

Current status of lung cancer

in Queensland, 1982 to 2004

December 2007



Viertel Centre for Research in Cancer Control

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DISCLAIMER

This report is not intended to replace medical advice. The information and data contained in this report was the most recent available at the time of publication; however, data and published research are continually being updated. In light of these considerations, and where relevant, the authors recommend that readers of this publication seek the advice of their general practitioner or treating physician in relation to their individual situation.

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Executive Summary

The Cancer Council Queensland is dedicated to eliminating cancer and diminishing suffering from cancer through research, treatment, patient care and prevention and early detection.¹ Part of this commitment includes informing Queenslanders of the latest available data on cancer.

This report is the second in a series (following an earlier publication on prostate cancer),² and contains a comprehensive description of lung cancer incidence, mortality, survival and prevalence in Queensland utilising the most recent information released by the Queensland Cancer Registry. Comparisons are also made against Australian and international results where applicable.

Comment boxes appear throughout the report. These comments have been included to expand on the statistical information that has been presented and to provide more detailed information on recently published research into lung cancer epidemiology and the effects of smoking.

All data contained in this report relates to primary lung cancers only. It should also be noted that this report does not include any analysis of the stage of lung cancer at the time of diagnosis or the treatments received by patients. Similar to other cancer registries in Australia, staging and treatment data are not routinely collected by the Queensland Cancer Registry. This has limited our ability to interpret whether changes in lung cancer mortality and survival were predominantly due to earlier/late diagnosis or different treatment regimens.

An outline of each section of the report, including some of the main results, is given below:

Section 1 – Introduction

This section provides background information on the physiology of lung cancer along with a description of the main types of lung cancer – small cell lung cancer, squamous cell carcinoma and adenocarcinoma. Potential risk factors for lung cancer are identified, with a particular focus on the evidence linking smoking and lung cancer. An overview of the contents and limitations of the report is also included.

Section 2 – Incidence

About 1740 new cases of lung cancer were diagnosed in Queensland in 2004, and almost two-thirds of these cases were males. After adjusting for age, this meant that about one out of every 1600 males and one out of every 3200 females living in Queensland were diagnosed with lung cancer during 2004. Between 2000 and 2004, 11% of all new cancer diagnoses among males were lung cancer, compared to 7% among females. For both males and females lung cancer was the fourth most commonly diagnosed cancer.

Nearly all (95%) lung cancers were diagnosed among people aged 50 years or older, with incidence rates highest for people aged 75-79 years. One-third (33%) of all lung cancers diagnosed among females were adenocarcinomas compared to 27% for males, while squamous cell lung carcinomas were more common for males (24%) than females (15%).

The Queensland incidence rate for lung cancer was higher than the national average for males and similar for females. Compared to other countries, lung cancer incidence rates among males in Australia were similar to Japan and China, and lower than the United Kingdom, Canada and the United States. Lung cancer incidence rates for females in Australia were higher than in many other developed countries, such as France, Germany and Japan, but were lower than the United Kingdom, Canada and the United States.

Among males, lung cancer incidence rates have been gradually declining in Queensland, with a total decrease of 30% between 1982 and 2004. In contrast, there has been a steady increase in lung cancer incidence among females, with the rate rising by a total of 72% over the same period. The incidence trends varied by both age group and type of lung cancer.

Section 3 – Survival

The length of time that a person survives following a diagnosis of lung cancer is generally quite short compared to most other types of cancer. In terms of relative survival (which takes into account the expected survival of people in the general population) for lung cancer within Queensland, 42% of females and 36% of males were still alive one year after being diagnosed. After five years, survival decreased to only 16% among females and 11% among males.

The prognosis for people diagnosed with lung cancer at a younger age was better than for those in the older age groups. Survival from non-small cell lung cancers was better than for small cell lung cancer. While Queenslanders of both sexes have shown small improvements in lung cancer survival since 1982, there has been no evidence of change in survival rates since the late 1980s.

Lung cancer survival in Queensland was similar to survival rates throughout the rest of Australia.

Section 4 – Mortality

Lung cancer was the third most common individual cause of mortality among males and fifth most common among females, with ischaemic heart disease and stroke being the major causes of mortality for both sexes. There were about 1450 deaths due to lung cancer recorded in Queensland during 2004 (66% males and 34% females). This meant that about one out of every 1800 males and one out of every 4200 females (age-adjusted) died from lung cancer in Queensland that year. Between 2000 and 2004, lung cancer was by far the leading cause of cancer-related deaths in Queensland for males (23% of all cancer deaths), and was also the second most common cause of cancer mortality (16%) among females, slightly behind breast cancer.

Mortality rates for lung cancer peaked for both males and females aged in their early 80s. Adenocarcinoma was responsible for 32% of lung cancer deaths among females and 27% among males, and squamous cell carcinomas also accounted for a large proportion of lung cancer deaths among males (24% compared to 15% for females).

Lung cancer mortality rates for males in Queensland were slightly higher than the Australian average, while the rates for females were similar. Although the lung cancer mortality rate for females in Australia was higher than in many other developed countries, the rates for both sexes were much lower than corresponding rates in the United Kingdom, Canada and the United States.

Due to the poor survival from lung cancer, mortality trends closely reflect the trends for lung cancer incidence. Since 1982, lung cancer mortality rates in Queensland have been decreasing by 1.6% per year among males (an overall decrease of 29% to 2004), but have been increasing by 2.7% per year for females (an overall increase of 79%). Similar to incidence, trends in lung cancer mortality vary by age group and morphology.

These trends in lung cancer mortality rates (increasing among females, decreasing among males) were similar to those in many countries. Some exceptions include China and South Korea, where mortality rates for males were increasing, and Japan and Russia, where mortality rates for females were decreasing. There was also evidence from several other countries, including the United Kingdom and the United States, that lung cancer mortality rates among females had stabilised.

Section 5 – Prevalence

Prevalence is an important measure because it can provide an indication of the number of people who may require short-, medium- and long-term medical treatment and support for a disease.

As at the end of 2004, there were approximately 1950 males (about one out of every 900 after age-adjustment) and 1270 females (around one out of every 1600) living in Queensland who had been diagnosed with lung cancer during the previous 20 years. Most (85%) of these lung cancer patients had been diagnosed during the previous 10 years, and around two-thirds (65% for males and 67% for females) had been diagnosed within the past 5 years.

Section 6 – Geographical and socio-demographic differences

Incidence and mortality rates for lung cancer were much higher for those people living in more rural parts of the State (in relation to South-East Queensland), and for persons living in the most socio-economically disadvantaged areas (in relation to the middle socio-economic group).

Among males in Queensland, there was an increasing gradient in the risk of developing and dying from lung cancer as place of residence became more remote/less accessible. Over the 5 years from 2000-2004, males in inner regional and outer regional areas were found to have a 20% greater lung cancer incidence risk and males in remote areas a 34% greater risk compared to those living in South-East Queensland. Females from remote areas also had a 35% greater risk of being diagnosed with lung cancer than those living in the major cities. The relationship between remoteness of residence and lung cancer mortality displayed similar patterns.

In terms of socio-economic status (SES), males from disadvantaged areas had a 35% higher risk and females a 37% higher risk of developing lung cancer compared to those in the middle SES category, while males from the most affluent parts of Queensland had a 36% lower risk of being diagnosed with lung cancer. The differentials by SES grouping remained significant for lung cancer mortality.

There were also differences in lung cancer survival by geographic accessibility/remoteness and socio-economic status. People living in outer regional areas had a 23% lower chance of survival compared to those residing in South-East Queensland, while there was some evidence that both males and females in affluent areas experienced better survival from lung cancer than those living in the most socio-economically disadvantaged parts of Queensland.

Appendix A – Other sources of information

This section contains references to other related sources of data on cancer in Queensland, as well as links to internet resources that provide information on lung cancer that is outside of the scope of this report (such as further information on symptoms and treatment options).

Appendix B – Methods

Extra detail is given on the data sources (including the Queensland Cancer Registry), lung cancer morphology codes, statistical measures and methods, and the geographical/socio-demographic definitions used throughout the report.

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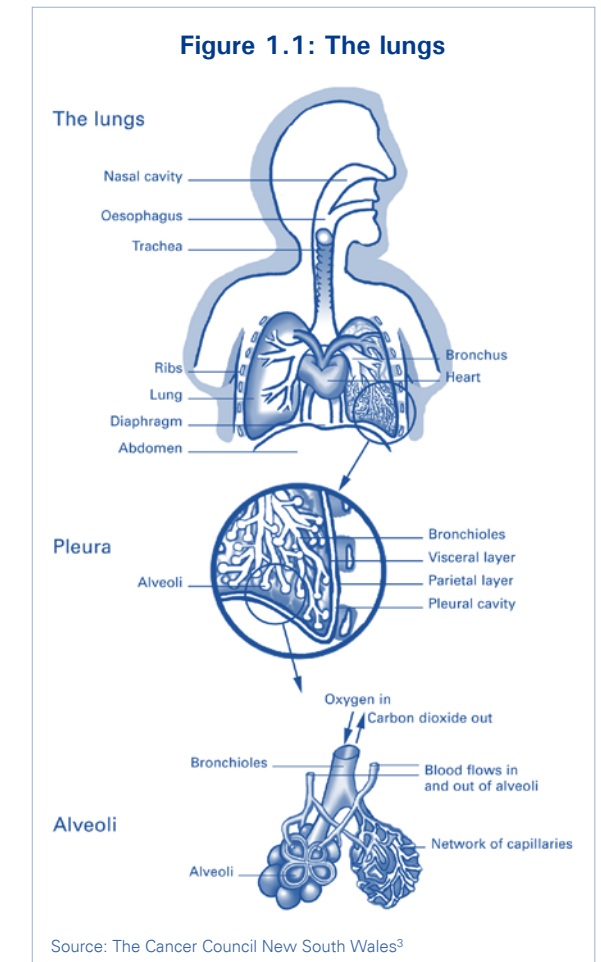
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1 Introduction

1.1 What is lung cancer?

Our lungs take up most of the region enclosed by our ribs (see Figure 1.1). As we breathe in through our nose or mouth, air goes into the throat and down the trachea (windpipe) into the chest. The trachea initially divides into two tubes called bronchi, one going to each lung. These tubes then become smaller and smaller until they empty into the alveoli, which are minute, air-filled sacs. The alveoli are surrounded by a network of tiny blood vessels (capillaries) which allow the transfer of oxygen and carbon dioxide into and out of the blood stream through the thin walls of the alveoli.³

Lung cancer can originate anywhere in the lungs. It occurs when abnormal cells form and start to multiply uncontrollably. Although lung cancer usually takes many years to develop, these delinquent cells may begin to appear soon after a person is exposed to a cancer-causing substance, such as tobacco smoke. The abnormal cells form clumps known as tumours, which may be malignant (cancerous) or benign. Benign lung tumours are not lung cancer and in most cases are not life-threatening. However, if the tumour is cancerous, it will invade and damage surrounding healthy tissue in the lungs and may also spread to other parts of the body.⁴⁻⁶



Lung cancer causes more deaths than any other type of cancer, and was estimated to be responsible for about 1.3 million deaths worldwide during 2005 (2% of all causes of death).⁷ In Australia, lung cancer is one of eight types of cancer included in the National Health Priority Area initiative, in recognition of the impact that it has on the health of Australians and the potential for significant health gains through prevention and control.⁸

1.2 Are there different types of lung cancer?

There are several different types of lung cancer, defined by the area of the lung that is affected and the size and type of cells that make up the cancer. These different subtypes of lung cancer are commonly divided into two main groups – small cell lung cancers (SCLCs) and non-small cell lung cancers (NSCLCs).

Small cell lung cancers

The first main group is “small cell lung cancers”, of which most are of the type “small cell carcinoma” (also known as “oat cell cancer”). Small cell lung cancers were estimated to account for 14% of all lung cancer cases throughout the USA and Europe during 2004.⁹ They usually grow in the main airways (left or right bronchus) in the centre of the chest (see Figure 1.1). Small cell lung cancers are the most aggressive form of the disease, having greater potential to spread to other parts of the body (metastasise) than other types of lung cancer. Virtually all patients with small cell lung cancer have a smoking history.⁹

Non-small cell lung cancers

The remaining forms of lung cancer form a heterogeneous group known as “non-small cell lung cancers”. Non-small cell lung cancers are typically slower to grow and spread compared to small cell lung cancer, and as a result they tend to have a slightly better prognosis.¹⁰ This category of lung cancer includes squamous cell carcinomas, adenocarcinomas and large cell carcinomas, along with a range of less common subtypes.

Squamous cell carcinomas

“Squamous cell carcinomas” develop from the cells that line the airways and are often found in the windpipe (trachea) or the main airways (left or right bronchus) (refer to Figure 1.1). These tumours have the capacity to grow to large sizes and usually form cavities in the lung.¹⁰ Similar to small cell lung cancers, squamous cell carcinomas are predominantly linked to smoking.¹¹

Adenocarcinomas

“Adenocarcinomas” develop from a type of cell in the lungs that produces phlegm (mucus), and are more likely to occur in the outer regions (periphery) of the lung.¹⁰ These cells tend to form thick tumours that make breathing more difficult. There are several varieties of adenocarcinoma; they usually grow slowly with few symptoms, but in some instances they can be extremely aggressive. While it is the most common type of lung cancer seen in non-smokers,^{12,13} smoking has been increasingly associated as a cause of adenocarcinoma in more recent years.¹⁴⁻¹⁶

Other types of lung cancer

For the purposes of this report, the remaining types of non-small cell lung cancer, including large cell carcinomas and carcinoid lung cancers, were grouped into a category called “other types of lung cancer”. As has been the case in other studies,^{17,18} large cell carcinomas were not grouped as a separate category due to the potential for variable classification by pathologists.^{19,20}

Throughout this report, lung cancer data will be reported for the following subgroups: small cell lung cancers, squamous cell carcinomas, adenocarcinomas and other types of lung cancer. Details about the specific morphology codes used for each of these lung cancer subtypes are contained in Appendix B.

1.3 What are the main causes of lung cancer?

Although many factors may influence whether a person develops lung cancer, tobacco smoking is by far the most important risk factor. The causal relationship between tobacco smoking and lung cancer is well established,^{14,21} having first been reported in the mid 20th century.²²⁻²⁴ There is also sufficient evidence to conclude that exposure to second-hand smoke (also known as passive smoking, environmental tobacco smoking (ETS) or involuntary smoking) is a cause of lung cancer.¹⁴

Comment 1.1 – What do the experts say about smoking, exposure to second-hand smoke, and the development of lung cancer?

The following statement was released in 2002 by the International Agency for Research on Cancer (IARC) in a report on the effects of tobacco smoke.¹⁴

“The major cause of lung cancer is tobacco smoking, primarily of cigarettes. In populations with prolonged cigarette use, the proportion of lung cancer cases attributable to cigarette smoking has reached 90%.

The duration of smoking is the strongest determinant of lung cancer in smokers. Hence, the earlier the age of starting and the longer the continuation of smoking in adulthood, the greater the risk. Risk of lung cancer also increases in proportion to the numbers of cigarettes smoked.

Tobacco smoking increases the risk of all histological types of lung cancer including squamous-cell carcinoma, small-cell carcinoma, adenocarcinoma (including bronchiolar/alveolar carcinoma) and large-cell carcinoma. The association between adenocarcinoma of the lung and smoking has become stronger over time. The carcinogenic effects of cigarette smoking appear similar in both women and men.

Stopping smoking at any age avoids the further increase in risk of lung cancer incurred by continued smoking. The younger the age at cessation, the greater the benefit.”¹⁴

In regard to exposure to second-hand smoke:

“More than 50 studies of involuntary smoking and lung cancer risk in never-smokers, especially spouses of smokers, have been published during the last 25 years. These studies have been carried out in many countries. Most showed an increased risk, especially for persons with higher exposures... This evidence is sufficient to conclude that involuntary smoking is a cause of lung cancer in never-smokers.”¹⁴

Other potential risk factors for lung cancer may include:^{6,14,25,26}

- Family history of lung cancer
- Air pollution
- Other pre-existing diseases of the lungs, such as tuberculosis and pneumonia
- High doses of radiation
- Exposure to industrial and chemical carcinogens, such as asbestos, arsenic or radon

Comment 1.2 – Does giving up smoking reduce the risk of developing lung cancer?

"It is never too early or too late to stop smoking – there is always a health benefit to be gained by quitting."²⁷

The most effective way to reduce the risk of lung cancer is not to smoke.²⁸ Studies have also shown that the earlier a person stops smoking, the less likely they are to develop lung cancer.^{29,30} Compared to someone who continues to smoke, the risk of developing lung cancer can be reduced by at least 90% if a person stops smoking before they reach 30 years of age, and even people who stop smoking in their 40s or 50s substantially reduce their risk.^{29,31,32} The benefits of smoking cessation appear to vary according to the type of lung cancer, with a greater risk reduction reported for small cell lung cancer and squamous cell carcinoma compared to adenocarcinoma.^{30,33}

Reducing the amount of tobacco smoked may also be beneficial. For example, former heavy smokers (minimum 15-20 cigarettes per day) who cut back on the number of cigarettes they smoke by at least half have been estimated to reduce their relative risk of developing lung cancer by between 25%-35%.^{34,35}

In contrast, lower tar cigarettes seem to have minimal impact. A recent study found that smokers experience a similar intake of lung carcinogens irrespective of whether they smoke regular or lower tar cigarettes, thereby exposing them to the same level of risk of developing lung cancer.³⁶

Regardless of whether smokers reduce their level of smoking or even quit smoking altogether, current and ex-smokers always remain at increased risk from lung cancer compared to those people who have never smoked.²⁹⁻³¹ Combined with the highly addictive nature of nicotine,^{37,38} this emphasises the importance of preventive campaigns designed to reduce the uptake of smoking.^{39,40}

1.4 Purpose, structure and limitations of this report

This report was designed to give a statistical overview of lung cancer in Queensland, using the latest available data from the Queensland Cancer Registry (QCR). The QCR is a population-based cancer registry and maintains a record of all cases of cancer (excluding non-melanoma skin cancer) diagnosed in Queensland since 1982. At the time of preparation of this report, the latest data available from the QCR was for the 2004 calendar year.

The main questions covered in this report include:

- How many people are diagnosed with lung cancer? (incidence);
- How long do people live after being diagnosed with lung cancer? (survival);
- How many people die from lung cancer? (mortality); and,
- How many people are still alive after being diagnosed with lung cancer? (prevalence).

For most of these topics, data were examined by sex, age group and type of lung cancer (morphology group). Some of the results for lung cancer were compared to other types of cancer, and where possible, information for Queensland was also compared against interstate and international data.

The report also includes a description of geographical and socio-demographic differences in lung cancer incidence, mortality and survival. Data were grouped by regions within Queensland, by accessibility and remoteness (using the ARIA+ index⁴¹), and by socio-economic status (using the socio-economic index for areas (SEIFA) index of relative socio-economic disadvantage⁴²).

A focus of the report is the relationship between lung cancer and smoking. Comment boxes throughout the report highlight the way in which smoking contributes towards the patterns seen in lung cancer incidence, survival and mortality.

Analyses by the stage of lung cancer at the time of diagnosis or the treatments received by patients would be informative in terms of whether changes in lung cancer mortality and survival were predominantly due to earlier/late diagnosis or different treatment regimens. However, data on staging and treatment are not routinely collected by the Queensland Cancer Registry, in line with the current practices adopted by most of the population-based cancer registries in Australia. As such, no information on cancer stage or treatment in Queensland has been included in this report.

In accordance with usual reporting practices,⁴³ the data contained in this report relates solely to primary lung cancers i.e. cancers that originate in other parts of the body such as the breast or bowel and subsequently spread to the lungs have been excluded. Unless otherwise stated, all data for Queensland were averaged over the 5-year period from 2000-2004 (a 5-year period was used to reduce the effects of random fluctuations from year to year).

Because of the statistical focus, a discussion of the potential symptoms of lung cancer as well as the various methods of detecting and treating lung cancer is beyond the scope of this report. A list of other possible sources of information on these topics is included at the end of the report (see Appendix A). Details of the data sources, definitions and statistical methods used throughout the report are contained in Appendix B.

Comment 1.3 – Tobacco control activities conducted by The Cancer Council Queensland

The Cancer Council Queensland's vision for tobacco control is to improve the health and well-being of all Queenslanders by eliminating the health, social, environmental and economic consequences of tobacco use. The Cancer Council implements a range of comprehensive strategies throughout Queensland towards this goal, including mass media advertising, health professional training, worksite smoking cessation programs, distribution of public education materials, sponsorships, advocacy, research, evaluation and public relations activities.

The Cancer Council, in collaboration with Queensland Health, funds a range of targeted, state-wide media campaigns to encourage smokers to call the Quitline for assistance to quit smoking. Smoking cessation programs are also provided in worksite, health and community settings. As an example, since 1998 The Cancer Council has offered work-places the Fresh Start® Program to encourage employees to quit smoking, via on-site group smoking cessation courses run by trained facilitators throughout Queensland. The Cancer Council also offers a range of workshops in smoking cessation and counselling skills for health professionals including dentists, general practitioners, nurses and allied health workers.

In addition to smoking cessation, The Cancer Council aims to prevent the uptake of smoking in Queensland. A number of resources are offered to schools to assist in tobacco control education including the Critics Choice Project, promotion of National Youth Tobacco Free Day, the Be Smokefree! sports sponsorship program and specific resources targeted at young people.

Further information about The Cancer Council Queensland's smoking prevention and control activities can be found at www.cancerqld.org.au.

2 Incidence

The incidence of a disease measures how many people within a specified population are diagnosed with that disease in a given time period (typically the number of new cases each year), while the incidence rate expresses the same data in terms of a set population size (i.e. number of new cases per 100,000 population per year).

Incidence is an important measure for all types of cancer because it gives an indication as to how many people require intensive treatment and other short-term services immediately after diagnosis. Evaluating trends in the incidence rate is also a good way to monitor the effectiveness of current strategies to prevent cancer.

Comment 2.1 – Smoking and lung cancer incidence

- Smoking has been identified as a risk factor for many different types of cancer. Most bodily organs are adversely affected by tobacco smoke. Apart from lung cancer, smoking can also cause cancer of the mouth, larynx, oesophagus, bladder, pancreas, stomach, liver, kidneys, cervix and uterus as well as myeloid leukaemia.¹⁴
- Of all these organs, the lungs are most at risk from smoking. A large number of scientific studies have estimated that smokers have a 15- to 30-fold increased risk of developing lung cancer compared to non-smokers.^{25,44}
- During the year 2000, it was estimated that 85% of lung cancers in males and 47% of lung cancers in females were attributable to smoking worldwide.⁴⁵ This variation by sex was most likely due to historical smoking patterns, with the percentage of lung cancers that were attributable to smoking being higher in countries where smoking had been more common, especially among females.⁴⁶ In Australia, the proportion of smoking-attributable lung cancer has been estimated at 84% for males and 77% for females,⁴⁷ while studies in North America, Europe and Japan found 91% of lung cancer among males and 69% among females had been caused by smoking.⁴⁴
- Lung cancer risk increases dramatically according to how many years a person has smoked and, to a lesser extent, how heavily they smoke.^{48,49} For example, a person who starts smoking before the age of 15 years is estimated to have around double the risk of developing lung cancer compared to those who start smoking when they are aged 20 years or older.²⁹
- There has been increasing evidence of a link between exposure to second-hand smoke and lung cancer. Studies have consistently found that the risk of developing lung cancer is between 20% to 30% higher for non-smokers who live with a partner who smokes at home, and 10% to 20% higher among non-smokers who are exposed to cigarette smoke at work.^{14,50,51}
- Researchers have concluded that pipe or cigar smoking is also strongly associated with lung cancer (as well as cancer of the pancreas, stomach or bladder).^{14,52}

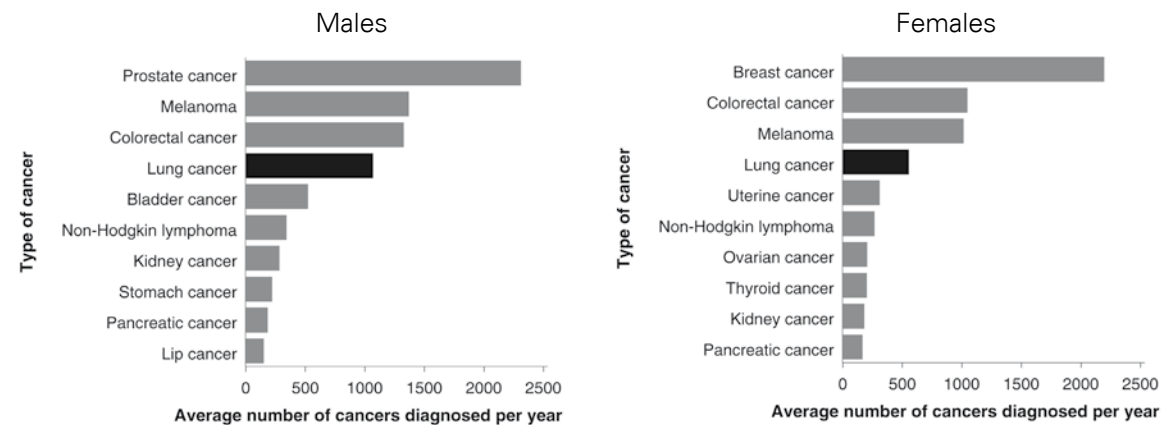
2.1 How many people are diagnosed with lung cancer in Queensland each year?

