Past & future causes of death - implications for planners

Richard Cumpston

Summary

Since the Commonwealth Department of Health was established in 1921, standardised death rates have fallen substantially. Initially these falls may have been due to the use of antibiotics and public health measures such as vaccination. Reflecting peaks in the use of alcohol and tobacco, deaths due to cancer and heart disease rose, but are now falling.

Some increases have occurred over the last 20 years, particularly in deaths due to infectious diseases, mental disorders and diseases of the nervous system. Possible causes of the increases in mortality rates from some causes at older ages may be changes in classification procedures, side effects from drugs or poorer care.

Projections have been made of deaths from each major cause in the next 20 years, assuming that rates of change in mortality rates from 1975 to 1999 continue until 2021. These "trend" projections suggest that total death numbers will increase from about 135,000 in 2001 to 230,000 in 2021, with very large increases in deaths from mental disorders and diseases of the nervous system.

Projections were also made assuming that any past reductions in mortality rates will continue, but no further increases will occur. These "optimistic" projections suggest that total death numbers will increase from about 133,000 in 2001 to 169,000 in 2021. This estimate for 2021 is close to that implied by the most recent population projections of the Australian Bureau of Statistics.

Under these optimistic projections, deaths from heart disease may fall from about 52,000 in 2001 to 48,000 in 2021, while cancer deaths may rise from about 39,000 to 69,000, and deaths from all other causes may rise from 42,000 to 59,000. About 85% of deaths in 2021 are projected to be amongst persons 65 and over.

Increased death numbers suggest that more care will be needed for persons in the last few years before death. Much of this added burden may have to be met by nursing homes. Large increases in medical costs are also likely, particularly if expensive new treatments emerge for cancer and other diseases.

Given the high costs of care, it is surprising that so little attention has been given to the relationships between death rates, risk factors and treatment changes.

2. Age-standardised death rates

### Age-standardised deaths per 100,000 persons
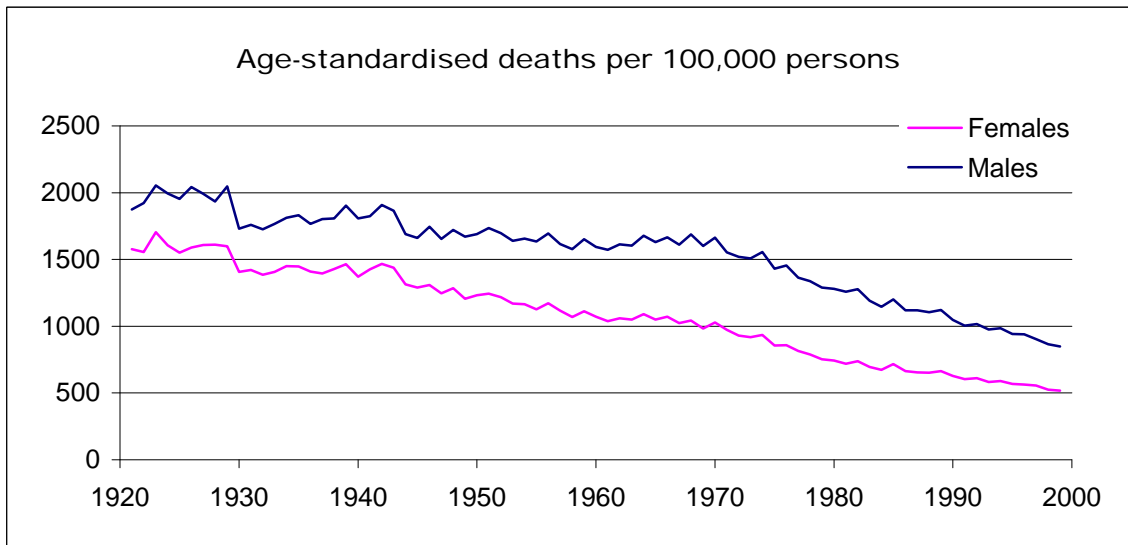
Mortality rates for each 5-year age group from 1921 to 1988 were obtained from d'Espaignet ET, van Ommeren M, Taylor F, Briscoe N & Pentony P (1991). Rates from 1989 to 1999 were calculated from death numbers supplied by the Australian Bureau of Statistics, together with rates at age groups 85-89, 90-94, 95-99 and 100+ for 1968 to 1988.

Age-standardised death rates were calculated from age-specific death rates for 1921 to 1999, by assuming that the Australian population has always had the same age and sex composition as in 2001. Female standardised death rates were 16% lower than those for males in 1921, and are now 39% lower. Some of the reasons for the changes in age-standardised death rates have been

- very large falls up to 1960 in deaths from infectious diseases, and a doubling in such deaths since 1985

- rising deaths from neoplasms for males, largely due to smoking and occupational exposures, with slight recent falls

- unexplained increases in deaths from mental disorders since 1950

- falls in deaths from diseases of the nervous system, with unexplained increases since 1980

- rising deaths from diseases of the circulatory system until the 1960s, then large continuing falls

- falling deaths from diseases of the respiratory, digestive and genitourinary systems

- falling deaths from accidents, largely due to road safety measures.

**Age-standardised deaths per 100,000 - infectious**
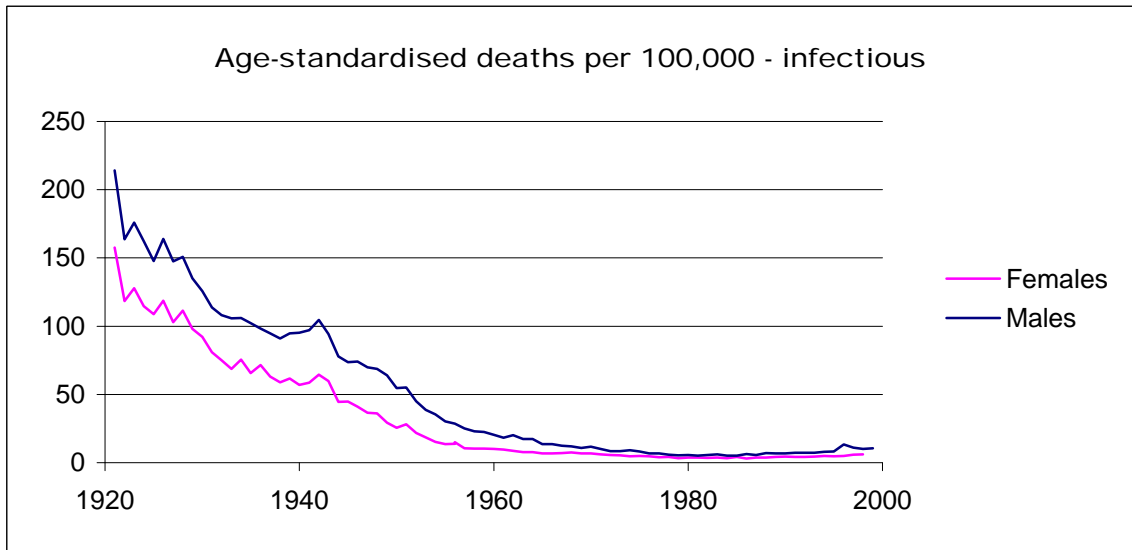
Standardised mortality rates from infectious diseases fell until about 1985, but have approximately doubled since then. AIDS, or drug-resistant infections, may be responsible.

