AGEING HORIZONS

Policies for ageing societies

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Biodemography and longevity

Editorial

The number of centenarians in Japan increased almost one-hundredfold from 154 in 1963 to more than 13,000 at the beginning of this century[1], and is projected to increase to almost one million by 2050[2]. Although the majority of the populations in the developed world still die in their 70s and 80s, extreme longevity is becoming much less uncommon. The possibility of a future in which extreme longevity becomes the common experience of mankind is now being taken very seriously. The likelihood of such a future, and its implications for policy, is the theme of this issue of Ageing Horizons.

The limits to life expectancy and their relevance for demographic projections

At the beginning of 2004, the United Nations Population Division published its second set of long-range population projections, this time extending the projection period until the year 2300. It is of course very unusual for demographic projections to extend as far as this: small errors in the underlying assumptions lead quite quickly to very large errors in population estimates. The exercise does, however, demonstrate the size of the effect that results from quite small variations in assumptions about fertility. The projections incorporate various alternative fertility scenarios around a central projection, which assumes that fertility everywhere will converge to replacement level by the end of the present century and remain at that level until 2300. Although the differences in fertility rates that define the 'high' and 'low' alternative scenarios are modest – only 0.25 children more or less than the replacement level – they lead to very large differences in global population, between 2.3 and 36.4 billion[3].

There are, however, no alternative mortality scenarios, just one 'business-as-usual' (Demeny, 2004, p.509) set of assumptions. For Europe and the other more developed regions of the world, reductions in old age mortality rates will be the main driver of life expectancy gains throughout the projection period; and it is assumed that current trends in mortality improvements in

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these regions will continue more or less unchanged. After 2100, this will also be true of the less developed regions. In Africa, which now has relatively high mortality rates in early and middle life, 'the effects of HIV/AIDS will have been wrung out of the system (p59)' by the end of the century, and infant and child mortality will by that time be sufficiently low for any future reductions to have a negligible impact on life expectancy at birth. With these provisos about regional differences, the rate of mortality change that is projected for the next 50 years (in the main UNPD 2000-2050 projections) is 'simply' extended into the future.

> There are wide disagreements about how and how much human mortality might change in the next three centuries. Some hold a less sanguine view about the likely pace of progress in longevity than even the rather cautious assumptions incorporated in the UN projections. Others foresee far greater gains in survival rates. (Demeny, 2004)

These 'rather cautious' assumptions about rates of mortality improvement lead to a female life expectancy at birth of 100 years or more in 51 countries by the year 2300. Japanese woman will still be the longest-lived in the world, with a life expectancy at birth of 108 years. Very few countries indeed – and none outside Africa – will have female life expectancies of less than 90 years. Male life expectancy lags behind, but will still reach 100 years or more across all of Western Europe and Scandinavia. All that is required, therefore, to push life expectancy up to 100 years across most of the OECD is 'business as usual' for another three centuries.

Since fertility and mortality in the different regions of the world are assumed to be increasingly convergent after 2100, it should come as no surprise to learn that the age profiles of populations in different parts of the world look very similar by the end of the projection period. In Europe in the year 2300, 35% of the population will be aged 65 years or more, in Africa 30%. More than half of the older population will be aged 80 years or more – in both the less developed and the more developed regions of the world. At present about 22% of the older population in the more developed regions are in this age group.

As Demeny points out, there are some analysts who think the UN projections for the year 2050 (which form the basis for the long range projections) may be too conservative. In France, for example, the mortality forecasts of INSEE (Institut National de la Statistique et des Etudes Economiques) put female life expectancy at birth in 2050 at 91 years compared to 87 years in the UN data (Willard, 2003). And Oeppen and Vaupel (2002) are even more optimistic about trends in 'best-practice' countries.

> Because best-practice life expectancy has increased by 2.5 years per decade for a century and a half, one reasonable scenario would be that this trend will continue in coming decades. If so, record life expectancy[4] will reach 100 in about six decades.

