The relationship between longevity and healthy life expectancy

Jean-Marie Robine, Yasuhiko Saito and Carol Jagger

Jean-Marie Robine, National Institute for Health and Medical Research, INSERM, France. (This manuscript was completed while the author was Visiting Professor at Nihon University Advanced Research Institute for the Sciences and Humanities, Tokyo.)

Yasuhiko Saito, Nihon University Advanced Research Institute for the Sciences and Humanities, Tokyo.

Carol Jagger, Department of Health Sciences, University of Leicester, UK.

ABSTRACT

What is the relationship between longevity and health? Health expectancies were developed more than 30 years ago specifically to answer this question. It may therefore be the time to try to answer this question, though it is worth noting that the question implies a unidirectional relationship. Almost no one questions the positive association between health and longevity. It is expected that healthy, robust people will live, on average, longer than frail people. This heterogeneity in terms of robustness/frailty may explain the shape of the mortality trajectory with age, i.e. the oldest old seem to follow a lower mortality schedule (Vaupel et al., 1979). On the other hand, many people wonder about the relationship between longevity and health. Are we living longer because we are in better health? Are we living longer in good health? Or are we merely surviving longer whatever our health status? In other words, can we live in good health as long as we can survive? And this is exactly the purpose of health expectancies: monitoring how long people live in various health statuses (Sanders, 1964; Sullivan, 1971; Robine et al., 2003a).

KEY WORDS

longevity     health     morbidity     disability     life expectancy

THE THREE THEORIES OF THE 1980s

In the absence of data, and particularly of chronological series on the health status of elderly populations, three theories about the future health status of old people were...
The relationship between longevity and healthy life expectancy

hypothesised in the 1980s. The first two proposed, alternatively, a compression or an expansion of morbidity. The third proposed a kind of equilibrium between longevity and health. According to Fries, life expectancy was close to its maximum in the 1980s. Therefore, medical progress and health behaviours can only reduce the number of bad years to a small part of the life expectancy, leading to the compression of morbidity (Fries, 1980). On the opposite side, according to Gruenberg (1977) and Kramer (1980), the same medical progress will increase the survival of frail elderly people such as those with dementia. This trade-off between longer life and worsening health will lead to an expansion of morbidity (Oshansky et al, 1991). Between these two extreme futures, Manton (1982) proposed a dynamic equilibrium in which increased survival is offset by better control of chronic diseases, keeping the proportion of life lived in good health more or less constant.

THE LONGEVITY REVOLUTION

Worries about the future health status of the older population, combined with the observation of an increase in the number of the ‘oldest old’ (defined as 85 years old or more), led the health authorities of the most developed countries to build up population health surveillance systems in the 1980s or 1990s, including repeated cross sectional health surveys that allowed the functional health status of older people to be monitored. But no theory on health at that time was anticipating the longevity revolution that is currently occurring in most developed countries and that has led to impressive numbers of nonagenarians and centenarians (Robine et al, 2003b; Robine & Cheung, 2008; Robine & Saito, 2009a).

In the following sections, we answer the question on the relationship between longevity and health. First, at an individual level, we address whether centenarians are healthy people. Second, at the national level, we answer whether the increase in healthy life expectancy is slower or faster than the increase in total life expectancy. Finally, at the global level, we address whether countries with the highest life expectancies also have the highest healthy life expectancies.

ARE CENTENARIANS HEALTHY PEOPLE?

Most published centenarian studies consist of small convenience samples of interested people who volunteer to participate in scientific studies exploring their ‘extreme longevity’. This often leads to the feeling that centenarians are healthy people, free of most of the ageing-related impairments and free of cognitive disorders. In reality, the few representative or quasi-representative studies of nonagenarians and centenarians have demonstrated that they are in relatively poor health, with a significant proportion being bedridden and/or demented (Suzuki et al, 1995; Allard & Robine, 2000; Andersen-Ranberg et al, 1999; 2001; Nybo et al, 2001; Motta et al, 2005; Gondo et al, 2006). According to Gondo and colleagues, less than 2% (5/304) of the Japanese centenarians are in perfect health, defined as having no sensory problem, no cognitive deficit and being fully independent in basic activities. Most of them (243/304) should be considered as frail or fragile people (Gondo et al, 2006), confirming a previous study showing that only 1% (7/602) of Italian centenarians were fully independent (Motta et al, 2005). Moreover, according to the authors, none of them continued social or productive activities that could be considered as examples of successful ageing in accordance with the usual definition of this concept (Rowe & Kahn, 1987).

