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# Steep Increase in Best-Practice Cohort Life Expectancy

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BEST-PRACTICE LIFE EXPECTANCY—namely, the highest life expectancy observed among national populations—reflects the world's best health experiences. These record values set the potential aspiration levels of longevity for non-leading countries. The shape of trends in best-practice life expectancy shows to what extent developed countries as a group are able to achieve low mortality. Oeppen and Vaupel (2002) found that best-practice life expectancy increased steadily and nearly linearly between 1840 and 2000, with no signs of leveling off. Reports of more recent changes in life expectancy among women in Japan, and more detailed analyses of mortality trends, have indicated that best-practice life expectancy has continued to rise in the twenty-first century (Human Mortality Database 2010; Rau et al. 2008). The steady trend in best-practice life expectancy contrasts with more variable changes in individual countries. Correspondingly, some studies have suggested forecasting an individual country's mortality by means of a model that describes convergence toward the life expectancy leader (Lee 2006; Torri and Vaupel 2011).

The present study seeks to complement Oeppen and Vaupel's work on best-practice period life expectancy by analyzing trends in best-practice cohort life expectancy among females, ranging from older to younger birth cohorts. While conventional (period) life expectancy is a synthetic statistic that can be interpreted as a measure of the average level of the hazard of death in a given calendar year, cohort life expectancy reflects the actual survival experiences of people born in a specific calendar year. For a given calendar year, cohort life expectancy can be lower or higher than period life expectancy. If mortality decreases over time, a cohort benefits from a declining risk of death; and cohort life expectancy exceeds period life expectancy.

The existing demographic toolkit includes techniques for the translation of time series of period demographic measures into time series of the same measures for successive cohorts (Ryder 1964; Andreev 1972; Bongaarts and Feeney 2003). Some recent studies have focused on modeling the relationship between period and cohort life expectancies. These models were based on certain assumptions that determine the character of mortality variation across ages and time (Canudas-Romo and Schoen 2005; Goldstein and Wachter 2006; Goldstein 2008; Missov and Lenart 2011). It was shown that if mortality decreases, cohort life expectancy increases more than period life expectancy.

We assess trends in best-practice cohort life expectancy in two steps. First, we calculate best-practice life expectancy for female cohorts born from 1870 to 1950 from the Human Mortality Database (HMD), complemented by Lee–Carter projected mortality in non-extinct cohorts (Lee and Carter 1992; Lee and Miller 2001; Andreev and Vaupel 2006). Second, we compare the best-practice cohort trend with the corresponding trend in best-practice period life expectancies and analyze the age composition of changes in cohort and period longevity. Finally, we discuss the findings and prospects for future advances in survival and longevity.

## Data

The HMD provides detailed data on mortality classified by single-year ages, single calendar years, and single years of birth. Currently, the HMD includes 37 countries and areas of the world. Although the longest country series (Sweden) starts as early as 1751, we do not use data prior to 1870 for two reasons. First, there are almost no original single-year age-specific mortality data before the 1860s. This obstacle makes it difficult to calculate precisely the life expectancies by single-year cohorts. The lack of detailed data for the first years of life is especially critical because of the very high and highly changeable infant and childhood mortality in historical populations. Second, historical mortality data suffer from serious quality problems resulting from incomplete registration of births and deaths, which led to the substantial understatement of infant mortality (Glass 1951; Krause 1959; Hollingsworth 1968; Thorvaldsen 2002). In Scandinavia, a greater degree of completeness of vital events registration was achieved in the 1860s, with the introduction of centralized registration systems (Wilmoth and Lundström 1996; Thorvaldsen 2002; Gleij, Lundström, and Wilmoth 2010).

We also excluded from analysis all observations that were based on age-aggregated original data or were labeled in the HMD documentation as data of problematic quality. Special attention was paid to data on the non-Maori population of New Zealand, which experienced the world's highest life expectancy in most years between 1876 and 1940. In their rigorous investigation of best-practice period life expectancy, Vallin and Meslé (2009)

closely examined mortality data in New Zealand. They found that, from the 1870s to the 1920s, the life expectancy gap between New Zealand and the second-place country was greater than the gaps before and after this period. This was attributed to the “singular population history” of New Zealand, a country with a small and highly selective (through migration) population in its early years. As the population grew, conditions became more “normal,” and New Zealand became more similar to other low-mortality countries. For this reason, Vallin and Meslé excluded all data from New Zealand from their analysis. An alternative explanation attributes New Zealand’s mortality advantage in the beginning of the twentieth century to an unusually early beginning of fertility decline and highly favorable socioeconomic conditions (Pool and Cheung 2002).

