How Should Population Ageing Be Measured?

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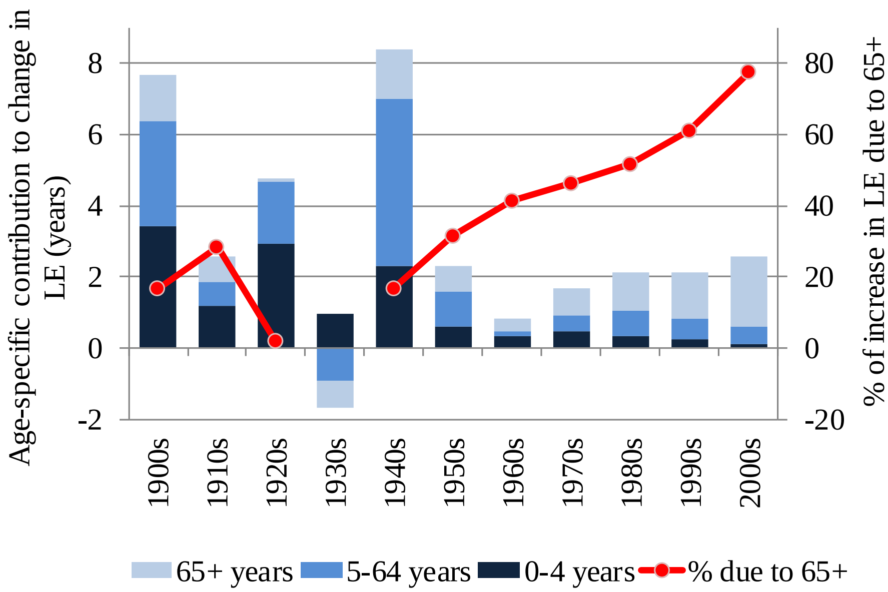
In 1950 people aged 65+ represented 1 in 12 of the European population. Today their share is 1 in 6. While declining fertility and infant mortality levels formed the basis for this growth from the end of the 19th century until WWII, for example through the defeat of child killing infectious diseases, since the 1970s falling old-age mortality has been an additional driving force (see Figure 1 for England and Wales). This 'population ageing' has worried policy makers because for every worker paying tax and national insurance there are more older citizens, with greater demands on social insurance, health and welfare systems and increasing volumes of morbidity and disability (Doyle et al. 2009; Dyer 2006; Polder et al. 2002; Wright 2002). However, the extent, speed and impact of population ageing have all been exaggerated because the standard indicator, the Old Age Dependency Ratio – does not take proper account of falling mortality, nor the population who sustains them. We therefore propose an indicator, the Real Elderly Dependency Ratio, that does both. Results show that old age-dependency turns out to have fallen substantially in industrialised countries over recent decades, and is likely stabilize close to its current level.

Background

The standard indicator of population ageing is the old-age dependency ratio (OADR). It takes the number of those who have reached the state pension age and divides it by the number of 'working age' (16-64 years) adults in order to measure the elderly population relative to those who pay for them. Despite the raising of the state pension age in many European countries, which will shift millions of people from 'old' to 'working age', the 'standard' OADR will still reach 47 elderly (65+) per 100 persons of working age (15-64) by 2050, almost double from today's ratio (http://esa.un.org/wpp/Excel-Data/population.htm) and hence policy makers' concern.

However, the OADR is not 'fit for purpose'. It counts neither the 'dependent' elderly nor those who sustain them. It merely takes a cut-off point (the state pension age) and assigns adults to the two sides of the ratio accordingly. This might be a useful rule of thumb if the relative size of these two age groups tracked the volume of old-age dependency, but it does not. An alternative measure that gives a more accurate and very different picture is therefore proposed here. The implications of this analysis are explored for public health, clinical practice and future demand for healthcare.

Fig. 1. Change in life expectancy (in years) between ten-year periods broken down by age groups. 1900-2010. England and Wales.



Data source and method used to calculate life expectancy: Human Mortality Database. www.mortality.org. Example of result: Life expectancy increased by 2.6 years between 2000 and 2010, 0.1 years of which came from improved infant and child survival and, respectively 0.5 and 2.0 years from lower mortality among 5-64 and ≥65 year olds.

