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The Impact of Health Care on Mortality: Time Trends in Avoidable Mortality in Australia 1968-2001

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Abstract

We investigate the extent to which health care has contributed to the decline in mortality rates in Australia over recent decades by examining trends in avoidable mortality between 1968 and 2001. Avoidable mortality refers to deaths from certain conditions that are considered to be largely avoidable given timely and effective health care. Using unit record mortality data, we classified deaths into three avoidable categories: conditions amenable to medical care ('medical care indicators' (MCI)), conditions responsive to health policy but that are considered to lack effective treatment once the condition has developed ('health policy indicators' (HPI)), and ischaemic heart disease (IHD). 'Nonavoidable' deaths included the remaining causes of death.

Our findings suggest that the Australian health care system has made substantial contributions to the reduction in mortality over the past three decades. This is shown in the steady decline in avoidable mortality rates with slower declines in nonavoidable mortality rates. Between 1968 and 2001, total avoidable death rates fell around 70% (68.4% in females, 72.2% in males) and nonavoidable rates fell around 34% (34.6% in females, 33.2% in males). Using Poisson regression, the annual declines in avoidable mortality rates were as follows (95% CIs in parentheses): 3.47% (3.44-3.50%) in females and 3.89% (3.86-3.91%) in males. For nonavoidable mortality rates, the annual declines were 1.09% (1.05-1.13%) in females and 0.95% (0.92-0.98%) in males. The trends in avoidable mortality in Australia were similar to those of other European countries, with Australia improving it's ranking between 1980 and 1998, performing particularly well with respect to MCI.

In females, declines in MCI death rates made the largest contribution to the decline in avoidable mortality rates (54%) with the IHD contribution being 45%. In males, reductions in IHD death rates made the largest contribution (57%), with the MCI contribution being 32%. For both sexes, most of this decline occurred in only a small number of the thirty-five MCI causes – cerebrovascular disease, cancer of the breast (females), cancer of the colon and rectum, perinatal deaths and pneumonia. Declines in HPI death rates made a negligible contribution in females (1%) and only a modest contribution in males (11%).

While the observed declines in avoidable mortality rates may also reflect changes in other factors that influence mortality such as environment and socioeconomic conditions, they are consistent with, and suggestive of, the health care system being an important determinant of health improvements in Australia in recent decades.

INTRODUCTION

Life expectancy in Australia, as in other developed countries, has been steadily increasing over the last century due to falling death rates across all ages. While the reduction in mortality rates in the early part of the century has been largely attributed to improvements in living conditions, in more recent decades health care is thought to have played an important role.[1] The question is, to what extent has health care contributed to reducing mortality rates in Australia?

One approach for assessing the contribution of health care to declining mortality rates is through the application of the concept of avoidable mortality. Avoidable mortality refers to deaths from certain conditions that are considered to be largely avoidable given timely and effective health care. Trends in avoidable mortality over time can be used to estimate the contribution of health care to falling mortality rates. Comparisons of these trends across countries or regions can indicate relative weaknesses in health care systems requiring further investigation.[2]

The concept of avoidable mortality has evolved over time and has been variously referred to as avoidable death (e.g. Holland[3]), amenable mortality or death from amenable causes (e.g. Poikolainen & Eskola[4]), or mortality from diseases/conditions amenable to medical intervention/health care (e.g. Mackenbach et al.[5]). While it has been applied in over 70 empirical studies,[2] three groups have been central to its development: the Preventable and Manageable Diseases Working Group chaired by David Rutstein,[6-8] the work of John Charlton and colleagues,[9-11] and the European Community Concerted Action Project (ECCAP) on Health Services and Avoidable Deaths.[3 12-14]

In 1976, Rutstein's group first proposed the idea of counting avoidable deaths to measure the quality of medical care.[6] Based on expert opinion, the group identified causes of 'unnecessary disease and disability' and 'unnecessary untimely deaths' that could be used as indexes of the quality care. They listed over 70 conditions in which death was considered to be avoidable given timely and appropriate medical care and a further 23 conditions that were considered to have highly effective interventions but for which not all deaths would be avoidable. Medical care was defined broadly. Consequently, conditions included those that were medically treatable (e.g.

appendicitis), primarily preventable (e.g. lung cancer) or both (e.g. diphtheria). The authors suggested an immediate use of their method would be to use death record information to tabulate untimely deaths across the states. In 1976, Adler adopted this idea and published a letter reporting that 14% of deaths in the United States in 1968-1971 were avoidable.[15]

Charlton and colleagues were the first to publish a comprehensive study applying the conceptual framework developed by Rutstein's group. They adapted the concept of unnecessary untimely deaths to examine the performance of the National Health Service across regions in England and Wales.[10] From Rutstein and colleagues' lists, they selected a subset of 14 diseases (plus perinatal mortality) that were regarded as most amenable to medical intervention and for which there was a significant number of deaths to allow analysis of variation across different health authorities. Age limits were set for each cause (mostly 5 to 64 years, with a narrower age range for selected causes) to increase the proportion of mortality potentially avoidable. Notably, they excluded from their measure deaths from conditions such as lung cancer that were dependent mainly on primary prevention. Applying this method, they found large variations in avoidable deaths across the different regions, most of which could not be explained by socioeconomic indicators such as the proportion of unskilled workers in the region. As Charlton and colleagues pointed out, regardless of whether or not disease incidence influenced this variation, it indicated areas that required action given that the deaths were potentially avoidable. Since this study, Charlton and colleagues have used various revisions of this list to study time trends in avoidable mortality within the U.K. and internationally.[16-18]

Following Charlton and colleagues' work, ECCAP produced a series of atlases mapping avoidable mortality across member countries of the European Community between 1974 and 1989.[3 12-14] These works, published between 1988 and 1997, incorporated several substantial revisions to the list of avoidable deaths, reflecting varying country participation in the project together with advances in, and definitions of, health care over the period. The first version of the list, based on a modification of that of Charlton et al., included 17 conditions.[3 12] Fourteen of these conditions were considered avoidable given timely and appropriate medical intervention, while for three conditions amenability was considered to be mainly through primary prevention at the national level. Like Charlton, the ECCAP Group adopted an upper age limit of 65, with a lower age limit for selected causes. In the second version of the list, a further eight conditions were included, however the extent to which health services could contribute to reducing mortality for these causes was described as “less certain”.[13] In the final version, the definition of avoidable death was narrowed so that the list included 16 causes, all of which were considered amenable to treatment or primary or secondary prevention provided by health care services. Conditions where amenability was thought to be through prevention at a national level and more dependent on actions outside the direct control of the health services were excluded.[14]

Largely based on the lists published by these three groups, there have been many country-specific studies of avoidable mortality. The majority of these have been set in Europe examining deaths in the early 70s and the late 80s. However, there have been many study-specific variations in the lists of avoidable deaths used. This reflects variation in definitions of medical or health care and what is considered avoidable across countries and over time. In more narrowly-defined lists, including those of Charlton et al.[10], Mackenbach et al.[19], Boys et al,[20] the ECCAP group’s latest version,[14] and a recent list by Nolte and McKee,[2] essentially only those causes that are amenable to medical intervention through primary or secondary prevention or treatment are included. This contrasts with other studies such as those by Albert and colleagues,[21] Tobias and Jackson,[22] and Westerling and Rosen,[23] that also include causes of death predominantly responsive to primary prevention through population level interventions including policies outside the direct control of health services (e.g. tobacco control and road safety). These studies that adopted a broader list of avoidable causes usually sub-classify the avoidable deaths based on whether they are predominantly ‘treatable’ (also known as ‘medical care indicators’) or ‘preventable’ (‘health policy indicators’). Tobias and Jackson modified this approach, by partitioning each cause of avoidable death among three subcategories according to the level of intervention, i.e., primary, secondary and tertiary prevention, using an expert consensus process.[22]

Time trend studies of avoidable mortality have been used to estimate the contribution of health care systems to reductions in mortality and to compare the effectiveness of health care systems across countries or regions. In nearly all of the industrialised countries studied, avoidable mortality rates have gradually fallen over recent decades and at a faster rate than mortality from nonavoidable causes, suggesting that health care has had a definite impact on mortality.[4 17 20 22 24-35] The few exceptions are some studies of Eastern European countries studied in the 1980s and 1990s.[35 36]

Only two time trend studies have included Australia. The New South Wales (NSW) Department of Health investigated avoidable mortality trends in their state using the system developed by Tobias and Jackson, partitioning each cause of avoidable mortality into three levels of intervention - primary, secondary and tertiary. Consistent with studies of other developed countries, they found that while both avoidable and unavoidable death rates fell over time, avoidable death rates declined at a faster rate than unavoidable deaths. Between 1980 and 2000, the proportion of premature deaths (i.e. those occurring in those aged less than 75 years) attributable to all avoidable causes fell from 75% to 61%, while the proportion attributable to unavoidable causes rose from 25% to 39%. The majority of deaths and the greatest absolute reduction in deaths during this time were preventable through primary level interventions, however relative reductions were greater for secondary and tertiary causes of death. Overall the findings suggest that health care interventions contributed to the reductions in mortality between 1980 and 2000 in NSW. However, the absolute rates of avoidable mortality were substantially higher than those published for other countries. This is because the avoidable mortality classification used includes a considerably larger list of conditions than those in other studies, the list having been constructed to measure 'theoretical scope for population gain, not what may be considered feasible given current technology, available resources and competing values."[22] Thus, while the historical trends give an indication of progress, the more comprehensive list used in the NSW study is less useful as a measure of the quality of contemporary care. Further, the relative effectiveness of the health system (i.e. compared with other countries) is not apparent as no comparisons were made with other regions or countries using similar methodology.