In 2004 there were 1737 lung cancers diagnosed among Queensland residents. Almost two-thirds of these new lung cancer diagnoses (1109) were for males, with 628 cases diagnosed among females. The corresponding age-standardised rates were 62 cases of lung cancer per 100,000 males and 31 cases per 100,000 females.

Between 2000 and 2004, lung cancer was the fourth most common cancer diagnosed among males in Queensland (Figure 2.1), behind prostate cancer, melanoma and colorectal cancer, with an average of 1068 lung cancers diagnosed each year. This represented almost 11% of all new cancer diagnoses among Queensland males during that time period.

Lung cancer was also the fourth most common cancer diagnosed among females, behind breast cancer, colorectal cancer and melanoma. There were an average of 554 lung cancers diagnosed each year among females living in Queensland, representing 7% of all cancer diagnoses among females between 2000 and 2004.

Figure 2.1: Average number of diagnoses per year for the most common types of cancer by sex, Queensland, 2000-2004



Data source: Queensland Cancer Registry.

Comment 2.2 – Why don't all smokers develop lung cancer?

The link between smoking and lung cancer is one of the most thoroughly documented relationships in biomedical research.²⁵ Despite strong evidence and widespread agreement among health experts that smoking is a causal factor for lung cancer,^{14,53-56} there is still some debate regarding the definition and interpretation of causality.⁵⁷⁻⁵⁹

Causality is a complex concept.^{60,61} The presence of a causal factor does not necessarily result in an effect occurring. For example, speeding can cause a car accident, but not all speeding cars crash. Similarly, if a person smokes, they will not automatically develop lung cancer in the future.

Studies from a number of developed countries indicate that a life-long smoker has between a 10%-20% risk of developing lung cancer.^{29,32,55,62} However, a smoker is far more likely to develop lung cancer than a non-smoker, especially if they have smoked heavily for many years.^{14,25,48} Smoking should therefore be considered as a factor which often forms part of the causal mechanism leading to lung cancer, in combination with other effects such as genetic traits.

The methods by which environmental carcinogens, such as tobacco smoke, can cause lung cancer are complicated and not fully understood. The specific roles of factors such as gender, race, age and pre-existing lung disease in influencing an individual's susceptibility to develop lung cancer from smoking remain uncertain.^{63,64} Continuing research focussed on the areas of genetics, biochemistry and molecular epidemiology seeks to determine why some smokers develop lung cancer and others do not.^{28,55,65}

Comment 2.3 – Lung cancer and non-smokers

“Although smoking remains the predominant cause of lung cancer, lung cancer in never smokers is an increasingly prominent public health issue.”⁶⁶

Around 10% of lung cancer patients in the United States are lifelong non-smokers,¹³ and lung cancer among non-smokers caused more deaths in the USA during 2006 than the total number of deaths due to either brain or bladder cancer.⁶⁷ Adenocarcinoma is the most common type of lung cancer diagnosed among never smokers.^{13,66,68} Non-smoking females are more prone to develop lung cancer than non-smoking males, and non-smokers are more likely to be diagnosed with lung cancer at an older age compared to smokers.^{13,66,68}

The reasons why some people who are lifelong non-smokers develop lung cancer are not entirely clear, which has hindered efforts to reduce the burden of lung cancer among non-smokers.⁶⁷ As stated earlier (Comment 1.1), exposure to second-hand smoke has been recognised as a cause of lung cancer in those who have never smoked.¹⁴ Some other potential risk factors that may be particularly relevant to non-smokers include:^{13,66,68,69}

- family history of cancer (especially early onset cancers) or genetic factors
- pre-existing non-malignant lung disease (e.g. pneumonia, tuberculosis)
- indoor pollutants (including radon exposure and some cooking vapours)
- exposure to certain dusts (from work or hobby-related activities e.g. metal, concrete, wood, cotton, textile fibres, fibreglass or sand)

Based on 2004 data, males in Queensland were estimated to have a 1 in 23 risk of being diagnosed with lung cancer by the age of 75, while for females the risk was 1 in 42.⁴³

Comment 2.4 – Do smokers understand their risk?

A recent study in the United States found that smokers underestimate their risk of developing lung cancer.⁷⁰ According to this study, smokers are generally not aware that their risk of lung cancer increases the more that they smoke, many think that lung cancer can be cured, and there is widespread belief that exercise and/or vitamins are able to counteract the harmful effects of smoking.⁷⁰

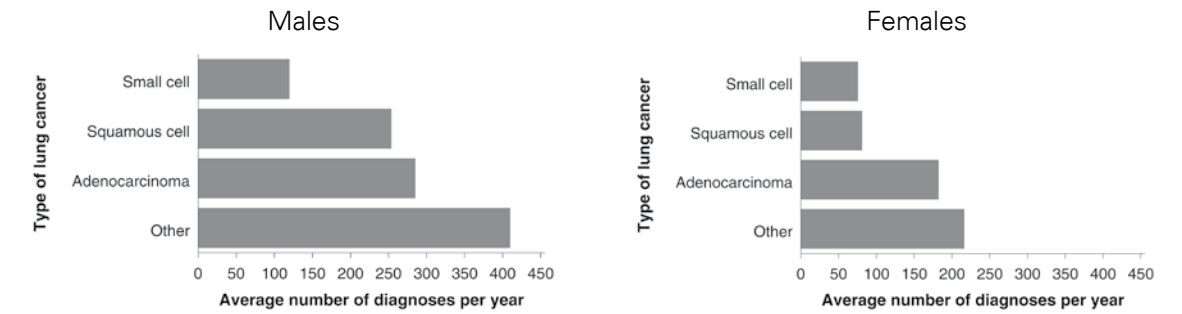
A separate survey of adolescents found that while they overestimated the likelihood of smokers developing lung cancer, they misjudged the extent of mortality caused by lung cancer.⁷¹ Many viewed their own level of risk as being less than for other smokers, and heavy smokers did not think they were at any greater risk of lung cancer compared to those who smoked fewer cigarettes.⁷¹

This indicates that at least some people take up smoking with an inadequate knowledge of the potential risks they are taking.⁷⁰

2.2 What are the most common types of lung cancer diagnosed in Queensland?

Figure 2.2 shows that almost one-third (29%) of lung cancers diagnosed in Queensland were adenocarcinomas, with this proportion higher among females (33%) than males (27%). In contrast, squamous cell lung carcinomas were far more common for males (24%) compared to females (15%). Small cell lung cancers were relatively rare, particularly among males (11% for males, 14% for females). The remaining types of lung cancer collectively comprised 38% of lung cancer diagnoses for males and 39% for females.

Figure 2.2: Average number of diagnoses per year by type of lung cancer and sex, Queensland, 2000-2004



Data source: Queensland Cancer Registry.

Comment 2.5 – Why are there differences in the types of lung cancers diagnosed among males and females?

There is a distinct difference in the histological distribution of lung cancer by sex throughout the world, with females having consistently higher proportions of adenocarcinoma and lower proportions of squamous cell carcinoma than males, both currently and historically.^{67,72,73}

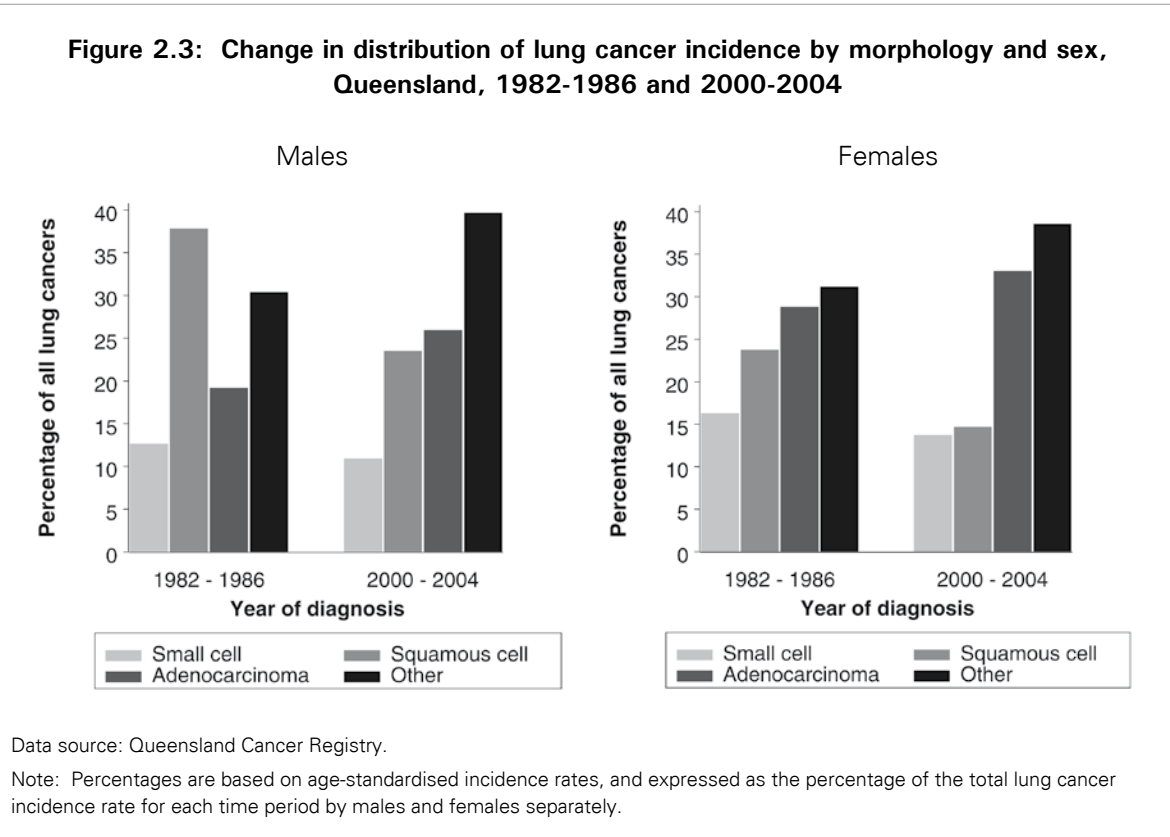
A possible explanation for the different proportions of lung cancer types by sex is that smoking behaviour has varied between males and females in the past. Filtered cigarettes are more likely to cause adenocarcinoma, while unfiltered cigarettes are more strongly associated with squamous cell carcinoma.¹⁷ The introduction of filtered cigarettes in the 1950s corresponded with the time period when more females were beginning to smoke, while male smokers were traditionally more likely to smoke unfiltered cigarettes and gradually made the transition to filtered cigarettes.^{17,74} (For further information on the association between adenocarcinoma and filtered cigarettes, see Comment 2.6.)

Another theory is that the increased proportion of adenocarcinoma among females may be due to greater exposure to second-hand smoking compared to males.⁷³ However, the evidence for a specific association between second-hand tobacco smoke and adenocarcinoma is limited.^{75,76}

Other suggestions put forward include the potential role of female hormone receptors in the development of adenocarcinoma,^{77,78} possible differences in the way that males and females smoke (for example, whether females inhale cigarette smoke differently to males),⁷⁷ and/or a genetic predisposition towards developing adenocarcinoma among females with a family history of lung cancer.⁷⁸

There have been large changes in the distribution of the subtypes of lung cancer diagnosed over the last 20 years in Queensland (Figure 2.3). Among males, squamous cell carcinoma decreased from 39% in 1982-1986 to 24% in 2000-2004 and adenocarcinoma increased from 20% to 27% over the same period. A similar pattern has also been observed for females, with growth in the proportion of adenocarcinomas (28% to 33%) and a large decrease in the proportion of squamous cell carcinomas (24% to 15%). The relative percentage of small cell lung cancer decreased only slightly for both males (13% to 11%) and females (16% to 14%), while the proportion of other types of lung cancer has increased for both sexes (28% to 38% for males and 31% to 39% for females).

The proportion of adenocarcinoma has also been increasing over time elsewhere in Australia, and throughout Europe and the USA.^{74,79,80} Between 1970 and 1995, the percentage of lung cancers diagnosed in the United States that were adenocarcinomas nearly doubled for males and increased by about one-third among females.⁸⁰



Comment 2.6 – Why has the mix of lung cancers changed over time?

In many countries, squamous cell carcinoma has historically been the most common form of lung cancer diagnosed among males, although recently adenocarcinoma has surpassed squamous cell carcinoma in some male populations. For females, adenocarcinoma has typically been more common than squamous cell carcinoma throughout the world, both in the past and even more so currently.^{72,80}

Modifications in cigarette design, cigarette composition and smoking behaviour are widely believed to have caused the rapid, relative increase in the incidence of adenocarcinoma in comparison to other types of lung cancer, particularly the shift to low-tar, low-nicotine filter cigarettes which became more popular during the 1960s and 1970s.^{17,81-83}

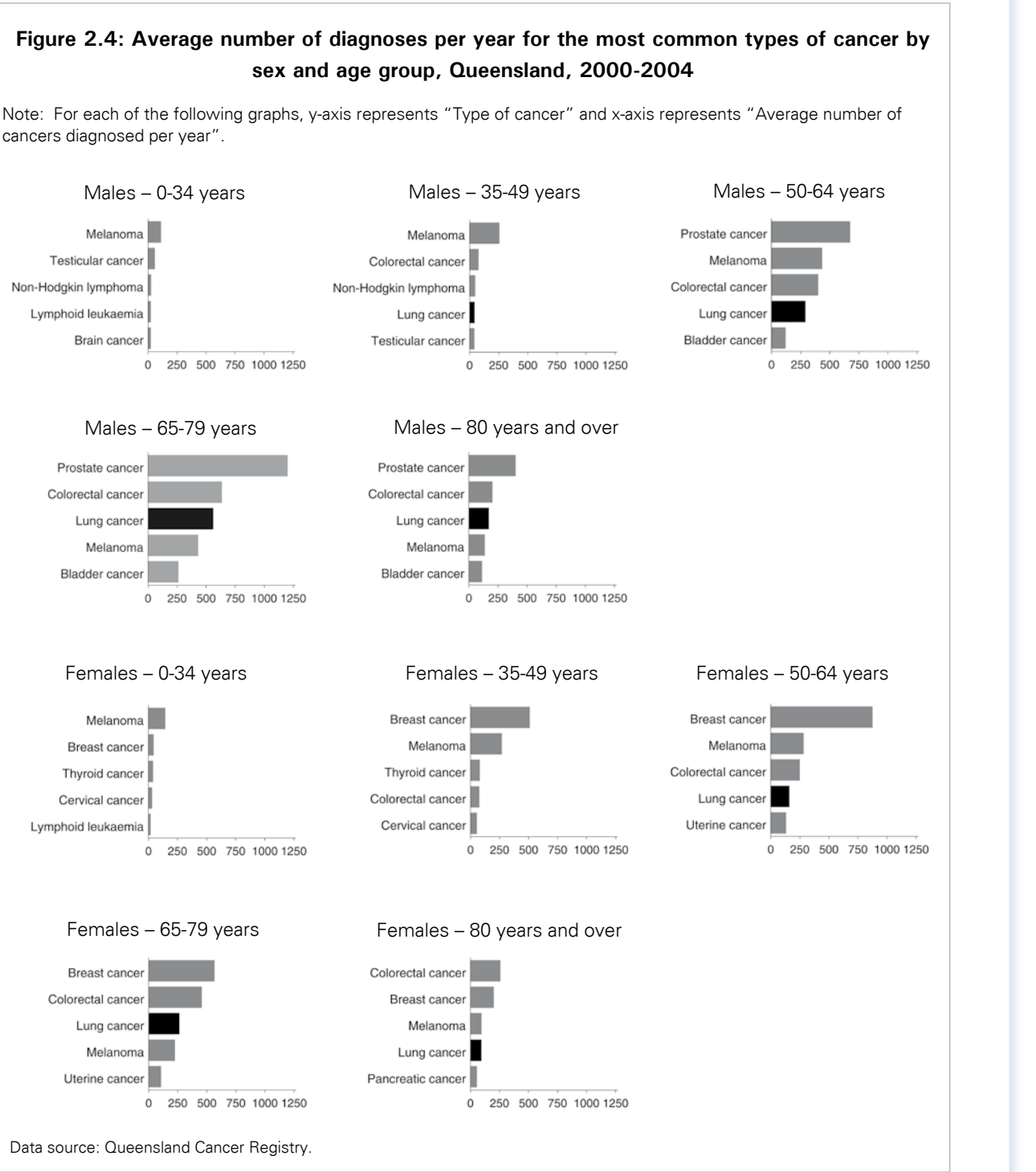
There are two main reasons behind this theory. First, the smoke from filtered cigarettes tends to be inhaled more deeply than for unfiltered cigarettes in order to satisfy the nicotine craving, resulting in a higher concentration of carcinogens in the outer areas of the lungs where adenocarcinoma tends to form. Second, the tobacco blends used in cigarette manufacturing were changed to include higher levels of nitrates, which have been linked to the development of adenocarcinoma.^{17,79,82}

2.3 At what age are people diagnosed with lung cancer?

2.3.1 Most common types of cancer diagnosed by age group

Lung cancer is very rare among people younger than 35 years of age; less than 1% of all cancers diagnosed in this age group in Queensland were lung cancers. This proportion generally increased with age: 4% of all cancers among people aged 35-49 were lung cancers, 8% among people aged 50-64, 12% among people aged 65-79, and 9% among people aged 80 years and over.

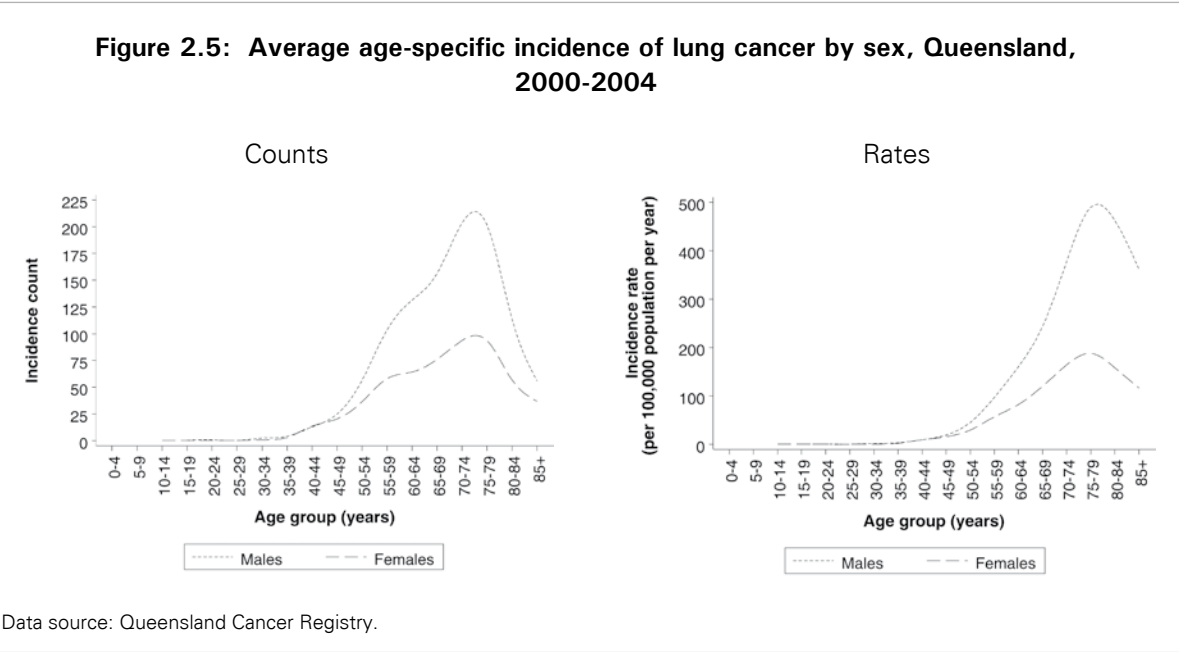
Lung cancer was the fourth most common cancer for males between the ages of 35 and 64 years, and the third most common cancer for males aged 65 years and over. Lung cancer was also the third most common cancer for females aged 65-79, and the fourth most common cancer among females in both the 50-64 and 80 years and over age groups (Figure 2.4).



2.3.2 Age-specific incidence rates

Almost 95% of all lung cancers (96% in males and 93% in females) diagnosed in Queensland were among people aged 50 years or older. Lung cancer incidence counts and rates were fairly similar for males and females under the age of 50, but among people over 50 years of age, males had much higher age-specific counts and rates than females (Figure 2.5).

The number of lung cancers diagnosed was highest in the 70-74 age group for males (average of 203 diagnoses per year) and for females aged 70-79 (average of 94 diagnoses per year). Incidence rates peaked in the 75-79 age group for both males and females, at 490 and 188 diagnoses per 100,000 population per year respectively.



Comment 2.7 – How does the age of smoking uptake relate to age at diagnosis with lung cancer?

Most smokers take up the habit at an early age.⁸⁴ In 2004, the average age at which smokers in Australia began to smoke daily was estimated at 18 years for males and 19 years for females.⁸⁵ The proportion of the Australian population who were current smokers peaked in the 20-29 age group for both males (31%) and females (28%).⁸⁵

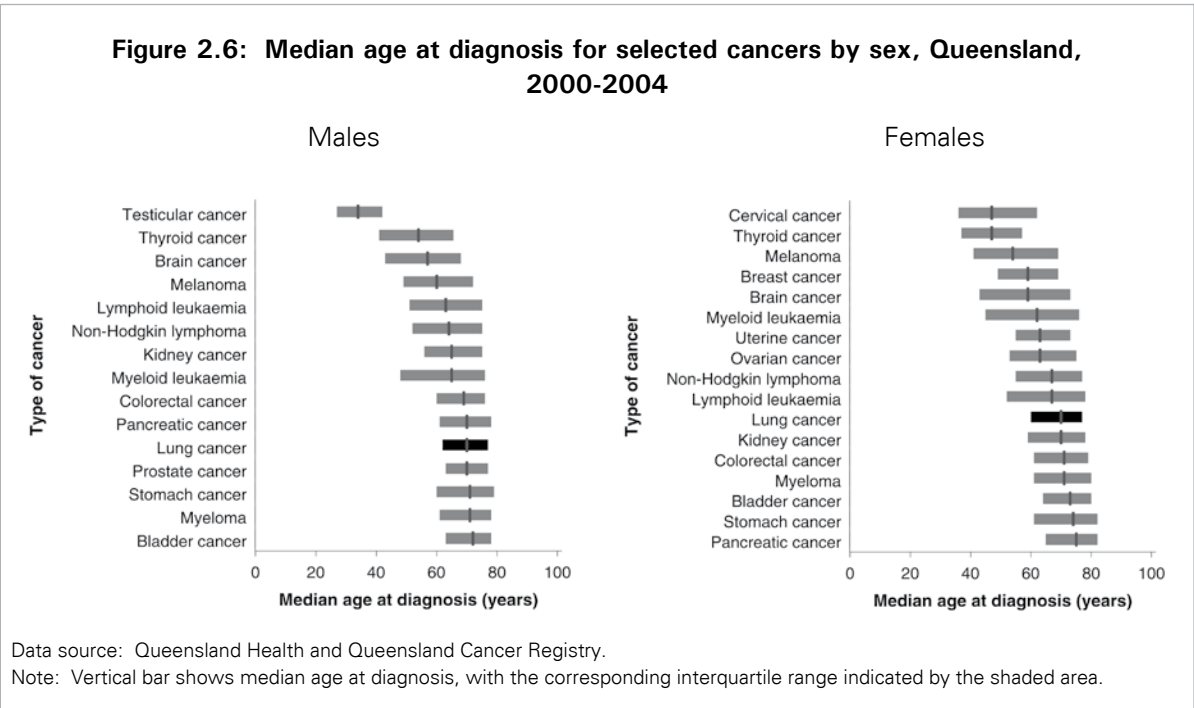
However, the majority of lung cancers are not diagnosed until a person is in their 60s or 70s. Thus, for most people who develop lung cancer, there is a long latency period of up to 50 years between when they start to smoke and when they are diagnosed with lung cancer.⁵⁴

The reason for this is that smoking has a cumulative harmful effect on the lungs. Each cigarette that a person smokes causes microscopic damage to the DNA in lung cells, which the body attempts to repair.⁶⁵ Over a long period of time, this damage may lead to the development of lung cancer, particularly among those individuals who have a genetically reduced capacity to repair their DNA⁸⁶⁻⁸⁹ and those who began smoking at an earlier age.⁹⁰

2.3.3 Median age at diagnosis

If the age at diagnosis for each patient is ranked in ascending (or descending) order, then the median age is the observation ranked in the middle; that is 50% of patients are diagnosed at an older age and 50% are diagnosed at a younger age compared to the median.