Even if we agree that the health selection and (perhaps) some data quality problems (Statistics New Zealand 2006) affected early mortality data from New Zealand, these issues had been resolved by the 1920s. If the substantial mortality advantage of New Zealand in the 1910s and 1920s was really related to the “healthy migrant” effect, this advantage should be especially notable at older ages (e.g., in the most selective old cohorts). Comparing New Zealand’s age-specific death rates of the 1920s with the experience of the second-best country (Norway), we found that the mortality advantage of New Zealand was pronounced at ages under 40 and did not hold at older ages (analysis not shown here). After taking into account this result, as well as the selectivity argument of Vallin and Meslé (2009), we decided to use a portion of the New Zealand data: those from 1926 onward.

The following country series were used in the computation: Australia (since 1921), Austria (since 1947), Belgium (since 1919), Canada (since 1921), Denmark (since 1870), East Germany (since 1956), England and Wales (since 1870), Finland (since 1878), France (since 1870), Iceland (since 1870), Ireland (since 1950), Italy (since 1872), Japan (since 1947), the Netherlands (since 1870), New Zealand, non-Maori (since 1926), Northern Ireland (since 1922), Norway (since 1870), Portugal (since 1940), Scotland (since 1870), Spain (since 1908), Sweden (since 1870), Switzerland (since 1876), the United States (since 1933), and West Germany (since 1956).

For most of the countries studied, the last available year in the HMD was 2008. Period female life tables for every country and calendar year were retrieved from the HMD. The best-practice period life expectancies for the years 1870 to 2008 were obtained as the highest annual life expectancies.

Precise estimates of cohort life expectancy have to be computed from death rates covering the entire range of ages. For all non-extinct cohorts, unobserved death rates at older ages were estimated using the Lee–Carter (LC) model, in which variation in death rates across ages and time is expressed as

$$\ln m_{x,t} = a_x + b_x k_t + \varepsilon_{x,t},$$

where  $a_x$  is an average age effect,  $k_t$  is a time effect reflecting average mortality level at time  $t$ , and  $b_x$  is an interaction term that expresses sensitivity of the death rate at age  $x$  to temporal changes reflected by  $k_t$ , and  $\varepsilon_{x,t}$  is a set of random disturbances. For the identification of the model, we used observed death rates  $m_{x,t}$  over a relatively short period, from 1960 to 2008. According to Vallin and Meslé (2009), this time period corresponds to their last segment of period longevity progress. This segment is characterized by progress that was slower than that of the previous segment (1885–1959). For each country, the LC-based death rates for the years from 2009 to 2050 were computed with fixed vectors  $a_x$  and  $b_x$ . The country-specific  $k_t$  values were calculated as an extrapolation of the  $k_t$  trend of 1960–2008 according to a linear model of a random walk with drift.<sup>1</sup> Country-specific life expectancy estimates were thus obtained for non-extinct cohorts. Finally, for each year of birth between 1870 and 1950, best-practice cohort life expectancy was obtained as the maximum of country-specific cohort life expectancies.

In further analysis, cohorts born from 1870 to 1920 are considered as cohorts with *observed* mortality, since life expectancies in these cohorts are entirely or predominantly determined by observed death rates. The cohorts born from 1921 to 1950 are considered as cohorts with partly modeled mortality. In these cohorts, mortality rates are observed only until ages 87 or 58, respectively. Life expectancies in these cohorts are considered as *predicted* values, since they more strongly depend on the LC-assessed age-specific death rates.

## Results

### Best-practice longevity trends

All of the countries that have reported the highest period or cohort life expectancy for females since 1870 are listed in Appendix 1. In the period dimension, the highest life expectancy was reached exclusively in Scandinavia from 1870 to 1919. In many years, the leading position was taken by Norway. In some years, the top spot was held by Sweden, Iceland, or Denmark. During the 1920s and the 1930s, New Zealand and (for a few years) Australia claimed the top position. Between 1942 and 1981, the highest levels of period longevity were observed in Norway, Iceland, and Sweden. Most recently, from 1982 to 2008, Japan reported the highest average female length of life.

