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# COHORT DIFFERENCES IN MORTALITY AND MORBIDITY

By Carol Jagger, Kaare Christensen and Michael Murphy

ABSTRACT

In 1900 life expectancy at birth in the UK was only 46 years for men and 53 years for women. Just over a century later life expectancy at birth has increased by around 30 years and by 2007 had reached 77.5 years for men and 81.7 years for women. The population aged 85 years and over, often termed the 'oldest old', are now the fastest growing section of our population. For the 1921 cohort only 18% of men and a third of women reached the age of 85 years but for the 1951 birth cohort it is expected that almost half of men and 60% of women will achieve that age. The important question for health care planners and society is whether the large number of those who will reach 85 years in the future are similar in health characteristics to those attaining 85 years now.

This question was addressed by substantive results and by methodological papers in the 'Cohort' theme of the Joining Forces on Mortality and Longevity conference in October 2009. Here we provide an overview of the papers, some of which are presented in full in this issue (see Murphy (2009), Di Cesare & Murphy (2009), O'Connell & Dunstan (2009), Forfar (2009)).

KEYWORDS

Cohort Study; Mortality; Disability; Disease

CONTACT ADDRESS

Carol Jagger, AXA Professor of Epidemiology of Ageing, Institute for Ageing and Health, Newcastle University, Campus for Ageing and Vitality, Newcastle upon Tyne NE4 5PL, U.K.
Tel: +44 (0)191 248 1117; Fax: +44 (0)191 2481101; E-mail: carol.jagger@ncl.ac.uk

## 1. Introduction

Over the last two centuries the UK population has gone through the epidemiologic transition, moving from high birth and death rates to low birth and death rates through the shift from infectious to chronic diseases. The consequent rise in life expectancy at birth and indeed at later ages shows no sign of slowing down at present or levelling off at any previously proposed limit (Fries 1980, 1989). Whether the current older population is similar in health characteristics to the generation of elderly individuals before them is a crucial question for health care planners and society.

There are good reasons why we might expect new cohorts of older people to differ from previous ones since they have experienced economic, social and technological changes at different times in their life course. For instance, birth cohorts born after 1948 have benefitted from the National Health Service throughout their lives together with the start of mass vaccination programmes in the 1950s. During the same period improvements in diet and

the environment have also played their part alongside advances in medicine which have transformed the prevention, diagnosis and treatment of many diseases.

Risk factors for mortality and morbidity at an individual level include biological, sociodemographic and medical factors. Although education, working history, diet and nutrition, and social interaction have all been implicated, particular birth cohorts have differed systematically on many such factors. In this paper we review such cohort differences in mortality and morbidity and how these might inform future trends. In section 1 we cover cohort patterns in mortality with particular references to the so called 'golden cohort' in the UK born in the 1920s and 1930s and whether a similar pattern exists in New Zealand, together with two further papers on methodological issues of detecting cohort patterns. Section 2 reviews cohort differences in morbidity, in the UK and other, predominantly European, countries. The final section suggests how these might play out in future trends in the UK.

## 2. Mortality

Assumptions about future mortality are more important than those for factors such as fertility, migration, disability trends or real interest rates for financial projections of the US Social Security system (Social Security Administration 2008). Recently, one factor has been assumed to be a key driver of future mortality in both official British population projections and many actuarial ones: a 'cohort effect' associated with a group who were born in a period centred on the early 1930s who have been identified as having experienced particularly rapid improvements in mortality rates and are often referred to as the 'golden generations' or 'golden cohorts' (Office Of Population Censuses And Surveys 1995; Willets 2004; Willets et al. 2004). At present, overall age standardised mortality rates (both sexes combined) are improving at about 2.5% per annum in England and Wales, but current trends are heavily influenced by deaths among the birth cohorts of the 'golden generations' (Office For National Statistics 2008). Current British official mortality projections assume that these cohorts will continue to enjoy advantages up to the highest ages (Office For National Statistics 2009) although this must be speculative since, although the mortality patterns of these cohorts has been discussed for almost two decades, there is no clearly-established mechanism for the observed trends. Although rates of mortality improvement have been generally accelerating for at least the last half-century, the official projections assume that overall annual mortality improvement will decline by more than 60% to a value of 1% per annum in about 25 years' time after current high rates, including the 'golden generations' effect, has worked itself out of the system. While the better mortality of the golden cohorts than earlier ones plausibly reflects generally

