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Supporting information

Supplementary methods and results

This appendix was part of the submitted manuscript and has been peer reviewed.
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Appendix to: Lopez AD, Adair T. Slower increase in life expectancy in Australia than in other high income countries: the contributions of age and cause of death. *Med J Aust* 2019; doi: 10.5694/mja2.50144.

Slower increase in life expectancy in Australia than in other high income countries: the contributions of age and cause of death: Supplementary methods and results

Supplementary methods

List of high income countries included in analysis

Australia; Austria, Belgium, Denmark, Finland, France, Germany, Greece, Iceland, Ireland, Italy, Malta, Netherlands, Norway, Portugal, Spain, Sweden, Switzerland, United Kingdom (western Europe); Israel, Brunei, Japan, Singapore, South Korea, New Zealand, Canada, United States.

Description of the life table decomposition method

A widely-used summary method to measure the contributions of age groups and causes of death to mortality differences in life expectancy at birth between two populations is the life table decomposition method developed by Arriaga and Pollard.[1,2] Following this method, the contribution of mortality differences within age groups to the life expectancy at birth gap was calculated as:

$${}_n\Delta_x = \frac{l_x^1}{l_0^1}\cdot\left(\frac{{}_nL_x^2}{l_x^2} - \frac{{}_nL_x^1}{l_x^1}\right) + \frac{T_{x+n}^2}{l_0^1}\cdot\left(\frac{l_x^1}{l_x^2} - \frac{l_{x+n}^1}{l_{x+n}^2}\right)$$

$${}_\infty\Delta_x = \frac{l_x^1}{l_0^1}\cdot\left(\frac{T_x^2}{l_x^2} - \frac{T_x^1}{l_x^1}\right)$$

$$e_0^0(2) - e_0^0(1) = \sum\nolimits_x {}_n\Delta_x$$

where ${}_n\Delta_x$ is the contribution of mortality difference in age group x to $x+n$ to differences in life expectancy at birth at birth, ${}_\infty\Delta_x$ is the contribution of mortality difference in the open-ended age group to differences in life expectancy at birth at birth, l_x^1, ${}_nL_x^1$ and T_x^1 are life table functions in the other population, l_x^2, ${}_nL_x^2$ and T_x^2 are life table functions in the Australian population, $e_0^0(2)$ is life expectancy at birth at birth in the Australian population and $e_0^0(1)$ is life expectancy at birth at birth in the other population.(3) At a given time, the total life expectancy at birth gap between Australia and the other population is equal to the sum of the sum of the contribution of all age groups.

Decomposition of the contribution of causes of death to life expectancy at birth was computed as follows:

$${}_n\Delta_x^i = {}_n\Delta_x\cdot\left(\frac{{}_nR_x^i(2).\,{}_nm_x(2) - {}_nR_x^i(1).\,{}_nm_x(1)}{{}_nm_x(2) - {}_nm_x(1)}\right)$$

where ${}_n\Delta_x^i$ is the contribution of cause i in age groups x to $x+n$ to differences in life expectancy at birth at birth, ${}_n\Delta_x$ is the contribution of all-cause mortality difference in age groups x to $x+n$ to differences in life expectancy at birth at birth (as above), ${}_nm_x(1)$and ${}_nm_x(2)$ are the all-cause mortality rates in age groups x to $x+n$ in the other and Australian population respectively and ${}_nR_x^i(1)$ and ${}_nR_x^i(2)$ are the proportion of deaths from cause i in age groups x to $x+n$ in the other and Australian population respectively.[3]

In summary, the sum of the contribution of all age groups or all causes equals the difference in life expectancy at birth between Australian and the comparator country or group of countries. The age and cause contribution to the change in the life expectancy at birth gap over a period was measured as the contribution at the end of a period minus the respective contribution at the start of a period. This approach attributes change in relative life expectancy at birth during each period to change in the relative contribution of each age group or each cause. Age groups or causes that contribute to increases in Australia's relative life expectancy at birth would have favourable mortality trends in those age groups or causes in Australia compared with the comparator country or countries.

Supplementary results: Regression analysis of life expectancy trends

Linear regression analysis by period indicated that life expectancy for both males and females increased more rapidly during 1990–2003 than during 2003–2016.

