

Trends in cancer mortality during the 20th century in Australia

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Abstract

An epidemiological study was conducted, using annual cancer mortality data over the period 1907 to 1998, to explore change in Australian cancer mortality. A 3-year moving average mortality was calculated to minimise the annual fluctuations over the study period. The results suggested that overall cancer mortality rose slightly over the past century, with a small decrease in more recent years. The male and female cancer mortality rates diverged over time. Younger age groups had low and stable death rates, 35–59 years age groups demonstrated decreased rates, and older age groups had increased rates over the study period. Modifiable lifestyle factors and other possible reasons for the changes were explored.

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ABOUT 22.4 MILLION people around the world were living with cancer in 2000,^{1,2} with 10.1 million people newly diagnosed that year. In the same year 6.2 million people were killed by cancer.¹ In Australia, about 459 000 people were diagnosed with new cases of cancer in 2000.³ The Australian Bureau of Statistics revealed that cancer was the second largest cause of death in Australia in 2001, with 29% of total deaths.⁴ Cancer was responsible for 19% of the disease burden and attributed to 30% of years of life lost due to premature mortality in Australia in 1996.⁵

What is known about the topic?

Cancer contributes to a large number of deaths in Australia.

What does this paper add?

This paper documents the trends in cancer mortality during the 20th century, highlighting increasing mortality until the late 1990s. The authors suggest possible explanations for the increasing mortality rates for lung cancer seen during this time period, as well as for the other significant cancers for both males and females.

What are the implications for practitioners?

The authors conclude that many factors contributed to the changes in Australian cancer mortality over the 20th century, including behavioural, environmental, dietary, and socioeconomic factors as well as relevant health education and promotion campaigns, medical progress, interventions and the knowledge of causation. The authors suggest the need for policy makers to continue targeting high-risk groups in regard to cancer prevention, as well as investing in ongoing broad spectrum campaigns.

There has been an “epidemiologic transition” for disease distribution⁶ in the developed world including Australia. This transition indicates the change from the “age of pestilence and famine,” in which human mortality rates were dominated by infectious diseases, to the current age of morbidity and “mortality from degenerative, man-made, and stress-related diseases in which mortality from chronic diseases predominates”.⁶ The research into chronic diseases, including cancers, may be more significant in view of the fact that Australia’s population is ageing. This paper examines change in cancer mortality in Australia from 1907 to 1998, reviews the periods of decline, increase and stagnation, and gives possible explanations for the variations. The objectives were to examine the long-term trend of cancer mortality, to explore possible influencing factors, and to provide suggestions to policy makers and the local community for cancer prevention.

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Mortality, routinely collected worldwide, is recognised as one of the finest indicators of health, or ill health, in the general population. Death rates are said to give insight into changing social and environmental conditions, medical interventions, lifestyles, and trends in underlying risk factors, and can reflect circumstances surrounding the time of death.³

Methods

Sources of data

Mortality data

Annual data on deaths from all cancers (140-208 in the International classification of diseases, injuries and causes of death, ninth revision, [ICD-9]) from 1907–1998, were provided by the Australian Institute of Health and Welfare (AIHW), broken down by age (5-year group) and sex. Although originally coded in various earlier revisions of the classification, data had been forward mapped to the ICD-9 by the AIHW to ensure consistency of interpretation.

Death certificates certified by a medical practitioner or coroner form the basis of deaths data in Australia. The state and territory Registrars of Births, Deaths and Marriages collect these data for legal as well as health-related purposes and are the original source of the deaths data. These data have been assembled, coded and published by several agencies since 1900, including the Commonwealth Statistician's Office, and the Commonwealth Bureau of Census and Statistics, now known as the Australian Bureau of Statistics (ABS).

As defined by the World Health Organization, an underlying cause of death is the disease or injury that initiated the train of events leading directly to death, or the circumstances of the accident or violence, which produced the fatal injury. Only underlying cause of death data for cancers were presented in this study.

Population data

The population data used in this study for the period 1907–1970 were extracted from the censuses in 1901, 1911, 1921, 1933, 1947, 1954, 1961 and 1966, and arithmetically interpolated to

form the populations between the censuses. Since 1971 annual mid-year estimated resident populations have been used. These different methods are likely to have little effect on the results.

Statistical methods

Overall annual mortality rates (per 100 000 population) and mortality rates for various cancers were calculated for 1907–1998. Standardised age and sex-specific mortality rates were calculated using a standard population (direct standardisation method). Long-term trends for mortality over the study period were examined in various age groups, using linear regression analysis. The mortality trend difference between males and females was also checked by testing the difference in slopes. The 1991 Australian population was used as the standard population in this study, as this is the standard generally used by the AIHW in its mortality trend studies.