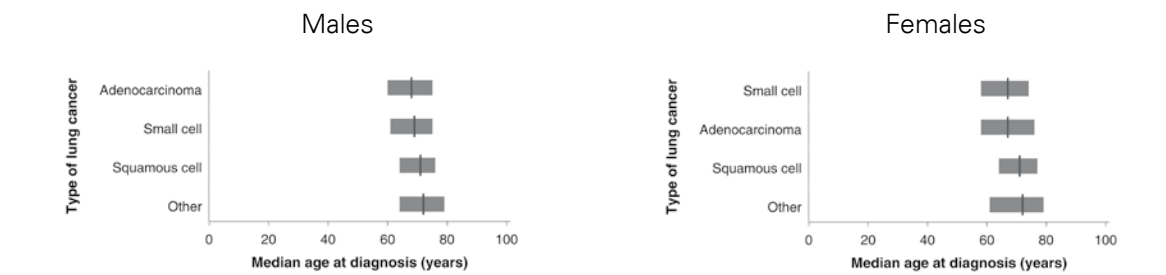
The median age at diagnosis for lung cancer in Queensland was 70 years for both males and females (Figure 2.6). This was considerably older than the median age at diagnosis for all types of cancer combined for females (64 years) and also slightly higher than the overall median age for males (68 years). Of the main types of cancer, testicular cancer (males), cervical cancer (females) and thyroid cancer all had a much younger median age at diagnosis compared to lung cancer, while bladder cancer (males), and stomach and pancreatic cancers (females) had a higher median age at diagnosis.



There has been an upwards shift in the age of diagnosis for lung cancer in Queensland over the last two decades. Since 1982-1986, the median age at diagnosis has increased by 3 years (from 67 to 70) for males and 5 years (from 65 to 70) for females. This is consistent with an increase in the average age of diagnosis for lung cancer patients that has been reported in many European countries.⁷⁴ The median age at diagnosis for all cancers combined in Queensland has also risen slightly over the same period (by 2 years for males and 1 year for females).

Figure 2.7 shows that among both males and females, the median age at diagnosis for adenocarcinoma (68 years and 67 years respectively) and small cell lung cancer (69 and 67 years) was lower than for squamous cell carcinoma (both 71 years) and other lung cancers (both 72 years).

Figure 2.7: Median age at diagnosis by type of lung cancer and sex, Queensland, 2000-2004



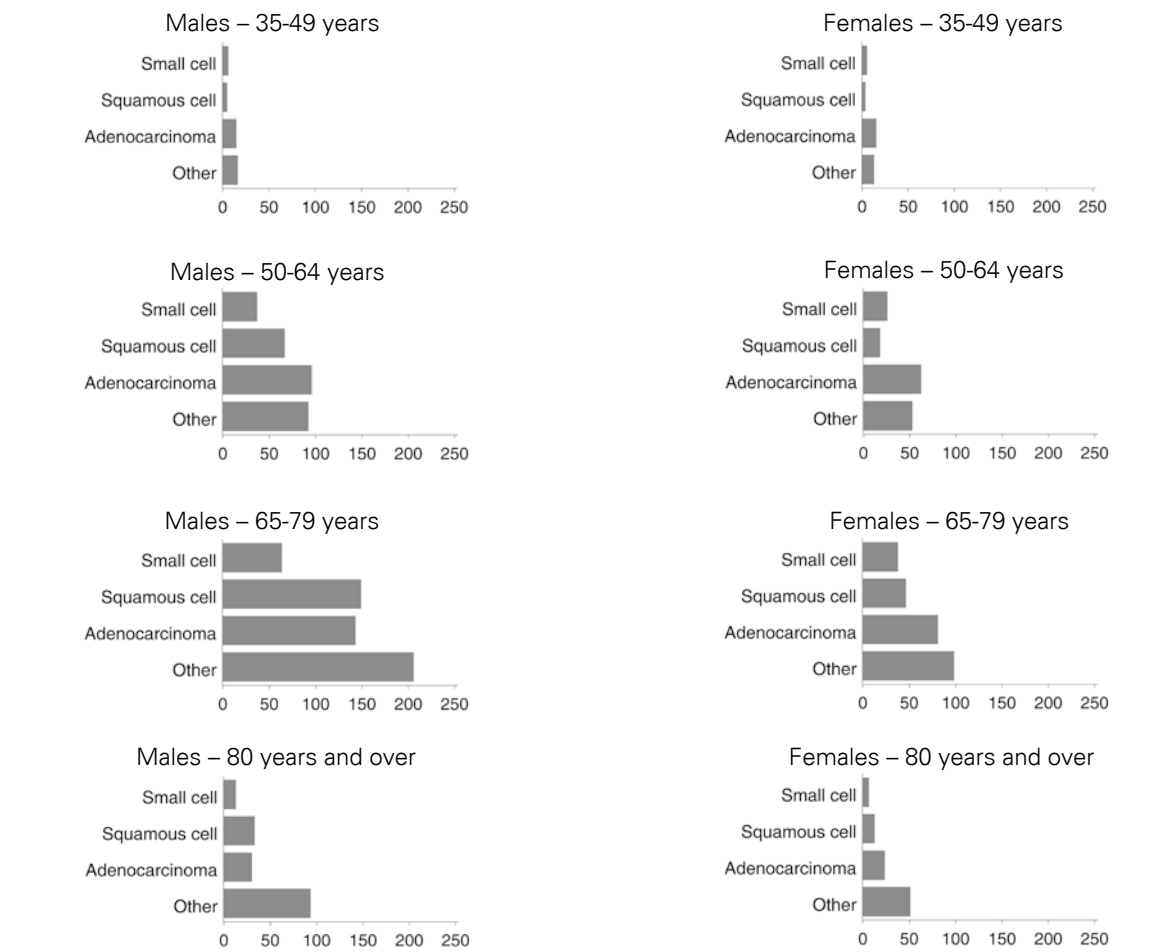
Data source: Queensland Cancer Registry.
Note: Vertical bar shows median age at diagnosis, with the corresponding interquartile range indicated by the shaded area.

2.3.4 Diagnoses by type of lung cancer and age group

Squamous cell carcinomas were diagnosed slightly more often than adenocarcinomas among males aged 65 years and over, while the incidence of adenocarcinomas was much higher among females and younger males (Figure 2.8). Other types of lung cancer comprised 55% of diagnoses for people aged 80 years or older.

Figure 2.8: Average number of diagnoses per year by type of lung cancer, sex and age group (35 years and over)*, Queensland, 2000-2004

Note: For each of the following graphs, y-axis represents “Type of lung cancer” and x-axis represents “Average number of diagnoses per year”.



Data source: Queensland Cancer Registry.
Note: *There were an insufficient number of cases to include data on lung cancer by morphology type for persons aged 0-34 years.

2.4 Are incidence rates for lung cancer different elsewhere?

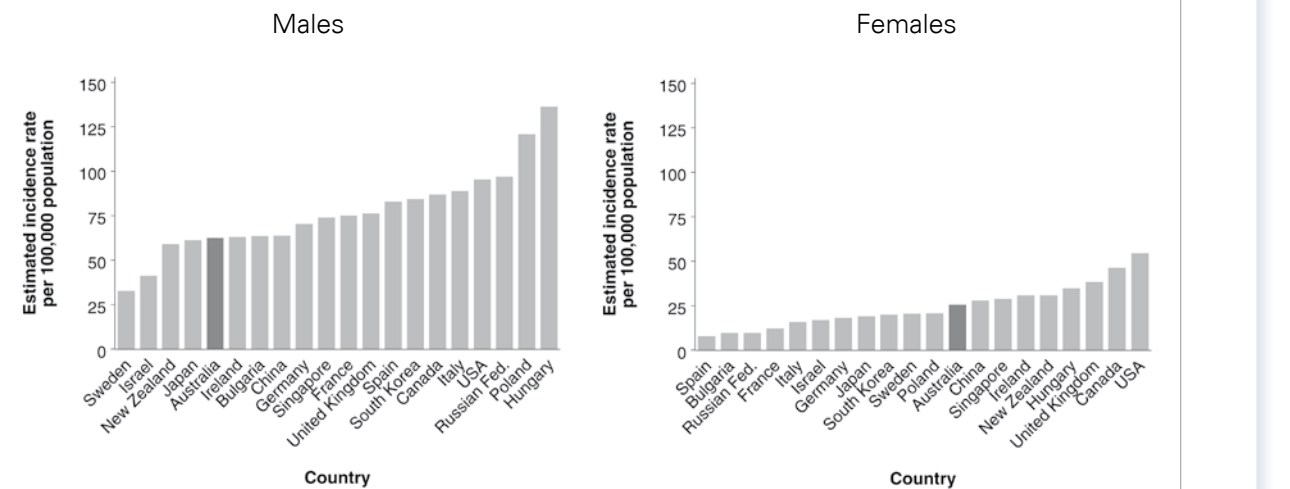
2.4.1 International comparisons for incidence

In 2002 there were an estimated 1.35 million people diagnosed with lung cancer worldwide.⁴⁵ This represented 12% of all invasive cancers diagnosed throughout the world,⁴⁵ and was an increase of about 130,000 compared to the number of lung cancers diagnosed in 2000.⁹¹ Over 70% (or about 960,000) of these lung cancer diagnoses were among males, and just under 30% (around 390,000) were among females.⁴⁵ For both sexes, the estimated number of lung cancer cases that were diagnosed during 2002 were fairly evenly split between developed and developing countries.⁴⁵

Globally, lung cancer has been the most common cancer since 1985.⁴⁵ This is driven mainly by the very high incidence among males. Lung cancer was the most common cancer diagnosed among males worldwide during 2002, followed by prostate cancer (more common in developed countries) and stomach cancer (particularly in developing countries). Among females, lung cancer was the fourth most diagnosed cancer, behind breast cancer, cervical cancer (mostly in developing countries) and colorectal cancer.⁴⁵

In comparison to estimated lung cancer incidence rates for other countries during 2002, Australia reported lower rates for males in relation to many developed countries, but had one of the higher lung cancer incidence rates for females (Figure 2.9). Eastern European countries, especially Hungary and Poland, and North America had the highest age-standardised rates of lung cancer incidence among males, while age-standardised rates were highest for females in North America and Northern Europe. For both sexes, lung cancer incidence rates were lowest in Western, Middle and Eastern Africa, with age-adjusted rates of between 3 to 6 cases per 100,000 males and between 1 to 3 cases per 100,000 females.^{45,92}

Figure 2.9: Estimated age-standardised rate* of lung cancer incidence by sex for selected countries, 2002



Data source: GLOBOCAN 2002, International Agency for Research on Cancer (IARC).⁹²
Note: *Rates age-standardised to the Australian standard population (2001) using broad age groups.

Comment 2.8 – Smoking and international lung cancer incidence

*"A consideration of the epidemiology of lung cancer consistently reinforces one major theme. The pandemic of lung cancer is a consequence of the tragic and widespread addiction to cigarettes throughout the world."*²⁵

The extent of smoking around the world since the latter half of the 20th century is widely recognised as a global epidemic or pandemic.⁹³⁻⁹⁸ In 2003, around 1.3 billion people worldwide smoked cigarettes or used other tobacco products (about 1 billion males and 250 million females).⁹³ It is predicted that the number of smokers will rise to between 1.5 to 2.2 billion by 2050, although this will mainly be due to population expansion.⁹⁹

While smoking rates are declining in most industrialised nations, in many developing nations they are still very high for males and on the increase for females. It has been estimated that about 35% of men in developed countries smoke, compared with 50% of men in developing nations.⁹⁹ In contrast, around 22% of women in developed countries smoke and 9% of women in developing countries.⁹⁹

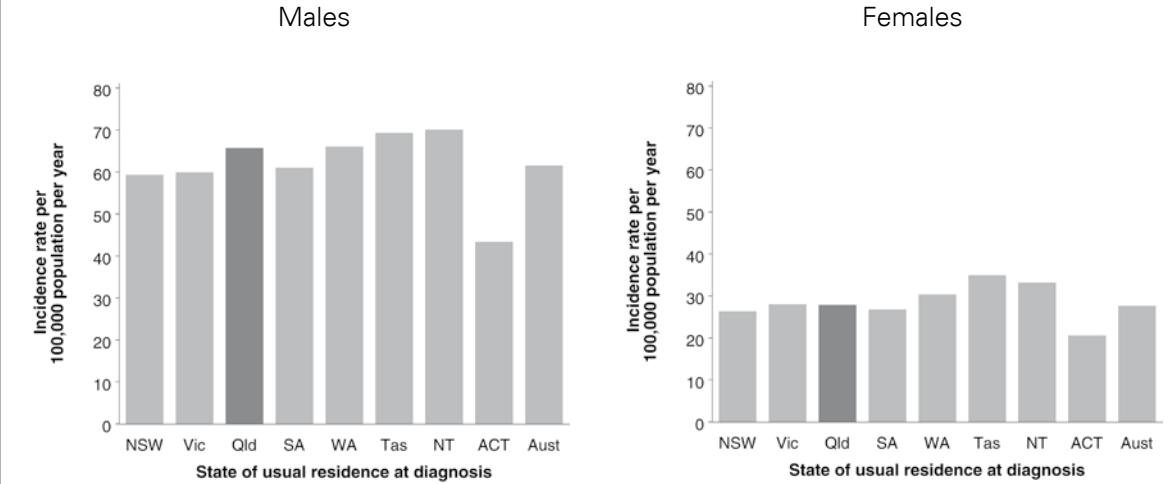
Between 90% to 95% of lung cancer cases are thought to be attributable to smoking among males in Europe and North America, where lung cancer incidence rates are highest.^{45,100} For women, lung cancer incidence was highest in parts of the world where smoking among females has been popular or accepted for longer, such as North America, Northern Europe and Australia/New Zealand. The percentage of female lung cancers linked to smoking in these areas is between 55% to 85%.^{45,100}

One exception to the close association between smoking prevalence and lung cancer incidence is the relatively high rate of lung cancer for women in China, where female smoking is uncommon, especially among younger women.^{99,101} It is believed that exposure to factors such as second-hand tobacco smoke, cooking fumes from fried food, coal smoke and air pollution may be responsible for the elevated incidence rates of lung cancer among Chinese females.^{102,103}

2.4.2 Interstate comparisons for incidence

Between 1999 and 2003 the lung cancer incidence rate for males in Queensland was higher than the Australian average, while for females the incidence rate was similar to Australia as a whole (Figure 2.10). The highest lung cancer incidence rates were reported in Tasmania and the Northern Territory for both sexes, while the lowest incidence rates were in the Australian Capital Territory.¹⁰⁴

Figure 2.10: Age-standardised rates* of lung cancer incidence per year by State/Territory and sex, Australia, 1999-2003



Data source: Australian Institute of Health and Welfare (AIHW) and Australian Association of Cancer Registries (AACR).¹⁰⁴
Note: *Rates age-standardised to the Australian standard population (2001).

Comment 2.9 – Smoking in Australia

According to the 2004 National Drug Strategy Household Survey conducted by the Australian Institute of Health and Welfare, 21% of people aged 14 years and over in Australia were current smokers (23% of males and 19% of females); 17% smoked daily, 2% smoked weekly and a further 2% smoked less regularly. Just over one-quarter (26%) of the population were ex-smokers and the remaining 53% had never smoked.⁸⁵

Smoking estimates varied by State and Territory. The percentage of people aged 14 and over who were current smokers (including daily and non-daily smokers) ranged from 20% in Western Australia to 33% in the Northern Territory among males, and from 17% in Western Australia to 29% in the Northern Territory among females. Queensland reported a slightly higher proportion of current smokers (25% of males and 21% of females) compared to the national average.⁸⁵

2.5 How have lung cancer incidence rates changed over time?

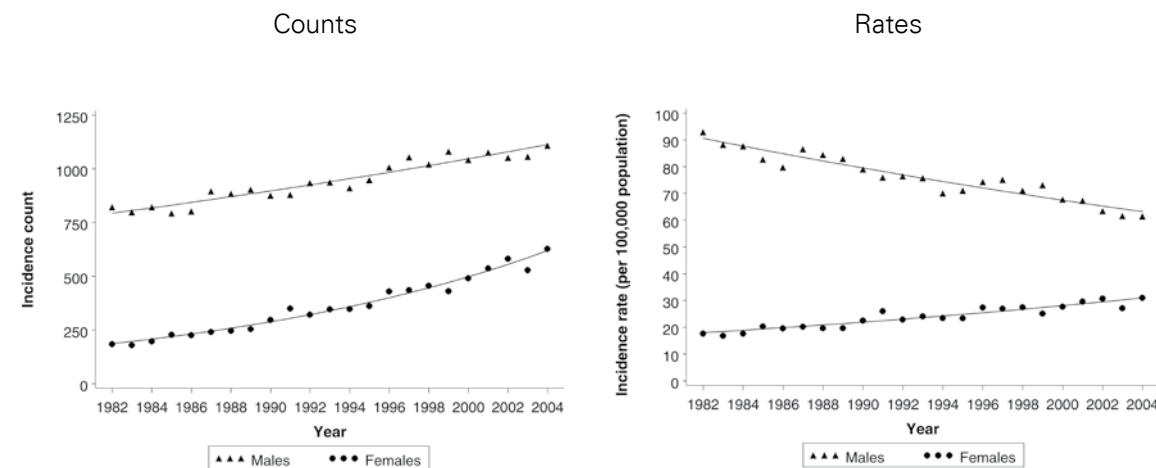
2.5.1 Incidence trends for Queensland

In 1982 there were 822 lung cancers diagnosed among males in Queensland, and 185 lung cancers diagnosed among females (equating to age-standardised rates of 93 cases per 100,000 males and 18 cases per 100,000 females).

Since 1982 the rates for lung cancer incidence among males have decreased by 1.6% per year (Figure 2.11). Even though incidence rates for males were decreasing, there has been an increase of 1.6% per year in the actual number of lung cancers diagnosed among males in Queensland (a total increase of 40% from 1982 to 2004). This is due to the increasing and ageing population.

The opposite trend for incidence rates was observed among females, with rates of lung cancer diagnosis increasing steadily by 2.5% per year from 1982 until 2004. This corresponded to the number of females who were diagnosed with lung cancer more than tripling over this time period, with a yearly increase of 5.6%.

Figure 2.11: Trends in lung cancer incidence by sex, Queensland, 1982-2004



Linear trends (estimated average yearly percentage change, with 95% confidence intervals shown in brackets):

Males 1982-2004 = +1.6% (+1.3%,+1.8%). **Males** 1982-2004 = -1.6% (-1.9%,-1.4%).
Females 1982-2004 = +5.6% (+5.2%,+6.1%). **Females** 1982-2004 = +2.5% (+2.1%,+2.9%).

Data source: Queensland Cancer Registry.

Notes: Rates age-standardised to the Australian standard population (2001).

Trends modelled using Joinpoint software (version 3.0), Statistical Research and Applications Branch, National Cancer Institute.¹⁰⁵

Comment 2.10 – Why have lung cancer incidence rates changed over time?

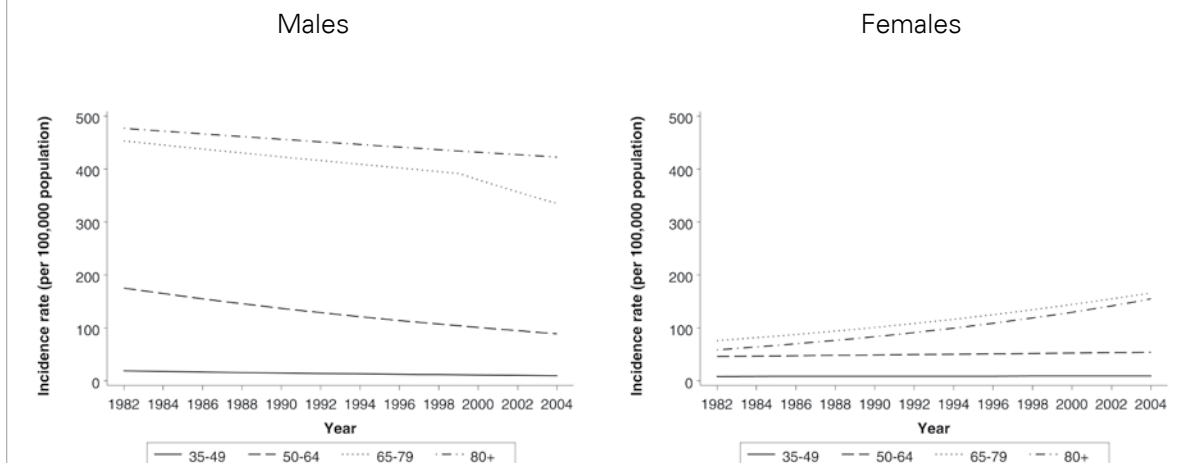
To a large extent, trends in lung cancer incidence and mortality rates reflect variations in the smoking behaviour of the population from a few decades earlier.^{54,81,106} The time lag is due to the long latency period between when a person starts smoking and when they are diagnosed with lung cancer.^{54,81}

This is illustrated by changes in smoking rates within Australia. The proportion of adult males who were smokers has gradually declined from an estimate of 72% in 1945 to 26% in 2004. For females, the estimated prevalence of smoking among adults was 26% in 1945, increased to 33% in 1976, then decreased to 20% by 2004.¹⁰⁷⁻¹⁰⁹ Allowing for the lag period, these trends in smoking prevalence are generally consistent with the converging lung cancer incidence rates for males and females that are currently being observed within Australia (see Figure 2.13). They also form the basis for the prediction that lung cancer incidence rates among females should peak within the next few years (see Section 2.5.3).

Trends in lung cancer incidence were more encouraging among males aged under 80 years and females aged less than 65 years (Figure 2.12). For males aged 35-79 years, the incidence of lung cancer was decreasing by about 3% per year, although for those aged 65-79 years this trend started only recently (since 1999). This compared to a non-significant decrease of 0.5% per year among males aged 80 years and over. For females, the rate of increase in lung cancer incidence was greater among the older age groups, with increases ranging from 0.4% per year (non-significant) in the 35-49 age bracket up to 4.5% per year among those aged 80 years and over.

Reported trends in lung cancer incidence by sex and age group in New South Wales were broadly similar.^{110,111}

Figure 2.12: Trends in lung cancer incidence by sex and age group (35 years and over)*, Queensland, 1982-2004



Linear trends (estimated average yearly percentage change, with 95% confidence intervals shown in brackets):

Males 35-49 1982-2004 = -2.9% (-3.8%,-2.0%) **Females 35-49** 1982-2004 = +0.4% (-1.1%,+1.8%)
Males 50-64 1982-2004 = -3.0% (-3.4%,-2.6%) **Females 50-64** 1982-2004 = +0.7% (+0.0%,+1.4%)
Males 65-79 1982-1999 = -0.9% (-1.3%,-0.4%) **Females 65-79** 1982-2004 = +3.6% (+3.1%,+4.2%)
1999-2004 = -3.1% (-5.6%,-0.5%) **Females 80+** 1982-2004 = +4.5% (+3.3%,+5.7%)
Males 80+ 1982-2004 = -0.5% (-1.2%,+0.1%)

Data source: Queensland Cancer Registry.

