

Peer Review

Age-specific trends in cardiovascular mortality rates in Australia between 1980 and 2005

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Aim: Recent analyses suggest the decline in coronary heart disease (CHD) mortality rates is slowing in younger age groups in countries such as the UK and US. We aimed to assess recent mortality rate trends in all circulatory disease and its subtypes in Australia.

Methods: Annual all circulatory, CHD, and cerebrovascular disease mortality rates between 1980 and 2005 for Australia were analysed. Data were stratified by sex and ten-year age group (age 35 to 85+). The annual rate of change and significant changes in trends were identified using joinpoint Poisson regression.

Results: Age standardised all circulatory disease mortality rates continue to decline in Australia, falling from 441 per 100,000 in 1980 to 145 per 100,000 in 2005 for males and from 264 per 100,000 to 96 per 100,000 for females. The rate of decline from both CHD and cerebrovascular disease appears to be stable or accelerating for individuals aged 55 years and over. However, the decline in young men and women aged 35-54 years is slowing for CHD and cerebrovascular disease mortality alike (except cerebrovascular disease mortality in males aged 35-44). For females aged 35-44 and 45-54 there has been no change in the cerebrovascular mortality rate since 1993 and 1999, respectively.

Conclusions: In Australia, whilst in older adults the decline in cardiovascular mortality rates is generally accelerating, in younger adults it appears to be slowing. It will be important to identify the causes of these trends.

Introduction

Age-standardised cardiovascular disease (CVD) mortality rates have been continually declining since the 1960s in the developed world¹. Between 1990 and 1997 it appeared that there was a slowing of the decline in age-standardised cerebrovascular and coronary heart disease (CHD) mortality rates in the US.¹ However, more recent analyses suggest the decline in age-standardised CHD mortality rates has continued in countries such as the US and UK since 1997, and has actually accelerated in recent years.^{2,3}

In younger adults these trends appear to differ. Recent data suggests a slowing of the decline in CHD mortality rates at younger ages in several developed countries (2-5). Specifically, there has been a slowing in the decline of CHD mortality rates in individuals aged under 55 years in the UK and US (2, 4). In Wales this is most pronounced in the most deprived population sub-group where CHD mortality rates have stopped decreasing at all for the first time in over two decades.³

To date there have been no age-specific analyses of trends in CVD mortality rates within Australia. Here we analysed trends in age-specific CVD mortality rates, and its major subtypes – CHD and cerebrovascular disease – in Australia between 1980 and 2005.

Methods

Data

National mortality rates were obtained for ten year age groups from age 35 to 84 years between 1980 and 2005 for all circulatory disease (ICD-9 codes 390-459 & ICD-10 codes I00-99), CHD (ICD-9 codes 410-414) and cerebrovascular disease (ICD-9 codes 430-438 & ICD-10 codes I60-I69). Number of deaths and population counts obtained for Australia (source: Australian Institute of Health and Welfare) were used to calculate annual mortality rates. Within each 10 year age group the number of deaths in each year was divided by the mid-year population to calculate the age-specific mortality rate for that year. Age-standardised mortality rates were calculated for all circulatory disease mortality based on the World Health Organisation World Standard Population (New), for comparability with other international analyses. Direct standardisation was used. For males and females separately, the corresponding age-specific estimated mortality rates for all circulatory causes of death (for each 5 year age group from 0-4 to 85+, calculated as above) were applied to the World Standard Population.⁶

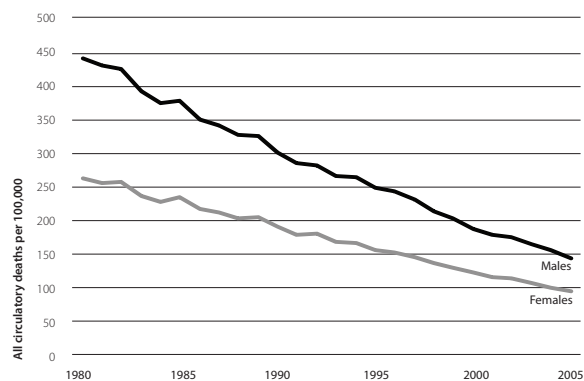
Joinpoint Poisson regression provided the estimated annual percentage change (EAPC) in each mortality rate and detected points in time at which significant changes in the trends occurred (Joinpoint Regression Program, Version 3.4.2. October