Counting the 'dependent' elderly

Paradoxically, the main process that causes population ageing – declining old-age mortality – makes age a poor measure of its progress. When lifespans lengthen, any given age becomes a marker reached earlier along a lifecourse. For instance, in 1900 mean life expectancy for a 65 year old woman in England and Wales was 11 years. Today she could expect to live another 21 years (respectively 10 and 18 years for men). We can best capture this changing significance of age by realizing that the age of a population comprises two components: the *years lived* of its members (their ages) and their *years left* (their remaining life expectancies or RLE). In a period of lengthening lifespans, not only does the average age of the population increase, so too does the RLE associated with each age (Sanderson and Scherbov 2007). Its effects are substantial. The median age of the population did not climb above 25 until the start of the last century, since when it has risen to 40. Yet across this period, life expectancy at this rising median age *also* increased, so that while the median age of 24 in 1900 carried a life expectancy of 39 more years, 40 year olds in 2009 could expect to live a further 42 years. In aggregate terms, the population of 2009, despite being much 'older' as measured by *years lived*, was nevertheless 'younger' than that of 1900 in terms of *years left* for its members to enjoy. This is crucial, because many behaviours and attitudes (including those related to health) are more strongly linked to RLE than to age (Cocco and Gomes 2012; Hamermesh 1985; Post and Hanewald 2012; Van Solinge and Henkens 2010). Using both years lived and years left also helps remind us that populations and individuals are rather different things. Thus unlike an individual, populations can grow older (a rise in average years lived) *and* younger (a rise in average years left) at the same time: just what has been happening to the British population!

The OADR defines all people above the statutory pension age as 'dependent', regardless of their economic, social or medical circumstances. This overlooks the fact that rising RLE renders these elderly 'younger', healthier and fitter than their peers in earlier cohorts. Many have accumulated substantial assets. Currently over one million are still working, mostly part-time, many with valuable experience or specialist knowledge. The spending power of the 'grey pound' has risen inexorably. Many do volunteer work vital to the 'third sector' or look after grandchildren. We know that most acute medical care costs occur in the final months of life, with little impact from the age at which these months occur (Christensen et al. 2009; Sanderson and Scherbov 2010). At least some forms of disability are being postponed to later ages. Good data on population health by age is only available for the last decade, but RLE data is a robust substitute as it provides a more accurate picture of the extent of ageing by taking account of falling old-age mortality. Therefore, following Sanderson and Scherbov and others (Lutz et al. 2008a, b; Ryder 1975; Sanderson and Scherbov 2010, 2007; Basten et al. 2013; Lutz 2009) we use RLE of ≤ 15 years as the threshold of dependency, rather than a fixed age boundary, but do so for each sex separately.