With respect to cohort life expectancy, Norway was the leader for most of the birth years from 1870 to 1920. This dominance was interrupted only a few times by Iceland and Sweden. Among the cohorts of 1921 to 1950 with (partly) predicted mortality, the highest life expectancy was achieved by five countries. During the 1920s, the top position belonged to Australia, Switzerland, Norway, and New Zealand. The leading position belonged to Switzerland

for the cohorts born from 1929 to 1950, except for the birth years 1944–1948, with Australia taking the lead.

Figure 1 shows changes in record period and cohort life expectancies. The corresponding numerical data are given in Appendix 2. In the period dimension, the observed longevity series covers the time span from 1870 to 2008. This series was projected from 2009 to 2050 with the LC model. In the cohort dimension, the observed series covers the birth years from 1870 to 1920. This series was projected until 1950 with the help of the LC model. In addition, the cohort life expectancy increase in 1870–1920 was fitted by a linear trend, which was continued until 1950. The period series from 1870 to 2008 and from 1960 to 2008 were also fitted by long-term and short-term linear trends, respectively. Both trends were then continued until 2050.

In line with Oeppen and Vaupel (2002), we found that apart from small fluctuations the best-practice period life expectancy increased steadily from 1870 to 2008 (Pearson's  $r=0.991$ ). Record life expectancy among cohorts born in 1870 to 1920 also increased very regularly ( $r=0.985$ ), and faster than period life expectancy. The difference between the rates of progress led to a widening of the cohort/period life expectancy gap.

The linear trend across cohorts and the long-term linear trend across calendar years are expressed as

$$e^C(t) = c_0 + c_1(t - 1870)$$

and

$$e^P(t) = p_0 + p_1(t - 1870),$$

respectively, where  $e^C$  and  $e^P$  denote cohort and period life expectancies and  $c_0, c_1, p_0, p_1$  are parameters.

To compare cohort and period survival, Goldstein and Wachter (2006) defined the cohort vs. period length-of-life *gaps* and *lags*. The *gap* is defined as the difference between the life expectancy of the cohort born in year  $t$  and the period life expectancy in the same year  $t$ . This quantity can also be understood as the cohort *lifetime survival benefit*. It expresses the prolongation of life achieved by an average cohort member as a result of his or her survival into a lower-hazard future.

Once the parameters  $c_0, c_1$ , and  $p_0, p_1$  are known, the cohort/period linear-trend gap in year  $t$ ,  $G(t)$ , can be computed:

$$G(t) = (c_0 - p_0) + (c_1 - p_1)(t - 1870).$$

For year  $t$ , the *lag* is defined as the time interval between this calendar year and the year of birth  $t_0$ , such that  $e^C(t_0) = e^P(t)$ . The linear-trend lag,  $L(t)$ , can be computed as