2009; Statistical Research and Applications Branch, National Cancer Institute). Joinpoint regression is a statistical method which identifies points (joinpoints) where the direction or the magnitude of the trend significantly changes. The analysis starts with a minimal number of joinpoints (eg 0 joinpoints, which represents a straight line) and tests whether one or more joinpoints (here up to a maximum of 3) are significant and need to be added to the model. In the final model every joinpoint represents a significant change in the slope of the trend. A regression line is fitted to the natural logarithm of the rates to calculate the EAPC. The joinpoint permutation test was used to select the most parsimonious model that best fitted the data. A maximum of three joinpoints was allowed for estimations. For each annual percentage change estimate, the corresponding 95% confidence interval (95% CI) was calculated.⁷

Results

The age-standardised rate of all circulatory disease mortality has declined since 1980 in Australia (Figure 1), from 441 per 100,000 to 145 per 100,000 in 2005 for males and from 264 per 100,000 to 96 per 100,000 in 2005 for females.

Figure 1: Age standardised all circulatory disease mortality rates (standardised to the World Health Organisation World Standard).



Age-specific all circulatory disease mortality rates declined between 1980 and 2005 for men and women aged 55 years and over, with the rate of decline generally accelerating in the most recent period (data not shown – Supplementary Table available). In both males and females aged 35–44 and 45–54, circulatory disease mortality rates declined continuously until the early 1990s, after which the rate of decline slowed.

Similarly, age-specific rates of CHD and cerebrovascular disease decreased in all age groups in both males and females between 1980 and 2005 (Figure 2). Reductions in CHD mortality rates ranged from 3150 per 100,000 in 1980 to 1079 per 100,000 in 2005 for males aged 75–84 to 42 per 100,000 in 1980 to 16 per 100,000 in 2005 for males aged 35–44 years. For females, the reduction in CHD mortality rates ranged from 1824 per 100,000 in 1980 to 643 per 100,000 in 2005 for 75–84 year olds to 11 per 100,000 in 1980 to 4 per 100,000 in 2005 for females aged 35–44 years. Joinpoint analysis of CHD mortality rates demonstrated that for males and females aged 55–64, 65–74 and 75–84 the CHD mortality rate decline accelerated from the late 1980s/ early 1990s. In contrast, for male and female 35–44 and 45–54 year olds the most recent change in rate was a deceleration in the decline (Table 1a, Figure 2a).

Figure 2: Trends in age-specific (A) coronary heart disease mortality rates and (B) cerebrovascular disease mortality rates for each 10 year age group between 1980 and 2005