Table 1. Linear regression analysis of life expectancy in Australia, 1990–2016, by sex and period

	Coefficient*	r^2	*P*
Men			
1990–2003	0.3075	0.995	< 0.001
2003–2016	0.2005	0.960	< 0.001
Women			
1990–2003	0.2176	0.997	< 0.001
2003–2016	0.1264	0.959	< 0.001

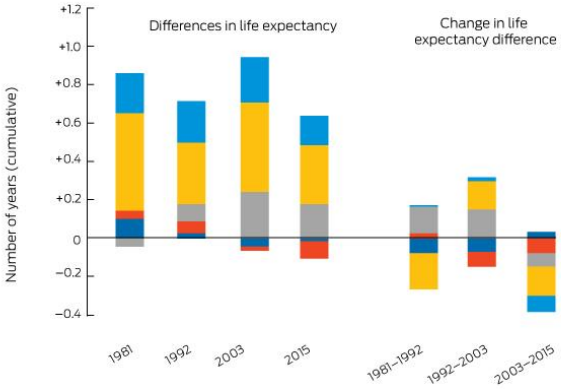
* That is, increase in life expectancy per year.

The 95% uncertainty intervals (UIs) for life expectancy in 2012 and 2016 overlapped substantially, indicating no significant increase in life expectancy for either sex. Life expectancy for males in 2012 was 80.2 years (95% UI, 79.9–80.4 years), in 2016 it was 80.4 years (95% UI, 79.6–81.1 years). For women, life expectancy in 2012 was 84.3 years (95% UI, 84.1–84.5 years, in 2016 it was 84.5 years (95% UI, 83.7–85.2 years).

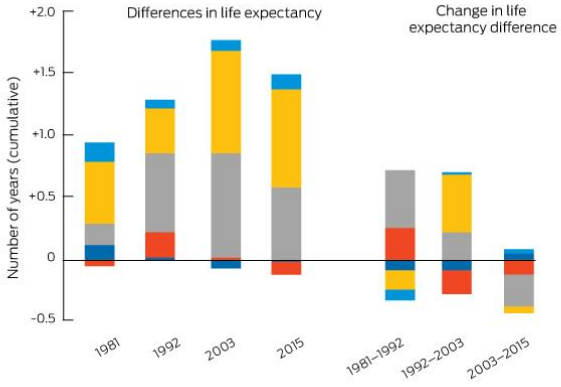
Supplementary results: Age group-specific contributions to differences in life expectancy at birth for males between Australia and western Europe and the United States, 1980–2016*

Figure 1 (please note different scales)

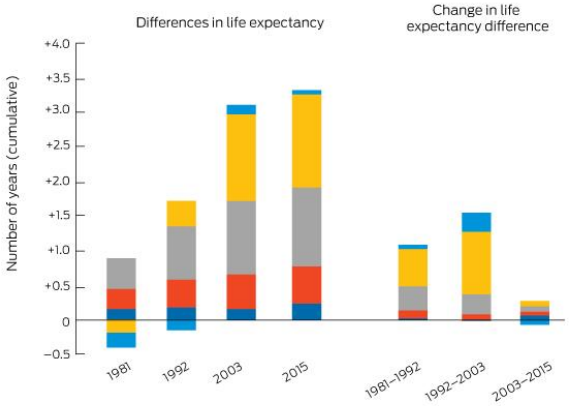
A. Western Europe: females



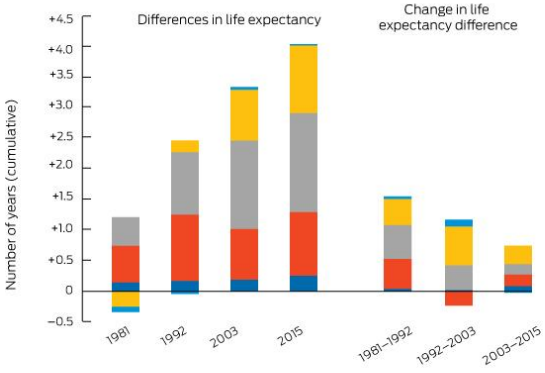
B. Western Europe: males



C. United States: females



D. United States: males



* Years are 3-year means for 1980–1982, 1991–1993, 2002–2004, 2014–2016.