Notes: *There were an insufficient number of cases to calculate lung cancer incidence trends for persons aged 0-34 years.

Rates age-standardised to the Australian standard population (2001).

Trends modelled using Joinpoint software (version 3.0), Statistical Research and Applications Branch, National Cancer Institute.¹⁰⁵

Comment 2.11 – Are there differences in smoking by age group?

A survey of Queenslanders in 2004 found that smoking became less common as age increased: 30% of people aged 20-29 were current daily smokers, compared to 23% in the 30-49 age group, 18% in the 50-59 age group and 11% of those aged 60 and over.¹¹² Similar patterns in smoking by age group have also been reported for Australia as a whole.⁸⁵

Throughout Australia, the proportion of smokers in each age group has been decreasing over the last 25-30 years, particularly during the 1980s and late 1990s, with the largest relative decreases occurring among the middle and older age groups.^{108,113}

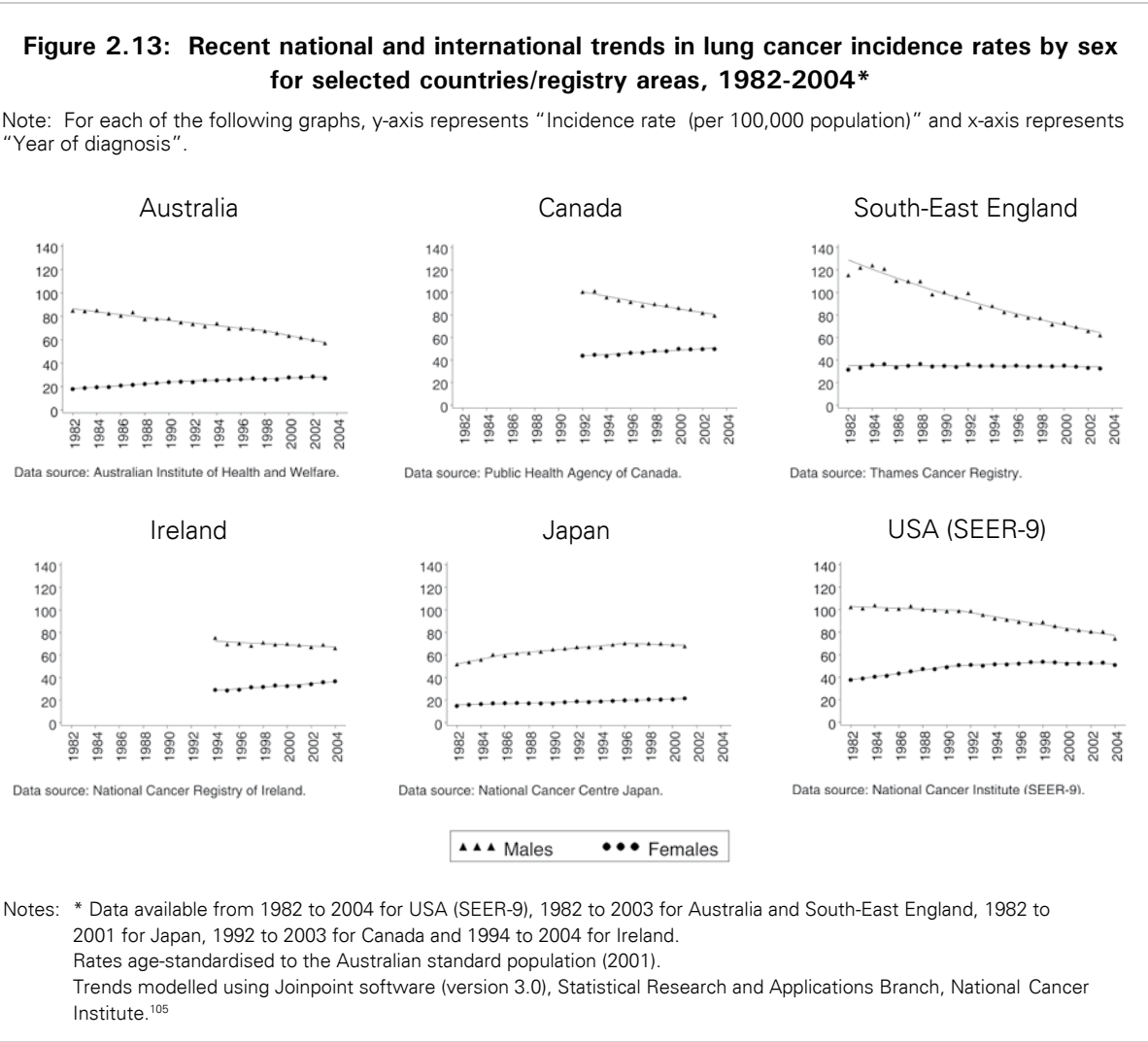
While younger people are more likely to smoke, a study into smoking behaviour in Victoria found that they tended to smoke fewer cigarettes per day compared to older smokers. Of smokers aged 18-29 years, 45% of males and 63% of females were reported to smoke 10 cigarettes or less per day, compared to 36% of male smokers and 41% of female smokers aged 30 years and over.¹¹⁴

2.5.2 International incidence trends

The estimated number of lung cancer cases worldwide increased by 51 % between 1985 and 2002 (44% increase for males and 76% increase for females).⁴⁵ However, after taking into account population increases and the ageing of the population, there was a small decrease (3%) in the age-standardised lung cancer incidence rate among males throughout the world during this period, compared to a 22 % increase in the age-standardised rate among females.⁴⁵

Lung cancer incidence trends for countries or cancer registry areas for which time series data were available are shown in Figure 2.13. Lung cancer incidence rates peaked among males in North America, Australia, New Zealand and North-Western Europe in the early 1980s and have since been declining.^{81,115} In contrast, the rates for males in many Southern and Eastern European countries, Japan and China, as well as for females from most developed countries, either continue to increase or are just starting to plateau.^{81,115-117} Trend data on lung cancer from developing countries throughout Asia, Africa and South America is more scarce, but there is some evidence that incidence rates are on the rise, particularly among males.^{118,119} The resultant shift in the global burden of lung cancer is illustrated by the fact that in 1980 it was estimated that 31% of new lung cancers were diagnosed in developing countries, but by 2002 this had risen to about 50%.⁴⁵

Trends in lung cancer incidence by sex for Australia were similar to those reported for Queensland, although the magnitude of the yearly changes was slightly different. The trend models indicate a decrease of 3.2% per year in lung cancer incidence rates among males in Australia since 1998 and an increase of 1.2% per year for females since 1991 (Figure 2.13).



2.5.3 Incidence projections to 2011 for Australia

The Australian Institute of Health and Welfare (AIHW) has published a report on projections of cancer incidence in Australia up to 2011.¹²⁰ While these projections were primarily based on the age-specific incidence rates observed between 1982 and 2001, historical trends in smoking from the mid-1940s to the mid-1970s were incorporated in the projections.

These projections predict that lung cancer incidence rates for males in Australia will continue to decrease over the next few years. Rates for females are likely to continue to increase, albeit at a lower rate than at present, with a possible peak in incidence around the end of the projection interval (i.e. 2011). However, the actual number of new cases of lung cancers diagnosed among both males and females in Australia is expected to continue increasing until at least 2011. For males this is driven solely by population growth (particularly within the older age groups).¹²⁰ Unpublished state-based information suggested that projected lung cancer incidence trends for Queensland were generally consistent with the national projections.¹²¹

Producing lung cancer projections is inherently challenging, due to the complex patterns of change experienced over the last few decades, and the assumption that what has happened in the past will continue into the future.¹²² Alternative assumptions and models are likely to produce differing projections.^{120,122}

Comment 2.12 – Evolution of the worldwide tobacco epidemic

"Geographic patterns of lung cancer incidence and mortality are very much influenced by past exposure to tobacco smoking."⁴⁵

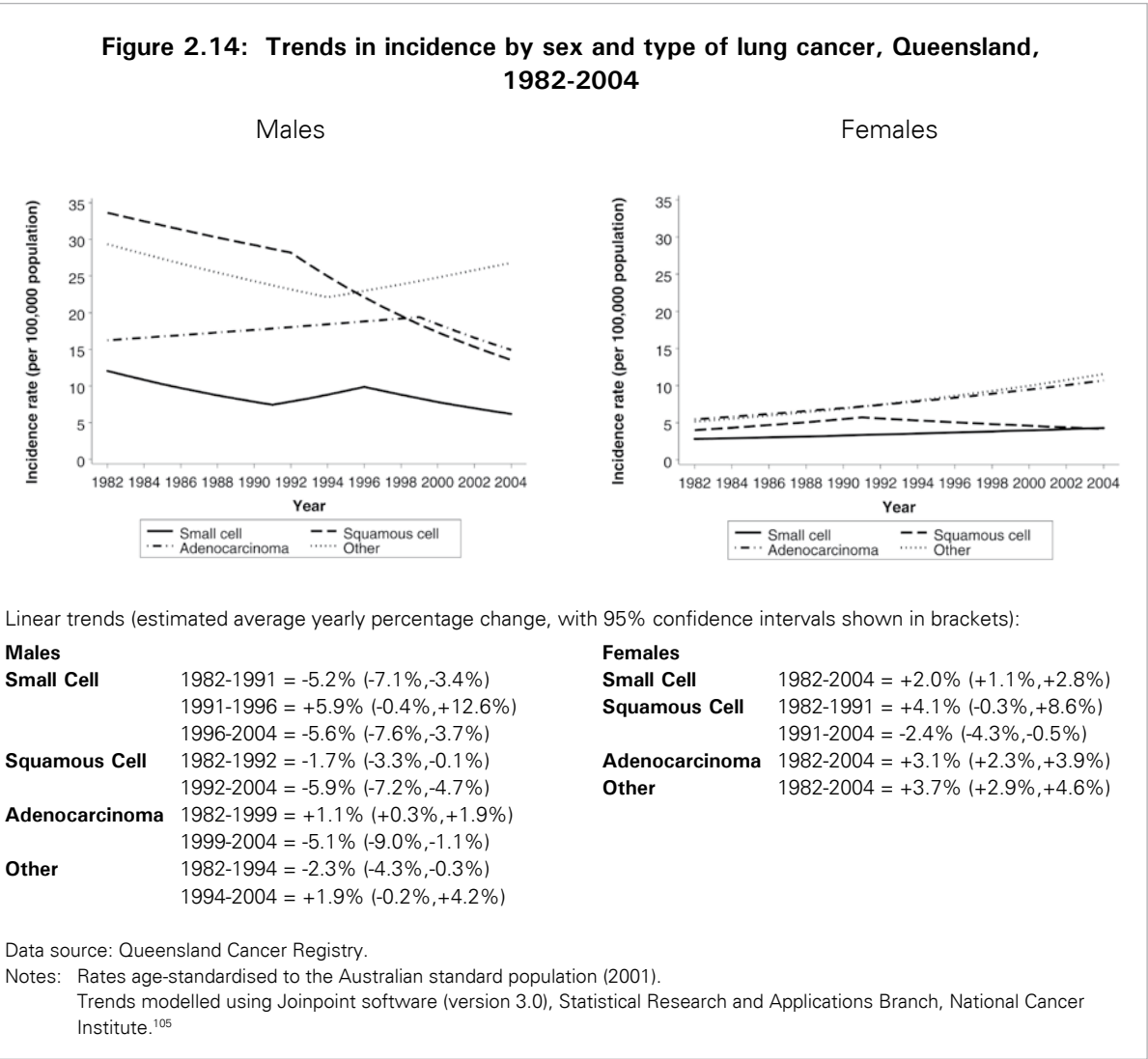
Researchers from the World Health Organization have suggested a four stage model based on tobacco consumption to explain differences in lung cancer trends around the world.^{93,97} Although the model may not exactly describe the relationship experienced between smoking and lung cancer in every country, it provides a framework for understanding how the health effects of smoking become evident after a delay of three to four decades,⁹⁷ and emphasises the need for sustained commitment at every stage to reduce tobacco use.⁹³

- **Stage 1** – This stage includes countries where the smoking epidemic has not yet taken off but the population is vulnerable to the tobacco industry; smoking rates are fairly low among males (less than 15%) and even lower among females (no more than 5%-10%). Lung cancer is rare, with incidence rates generally comparable to a non-smoking population. Examples include many countries throughout Africa.
- **Stage 2** – There is a rapid rise in smoking among males, peaking at between 50%-80%, with smoking also becoming more common among females. The proportion of ex-smokers is low, and tobacco control is limited. Lung cancer becomes increasingly common, particularly for males. Many countries in Asia, North Africa, and South America are at this stage.
- **Stage 3** – Characterised by a change in the public perception of smoking from being a socially acceptable behaviour to being a health hazard, along with the introduction of comprehensive tobacco control legislation. Smoking rates are falling for males and have typically plateaued at between 35%-45% among females. Lung cancer rates continue to rise sharply before peaking towards the end of this phase. Countries in Eastern and Southern Europe are examples of this stage of the smoking epidemic.
- **Stage 4** – Smoking rates for both males and females continue to decline in parallel, with smoking still slightly more common among males. It is also likely that differences in smoking by socio-economic status will persist and perhaps even widen. Legislation allowing a smoke-free environment becomes a key issue during this stage. Lung cancer rates for males continue to decrease, but may still be rising among women in response to the later peak in smoking prevalence for females. Most industrialised countries are now at this stage, including Australia, North America and North-Western Europe.

2.5.4 Incidence trends by lung cancer morphology

Trends in lung cancer incidence by sex in Queensland vary according to the type of lung cancer (Figure 2.14). Incidence rates are currently declining across the three main morphology types for males (each decreasing by between 5%-6% per year), with the current decreasing trends only being observed since the mid to late 1990s for small cell lung cancer and adenocarcinoma. There has been more variability in the year to year incidence for males within the grouping of “other types of lung cancer”, with the latest trend being a marginally significant increase of almost 2% per year.

The overall increasing trend in the rate of lung cancer diagnoses among females appears to be driven by adenocarcinoma and other types of lung cancers (both increasing by between 3% - 4% per year). Incidence of small cell lung cancer is also continuing to rise for females (2% per year), while the incidence rate for squamous cell carcinoma has been decreasing since the early 1990s by more than 2% per year.



The trends by lung cancer subtype in Queensland were broadly consistent with those which have been reported throughout Australia, North America, parts of Europe and Japan.^{72,81,123}

Some of the potential reasons for the differences in trend by type of lung cancer and sex have been examined earlier in this report (see Comment 2.5, Comment 2.6 and Comment 2.10), and are most probably related to changes in smoking behaviours.⁸¹

Comment 2.13 – What is being done in Australia to reduce tobacco use?

In late 2004, the Commonwealth Department of Health and Ageing released a comprehensive tobacco control strategy,¹²⁴ with the aim of significantly improving health and reducing the social costs caused by tobacco use. The strategy includes:¹²⁴

- Reducing the use of, and exposure to, tobacco products through further regulation e.g. restricting tobacco promotion, making tobacco products less affordable and eliminating second-hand tobacco smoke in workplaces;
- Increasing promotion of the quit smoking and smokefree messages;
- Improving the quality of, and access to, services and treatments for smokers;
- Providing more support to those responsible for helping children to develop a healthy lifestyle e.g. parents, carers, schools and community organisations;
- Addressing social, economic and cultural determinants of tobacco use;
- Tailoring anti-tobacco messages and support towards disadvantaged groups; and,
- Developing a priority-driven research agenda e.g. obtaining better information on the perceptions and needs of smokers and public attitudes towards tobacco control.

Comment 2.14 – Issues affecting the future international burden of lung cancer

The shift towards a higher proportion of lung cancer cases occurring in developing countries appears set to continue.^{55,116} It is thought that by the year 2025, 85% of the world’s smokers will live in developing countries,⁹⁶ and by 2030 it is expected that around 70% of all tobacco-related deaths (including lung cancer) will occur in the world’s poor and middle income nations, compared to the current estimate of 50%.^{98,99}

Smoking patterns in China are likely to strongly influence the global number of lung cancer cases within the next 10 to 20 years. One-third of all cigarettes are currently smoked in China; that country’s annual consumption of cigarettes grew from 500 billion in 1980 to 1,800 billion in 1996, mainly due to a large increase in the prevalence of smoking among males.¹⁰² As a result, it is predicted that lung cancer incidence among Chinese males will rise dramatically.^{101,116,125} Combined with China’s huge population, this will have serious implications for the global burden of lung cancer.^{55,126}

Another important international issue is the prevalence of smoking among children and teenagers, particularly the increasing use of tobacco products among girls in developing countries.^{99,127} A recent report by The American Cancer Society stated that throughout the world nearly 100,000 additional children and adolescents become addicted to smoking every day.⁹⁹ Using data from the Global Youth Tobacco Survey, conducted between 1999 and 2005, other researchers have suggested that about 17% of school students aged 13 to 15 either smoked cigarettes and/or used other tobacco products.¹²⁷ Some authors have cited the increasing proportion of young smokers to suggest that the lung cancer epidemic may not be over yet, even within some industrialised nations.^{74,128}

Despite these issues, optimism remains high that the worldwide lung cancer epidemic can be contained via tobacco control.^{55,96,99,126}

3 Survival

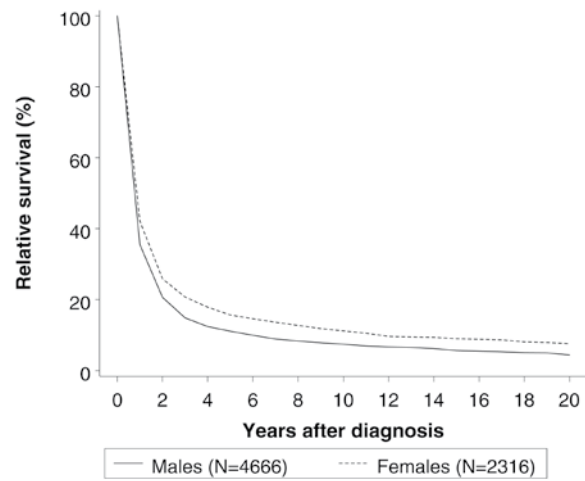
Survival is the length of time a person remains alive after being diagnosed with lung cancer. The crude survival rate is the proportion of people diagnosed with lung cancer who remain alive after a given length of time (for example, 1 year). Relative survival divides the crude survival rate by the expected survival rate of the general population, and is usually expressed as a percentage. A relative survival estimate of 100% suggests that lung cancer patients have the same survival expectations as the general population (see Appendix B for more details).

3.1 How long do people in Queensland survive after being diagnosed with lung cancer?

3.1.1 Survival by sex

Survival from lung cancer is poor. For people at risk from lung cancer in Queensland during the period 2000-2004, 1-year relative survival was 42% for females and 36% for males, 5-year relative survival was 16% and 11% respectively, 10-year relative survival was 11% and 7% respectively, and after 20 years relative survival dropped to 8% for females and 4% for males (Figure 3.1).

Figure 3.1: Relative survival from lung cancer by sex, Queensland, 2000-2004



Data source: Queensland Cancer Registry.
Notes: Relative survival calculated using the period method, for persons aged 0-89 years at time of diagnosis.
Data are for "at risk" cases in the period 2000-2004.
"N" is the initial number of "at risk" cases by sex.

Comment 3.1 – Does smoking status affect lung cancer survival?

The scientific evidence in regard to whether smoking status affects survival has been mixed.^{129,130} However, several recent, large studies have suggested that non-smokers who develop lung cancer experience better survival than smokers, after taking into account other factors such as demographic characteristics and existing comorbid diseases.¹³¹⁻¹³³ For example, a study in the United States found that lung cancer patients who were current smokers at the time of diagnosis had a 26% greater risk (adjusted) of dying from lung cancer compared to non-smokers and ex-smokers combined.¹³¹

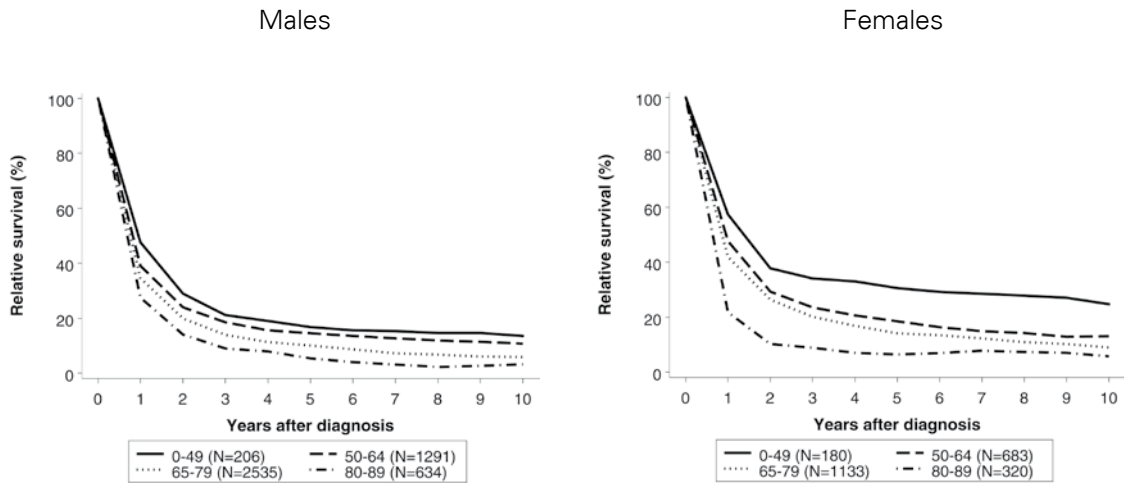
These observed differences in survival by smoking status have prompted cancer researchers to ask whether lung cancer among non-smokers is a different form of the disease compared to lung cancer which develops as a direct result of a person smoking.^{132,134} Although this question has not been completely resolved at present, there is a growing body of literature indicating that the biological mechanisms via which smokers and non-smokers develop lung cancer are distinctly different.^{13,66,133,134}

Studies which examined the effect of smoking cessation on survival have found that among females with non-small cell lung cancer, survival time was associated with the length of time since quitting smoking.^{135,136} However, no association with smoking cessation was observed among females with small cell lung cancer or males with any type of lung cancer.^{135,136}

3.1.2 Survival by age group

Survival was better for people who were diagnosed with lung cancer at a younger age compared to lung cancer patients in the older age groups (Figure 3.2). The differences in survival by age group were more evident among females than males. Between 2000 and 2004, 5-year relative survival from lung cancer was 31% for females aged under 50, and decreased to 18% for those aged 50-64 years, 14% for 65-79 year olds and 6% for those aged 80-89 years at diagnosis. Among males, 5-year relative survival was 17% for those aged 0-49 years when diagnosed, and declined to 15%, 10% and 5% respectively for those aged 50-64, 65-79 and 80-89 years at diagnosis.

Figure 3.2: Relative survival from lung cancer by age group and sex, Queensland, 2000-2004



Data source: Queensland Cancer Registry.
Notes: Relative survival calculated using the period method, for persons aged 0-89 years at time of diagnosis.
Data are for "at risk" cases in the period 2000-2004.
"N" is the initial number of "at risk" cases within each age group by sex.

Comment 3.2 – What other factors are associated with survival time following a diagnosis of lung cancer?