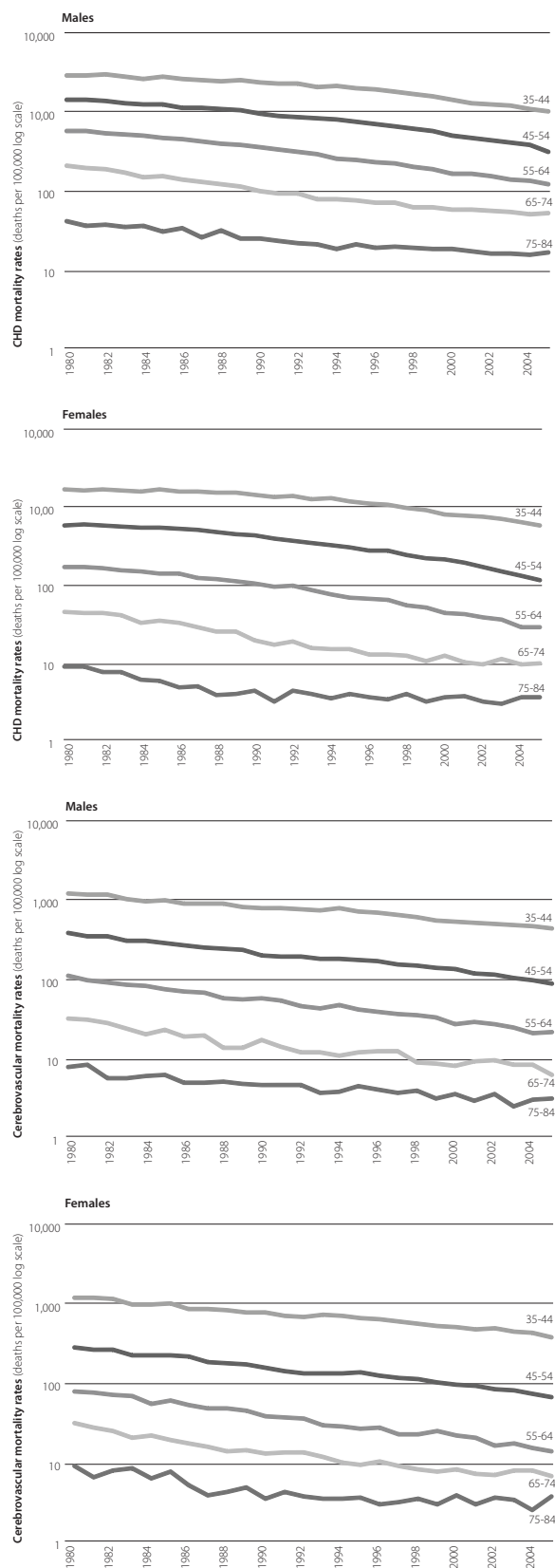


Table 1a: Annual change in rate (95% CI) of (A) coronary heart disease, and (B) cerebrovascular disease mortality between 1980 and 2005. The annual change in rate in each period is significantly different from the preceding period, as determined by joinpoint analysis.

	Age group	Period I		Period II		Period III		Period IV	
		Years	EAPC	Years	EAPC	Years	EAPC	Years	EAPC
males	35-44	1980-1994	-5.1 (-5.8,-4.3)	1994-2005	-2.2 (-3.4,-0.9)				
	45-54	1980-1994	-7.1 (-7.4,-6.7)	1994-2005	-4.0 (-4.6,-3.3)				
	55-64	1980-1987	-4.1 (-4.8,-3.5)	1987-2005	-6.9 (-7.1,-6.7)				
	65-74	1980-1988	-3.8 (-4.4,-3.2)	1988-1997	-5.3 (-6.0,-4.6)	1997-2005	-8.3 (-9.2,-7.4)		
	75-84	1980-1994	-2.4 (-2.7,-2.1)	1994-2005	-6.4 (-6.9,-5.9)				
females	35-44	1980-1988	-9.9 (-12.2,-7.7)	1988-2005	-1.3 (-2.2,-0.4)				
	45-54	1980-1996	-8.0 (-8.7,-7.2)	1996-2005	-3.3 (-5.6,-1.0)				
	55-64	1980-1992	-5.2 (-5.7,-4.6)	1992-2005	-8.8 (-9.5,-8.1)				
	65-74	1980-1985	-1.6 (-2.5,-0.7)	1985-1990	-4.7 (-5.9,-3.4)	1990-2000	-6.8 (-7.2,-6.4)	2000-2005	-11.2 (-12.5,-9.8)
	75-84	1980-1987	-1.0 (-2.1,0.0)	1987-1994	-3.0 (-4.2,-1.8)	1994-2005	-6.6 (-7.2,-6.1)		

