event, and possibly also because many health outcomes develop over long time periods). However, there is now a growing consensus that austerity is having a negative impact on both physical and mental health (Barr et al. 2012; Barr et al. 2015; Barr et al. 2016; Moffatt et al. 2015), particularly on elderly mortality (Loopstra et al. 2016). There have also been other associated issues which may indirectly impact on health including increases in food bank utilisation (Author & Author 2015) and homelessness (Loopstra et al. 2015). Similar observations of the negative effects of recession and austerity policies on health have also been shown during other periods of economic downturn (Stuckler et al., 2009a; 2009b).

Given the widespread societal change, what does the geography of mortality look like in this new austerity society? In our study, we present evidence that longstanding mortality rate declines reversed between 2014 and 2015 particularly in the elderly (but also for most age groups). We explore how these changes have occurred geographically, as well as examine possible correlates of these changes. To date there is only one other published study that has examined the impact of cuts to income support and pensioner credits on old age mortality in the years up to 2013 (Loopstra et al. 2016). As yet no papers have been published on the further and faster rise in mortality that took place in 2015.

Methodology

We used mid-year population estimates data for England and Wales from the Office for National Statistics (ONS)[1]. Annual data on mid-year (data for 1st July to 30th June) population estimates for Local Authorities[2] are provided (n = 348, mean population size in 2015 was 166,337), and the dataset includes death counts as well. Data are supplied by sex and ages in single years (5 year age bands were used to minimise small number issues). We focus mostly on old age mortality for the age bands 80-84, 85-89 and 90+ because at these ages mortality rates are greatest (i.e. patterns are less likely to influenced by chance), as is their dependence on health and social care services due to the risky burden of morbidity that inevitably comes with age. We calculate age-specific rates by sex for Local Authorities by year. To measure the relative change between years, we calculate the rate ratio (i.e. divide the two mortality rates – the more recent one by the later one). Age-specific rates were adjusted using the single year of age data to account for any potential age-aggregation bias (i.e. adjusting rates based on differences in individual age composition rather than just calculating the overall 5 year age band mortality rate). This was important to account for whether differences between years were the result of differences in the composition of age bands or cohort effects[3] (Gelman & Auerbach 2016). Data for 2015 were not available for

[1] Data are available here: https://www.ons.gov.uk/file?uri=/peoplepopulationandcommunity/populationandmigration/populationestimates/datasets/populationestimatesforukenglandandwalesscotlandandnorthernireland/mid2015/ukmye2015.zip

[2] We refer to all 'London Boroughs', 'Districts' and 'Unitary Authorities' collectively as Local Authorities since this is how they are referred to by the ONS as a collective set of areas.

[3] Using the non-adjusted age-specific rates did not alter the findings, suggesting that age-aggregation bias was not an important factor.

Scotland at a local level, although it has been reported elsewhere that national patterns were similar (ONS 2016b; Dorling 2016c).

We defined six categories based on the numbers of age groups involved and the size on the increases in mortality rates. These six categories were arbitrarily defined, but were defined before we saw what they revealed based on cut-offs automatically provided by the software used. The results were so interesting that we have simply used these, and additional analyses presented in the Appendix suggest that other combinations would have produced similar results. Note that a rise of 6.5% is one extra death for every 15 that usually occur and a rise of 15% is one extra death for just under every 7 that normally occur. Our categorisation divided up areas into the following hierarchical groups (i.e. areas belonged to only one category based on the 'severity' of their changes):

1. Three or more sex-specific age groups with a rate ratio of greater than 15%
2. Two sex-specific age groups with a rate ratio of greater than 15%
3. Three or more sex-specific age groups with a rate ratio in greater than 6.5%
4. Two sex-specific age groups with a rate ratio in greater than 6.5%
5. One sex-specific age group with a rate ratio in greater than 6.5%
6. None of the above.

Two explanatory factors for the relative changes in mortality were considered. The mid-year population estimates also included internal and international migration flow data by sex and five year age band. We compared these measures to the rate ratios to examine whether migratory patterns may help to explain changes in Local Authorities (i.e. the inflow of older unhealthy migrants returning from abroad). There is limited migration of these age groups, so we hypothesise that it is unlikely to explain any patterns. We also used the English Indices

of Multiple Deprivation (IMD) 2015 Local Authority summary statistics to examine whether the changes varied in areas with different levels of deprivation (n = 326). We do not include the Welsh Local Authorities (n = 22) in our analysis of deprivation since their multiple deprivation measure is different.