Age-standardised deaths per 100,000 - neoplasms
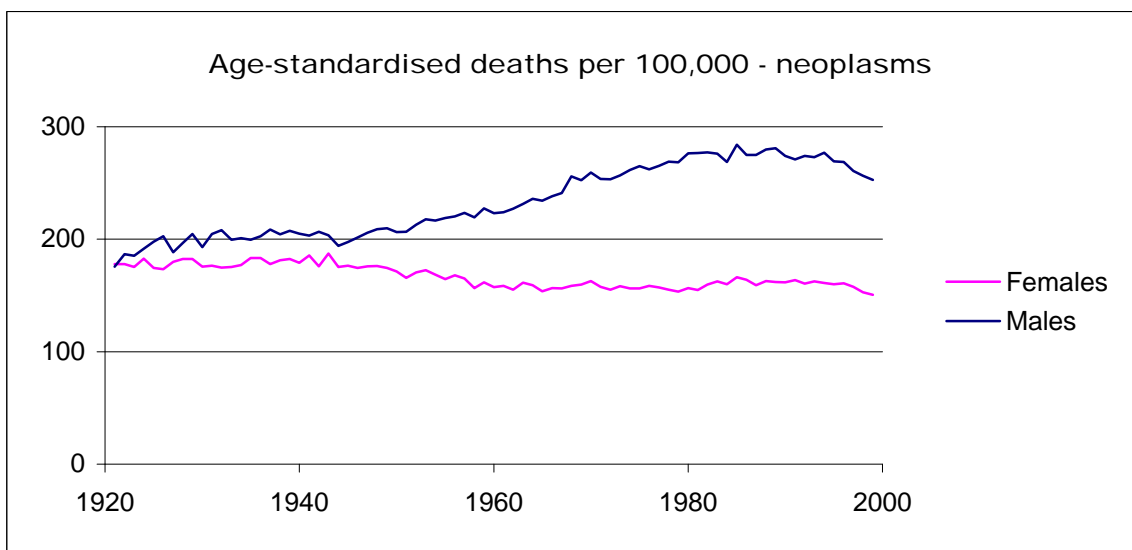
Standardised mortality rates from neoplasms were broadly similar for males and females in 1921, but female rates have declined slightly, while male rates have generally risen. Only since 1994 has any clear trend downwards in male mortality rates been visible. Tobacco consumption peaked for males in 1960, and for females in 1976 (see 3.2). A 25-year delay between smoking and lunf canner has been suggested as the reason for the delayed peak in cancers for males.

Age-standardised deaths per 100,000 - endocrine, nutritional, metabolic, immunity
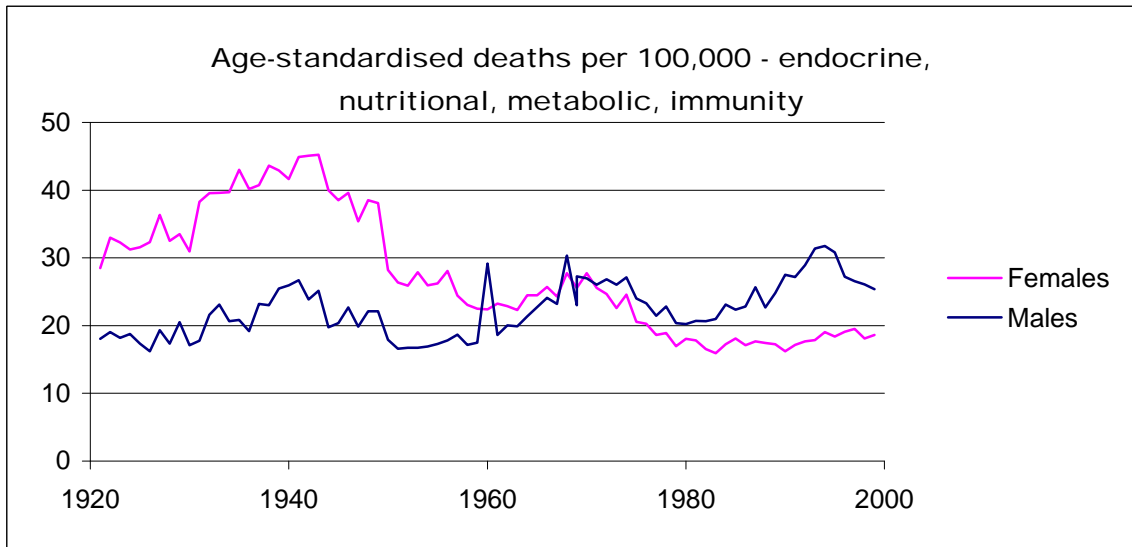
It is not clear why age-standardised death rates from endocrine, nutritional, metabolic and immunity diseases have risen since about 1980. The elevated levels from about 1932 to 1949 may have reflected dietary inadequacies.

Age-standardised deaths per 100,000 - mental disorders
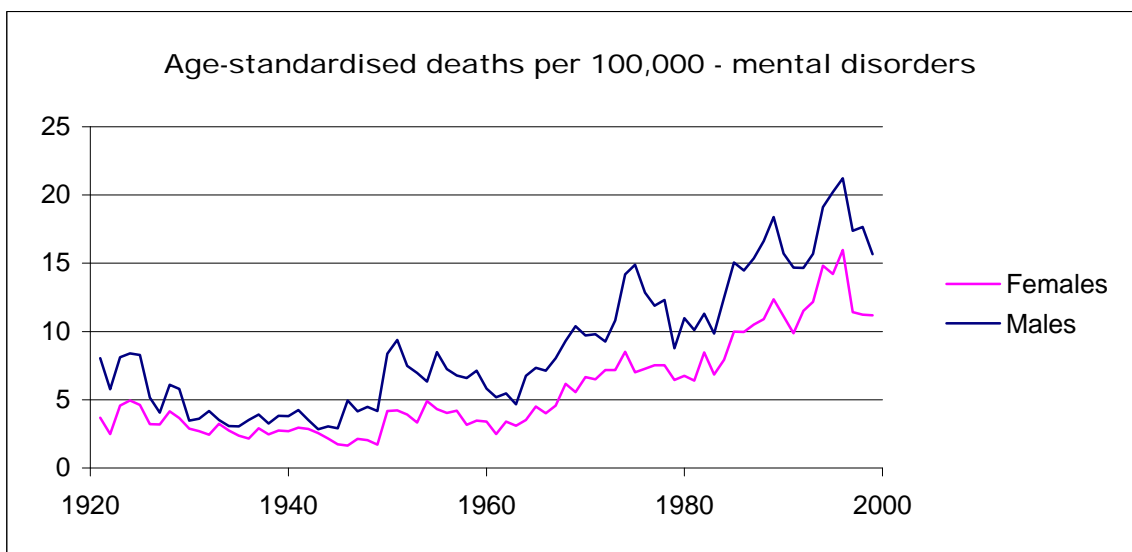
Age-standardised death rates from mental disorders have roughly tripled since 1950. Some of the possible reasons for increasing mortality rates from mental disorders and diseases of the nervous system are:

- changes in cause of death classification procedures

- side-effects from drugs used to control other diseases

- poorer care of aged persons.