A range of patient-related and tumour-related features have been identified as possible prognostic factors for lung cancer. Apart from smoking status and histology subtype, some of the main factors associated with increased length of survival following a diagnosis of lung cancer include:

- early stage of disease at diagnosis^{129,130,137-139}
- female gender^{73,130,137-142}
- younger age at time of diagnosis^{130,137,139,140}
- absence of comorbid diseases^{81,143,144}
- better functional status (e.g. ability to perform normal daily activities)^{129,130,138,139}

However, the evidence linking these factors to lung cancer survival is not always consistent (particularly for gender and age). Some studies have reported insignificant or even inverse associations between these factors and survival.^{129,137} Differences in the characteristics and treatments of the patients being studied, varying study methodologies and sample sizes, or different sets of prognostic factors being evaluated may explain some of the contrasting results.¹²⁹

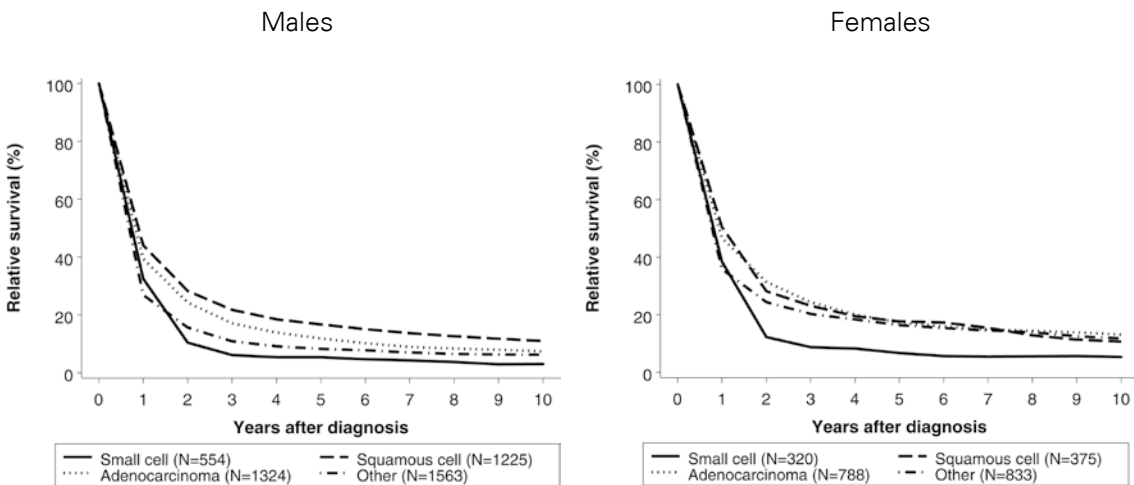
The reasons why females with lung cancer tend to survive longer than males are unclear.^{142,145} It has been hypothesised that reduced survival among older people could be partly due to less aggressive treatment compared to younger lung cancer patients,¹³⁸ but such theories remain open to speculation.

3.1.3 Survival by lung cancer morphology

Among males, survival was highest for squamous cell carcinoma, followed by adenocarcinoma and other types of lung cancer, with 5-year relative survival of 17%, 12% and 8% respectively (Figure 3.3). The survival curves for each of the three non-small cell subtypes of lung cancer was very similar among females, particularly from 4 years after diagnosis and onwards, with each of these morphology groups recording 5-year relative survival between 16%-18%. Survival was poorest for patients diagnosed with small cell lung cancer, with 5-year relative survival of only 5% for males and 7% for females.

Studies on survival by type of lung cancer in Canada and Norway have reported similar results to those shown here, with survival highest among females with adenocarcinoma and males with squamous cell carcinoma, and survival lowest for those diagnosed with small cell lung cancer among both sexes.^{146,147} At a broader level, statistics from the United States and throughout Europe have consistently demonstrated significantly better survival among patients with non-small cell lung cancer compared to those with small cell lung cancer.^{81,148,149}

Figure 3.3: Relative survival from lung cancer by type of lung cancer and sex, Queensland, 2000-2004



Data source: Queensland Cancer Registry.
Notes: Relative survival calculated using the period method, for persons aged 0-89 years at time of diagnosis.
Data are for “at risk” cases in the period 2000-2004.
“N” is the initial number of “at risk” cases within each morphology group by sex.

Comment 3.3 – Why is lung cancer survival so poor?

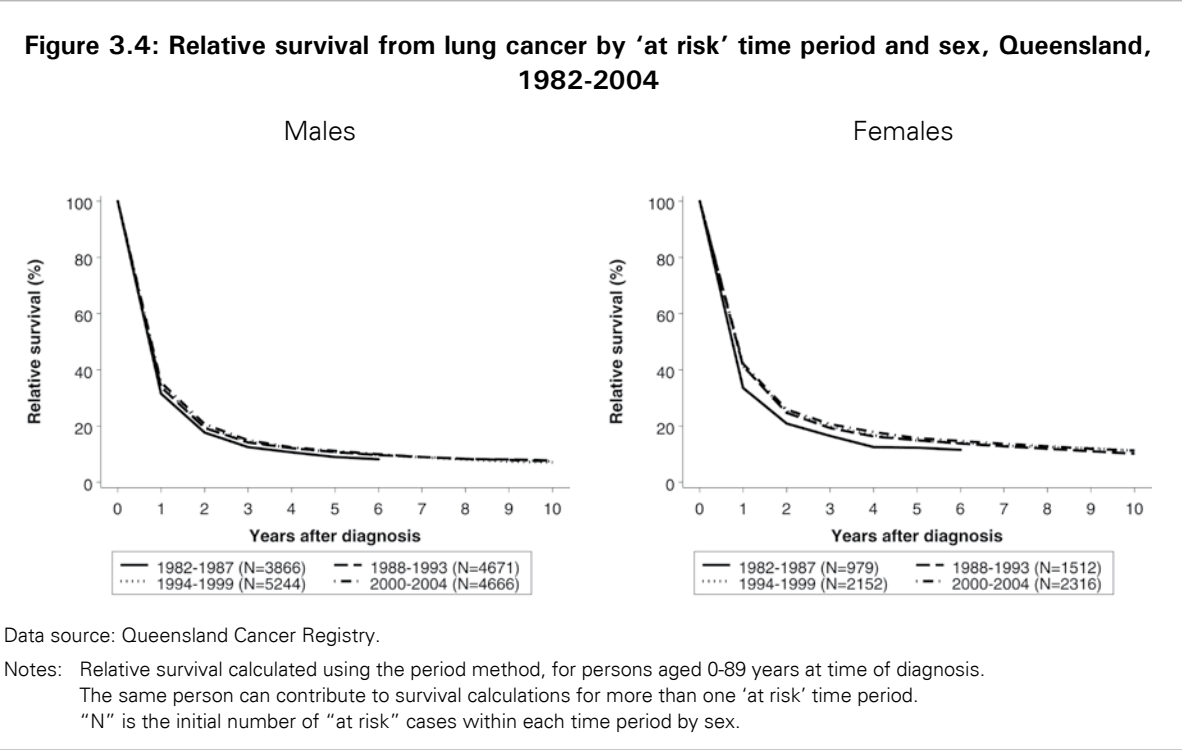
As with all cancers, earlier diagnosis of lung cancer will improve the likelihood that treatment will be successful and reduce the chance that it has spread to other parts of the body. A difficulty with lung cancer is that it often doesn’t cause symptoms in its early stages of development. By the time symptoms occur and a diagnosis is obtained, lung cancer is usually well advanced and treatment options are limited.¹⁵⁰⁻¹⁵³

There is some evidence that the multidisciplinary management of lung cancer may have a beneficial outcome;^{154,155} however, advances in surgical techniques and refinements in chemotherapy and radiotherapy have had little effect on overall survival rates.¹⁵⁶ While the use of chemotherapy has resulted in some improvement in short-term survival for patients with small cell lung cancer, their longer-term prognosis remains poor.^{81,157} The only real chance of cure is among patients who have surgery prior to the lung cancer metastasising, particularly those with non-small cell lung cancer.^{81,158}

Another probable reason why survival for lung cancer is poor in comparison to other cancers is the effect of smoking. It is likely that smoking-related comorbidities such as cardiovascular diseases or chronic obstructive pulmonary disease may have an additional negative impact on survival.^{131,159} There is also some evidence that current or previous smoking may have a deleterious effect on the use of radiotherapy or chemotherapy when treating lung cancer.^{160,161}

3.1.4 Survival by 'at risk' time period

There were small improvements in relative survival from lung cancer in Queensland during the mid to late 1980s (Figure 3.4). For males, 5-year relative survival improved slightly from 9% in 1982-1987 to 11% in 1988-1993, while for females 5-year relative survival rose from 12% to 15% over the same time interval. However, more recently there has been little change in survival for lung cancer patients, with the survival curves for males and females 'at risk' from lung cancer during 2000-2004 very similar to the respective survival curves for 1988-1993 and 1994-1999.

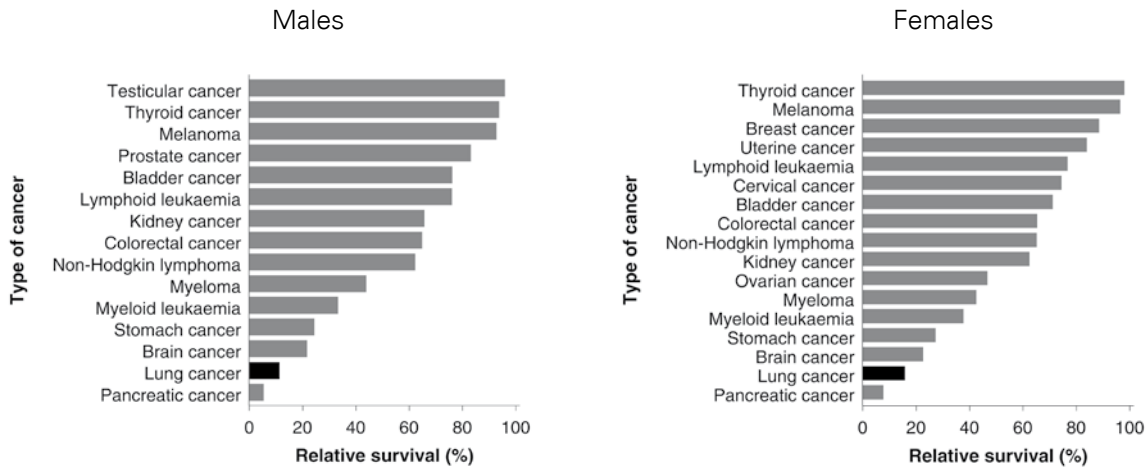


Survival for patients with lung cancer in Australia, Europe and North America has also shown little improvement over the last two or three decades, both in terms of all lung cancers combined and by the individual histology groups.^{81,147,157,158,162-164}

3.2 How does survival from lung cancer compare with other cancers?

Survival for lung cancer was very poor in comparison to most other types of cancer (Figure 3.5), with pancreatic cancer being one of only a few types of cancer with lower 5-year survival (5% for males and 8% for females). In contrast, melanoma, testicular cancer (males) and thyroid cancer had the best survival among the more common types of cancer, with 5-year survival rates of over 90% for each of these cancers. Five-year survival was also high for breast cancer among females (89%) and prostate cancer among males (83%).

Figure 3.5: 5-year relative survival for selected cancers by sex, Queensland, 2000-2004



Data source: Queensland Cancer Registry and Queensland Health.

Notes: Relative survival calculated using the period method, for persons aged 0-89 years at time of diagnosis. Data are for 'at risk' cases in the period 2000-2004.

Comment 3.4 – Will screening for lung cancer improve survival?

One potential option for diagnosing lung cancer earlier, and thereby improving the likelihood of successful treatment, is the use of screening tests for those considered to be at higher risk.^{150,151,165-167}

Chest x-rays were investigated as a screening tool for lung cancer during the 1970s and 1980s.^{156,165} However, large-scale scientific studies failed to find any improvement in lung cancer mortality rates associated with this approach.^{150,156,165}

The advent of low-dose computed tomography (CT) scanning, which is more sensitive for detecting smaller growths in the lungs,^{151,168} sparked renewed interest in screening for lung cancer in the mid to late 1990s.^{156,169} Evaluation of the effectiveness of CT screening to improve lung cancer survival is continuing, but preliminary results generally appear promising.^{150,151,167-171}

However, expert opinion on the value of CT scanning for lung cancer remains divided. Some commentators have suggested that widespread lung cancer screening using CT scanning should not be introduced until the mortality or survival benefits are more clearly identified. They cite reasons such as possible biases in screening studies (which result in an apparent improvement in survival time but no real change in lung cancer mortality rates), unnecessary exposure to radiation and possible complications arising from biopsy or surgery for those who don't actually have lung cancer, the high financial cost of screening programs, and a potential decrease in the motivation to stop smoking for those whose screening results show that they do not have lung cancer.^{172,173} Even those who advocate using CT scanning for lung cancer express caution because of some of these issues.^{151,166,169}

Population screening for lung cancer is currently not recommended by The Cancer Council Australia or major cancer organisations in other countries.^{167,168,172} Research into new methods for the early detection of lung cancer is ongoing, with the goal of making screening for lung cancer a viable option in the future.^{165,167,168,174,175}

3.3 Is survival for lung cancer different elsewhere?

3.3.1 International comparisons for survival

Reported differences in lung cancer survival between countries do not necessarily translate into real differences, but may be due to characteristics of the data collection and/or statistical analysis methods¹⁷⁶ (see Appendix B). Even when considering these limitations, the prognosis for people diagnosed with lung cancer is consistently poor worldwide. Lung cancer survival in Queensland (and Australia) was found to be slightly lower than for the United States¹⁵⁸ and Canada,¹⁷⁷ but higher in comparison to many areas of Europe.¹⁷⁸

In the United States, 5-year relative survival for lung cancer between 1995-2000 was estimated at 14% for males and 17% for females.¹⁵⁸ Similar results were published for Canada over the period 1995-1997 (5-year relative survival of 14% for males and 18% for females).¹⁷⁷

Survival was generally lower throughout Europe, with the average 5-year relative survival for lung cancer during 1990-1994 estimated to be just under 10% for both males and females.¹⁷⁸ The 5-year survival rate by type of lung cancer was about 15% for patients with non-small cell lung cancer and only 5% for those diagnosed with small cell lung cancer.⁷⁴ Of the European countries for which data were available, lung cancer survival was highest in Austria, France and Spain for males (all with 5-year relative survival of 12%-13%) and Switzerland, Austria and France for females (all around 16%). Conversely, 5-year relative survival was lowest in Poland, Denmark and the Czech Republic among males (each about 6%) and Denmark, Poland and Scotland for females (6%-7%).^{74,178}

3.3.2 Interstate comparisons for survival

Based on the latest data available, there were only minor differences in 5-year relative survival for lung cancer across Australia (Table 3.1), although the time periods were different. Five-year relative survival for males varied from 10% in Victoria, South Australia and Western Australia up to 13% in New South Wales. Among females, 5-year survival ranged from 12% in Victoria to 15% in New South Wales.

Table 3.1: 5-year relative survival* for lung cancer by State/Territory and sex			
State/Territory	Cohort	5-year relative survival (%) (95% confidence interval)	
		Males	Females
Queensland	1996-2000	12.2 (11.1-13.2)	14.6 (13.0-16.4)
New South Wales	1999-2003	12.7 (11.7-13.6)	15.4 (14.0-16.9)
Victoria	1990-1997	10.0 (10.0-11.0)	12.0 (11.0-13.0)
South Australia	1977-2003	10.2 (9.6-10.8)	13.9 (12.7-15.1)
Western Australia	1994-1997	10.3 (9.0-11.6)	13.4 (11.1-15.6)
Australia – Total	1992-1997	11.0 (10.6-11.4)	14.0 (13.3-14.7)
Data sources: Queensland Health and Queensland Cancer Fund; ¹⁴⁰ Cancer Institute NSW; ¹⁷⁹ The Cancer Council Victoria; ¹⁸⁰ South Australian Cancer Registry; ¹⁸¹ Western Australian Cancer Registry; ¹⁸² and the Australian Institute of Health and Welfare. ¹⁶⁴			
Notes: * This table shows the most recent 5-year relative survival estimates for each State (including Queensland) calculated using the cohort method. Some of the same issues that have to be taken into consideration when comparing lung cancer survival between countries also apply when making comparisons within Australia, particularly differences in the most recent time periods for which survival data were available. For further details on survival calculations and interpretation, see Appendix B. Comparable data on lung cancer survival were not available for Tasmania, the Australian Capital Territory or the Northern Territory.			

Examining survival by the lung cancer subtypes, between 1992-1997 the 5-year relative survival from small cell lung cancer was similar in Queensland compared to Australia as a whole.¹⁸³ However, 5-year relative survival for adenocarcinoma was slightly lower for males in Queensland than for Australian males (11% and 14% respectively), while females experienced somewhat similar survival of 17% and 21% respectively.¹⁸³ The different calculation methods used (period method for Queensland and cohort method for Australia) may have influenced these comparisons, however the impact is likely to be minimal (see Appendix B).

Comment 3.5 – Long-term lung cancer survivorship

Issues surrounding the longer-term survival of lung cancer patients are likely to become increasingly important following potential advances in early detection and treatments, along with increases in the number of long-term survivors due to population growth and ageing.¹⁸⁴

Studies of lung cancer patients who survived for 5 or more years have found that they generally report a lower quality of life compared to either the general population or long-term survivors from other types of cancer,¹⁸⁴ particularly in regard to physical functioning.¹⁸⁵ Possible reasons for differences in quality of life include the adverse effects of treatment, the common presence of comorbid illnesses (often smoking-related), and a greater potential for the recurrence of lung cancer or the development of subsequent primary cancers.^{184,185}

These findings suggest that the ill-effects of lung cancer are persistent, and that lung cancer survivors require ongoing assessment and care beyond the short term.¹⁸⁴

4 Mortality

Mortality measures how many people in a population die from a specific disease over a given time period. Similarly to incidence, mortality can either be expressed as a number (i.e. the number of deaths due to lung cancer each year) or as a rate (i.e. the number of deaths due to lung cancer per 100,000 population per year).

Due to the poor survival of lung cancer patients (see Chapter 3), the incidence rate (IR) and mortality rate (MR) are generally quite similar. The ratio of MR:IR for lung cancer varied between 0.80 to 0.88 throughout the world during 2002,¹¹⁶ while the ratio was 0.82 in Queensland between 2000-2004 (0.85 for males and 0.77 for females). In comparison, the ratio of MR:IR for melanoma in Queensland was 0.10 (0.12 for males and 0.07 for females), reflecting the high survival rates among melanoma patients.

Comment 4.1 – Smoking and mortality

“For the first time ever, the world’s leading agent of death is a man-made substance - tobacco.”¹⁸⁶

Consider the following statistics about deaths caused by smoking:

- It is estimated that one out of every two lifetime smokers will eventually be killed by a disease caused by their tobacco smoking.^{44,99,187}
- Researchers have reported that more than one out of every 5 cancer deaths in the world during 2000 was caused by smoking.¹⁸⁸
- Smoking-related diseases are the leading cause of preventable premature deaths in Australia.¹⁸⁹ During 2003, just over 15,500 deaths (10,100 males and 5,400 females) in Australia were attributable to smoking.¹⁹⁰ This equated to 12% of all deaths in Australia that year (15% for males and 8% for females).
- Worldwide, one hundred million people are reported to have died from tobacco use during the 20th century.⁹⁹ Smoking currently causes around 5 million premature deaths each year.^{44,99,191} It has been projected that smoking will kill 10 million people around the world every year by 2020, with 70% of these deaths occurring in developing countries.⁹⁹
- A 5% absolute reduction in the worldwide smoking prevalence by 2020 would prevent at least 100 million tobacco-related premature deaths.¹⁸⁶

Focussing specifically on lung cancer deaths due to smoking:

- A higher proportion of lung cancer deaths were attributable to smoking than for any other disease.¹⁹¹ It was recently estimated that 84% of lung cancer deaths in Australia were related to smoking,¹⁹⁰ similar to all industrialised nations (86%) and higher than in developing countries (55%).¹⁹¹
- A higher proportion of lung cancer deaths were attributable to smoking among males than for females (88% and 75% respectively in Australia).¹⁹⁰
- The proportion of lung cancer deaths due to smoking peaked in the older age groups, with 76% of lung cancer deaths attributable to smoking among Australians aged 25-64, 87% for 65-74 year olds and 85% for those aged 75 and over.¹⁹⁰
- It has been estimated that lung cancer was responsible for 41% of smoking-related deaths in Australia and 73% of smoking-related cancer deaths.¹⁹⁰ This compares to global estimates of lung cancer causing 18% of all smoking-related deaths and 58% of smoking-related cancer deaths.¹⁸⁵

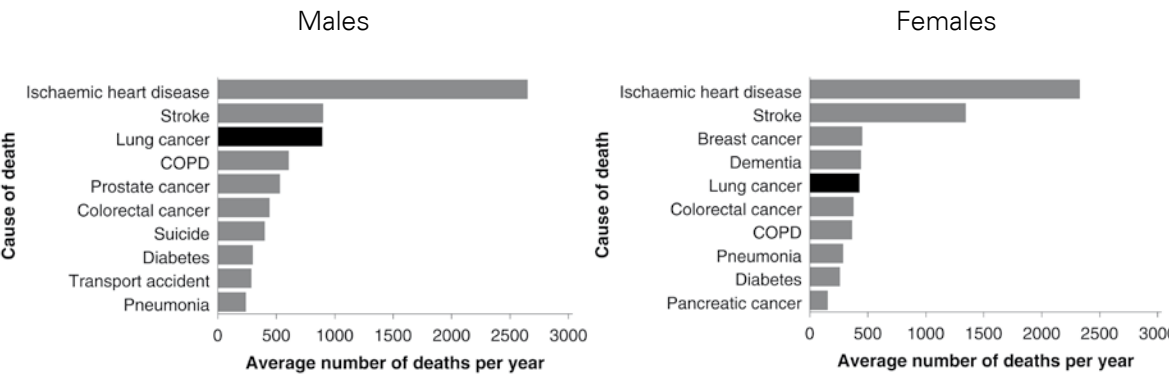
4.1 How many people die from lung cancer in Queensland each year?

In 2004, 1448 Queensland residents died from lung cancer. Around two-thirds of these lung cancer deaths (958) were males, while 490 were females. The corresponding age-standardised mortality rates were 54 lung cancer deaths per 100,000 males and 24 deaths per 100,000 females.

Between 2000 and 2004, cancer was the leading cause of death for both sexes, causing 31% of male deaths and 26% of female deaths in Queensland. Among individual causes of death, lung cancer was the third most common for males (7%), behind ischaemic heart disease (21%) and stroke (7%) (Figure 4.1). Among females, lung cancer was the fifth highest cause of mortality (4%), after ischaemic heart disease (21%), stroke (12%), breast cancer (4%), and dementia (4%).

Lung cancer was most prominent as a cause of mortality among persons aged 50-79 years. It was the second most common cause of death overall among males in this age group and was also second among females aged 50-64 years, and third among females aged 65-79 years.

Figure 4.1: Average number of deaths per year for the most common causes of death by sex, Queensland, 2000-2004



Data source: Australian Bureau of Statistics.

Note: COPD = chronic obstructive pulmonary disease.

ICD-10 codes used to define each condition were based on those used by ABS¹⁹² and AIHW.¹⁹³

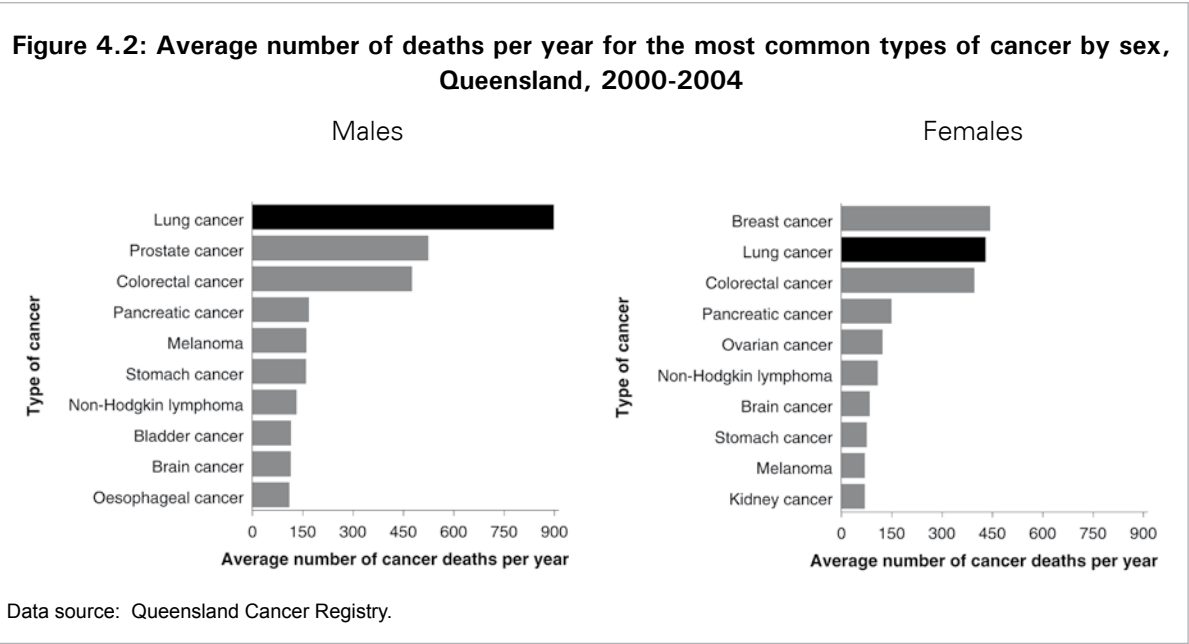
Comment 4.2 – Do people with lung cancer always die specifically from lung cancer?