On the other hand, this and other studies have suggested that these extremely old people were in relatively good health five or 10 years previously (Hitt et al, 1999; Evert et al, 2003). For instance, among the 1905 Danish cohort, the great majority of those who became centenarians in 2005 were physically independent when they were 92 years old. Therefore, only a modest
The relationship between longevity and healthy life expectancy

decline in the proportion of independent individuals was observed within this cohort between the ages of 92 and 100. (Christensen et al., 2008). In other words, differential mortality must have eliminated the frailer dependant nonagenarians. Japanese studies confirmed this observation, even between the ages of 100 and 110 years (Willcox et al., 2007; 2008).

Indeed, nonagenarians and centenarians are strongly selected people and this creates new concerns, as their numbers are exploding in many countries. For instance, in Japan the number increased from 154 in 1963 to 36,276 by 2008 (Robine & Saito, 2009b), a 235-fold increase in less than 50 years! This phenomenal increase is mainly due to the fall in mortality above the age of 80 years, and the same questions arose: are older people more likely to become centenarians because they are in better health or because it is much easier to survive today? Although it is very difficult to answer this question, there is evidence in favour of a strong decline in the mortality selection. In Denmark, where the number of centenarians is increasing relatively slowly compared to most of the western European countries (Robine & Saito, 2009a), over the decade from 1995 to 2005 the functional health status of female centenarians (100) significantly improved. However, there were no clear changes for male centenarians (Engberg et al., 2008b). On the other hand in Japan, where the number of centenarians has increased more than threefold every decade since the 1970s (Robine & Saito, 2009b), occasional centenarian surveys commissioned by the government demonstrated significant declines in the functional health status of Japanese centenarians (Gondo, 2008), results confirming a previous study carried out in Okinawa (Suzuki et al., 1995). The ECHA (European Challenge for Healthy Ageing) project found a strong north-south gradient in handgrip strength in nonagenarians and centenarians (Jeune et al., 2006), which is in the opposite direction to the gradient of the centenarian increase (Robine & Saito, 2009a). Danish centenarians show the highest handgrip strength whilst Italy displays the highest centenarian increase. Studies on the correlations between the level of mortality selection and cognitive functional status are rare (Engberg et al., 2008a) and we can only expect that new studies such as the Five-Country Oldest Old Project (5-COOP) will shortly bring comparable data on the cognitive status of the centenarians in various geographic settings (the five countries are Denmark, France, Japan, Sweden and Switzerland).

IS HEALTHY LIFE EXPECTANCY INCREASING FASTER THAN TOTAL LIFE EXPECTANCY?

A recent OECD study found mixed results on ADL (activities of daily living) disability trends among the population aged 65 and over. ADL difficulties denote a severe level of disability. Out of the 12 countries studied, only five (Denmark, Finland, Italy, the Netherlands and the United States) showed clear evidence of a decline in disability among elderly people. Three countries (Belgium, Japan and Sweden) reported an increasing rate of severe disability among people aged 65 and over during the last five to ten years, and two countries (Australia and Canada) reported a stable rate. In France and the UK, data from different surveys showed different trends in ADL disability rates, making it impossible to reach any definitive conclusion on the direction of the trend (Lafortune & Balestat, 2007). The most worrying of these results was the fact that, if we put aside Italy, the countries showing clear evidence of disability decline were the countries displaying the weaker increase in life expectancy at age 65. Most countries experiencing a strong increase in life expectancy at age 65 reported increasing or stable disability rates. These results suggest that it may be difficult to reduce the level of disability among older people in countries where life expectancy at age 65 strongly increases.
The relationship between longevity and healthy life expectancy