We used Geographic Information Systems (GIS) to visualise the spatial distribution of the rate ratio. Two types of maps are used to visualise our data: standard equal area maps that are geographically correct, and cartograms whereby the size of areas are adjusted in relation to their population size whilst also maintaining topology (Tobler 2004). Both approaches present different geographies – one dictated by space, the other by people. Rate ratios were divided into quantiles based on all sex-specific age band values to allow for fairer comparisons when plotted together. Our geographical analysis was supplemented through calculating the Moran's *I* coefficient (Moran 1950) which measures the extent of spatial autocorrelation (i.e. how spatially clustered the data are) to give us a formal measure of the existence of geographical patterns. Queen contiguity (order = 1) was used to define the spatial structure of the data (i.e. compare Local Authorities with all surrounding areas that share a common boundary in any direction). We also examine the association of the rate ratio variables to our explanatory factors using Pearson's correlation coefficient. A paired sample t-test was used to test whether mortality rates between years were significantly different. Analyses were undertaken using QGIS, GeoDa, R and Microsoft Excel.

Results

Relative changes in mortality rates in England and Wales, 2014-15

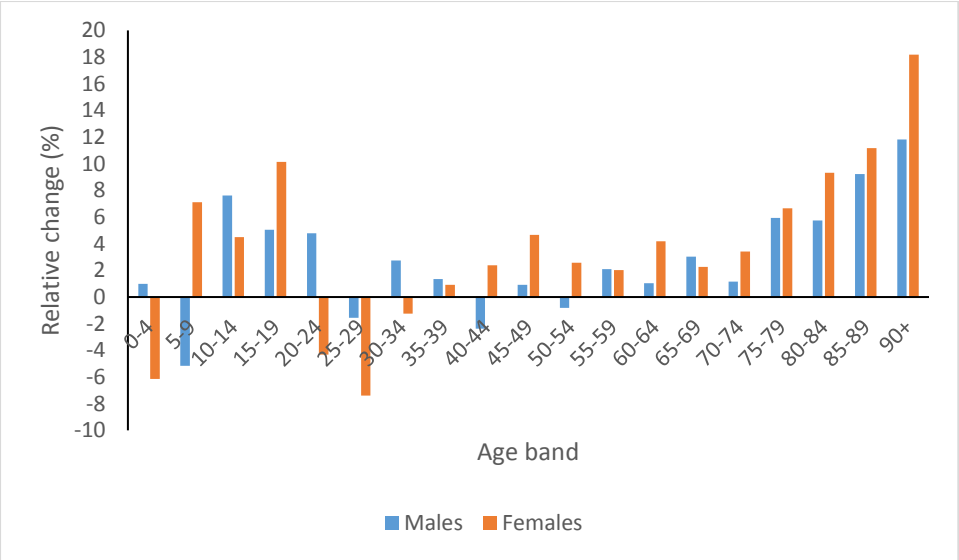

Figure 1: Relative change of mortality rates by sex and 5 year age band for England and Wales, 2014-15.

Figure 1 presents the relative change (rate ratio) of mortality rates by age band and sex for England and Wales (2014-15). Deaths rose by 11.8% and 18.2% for males and females respectively who had survived to age 90; by 9.2% and 11.2% for those aged 85-89; and 5.7% and 9.3% for those aged 80-84. We estimate that if 2015 mortality rates had remained the same as 2014 rates, then we would have seen 39,074 fewer deaths in 2015. The majority of these excess deaths were above the age of 80 (an additional 32,208 deaths, equivalent to 82.4% of all additional deaths).

Whilst the relative change in mortality rates increased with age, not all age groups saw increases. There were falls for infants and in adults aged 25-29. These falls reflect patterns observed elsewhere such as declining car use (i.e. driving has become less affordable) during the period of austerity which may be having a positive effect on some aspects of population

health (Stuckler et al. 2011; Minton et al. 2016). Furthermore the age 25-29 age group had the highest net international in-migration in the year to July 2015 of over 60,000 additional young and presumably very healthy people coming into England and Wales, mostly from the rest of the EU.

When both relative risk and baseline mortality risk are considered together, the effects of rising mortality risks are greatest in people above retirement age, rising monotonically (females) or near monotonically (males) with age after the age of 65. The relative change in mortality rates was also higher for females for most ages (particularly the age group 90+). However older men's mortality rates had been declining faster than older women's in the decade before 2010, partly due to the later take up of smoking among females (Pampel 2005).