	age group	Period I		Period II		Period III		Period IV	
		Years	EAPC	Years	EAPC	Years	rate change	Years	EAPC
males	35-44	1980-2005	-3.6 (-4.2,-3.1)						
	45-54	1980-1988	-8.7 (-11.2,-6.1)			1988-2005	-4.3 (-5.4,-3.2)		
	55-64	1980-2005	-6.1 (-6.3,-5.8)						
	65-74	1980-1991	-5.7 (-6.3,-5.2)	1991-1996	-3.1 (-5.9,-0.2)	1996-2005	-6.6 (-7.6,-5.7)		
	75-84	1980-1991	-4.7 (-5.3,-4.1)	1991-1994	-0.5 (-9.7,9.6)	1994-2005	-5.1 (-5.8,-4.5)		
females	35-44	1980-1993	-7.2 (-9.3,-5.1)	1993-2005	-0.1 (-2.9,2.8)				
	45-54	1980-1986	-9.2 (-11.7,-6.6)	1986-1999	-5.7 (-6.9,-4.5)	1999-2005	-1.7 (-5.3,2.1)		
	55-64	1980-2005	-6.7 (-7.0,-6.4)						
	65-74	1980-2005	-5.3 (-5.6,-5.0)						
	75-84	1980-1991	-4.7 (-5.3,-4.1)	1991-1994	-0.5 (-9.7,9.6)	1994-2005	-5.1 (-5.8,-4.5)		

Decreases in cerebrovascular disease mortality rates ranged from 1298 per 100,000 in 1980 to 465 per 100,000 in 2005 for males aged 75–84 years to 8 per 100,000 in 1980 to 3 per 100,000 in 2005 for males aged 35–44 years. For females, the reduction in cerebrovascular mortality rates ranged from 1222 per 100,000 in 1980 to 391 per 100,000 in 2005 for 75–84 year olds to 9 per 100,000 in 1980 to 4 per 100,000 in 2005 for females aged 35–44 years. Joinpoint analysis of cerebrovascular disease mortality rates demonstrated that a slowing in the cerebrovascular mortality rate decline in females aged 35–44 and 45–54 years and males aged 45–54 years occurred in the most recent period (Table 1b, Figure 2b).

For females aged 35–44 and 45–54, this slowing has led to a plateau in the cerebrovascular mortality rate, with no significant change in cerebrovascular mortality rates since 1993 and 1999, respectively. For males aged 35–44 the annual rate of change for cerebrovascular mortality was a constant -3.6% between 1980 and 2005. No significant change in the trend for cerebrovascular disease mortality rates was detected for males aged 55–64 years and females aged 55–64 and 65–74 years throughout the entire analysis period. A plateau in the mortality rate declines in the early 1990s prior to further acceleration in the most recent periods was observed for males aged 65–74 and 75–84 years and females aged 75–84 years.

Discussion

This detailed analysis of CVD mortality rates between 1980 and 2005 demonstrates that within Australia, individuals aged over 55 years showed either continued or accelerated declines in CHD and cerebrovascular disease mortality rates in both sexes in most recent times. A slowing in the rate of decline of CHD was the most recent change observed in males and females aged between 35 and 54 years. Trends in cerebrovascular disease mortality were similar, but more variable. For males aged 45–54 years and females aged 35–54 years a slowing in the rate of decline was observed in the most recent time period, resulting in a non-significant change in the cerebrovascular disease mortality rates for females since the 1990s.

The continuing or accelerating decline in CHD and cerebrovascular disease mortality rates estimated in Australian adults aged 55 years and older is consistent with trends in other developed nations.^{2,3} Improvements in population risk factors⁸ and a more widespread uptake of effective therapies⁹ are the likely explanations for this continued decline.^{10,11}

A recent slowing in the rate of CHD mortality improvement in individuals less than 55 years of age has been reported for the US, UK, and Scotland.^{2,4} Furthermore, a prior analysis of age and cohort specific CHD mortality rates in Australia suggested a slowing prior to 1992 for males born between 1955 and 1964.¹²

Here, we confirm this suggestion and also report similar findings for females and cerebrovascular disease. Follow-up of this data beyond 2005 will be necessary to understand whether these observations are age-group or birth-cohort specific.