Confirming the OECD study, Danish, Dutch and American studies show a clear compression of disability among their elderly populations but these three countries are also those lagging behind in terms of life expectancy at age 65. Thus, in the United States, active life expectancy\(^1\) at age 65 increased much faster than total life expectancy from 1982 to 2004, illustrating the scenario of compression of disability (Cai & Lubitz, 2007; Manton et al, 2006; 2008; Manton, 2008). According to Yang (2008), life expectancy with unhappiness was even more compressed than the total number of years with ADL difficulties over that period. In the Netherlands, life expectancy without physical limitations greatly improved from 1981 to 2007, whilst total life expectancy increased marginally for females during the same period. On the other hand, life expectancy without chronic diseases was reduced for both sexes (Bruggink et al, 2009; Perenboom et al, 2004a; 2004b; 2005). In Denmark, the recent rise in life expectancy after many years of stagnation appears to be accompanied by generally improved health status among the elderly. During the most recent period, from 1994 to 2005, healthy life expectancy increased more than total life expectancy for both sexes (Bronnum-Hansen, 2005; Jeune & Bronnum-Hansen, 2008).

Belgian studies also confirm the OECD study but only for females, for whom an expansion of disability is observed during the period 1997–2004. Otherwise, in general at age 65, healthy life expectancies increased faster than total life expectancy, though not always (Van Oyen et al, 2008). Japanese trends of healthy life expectancy from 1986 to 2004 also confirm the OECD results, showing that a period of morbidity compression up to 1995 was then followed by an expansion of morbidity (Yong & Saito, 2009). To our knowledge, there is no study on health expectancies in Sweden that can confirm the OECD study and similarly there are no recent Australian and Canadian studies on the trend in health expectancy. British studies, covering the period from 1980 to 2006, showed that healthy life expectancies did not increase in the UK by as much as total life expectancy, with the result that both men and women are living more years in poor health or with a limiting long-standing illness than previously (Kelly et al, 2000; ONS, 2006; 2008). However, the most recent evidence suggests a more positive trend (Smith et al, 2008). In France, it is difficult to conclude the direction of the trend as stated by the OECD study because significant changes in the survey designs occurred over time. However, trends in disability-free life expectancy from 1980 to 2003 seem to have remained stable for moderate levels of disability and to have increased for the most severe levels of disability (Cambois et al, 2006; 2008). In total, for these seven OECD countries there is no strong evidence of compression of disability, whereas strong increases in life expectancy at age 65 are evident, especially in Japan.

We found recent studies of health expectancy trends for countries other than the 12 included in the OECD study, including China and Thailand, as well as Baltic and Eastern European countries. This group of studies covers a much more comprehensive set of countries and may allow more general conclusions to be drawn. Austrian studies found that life expectancy in good perceived health increased faster than total life expectancy from 1978 to 1998 (Doblhammer & Kytir, 2001). German studies covering the period 1984–1998 suggest that the population of Germany is going to live longer and in a better health state (Kroll et al, 2008). Spanish studies showed that there was no clear trend in life expectancy in good perceived health in Spain from 1987 to 2003 (Gomez Redondo et al, 2005) and whilst a compression of disability was generally observed, ADL disability underwent a sharp rise among women between 1986 and 1999 (Sagardui-Villamor et al, 2005). In Switzerland, at age 65, life expectancy without disability and life expectancy in good perceived health increased faster than total life expectancy between 1992 and 2002 (Guilley, 2005). In the Czech Republic, life expectancy in good

---

\(^1\) Active life expectancy (ALE) is usually computed using the prevalence of ADL difficulties. Therefore ALE is a disability-free life expectancy corresponding to the life expectancy without ADL difficulties.
perceived health increased faster than total life expectancy between 1993 and 2002 (Hrkal, 2004) and in Lithuania, there was some evidence of compression of morbidity between 1997 and 2004 (Kalédiené & Petrauskiené, 2004). The Chinese studies came to the same conclusion for China over the period 1987-2006 (Liu et al, 2009; Lai, 2009) but the surveys used are poorly comparable with the western surveys. Finally, in Thailand, life expectancy in good perceived health increased faster than total life expectancy between 1986 and 1995 (Jitapunkul & Chayovan, 2000).