**Age-standardised deaths per 100,000 - nervous system**
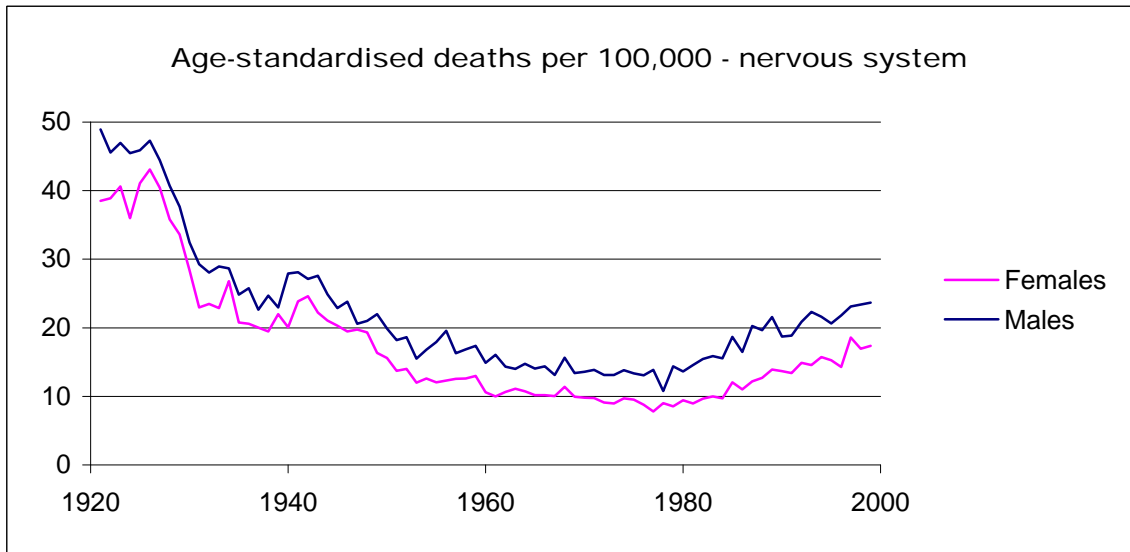
Age-standardised death rates from diseases of the nervous system have almost doubled since 1980. Again, this may reflect changes in classifications rather than real increases. The possible reasons suggested for increasing deaths from mental disorders may also apply to deaths from diseases of the nervous system.

Age-standardised deaths per 100,000 - circulatory system
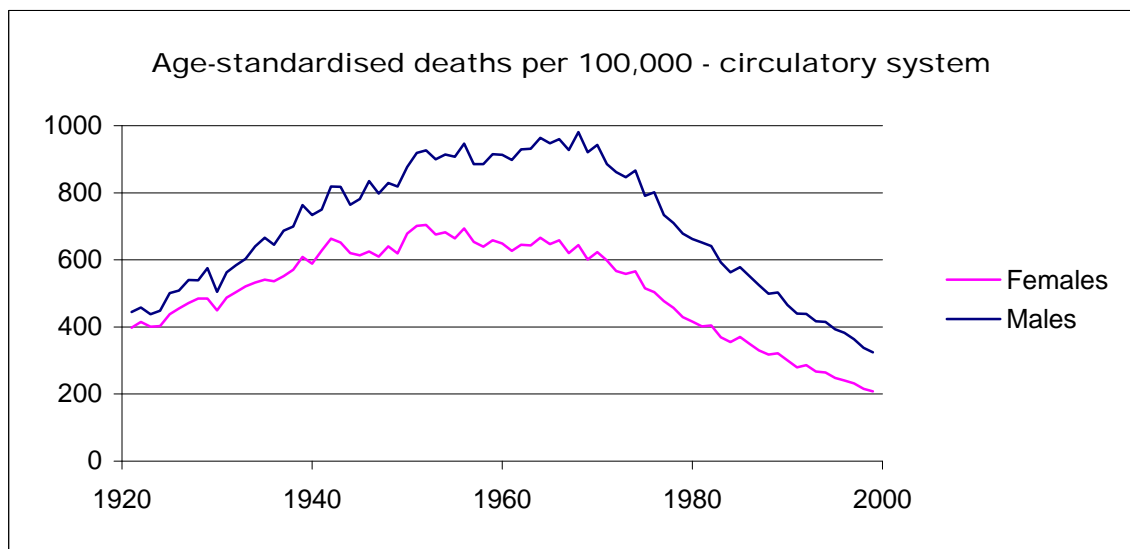
Diseases of the circulatory system have been the major cause of death throughout. Age-standardised death rates climbed until about 1950, remained static until about 1970, and have been falling steadily since. Reductions in tobacco consumption by males may have given prompt reductions in associated deaths of the circulatory system, but other reasons must have been responsible for the reductions in female deaths.

Age-standardised deaths per 100,000 - respiratory system
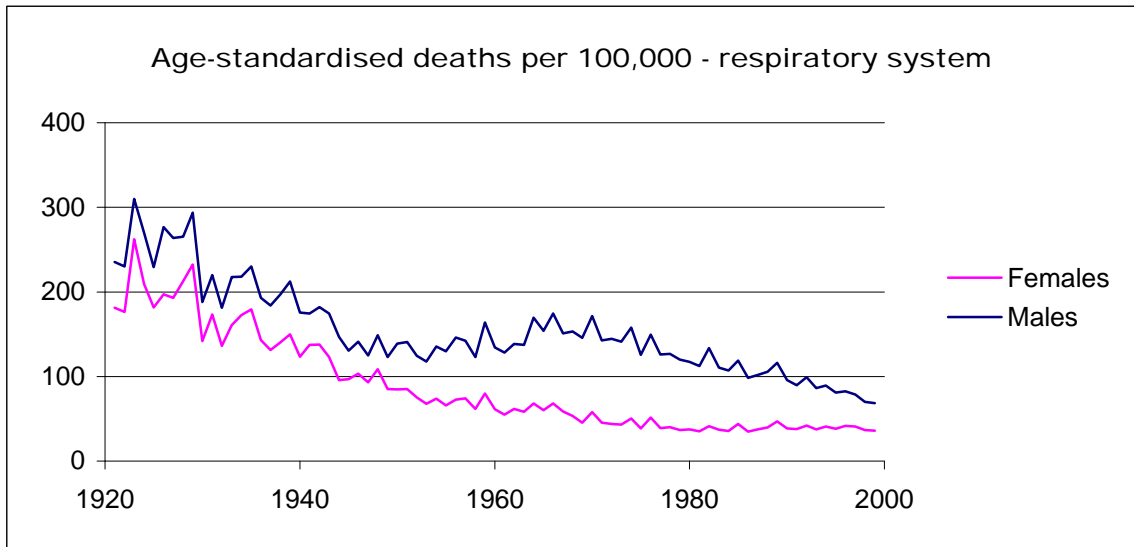
Age-standardised death rates from respiratory diseases fell until about 1950, perhaps reflecting wider use of vaccines and better medical treatment. Subsequent Increases for males until 1966 may have resulted from greater use of tobacco.

Age-standardised deaths per 100,000 - digestive system
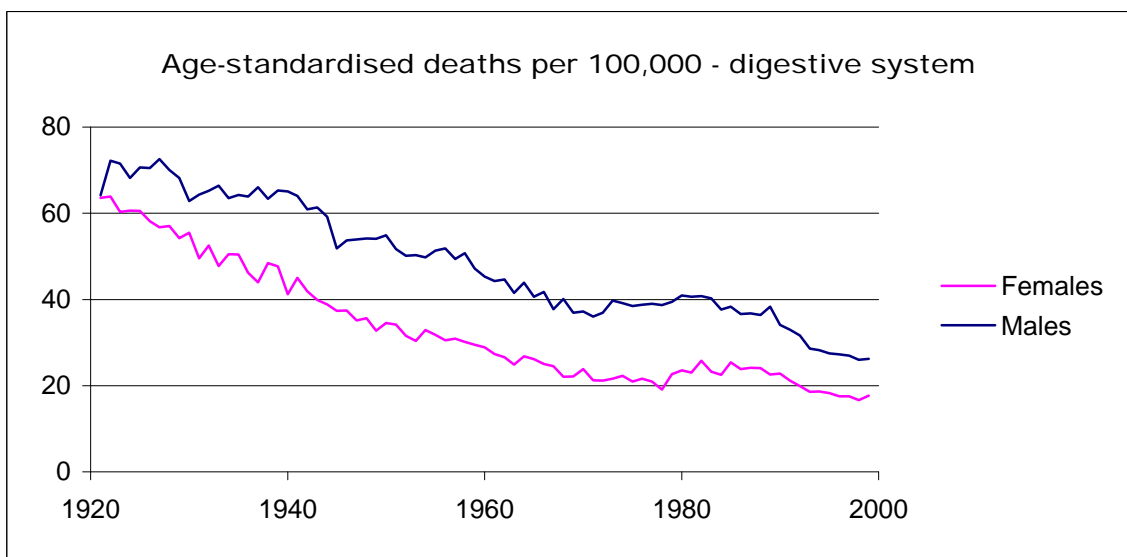
The large falls in age-standardised death rates from diseases of the digestive system until about 1970 may reflect better medical treatment. The subsequent increases to peaks in about 1980 may reflect the peak use of alcohol (see 3.1).