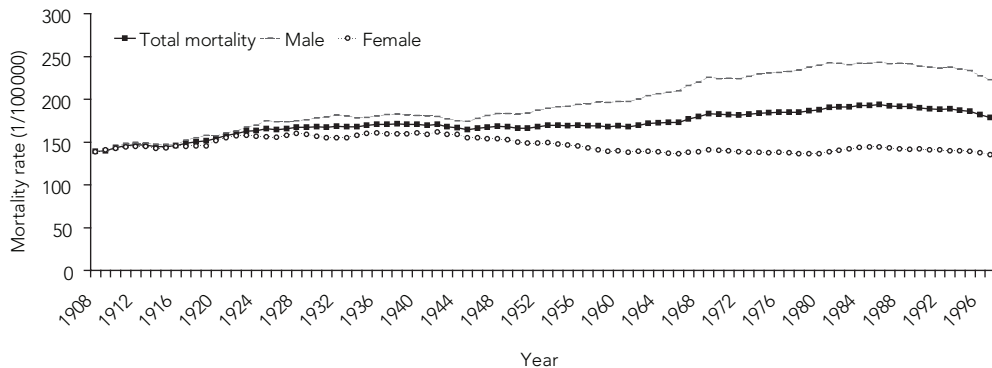
Death rates were influenced by exclusion and inclusion of certain groups over time. Before 1966, deaths of full-blood Aboriginals were not counted.⁷ Overseas armed forces who died between September 1939 and June 1947 were not counted.⁷ Australian forces overseas during World War 1 (1914–1918) were excluded from both the population and death statistics.⁷

The use of 3-year moving average charts minimised the fluctuations of the annual data to allow analysis of the underlying trend.⁸ By smoothing year-to-year peaks and dips, a clearer interpretation of data was obtained.⁹ These calculations were completed using the analysis package Microsoft Excel 2003 (Microsoft Corporation, Redmond, Wash, USA), and the 3-year average rate is expressed as the middle year. For example, the value for 1995 is actually an average of 1994, 1995 and 1996.

Results

Cancer mortality trends in Australia, 1907–1998

There was an increasing trend for the overall cancer mortality rate in Australia over the study

I Three-year moving average: overall cancer mortality in Australia, 1907–1998

period, from 138.9/100 000 in 1908 (the average value of 1907, 1908 and 1909) to 178.4/100 000 in 1997, with the highest rate in 1986 (193.5/100 000) (Box 1). Seven phases were discerned over the study period and summarised in Box 2.

A comparison between males and females shows that the mortality rate for cancers was significantly higher for males than females since 1910 ($P < 0.001$). The male cancer mortality trend followed the overall cancer mortality trend, but at higher rates. The male mortality rates ranged from 139.2/100 000 in 1908 to 222.5/100 000 in 1997, with the highest in 1986 (243.2/100 000).

The female cancer mortality trend did not follow closely to the overall cancer mortality trend. The rates increased with little variations until 1943, and then rapidly fell in 1959. The female trend then followed more closely the overall cancer mortality trend, except with much

lower rates, smaller increases and smaller decreases. The female rates ranged from 138.5/100 000 in 1908 to 134.8/100 000 in 1997, with the highest in 1942 (161.3/100 000).

Cancer mortality trends in Australia by age, 1907–1998

Cancer mortality rates increased with age. Age groups 0–4 years to 30–34 years had very low and stable mortality rates. Age groups 35–39 years to 55–59 years had decreased rates, while age groups 60–64 years to 85+ had increased rates over the study period.

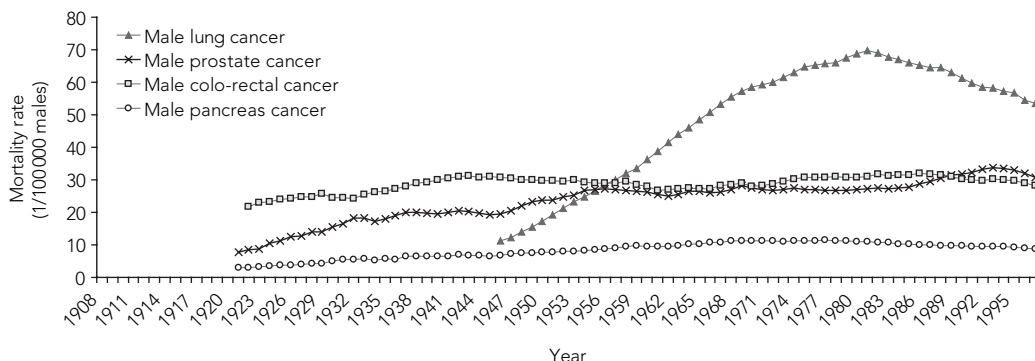
Male cancer mortality in Australia, 1907–1998