$$L(t) = \frac{(c_0 - p_0)}{c_1} + \frac{(c_1 - p_1)}{c_1}(t - 1870).$$

**FIGURE 1 Trends in best-practice period and cohort life expectancies since 1870, females**

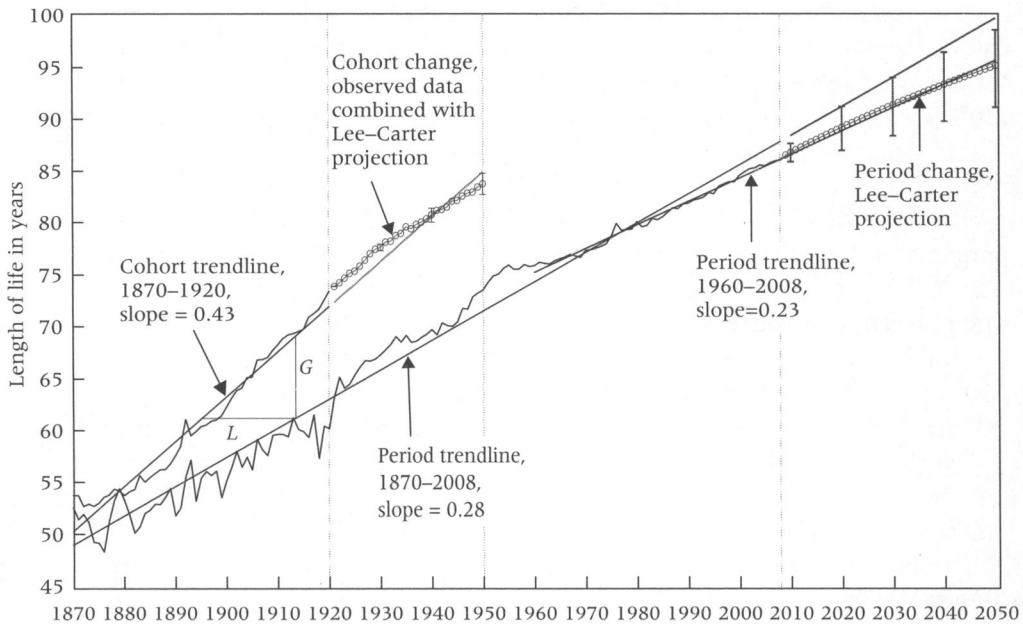


Table 1 provides the OLS estimates of the  $p$  and  $c$  parameters derived from the 1870–2008 series and the 1870–1920 series, respectively, and  $p$  parameters estimated from the 1960–2008 series. They suggest that the mean annual increase in best-practice cohort life expectancies between 1870 and 1920 is 0.43 years. The mean annual increase in best-practice period life expectancy between 1870 and 2008 is 0.28 years. Correspondingly, between 1870 and 1920,  $G$  increases from 1.3 to 8.9 years, and  $L$  increases from 3.0 years to 20.3 years. The linear-trend-based gaps and lags are not affected by fluctuations characteristic of the corresponding empirical gaps and lags.

For 1920, the observed best-practice cohort life expectancy is 73.4 years, with the corresponding linear-trendline value being 71.9 years. When extended, the long-term linear cohort trend leads to a life expectancy of 84.9 years and a 13-year cohort/period longevity gap in 1950.

With the LC-forecasted mortality, best-practice life expectancy is 83.8 years in the 1950 cohort, 10.3 years higher than the observed best-practice period life expectancy in the same year. We also found that if the mortality decrease continues according to the LC projection, the best-practice female cohort life expectancy can reach 93 years among those born during the 1970s (not shown in Figure 1).

Figure 1 shows future best-practice period life expectancy changes that are projected with the LC model fitted to mortality data for 1960–2008. Although the LC-projected trajectory is concave, until 2050 it remains in-

**TABLE 1** Linear trends in best-practice cohort and period life expectancies, females

	Range of years	Intercept	Slope	Pearson <i>r</i>
$e^C(t)$	1870–1920	50.260	0.430	0.985
$e^P(t)$	1870–2008	48.968	0.281	0.991
$e^P(t)$	1960–2008	75.227	0.227	0.995

distinguishable from the extrapolated short-term linear trend, with its slope equal to 0.23 years.

### Age patterns of progress

When mortality decreases, age patterns of cohort survival differ from the conventional period curves. The mortality decrease retards age-related mortality elevation and leads to a flattening of cohort mortality curves.

Figure 2 presents a decomposition of increasing period and cohort best-practice female life expectancies by age interval. For every year between 1870 and 1950, the period or cohort length of life is presented as a sum of lifetimes lived within five age intervals: 0 to 14, 15 to 44, 45 to 64, 65 to 84, and 85 and older:

$$e_0 = (T_0 - T_{15}) + (T_{15} - T_{45}) + (T_{45} - T_{65}) + (T_{65} - T_{85}) + T_{85}, \text{ assuming } l_0 = 1.$$