Age-standardised deaths per 100,000 - genitourinary system
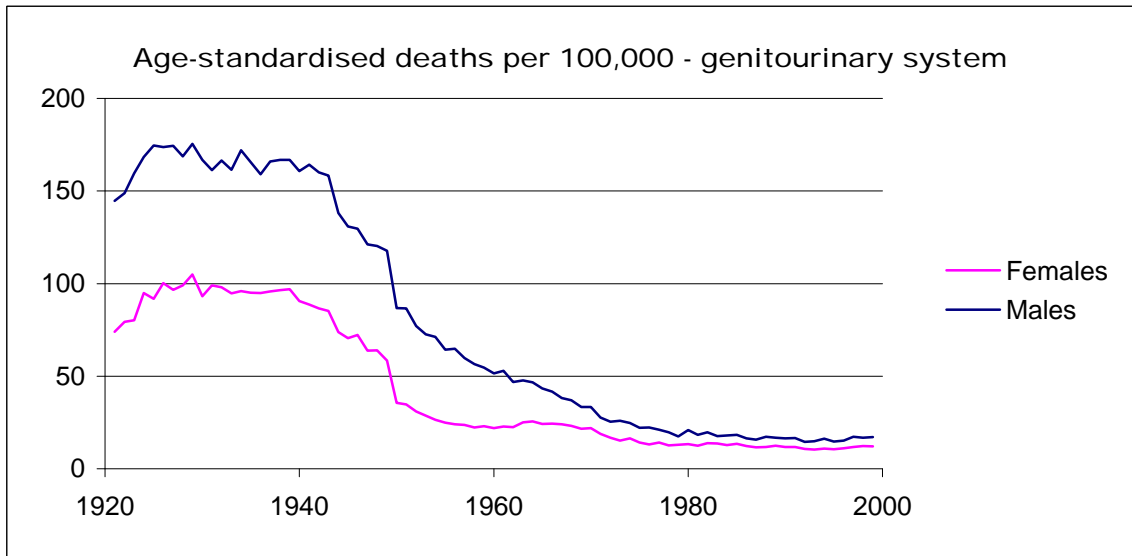
The large falls in age-standardised death rates from diseases of the genitourinary system between 1940 and 1960 may reflect the greater use of antibiotics. Subsequent falls may reflect a range of improvements in treatment procedures.

Age-standardised deaths per 100,000 - accidents
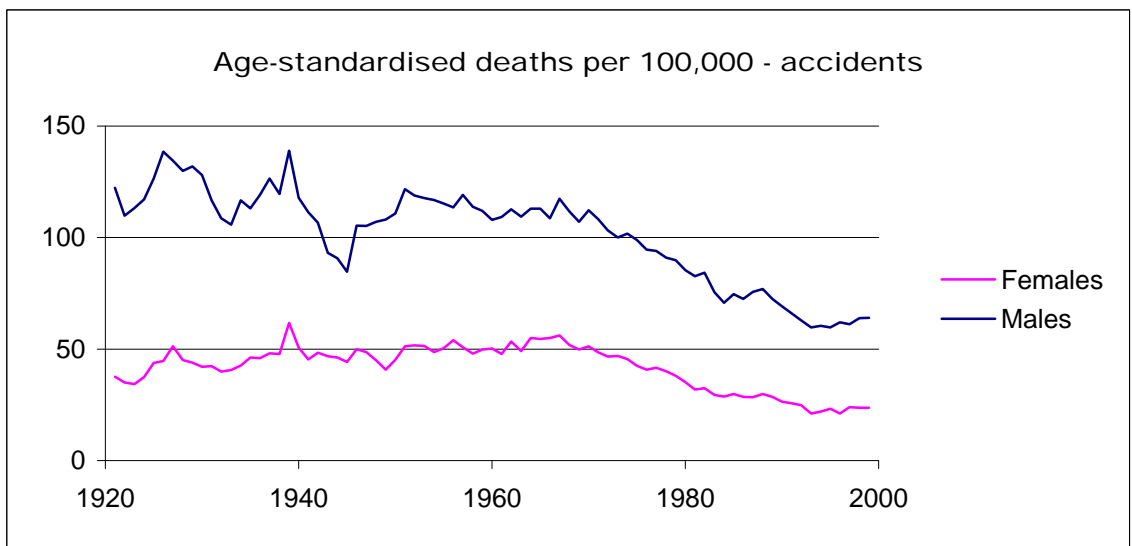
Petrol rationing may have reduced accidents in the 1940s. Seatbelts and other road safety legislation may have reduced motor vehicle fatalities from about 1970 on. Both males and females have shown increases in death rates since 1994.

3. Risk factors

3.1 Alcohol

Alcohol consumption (litres per head)
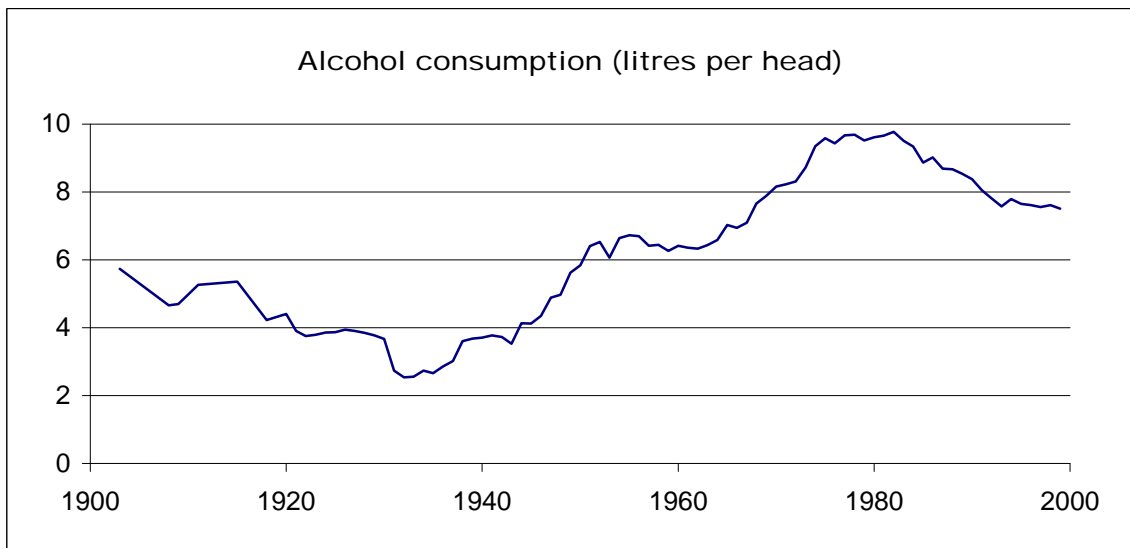
The above figures up to 52-53 are from Australian yearbooks, and thereafter from "Apparent consumption of foodstuffs" (ABS catalogue no 4306.0). They show a fall to 2.5 litres per head in 1932, a rise to 9.8 in 1982, and a subsequent fall to 7.5 in 1999

The International Agency for Research on Cancer (1988) has concluded that the occurrence of malignant tumours of the oral cavity, pharynx, larynx, esophagus and liver is casually related to the consumption of alcoholic beverages. Higginson, Muir & Munoz (1992) comment:

> "…liver biopsies of heavy drinkers have unequivocally demonstrated the pathogenic sequence of alcoholic hepatitis, cirrhosis and cancer. The epidemiological and pathological findings suggest that these lesions depend on heavy drinking, and that there may be a threshold below which toxic effects do not occur. The complementary effects of hepatitis viruses need to be considered in such cases … These observations contrast the liver with other organs, eg esophagus, with high relative risks and where no obvious threshold is observed, and where it has been suggested that alcohol may act as a solvent for carcinogens occurring in tobacco or the diet.."