A paired sample t-test of differences in mortality rates for 2014 and 2015 data across Local Authorities demonstrated that mortality rates in 2015 were significantly greater than 2014 at the $p < 0.001$ level for males and females aged 80-84, 85-89 and 90+ suggesting that it is appropriate to explore relative changes.

Figure 2: The relative change (rate ratio) in mortality rates by sex and age band for England and Wales, 2014-15

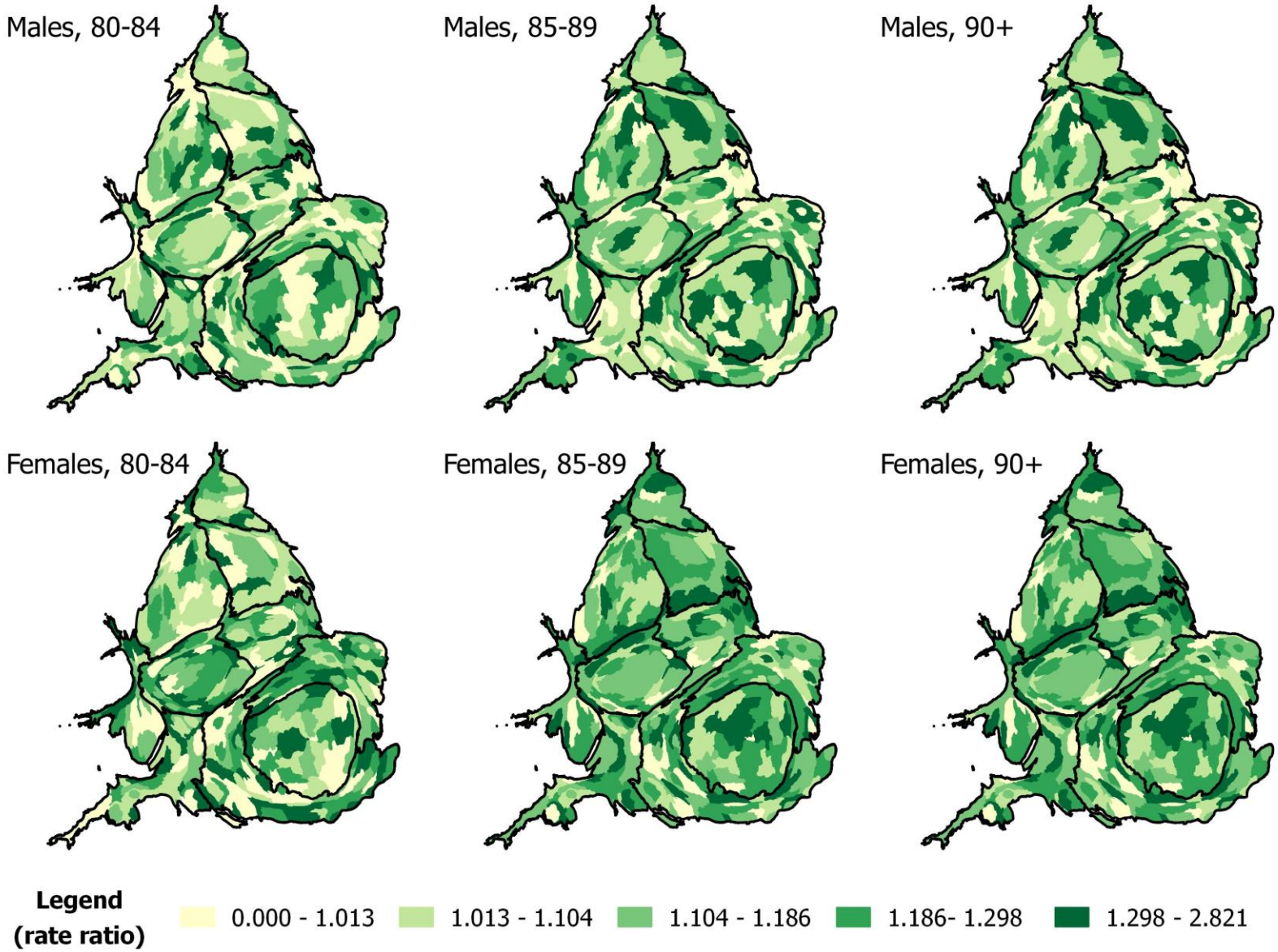

Figure 3: The relative change (rate ratio) in mortality rates by sex and age band for England and Wales, 2014-15 (visualised using cartograms)