Supplementary results: Differences in life expectancy between Australia and individual high income countries, 1980–2016

Table 2. Difference in life expectancy for males between Australia and individual high income countries, 1980–2016 (3-year average), ranked by difference in 2015

	Difference in life expectancy (years)				Change (years)		
Country	**1981**	**1992**	**2003**	**2015**	**1981–1992**	**1992–2003**	**2003–2015**
Singapore	2.4	0.6	–0.1	–1.1	–1.8	–0.7	–1.0
Switzerland	–1.2	0.2	0.1	–0.4	1.4	–0.1	–0.5
Japan	–2.5	–1.5	–0.2	–0.1	0.9	1.3	0.0
Iceland	–2.5	–1.6	–0.8	0.0	0.9	0.8	0.8
Spain	–1.2	0.8	1.4	0.3	2.0	0.6	–1.0
Sweden	–1.8	–0.7	0.1	0.3	1.1	0.8	0.2
Norway	–1.2	0.4	1.0	0.5	1.6	0.6	–0.5
Italy	0.2	0.6	0.6	0.6	0.4	0.0	0.0
Canada	–0.8	0.0	0.7	0.8	0.8	0.6	0.1
Netherlands	–1.3	0.5	1.6	0.9	1.8	1.1	–0.7
New Zealand	1.0	1.3	1.0	0.9	0.3	–0.2	–0.1
Israel	–0.6	0.4	1.3	0.9	1.0	0.9	–0.5
France	0.6	1.2	1.8	1.4	0.6	0.6	–0.4
Malta	1.5	0.5	1.7	1.5	–1.0	1.2	–0.2
Austria	2.1	2.1	2.0	1.5	–0.1	–0.1	–0.4
United Kingdom	1.0	1.3	1.8	1.6	0.3	0.5	–0.2
Ireland	1.2	2.1	2.5	1.6	0.8	0.4	–0.9
Denmark	–0.2	1.9	2.8	1.8	2.1	0.9	–1.0
Finland	1.7	2.8	2.9	1.9	1.2	0.1	–1.0
Greece	–3.6	0.0	1.5	2.1	3.6	1.5	0.6
Belgium	1.2	1.7	2.5	2.1	0.4	0.8	–0.4
Germany	1.3	2.1	2.3	2.1	0.8	0.2	–0.2
Portugal	2.8	3.6	3.8	2.8	0.7	0.3	–1.0
South Korea	7.8	5.9	4.2	2.8	–1.9	–1.7	–1.4
USA	0.9	2.4	3.3	4.0	1.5	0.9	0.7
Brunei	2.3	2.8	3.5	6.0	0.5	0.7	2.5
Australia: ranking	**12**	**5**	**4**	**5**	**5**	**6**	**19**

Table 3. Difference in life expectancy for females between Australia and individual high income countries, 1980–2016 (3-year average), ranked by difference in 2015