In the other study, Kjellstrand and colleagues investigated death rates for six avoidable causes of death (in addition to maternal and infant mortality) for the period 1980-1990 in order to compare the "success, cost and efficiency of modern medicine" across 10 developed countries.[34] Based on the six indicators, death rates from avoidable causes fell at a greater rate than "unavoidable" causes. Australia showed the greatest reduction in avoidable mortality over the decade, changing its rank from fourth to second out of the ten countries. However, as this study used only six indicators for avoidable mortality, it accounted for a total of only 22 of 258 deaths per 100,000 per year (8.4%) in 1980 and 11 of 213 deaths per 100,000 per year (4.8%) in 1990. Moreover, the unavoidable group included a large number of what would normally be regarded as avoidable deaths.

Given the limited published data on avoidable mortality in Australia, in this paper we examine the trends in avoidable and nonavoidable mortality in Australia between 1968 and 2001 and compare these trends with selected European countries. This is particularly timely given the recently published review and update of measures of avoidable mortality.[2] In doing this, we aim to: (1) assess the contribution of the Australian health care system to declining mortality rates over the past three decades, and (2) determine the relative effectiveness of Australia's health care system over recent decades.

METHODS

We used de-identified unit record mortality data from the Australian Bureau of Statistics (ABS). The underlying cause of death on each unit record is based on death certificate information supplied by the doctor certifying that death which is then coded by a professional coder. The 8th Revision of the International Classification of Disease (ICD-8) was used for deaths registered between 1968 and 1978, ICD-9 for 1979-1998 and ICD-10 for deaths registered from 1999 onwards.

Largely following the work of Nolte, McKee and colleagues,[2 35] we classified deaths into three avoidable categories: (1) conditions amenable to medical care ('medical care indicators' (MCI)), (2) conditions responsive to health policy but that are considered to lack effective treatment once the condition has developed ('health policy indicators' (HPI)), and (3) ischaemic heart disease (IHD). The list of conditions and their corresponding codes are shown in Table 1. A fourth category, 'nonavoidable', includes the remaining causes of death.

Medical care indicators, which Nolte and McKee refer to as amenable mortality, are conditions that are considered to have identifiable effective interventions that are administered by health care providers. They include conditions "from which it is expected death to be averted even after the condition has developed".[2] This definition necessarily excludes preventable conditions that have a relative lack of effective treatment once they have developed (e.g. lung cancer, liver cirrhosis). We used Nolte and McKee's recently updated list that was developed after an extensive review of the literature and which is largely based on the work of Charlton,[10] Mackenbach,[37] and Tobias and Jackson.[38] It takes account of recent advances in health care and extends the age limit to 74 years for most conditions to reflect increasing life expectancy. A detailed justification for the selection of these conditions and the age limit set (at 74 for most causes) is outlined in Nolte and McKee's review.[2] Our list of MCI differs to that of Nolte and McKee only in that we have included asthma. This was not included in their final list because of the inability to separately access the code for this condition from the World Health Organization mortality files from which they sourced their data. There are also some minor coding differences that are noted in Table 1.

The three HPI causes on our list are those consistently used in studies that include such causes in the definition of avoidable mortality.[13 19 21 23 26 35 36 39 40] The ICD-8 and ICD-9 codes for these causes are taken from the second ECCAP list.[13] To derive the ICD-10 codes for these causes, we used mapping tables supplied by the National Centre for Classification in Health in Australia.

Ischaemic heart disease is classified separately, in line with the argument that this condition lies somewhere between the 'health policy' and 'medical care' categories. Moreover, the extent to which medical care contributes to reductions in mortality from this condition remains uncertain and primary prevention is understood to contribute significantly. Further, if IHD were enumerated in the MCI category, the large number of deaths from this cause is likely to obscure the contribution of other causes in this group.[2 35]

Using direct standardisation, we calculated age-standardised annual mortality rates in males and females aged less than 75 years for the four categories of death (MCI, HPI, IHD and nonavoidable causes). To estimate person-years at risk, we used population data supplied by the ABS. These data are estimates of the Australian mid-year resident population by 5-year age bands and sex (population data for 1968-1970 are arithmetically interpolated from census data which are based on actual place of enumeration not usual residence[41]). We used the Australian 2001 population for rate standardisation.

Table 1 Avoidable causes of death

Cause of Death	Age Range	ICD-8	ICD-9	ICD-10
Medical Care Indicators				
Intestinal infections	0-14	000-009	001-009	A00-A09
Tuberculosis	0-74	010-019	010-018, 137	A15-A19, B90
Other infections (diphtheria, tetanus, poliomyelitis	0-74	032, 037, 040-043	032, 037, 045	A36, A35, A80
Whooping cough	0-14	033	033	A37
Septicaemia	0-74	038	038	A40-A41
Measles	1-14	055	055	B05
Malignant neoplasm of colon and rectum	0-74	153-154	153-154	C18-C21
Malignant neoplasm of skin (excl. melanoma)	0-74	173	173	C44
Malignant neoplasm of breast	0-74	174	174	C50
Malignant neoplasm of cervix uteri	0-74	180	180	C53
Malignant neoplasm of cervix uteri and body of uterus (excl. overlap with above codes)	0-44	182	179, 182	C54-C55
Malignant neoplasm of testis	0-74	186	186	C62
Hodgkin's disease	0-74	201	201	C81
Leukaemia	0-44	204-207	204-208	C91-C95
Disease of the thyroid	0-74	240-246	240-246	E00-E07
Diabetes mellitus	0-49	250	250	E10-E14
Epilepsy	0-74	345	345	G40-G41
Chronic rheumatic heart disease	0-74	393-398	393-398	I05-I09
Hypertensive disease	0-74	400-404	401-405	I10-I13, I15
Cerebrovascular disease	0-74	430-438	430-438	I60-I69 G45
All respiratory diseases (excl. pneumonia/influenza)	1-14	460-466 490-519	460-479 488-519	J00-J06 J20-J99
Influenza	0-74	470-474	487	J10-J11
Pneumonia	0-74	480-486	480-486	J12-J18
Peptic ulcer	0-74	531-533	531-533	K25-K27
Appendicitis	0-74	540-543	540-543	K35-K38
Abdominal hernia	0-74	550-553	550-553	K40-K46
Cholelithiasis and cholecystitis	0-74	574-575	574-575.1	K80-K81
Nephritis and Nephrosis	0-74	580-584	580-589	N00-N07, N17-N19, N25-N27
Benign prostatic hyperplasia	0-74	600	600	N40
Maternal deaths	All	630-678	630-676	O00-O99
Congenital cardiovascular abnormalities	0-74	746-747	745-747	Q20-Q28
Perinatal deaths (excl. stillbirths)	All	760-779	760-779	P00-P96, A33-A34
Misadventures to patients during surgical and medical care (incl. complications)	All	E930-E936	E870-876, E878-E879	Y60-Y69, Y83-Y84
Asthma	0-74	493	493	J45-J46

(continued…)

Table 1 Avoidable causes of death *(continued)*

Cause of Death	Age Range	ICD-8	ICD-9	ICD-10
Ischaemic heart disease	0-74	410-414	410-414	I20-I25
Health Policy Indicators				
Malignant neoplasm of trachea, bronchus & lung	0-74	162	162	C33-C34
Chronic liver disease and cirrhosis	0-74	571	571	K70, K71.7, K73-K74, K76.0
Motor vehicle accident	0-74	E810-E823	E810-E825	V02-V04, V06.1, V09.0-V09.3, V12-V14, V19.0-v19.6 V20-v79 V80.3-V80.5, V81.0-V81.1, V82.0-V82.1, V83.0-V83.3, V84-V88, V89.0, V89.2-V89.9

Notes.

1. Causes and codes for medical care indicators taken from Nolte and McKee[2] with the following exceptions: (a) "Chronic rheumatic heart disease" ICD-8 codes listed in source as 393-396, corrected to 393-398; (b) code G45 (transient ischemic attack) added to ICD-10 cerebrovascular disease codes (transient ischaemic attack already included in ICD-8 and ICD-9 codes); (c) "All respiratory diseases (excl. influenza/pneumonia)" listed in source as J00-J09, J20-J99 corrected to J00-J06, J20-J99; (d) ICD-9 code 771.3 (tetanus neonatorum) added to perinatal death category (tetanus neonatorum already included in ICD-10 category, and in ICD-8 is included in "Other infections" as part of tetanus (A037)); (e) ICD-8 codes for "Misadventures to patients during medical or surgical care" supplied by the authors; (f) "Asthma" added to list.

2. Codes for health policy indicators taken from Holland for ICD-8 and ICD-9,[13] and assigned by author for ICD-10 as indicated in Methods.

Rates were calculated by actual year of death for 1968 (the year ICD-8 coding was first used in Australia) to 2001, based on deaths registered between 1968 and 2002. Given that a proportion of deaths is registered after the actual year of death, not all deaths occurring in these years will necessarily be counted. However, analysis of deaths in Australia has shown that less than 0.1% of deaths are registered after the second year.[42]

In addition to presenting the directly age-standardised rates, we modelled mortality trends using Poisson regression. The observed number of deaths by year and age group were assumed to be Poisson distributed, fitting a log-linear rate equation with log of person-years as an offset. Annual rates of change in mortality rates were calculated by exponentiation of the coefficient for trend (annual percent change = [exp (coef) – 1] x 100).