For males, lung cancer was the most common cancer causing deaths in Australia in 1998, followed by prostate, colorectal and pancreatic cancers (Box 3). These four cancers together accounted

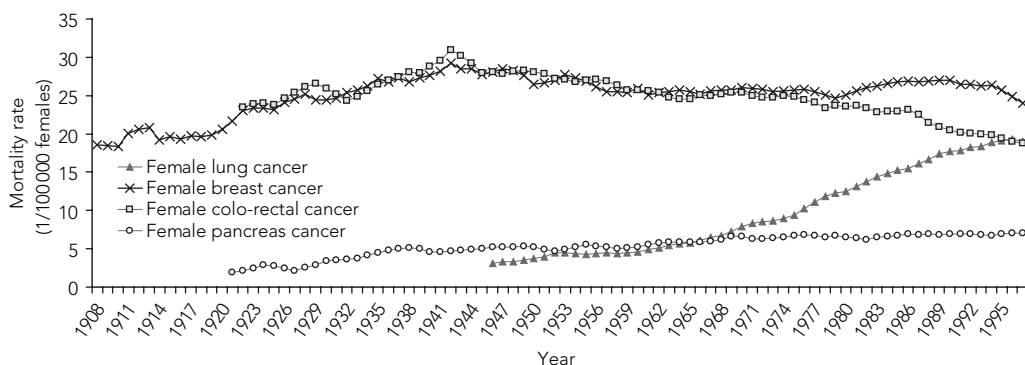
2 Australian cancer mortality trends, 1907–1998

Phase	Time period	Description of characteristics
I	1908–1925	An overall rapid increase with a small dip between 1913 and 1916
II	1926–1942	Slight increase
III	1943–1961	Minor stagnation ranging between 164.4/100 000 in 1945 and 169.5/100 000 in 1953
IV	1962–1969	Slow increase to 173.1/100 000 in 1966, then rapid increase to 183.1/100 000 in 1969
V	1970–1972	Slight decrease to 181.2/100 000 in 1972
VI	1973–1986	Slow, stable increase to 193.5/100 000 in 1986
VII	1987–1997	Slow decrease to 188.4/100 000 in 1993, followed by a sharp decrease to 178.4/100 000 in 1997

3 Three-year moving average: leading male cancer mortality causes in Australia, 1907–1998



4 Three-year moving average: leading female cancer mortality causes in Australia, 1907–1998



for 54.6% of the overall male cancer mortality in 1998, with lung cancer accounting for 24.5%.

Since first recorded in 1945, male lung cancer mortality rates increased very rapidly from 11.3 per 100 000 males in 1946 to 69.7 in 1981. The rate decreased to 53.6/100 000 in 1997. The decline in male lung cancer mortality contributed to the reduction of the overall male cancer mortality rates.

The second leading cause of male cancer mortality is prostate cancer, which accounted for 13.5% of the overall male cancer mortality in 1998. The mortality has been recorded since 1920, with a slow increase observed until 1956 (27.2/100 000). The rates kept relatively stable until 1985, when they increased suddenly to 33.7/100 000 in 1993, overtaking colorectal can-

cer in 1988. Since 1993 the rates have decreased, at 30.6/100 000 in 1997.

As the third leading cause of cancer mortality, colorectal cancer accounted for 12.6% of male cancer mortality in 1998. The mortality rate increased from 1921 to 1943 (31.3/100 000), and then fell to 26.8 in 1961. Rates were stable for about 5 years, and then slowly increased to 32.0/100 000 in 1986. From that time the rates decreased, and became the third leading cause of male cancer mortality in 1989, ending the study period with the rate 28.4/100 000.

Male pancreatic cancer death rate increased from 1920 until 1970 (11.3/100 000), and then kept stable and hit the highest rate of 11.4/100 000 in 1977. The rates since have steadily decreased to 8.9/100 000 in 1997.