Oeppen and Vaupel argue that the demographic data, if they are read properly, offer no support for the assumption that life expectancy in the developed world is rapidly approaching its limit. Life expectancy gains may have stagnated in some countries, but we would do better to regard this as a localised symptom of under-performance than a sign of the approaching limits to life expectancy. By pooling historical data from best practice countries, it is possible in fact to discern a more or less linear increase in life expectancies over time[5]. Not only have official population

projections tended to under-estimate life expectancy gains in recent years, but past predictions about the inevitable deceleration of mortality improvements at older ages have been confounded by mortality improvements in best practice countries.

The UNPD report may be more conservative than Oeppen and Vaupel in its assumptions about mortality changes up to 2050, but it does nonetheless follow their recommendation in refusing to set any kind of limit to the life expectancy that countries could reach within the projection period. Their projections take no account, therefore, of predictions such as those made by Olshansky *et al* (2001) that combined life expectancy at birth is unlikely to rise above 85 years even in countries like Japan[6]. Instead of assuming that the rate of reduction in mortality rates at older ages will slow down some time during the next three hundred years, they assume a more or less constant rate of improvement – which stands in marked contrast to many official projections drawn up for much shorter time periods by national agencies such as the Government Actuary's Department in the UK[7]. They have decided, in other words, that their projections should not be guided by the view that efforts to extend survival at advanced ages are likely to yield diminishing returns.

The belief that human life expectancy cannot rise much further is firmly rejected then by Oeppen and Vaupel, who regard it not only as false but 'pernicious'. Why pernicious? Because it seriously misleads demographers by causing them to under-estimate likely future reductions in mortality rates at older ages, and hence distorts the decisions that governments and individuals have to make about provision for old age. It allows us to exclude from our practical considerations a future, which is not merely possible, but quite likely.

The contrary belief – that there are no fixed limits to the human life span[8] – gives us licence to speculate about possible demographic futures that may now seem fantastic and implausible. Caselli and Vallin (2001), for example, run through a set of projections with what they regard as an arbitrary limit on life expectancy of 150 years. And Lee & Goldstein (2003) consider the consequences of a 'proportional rescaling' of the human life cycle with more or less the same limit. Projections such as these are of course speculative exercises. They do not purport to tell us anything about what is likely to happen to life expectancy in the near future[9]. Rather they examine the broader demographic implications of an increase in life expectancy that is no longer thought to lie beyond the bounds of plausibility. They look at scenarios that might be realised some time in the not too distant future. The failure to maintain a clear distinction between the two kinds of exercise is one of the criticisms that Olshansky (2004) directs against the key assumption behind the UN projections, namely that technological ingenuity will enable us to hold mortality improvements to a trajectory that otherwise seems implausible.

The state of the current debate about the limits to human life expectancy and the relevance of such limits for projected changes in mortality rates are the themes of the review essays by James Vaupel & Kristin von Kistowski and by Bruce Carnes and colleagues in this issue of Ageing Horizons.

Increasing life expectancy and the prospects for a compression of morbidity

It is hard to resist the thought that the benign scenario of a compression of morbidity in later life becomes increasingly unlikely as the limits to life expectancy recede into the future. The possibility that increases in healthy life expectancy may fail to keep pace with continuing increases in life expectancy – with the result that extended survival is accompanied by a gradually extending period of frailty - becomes that much harder to ignore. And it is indeed the intention of Oeppen and Vaupel that we should find no warrant for complacency about the future burden of an ageing population in mistaken views about the limits to life expectancy.

James Fries (2004) has argued that the nature of the condition of frailty effectively rules out this kind of scenario. Frail individuals continue to age and grow frailer. It is in the nature of their condition – even if we suppose them to be free of any fatal degenerative disease - that they are extremely vulnerable to environmental stress and insult. Their condition, furthermore, is progressive, as their bodies become increasingly incapable of stabilising disruption and imbalance in physiological systems essential for survival.