RESULTS

Overall trends in avoidable and nonavoidable mortality in Australia

Age-standardised mortality rates for the three avoidable death categories (MCI, HPI, IHD) and for nonavoidable deaths from 1968 to 2001 are shown in Figure 1 (see also table in Appendix). The steady decline in total mortality rates over this period was largely due to the fall in deaths from avoidable rather than nonavoidable causes, in both females and males. Taking all avoidable causes together, the death rates in females fell from 323 to 102 deaths per 100,000 person years (68.4%), and rates in males fell from 600 to 167 per 100,000 person years (72.2%). Using Poisson regression, the annual decline in death rates was 3.47% (95% confidence interval 3.44-3.50%) in females and 3.89% (95% CI 3.86-3.91%) in males.

Over the same period, the fall in death rates from nonavoidable causes was less pronounced. Female nonavoidable death rates fell from 159 to 104 deaths per 100,000 person years (34.6%) and male rates declined from 274 to 183 deaths per 100,000 person years (33.2%). Using Poisson regression, the annual decline in rates was 1.09% (95% CI 1.05-1.13) in females and 0.95% (95% CI 0.92-0.98%) in males. Thus, between 1968 and 2001, the proportion of total mortality attributed to avoidable causes fell in both males and females. Avoidable causes declined from approximately two thirds of total deaths (67.0% and 68.6%, females and males respectively) to one half of all deaths (49.6% and 47.7%, females and males, respectively).

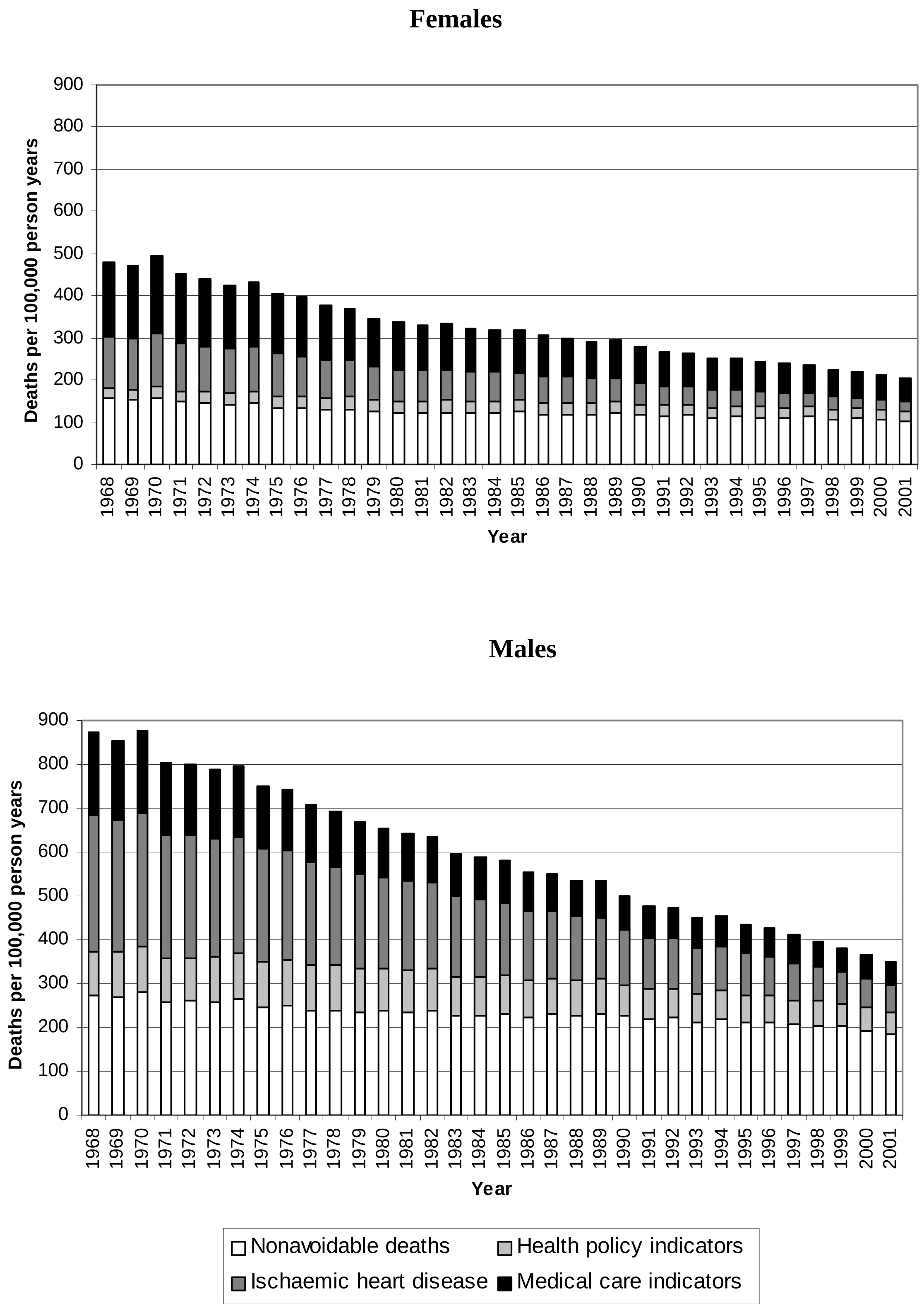

Figure 1. Age-standardised death rates (in population aged 0-74 years) for the three avoidable death categories - medical care indicators, ischaemic heart disease and health policy indicators - and nonavoidable deaths, 1968-2001.

To examine the patterns of avoidable and nonavoidable mortality across age groups, we stratified our sample into groups: 0-4 years, then by ten-year intervals. Results are shown in Figures 2 and 3. Between 1968 and 2001 total avoidable mortality rates declined in all age groups, with annual percentage declines lowest in those aged 25-34 years (2.75% with 95% CI 2.55-2.94% in females and 2.93% with 95% CI 2.80-3.07% in males). Declines were highest in those aged 0-4 years (5.36% with 95% CI 5.23-5.48% in females and 5.61% with 95% CI 5.50-5.71% in males). Nonavoidable rates also declined in most age groups, but more slowly than for avoidable mortality. Annual percentage declines in females ranged between 0.42% (95% CI 0.37-0.48%), in those aged 65-74 years, and 2.72% (95% CI 2.58-2.87%), in those aged 0-4 years. In males the rates ranged between 0.17% (95% CI 0.07-0.27%), in those aged 35-44 years, and 2.94% (95% CI 2.70-3.19%), in those aged 5-14 years. There were two exceptions to the nonavoidable mortality pattern. First, in females aged 15-24 years there was no significant fall in nonavoidable death rates (annual decline of 0.13%, 95% CI -0.08-0.35%). Second, in males aged 15-24 and 25-34 years increasing rates of nonavoidable deaths were observed (annual increases of 0.34% (95% CI 0.21-0.46%) and 1.45% (95% CI 1.33-1.56%), respectively).[a]

Trends in mortality rates for medical care indicators

Medical care indicator death rates fell from 177 to 58 deaths per 100,000 person years in females (67.2%), and from 190 to 52 deaths per 100,000 person years in males (72.6%), between 1968 and 2001. Poisson regression showed an annual death rate decline of 3.42% (95% CI 3.38-3.46%) for MCI deaths in females and 4.00% (95% CI 3.96-4.04%) in males. Although death rates for MCI were lower in females than males, the proportion of total avoidable mortality attributed to MCI was higher in females (range 51-57%, between 1968 and 2001) than males (26-32%). Over half of the decline in avoidable mortality rates in females (54%), and a third (32%) in males, was attributable to MCI. (See table in Appendix).

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[a] These patterns can be partly explained by an overall rise in suicide rates, particularly in young men. Between 1968-1970 and 1999-2001, rates rose from 11.7 to 21.3 suicide deaths per 100,000 person years, and 20.9 to 34.2 suicide deaths per 100,000 person years, in 15-24 year old and 25-34 year old males, respectively. In females aged 15-24 years, rates rose from 4.6 to 5.5 suicide deaths per 100,000 person years. With suicide excluded, the nonavoidable death rate actually falls over time in females and males aged 15-24 years.