Female cancer mortality in Australia, 1907–1998

Breast, lung, colorectal and pancreatic cancers accounted for 51.1% of overall female cancer mortality in 1998 (Box 4). Breast cancer accounted for 17.6% of overall female cancer mortality. The rate increased from 18.5/100 000 in 1908 to 29.2 in 1942, and then decreased to 25.1 in 1961. In 1963 it became the leading cause of female cancer mortality, with rates keeping relatively stable until 1979 and increasing to 27.0/100 000 in 1990. Decreasing ever since, the rate in 1997 was 24.0/100 000.

Female lung cancer mortality rates have increased steadily ever since it was first recorded in 1945 from 3.1/100 000 in 1946 to 19.0 in 1997. Lung cancer has only recently become the second major cause of female cancer mortality. In 1998 lung cancer accounted for 14.2% of the overall female cancer mortality.

When colorectal cancer mortality was first recorded in 1921, it was the leading cause of female cancer mortality. It increased with stagnation to 30.9/100 000 in 1942, and has decreased ever since to 18.8 in 1997. In 1998 it accounted for 14.2% of the overall female cancer mortality, while pancreatic cancer accounted for 5.2%.

Pancreatic cancer has had an overall increase since first recorded in 1920 (2.0/100 000 female population). The highest rate seen over the study period of 7.1/100 000 was in 1997. It is also important to note that the “cervix and uterus cancer” mortality rates reduced dramatically from 21.9 in 1921 to 5.1 in 1997.

Discussion

This research studied Australian cancer mortality trends over the 20th century. Australian cancer mortality rose slightly overall in the past century, with a small decrease in more recent years. Male and female cancer mortality rates diverged since the late 1910s, with male mortality becoming much higher than female mortality. The cancer mortality rate increased with age over the study period. Leading cancers for deaths included lung, prostate, colorectal, and pancreatic cancers for

males and breast cancer, lung, colorectal and pancreatic cancers for females in Australia.

Many factors contributed to the changes in cancer mortality over the 20th century, including behavioural, environmental, dietary and socio-economic factors and relevant health education/promotion campaigns. In recent years cancer was identified as a National Health Priority Area in Australia.^{10,11} The National Cancer Control Initiative focused on cancer prevention and treatment, specifically colorectal, lung, breast, cervical, and prostate cancers, melanoma and non-Hodgkin's lymphoma, and has funded programs to enable prevention, screening and early detection, treatment, support for cancer patients and palliative care.^{10,11} Public health and medical care progress, as well as the advanced technology of clinical medicine, have also aided the fight against cancer mortality.¹ Improvements in economic and social conditions have allowed changes to occur.³

Tobacco is responsible for 30% of all cancer cases in most developed countries and is considered the world's most avoidable cause of cancer.¹ Smoking causes cancer at many sites including lung, throat, mouth, pancreas, bladder, stomach, liver, and kidney.¹ Since the 1900s, when tobacco and cigarettes first became commercially available, lung cancer has steadily increased.¹² Although the link between lung cancer and smoking was first observed in the 1950s, no action was taken in Australia until the 1970s.^{12,13} The delay to restrict tobacco advertising, initiate health warnings, create smoke-free policies and adopt preventative strategies has allowed cancer rates and other health problems to rise — 16.8% of new cancer cases in males and 7.9% in females were attributable to smoking over the recent decades.³

Alcohol abuse is another major risk factor for a wide range of cancers, including cancers of the oral cavity, pharynx, larynx, oesophagus, liver and breast.^{1,14} In Australia, alcohol is responsible for 6.5 cancer deaths per 100 000 persons.³ The estimated lifetime risk of cancers attributable to alcohol is 1 in 94 for males and 1 in 76 for females,³ with risks being greater if the person smokes as well.^{1,14} Heavy binge-drinking was

once the dominant pattern of drinking in Australia. Since the 1960s drinking culture has changed with a shift towards a wine culture and the move to integrate alcohol with food.¹⁵⁻¹⁷

In developed countries, nearly as many cancer cases are attributable to an unhealthy diet and an inactive lifestyle as to smoking tobacco.¹ Physical inactivity is specifically a risk factor for colon and breast cancer,¹⁴ and regular physical activity protects against some forms of cancers.³ The National Government set up the “Life Be In It” campaign in 1978 promoting a healthy diet and an active lifestyle.¹⁸ It was discontinued however, due to removal of funding in 1981,¹⁸ and a replacement national initiative was not allocated until 2004.¹⁸

An unbalanced dietary intake and obesity could be important risk factors for cancers of the colon, rectum, stomach, pancreas and oesophagus.³ In the 1990s the Australian Government introduced the Australian Guide to Healthy Eating, which has developed into Eat Well Australia.^{18,19} Unfortunately, socioeconomically disadvantaged people, including Indigenous Australians, are more likely to smoke, exercise less, have few or no usual daily serves of fruit, and be obese, which are risk factors for various illnesses as well as cancer.³