improving conditions over time, the slowing down of mortality improvement for later cohorts born from around the mid-1950s has attracted less attention (Aylin *et al.*, 1999), but the assumption of decelerating mortality improvement depends crucially on the mortality experienced by these groups in later life and more insight may be obtained by investigating cases with apparently less favourable as well as apparently more favourable patterns.

The case against UK mortality forecasts relying strongly on the 'golden generations' when there is little proven evidence of causal mechanisms is argued more fully later in this issue (see Murphy, 2009). Currently there are only a number of hypotheses including changing smoking patterns, better diet and environmental conditions during and after the Second World War, those born in periods of lower fertility facing less competition for resources later in life, and benefits from both medical advances and the introduction of the Welfare State. The likely size of any effect can be gleaned for some of these from looking at other countries. Although framed as the opposite hypothesis that poorer nutrition and diet in early life has a significant effect on later mortality, analysis of countries such as Finland, Russia and the Netherlands that have endured severe famines suggest that there is little, if any, effect on the later mortality of children born around these times (Murphy, 2009).

Murphy also discussed the role of immigration and emigration in determining cohort effects from mortality data (Murphy, 2009) and these are further explored by O'Connell and Dunstan (O'Connell & Dunstan, 2009), who present a comparative analysis of the UK's golden cohort with New Zealand cohorts of the same time. Some evidence of a golden cohort in New Zealand born around the 1930s is reported but, contrary to UK projections, such cohort effects are not modelled in New Zealand population projections resulting in perhaps more pessimistic assumptions. In contrast to this mortality rates in middle and older ages are lower in New Zealand than in the UK and moreover have seen greater improvements in recent years, despite significantly worse mortality in the Maori population.

The question of how cohort effects should be incorporated into mortality forecasts was addressed by two methodological papers under the Cohort theme. Forfar (Forfar, 2009) used UK mortality data covering the period 1961-2007 to first demonstrate the presence of a cohort effect and then incorporated this into the age-period Lee–Carter model to form the extended Lee–Carter Model (Sen, 2008) to provide a significantly better fit to the data. Subsequent use of the extended model gives forecasts for the period expectation of life at birth that is around 5 years higher by 2054 than the 2008-based ONS projections, although the 95% bounds did overlap.

Cause-specific mortality forecasts are important not only to understand overall mortality trends but also because different diseases have different demands from, and different costs of, health and social care. Di Cesare and

Murphy (Di Cesare & Murphy, 2009) explored which of four models (Lee–Carter, Booth-Macdonald-Smith variant of Lee–Carter, Age-Period-Cohort, or Bayesian) best explained trends in three different causes of death, the latter chosen because of their strong underlying period or cohort effects: lung cancer (cohort); influenza, pneumonia and bronchitis (period); and motor vehicle accidents (neither). They conclude that no single model is most accurate for all three causes and the best model depended on the underlying mechanisms driving the trends.

## 3. Morbidity

Exceptionally long-lived individuals form that segment of the Western population that is both the most rapidly expanding and the most susceptible to disease and disability. If the pace of increase in life expectancy in developed countries over the past two centuries continues through the 21st century, the majority of babies born since 2000 in France, Germany, Italy, the United Kingdom, the United States, Canada, Japan and many other countries will celebrate their 100th birthdays (Christensen *et al*., 2009). A key question is whether increases in life expectancy are being accompanied by a concurrent postponement of limitations and disability. The question is still open but recent research suggests that ageing processes are modifiable and that, in some countries at least, people are living longer without severe disability.