If, however, it is indeed the case, as many biodemographers now think (Wachter, 2003), that human mortality rates might reach a plateau in advanced old age – and furthermore that it is possible to lower the level of this plateau (i.e. to reduce the level of the more or less constant mortality risk to which people at these ages would be subject) – then the prospect of extended survival in a condition of frailty starts to look more plausible.

What these two scenarios require us to consider is the evolution of the relationship between increasing life expectancy and healthy life expectancy. Will the additional years of life that are gained as a result of the continuing postponement of death into more advanced old age be years of good health or years of disability and frailty? Taking the long-term view – looking across the entire course of the twentieth century – there seems now to be very good evidence of an absolute compression of morbidity and disability in more recent cohorts of older people (Fogel, 2005). Evidence on *current* (or more short-term) trends in health expectancies seems, however, to be much less clear-cut, and it has been suggested that some countries in the world, those with the highest life expectancies which have already seen some compression of morbidity as a result of

improved health behaviours, could be experiencing a 'second wave' expansion of morbidity along with the emergence of very old and frail populations (Robine & Michel, 2004). The third review essay in this issue of Ageing Horizons, by Jean-Marie Robine and Carol Jagger, assesses the state of current thinking on this question.

Increasing life expectancy and the technologies of age-retardation

> Although it is likely that anticipated advances in biomedical technology and lifestyle modifications will permit life expectancy to continue its slow rise over the short term, a repetition of the large, rapid gains in life expectancy observed during the twentieth century is extremely unlikely. Such gains would require an ability to slow the rate of aging – a technological capability that does not exist today and that, even if it did, would require implementation on a broad scale in order to have a measurable impact on the vital statistics of a population (Olshanksy & Carnes, 2004).

When Paul Demeny describes the mortality trends that are required to achieve the life expectancies in the UN's long range projections as 'business as usual', we should not suppose that he also means business as usual for the array of forces driving these mortality improvements. It seems unlikely, and this is Olshansky's point, that such an outcome could be achieved without radical advances in our ability to manipulate the basic biology of ageing. There is a limit to the potential mortality improvements that we can reasonably expect from incremental improvements in the spread of *healthful living* throughout society and in the effectiveness of *disease prevention and cure*[10]. To move beyond this limit we have to tackle the underlying causes of the exponential increase in the risk of mortality that characterises the post-reproductive portion of the lifespan – ageing[11].

The nature of our response to the prospect of effective age-retarding technologies that would extend the average human lifespan well beyond what we might expect from the widespread adoption of *healthful living* and more effective *disease prevention and cure* is the topic of the final review essay by Nick Bostrom in this issue of Ageing Horizons. Although it would be overstating the case to say that there is a consensus among experts about the likelihood of developing these technologies in the foreseeable future, there is an increasing willingness to accept that they are not so far over the horizon of scientific advance that we need not trouble ourselves about their social and ethical implications[12].

In 2002, the political theorist, Francis Fukuyama, laid down a conservative (i.e. 'anti-posthumanist') position on the development of biomedical technologies for the *enhancement* of human capabilities – as distinct from technologies which restore or preserve our capabilities (Fukuyama, 2002). This was quickly followed by a major report on the same topic from the United States President's Commission on Bioethics (PCBE, 2003). Fukuyama and the PCBE agree in finding a great deal of cause for concern in the prospect of age-retarding technologies. They are both inclined to the view that our societies would do well to resist the collective temptation that it presents. They want to draw a firm line between, on the one hand, the potential mortality gains that might be achieved by healthful living and more effective disease prevention, and on the other, the potential impact on survival of developments in regenerative medicine or the biology of ageing. On one side of the line is something which is worth striving for. On the other, there is something that is, at best, of questionable value, and at worst, meretricious, or even downright harmful.