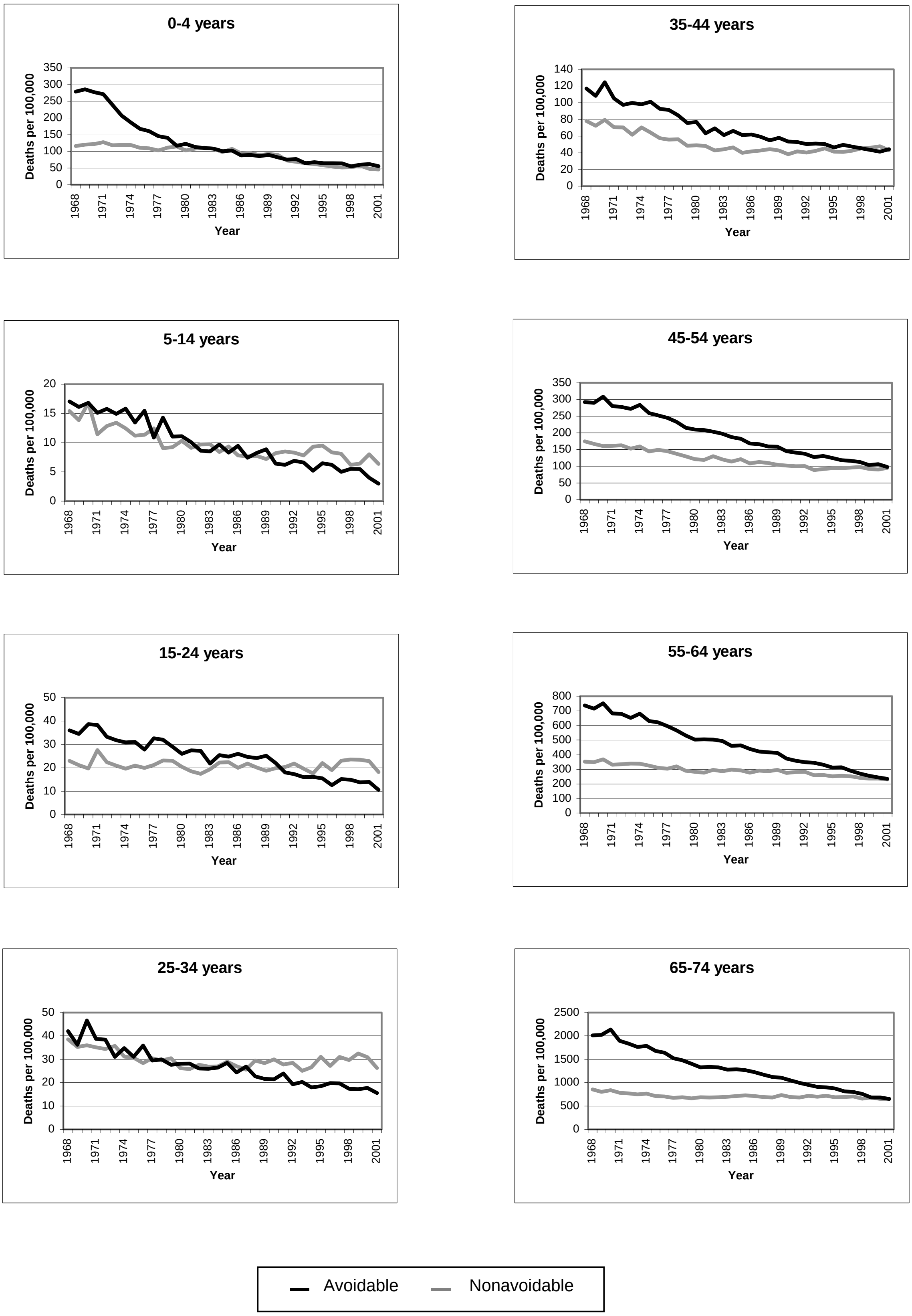

Figure 2. Avoidable and nonavoidable death rates by age group – females (0-74 years)

Note. Because of the large variation in death rates across age groups, different scales are used.

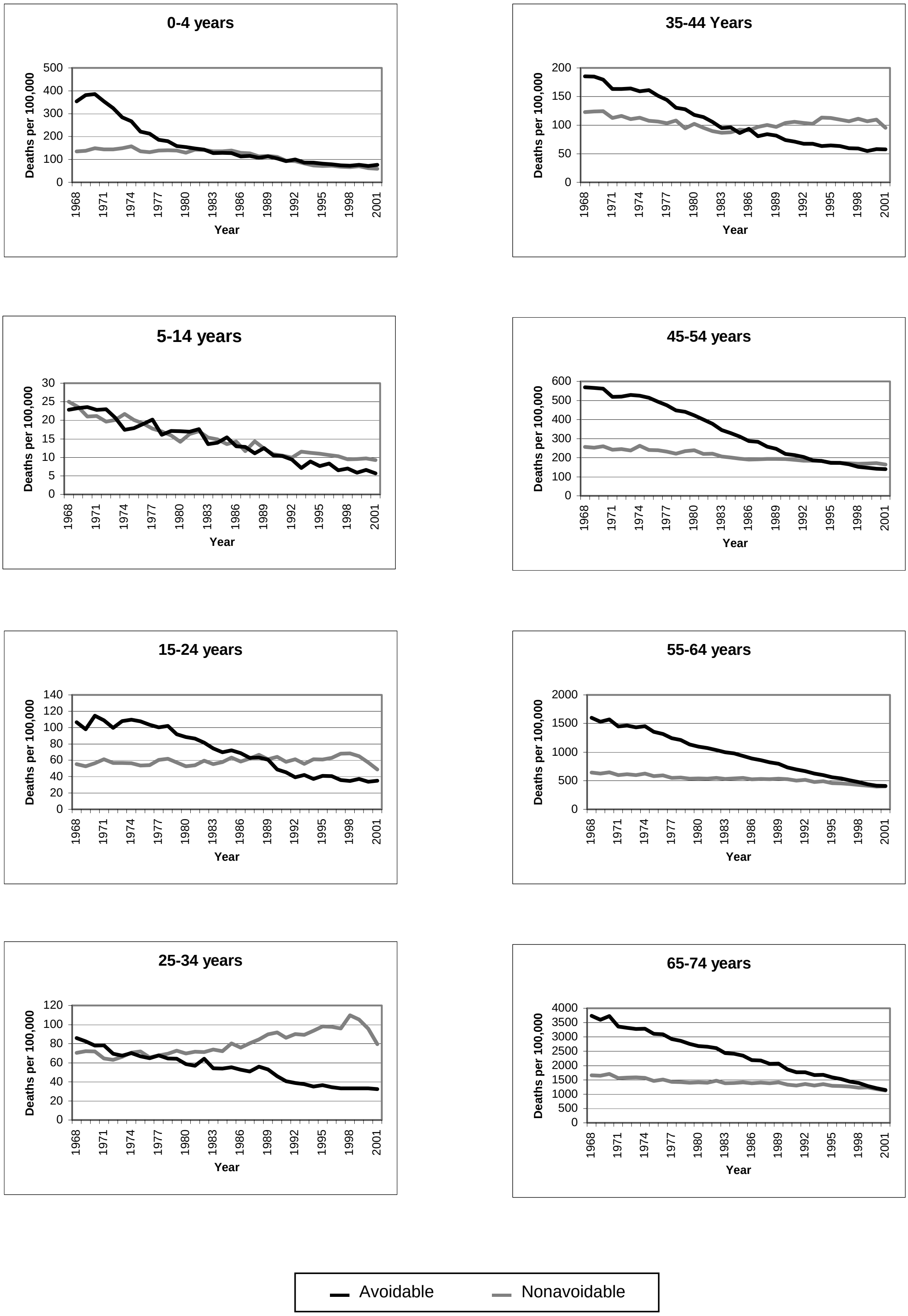

Figure 3. Avoidable and nonavoidable death rates by age group – males (0-74 years)

Note. Because of the large variation in death rates across age groups, different scales are used.

There was a significant decline in death rates for all except four of the 35 causes in the female population and five of the causes in the male population. For two of these MCI causes - septicaemia and misadventures to patients during surgical and medical care - deaths rates actually increased over time, while death rates from two others - whooping cough and malignant neoplasm of the skin - showed no significant change, in both female and males. These four causes contributed little to the avoidable mortality rates - all had death rates of less than 3 per 100,000 in any particular year. In addition, death rates for cancer of the colon and rectum in males (around 17 per 100,000 person years at the start and the end of the 34 year period) showed an increasing trend before starting to fall in the late 80s.

To determine the MCI causes that contributed most to avoidable mortality, we calculated 3-year average mortality rates for the start of the period (1968-1970) and for the end of the period (1999-2001). As shown in Table 2, the five MCI causes with the highest death rates in both periods in males and females were cerebrovascular disease, malignant neoplasm of the colon and rectum, perinatal deaths and pneumonia, and, in females only, malignant neoplasm of the breast. Together, these leading causes contributed over 70% of the total MCI death rate in females in 1968-1970 (72%) and 1998-2000 (78%), and around 70% in males (69% and 73% for the two periods, respectively). Rates for all other MCI were 10 per 100,000 person years or less, with most causes having rates of less than 2 per 100,000 person years, in both periods. Cerebrovascular disease, perinatal deaths and pneumonia showed the greatest absolute declines in mortality rates of the MCI between 1968-1970 and 1998-2000.

The fall in MCI death rates between 1968 and 2001 was evident across all age groups. However, two contrasting age-specific trends are of note. First, the proportion of avoidable deaths that could be attributed to MCI was particularly high in those aged 0-4 years over the entire period (an average of 94% (range: 91-96%) in females and 94% (91-97%) in males). Second, this proportion was notably smaller in those aged 15-24 years than in the other age groups (30% (range: 22-40%) and 14% (9-22%), females and males, respectively).

Table 2. Leading Medical Care Indicator (MCI) death rates (per 100,000 person years) in population aged 0-74 years

	Females		Males	
	1968-1970	1999-2001	1968-1970	1999-2001
Cerebrovascular disease	67.51	11.43	75.76	15.35
Malignant neoplasm of breast	22.47	18.99	-	-
Malignant neoplasm of colon and rectum	16.81	11.18	17.90	17.20
Perinatal deaths	12.02	3.01	17.67	4.09
Pneumonia	9.41	1.66*	17.13	2.55
All other MCI	50.22	13.17	58.77	14.70
TOTAL MCI	178.43	59.44	187.23	53.89

* Because of the large fall in pneumonia deaths, this cause fell from 5th to 6th largest with cervical cancer (both categories combined) having higher rates than pneumonia in 1999-2001 with 2.08 deaths per 100,000 person years.

Trends in mortality rates for ischaemic heart disease

There was a large fall in IHD death rates between 1968 and 2001, from 122 to 22 deaths per 100,000 person years in females (82.0%), and from 310 to 63 deaths per 100,000 person years in males (79.7%). The annual decline was 4.76% (95% CI 4.71-4.81%) and 4.62% (95% CI 4.59-4.66%) in females and males, respectively. Just under half of the decline in avoidable mortality rates in females (45%), and over half (57%) in males, was attributable to IHD. (See table in Appendix). The large IHD death rates in males account for a large portion of the sex difference in total mortality. The IHD trends are largely accounted for by those aged 35 years and older, with IHD death rates in younger age groups being very low and hence changing little over time.