Figures 2 and 3 present standard equal area projection choropleth and cartogram (equal population) choropleth maps, respectively, all of the relative change stratified by age band and sex. Whilst not all Local Authorities have experienced increasing mortality rates, most have in at least one of the maps shown in these two figures. There is no spatial patterning to the rises; all types of Local Authorities appear to have experienced this phenomenon. The lack of any spatial patterning was supported by the Moran's *I* values, presented in Table 1, demonstrating little evidence of spatial autocorrelation, as well as by exploring the correlation between male and female values by age band (Table 2) and the correlation between age bands within sex (Table 3). Our results show weak to no correlation across our measures, and so no obvious geographical explanation for these rises. This is in great contrast, say, to the rises observed in the late 1960s in England and Wales, which was caused by an influenza epidemic, and spatially patterned accordingly (Hunter & Young 1971).

Table 1: Moran's *I* values for each sex and age group rate ratio.

	Rate ratio (males)			Rate ratio (females)		
	80-84	85-89	90+	80-84	85-89	90+
Moran's *I*	0.042	0.021	-0.003	0.001	-0.024	-0.022

Table 2: Correlation between male and female age-specific rate ratio values.

Age band	Correlation between male and female rate ratios
80-84	0.157
85-89	0.148
90+	0.129

Table 3: Correlation between age-specific rate ratio values within sex.

	Females			Males		
	80-84	85-89	90+	80-84	85-89	90+
80-84	1			1		
85-89	0.021	1		0.193	1	
90+	-0.003	0.011	1	0.122	0.064	1

We also analysed the association of these changes to our explanatory factors (Table 4). For each of our measures, we only find weak correlations suggesting that these relative changes in mortality rates were unrelated to migratory patterns or deprivation. We also examined other Local Authority summary measures of IMD, however they did not alter the findings (results not shown).

Table 4: Level of correlation of explanatory factors to the rate ratio change.

Variable	Rate ratio (males)			Rate ratio (females)		
	80-84	85-89	90+	80-84	85-89	90+
Net internal migration of age group	0.017	-0.037	-0.146	0.020	-0.025	-0.032
Net international migration of age group	0.019	-0.021	0.081	-0.026	-0.040	0.065
Mean deprivation score in Local Authority	-0.031	0.009	0.106	-0.024	0.006	0.087

Trends in relative changes of mortality rates for England and Wales, 2003-15

Each of our sex-specific age band measures were summarised in Figure 4 to explore the overall extent of the relative mortality changes. We also calculated the measure for relative changes between 2013 and 2014. Once again there is no spatial patterning to be seen in either the equal area maps or equal population cartograms. It is clear that what has happened has occurred everywhere. The main difference between the maps over time is the sudden change in the experiences of almost all Local Authorities by 2015. In 2013-14, 4.3% of Local Authorities were categorised in the top group ('3+ subgroups with relative

changes 15%+') compared to 60.9% in 2014-15. In 2013-14, 27.9% were on the bottom category ('None of the categories') whereas in 2014-15 there was only one Local Authority (the 'City of London') in this category. We did find evidence of negative correlation for values between years (Table 5). Local Authorities with higher rate ratios in 2013-14 were associated with lower rate ratios in 2014-15. In other words it is possible that in those areas where many frail elderly people did survive through the year to July 2014, fewer then survived in 2015. The year to July 2014 was not a good year for mortality, but it was not unusually bad. The year to July 2015 was exceptionally bad and the early years (2012 and 2013) were also very poor for mortality among the elderly, but not as devastating as 2015 was. Before this period mortality had almost always falling among the old in England and Wales, decade after decade (ONS 2015a; 2015b).

Table 5: Correlation between the age-specific rate ratios for 2013-14 and 2014-15.