Armstrong (1985) showed age-standardised rates of liver cancer for males dropping from about 15 per 100,000 in 1910-19 to 1.5 in 1960-69, then rising slightly. This sharp drop is not matched by the changes in alcohol consumption. Rates of cancer of the oesophagus for males fell slightly from 1935-44 to 1955-64, then rose again.

3.2 Tobacco consumption per head

Tobacco consumption (kgs per head)
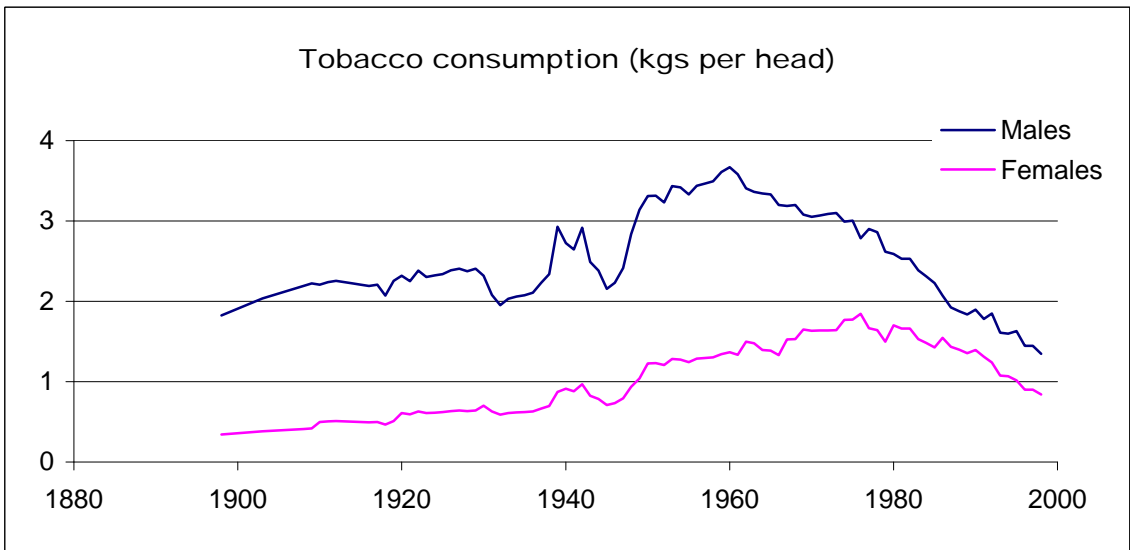
Rates for persons from 1908 on were obtained from AIHW (2000, p354). A rate for 1894-98 was obtained from the Victorian Yearbook 1895-8 (p839), and a rate for 1903 from Walker (1984, p34). Rates for males and females were derived using the assumed smoking percentages in 3.3, and the assumption that a female smoker smokes 85% as much tobacco as a male.

3.3 Percentages of males and females smoking

Percentages of adults smoking
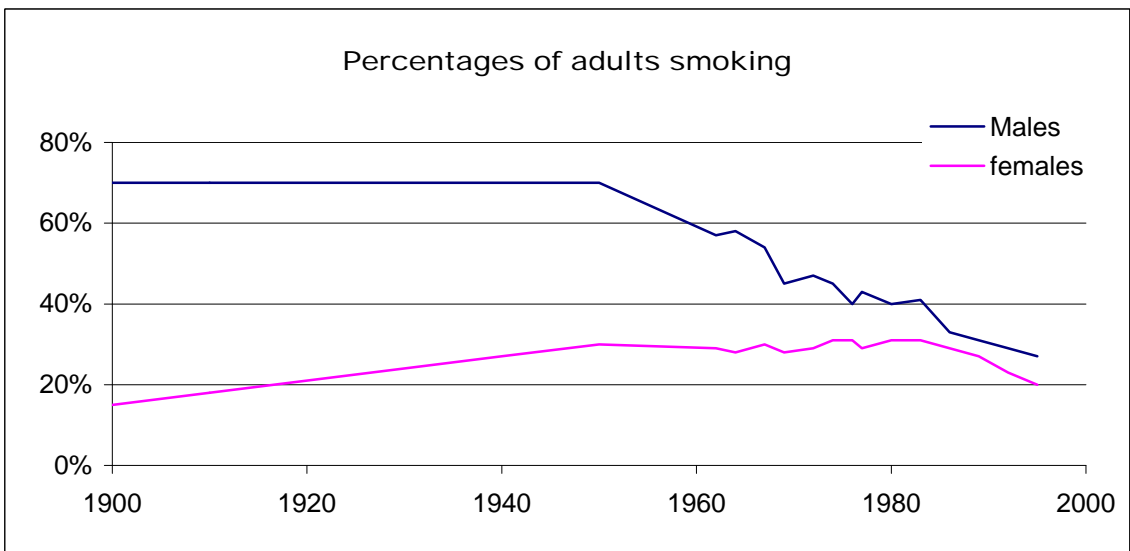
Year	Minimum age of respondent	Percent males smoking	Percent females smoking	Source
1900		70%	15%	Estimated
1910		70%	18%	Estimated
1920		70%	21%	Estimated
1930		70%	24%	Estimated
1940		70%	27%	Estimated
1950	21	70%	30%	Walker (1984, p93)
1962	21	57%	29%	Walker (1984, p93)
1964	21	58%	28%	Walker (1984, p93)
1967	21	54%	30%	Walker (1984, p93)
1969	21	45%	28%	Walker (1984, p93)
1972	14	47%	29%	Walker (1984, p93)
1974	14	45%	31%	Walker (1984, p93)
1976	16	40%	31%	Walker (1984, p93)
1977	18	43%	29%	Walker (1984, p93)
1980	16	40%	31%	Walker (1984, p93)
1983	18	41%	31%	AIHW (2000, p150)
1986	18	33%	29%	AIHW (2000, p150)
1989	18	31%	27%	AIHW (2000, p150)
1992	18	29%	23%	AIHW (2000, p150)
1995	18	27%	20%	AIHW (2000, p150)

The figures for 1950 to 1980 are from Walker (1984, p93), and subsequent figures from AIHW (2000, p150).

The 1974 survey estimated that 33% of men and 60% of women had never smoked regularly. Of those aged 70+, 24% of men and 79% of women had never smoked regularly. The estimated percentages smoking in 1900, 1910, 1920, 1930 and 1940 are broadly based on these estimated percentages of non-smokers.

Walker (1984) provides examples of the advertising of Cameo cigarettes for women in the Bulletin in 1905. He commented:

> "women smokers seem to have become perceptible about the 1920s."

> "…Cigarette advertising of the 1930s was noticeably directed at the woman smoker."

> "…Cigarette smoking was more accessible to the 'business' girl who earned her own income and this strengthened the relationship between smoking and independence. During the war more women went into civil and military jobs and female smoking became common and widely acceptable."