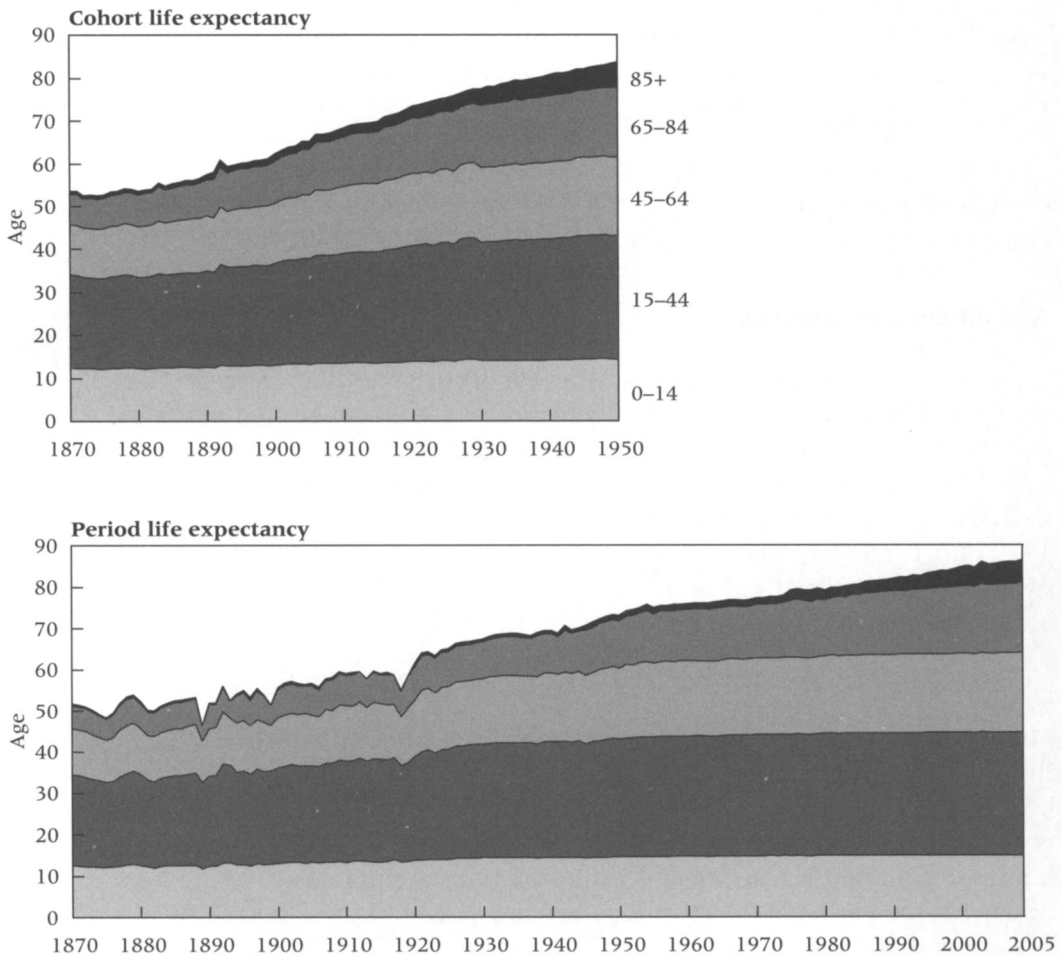
The additive terms are interrelated because the lifetime within each age interval, except the first one, depends on the number of survivors to its beginning.

In spite of some short-term distortions in period longevity, the general tendencies in Figure 2 are clear. Within four closed intervals covering ages under 85, the period and cohort lifetimes increase, and the lifetimes within the intervals increasingly approach the intervals' lengths. For each of the intervals, the pace of this change is steeper in the cohort dimension. The cohort advantage is especially pronounced for ages over 65.

Table 2 shows lifetime distributions of best-practice cohort and period lengths of life by age intervals in 1870 and 1950. In 1870, the age distributions were quite similar in the period and cohort dimensions. Between 1870 and 1950, the cohort and period lengths of life increased by 30.1 and 21.0 years, respectively. The shares of these incremental lifetimes lived after age 65 constitute about one-third in the period dimension and over one-half in the cohort dimension. Table 2 shows that the observed cohort lifetime benefit (gap) equals 1.2 years in 1870 and 10.3 years in 1950. In the cohort of 1950, a 70 percent share of the cohort lifetime benefit is expected to be lived at ages 65 and older, and a 38 percent share at ages 85 and older.

It is interesting to compare best-practice cohort and period life expectancies at various ages. Some of these are shown in Table 3. An especially

**FIGURE 2** Changes in best-practice cohort and period lifetimes by age group over time, in years, females



notable comparison is for age 65, which is the legal retirement age in many industrialized countries today. From 1870 to 1950, cohort life expectancies increased from 15.4 to 24.8 years, and period life expectancies increased from 13 to 16.3 years. The corresponding cohort/period gap increased from 1.4 to 8.5 years.

The differences between the cohort life expectancy at age 65 and period life expectancy at the same age and in the same countries in the years when this age is reached by the cohort of interest are 0.8 years and 1.8 years for the Norwegian cohort of 1870 (versus period 1935) and the Swiss cohort of 1950 (versus projected period 2015), respectively.