First recorded in 1945, lung cancer has been a major contributor to cancer mortality. Although a decrease in male lung cancer mortality has been observed since 1981, the rates still continue to rise for females in Australia. Research has identified a 20-year time lag with lung cancer mortality mirroring tobacco smoking patterns.¹⁴ It was observed that there were parallel decreases of both male smoking and male lung cancer mortality since the early 1980s, which could be due to the effect of smoking control measures taken by the Australian Government in the 1970s (1.9% average annual decrease of male lung cancer mortality since 1981).³ However, the move forward in women’s liberation may have added to the increased smoking status of women (0.7% annual average), and in turn may have made a significant contribution to the rise of female lung cancer mortality (2.9% annual average).³ Other

changes over the 20th century include the increase in global air pollution (estimated to cause about 5% of lung cancer mortality),³ and the causation of lung cancer from asbestos, which has a multiplicative risk of cancer if a person smokes tobacco as well.²⁰

Female breast cancer mortality gradually rose until 1942, and has since slightly decreased. The main change over the 20th century has been the government national breast cancer screening program, BreastScreen Australia, which was initiated in 1991, providing free mammogram screening every 2 years for women 40 years old and above.¹¹ The mortality dropped by an annual average of 1.6% since the initiative started.³ In 1995 the National Government established an independent organisation, the National Breast Cancer Centre, which works with women, researchers, health care professionals, cancer organisations, and the government to impact clinical practice, policy and information in breast cancer.¹¹

Male prostate cancer mortality rose slowly since first being recorded in 1920, with a recent decreased trend. Factors which may reduce the risk of prostate cancer include daily intake of selenium or vitamin E, finasteride — an alpha reductase inhibitor¹⁴ — and masturbation or any activity that causes ejaculation.²¹ Prostate-specific antigen testing was introduced in the early 1990s to identify cancers before the onset of clinical symptoms.^{10,22}

Colorectal cancer mortality increased until the 1940s when rates started to fall. In the 1960s, male and female rates diverged with male rates increasing and female rates decreasing. Over the past century, the correlation between meat consumption and colorectal cancer has become more prominent, along with other risk factors such as being overweight and physical inactivity.¹⁴ Low fat and saturated fat intake,¹⁴ or use of aspirin and other non steroidal anti-inflammatory drugs²³ have been found to reduce the risk of colon cancer. In 2000 the federal government promised \$7 million over 4 years to improve knowledge and services for detecting colorectal cancer, including the initiation of a pilot study

to test a population-based screening program for bowel cancer.³

Pancreatic cancer mortality increased, with stagnation, since first being recorded in 1920. Male rates peaked in 1977 at a rate of 11.4/100 000 males and have decreased since to 8.9 in 1997. Female rates were much lower, but continue to climb with the highest rate seen in 1997 (7.1/100 000 females). Tobacco smoking is estimated to cause 24% of male pancreatic cancer and 19% of female pancreatic cancer.²⁴ Higher mortality may occur for pancreatic cancer because there are no early specific symptoms, no effective screening strategy, and most patients already have advanced levels of pancreatic cancer when they seek professional help.²⁴

The limitations of this study include the reliance on death certificates and the underlying cause of death, which prohibit analysis of morbidity. There were changes in inclusions/exclusions of certain population groups in population statistics which may have influenced the results.

Conclusion

Australian cancer mortality has been investigated in this paper as an indicator of health, or ill health, in the general population. Fluctuations in rates were investigated in regard to sex, age, specific cancers, relevant health education and promotion campaigns, medical progress and intervention, behaviour and lifestyle, changing social and environmental conditions, socioeconomic factors and trends in other underlying risk factors. Many of these factors were intertwined and changes were needed and have occurred from all facets. For instance the social acceptability of tobacco use (responsible for 30% of all cancer cases in most developed countries¹) has affected and been affected by changes in behaviour, lifestyle, education and promotion campaigns. Knowledge of causation, awareness and responsibility of government to inform the Australian population were also likely contributing factors to the fluctuations in cancer mortality rates.

Regretfully, socioeconomically disadvantaged groups, such as Indigenous Australians, are more likely to smoke, exercise less, have an inadequate diet and be obese, which are all risk factors for various illnesses including cancer.³ This clearly illustrates the need for policy makers to continue targeting high-risk groups in regard to cancer prevention, and also ongoing broad spectrum campaigns.

Competing interests

The authors declare that they have no competing interests.

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