4. Age-specific mortality rates

**Deaths per 100,000 - neoplasms - females 65-99**
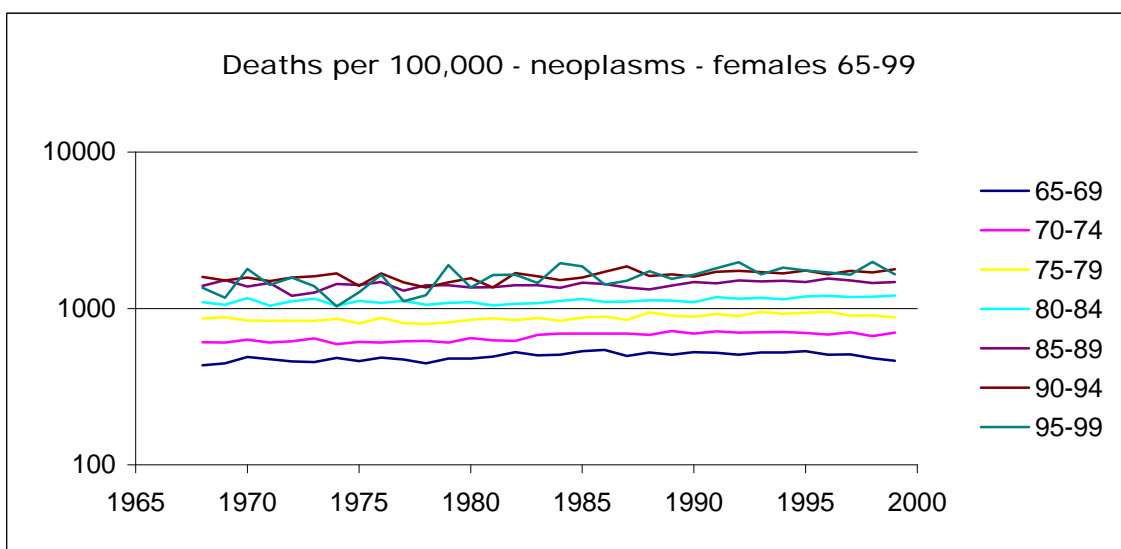
The above graph shows deaths per 100,000 females, for each 5-year age group from 65 to 99, for the calendar years 1968 to 1999. The lines for each age-group are relatively flat, suggesting that little or no progress has been made in the treatment of cancer in these older age groups. The lines are also close together, suggesting that cancer is less age-dependent than most other causes of death.

Deaths per 100,000 - mental disorders - females 65-100+
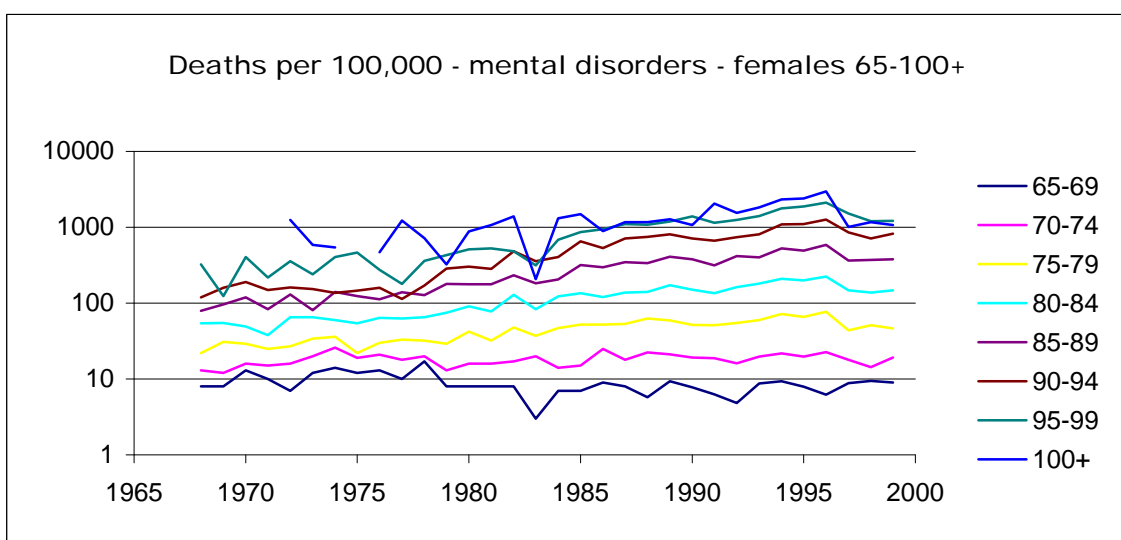
Deaths from mental disorders increase rapidly with age, and appear to have spread further apart from 1968 to 1999. Fitting a trend line for each age group gives stable mortality rates up to age 84, and rising rates at older ages. Assuming these rates of change to continue until 2021 gives very high projected numbers of deaths from mental disorders (see 6.). A second set of projections was made assuming negative past growth rates to continue, but any positive growth rates to be zero in future (see 7.). The reasons for past growth rates in deaths from mental disorders at older ages are uncertain, and there is even greater uncertainty about appropriate assumptions for the future.

Deaths per 100,000 - nervous system - females 65-99
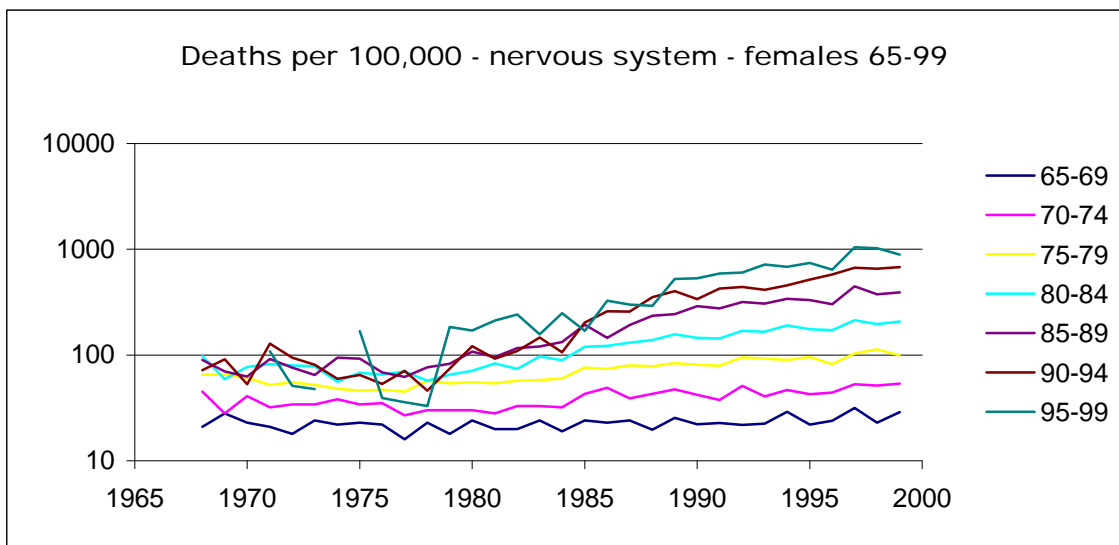
Deaths from diseases of the nervous system also increase rapidly with age, and appear to have spread even more rapidly than deaths from mental disorders. Fitting a trend line for each age group gives stable mortality rates up to age 74, and rising rates at older ages.