Trends in mortality rates for health policy indicators

Overall, HPI contributed relatively little to the decline in mortality between 1968 and 2001 and showed a different pattern to the other categories of death. Reductions in HPI death rates accounted for less than 1% of the decline in avoidable mortality in females and 11% in males. While the proportion of avoidable mortality attributed to HPI was relatively small, this proportion rose steadily over the 34-year period from around 7% to 21% in females and 17% to 31% in males (see table in Appendix).

In females, there was actually an increase in HPI over time, with 24 per 100,000 person years in 1968, peaking at 30 deaths per 100,000 person years in 1978. There was no appreciable decline occurring until the 1990s, with the rate falling to 22 per 100,000 person years by 2001 (an overall decline of 8.3%). However, this pattern of aggregate causes of deaths masks the true picture as the three HPI causes in females show different trends over this period. As shown in Figure 4, there was a considerable rise in tobacco-related deaths (malignant neoplasm of the trachea, bronchus and lung) with an annual increase of 2.36% (95% CI 2.24-2.49%), mostly accounted for by deaths in those aged 65-74 years. In contrast, there was a significant fall in motor vehicle deaths of 3.55% per year (95% CI 3.42-3.67%); and after initially rising, a small overall fall in deaths from chronic liver disease and cirrhosis of 2.01% per year (95% CI 1.80-2.23%).

In males, the pattern of HPI deaths was different to that of females. The overall HPI rate fell from 100 deaths to 51 deaths per 100,000 persons (49%), representing an average annual decline of 2.34% (95% CI 2.30-2.39%), with most of the decline occurring after 1983. Overall, annual death rates declined for all three causes. Motor vehicle accidents declined 4.11% (95% CI 4.03-4.18%), malignant neoplasm of the trachea, bronchus and lung declined 1.31% (95% CI 1.25-1.37%), and chronic liver disease and cirrhosis declined 1.70% (95% CI 1.57-1.83%). However, death rates from the latter two causes actually rose during the 1970s before falling thereafter (see Figure 4).

The overall patterns for HPI across age groups generally followed similar trends to those described above. However, HPI made a relatively larger contribution to the avoidable mortality rate in both sexes in younger age groups (those aged 5-14, 15 to 24 and 25-34 years), due to the large proportion of deaths from motor vehicle accidents.

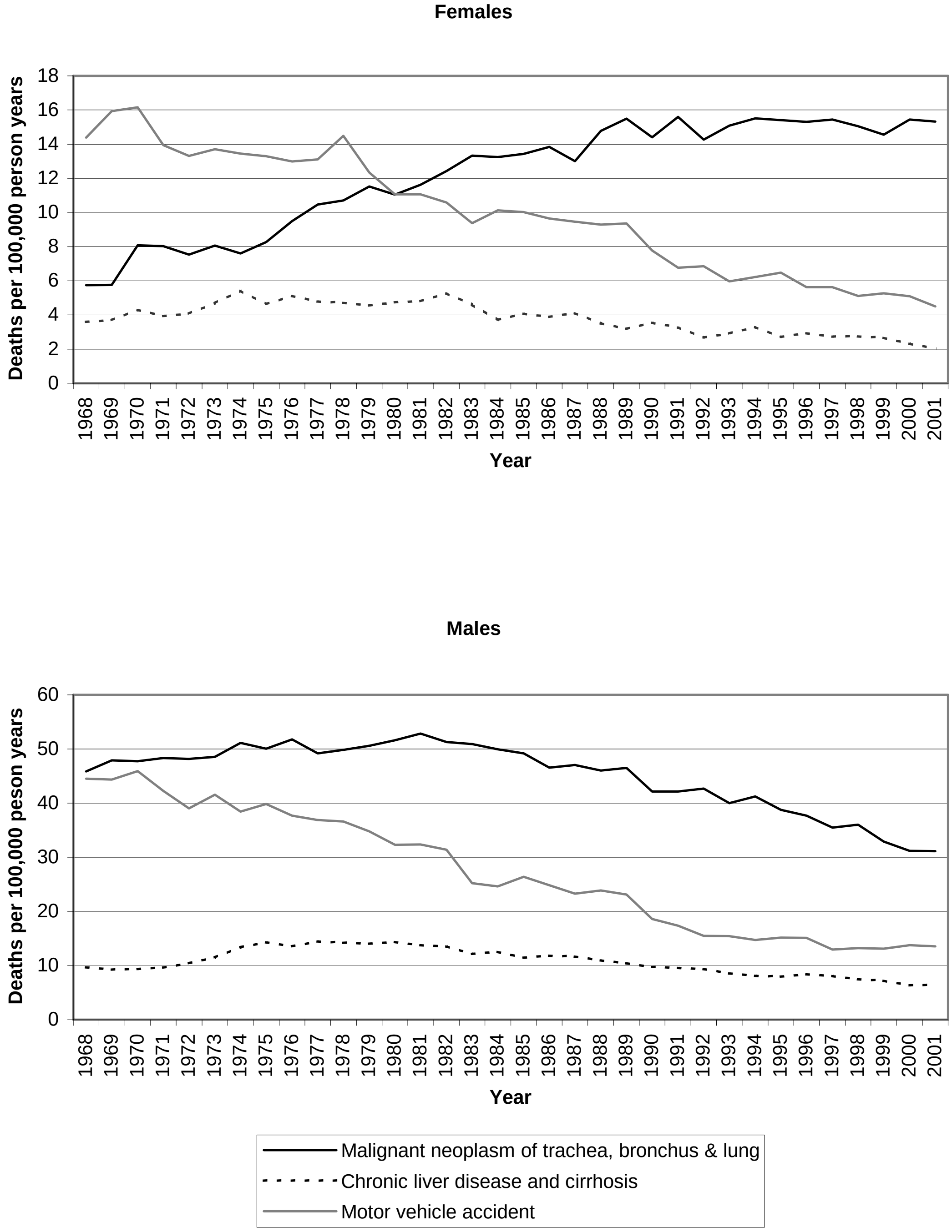

Figure 4. Deaths rates (per 100,000 person years) for HPI causes (population 0-74 years)

Note. Because of the large differences in death rates across sex, different scales are used.

Comparisons between Australian and European avoidable mortality trends

We compared avoidable mortality trends in Australia with those in Europe using results recently published by Nolte and McKee for selected European countries for the years 1980, 1990 and 1998.[2] In order to do this, we needed to make several adjustments to our method: We (1) excluded asthma, (2) classified only MCI and IHD (and not HPI) as avoidable mortality, and (3) directly age-standardised rates using the European standard population.

The age-standardised avoidable mortality rates for the nine European countries for which there are comparable data,[b] and for Australia, are shown in Figures 5 and 6. Comparisons across countries show similar patterns in both females and males. There were substantial declines in MCI death rates in all countries between 1980 and 1990 and between 1990 and 1998, the declines being steepest in the 1980s (Figure 5). With few exceptions, the rankings of countries for MCI death rates changed little across the three time periods (see Table 3). In 1980, Australian females had the fourth lowest MCI rate with 110 deaths per 100,000 person years. This compares with a median rate across countries of 119 deaths per 100,000 person years, with France having the lowest rate with 86 deaths per 100,000 person years, and Portugal the highest with 181 deaths per 100,000 person years. In 1998, Australian females were ranked third lowest with 64 deaths per 100,000 person years (median: 70.37), compared with France with 61 deaths per 100,000 person years, and Portugal with 97 deaths per 100,000 person years. In terms of MCI deaths as percentage of total deaths, Australia's ranking was similar across the time periods, being fourth in 1980 with 32.3% (median: 34.0%, range: 28.5-43.7%), and second in 1998 with 28.3% (median: 29.4%, range: 28.2-35.0%).

Similar rankings were evident in Australian males. In 1980, they had the third lowest MCI rate when compared with European males, being 117 per 100,000 person years. This compares with a median rate across countries of 132 deaths per 100,000 person years, again with France having the lowest rate with 88, and Portugal the highest with 251, deaths per 100,000 person years. By 1998, Australia was ranked the lowest, with 60 deaths per 100,000 person years (median: 72.0), compared with France with 65,

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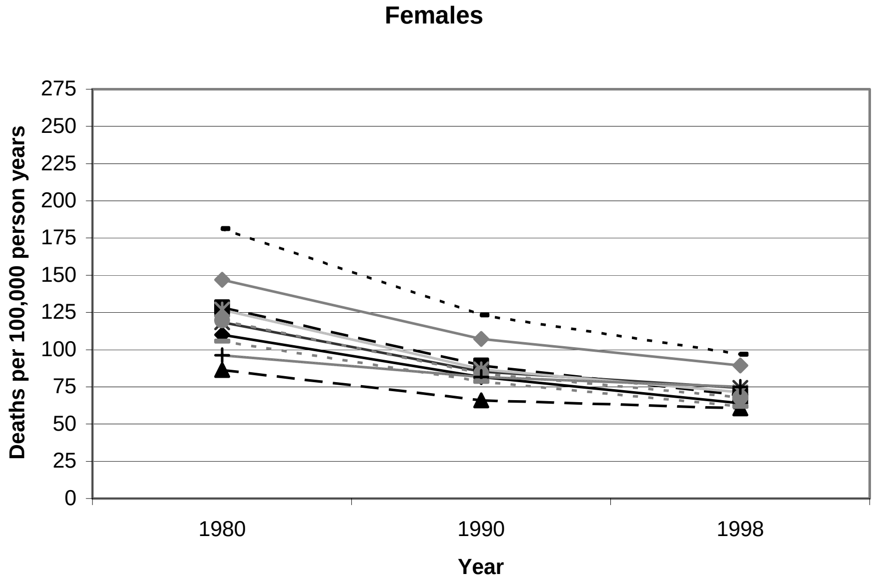
[b] Nolte and McKee examined 12 European countries. However, for three of these (Denmark, Finland, and Sweden) selected amenable causes were excluded in the calculation of rates so the rates for these countries are not directly comparable with those for Australia.