**TABLE 2 Cohort and period lifetimes by age group in countries with the highest life expectancy at birth, 1870 and 1950, females**

	1870	1950	Increase
<b>Cohort length of life</b>			
0–14	12.52	14.51	2.00
15–44	21.64	28.70	7.06
45–64	11.72	18.46	6.74
65–84	7.10	16.30	9.20
85+	0.73	5.80	5.06
Total	53.71	83.77	30.06
<b>Period length of life</b>			
0–14	12.69	14.57	1.88
15–44	22.25	28.62	6.37
45–64	11.52	17.38	5.86
65–84	5.65	11.47	5.82
85+	0.44	1.48	1.04
Total	52.55	73.53	20.98
Cohort/period gap	1.16	10.25	

NOTE: The lifetime values correspond to the following best-practice populations: Norway (cohort 1870), Switzerland (cohort 1950), Norway (period 1870), and Iceland (period 1950).

**TABLE 3 Cohort and period life expectancy at various ages in countries with the highest life expectancy at birth, 1870, 1950, and 2008, females**

Age	Cohort		Period		
	1870	1950	1870	1950	2008
0	53.71	83.77	52.55	73.53	86.04
15	52.02	71.82	49.19	60.90	71.38
45	30.24	42.93	26.82	32.92	42.08
65	15.35	24.80	12.98	16.33	23.63
85	4.77	8.59	4.88	5.96	8.19

NOTE: The life expectancy values correspond to the following best-practice populations: Norway (cohort 1870), Switzerland (cohort 1950), Norway (period 1870), Iceland (period 1950), and Japan (period 2008).

## Discussion

The rise of cohort and period longevity is a consequence of persistent mortality decline (Goldstein and Wachter 2006). Prior modeling of period and cohort mortality showed that if the force of mortality decreases over time at a constant rate (Vaupel 1986; Vaupel and Gowan 1986), the result is a linear increase in period life expectancy and a steeper linear increase in cohort life expectancy (Goldstein and Wachter 2006; Missov and Lenart 2011).

This study provides new evidence on best-practice cohort longevity from long-term international mortality data. We used female HMD data from 1870 to 2008 and projected mortality at unobserved ages in non-extinct cohorts. The Lee–Carter model, used for projecting, was fitted to relatively slowly decreasing mortality in 1960–2008.

We found that best-practice female life expectancy increased across cohorts from 1870 to 1920 by an average of 0.43 years annually. Best-practice period life expectancy between 1870 and 2008 increased by 0.28 years annually, which is slightly faster than predicted by the Oeppen–Vaupel trend line (Oeppen and Vaupel 2002). The extrapolation of these linear trends resulted in a best-practice average length of life of 84.9 years for the cohort of 1950. The LC-based mortality projection resulted in only a slightly lower length of life for the same cohort of 83.8 years. The cohort/period gap in the cohort of 1950 was close to 11 years. For females, mortality progress, if it continues, will lead to an average length of life of about 93 years and to a cohort/period gap of about 14 years among cohorts born in the 1970s.

Cohort longevity patterns are determined by shapes of mortality decrease over time. The person-years each cohort spends at older ages has been increasing faster than the total length of life. Half of the additional years of life gained by the best-practice cohort of 1950 compared to the best-practice cohort of 1870 is expected to be lived at ages 65 and older. The prolongation of life into old and oldest-old ages changes the traditional balance between the different stages of the life cycle and has large-scale socioeconomic consequences that may be addressed in different ways, including rescaling the life cycle or the redistribution of work among people of different ages (Lee and Goldstein 2003; Vaupel and Loichinger 2006).

Mortality forecasts are of great importance to the provision of policy-relevant information (Waldron 2005). The levels of survival to advanced ages reached by recent cohorts have been substantially higher than would have been expected from period mortality regimes when these cohorts were young and of working age, or even when they were approaching the age of retirement. Therefore, governments making institutional arrangements for retirement and health care could have been unaware of the actual prospects of cohort survival.

The increase in longevity across younger cohorts depends on future mortality reductions. Apart from the best-practice trends at the national level, reasons for optimism can be seen in the extremely low levels of mortality already found among certain sub-national groups (Martelin 1996; Murray et al. 2006; Shkolnikov et al. 2007) and in research indicating that considerable resources for further reductions in mortality are available through better control of risk factors by individuals and institutions (Manton, Stallard, and Tolley 1991).