Taken all together, it seems that healthy life expectancy is increasing more in the new emerging economies (China and Thailand) and Eastern European economies (the Czech Republic and Lithuania) than in the advanced Western economies. Except for Switzerland, there is no great evidence of compression of morbidity in the low mortality countries. The three advanced economies that clearly displayed a compression of disability among older people during the last decades - Denmark, the Netherlands and the US - are the three countries that lag behind the low mortality countries in terms of life expectancy at age 65.

DO COUNTRIES WITH THE HIGHEST LIFE EXPECTANCIES HAVE THE HIGHEST HEALTHY LIFE EXPECTANCIES?

The previous section suggests that healthy life expectancy is increasing most in countries lagging behind the longevity front runners, currently led by Japan. This may simply be due to the fact that countries that have the highest life expectancies also enjoy the highest healthy life expectancies. In this case, the observation of a strong increase in healthy life expectancy in the former countries would be part of their caching up. It was impossible to explore this kind of question until very recently because of an almost complete absence of comparable data on the functional health status of various national older populations. However, thanks to the development of the European Health Surveys System, it is now possible to examine such a question, at least within the European Union (EU).

Thus, we examined the correlation between life expectancy at age 65 and the number of healthy life years (HLY) in 2006 for the 24 EU member states having comparable disability data (HEMU, 2009). Healthy life years (HLY) is a European structural indicator that has been selected to assess the quality of the years lived by European citizens and to answer the question whether the additional years of life expectancy are years in good health. HLY is conceptually a disability-free life expectancy and is computed annually with data from EUROSTAT surveys on limitations in activities people usually do. The 2005 HLY values allowed the first pan-European study of health inequalities to be carried out (Jagger et al, 2008).

As shown by the scatter plot (Figure I), there is a positive correlation between the value of life expectancy at age 65 and the number of HLYs that people can expect to live, although the correlation coefficient is not excessively high, especially for females (R² equals 0.62 for males and 0.42 for females), suggesting that other factors are at play in determining the value of the healthy life years. For instance, the Swedish leading position in terms of HLYs at age 65 is a reminder of the north-south gradient observed about the functional health status of centenarians.

DISCUSSION

We explored three avenues to examine the relationship between longevity and healthy life expectancy. At the individual level, we looked at the most recent studies of centenarians. At the national level, we reviewed all existing time series on health expectancies; and at a more global level, we explored the correlation between life expectancy at age 65 and the number...
The relationship between longevity and healthy life expectancy

Firstly, we saw that centenarians are a strongly selected group. The phenomenal increase in their numbers, currently observed in Japan and in most Western European countries, is essentially due to the fall of mortality above the age of 80 years and it seems that this decrease in mortality selection has been accompanied by a parallel decline in the functional health status of the successive cohorts of new centenarians, at least in Japan. Secondly, we explored the relationship between the increase in healthy life expectancy and the increase in total life expectancy, at the country level, to assess whether increase in life expectancy is always accompanied by a compression of morbidity. We concluded from this section that it seems that healthy life expectancy increased most in the countries that lagged behind in terms of life expectancy at age 65. Indeed, with the exception of Switzerland, there is no strong evidence of compression of morbidity in the countries with the lowest mortality. Finally, we examined the correlation between life expectancy at age 65 and the number of healthy life years (HLY) for 24 European countries having comparable data on activity limitations in activities people usually do. We found a positive relationship, though not an extremely strong one, between the quantity and the quality of the years lived.