In 1995-6 Christensen and colleagues conducted a centenarian study of the Danish 1895-96 cohorts and in 2005 compared the data to the survey results for the 1905 cohort. They found that although 50% more people from the 1905 cohort reached 100 years old compared to the 1895-96 cohort, there was no increase in disability level. On the contrary there was a slight decrease. The 1905-cohort centenarian females performed slightly better than the 1895-cohort centenarian females. There was no difference between the male centenarians of the two cohorts (Engberg *et al*., 2008a; Engberg *et al*., 2008b).

The Danish findings are in agreement with studies on younger elderly that show that the prevalence of chronic disability is decreasing and that in a number of countries people are not only living longer but also better in successive cohorts (Äijänseppä *et al*., 2005; Freedman *et al*., 2002; Manton *et al*., 2006; Manton & Gu, 2001; Robine & Michel, 2004).

Psychosocial factors in ageing populations must be considered together with physical health problems. Although the incidence of clinically diagnosed depression declines after age 60, the frequency of self-reported symptoms of depression increases (Fiske *et al*., 2009; Johnson *et al*., 2002). The longitudinal study with multiple assessments of the entire Danish 1905 cohort from age 92 to 100 years showed that while on an individual level

depression symptomatology and cognitive disabilities increased with age, the overall depression level and cognitive functioning changed very little within this age range, because those surviving tended to be those with the best health, mood and cognitive function (Christensen *et al.*, 2008). This suggests that most individuals can expect to experience cognitive decline and increase in depression symptomatology close to their death, but also that postponement of this individual decline makes it possible for us to live in reasonable good physical and psychological health to the highest ages.

In the UK, the two existing cohort studies have shown rather different patterns to those in Denmark. Over the 1980s two cohorts of people aged 75 years and over, seven years apart and belonging to the same general practice were compared with respect to functioning and health, and five year survival (Spiers *et al.*, 1996). Although the later cohort were significantly more independent in daily functioning, as measured by activities of daily living, they rated their health worse than the earlier cohort and these differences were particularly marked in men aged 75-81 years. As poor self-rated health was equally predictive of five-year mortality in both cohorts, it was concluded that, although more severe disability had reduced in the later cohort, less severe disability indicated by poorer self-ratings of health, had increased.

The second UK study took place in the east Cambridgeshire centre of the Medical Research Council Cognitive Function and Ageing Study (MRC CFAS) (see www.cfas.ac.uk). Two non-overlapping cohorts aged 65-69 years in 1991/2 and 1997/8 were interviewed at home and provided information on self-reported diseases and conditions, self-rated health and disability, as well as undertaking an assessment of cognitive function (Jagger *et al.*, 2007). More diseases in number were noted in the later cohort and, within individual diseases and conditions, there were significant increases for arthritis and chronic airways obstruction. There was no significant difference between the cohorts in terms of disability or cognitive function as a whole although the later cohort displayed an increase in verbal fluency, a key component in tests of cognitive function, and this latter finding was also evident in the English Longitudinal Study of Ageing (Llewellyn & Matthews, 2009).

## 4. What the Future Holds

The UK has a long history of national birth cohort studies but the earliest of these, the National Survey of Health and Development, will only attain 65 years in 2011. True birth cohort studies of the oldest old in the UK have been absent until recently. The first results from a cohort of 85 year olds in Newcastle provides a picture of the high prevalence of disease though relatively good daily life functioning in this age group (Collerton *et al.*,

(2009)), though there is, as yet, no comparator cohort. On the other hand, a new MRC Cognitive Function and Ageing Study (MRC-CFAS) is currently in the field and subsequently will provide the most complete picture of changing health of cohorts aged 65 years and over in the UK to date. Therefore, although research to date is far from clear on whether the future UK older population will, as the Danish ones, enjoy better health and functioning than previously and therefore live longer free of disability, it should become clearer in the next few years.

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