Age Band	Males	Females
80-84	-0.290	-0.201
85-89	-0.243	-0.403
90+	-0.457	-0.517

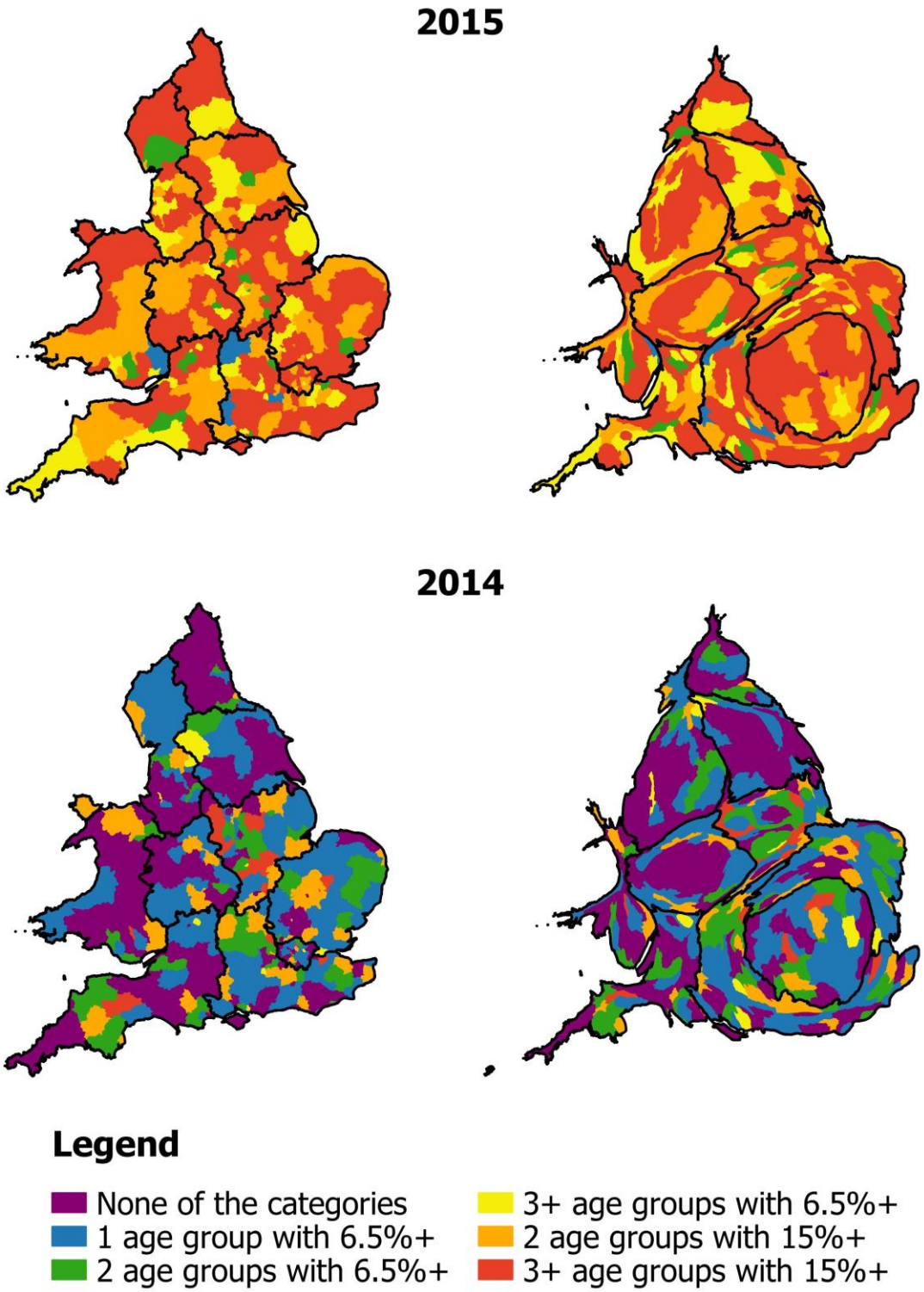

Figure 4: Categorising the extent of relative mortality changes in England and Wales, 2013-14 and 2014-15

We extended our categories back to 2003 and present the prevalence of each category in Figure 5. It is clear that the 2014 period was an outlier with a lower relative changed compared to previous years (in other words, 'things' did not get much worse in 2014). This will have contributed slightly to the large relative change in mortality rates in 2015, as it may be that people who did not die in 2014 were dying (more often than is usual) a year later. However, Figure 5 still shows that the changes observed in 2015 were of a higher magnitude compared to earlier trends (e.g. the mean percentage of areas with '3+ age groups with 15%+' prior to 2014 was 16.5%). Ignoring 2014, the highest category has grown annually since 2010, the period characterised by austerity. Similar trends have been reported in self-reported health amongst the whole population since 2010 (Dorling & Thomas 2016). This would suggest that 2015 was an exceptional year compared to what has come before it.