Deaths per 100,000 - circulatory system - females 65-100+
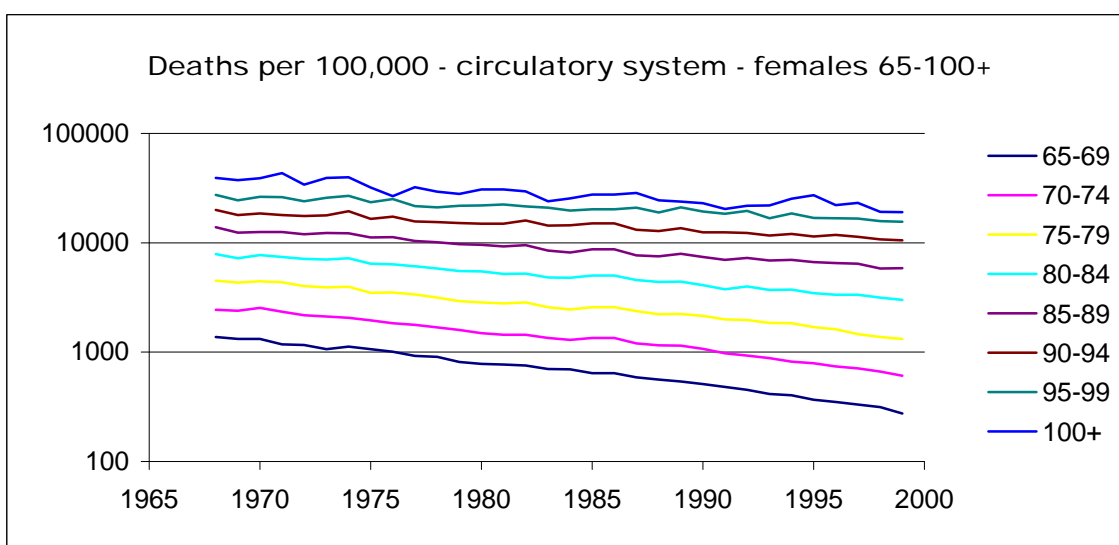
Death rates from diseases of the circulatory system have dropped at all ages, but at faster rates for middle-aged persons rather than the young or old. The declines may reflect the combined effects of better diet, healthier lifestyles, less smoking and better medicine, and continuing improvements seem plausible.

Deaths per 100,000 - respiratory system - females 65-100+
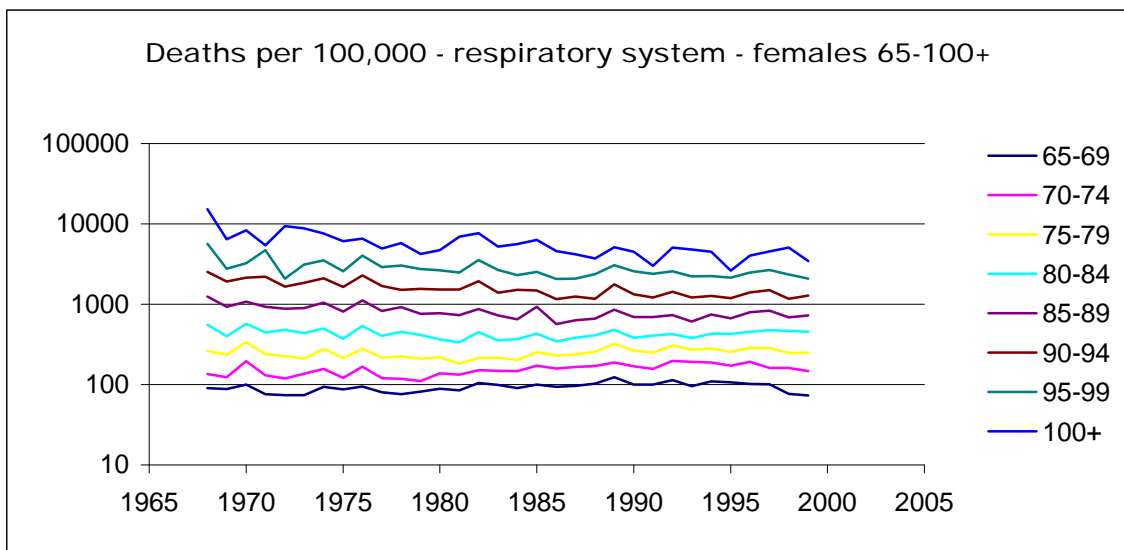
Death rates from diseases of the respiratory system have shown continuing reductions at neraly all ages.

Deaths per 100,000 - total - females 65-100+
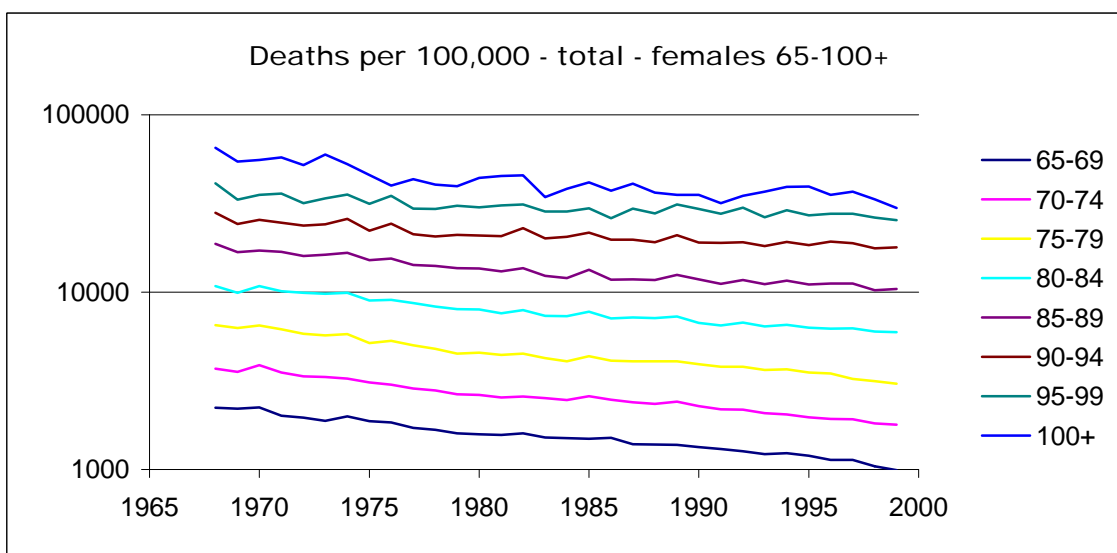
All-cause mortality rates showed declining trends for all age-groups, with the rates of decline being a little faster at young ages. The all-cause rates appear to be dominated by the declining trends in diseases of the circulatory and respiratory systems. Continuing declines in smoking seem likely to drive these two types down, as well as some types of cancer, and thus give further declines.

5. Projecting future numbers of deaths

Ideally, mortality projections should be based on a good understanding of the exposure and treatment factors that have been responsible for past mortality changes, and on detailed information on the likely effects of current medical developments. Lacking both, we are forced into some form of crude mathematical extrapolation of present trends.

For most causes of death and age groups, mortality rates over the period 1968 to 1999 followed reasonably straight lines (when plotted on logarithmic scales). Some abnormal patterns were evident in the data from 1968 to 1974, so these years were discarded. Exponential trend lines were fitted to the mortality rates from 1975 to 1999, for each cause of death and each 5-year age-group for males and females separately. The fitted growth rates were assumed to continue until 2021. The average mortality rates from 1995 to 1999 were used as the projection baselines.

The resulting projections showed large increases in the numbers of deaths from some causes, particularly mental disorders and diseases of the nervous system (see 6). The projections were repeated, replacing any positive growth rates with zero. This gave the "optimistic" projections in 7.