Altogether, these three results suggest that the strong increase in healthy life expectancy is more a feature of countries that are catching up with the best countries in terms of population health, rather than a characteristic of countries leading the longevity revolution. However, there is a clear trend showing that the higher the life expectancy, the higher the healthy life expectancy. Low mortality countries may not display obvious compression of disability, although they tend to enjoy the highest healthy life expectancies. For them, the fast accumulation of centenarians seems to be accompanied by a parallel decline in their functional health status. Although other factors, such as the initial level of disability in the various countries (Robine, 2006), may explain the empirical observations we report here, it seems sensible to conclude that there is no strong evidence today of compression of morbidity and disability in the countries that lead the longevity revolution.

**Figure 1: Correlation between life expectancy at age 65 and the number of healthy life years (HLY) in the European Union in 2006**

<table>
<thead>
<tr>
<th>Males</th>
<th>Females</th>
</tr>
</thead>
<tbody>
<tr>
<td>Healthy life years</td>
<td>Healthy life years</td>
</tr>
<tr>
<td>11</td>
<td>14</td>
</tr>
<tr>
<td>12</td>
<td>16</td>
</tr>
<tr>
<td>13</td>
<td>18</td>
</tr>
<tr>
<td>14</td>
<td>20</td>
</tr>
<tr>
<td>15</td>
<td>22</td>
</tr>
<tr>
<td>16</td>
<td>24</td>
</tr>
<tr>
<td>17</td>
<td>26</td>
</tr>
<tr>
<td>18</td>
<td>28</td>
</tr>
<tr>
<td>19</td>
<td>30</td>
</tr>
<tr>
<td>20</td>
<td>32</td>
</tr>
</tbody>
</table>

Source of data: European Health Expectancy Monitoring Unit (EHEMU) – Bulgaria and Romania did not participate in the 2006 SILC survey and Denmark was excluded, leaving 24 EU Member States for this analysis.
The relationship between longevity and healthy life expectancy

Address for correspondence
Jean-Marie Robine
INSERM, Health and Demography
Val-d’Aurelle
34298 Montpellier Cedex 5
France
Email: Robine@valdorel.fnclcc.fr

References


The relationship between longevity and healthy life expectancy


Hitt R, Young-Xu Y, Silver M & Perls T (1999) Centenarians: the older you get, the healthier you have been. The Lancet 354 (9179) 652.


Manton KG (1982) Changing concepts of morbidity and mortality in the elderly population. Memorial Fund Quarterly 60 (2) 183–244.

The relationship between longevity and healthy life expectancy


The relationship between longevity and healthy life expectancy


Working with Older People

Online access now authenticated by IP address, Athens and Shibboleth

In touch with best practice, Working with Older People offers unbiased and up-to-date information on:

• housing • employment • research
• education • training • health • well-being.

This easy-to-read colour Journal features a mix of articles, news, comment and research written by and for people working in the older people field.

ALL SUBSCRIPTIONS INCLUDE FREE ONLINE ACCESS TO ALL ISSUES OF THE JOURNAL

SAVE 20% ON TWO-YEAR SUBSCRIPTIONS

<table>
<thead>
<tr>
<th>Type</th>
<th>1 year</th>
<th>2 years</th>
<th>Save 20%</th>
</tr>
</thead>
<tbody>
<tr>
<td>INSTITUTIONAL LARGE – print and online (500+ online users)</td>
<td>£649</td>
<td>£1,040</td>
<td></td>
</tr>
<tr>
<td>INSTITUTIONAL MEDIUM – print and online (50 to 499 online users)</td>
<td>£499</td>
<td>£800</td>
<td></td>
</tr>
<tr>
<td>INSTITUTIONAL SMALL – print and online (2 to 49 online users)</td>
<td>£299</td>
<td>£480</td>
<td></td>
</tr>
<tr>
<td>INSTITUTIONAL – print and online (1 online user)</td>
<td>£149</td>
<td>£240</td>
<td></td>
</tr>
<tr>
<td>INDIVIDUAL – print and online*</td>
<td>£49</td>
<td>£80</td>
<td></td>
</tr>
</tbody>
</table>

* Individual subscriptions must be paid from a personal account and sent to a home address.

ISSN: 1366-3666

Subscribe online at www.pavilionjournals.com or call Pavilion Journals on +44(0)1273 783720