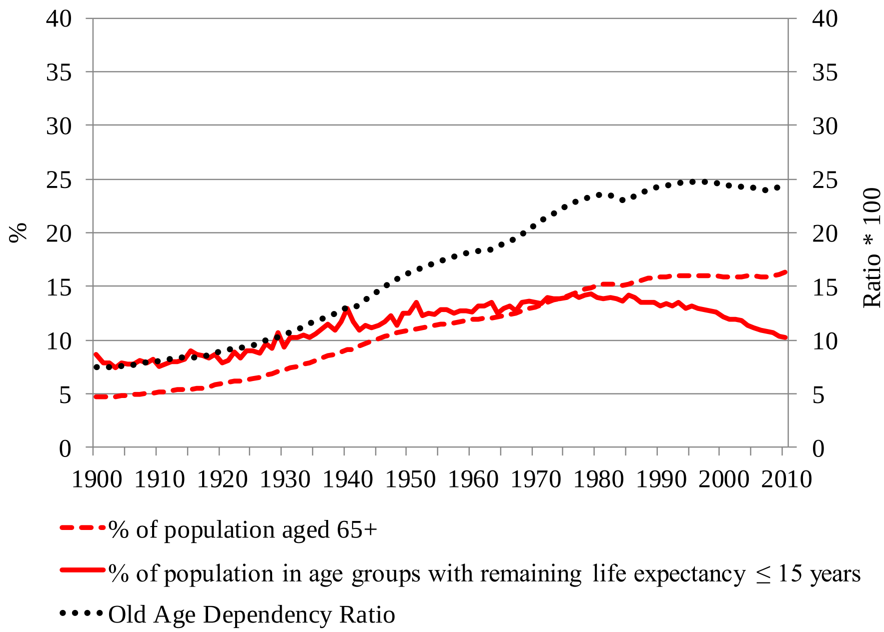
Counting the 'working' population

The OADR assumes that everyone of 'working age' actually works. However the knowledge economy keeps youngsters in education for longer while many older workers choose or are obliged to retire early. Meanwhile, greater gender equality and dual-career families have added millions of women workers to the labour market over the last 50 years. Using age to define the working population thus makes little sense. Indeed, in the case of Britain, if we count those not employed, for whatever reason, as dependent we find that there are more dependents of working age (9.5 million) than there are elderly who do not work. We therefore use the number actually employed, irrespective of age, for the denominator of what we call the Real Elderly Dependency Ratio (REDR; see appendix for detailed methods).

Results for England and Wales

According to the standard OADR, for every elderly aged 65+ there were 7-8 adults of working age (15-64) until about 1910 in England and Wales (Figure 2). The OADR subsequently increased almost linearly until about 1980 when there were just under four adults of working age for every elderly person. After a period of stagnation caused by the baby boom and the impact of immigration, the ratio started to increase again and now stands at 25%. This data underpins the population ageing debate, which typically concludes that the increasing burden of elder dependency will strain health and social care systems, limit the aspirations of universal health care and require raising the state pension age to limit the costs to the welfare state.

Fig. 2. Proportion of the population aged 65+, proportion of the population at ages with remaining life expectancy of ≤ 15 years, and the Old Age Dependency Ratio. England and Wales 1900-2011.

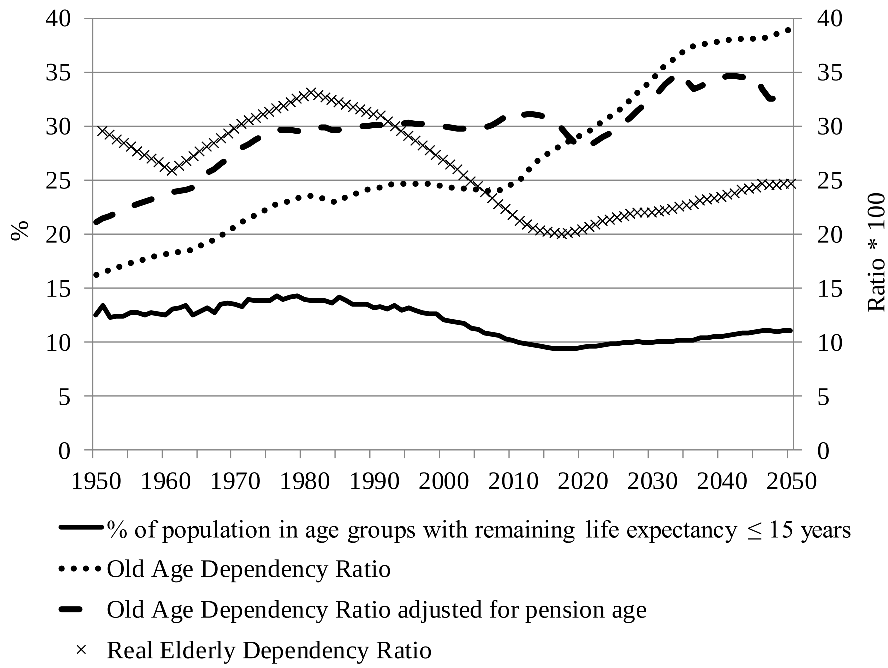


Source: Human Mortality Database. www.mortality.org. Meaning and definitions of each ageing indicator is provided in the Appendix. Authors' calculations.

However, if we define the 'dependent' elderly population as those with ages at which RLE is ≤15 years, we find a very different trend. Until well into the last century the proportion of those with RLE of ≤15 years to live was higher than those aged 65+, but from the late 1970s improvements to old-age mortality reversed the rise in the proportion of the population with low life expectancies, as Figure 2 shows.