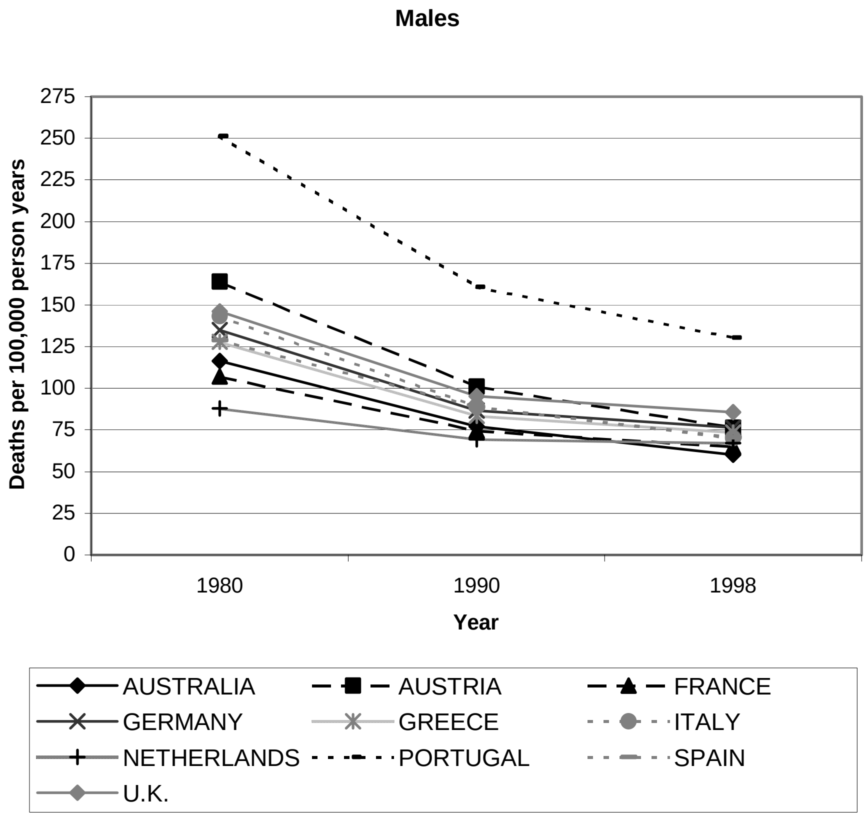


Figure 5. Deaths rates (per 100,000 person years) for medical care indicators in Australia and selected European countries (population aged 0-74 years)

Table 3. Avoidable mortality rates (per 100,000 person years) and ranks in Australia and selected European countries (population aged 0-74 years)

	MCI				MCI & IHD			
	1980		1998		1980		1998	
	Rate	Rank	Rate	Rank	Rate	Rank	Rate	Rank
FEMALES								
AUSTRALIA	110.06	4	64.01	3	185.74	8	92.23	4
AUSTRIA	128.54	8	69.41	5	175.91	7	102.06	7
FRANCE	86.31	1	60.62	1	105.63	1	70.27	1
GERMANY*	118.44	5	74.39	7	165.34	6	104.69	8
GREECE	127.08	7	71.32	6	151.98	4	94.78	5
ITALY	119.68	6	67.91	4	152.52	5	85.01	3
NETHERLANDS	96.31	2	75.00	8	144.53	3	101.52	6
PORTUGAL	181.39	10	96.86	10	211.35	9	115.84	9
SPAIN	105.75	3	61.93	2	126.70	2	76.74	2
U.K.	146.90	9	89.28	9	229.27	10	134.51	10
Median	**119.06**		**70.37**		**158.93**		**98.15**	
MALES								
AUSTRALIA	116.52	3	60.00	1	333.96	8	141.07	4
AUSTRIA	164.05	9	76.39	8	314.17	7	182.09	8
FRANCE	107.10	2	64.87	2	178.72	1	105.57	1
GERMANY*	135.01	6	76.37	7	299.54	6	170.37	7
GREECE	127.90	4	73.39	6	215.20	3	155.53	6
ITALY	143.10	7	70.00	4	250.70	4	131.02	3
NETHERLANDS	87.92	1	67.31	3	255.01	5	145.64	5
PORTUGAL	251.39	10	130.42	10	335.25	9	189.11	9
SPAIN	128.79	5	70.54	5	202.59	2	128.53	2
U.K.	146.16	8	85.58	9	396.88	10	211.78	10
Median	**131.90**		**71.97**		**277.28**		**150.59**	

* As data for west Germany were only available to 1990 from the World Health Organization mortality files, additional data were obtained from the Statistical Office Germany. Because separate data for east and west Berlin are no longer available after 1997 from this source, 1997 data are used in this analysis instead of 1998 data.

and Portugal 130, deaths per 100,000 person years. In terms of MCI deaths as a percentage of total deaths, Australia ranked third in both 1980, with 17.0%, (median: 20.2%, range: 14.0-30.5%), and 1998, with 14.5% (median: 15.0%, range: 12.9-21.3%).

Including both MCI and IHD as avoidable deaths results in similar patterns of decline in avoidable death rates across countries, but the absolute declines were obviously larger than when MCI deaths alone are included (see Figure 6). Notably, including IHD as an avoidable cause worsens Australia’s rankings for both females and males due to the relatively high IHD death rates in this country (see Table 3). France and the United Kingdom were ranked first and last, respectively, in both 1980 and 1998, in both sexes. In Australian females, avoidable death rates that include IHD are third highest (ranked eighth) in 1980, with 186 deaths per 100,000 person years (54.5% of total deaths). The median rate across all countries is 159 deaths per 100,000 person years (range: 106-229) and the median as a percentage of total deaths is 45.7% (range: 34.9-56.1%). However, by 1998, Australia had improved its ranking considerably to fourth with 92 deaths per 100,000 person years (median (range) across all countries: 98 (70-135)). Nevertheless, as a percentage of total deaths, Australia maintained a lower ranking at sixth (40.8%, median (range): 40.5% (32.6-45.0%)). However, it is worth noting that between 1980 and 1998, Australian females showed the greatest decline in IHD rates in both absolute and percentage terms compared with females in the other countries.

Similarly, for Australian males in 1980 the avoidable death rate including IHD is third highest (ranked eighth) with 334 deaths per 100,000 person years (48.6% of total deaths). The median for all countries is 277 deaths per 100,000 person years (39.9% of total deaths), with France having 179 deaths per 100,000 person years (25.6%) and the United Kingdom 397 deaths per 100,000 person years (53.4%).

However, by 1998, Australia had improved its ranking considerably to fourth lowest (141 deaths per 100,000 person years; median (range): 151 (106-212)). When measuring avoidable deaths as a percentage of total deaths, however, Australia’s ranking remained low (ninth with 34.1%; median: 32.0% (21.0-43.0%)). However, like the female population, Australian males showed the greatest decline in IHD rates between 1980 and 1998 of any of these countries, in both absolute and percentage terms.

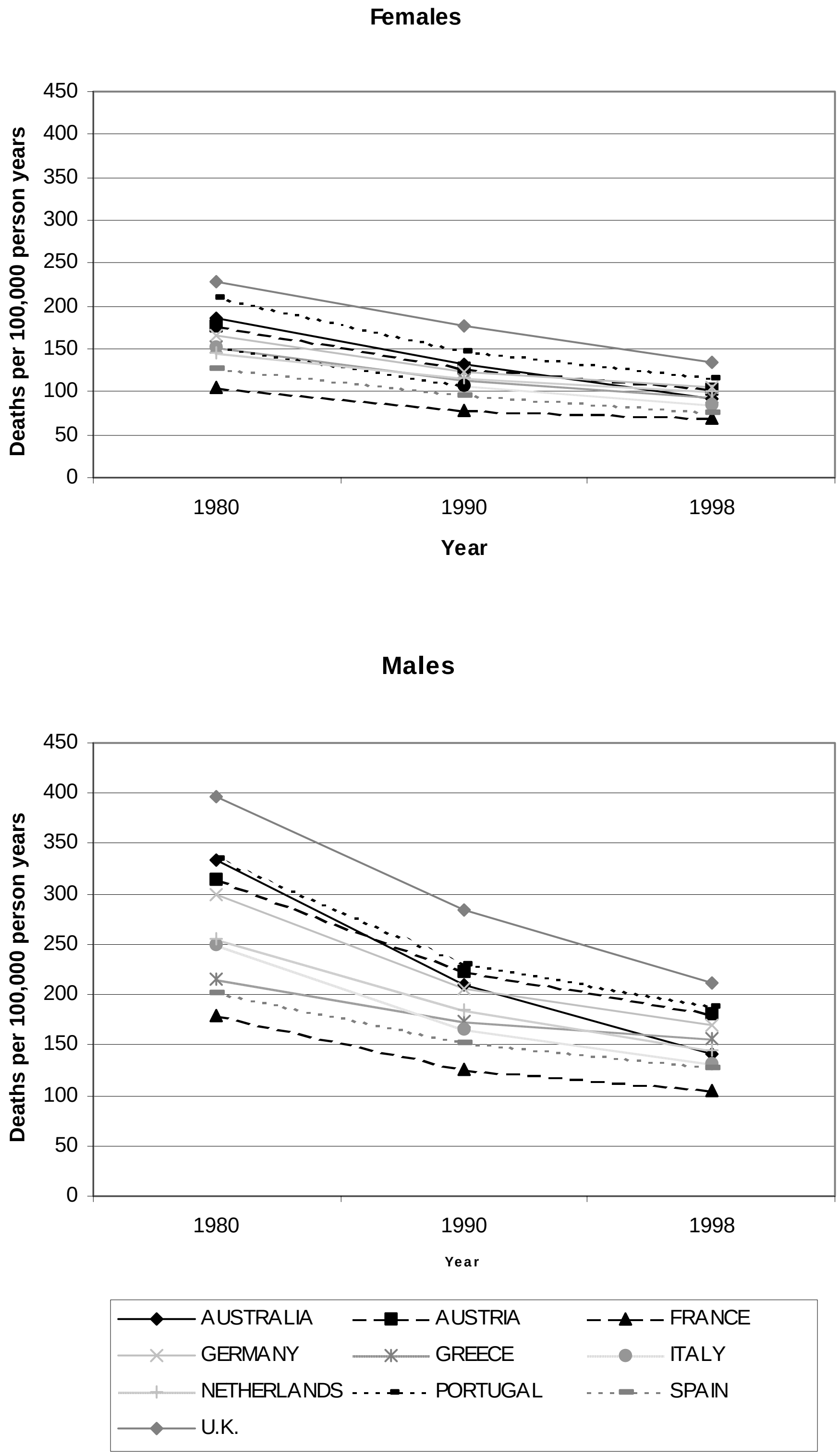


Figure 6. Deaths rates (per 100,000 person years) for medical care indicators and ischemic heart disease (combined) in Australia and selected European countries (population aged 0-74 years)

Note. Different to the scale used in Figure 5.