In the current analysis, the year in which the slowing of the decline in CHD mortality rates commenced in Australia is estimated to occur between 1988 and 1996. This is similar to the US, in which the deceleration was shown to commence in 1989, with further deceleration observed in 2000.² In the UK and Scotland the decelerations commenced slightly later, between 1994 and 2003.^{3,4} The window for the commencement of the decline in cerebrovascular mortality rates in Australia was estimated to occur during a similar time frame as was observed for CHD, ranging between 1988 and 1999. A slowing in the cerebrovascular mortality rate decline in the late 1980s/ early 1990s was demonstrated for all age groups, both in the current study and previously, for a number of countries including the US and Australia.^{1,13-15} The current study demonstrates that in Australia the observed slowing of the rate of decline of cerebrovascular disease mortality rates in the early 1990s was followed by an increase in the rate of decline since the mid-1990s for those aged over 55 years. Similarly, recent analysis of age-adjusted cerebrovascular death rates in the US revealed a continuation of decline at the beginning of the 21st century.¹⁶

Potential causes of the estimated slowing of the rate of decline of CHD and cerebrovascular disease mortality rates in younger adults include artefact (such as coding changes), the reaching of a natural low rate that cannot be improved upon, the worsening or lack of further improvement in risk factors, and absence of further decreases in case-fatality rates related to treatment. It is possible that changes in coding of cause of death, either due to physician coding practice or the change from ICD-9 to ICD-10 (which occurred in Australia in 1998) had a role in the observed trends. The change from ICD-9 to ICD-10 is estimated to lead to a slight increase in coding of deaths due to cerebrovascular disease and a slight decrease in coding of deaths to diseases of the heart¹⁷. However, as we observed similar trends for all circulatory disease (which as an overarching category is less likely to experience coding changes) and for both CHD and cerebrovascular disease, we believe that this role is unlikely to be large. In addition, the slowing in the rate decline observed in those under 55 occurred in all cases prior to 1998. A nadir is also unlikely. This is because different countries have demonstrated a plateau at different absolute rates and because some analyses have shown an increase in mortality rate.³ For example, for males aged 45–54, a plateau in the CHD mortality rate was seen at

approximately 50 per 100,000 in Australia but 100 per 100,000 in the USA.² It appears most likely that the slowing of the mortality rate decline observed in individuals under 55 years is a result of changes in risk factors or treatment trends. A slowing in the decline could equally be caused by a worsening of risk factors (such as obesity and hypertension), or by diminishing returns from previously successful interventions (such as smoking cessation or hypertension control). The increased prevalence of obesity and diabetes has been estimated to increase the numbers of CHD deaths over time,¹⁸ and others have also predicted that the increasing prevalence of obesity and diabetes will exert a greater impact on CVD mortality rates.¹⁹

A key limitation of the current study is that the analysis of population mortality rate trends does not indicate to what extent the trends are a result of changes in incidence or changes in case-fatality. It will be important to investigate this further if we are to gain a more in-depth understanding of the underlying cause of the decline in trends.

It is essential that we expound the underlying causes of the slowing of the CVD mortality rate decline in young adults. The escalating prevalence of obesity and diabetes is projected to continue in future years.^{20,21} If these conditions are indeed contributing to the slowing of the decline of CVD mortality rates, then we may expect further worldwide increases in CVD mortality rates. Moreover, as the existing cohort of young adults age, current declines in CVD mortality amongst the elderly may be diminished.

In conclusion, the decline in CHD and cerebrovascular disease mortality rates is slowing in Australian males and females aged under 55 years. These results are similar to that observed for CHD in the US and UK. Understanding the causes of these trends will be essential to predict whether the slowing of the CVD mortality rate decline is likely to continue in young adults, and even to extend to older age groups.

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