6. Projections assuming past growth rates

Cause	Deaths 2001 Females	Deaths 2021 Females	Growth pa Females	Deaths 2001 Males	Deaths 2021 Males	Growth pa Males
Infectious diseases	770	2609	6.3%	938	2581	5.2%
Neoplasms	16939	28150	2.6%	22110	40236	3.0%
Endocrine diseases	2229	4146	3.2%	2412	5656	4.4%
Mental disorders	2406	15441	9.7%	1811	8319	7.9%
Nervous system	2624	22788	11.4%	2097	11817	9.0%
Circulatory system	27113	25840	-0.2%	25427	24807	-0.1%
Respiratory system	4853	8060	2.6%	5624	6608	0.8%
Digestive system	2177	3821	2.9%	2131	3185	2.0%
Genitourinary system	1556	3195	3.7%	1228	2214	3.0%
Accidents	2278	1812	-1.1%	5417	4877	-0.5%
Other	1796	2437	1.5%	1435	1438	0.0%
Total of above	64741	118299	3.1%	70630	111737	2.3%

These projections suggest about 230,000 deaths in 2021, compared with 135,000 in 2021.

7. Optimistic projections, assuming no positive growth rates

Cause	Deaths 2001 Females	Deaths 2021 Females	Growth pa Females	Deaths 2001 Males	Deaths 2021 Males	Growth pa Males
Infectious diseases	676	1049	2.2%	862	1299	2.1%
Neoplasms	16695	25559	2.2%	21915	37349	2.7%
Endocrine diseases	2171	3291	2.1%	2284	4021	2.9%
Mental disorders	1910	3178	2.6%	1533	2528	2.5%
Nervous system	2058	3293	2.4%	1812	3186	2.9%
Circulatory system	27113	25840	-0.2%	25427	24807	-0.1%
Respiratory system	4763	7088	2.0%	5624	6608	0.8%
Digestive system	2130	3134	1.9%	2112	2826	1.5%
Genitourinary system	1489	2289	2.2%	1222	2089	2.7%
Accidents	2278	1812	-1.1%	5416	4875	-0.5%
Other	1764	1995	0.6%	1418	1285	-0.5%
Total of above	63047	78529	1.1%	69625	90873	1.3%

These projections suggest about 169,000 deaths in 2021, compared with 133,000 in 2021.

8. Comparisons with ABS projections for 2106 to 2021

Numbers of persons from 1999 to 2021 were taken from the series II projections in "Population projections Australia 1999-2101" (Australian Bureau of Statistics 2000). These projections assume a total fertility rate of 1.6 per 1000, and net inwards migration of 90,000 a year. The numbers of deaths from 2106 to 2021 in the ABS series II projection can be roughly estimated as

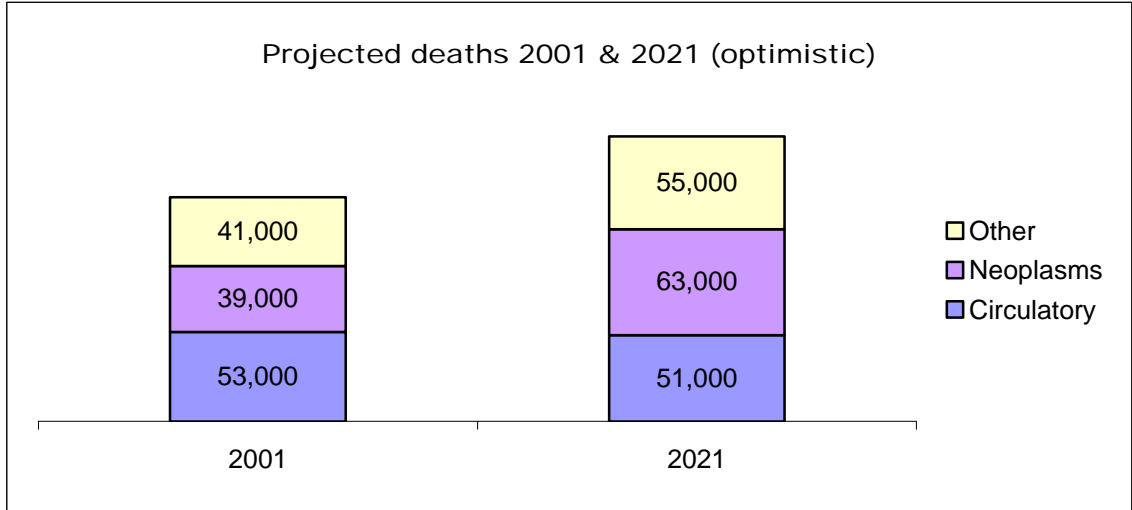|	
number of births (roughly the number aged 0-4 at 2021)	1210800
plus net inwards migration	450000
less growth in total persons	-853587
expected number deaths 2016 to 2021	807213
expected number deaths pa 2016 to 2021	161443

For comparison, the "optimistic" numbers of deaths projected here are

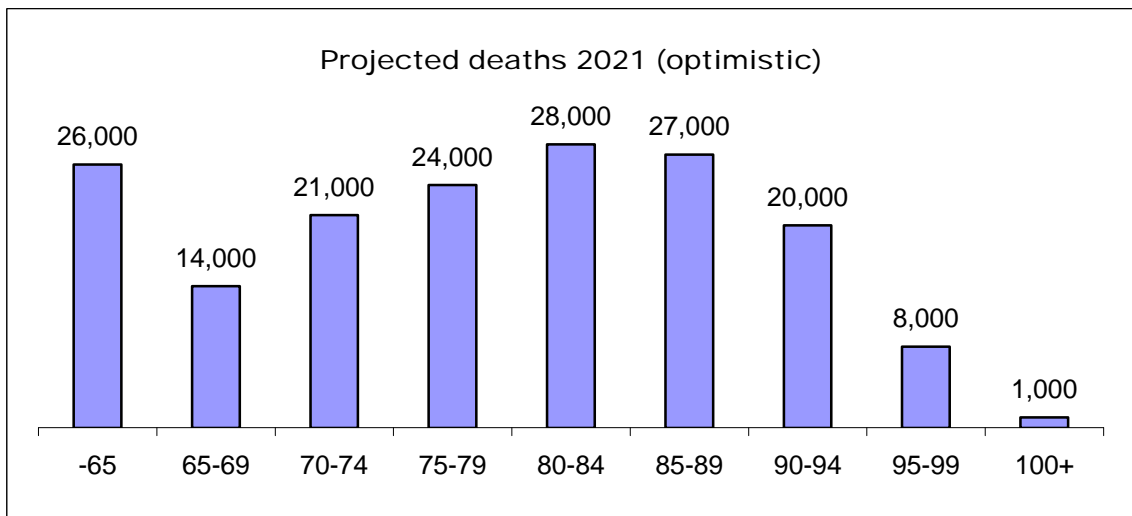|	
expected number in 2016	151940
expected number in 2021	169402
expected number deaths pa 2016 to 2021	160671
expected number deaths as % of ABS projection	100%

The mortality rates assumed in the ABS projections up to 2027 assume the same rates of change as from 1971 to 1996, with adjustments to avoid increasing mortality rates and to conform to pre-determined life expectancies. The ABS approach is similar to that used in the "optimistic" projections here, assuming the same rates of change as from 1995 to 1999, with no positive growth rates. It is thus not surprising

that the "optimistic" estimate of deaths from 2016 to 2021 is very close to the ABS estimate.

9. Major causes of death in optimistic projections

Projected deaths 2001 & 2021 (optimistic)

	2001	2021
Other	41,000	55,000
Neoplasms	39,000	63,000
Circulatory	53,000	51,000

10. Age-patterns of projected optimistic deaths

Projected deaths 2021 (optimistic)

Age	Deaths
-65	26,000
65-69	14,000
70-74	21,000
75-79	24,000
80-84	28,000
85-89	27,000
90-94	20,000
95-99	8,000
100+	1,000

The above age distribution of deaths in 2021 was obtained from the projections for each major cause of death. About 85% of deaths are projected to occur amongst persons 65 or over, compared with about 79% in 2001. There may be about 143,000 persons dying at 65 or over in 2021, compared with about 111,000 in 2001. Most of these persons are likely to require some form of hospice or nursing home care before they die.

Acknowledgments

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