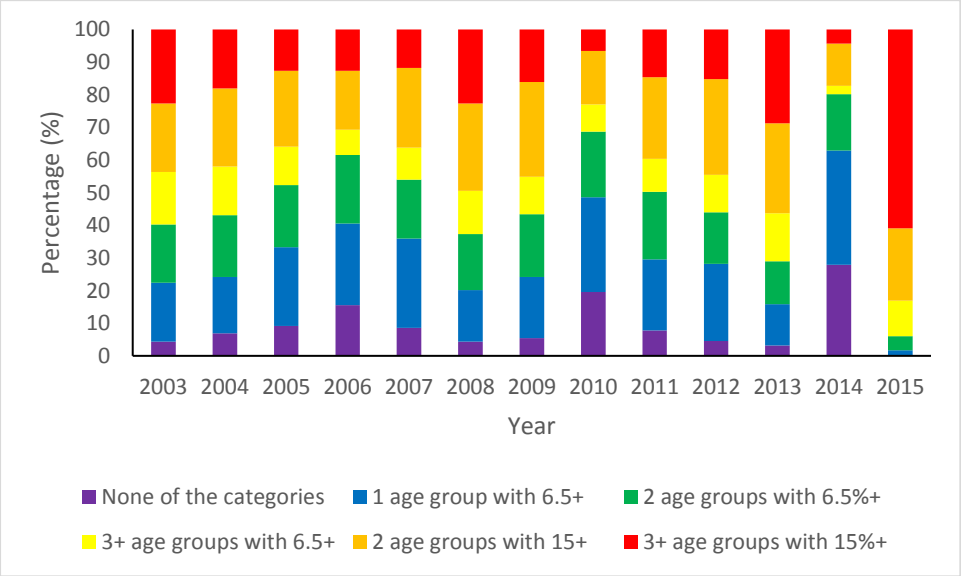

Figure 5: Relative changes in mortality rates of Local Authorities in England and Wales, 2003-2015.

Discussion

In England and Wales there were 39,074 more deaths in the year up to July 2015 as compared to year up to July 2014. The size of the rise was almost directly proportional to age in people above retirement age – the older (and thus frailer) an age group was, the greater the proportional rise in mortality was for that group. The geography of this change in mortality rates appears consistent across space – the effects are being felt everywhere; affluent and deprived areas, urban and rural regions, the North and South. The size, scale and lack of geography of these changes in 2015 (particularly in comparison to previous years) suggests that something wider is occurring at the population level.

England & Wales are not alone in seeing increased mortality risks in 2015. Increases have also reported in Scotland (ONS 2016b), USA (CDC 2016), France (National Institute of Statistics and Economic Studies 2016), Spain (Instituto Nacional de Estadistica 2016), Denmark (Statistics Denmark 2016) and Switzerland (Swiss Statistics 2016). Life expectancy declined for the first time since 1993 in the US (Xu et al., 2016), and while it only just improved in the UK in the most recent years data (ONS 2016c) preliminary analyses suggest that some Local Authorities have witnessed declines in life expectancy (Harrison 2016). It would appear that increases in mortality rates have occurred in more than on country worldwide, during a period of global economic recession but with different economic responses to that recession in different countries. Despite the similar experiences of the UK and USA to austerity, the level of increase in England & Wales seems particularly high and is only comparable to those that took place in Scotland that are higher still than in England and Wales (Dorling 2016c).

So what are the possible explanations for such a distinct reversal in mortality rates? It is possible that the effect size is random – mortality rates jump around from year to year – but typically they have continued to fall year on year with the rate of the fall itself changing. The difference between 2014 and 2015 was larger than any previously seen for at least four decades. Mortality rates have not spiked as much since the 1951 and 1968 influenza epidemics[4], and each epidemic displayed a distinct geography unlike the patterns we observe in 2015 (Hunter & Young 1971). Influenza also increases deaths in a few weeks rather than over many months (Fleming & Elliot 2008). It is true that mortality rates for respiratory causes increased in 2015 (ONS 2016a). Whilst 2015 experienced a flu virus strain that had greater prevalence in the elderly, levels were described by Public Health England as 'moderate' suggesting it is not the sole or even a substantial cause of the most recent rise in deaths among the elderly in England and Wales (Public Health England 2015). Prior to the two flu epidemics, we have not seen relative increases in mortality rates this large since the World Wars. The size of the change suggests that it is not random fluctuations.

The ONS attributes the increase in old age mortality rates to increases in deaths due to Dementias and Alzheimer's disease (particularly in comparison to other causes of death) (ONS 2016b). Exploring whether the geography of the relative change in Dementias and Alzheimer's disease match the geography we report will be necessary to understand why these increases have occurred. However, this explanation is confounded by efforts by the Department of Health to increase the diagnoses of these conditions (Department of Health 2015; ONS 2016b). The increase in these deaths may be capturing better diagnoses, as opposed to a wider population phenomenon, which may explain the increase in mortality

[4] The increase in mortality rates in both 1951 and 1968 was still lower than that witnessed in 2015.

rates for these causes. What we also need to ask is why people suffering from these two conditions are dying in greater number than before and not surviving for as long as they had been before. Could there be rising problems in social care and with the NHS itself providing crisis care? This would correspond with recently released statistics showing increases in delays discharging patients due to Local Authorities unable to provide care (NHS England 2016), as well as funding shortfalls in adult social care (ADASS 2016).