DISCUSSION

The avoidable mortality approach offers a simple method for estimating the impact of health care systems on mortality. Using this approach, our findings suggest that the Australian health care system has made substantial contributions to the reduction in mortality over the past three decades. This is shown in the steady decline in avoidable mortality rates. Moreover, the rate of decline has been faster than that for nonavoidable deaths, with deaths from avoidable causes falling from approximately two-thirds to half of total deaths over a 34-year period. These patterns of avoidable mortality are consistent with those in studies set in Europe, Asia and North America that have used similar measures of avoidable and nonavoidable deaths.[4 17 20 22 24-35]

Limitations

When interpreting the avoidable mortality patterns, several points about the classification are worth noting. As originally discussed by Rutstein and his colleagues, the chain of events that leads to death may be long and complex, thus the partitioning of deaths into those that are avoidable, and those that are not, is an inexact science.[6] Indeed, not all deaths categorised as avoidable are necessarily avoidable, rather a substantial proportion could be avoided through appropriate and timely health care. Further, the list of avoidable causes is not intended to cover all causes possibly treatable and/or preventable and the nonavoidable category will contain a proportion, albeit relatively small, of avoidable deaths. Finally, many conditions amenable to medical care are also preventable so the MCI reflect the impact of health policy to some degree, and similarly, the HPI partly reflect medical care. This is particularly important to bear in mind when interpreting the rates for HPI - health policy may have made a greater contribution to mortality than the findings suggest given that MCI include a subset of conditions that are also responsive to health policy. To a lesser extent, HPI will also reflect medical care advances, particularly in the management of motor vehicle trauma.

Critics of avoidable mortality have argued that the concept is limited because it does not take into account underlying disease incidence, i.e. lower death rates over time or across regions may just reflect lower incidence rates. This also needs to be kept in mind when interpreting the avoidable mortality rates given that varying incidence may reflect genetic, social and environmental influences, not just health care. However, this limitation is partly countered by Charlton and colleagues who point out that regardless of whether or not disease incidence influences variation in death rates, high avoidable mortality rates indicate areas of potential health system weakness given that the deaths are potentially avoidable.[10] Further, avoidable mortality studies that have taken into account underlying disease incidence as measured by routinely collected morbidity data have found that this only partly accounts for the observed variation in avoidable mortality. [18 43]Moreover, adjusting for incidence rates may lead to an underestimation (and where incidence rates actually increase, an overestimation) of the effectiveness of health care given such rates will, themselves, be at least partly determined by health care.

Finally, there were changes in coding practices during the series, with three successive versions of the ICD being implemented, and a change from a manual to automated cause of death coding in 1997.[44] While this potentially raises problems of time trends reflecting these changes, the use of aggregate categories means that any coding changes are unlikely to affect the results substantially. In our series, there were no changes in trends, in either direction or magnitude, in the three avoidable death categories or the nonavoidable category when new ICD editions were introduced, nor when the coding practice changed from a manual to an automated coding system. Such changes in coding practices, particularly the latter, are more relevant when looking at trends in individual causes of death. The single cause of avoidable death most affected by the changes is pneumonia. Under manual coding (prior to 1997), and when ICD-10 coding was introduced (after 1998), pneumonia deaths were often coded as a chronic underlying condition such as Alzheimer’s disease or malignant neoplasm This means an underestimation of pneumonia deaths compared with 1997 and 1998.[42 44] Nevertheless, pneumonia deaths, at least when not associated with a chronic underlying condition, have fallen substantially over this period.

Explanation of trends

The decline in avoidable mortality in Australia has mostly been due to falling rates of IHD, these being particularly dramatic in men. These well-documented declines reflect health policy interventions through reductions in smoking and dietary risk factors, and through medical care including prevention (management of abnormal blood pressure and cholesterol levels) and acute and subacute coronary care (e.g. surgical interventions such as bypass grafts and angioplasties).[45-49]

The absolute decline in MCI death rates has also been substantial. The causes that contributed most to this decline were cerebrovascular disease, perinatal deaths and pneumonia, these causes having high death rates at the start of the period. For cerebrovascular disease, health care interventions that are likely to have contributed to the decline in mortality include primary intervention such as carotid endarterectomy[50] and the management of modifiable risk factors using drug therapies for hypertension and hypercholesterolemia,[51] secondary prevention, e.g. using anticoagulant therapy for preventing stroke recurrence,[52] and tertiary intervention such as the use of organised stroke units.[53 54] Interpreting the impact of the health system on perinatal mortality is complex due to several interacting factors. The rates must be seen in the context of decreasing fertility rates in Australia[1] which alone will result in lower perinatal mortality rates over time as the rates in this study are given as a proportion of the total population not as a proportion of live births. Nevertheless, a range of health care interventions such as the introduction of neonatal intensive care units and improved paediatric and obstetric care have contributed substantially to the decline in perinatal mortality.[55 56] Further, improved prenatal screening for congenital abnormalities leading to termination will have influenced the perinatal death rate although this is difficult to quantify given notification of terminations is incomplete in Australia.[57] The downward trend in deaths from pneumonia in Australia has been previously well documented, much of the mortality decline from this condition and that of other infectious diseases in the last half century attributable to the health care system, including mass application of antibiotics and immunisation.[58]

The trends in avoidable mortality in Australia for MCI and IHD are similar to those of other European countries, although there is variation in the absolute rates. For comparisons based on MCI alone, Australia performs well and has actually improved its ranking over the past two decades. However, with IHD included, Australia’s rankings fall due to its relatively higher rates of IHD deaths. This fall in Australia’s ranking with the inclusion of IHD has been previously documented.[59] However, taking a snapshot of these rates obscures the fact that Australia has shown the greatest improvement in IHD rates since 1980, suggesting that our health system is actually performing relatively better than static rankings alone suggest.

Deaths rates in Australia for HPI have declined at a slower rate overall than for IHD and MCI. This reflects the increasing rather than decreasing rates of malignant neoplasm of the trachea, bronchus and lung over the entire period in women and up until the early 80s in men. Importantly, the lag between the exposure and onset of disease means that the effectiveness of any tobacco control interventions are not fully realised in these trends. The falling rate of lung cancer in men reflects the dramatic decline in the smoking rate in this population over the past several decades, while prevalence rates in women, although lower overall, have fallen at a slower rate, having started to fall only in the early 1980s.[60 61] In contrast to lung cancer, falling death rates from motor vehicle accidents have been a major contributor to the decline in avoidable mortality over the 34-year period in women, men and children. While much of this decline can be attributed to transport safety initiatives including national laws regarding alcohol control, speeding, and the wearing of seatbelts and child restraints, medical care has also made major contributions to the declining mortality rate.[62]

The relatively shallow decline in nonavoidable deaths was expected given that the overall decline in mortality over this period was anticipated to be mainly due to those causes responsive to healthcare intervention. The decline that did occur may represent the impact of factors outside of health care such as improvements in living standards. However, it may also reflect contributions of the health care sector given that the nonavoidable category is expected to contain a small proportion of avoidable deaths.

Conclusion

Over the period 1968 to 2001, Australia experienced a 68% decline in avoidable mortality rates for women and a 72% decline for men. The corresponding declines in non-avoidable mortality were 35% and 33%. Given that avoidable deaths were around two-thirds of all deaths for both sexes at the start of this period, these declines in avoidable mortality rates are substantial and have translated into marked improvements in life expectancy over this period.

For women, a little over one-half (54%) of the decline in avoidable mortality rates was attributable to a decline in the MCI death rate, while another 45% was accounted for by declines in IHD death rates. For men, reductions in IHD death rates accounted for the largest decline in the avoidable mortality rate (57%) while reductions in the MCI death rate accounted for 32%. Reductions in HPI death rates accounted or a negligible proportion of the decline in avoidable mortality rates in women (1%) but made a more pronounced contribution for men (11%).

In international comparisons with nine European counties for which comparable data are available for the years 1980, 1990 and 1998, MCI and IHD avoidable mortality rates in Australia are within the range for these countries with respect to the absolute level of, and the decline in, avoidable mortality. Within this range, Australia's ranking improved from eighth to fourth over the period for both sexes for combined MCI and IHD avoidable mortality rates.