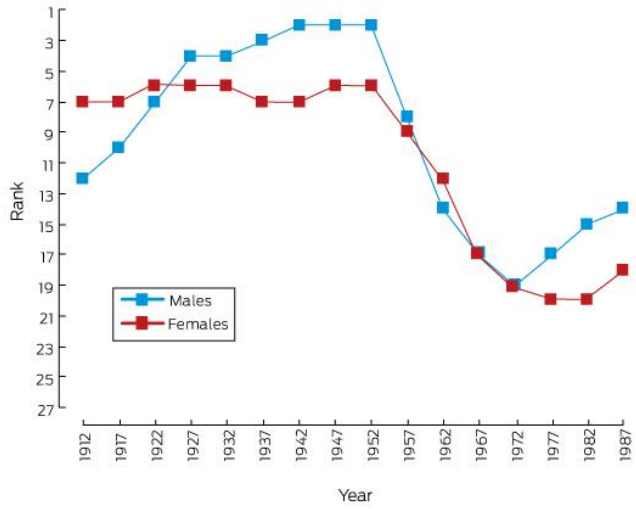
	Difference in life expectancy (years)				Change (years)		
Country	**1992**	**2003**	**2003**	**2015**	**1981–1992**	**1992–2003**	**2003–2015**
Japan	–0.9	–1.6	–2.1	–2.3	–0.7	–0.5	–0.2
Singapore	3.6	1.6	0.0	–2.1	–2.1	–1.5	–2.1
Spain	–0.4	–0.5	–0.4	–1.0	0.0	0.1	–0.6
France	–0.6	–1.0	–0.4	–0.7	–0.4	0.6	–0.4
Switzerland	–0.9	–0.6	–0.2	–0.6	0.2	0.4	–0.4
Italy	0.5	0.0	–0.2	0.0	–0.5	–0.2	0.2
Finland	0.2	1.2	1.1	0.2	1.0	–0.1	–0.9
South Korea	5.8	3.6	2.2	0.3	–2.2	–1.3	–1.9
Norway	–1.0	0.3	1.1	0.5	1.3	0.7	–0.6
Sweden	–0.9	–0.1	0.7	0.6	0.7	0.9	–0.1
Portugal	2.8	2.3	1.9	0.6	–0.5	–0.4	–1.2
Iceland	–1.6	0.0	0.5	0.6	1.6	0.4	0.2
Israel	2.7	2.7	1.8	0.6	0.1	–0.9	–1.2
Malta	4.5	2.4	2.3	0.7	–2.0	–0.2	–1.6
Canada	–0.8	–0.2	0.8	0.8	0.6	1.0	0.0
Austria	2.0	1.4	1.2	0.8	–0.6	–0.2	–0.4
Netherlands	–1.0	0.5	2.0	1.0	1.4	1.5	–0.9
Greece	–1.2	0.8	1.0	1.1	1.9	0.2	0.1
New Zealand	1.7	1.5	1.6	1.2	–0.1	0.0	–0.4
Belgium	1.5	1.0	1.5	1.2	–0.5	0.5	–0.3
Ireland	2.5	2.5	2.4	1.3	0.0	–0.2	–1.1
Germany	1.9	1.6	1.5	1.3	–0.3	–0.1	–0.2
Denmark	0.9	2.6	3.2	1.8	1.7	0.6	–1.3
United Kingdom	1.5	1.8	2.2	1.8	0.3	0.4	–0.5
USA	0.5	1.6	3.1	3.3	1.1	1.5	0.2
Brunei	6.9	5.2	4.2	5.1	–1.7	–1.0	0.9
Australia: ranking	**11**	**7**	**6**	**7**	**15**	**13**	**22**

Supplementary results: Birth cohorts

The increase in life expectancy at birth for Australian males between 1981 and 2003 was mainly attributable to reduced mortality for men aged 45–64 years during the 1980s or 65–84 years during the 1990s (Box 2 in main manuscript). This suggests that mortality risks were reduced to a greater degree in certain birth cohorts than in others. This is confirmed by the comparative analysis depicted in supplementary Figure 1, in which each cohort of Australian males born from the late 1920s to the early 1950s made a net positive contribution to overall Australian life expectancy compared with all but at most four other high income countries; for men born between 1942 and 1952, there was a net positive contribution compared with all other high income countries but one (Iceland). The relative contribution to differences in life expectancy for women between Australia and other countries was also greatest for this birth cohort, being positive compared with all but five or six other high income countries.

However, net positive contributions to differences in life expectancy at birth for males and females born in Australia from the late 1960s onwards were made with respect to fewer than half the high income countries. Indeed, Australian age-specific death rates for some of the younger birth cohorts have been significantly higher than for many other countries. For example, for the 1972 birth cohort (men aged about 45 in 2017), mean age-specific death rates have been 52% higher than in Singapore, 60% higher than in Sweden, 58% higher than in the Netherlands, and 43% higher than in Japan.[4] For the 1972 birth cohort of women, Australian mean age-specific death rates have been 34% higher than in Sweden, 27% higher than in Italy, and 26% higher than in Japan.[4]

Figure 2. Ranking of life expectancy at birth for Australian birth cohorts (ie, mean annual contribution to difference in life expectancy between Australia and other high income countries), 1982–2016, by sex



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