We can now add in the trend in employment, where later entry to employment, and earlier exit from it, has been more than offset by the dramatic rise in *mothers* employment, so that the proportion of the entire population who are at work is similar now (48%) to what it was sixty years ago (46%) (www.ons.gov.uk). Putting these two series together we have the REDR. As Figure 3 shows, while the conventional OADR increases, the REDR has actually *fallen* by one-third over the last four decades. Looking into the future, the OADR will rise, even if we adjust for the planned changes in the state pension age (OADRp). However, REDR is set to decline further, stabilize for several years then gradually increase, although at no point through to 2050 will it regain the levels experienced for most of last century. Moreover our projection is a conservative one, since we have held employment rates constant over time, when they are likely to increase due to the raising of the State Pension Age, disincentives to early retirement and further progress on gender equality. It is thus probable that the REDR will stabilise near its current level.

Fig. 3. Old Age Dependency Ratios, proportion of the population at ages with remaining life expectancy of ≤ 15 years, and the Real Elderly Dependency Ratio. England and Wales 1950-2050.

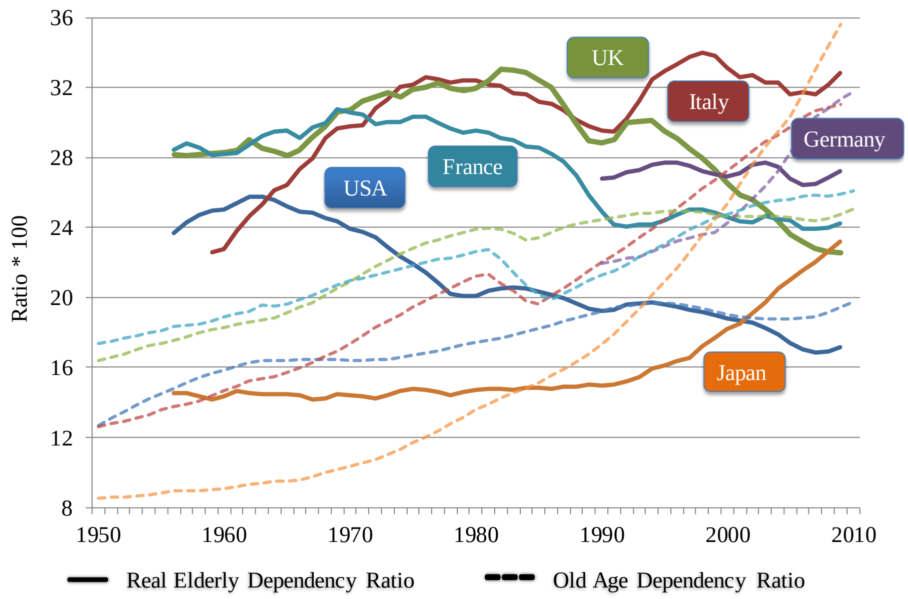


Source: Human Mortality Database. www.mortality.org; England & Wales Censuses; Office for National Statistics (www.ons.gov.uk). Meaning and definitions of each ageing indicator is provided in the Appendix. Authors' calculations.

International comparisons

Figure 4 shows how our new REDR measure and the conventional OADR compare over the last half century for several countries. While the OADR rises substantially everywhere, the REDR gives a more optimistic account of population ageing as moderate increases have only been observed for Italy and Japan. The experience of France and the US is broadly similar to that of the UK, save that in the US the steady decline in the REDR started earlier, owing to the timing and magnitude of the baby boom there. In Germany and Italy the REDR has been almost flat for two decades, due to slower growth in employment and low fertility. In all these countries immigration has played an important role in depressing the REDR compared to the OADR by raising employment rates. Conversely Japan, with relatively low fertility, immigration and female labour force participation, has seen its REDR rise rapidly. Latest available data shows that only the US had a lower REDR than the UK, but the UK is observing a faster the rate of decline.

Fig. 4. REDR and OADR, various countries, 1950-2010.



Source: Human Mortality Database (www.mortality.org); OECD.StatExtracts (http://stats.oecd.org). Authors' calculations.