The analyses presented in this paper suggest that the health system in Australia has played an important role in improving the health of the nation. Defining avoidable deaths as those amenable to intervention through the health care system, it has been shown that avoidable mortality rates have declined substantially over this period. It has also been shown that, over the last two decades, Australia's ranking with respect to such rates has improved in comparison with nine European countries. While the observed declines in avoidable mortality rates may also reflect changes in other factors that influence mortality such as environment and socioeconomic conditions, they are consistent with, and suggestive of, the health care system being an important determinant of health improvements in Australia in recent decades.

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Appendix Table

Age-standardised annual death rates (per 100,000 person years in population aged 0-74 years) by sex, for medical care indicators (MCI), ischaemic heart disease (IHD), health policy indicators (HPI), total avoidable (MCI, IHD and HPI combined), total nonavoidable (total minus total avoidable) and total deaths.

Year	MCI		IHD		HPI		Total avoidable		Total nonavoidable		Total
	Rate	%	Rate	%	Rate	%	Rate	%	Rate	%	Rate
FEMALES											
1968	177.32	54.96	121.56	37.68	23.73	7.36	322.61	67.04	158.57	32.96	481.18
1969	172.98	54.21	120.75	37.84	25.39	7.96	319.12	67.80	151.58	32.20	470.70
1970	184.75	54.54	125.46	37.04	28.55	8.43	338.76	68.29	157.27	31.71	496.03
1971	163.97	53.98	113.90	37.49	25.92	8.53	303.78	67.26	147.87	32.74	451.65
1972	159.78	54.32	109.44	37.21	24.93	8.48	294.16	66.77	146.38	33.23	440.53
1973	150.69	53.42	104.93	37.20	26.46	9.38	282.08	66.41	142.69	33.59	424.77
1974	152.81	53.34	107.18	37.42	26.47	9.24	286.46	66.44	144.71	33.56	431.17
1975	142.59	53.08	99.83	37.16	26.19	9.75	268.61	66.49	135.35	33.51	403.96
1976	139.96	53.26	95.23	36.24	27.59	10.50	262.78	66.48	132.48	33.52	395.26
1977	129.10	52.02	90.69	36.54	28.37	11.43	248.15	65.78	129.10	34.22	377.26
1978	121.34	50.70	88.11	36.81	29.89	12.49	239.34	64.67	130.77	35.33	370.11
1979	113.81	50.98	81.02	36.29	28.41	12.73	223.24	64.32	123.85	35.68	347.09
1980	111.46	52.05	75.85	35.41	26.86	12.54	214.17	63.57	122.75	36.43	336.92
1981	107.17	50.80	76.32	36.17	27.49	13.03	210.98	63.65	120.51	36.35	331.50
1982	107.34	51.27	73.74	35.22	28.30	13.51	209.38	62.86	123.71	37.14	333.09

Appendix Table: Age-standardised annual death rates (*continued)*

Year	MCI		IHD		HPI		Total avoidable		Total nonavoidable		Total
	Rate	%	Rate	%	Rate	%	Rate	%	Rate	%	Rate
1983	101.77	50.61	71.98	35.80	27.32	13.59	201.07	62.16	122.43	37.84	323.50
1984	101.46	51.46	68.61	34.80	27.10	13.74	197.16	61.57	123.05	38.43	320.21
1985	101.68	52.17	65.66	33.69	27.54	14.13	194.88	60.94	124.90	39.06	319.77
1986	94.99	51.08	63.62	34.21	27.38	14.72	185.99	61.01	118.88	38.99	304.87
1987	92.67	51.57	60.47	33.65	26.56	14.78	179.70	60.01	119.76	39.99	299.46
1988	89.48	51.58	56.41	32.52	27.59	15.90	173.47	59.40	118.55	40.60	292.02
1989	90.06	52.08	54.85	31.71	28.03	16.21	172.94	58.63	122.05	41.37	294.99
1990	83.78	52.19	51.02	31.78	25.73	16.03	160.52	57.91	116.69	42.09	277.21
1991	81.91	53.43	45.73	29.83	25.65	16.73	153.28	57.17	114.83	42.83	268.11
1992	78.67	53.39	44.88	30.46	23.80	16.15	147.35	55.64	117.46	44.36	264.81
1993	76.55	54.10	40.99	28.97	23.96	16.93	141.49	56.08	110.83	43.92	252.32
1994	76.63	55.02	37.64	27.02	25.01	17.96	139.28	55.15	113.27	44.85	252.55
1995	73.35	54.94	35.55	26.63	24.61	18.43	133.51	54.57	111.14	45.43	244.65
1996	71.59	55.78	32.87	25.62	23.87	18.60	128.33	53.74	110.48	46.26	238.81
1997	69.24	55.64	31.38	25.22	23.81	19.13	124.43	52.62	112.06	47.38	236.48
1998	65.57	55.94	28.72	24.50	22.91	19.55	117.20	52.03	108.06	47.97	225.26
1999	60.68	55.77	25.63	23.56	22.49	20.67	108.80	49.88	109.33	50.12	218.14
2000	59.73	55.50	25.04	23.26	22.86	21.24	107.63	50.38	105.99	49.62	213.61
2001	57.76	56.62	22.40	21.96	21.85	21.42	102.02	49.59	103.68	50.41	205.70

Appendix Table: Age-standardised annual death rates (continued)

Year	MCI		IHD		HPI		Total avoidable		Total nonavoidable		Total
	Rate	%	Rate	%	Rate	%	Rate	%	Rate	%	Rate
MALES											
1968	189.63	31.64	309.72	51.67	100.04	16.69	599.38	68.60	274.38	31.40	873.76
1969	181.70	31.21	298.95	51.36	101.46	17.43	582.11	68.23	270.99	31.77	853.10
1970	189.80	31.79	304.17	50.95	103.04	17.26	597.01	68.08	279.88	31.92	876.89
1971	166.01	30.40	279.93	51.26	100.16	18.34	546.10	67.85	258.81	32.15	804.91
1972	164.58	30.48	277.82	51.44	97.63	18.08	540.03	67.36	261.69	32.64	801.72
1973	159.75	30.08	269.72	50.79	101.61	19.13	531.08	67.24	258.71	32.76	789.79
1974	160.78	30.31	266.65	50.27	102.97	19.41	530.39	66.67	265.19	33.33	795.59
1975	143.37	28.52	255.15	50.75	104.20	20.73	502.72	67.04	247.15	32.96	749.87
1976	139.88	28.41	249.44	50.67	103.00	20.92	492.31	66.28	250.44	33.72	742.76
1977	128.95	27.60	237.66	50.87	100.56	21.53	467.18	66.03	240.31	33.97	707.49
1978	124.38	27.56	226.36	50.15	100.62	22.29	451.35	65.27	240.16	34.73	691.51
1979	117.49	27.11	216.50	49.96	99.35	22.93	433.34	64.78	235.61	35.22	668.95
1980	113.76	27.22	205.90	49.27	98.28	23.52	417.94	63.77	237.43	36.23	655.37
1981	107.40	26.29	202.06	49.47	99.00	24.24	408.46	63.63	233.42	36.37	641.88
1982	106.37	26.85	193.62	48.87	96.22	24.29	396.21	62.32	239.57	37.68	635.78
1983	97.27	26.37	183.33	49.70	88.26	23.93	368.87	61.89	227.13	38.11	596.00
1984	96.91	26.79	177.72	49.13	87.09	24.08	361.72	61.42	227.22	38.58	588.94

Appendix Table: Age-standardised annual death rates (*continued*)

Year	MCI		IHD		HPI		Total avoidable		Total nonavoidable		Total
	Rate	**%**	**Rate**	**%**	**Rate**	**%**		**Rate**	**%**	**Rate**	**%**
1985	94.51	27.13	166.84	47.90	86.99	24.97	348.34	60.09	231.31	39.91	579.65
1986	87.84	26.73	157.51	47.93	83.24	25.33	328.60	59.45	224.16	40.55	552.76
1987	85.92	26.71	153.71	47.79	82.01	25.50	321.63	58.40	229.10	41.60	550.72
1988	82.55	26.87	143.80	46.81	80.84	26.32	307.18	57.35	228.48	42.65	535.67
1989	84.32	27.74	139.63	45.93	80.05	26.33	303.99	56.74	231.81	43.26	535.80
1990	76.60	28.06	125.87	46.11	70.50	25.83	272.97	54.73	225.75	45.27	498.72
1991	72.30	27.95	117.23	45.33	69.09	26.71	258.62	54.32	217.50	45.68	476.12
1992	71.77	28.39	113.58	44.92	67.49	26.69	252.84	53.26	221.89	46.74	474.73
1993	68.84	28.89	105.46	44.26	63.96	26.85	238.26	52.80	212.99	47.20	451.25
1994	70.19	30.03	99.46	42.55	64.09	27.42	233.74	51.58	219.39	48.42	453.12
1995	65.89	29.61	94.81	42.60	61.85	27.79	222.55	51.25	211.69	48.75	434.24
1996	65.02	30.12	89.68	41.54	61.17	28.34	215.88	50.66	210.24	49.34	426.11
1997	62.92	30.99	83.62	41.18	56.52	27.83	203.05	49.53	206.89	50.47	409.95
1998	59.05	30.58	77.34	40.05	56.72	29.37	193.12	48.57	204.51	51.43	397.63
1999	54.33	30.11	72.90	40.39	53.24	29.50	180.47	47.18	202.03	52.82	382.51
2000	54.79	31.91	65.63	38.22	51.29	29.87	171.70	47.00	193.62	53.00	365.32
2001	52.39	31.42	63.22	37.92	51.10	30.65	166.71	47.65	183.13	52.35	349.84

Note. Denominator for percentages for MCI, IHD and HPI is total avoidable death rate; denominator for percentages for total avoidable and nonavoidable is total death rate.

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