Some of the problems raised by the PCBE share common ground with other possible technologies for the biological enhancement of human powers and capabilities. So, for example the very fact that age retardation is regarded as a form of biological enhancement rather than therapy makes it problematic for ethical assessments that look to balance risks against *bona fide* health benefits (though the PCBE does make it clear that this is not a morally decisive consideration). The PCBE insists on the importance of the distinction between interventions that enable individuals to fulfil their potential for a long and healthy life, and interventions that set out to increase this potential[13]. Another problem which applies 'across the board' to various forms of technologies for biological enhancement has to do with their likely effect on the kinds of social inequalities that policy should be concerned to diminish. On the plausible assumption that access to these technologies will be determined by the ability to pay – at least for a while - it seems inevitable that they should increase inequality of opportunity (Davis, 2004).

There is, however, a rather different set of problems that turn on a detailed utilitarian 'cost-benefit' assessment of the foreseeable consequences of extreme longevity for both individuals and societies – and are therefore peculiar to this specific form of biological enhancement. The argument that as individuals we have little to gain, and a great deal to lose, from a large number of extra years of life, that we jeopardize our chances of living fulfilling and meaningful lives by attempting to overcome the limits that ageing sets to our aspirations and hopes (Kass, 2004), has a familiar theological ring. It also runs up against familiar liberal objections: individuals should be free to decide for themselves whether or not an extension of life beyond what we might reasonably expect as the 'biological birthright' of our species is worthwhile.

Arguments about the wider social impact of the successful and widespread application of age retardation are not so easily parried, however. Even though there must be considerable uncertainty about the consequences of such speculative technologies, it seems sensible to try to make *some* assessment of what Fukuyama calls the 'external

costs' of a technology that would give a powerful extra impetus to a process of population ageing that is already a source of institutional strain. It is, after all, not that difficult to imagine what kinds of problem might arise for our collective life as a result of the sort of profound demographic change that we can expect from this technology. And even if we are unclear about how far this process has to go in order for these problems to arise, we might still be fairly sure that they will arise and that they have to be weighed in the balance with the benefits that more healthy life years confer on the individuals who enjoy them.

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Notes

[1] This figure is taken from Robine & Saito (2003).

[2] United Nations 2004 revised population forecasts

[3] They also include a 'constant growth' scenario, which assumes that fertility rates remain constant at the level estimated for 1995–2000. The total world population under this assumption is 133,592 billion.

[4] As Japanese women now have the highest life expectancy in the world, record life expectancy here means Japanese women. In the UNPD projections, Japanese females born in 2050 have a life expectancy of 92.4 years, increasing to 96 years by the end of the century.

[5] For a detailed discussion of the nature of this trend, see Lee (2003).

[6] The UNPD report contains an appendix by Jay Olshanksy which summarises objections to the decision to lift the cap on life expectancy gains. Earlier UN projections assumed, with Olshanksy *et al*, that increases in life expectancy would converge to a limit of 85 years.

[7] GAD's current projections assume that (i) future reductions in mortality rates will converge to 1% per annum across all ages by the year 2027; and that (ii) thereafter the rate of improvement will halve every 25 years.

[8] The claim that there is no *fixed* limit on human longevity does not entail of course that human beings can live forever. The point has to do rather with the nature of the constraints that evolutionary forces have imposed on human longevity. What degree of 'plasticity' should we expect in human longevity? See Robine (2003).

[9] Lee & Goldstein in fact suggest a figure of 15% for the likely increase in life expectancy over the course of this century.

[10] The terminology and classification come from Carey (2003), who identifies four main determinants of the future shape of the life span. Although *healthful living* and *disease prevention* may indeed be 'running out of steam', *regenerative medicine* and *age-retardation* lie just over the horizon.

[11] It is also argued that effective age-retarding technologies may well hold the key to preventing future expansion of morbidity as a result of increasing life expectancy. See, for example, Post (2004).

[12] Not everyone would agree. See Hayflick (2004).

[13] The distinction becomes harder to sustain if there are indeed no 'fixed' species-specific limits to life expectancy.