An alternative explanation may be that we are starting to see the effects of an ageing population. It is plausible that social and medical progress has prolonged the lives individuals who would have otherwise died earlier, and the jump in mortality rates are these individuals now reaching a point where further survival is harder to sustain. We may also be starting to see a plateau of potential human longevity (Oeppen & Vaupel 2002). However, many other affluent countries have far higher life expectancies than the UK does, and the UK has been falling in the international rankings in recent decades (Leon 2011). The explanation, that we are seeing a growing elderly cohort being prolonged into very old age, would also feed into the increase in Dementias and Alzheimer's disease. Whilst the largest increases in mortality rates have been experienced in the oldest age groups, Figure 1 demonstrates that most age bands have seen increasing mortality rates suggesting that it is not just an increase in very elderly people. Furthermore, if this was the case then we would have expected a gradual increase in the trend as opposed a sudden jump across each of our age bands. We also adjust our estimates for age to account for any compositional changes in the average age within strata (Gelman & Auerbach 2016). It is also worth mentioning that following the deaths of the vast majority of people born in the baby boom year of 1919 there was a slight reduction in the number of very elderly people living in England and Wales. The next boom year was 1946, and that cohort only turned 70 in 2016 so as yet the

UK has not seen a very large rise in its population aged over 80. This is partly due to how few births there were between 1920 and 1945.

The most prominent societal shift in England and Wales, coincident with the rises we report and map in this paper, has been the governmental shift towards austerity. Evidence is beginning to emerge on the impact austerity is having on health (Barr et al. 2015; Barr et al. 2016; Moffatt et al. 2015) particularly elderly mortality (Loopstra et al. 2016). There have been pronounced increases in NHS trusts with deficits since 2014/15 (Dunn et al. 2016), as well as funding crises in adult social care (ADASS 2016). We think that it is likely that the rises in death rates are consequences of under-investment (possibly combined with mis-investment) in healthcare and social care in recent years, and in particular within the NHS. Longevity has been rising in the affluent world for over 100 years, and in most of the world for more than 50 (Oeppen & Vaupel 2002; Leon 2011), but with this rising longevity has come rising age-related multimorbidity (Atun 2015), leading to ever rising healthcare and social care costs (Huber & Orosz 2003). Where rising expenditure on healthcare and social care for elderly people falls short of rising need, increasing elderly mortality can be expected. The consistency in the geography of the increases in mortality rates suggests that any factors associated with their increase must be universal in their exposure to the population.

Even individuals who are not directly affected may be indirectly impacted through stress and anxiety of the wider political system. Smaller changes to social provisions (e.g. bus services being cut, 'chit and chat' groups disappearing, libraries being shut) may accumulate in their 'burden'. Such changes have occurred everywhere. Given that the whole of Europe has experienced austerity to some degree, it would appear to be a consistent (geographical)

factor that could explain the increases in mortality rates both across England and Wales, as well as worldwide. Furthermore we must consider wider explanations. Austerity has mainly hit the young and poor. This includes people who work in old age homes who may now also have to take a second job, say, driving taxis at night. Could we be seeing the effects of austerity on one age group – the young – having its most obviously impact on another age group – the old? When the old become frail a 'triple-lock' on their pensions could be of very little protection when they become increasingly reliant on social services that are also being cut away. The effects do not have to be direct, but could be psychological through worrying about the situation as well (Matthews & Gallo 2011). However, Figure 1 demonstrates that it was not just the frail elderly though who are experiencing increasing mortality rates.

The move to an austere society appears to have had a relatively quick and unambiguous effect on mortality in the elderly in England and Wales, but the overall effects on health for younger people may be lagged, and may take decades to be properly understood (e.g. see Author et al. 2016b). Immediately following the Great Recession, suicide rates in the UK rose (Barr et al. 2012); a similar rise in suicides in the USA, for middle-aged White Non-Hispanics was observed following the 2008 recession (Case & Deaton 2015; Minton et al. 2016), but the same data also revealed sharp falls in vehicle related deaths in young adults of all ethnicities, and falls in rates of violent death in Black males (Minton et al. 2016). The slight falls in mortality rates we identified for both young adults and young children, along with evidence that road injuries fell from 10th to 16th place as a leading cause of years of life lost (YLL) in England from 2008 to 2013 (Newton et al. 2015)[5], suggests that in the short run, austere societies can reduce rather than increase mortality risks at some ages (Stuckler et al.