There is a common perception that almost all people diagnosed with lung cancer die from lung cancer.¹³¹ However, this is not necessarily the case; between 20% to 40% of early stage lung cancer patients die from other causes, mainly comorbidities related to smoking.^{131,144} Persons with lung cancer who died from other causes were more likely to be males and in the older age groups.¹⁹⁴

A recent study in Queensland reported that lung cancer patients were more than four times as likely to die from a non-cancer cause compared to the general population.¹⁹⁵ In contrast, non-cancer death rates for people diagnosed with melanoma or female breast cancer were about the same or lower than the general population. The increased risk of non-cancer deaths among lung cancer patients is probably due to the contribution smoking makes to other potentially fatal conditions such as ischaemic heart disease and stroke. Unlike most other types of cancer, the non-cancer mortality risk for lung cancer patients remained high irrespective of time since diagnosis.¹⁹⁵

All cancers combined caused an average of 3842 deaths per year among males and 2761 deaths per year among females in Queensland between 2000 and 2004. Lung cancer was the leading cause of deaths due to cancer for males in this period, responsible for almost a quarter (23%) of all cancer-related deaths, and the second most common cause of cancer mortality (16%) for females, only slightly behind breast cancer (Figure 4.2). However, in 2002 the number of lung cancer deaths was higher than the number of breast cancer deaths among females in Queensland for the first time. This result was repeated in 2004, making it likely that lung cancer will become established as the leading cause of cancer-related deaths among females within the foreseeable future.

In 2004, males in Queensland had a risk of 1 in 27 of dying from lung cancer before the age of 75, while for females the risk was 1 in 62.⁴³



Comment 4.3 – Differences in lung cancer mortality risk by smoking status and sex

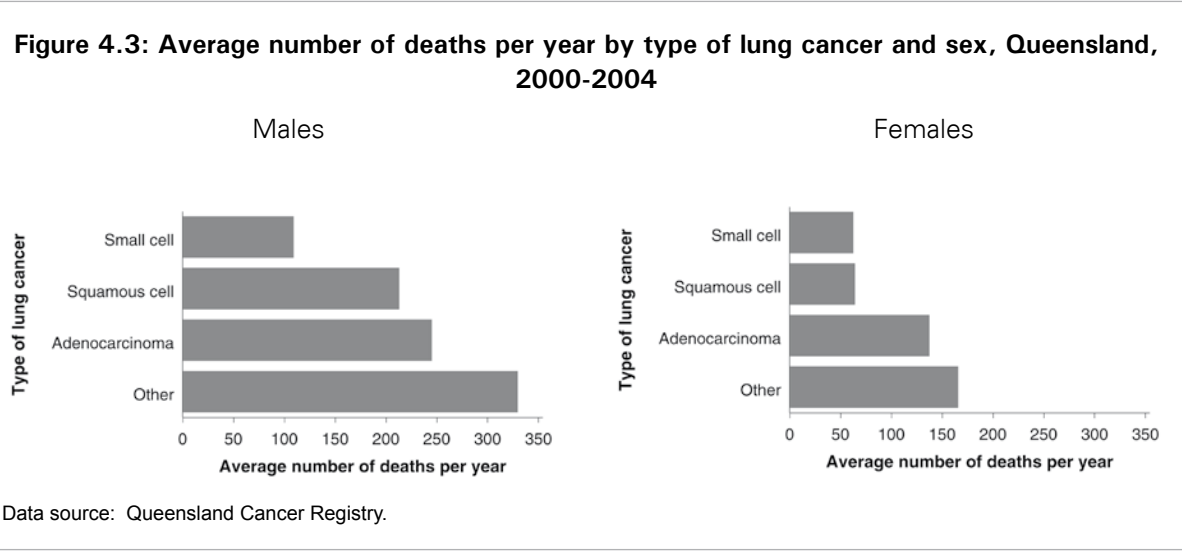
Studies in North America and Europe have reported a consistently higher lifetime risk* of death from lung cancer among male smokers compared to female smokers.^{29,56,196} For example, in the United Kingdom it was found that the lifetime risk of death from lung cancer was 16% for male smokers and 10% for female smokers (after excluding competing causes of death).²⁹ The higher lifetime mortality risk among males is believed to be due to females generally starting to smoke at a later age than males.¹⁹⁶

A large study in the United States found that among non-smokers, males had a higher lung cancer mortality rate compared to females (17.1 and 14.7 deaths per 100,000 person-years respectively).¹⁹⁷ However, the lifetime risk of death from lung cancer among non-smokers was generally similar for both sexes in the countries where data were available, and typically ranged between 0.5% and 1.5%.^{29,56,196}

* Note: These lifetime risk measures refer to the cumulative risk of death up to the age of 74 years.

4.2 What type of lung cancers do people die from?

Differences in lung cancer mortality by morphology group closely reflect the distributions presented earlier for lung cancer incidence (see Section 2.2). Adenocarcinoma was responsible for 32% of lung cancer deaths among females and 27% among males (Figure 4.3). Squamous cell carcinomas comprised a much greater proportion of mortality for males (24%) than females (15%), while small cell lung cancers were the cause of 12% of deaths for males and 15% for females. Over a third of lung cancer deaths (37% for males and 39% for females) were due to other types of lung cancer.

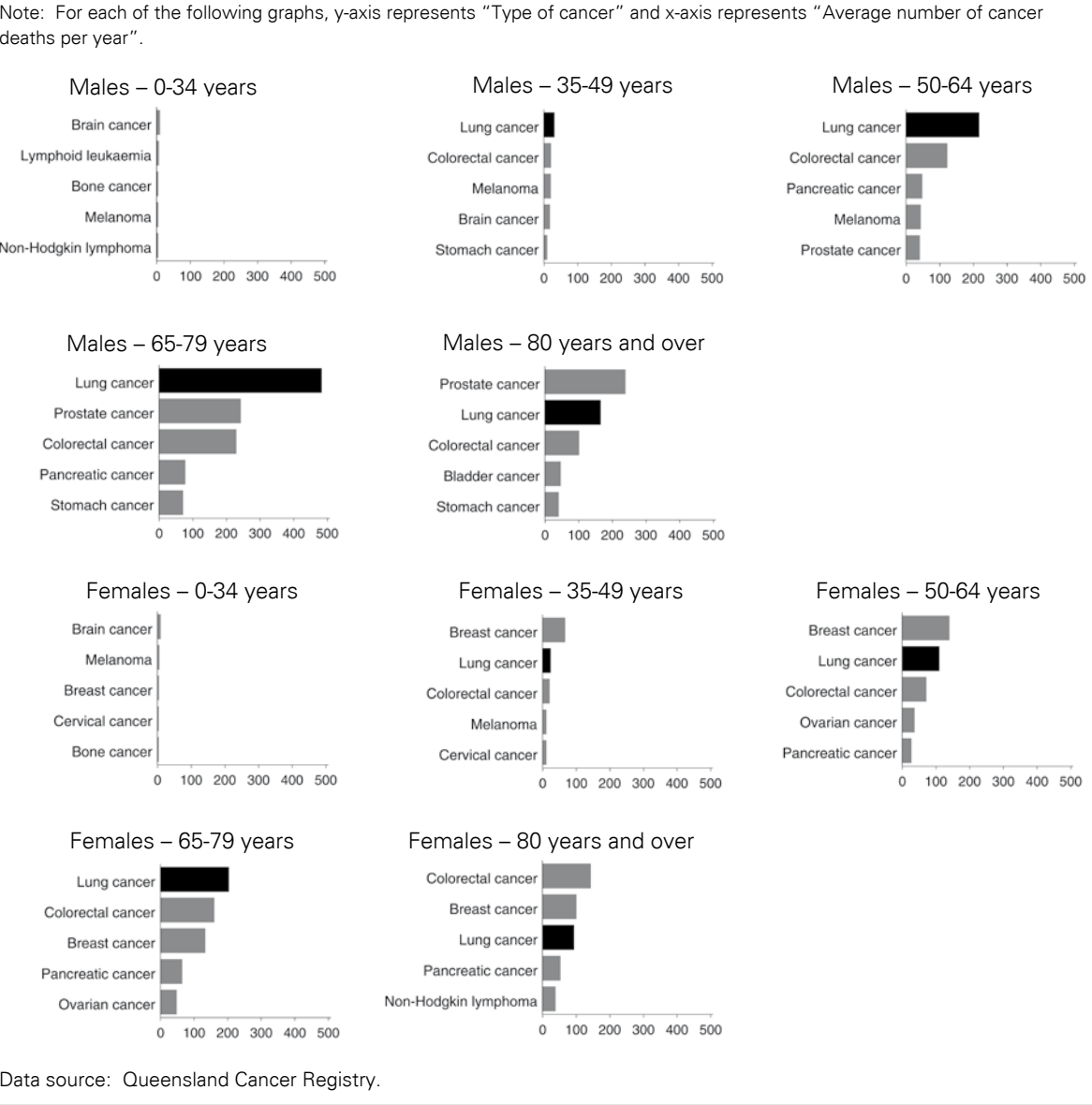


4.3 At what age do people die from lung cancer?

4.3.1 Most common types of cancer deaths by age group

Lung cancer was the most common cause of cancer-related death for males in Queensland aged 35-79 years and females aged 65-79 years (Figure 4.4). In particular, lung cancer accounted for 27% of cancer deaths for males in the 65-79 age group and 25% of cancer deaths for males in the 50-64 age group. It was also the second most common cause of cancer deaths for males aged 80 years and over (behind prostate cancer) and for females aged 35-64 years (behind breast cancer), and ranked third for females aged 80 years and over (following colorectal cancer and breast cancer). There were very few deaths due to lung cancer among males and females aged younger than 35 years.

Figure 4.4: Average number of deaths per year for the most common types of cancer by sex and age group, Queensland, 2000-2004



Comment 4.4 – Adolescent smoking

Most smokers get addicted to smoking in their teens^{99,198} (see Comment 2.7). Adolescents have been found to be more susceptible to nicotine addiction than adults, and can become dependent on the drug within weeks of smoking their first cigarette.¹⁹⁸

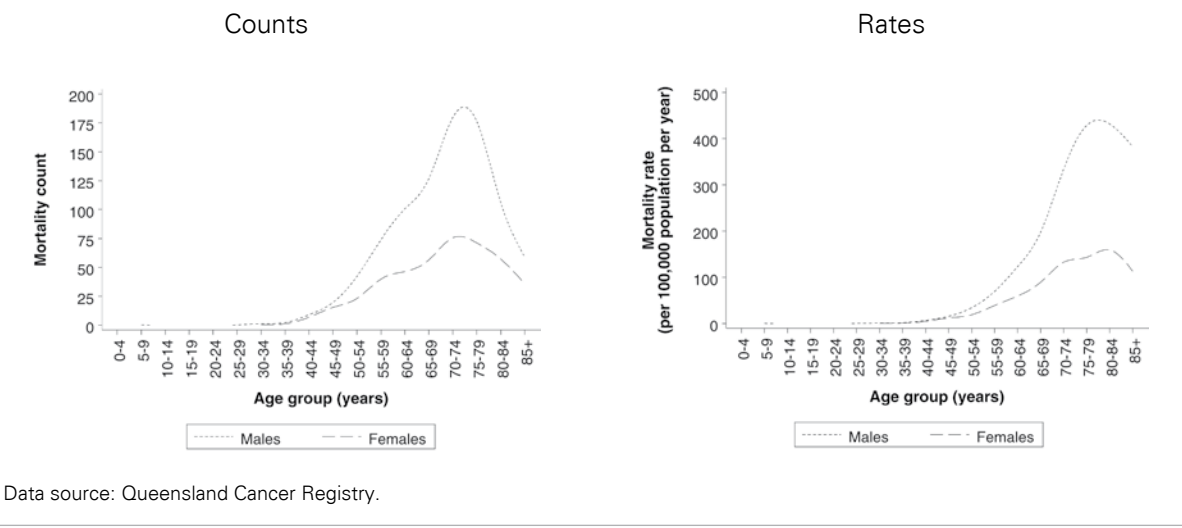
A wide variety of issues may influence a young person's decision to take up smoking or other forms of tobacco use. These factors include (but are not limited to):¹⁹⁸⁻²⁰¹

- Peer pressure
- Family influences (parents or siblings who are smokers)
- Inferior self-esteem
- Poor academic achievement
- Unstable family structure
- Stress
- Tobacco advertising
- Favourable portrayal of smoking in movies
- Low socio-economic status
- Cultural issues (especially in developing countries)
- Perceived benefits of smoking e.g. weight control
- Willingness to participate in risk-taking behaviours

4.3.2 Age-specific mortality rates

Over 95% of all lung cancer deaths in Queensland occurred among people aged 50 years or older. Figure 4.5 shows that the number of deaths was highest within the 70-74 age group for both males and females (average of 180 and 76 deaths per year respectively). Mortality rates due to lung cancer peaked in the 80-84 age group for both sexes, with 432 deaths per 100,000 males and 159 deaths per 100,000 females.

Figure 4.5: Average age-specific mortality per year for lung cancer by sex, Queensland, 2000-2004

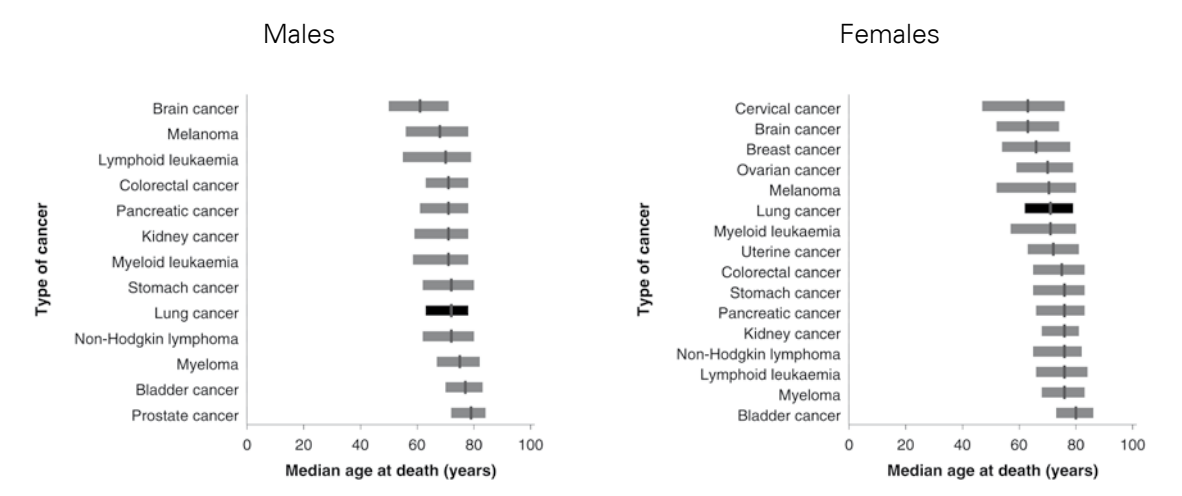


4.3.3 Median age at death

The median age at death for Queenslanders who died from lung cancer between 2000 and 2004 was 72 years for males and 71 years for females (Figure 4.6). This was same as the median age at death for all types of cancer combined for males and slightly younger than the median age for all female cancer deaths (73 years).

In relation to other types of cancer, the median age at death for lung cancer was considerably older than for deaths due to cervical cancer (females), brain cancer, melanoma (males) or breast cancer (females), but a few years younger than deaths due to bladder cancer or prostate cancer (males).

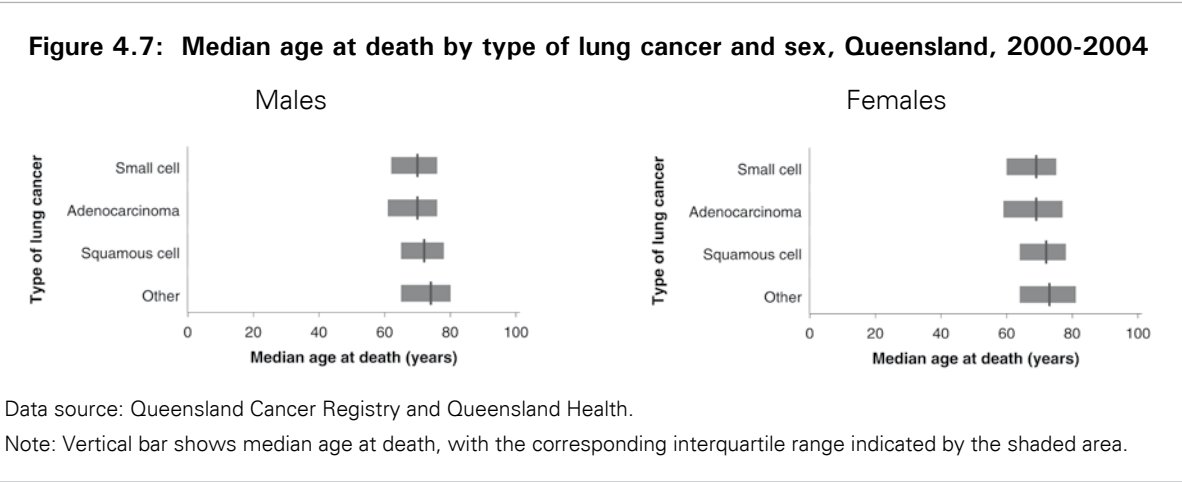
Figure 4.6: Median age at death for selected cancers by sex, Queensland, 2000-2004



Data source: Queensland Cancer Registry and Queensland Health.
Note: Vertical bar shows median age at death, with the corresponding interquartile range indicated by the shaded area.

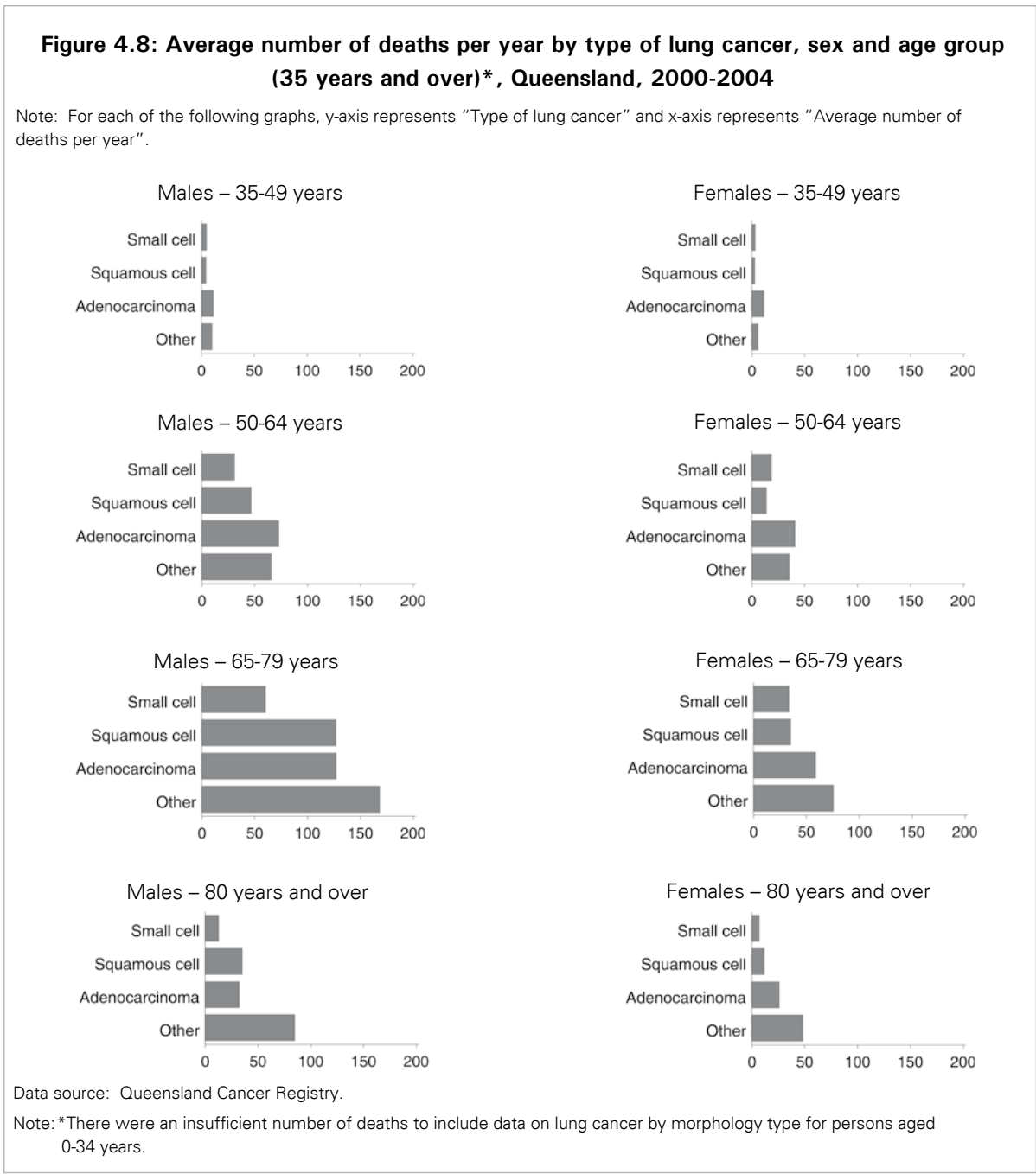
Compared to the period 1982-1986, by 2000-2004 the median age at death due to lung cancer increased for both males (from 68 to 72 years) and females (from 66 to 71 years). This increase in the median age at death was more likely to have been influenced by the rise in the median age at diagnosis, rather than the moderate improvement in survival for lung cancer in Queensland over the last 20 years (see Section 2.3.3 and Section 3.1.4). It was also typical of the rise in median age at death for both sexes that was observed for all cancers combined over this time.

Similar results were observed among males and females for the median age at death by type of lung cancer (see Figure 4.7). The “other” types of lung cancer group had the highest median age at death (74 years for males and 73 years for females). The median age at death for both adenocarcinoma and small cell lung cancer was 70 years for males and 69 years for females, compared to 72 years for either males or females with squamous cell carcinoma.



4.3.4 Deaths by type of lung cancer and age group

The percentage of lung cancer deaths that were caused by adenocarcinoma decreased markedly as age increased, falling from 37% for males in the 35-49 age group down to 20% among males aged 80 years and over, and decreasing from 49% to 28% between the 35-49 years and 80 years and over age groups for females (Figure 4.8). The proportion of lung cancer deaths caused by squamous cell carcinoma peaked in the 65-79 age group (26% for males and 17% for females), while the proportion of lung cancer deaths due to small cell lung cancer was highest in the 35-49 age group for males (16%) and females aged 50-79 years (17%). More than half of all lung cancer deaths were classified as due to other types of lung cancer for both males (51%) and females (52%) aged 80 years or older.



4.4 How much premature mortality is caused by lung cancer in Queensland?

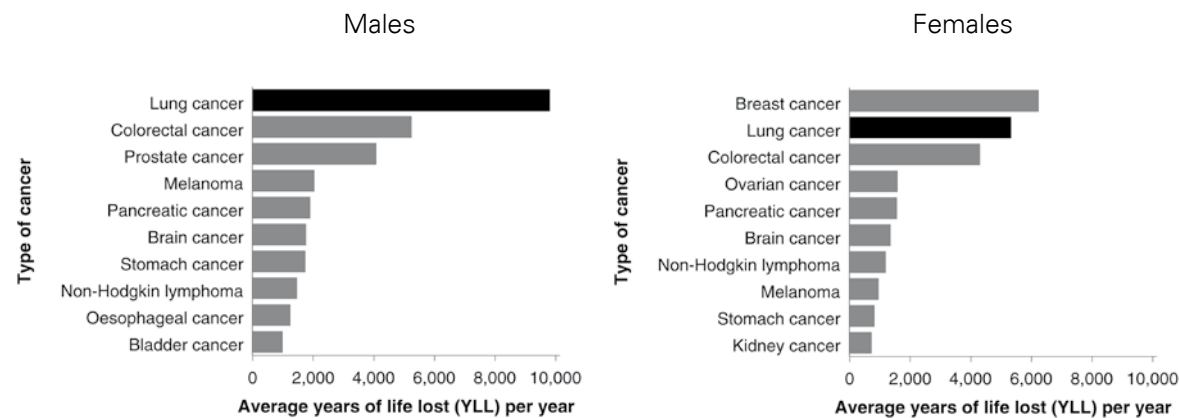
Premature mortality measures how much of their “expected” lifetime a person loses when they die. It is expressed in terms of years of life lost (YLL). For further details, see Appendix B.