Implications for health policy and practice

The very different story of population ageing told by our Real Elderly Dependency Ratio has several important implications for health policy and clinical practice. First, the OADR gives a false picture of both the level and trend in population ageing because it takes no account of rising life expectancies and changing employment rates. We have suggested an alternative as it should not be assumed that population ageing itself will strain health and social care systems. Demand for services will rise, but continue to be driven by other factors, chiefly progress in medical knowledge and technology, but also the increasing complexity of co-morbid age related conditions. However, as others have suggested, the economic costs of old-age dependency have typically been exaggerated and especially so in the UK (Bongaarts 2004; Mason et al. 2006). However this needs to be set against the insight that the last four decades have been ones in which the population, far from 'ageing' (as the OADR would suggest) has in fact been getting younger, with the rapid decline in the REDR producing a 'demographic dividend' of increasing numbers of people in work for every older person or child. How will services cope as this dividend declines?

Medical staff will need to stay alert to the changing relationship between 'old' and 'age' as old-age mortality rates continue to fall and the typical onset of senescence and its associated morbidities is delayed (Christensen et al. 2009; Rau et al. 2008; Vaupel 2010). Sixty may not quite be the new forty, but expectations formed by aspiring doctors and nurses in medical school about age and morbidity or the likely health status of older patients may become rapidly out of date.

More attention will need to be paid to the dynamic relationship between morbidity and remaining life expectancy. Age-specific disability rates appear to be falling (Crimmins 2004; Parker and Thorslund 2007; Schoeni et al. 2008; Christensen et al. 2009), yet recently born generations have a worse risk factor profile than older ones. For example, current obesity trends may have a major impact on public health through 'metabolic risk factor'-related diseases such as diabetes. Ageing-related diseases like osteoarthritis are predicted to increase and start at a younger age. This may not only result in an increased risk of cardiovascular and other chronic diseases, it also suggests that the ageing process can speed up as well as slow down, with obvious implications for public health policy.

We urgently need to understand the well-established positive association between education and health in the context of the expansion of tertiary education since the late 1960s. This is because it is yet unclear how far improvements in adult health has been a selection effect (i.e. those with more education were simply more likely to experience lower morbidity and mortality for other reasons, such as social class background) or an independent effect of education itself. If it was indeed the latter, we can expect a substantial 'education dividend' to improve mortality and morbidity rates in the decades to come. Should this occur, we could expect it to depress the REDR through its reduction of old-age mortality rates.

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Appendix

The following methods were used to calculate the different ageing indicators for Figures 2-4:

1. Proportion aged 65+: $\boldsymbol{Prop\ 65+} = \left(\frac{\boldsymbol{population\ 65+}}{total\ population}\right) * \mathbf{100}$

2. Proportion of the population with a Remaining Life Expectancy of 15 years or less (RLE15-).
   $\boldsymbol{Prop\ RLE15-} = \left(\frac{\sum_s \boldsymbol{population\ RLE15-}}{total\ population}\right) * \mathbf{100}$.
   For each sex *s* the age at which RLE15- is obtained from the life table. Given that this tends to fall between two ages, linear interpolation was applied to obtain the exact age. Subsequently, using population data by single age and sex the total population equal to and above this age is obtained (also through interpolation) and divided by the total population to give the proportion.

3. Conventional OADR: $\boldsymbol{OADR} = \left(\frac{\boldsymbol{population\ 65+}}{population\ 16-64}\right) * \mathbf{100}$

4. Pension-age adjusted OADR: $\boldsymbol{OADR}_p = \left(\frac{\sum_s \boldsymbol{population\ of\ legal\ retirement\ age\ or\ older}}{\sum_s population\ 16\ up\ to\ legal\ retirement\ age}\right) * \mathbf{100}$
   https://www.gov.uk/calculate-state-pension was used to estimate the population size of legal retirement age according to the recent and proposed changes in the legal pension age (which are different for men and women, which is why this was done for each sex separately).

5. Real Elderly Dependency Ratio: $\boldsymbol{REDR} = \left(\frac{\sum_s \boldsymbol{population\ RLE15-}}{population\ in\ paid\ employment}\right) * \mathbf{100}$