Some scholars have argued that new health threats have the potential to attenuate improvements in health (Olshansky et al. 2005). Obesity is one of

the most widely discussed risk factors (Olshansky et al. 2005; Breslow 2006; Kim and Popkin 2006; Houston et al. 2007). Although obesity doubtless plays a negative role, it has never produced life expectancy decrease in any of the advanced countries (Preston 2005; Campos et al. 2006; Orbach 2006; Christensen et al. 2009). In this regard, one should note that the remarkable rise in life expectancy over the twentieth century occurred despite the epidemic of cigarette smoking. The decline in all-cause mortality over the past two centuries suggests that the trend of improvements in life expectancy can continue, even if some adverse factors reduce the rate of progress from levels that might otherwise be achieved.

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## Note

Figures in this article are available in color in the electronic edition of the journal.

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1 We applied function *lca.forecast* from R package *demography* by Rob J. Hyndman available at «<http://robjhyndman.com/software/demography>».

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## Appendix 1

### Countries and years with best-practice period and cohort female life expectancies

Country	Years
<b>Period life expectancy, 1870–2008</b>	
Australia	1921–1922, 1924–1925
Denmark	1904, 1910, 1914–1915, 1918
Iceland	1889, 1892–1893, 1896, 1899, 1906, 1912–1913, 1917, 1919, 1946, 1949–1950, 1952, 1954–1955, 1958, 1961–1964, 1975–1981, 1983
Japan	1982, 1984–2008
New Zealand, Non-Maori	1926–1937, 1939–1941, 1944
Norway	1870–1871, 1873–1881, 1883–1886, 1897, 1900–1903, 1905, 1908, 1911, 1920, 1938, 1945, 1947–1948, 1951, 1953, 1956–1957, 1959–1960, 1965–1970, 1974
Sweden	1872, 1882, 1887–1888, 1890–1891, 1894–1895, 1898, 1907, 1909, 1916, 1923, 1942–1943, 1971–1973
<b>Cohort life expectancy, 1870–1920</b>	
Iceland	1891–1893
Norway	1870–1887, 1889–1890, 1894–1904, 1906–1920
Sweden	1888, 1905
<b>Predicted cohort life expectancy, 1921–1950</b>	
Australia	1921–1922, 1944–1948
Norway	1924–1925
New Zealand, Non-Maori	1927–1929
Switzerland	1923, 1926, 1930–1943, 1949–1950

## Appendix 2

Countries with best-practice period and cohort female life expectancies, 1870–2008

Year	Period life expectancy		Cohort life expectancy	
	Country	Years	Country	Years
1870	Norway	52.55	Norway	53.71
1871	Norway	51.41	Norway	53.71
1872	Sweden	51.92	Norway	52.67
1873	Norway	51.15	Norway	52.90
1874	Norway	49.22	Norway	52.68
1875	Norway	49.15	Norway	52.99
1876	Norway	48.30	Norway	53.55
1877	Norway	51.20	Norway	53.76
1878	Norway	53.18	Norway	54.33
1879	Norway	54.37	Norway	54.15
1880	Norway	53.28	Norway	53.71
1881	Norway	51.86	Norway	54.08
1882	Sweden	50.11	Norway	54.29
1883	Norway	50.71	Norway	55.64
1884	Norway	52.01	Norway	55.01
1885	Norway	52.31	Norway	55.45
1886	Norway	52.89	Norway	55.84
1887	Sweden	52.85	Norway	56.21
1888	Sweden	53.53	Sweden	56.23
1889	Iceland	54.39	Norway	56.78
1890	Sweden	51.77	Norway	57.56
1891	Sweden	52.53	Iceland	58.47
1892	Iceland	55.53	Iceland	61.06
1893	Iceland	57.13	Iceland	59.49
1894	Sweden	53.17	Norway	59.89
1895	Sweden	55.38	Norway	60.37
1896	Iceland	56.04	Norway	60.52
1897	Norway	55.65	Norway	60.88
1898	Sweden	56.07	Norway	61.01
1899	Iceland	53.52	Norway	61.42
1900	Norway	55.15	Norway	62.47
1901	Norway	56.45	Norway	63.36
1902	Norway	57.99	Norway	64.03
1903	Norway	56.46	Norway	64.28
1904	Denmark	57.42	Norway	65.29
1905	Norway	56.19	Sweden	65.37
1906	Iceland	59.15	Norway	66.96
1907	Sweden	58.13	Norway	66.99
1908	Norway	57.57	Norway	67.22
1909	Sweden	59.53	Norway	67.89
1910	Denmark	59.63	Norway	68.41
1911	Norway	59.63	Norway	69.00
1912	Iceland	59.39	Norway	69.36
1913	Iceland	61.23	Norway	69.46
1914	Denmark	60.10	Norway	69.68
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## Appendix 2 (continued)