4.4.1 Premature mortality by type of cancer

All cancers combined were responsible for about one-third of all premature mortality among both males (31%) and females (33%) in Queensland between 2000 and 2004.

Lung cancer was the leading cause of premature mortality due to cancer among males (Figure 4.9), responsible for 23% of cancer-related premature mortality and 7% of all premature mortality. Among females, lung cancer ranked second behind breast cancer, and caused 16% of premature mortality due to cancer and 5% of total premature mortality.

Figure 4.9: Average years of life lost per year for selected types of cancer by sex, Queensland, 2000-2004

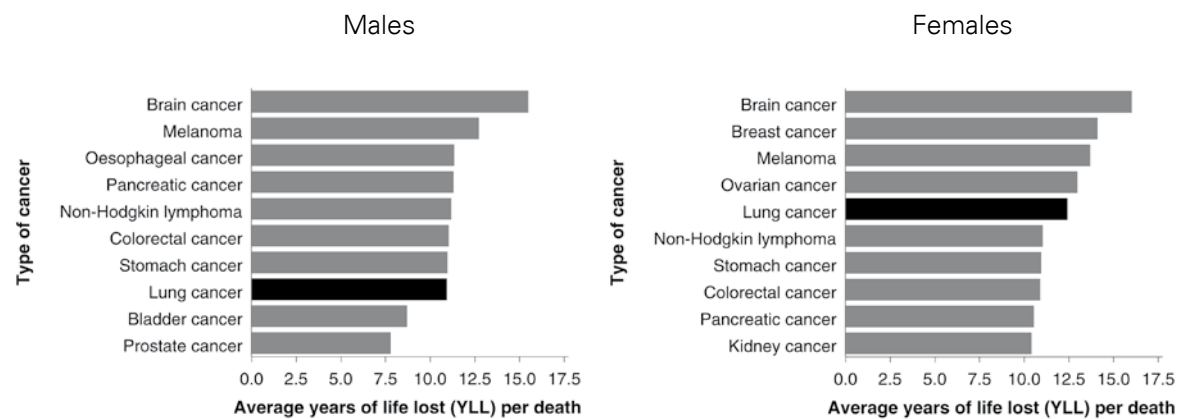


Data source: Queensland Cancer Registry.

Notes: 1. Only cancers with an average of at least 100 deaths per year for males and 60 deaths per year for females are shown.
2. YLL was calculated using life expectancy data from the 2003 Australian Burden of Disease study, based on 3% discounting with no age weighting.

Females who died from lung cancer lost a greater amount of life expectancy on average compared to males (12.4 and 10.9 YLL per death, respectively). For both sexes, the average YLL per death from lung cancer was similar to the average for all cancers combined (12.0 YLL per cancer death for females and 10.8 for males). Of the major types of cancer, brain cancer (16.0 YLL per death for females and 15.5 for males), female breast cancer (14.1 YLL per death) and melanoma (13.7 YLL per death for females and 12.7 for males) caused the highest premature loss of life per death (Figure 4.10).

Figure 4.10: Average years of life lost per death for selected types of cancer by sex, Queensland, 2000-2004



Data source: Queensland Cancer Registry.

Notes: 1. Only cancers with an average of at least 100 deaths per year for males and 60 deaths per year for females are shown.
2. YLL was calculated using life expectancy data from the 2003 Australian Burden of Disease study, based on 3% discounting with no age weighting.

Comment 4.5 – Lung cancer and premature mortality

“The major impact of lung cancer is through premature mortality rather than as a cause of long-term illness.”¹⁷¹

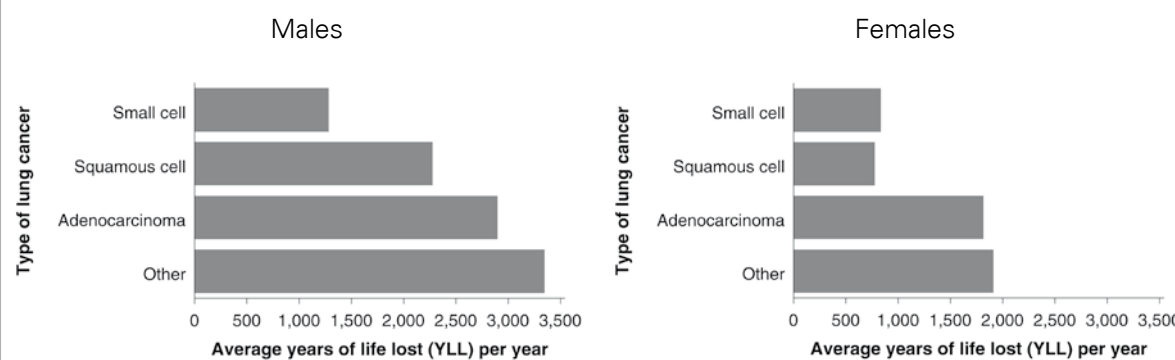
The measurement of premature mortality is influenced by both the number of deaths and the age at which people die from a particular cause. Lung cancer is a prominent cause of cancer-related premature mortality for both males and females, mainly because it causes a large proportion of cancer-related deaths (see Section 4.1). Females with lung cancer also tend to die at a slightly younger age compared to males (see Section 4.3.3), which helps to explain why lung cancer causes a higher number of YLL per death among females compared to males.

The importance of lung cancer as a cause of premature mortality was highlighted in a report on the burden of disease in Queensland.²⁰² The researchers found that during the late 1990s, lung cancer was the third leading cause of premature mortality among males in Queensland, after ischaemic heart disease and suicide, and ranked fourth among females, following ischaemic heart disease, stroke and breast cancer.²⁰² A more recent, national study on the burden of disease reported similar results for females, but for Australian males lung cancer was ranked second as a cause of premature mortality, behind ischaemic heart disease but before suicide.¹⁹⁰

4.4.2 Premature mortality by type of lung cancer

Adenocarcinoma caused 30% of the total premature mortality from lung cancer among males and 34% among females (Figure 4.11). Squamous cell carcinomas caused almost twice as much premature mortality among males than small cell lung cancers (23% and 13% respectively), while for females small cell lung cancers (16%) accounted for a slightly larger amount of lung cancer-related premature mortality than squamous cell carcinomas (15%). Other types of lung cancer were responsible for 34% of premature mortality among males and 36% of premature mortality among females with lung cancer.

Figure 4.11: Average years of life lost per year by type of lung cancer and sex, Queensland, 2000-2004

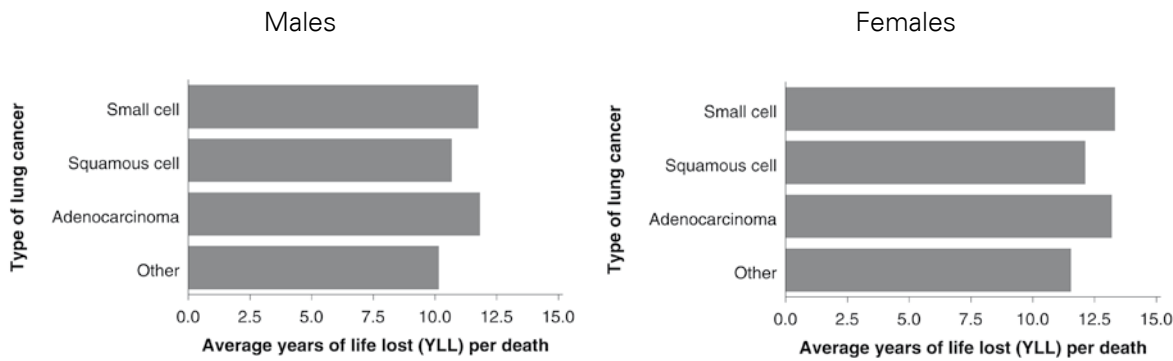


Data source: Queensland Cancer Registry.

Note: YLL was calculated using life expectancy data from the 2003 Australian Burden of Disease study, using 3% discounting with no age weighting.

Small cell lung cancers and adenocarcinomas caused the largest number of years of life lost per death, with an average of 13.3 and 13.2 YLL per death respectively among females, and 11.7 and 11.8 YLL per death respectively among males in Queensland (Figure 4.12). Deaths due to squamous cell carcinoma resulted in an average YLL per death of 12.1 for females and 10.7 for males, while other types of lung cancer had an average YLL per death of 11.5 among females and 10.1 among males.

Figure 4.12: Average years of life lost per death by type of lung cancer and sex, Queensland, 2000-2004



Data source: Queensland Cancer Registry.

Note: YLL was calculated using life expectancy data from the 2003 Australian Burden of Disease study, using 3% discounting with no age weighting.

Comment 4.6 – The social costs of tobacco smoking

The single greatest risk factor that contributes to loss of health in Australia is tobacco smoking, which has been estimated to cause around 12% of all deaths and 8% of the total national burden of disease.¹⁹⁰ Apart from lung cancer, smoking also greatly increases the risk of developing many other serious diseases, such as cardiovascular disease, chronic obstructive pulmonary disease (COPD) and a wide range of cancers.^{14,99}

While premature deaths related to smoking are the most obvious and tragic consequence, researchers have also attempted to quantify the financial costs imposed on society by smoking.²⁰³ These costs can be broken into two main categories: tangible and intangible. The main tangible costs of smoking include loss of productivity in the workplace and home due to premature deaths, sickness and absenteeism, as well as health care costs, while the intangible costs incorporate issues involving the effects caused by loss of life to the smoker and their family and friends.²⁰³ In the late 1990s, it was estimated that the tangible cost of tobacco use in Australia was \$7.6 billion per year and the intangible cost was \$13.5 billion per year, amounting to a total of \$21.1 billion per year.²⁰³ Around \$9.5 billion (45%) of the smoking-related social costs in Australia were considered to be avoidable.²⁰³

In 2000-2001, it was estimated that total health care expenditure on lung cancer alone in Australia was \$136 million (part of the tangible cost of smoking), with an average lifetime treatment cost of \$16,500 per patient.²⁰⁴ These costs are moderated by the lack of effective treatments available and the short survival time of lung cancer patients.¹⁷¹ Although specific data for lung cancer were not available for Queensland, in 2001 it was calculated that there were around 3400 smoking-related deaths in the State, as well as over 30,000 hospital stays directly attributable to smoking at a cost of almost \$138 million.²⁰⁵ A recent study used complex mathematical modelling to conservatively predict that for every 1000 people who quit smoking in Australia, over the following 10 years there would be a total saving of \$373,000 in health care costs, 18 deaths would be avoided and 47 life-years would be saved.²⁰⁶

4.5 Are mortality rates for lung cancer different elsewhere?

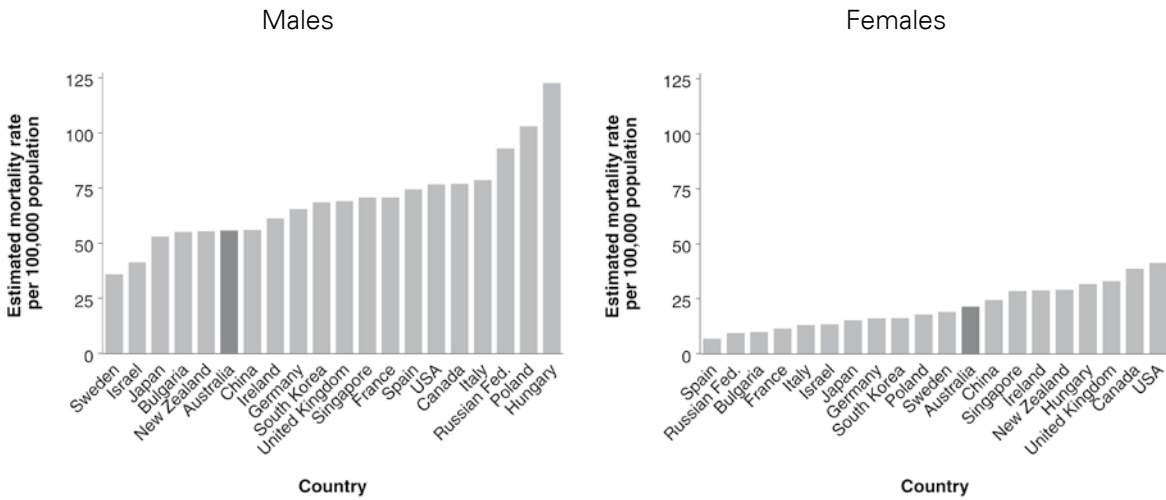
4.5.1 International comparisons for mortality

Lung cancer is the leading cause of cancer-related deaths worldwide, responsible for between 17% to 18% of all cancer mortality.^{45,207} In 2002 there were almost 1.2 million deaths caused by lung cancer internationally,⁴⁵ which was an increase from the 1.1 million deaths due to lung cancer in 2000.⁹¹

Around 72% (or 848,000) of lung cancer deaths throughout the world during 2002 occurred among males, and 28% (331,000) among females.⁴⁵ Lung cancer was by far the leading cause of cancer-related deaths among males, followed by stomach cancer and liver cancer, and ranked second among females behind breast cancer.^{45,207} However, lung cancer has caused more deaths per year than breast cancer among females in United States since 1987,¹¹⁵ and in some European countries (including Denmark, Sweden, The Netherlands, Poland and the United Kingdom) lung cancer has recently surpassed breast cancer as the leading cause of cancer deaths among females.²⁰⁸

Based on 2002 estimates, age-standardised lung cancer mortality rates for males in Australia were lower than in many other developed countries, while the rate for females was around the average for industrialised countries (Figure 4.13). Death rates due to lung cancer were highest for males in Eastern and Southern Europe and North America, and highest for females in North America followed by Northern Europe. The lowest age-adjusted mortality rates were reported in Western, Middle and Eastern Africa for both males and females, with rates of between 3 to 6 deaths per 100,000 for males and between 1 to 3 deaths per 100,000 females.⁹²

Figure 4.13: Estimated age-standardised rate* of lung cancer mortality by sex for selected countries, 2002



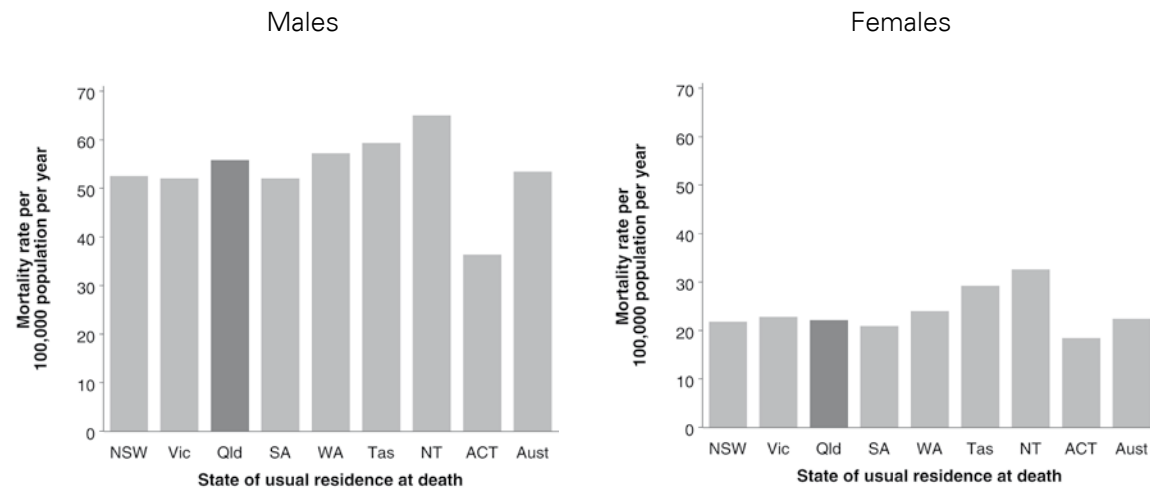
Data source: GLOBOCAN 2002, International Agency for Research on Cancer (IARC).⁹²

Notes: *Rates age-standardised to the Australian standard population (2001) in broad age groups.

4.5.2 Interstate comparisons for mortality

Males in Queensland recorded a slightly higher lung cancer mortality rate between 1999 and 2003 in comparison to the Australian average, while the mortality rate for females was similar to the whole of Australia (Figure 4.14). The age-standardised mortality rate for lung cancer was highest in the Northern Territory for both sexes, followed by Tasmania, and lowest in the Australian Capital Territory.¹⁰⁴

Figure 4.14: Age-standardised rates* of lung cancer mortality per year by State/Territory and sex, Australia, 1999-2003



Data source: Australian Institute of Health and Welfare (AIHW) and Australian Association of Cancer Registries (AACR).¹⁰⁴
Note: *Rates age-standardised to the Australian standard population (2001).

4.6 How have lung cancer mortality rates changed over time?

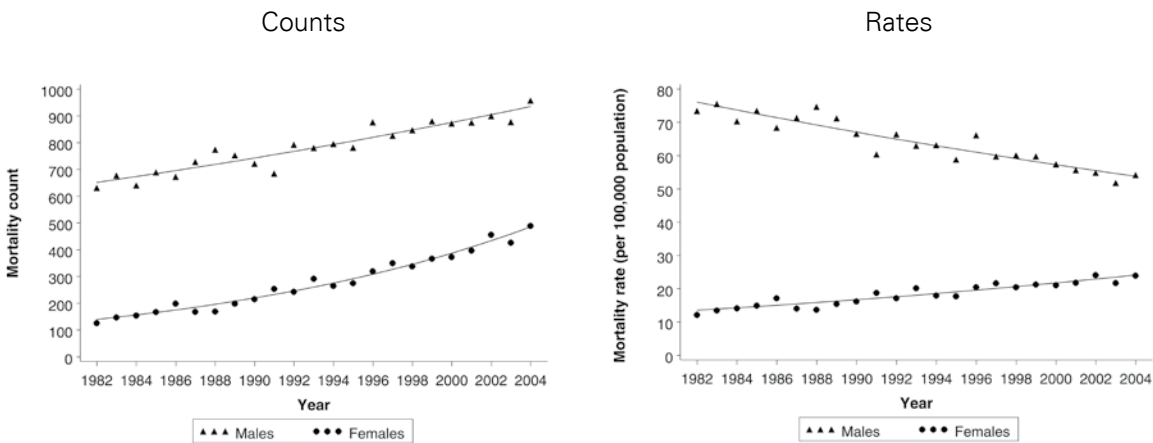
4.6.1 Mortality trends for Queensland

Trends in lung cancer mortality were very similar to the corresponding incidence trends in Queensland, reflecting the poor survival of lung cancer patients (see Section 3). In the period from 1982 to 2004 there was a steady decline in the lung cancer mortality rate for males in Queensland (-1.6% per year), but an increase in the mortality rate for females of 2.7% per year (Figure 4.15).

As a result, the gender difference for lung cancer mortality in Queensland is narrowing. In the early 1980s, males were about five times more likely to die from lung cancer than females; by the early 2000s, the excess in the mortality rate for males was around two and a half times higher compared to females.

Even though lung cancer mortality rates for males are decreasing, there has been an overall rise in the actual number of males dying from lung cancer, due to population growth and ageing. The number of male deaths has increased by 1.7% per year since 1982, an overall increase of 43% between 1982 and 2004. For females, the number of lung cancer deaths has been climbing by 5.8% per year over the same period, corresponding to a total increase of 248% (or almost three and a half times the number of deaths in 2004 compared to 1982).

Figure 4.15: Trends in lung cancer mortality by sex, Queensland, 1982-2004



Linear trends (estimated average yearly percentage change, with 95% confidence intervals shown in brackets):
Males 1982-2004 = +1.7% (+1.4%,+1.9%).
Females 1982-2004 = +5.8% (+5.4%,+6.3%).

Data source: Queensland Cancer Registry.

Notes: Rates age-standardised to the Australian standard population (2001).
Trends modelled using Joinpoint software (version 3.0), Statistical Research and Applications Branch, National Cancer Institute.¹⁰⁵

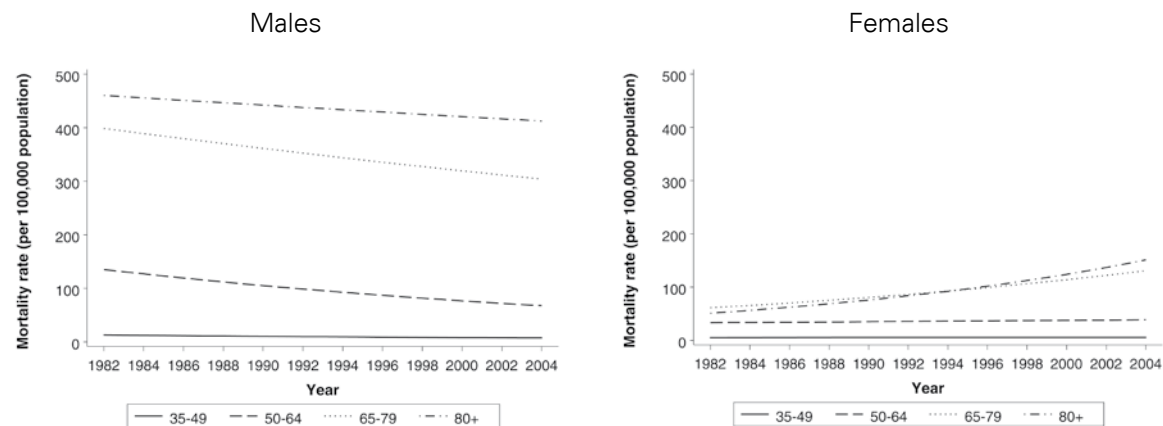
Comment 4.7 – Smoking and the declining sex differential in lung cancer mortality

A study involving data on lung cancer mortality from 21 high-income nations, including Australia, New Zealand, the United Kingdom and the United States, found that the convergence of male and female lung cancer mortality rates was strongly related to the prevalence of cigarette usage (with a 20 year lag period) by sex.²⁰⁹

For Australia, the gap in lung cancer mortality rates for males and females was reported to have peaked in 1961,²⁰⁹ which is consistent with the reduction in male smoking rates since the mid-1940s and the associated increase in female smoking until the mid-1970s (see Comment 2.10).

There were considerable differences in lung cancer mortality trends by age group and sex (Figure 4.16). Since 1982, mortality rates have been falling most quickly for males aged 35-64 (decreasing by around 3% per year), while older males have experienced a slower drop in the rate of lung cancer deaths (1.2% decrease per year for males aged 65-79 and only a small, non-significant decrease for males aged 80 years and over). Lung cancer mortality rates have been fairly stable among females aged 35-64 over the last 20 years, but were increasing for older women, with rises of 3.5% per year for those aged 65-79 and 5.1% per year for those aged 80 years and over.

Figure 4.16: Trends in lung cancer mortality by sex and age group (35 years and over)*, Queensland, 1982-2004



Linear trends (estimated average yearly percentage change, with 95% confidence intervals shown in brackets):

Males 35-49	1982-2004 = -2.7% (-3.7%, -1.7%)	Females 35-49	1982-2004 = +0.4% (-1.3%, +2.1%)
Males 50-64	1982-2004 = -3.1% (-3.7%, -2.5%)	Females 50-64	1982-2004 = +0.7% (-0.2%, +1.6%)
Males 65-79	1982-2004 = -1.2% (-1.5%, -1.0%)	Females 65-79	1982-2004 = +3.5% (+2.8%, +4.2%)
Males 80+	1982-2004 = -0.5% (-1.2%, +0.2%)	Females 80+	1982-2004 = +5.1% (+3.9%, +6.2%)

Data source: Queensland Cancer Registry.

Notes: *There were an insufficient number of cases to calculate lung cancer mortality trends for persons aged 0-34 years.
Rates age-standardised to the Australian standard population (2001).
Trends modelled using Joinpoint software (version 3.0), Statistical Research and Applications Branch, National Cancer Institute.¹⁰⁵

Comment 4.8 – Have tobacco control campaigns been effective in reducing lung cancer mortality rates?