[5] This is likely to be partly due to individuals taking fewer trips (or unable to afford a vehicle), as well as fewer heavy goods vehicles on the road (as seen in Greece).

2011; Minton et al. 2016). However, recent research on suicide trends in Scotland suggests that the mortality effects of socioeconomic change may, in the UK rather than the USA, be largely cohort rather than period effects, disproportionately affecting working age males from more socioeconomically deprived areas who first entered the labour market after the wide-reaching reforms of the Thatcher government had been enacted (Parkinson et al. 2016).

Population level trends in mortality usually respond to societal changes slowly since their causes often take a long time to take effect (Musterd et al. 2012). Similar lag effects during this period have been witnessed with food bank usage (Lambie-Mumford & Green 2015) and homelessness (Loopstra et al. 2015). The UK has been experiencing declining self-reported health and well-being since 2010, so it may be less of a surprise that trends in actual health are beginning to change (Dorling & Thomas 2016).

One criticism of our austerity interpretation would be the lack of geography to the relative changes. The scale of austerity varied socially and geographically, therefore we may have expected the geography of mortality to follow, suggesting that austerity may not be the driver. The Local Authorities with the largest amounts of cuts tended to be poor and have small elderly populations (Loopstra et al. 2016; Dorling 2016b). All Local Authorities have experienced cuts to social care and even low amounts of cuts could have had damaging results. Given the similarities in experiences worldwide, the austerity argument does seem plausible since it is common to each country despite differing contexts. Only through rigorous investigation as newer data are released will we be able to truly understand whether this is the case.

There are several limitations to our study. Our observations are only based on changes in mortality rates in a single year of data and therefore the importance of our findings will only become clear once future years of data have occurred (important as mortality rates are often presented as three- or five-year averages). Recently released data on absolute numbers of deaths suggest that 2016 continued with high levels of mortality as well suggesting that 2015 was not a 'one-off' event (ONS 2016d). Even if 2017 sees falls in elderly mortality rates, this may not be due to an improvement in healthcare and social care services, but due to the higher mortality in 2015 and 2016 being of sufficient scale to change the underlying composition of the elderly population if additional deaths occurred disproportionately amongst the most frail within each age group. Our analyses are fairly descriptive and are limited in their ability to explore and explain the underlying causes of the increasing mortality rates. Future research will need to examine additional factors associated with the increase in mortality rates, and testing whether changes in cuts to income support and/or pensioner credit are associated with changes in mortality rates will help evaluate whether austerity is a contributory factor in explaining the phenomenon. There were no publically data available on deaths by cause, limiting our ability to understand what causes were driving the increases in mortality rates by Local Authority. The scale of our analysis is the Local Authority level and this may hide some small level geographical patterns that might reveal more. Exploring the spatial distribution at smaller geographies will be key to helping us understand what factors are associated with these changes.

Conclusion

Separating out distinct causal factors to understand population level trends is almost always inherently difficult. Multiple forms of fiscal cut have occurred in the UK in recent years, each of which could have been an independent cause of harm. We offer possible explanations for our findings, although the truth is likely to lie somewhere in the middle of them. What is definite is that our findings demonstrate unprecedented changes in a time of no war, no great influenza epidemic, no freezing winter, and no cholera, with rising mortality rates amongst the elderly with no clear geographical pattern. Decades of progress in population health, with falling mortality rates becoming the norm, have been reversed, and the magnitude of this change suggests that 2015 is not an isolated event. The implications of these changes are profound given what has come before them, combined with the current political climate. England and Wales is experiencing a radical demographic change if such trends are sustained. Omran (1971) hypothesized that during the fourth stage of the demographic transition there would be severe fluctuations in mortality – is this now what we are set to experience ourselves?

What is especially troubling is that the marked rise does not appear to have been raised as unusual or picked up in the media.[6] The size and scale of the increase cannot be ignored. Mostly people who get to live to very old ages had quite a comfortable life. The majority of today's elderly were the middle class of a generation ago. If life for the elderly is getting worse, is this what we should expect for our own lives, for people who read and write papers in journals such as this? Are the elderly today merely the 'canaries in a coal mine'?

[6] The Office for National Statistics released the data at 10am on June 23rd 2016, the morning of the day of the EU referendum. There was no press release because of the vote.

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