Year	Period life expectancy		Cohort life expectancy	
	Country	Years	Country	Years
1915	Denmark	59.88	Norway	69.91
1916	Sweden	59.33	Norway	71.04
1917	Iceland	61.51	Norway	71.38
1918	Denmark	57.30	Norway	71.82
1919	Iceland	60.42	Norway	72.68
1920	Norway	60.17	Norway	73.56
1921	Australia	63.24	Australia	73.87
1922	Australia	65.16	Australia	74.24
1923	Sweden	64.10	Switzerland	74.68
1924	Australia	64.52	Norway	75.14
1925	Australia	65.38	Switzerland	75.36
1926	New Zealand	66.13	Switzerland	75.83
1927	New Zealand	66.75	New Zealand	76.41
1928	New Zealand	66.71	New Zealand	77.01
1929	New Zealand	66.90	New Zealand	77.43
1930	New Zealand	67.31	Switzerland	77.61
1931	New Zealand	67.78	Switzerland	78.11
1932	New Zealand	68.29	Switzerland	78.19
1933	New Zealand	69.03	Switzerland	78.73
1934	New Zealand	68.51	Switzerland	78.94
1935	New Zealand	69.14	Switzerland	79.57
1936	New Zealand	68.48	Switzerland	79.38
1937	New Zealand	68.60	Switzerland	79.80
1938	Norway	68.97	Switzerland	80.03
1939	New Zealand	69.26	Switzerland	80.33
1940	New Zealand	69.70	Switzerland	80.72
1941	New Zealand	69.20	Switzerland	81.16
1942	Sweden	70.35	Switzerland	81.25
1943	Sweden	70.09	Switzerland	81.47
1944	New Zealand	70.01	Australia	82.05
1945	Norway	70.45	Australia	82.13
1946	Iceland	71.74	Australia	82.56
1947	Norway	71.67	Australia	82.85
1948	Norway	72.87	Australia	82.96
1949	Iceland	73.24	Switzerland	83.45
1950	Iceland	73.53	Switzerland	83.77
1951	Norway	74.29		
1952	Iceland	74.89		
1953	Norway	75.06		
1954	Iceland	75.62		
1955	Iceland	75.92		
1956	Norway	75.53		
1957	Norway	75.54		
1958	Iceland	75.97		
1959	Norway	75.79		
1960	Norway	75.86		
1961	Iceland	76.20		

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## Appendix 2 (continued)

Year	Period life expectancy	
	Country	Years
1962	Iceland	76.08
1963	Iceland	76.03
1964	Iceland	76.35
1965	Norway	76.52
1966	Norway	76.70
1967	Norway	76.94
1968	Norway	76.79
1969	Norway	76.66
1970	Norway	77.31
1971	Sweden	77.38
1972	Sweden	77.53
1973	Sweden	77.71
1974	Norway	77.93
1975	Iceland	78.68
1976	Iceland	79.89
1977	Iceland	79.24
1978	Iceland	79.30
1979	Iceland	79.35
1980	Iceland	80.07
1981	Iceland	79.56
1982	Japan	79.71
1983	Iceland	80.37
1984	Japan	80.25
1985	Japan	80.53
1986	Japan	80.96
1987	Japan	81.41
1988	Japan	81.31
1989	Japan	81.78
1990	Japan	81.85
1991	Japan	82.16
1992	Japan	82.29
1993	Japan	82.44
1994	Japan	82.90
1995	Japan	82.79
1996	Japan	83.52
1997	Japan	83.75
1998	Japan	83.95
1999	Japan	83.95
2000	Japan	84.58
2001	Japan	84.91
2002	Japan	85.21
2003	Japan	85.30
2004	Japan	85.57
2005	Japan	85.49
2006	Japan	85.79
2007	Japan	85.98
2008	Japan	86.04

NOTE: Cohort life expectancies 1921–1950 are predicted values (see text on p. 422 for more details).