Tobacco control programs have played, and will continue to play, a vital role in reducing mortality rates from lung cancer and other smoking-related diseases, both in Australia and overseas.^{171,210,211}

The National Tobacco Campaign (NTC), which was launched throughout Australia in 1997, has been linked to improved awareness of the health consequences of smoking, increased intention to quit smoking, as well as a significant decline in smoking prevalence.^{212,213} The NTC involves partnerships between different levels of government and key health and medical bodies. A range of strategies are used, including confronting mass media advertisements, and, more recently, the prominent display of messages and graphic images on tobacco products, which warn about the potential health consequences of smoking.^{213,214} Tobacco packaging must also include the national Quitline telephone number and website address.

The introduction of tobacco control campaigns in other countries have also preceded a decrease in the proportion of people who smoke.^{215,216} In the United States, it has been estimated that lung cancer mortality rates have been lowered by up to 48% among males and 23% among females, mostly as a result of reductions in tobacco smoking.²¹⁷

Despite these successes, opportunities for progress in tobacco control remain. Most of the mortality gains appear to have been due to smoking cessation rather than decreases in smoking initiation amongst the young,²¹⁷ even though adult-focused tobacco control messages have been found to be relevant to adolescents.²¹⁸ There is also evidence that tobacco control campaigns have so far been relatively ineffective on older, long-term smokers who are unable or unwilling to quit.²¹⁵ Targeted approaches to tobacco control are also required for sectors of the community where smoking prevalence remains high, such as Indigenous people and the economically disadvantaged.¹⁷¹

4.6.2 International mortality trends

Trends in lung cancer mortality rates between 1982 and 2004 for 21 selected countries, including Australia, are displayed in Figure 4.17.

Death rates for males were decreasing significantly in all of the countries shown except for Bulgaria and Poland, where the rates were stable, and China, Israel and South Korea where mortality rates were rising. The greatest decreases were recorded in the United Kingdom and Australia, where the lung cancer mortality rates among males had been dropping by 3.3% per year between 1988 and 2004 and 3.2% per year between 1996 and 2003 respectively. In contrast, the largest increase was in South Korea, where the yearly mortality rate rose by 10.7% per year from 1985 to 1994, and had continued to grow by 2.6% per year between 1994 and 2004.

Among females, lung cancer mortality rates were increasing in all of the countries included in Figure 4.17, apart from Bulgaria, the UK and the USA where the rates were currently stable, and Hong Kong, Japan, Russia and Singapore which all had a decreasing trend. The decreases were greatest in Hong Kong, Japan and Russia, where the lung cancer mortality rates had been falling by between 1.7%-2.0% per year (since 1990 in Russia, 1991 in Hong Kong and 1998 in Japan). The largest rises were occurring in Spain (5.2% increase per year between 2000-2004). Female lung cancer mortality rates have also been rising rapidly in France (3.5% per year between 1982-2003), Sweden (3.0% per year between 1982-2002) and South Korea (10.0% per year from 1985-1994 and 2.6% between 1994-2004).

Of the countries shown in Figure 4.17, the current lung cancer mortality trends by sex can be summarised into the following six general patterns:

- An increasing trend for both sexes e.g. China, Israel, South Korea;
- An increasing trend for females and stable for males e.g. Poland;
- An increasing trend for females and a decreasing trend for males e.g. Australia, France, Germany, Hungary, Ireland, Italy, New Zealand, Spain, Sweden;
- A decreasing trend for both sexes e.g. Hong Kong, Japan, Russia, Singapore;
- A decreasing trend for males and stable for females e.g. Canada, United Kingdom, United States; and
- Stable trends for both sexes e.g. Bulgaria.

A similar study which examined lung cancer mortality trends from a range of countries between 1971 to 1995 identified up to seven possible trend groupings for lung cancer mortality by sex.²¹⁹ Other researchers have previously reported that by the late 1990s, lung cancer mortality rates were generally declining among males and increasing for females in many European countries.^{128,220-222}

The lung cancer mortality trends in China warrant special mention. The rise in lung cancer death rates has been found to be pervasive throughout the country, with mortality increasing among both sexes, in all age groups, and in both urban and rural areas between 1987 and 1999.¹⁰² If current smoking patterns persist in China, a huge epidemic of smoking-related deaths is predicted by 2050¹⁰² (see Comment 2.14).

Figure 4.17: Recent national and international trends in lung cancer mortality by sex for selected countries, 1982 to 2004*

Note: For each of the following graphs, y-axis represents "Mortality rate (per 100,000 population)" and x-axis represents "Year of death".

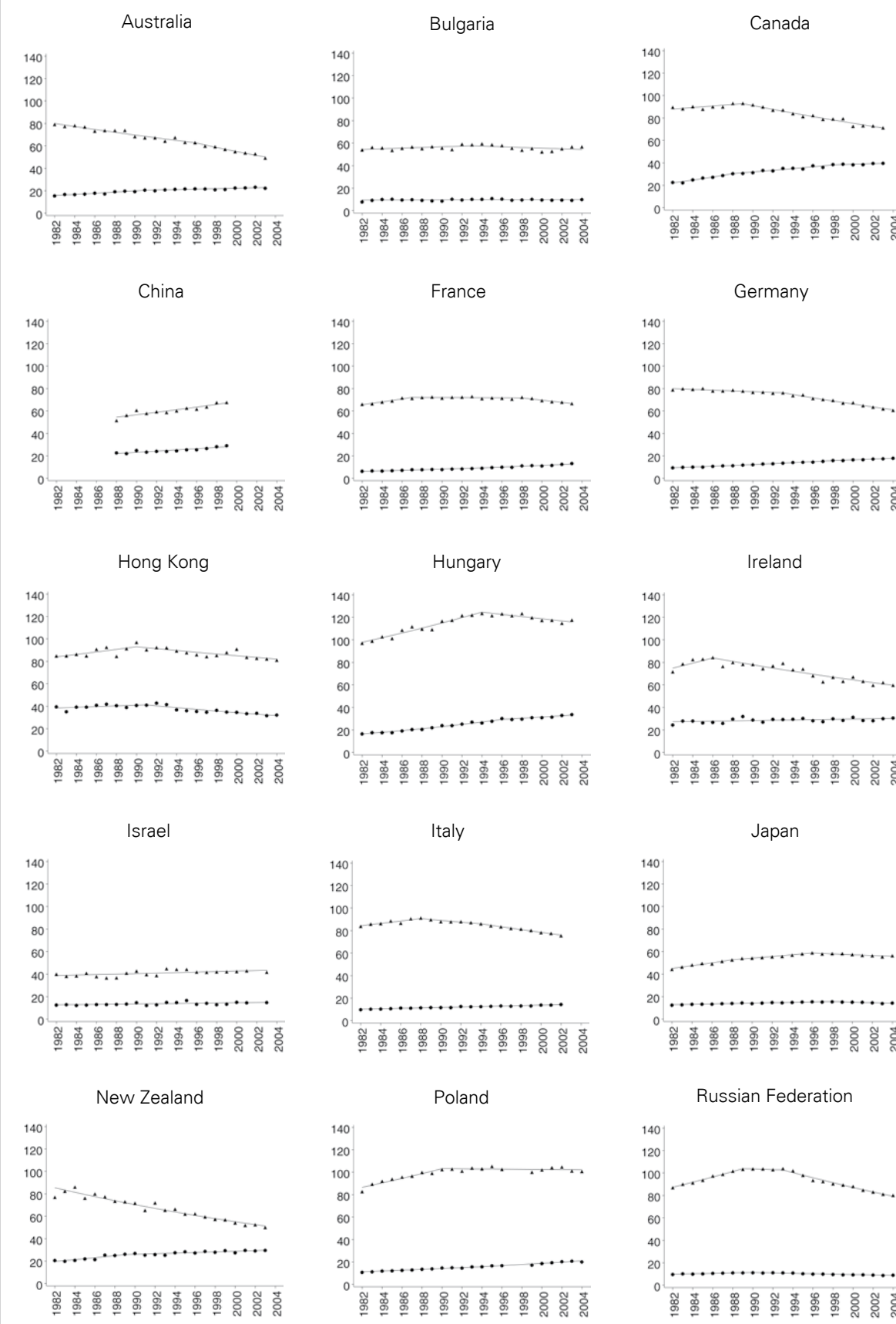
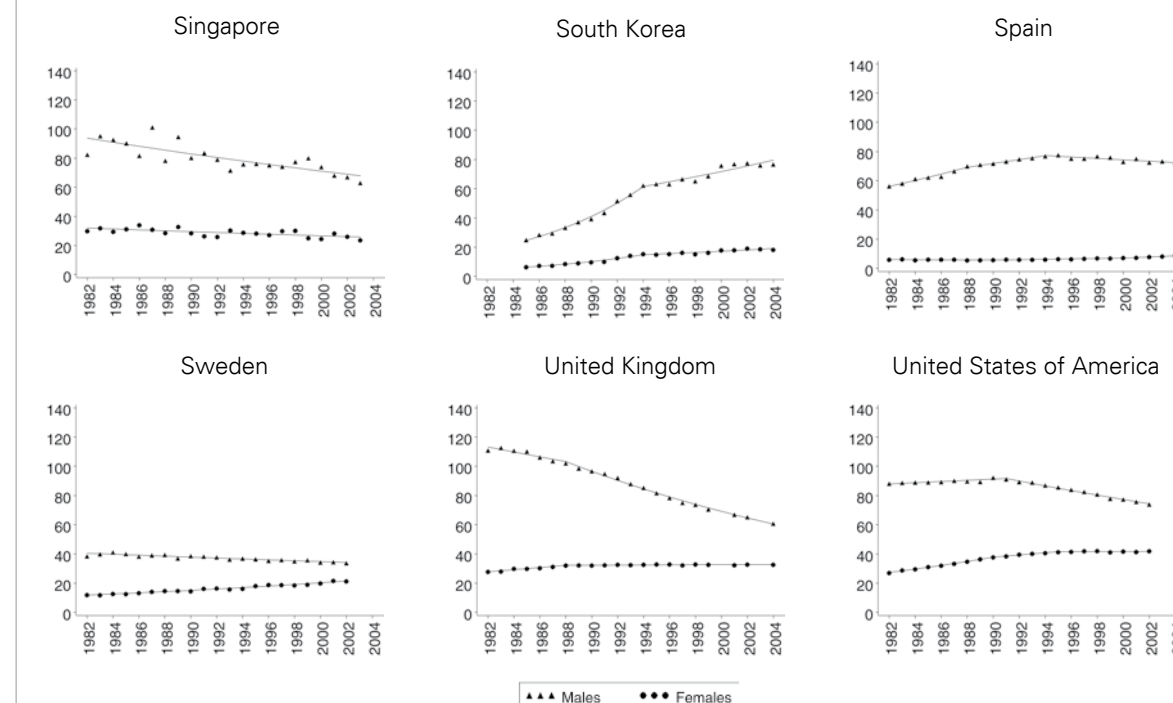


Figure 4.17 (cont.) Recent national and international trends in lung cancer mortality by sex for selected countries, 1982 to 2004*

Note: For each of the following graphs, y-axis represents "Mortality rate (per 100,000 population)" and x-axis represents "Year of death".



Data source: World Health Organization (WHO).²²³

Notes: * Data available from 1982 to 2004 for Bulgaria, Germany, Hong Kong, Ireland, Japan, Poland, Russia, Spain and the UK; from 1982 to 2003 for Australia, Canada, France, Hungary, Israel, New Zealand, and Singapore; from 1982 to 2002 for Italy, Sweden and the USA; from 1985 to 2004 for South Korea and from 1988 to 1999 for China. Rates age-standardised to the Australian standard population (2001). Trends modelled using Joinpoint software (version 3.0), Statistical Research and Applications Branch, National Cancer Institute.¹⁰⁵

Comment 4.9 – Differences in the worldwide tobacco control climate

Similarly to lung cancer incidence trends, disparities in lung cancer mortality trends between countries primarily reflect variation in smoking rates and practices over the past few decades^{128,220,222} (see also Comment 2.12). Variations in smoking behaviour between countries occur in the context of significant attitudinal differences in regard to tobacco control legislation and regulations, quitting behaviour and the health risks associated with smoking.^{112,224,225} An association has also been demonstrated between beliefs in the importance of not smoking and smoking behaviour in young adults.²²⁵ Such findings illustrate the need to tailor tobacco control campaigns in different countries to match the public's level of understanding and perceptions of smoking-related issues.²²⁴

Public sentiment helps to determine how feasible it is for authorities to introduce legislation to discourage smoking, such as increasing excise taxes or restricting smoking in public places.²²⁴ Due in part to advocacy by The Cancer Council Queensland and widespread public support, Queensland now has the most comprehensive tobacco control legislation in Australia.^{226,227} Smoking is prohibited indoors in all public places including workplaces, pubs, clubs and casinos (except for "high roller" rooms). Smoking is also prohibited outdoors within 10 metres of children's playgrounds, within four metres of non-residential building entrances, at major sporting stadiums, between the flags at beaches, and where food or drinks are available such as alfresco dining areas (with an exemption for smoking and drinking in 50% of the outdoor area on licensed premises).

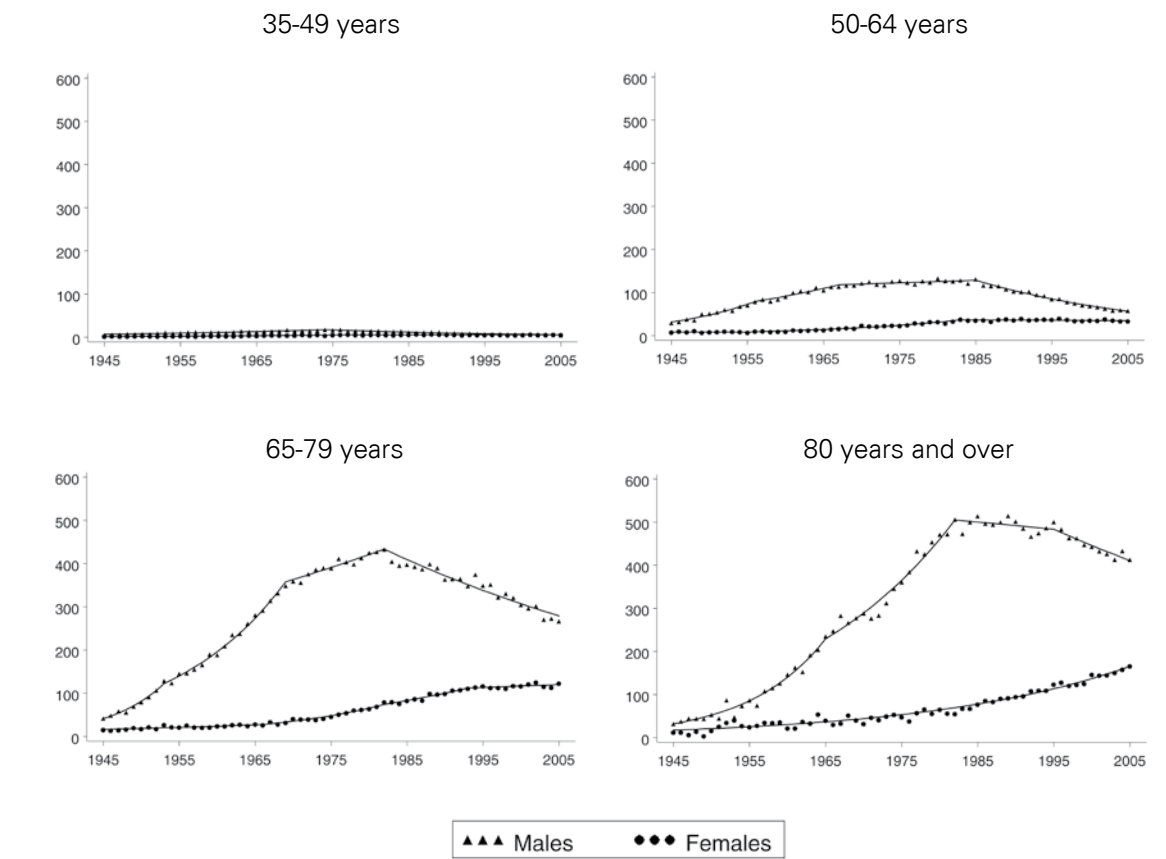
4.6.3 Long-term Australian mortality trends

Trends in mortality rates can often be characterised by one or more of the following effects: age group at death, period of death (e.g. calendar year) and birth cohort (based on year of birth). Age-period-cohort (APC) models are used to investigate these three possible drivers of the observed trends. (For further details on APC models, see Appendix B).

Australian lung cancer mortality data from 1945 to 2005 was analysed in this section. For both males and females there were significant influences of age, period and birth cohort on lung cancer mortality rates, suggesting that all three of these variables had an influence on the observed rates.

Figure 4.18: Age effect – long-term trends in lung cancer mortality by sex and age group (35 years and over)*, Australia, 1945-2005

Note: For each of the following graphs, y-axis represents "Mortality rate (per 100,000 population)" and x-axis represents "Year of registration of death".



Data source: Australian Institute of Health and Welfare (AIHW).²²⁸

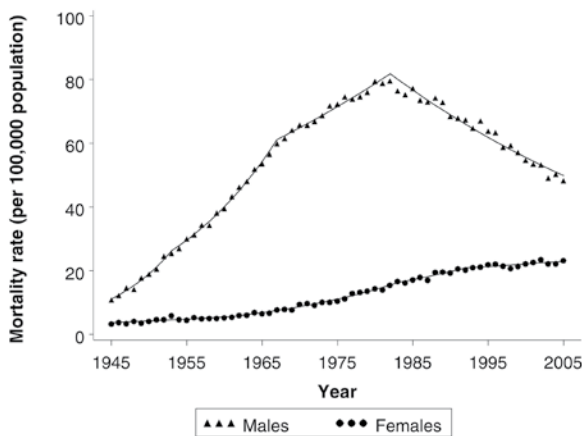
Notes: *There were an insufficient number of cases to calculate lung cancer mortality trends for persons aged 0-34 years. Rates age-standardised to the Australian standard population (2001). Trends modelled using Joinpoint software (version 3.0), Statistical Research and Applications Branch, National Cancer Institute.¹⁰⁵

Lung cancer mortality trends in Australia were not consistent across broad age groups (Figure 4.18). In particular, mortality rates among females aged 35-64 have been stable since the late 1970s/early 1980s, rates have started to level off (+0.6% per year) among females aged 65-79 years since 1993, but the lung cancer death rate has continued to climb by almost 4% per year among females aged 80 years and over. Therefore the overall increasing trend in lung cancer mortality rates among Australian females is due to trends in the older age groups (at least 65 years and over).

There were also differences in mortality rate trends by age group for males. Although rates were currently decreasing across all age groups for males, these decreases began earlier and were relatively larger among the younger age groups. Mortality rates began trending downwards for males aged 35-49 years in 1974 (-3.6% per year), in the early to mid 1980s for males aged 50-79 (-4.0% and -1.9% per year for the 50-64 and 65-79 age groups respectively), but not until 1995 (-1.6% per year) for males aged 80 years and over.

In terms of the period effect, long-term trend data clearly show the initially diverging trends in lung cancer mortality rates for males and females in Australia followed by rapidly converging trends (Figure 4.19). This convergence was brought about by the turnaround in the trend for lung cancer mortality among males. Between 1945 and the mid 1960s, mortality rates for males were increasing at a much quicker pace than for females. For example, the death rate due to lung cancer for males was increasing by 11.3% per year in the period from 1945-1953 and 6.2% per year between 1953-1967, compared to increases of 2.7% per year for females up to 1961. After 1967, the increase for males slowed to 2.0% per year, and eventually started to decrease by the early 1980s, with the current trend being a decline in the mortality rate of 2.1% per year since 1982. In contrast, the lung cancer mortality rate for females has continued to climb over the last 60 years, albeit at a slower rate more recently (0.7% per year between 1992 and 2005).

Figure 4.19: Period effect – long-term trends in lung cancer mortality by sex, Australia, 1945-2005



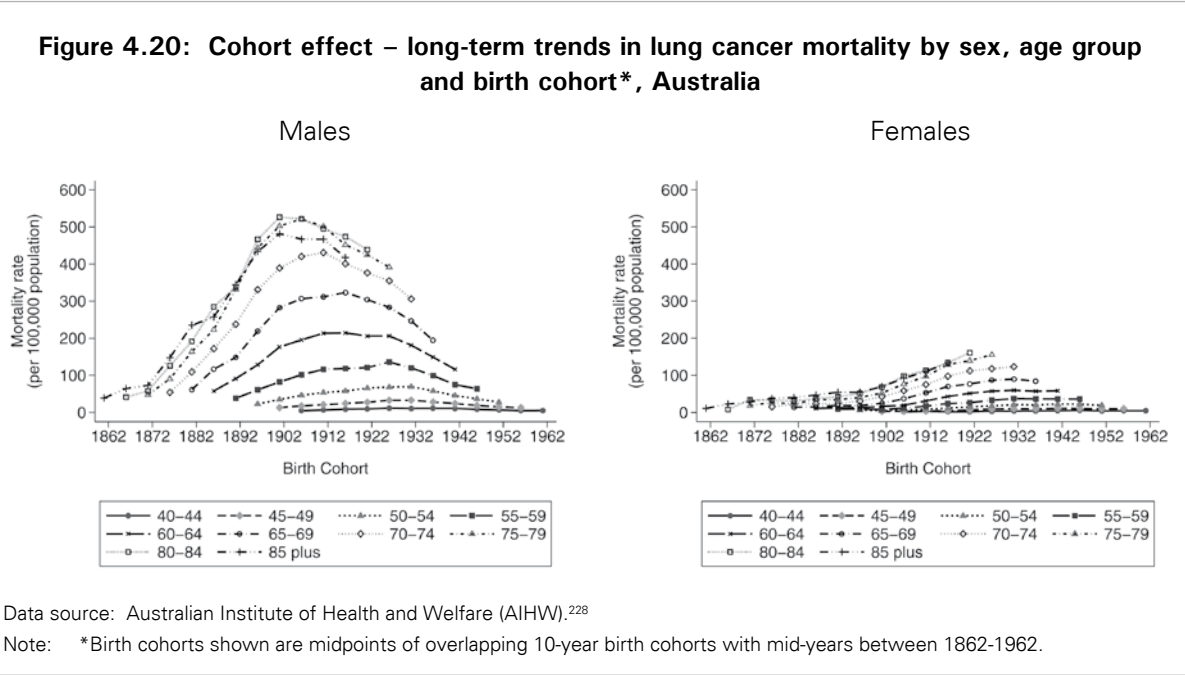
Linear trends (estimated average yearly percentage change, with 95% confidence intervals shown in brackets):

Males	1945-1953 = +11.3% (+9.0%,+13.7%)	Females	1945-1961 = +2.7% (+1.5%,+3.8%)
	1953-1967 = +6.2% (+5.6%,+6.9%)		1961-1983 = +4.9% (+4.5%,+5.4%)
	1967-1982 = +2.0% (+1.6%,+2.3%)		1983-1992 = +2.8% (+1.8%,+3.8%)
	1982-2005 = -2.1% (-2.3%,-2.0%)		1992-2005 = +0.7% (+0.4%,+1.1%)

Data source: Australian Institute of Health and Welfare (AIHW).²²⁸

Notes: Rates age-standardised to the Australian standard population (2001). Trends modelled using Joinpoint software (version 3.0), Statistical Research and Applications Branch, National Cancer Institute.¹⁰⁵

Figure 4.20 shows the cohort effects on lung cancer mortality rates by sex. The points vertically above each cohort's birth year correspond to the age-specific mortality rates for that particular birth cohort. Within each age group, lung cancer mortality rates for males were initially low among the earlier birth cohorts, increased for subsequent cohorts, and have then started to decrease among more recent cohorts. Among females however, the levelling off of the age-specific rates was more pronounced in the younger age groups, while the cohort trends were still increasing for females aged 70 years or older.



Similar to the results described above for Australia, age-period-cohort modelling using lung cancer mortality data from some European Union countries and in North America has generally found that lung cancer mortality rates have been declining for younger males (under 65 years of age) and had either reached a plateau or were starting to fall among older males. Mortality rates for females were increasing among both the younger and older age groups in most countries apart from the United Kingdom, Ireland, Canada, the United States and parts of North-Eastern Europe.²²⁹⁻²³¹ In countries where lung cancer mortality rates were decreasing for either males or females, the cohort results generally show that rates were decreasing among successive generations,²²⁹ although recently there appears to have been some moderation in these trends within the United States.²³²

Comment 4.10 – Predicted trends in lung cancer mortality in Australia

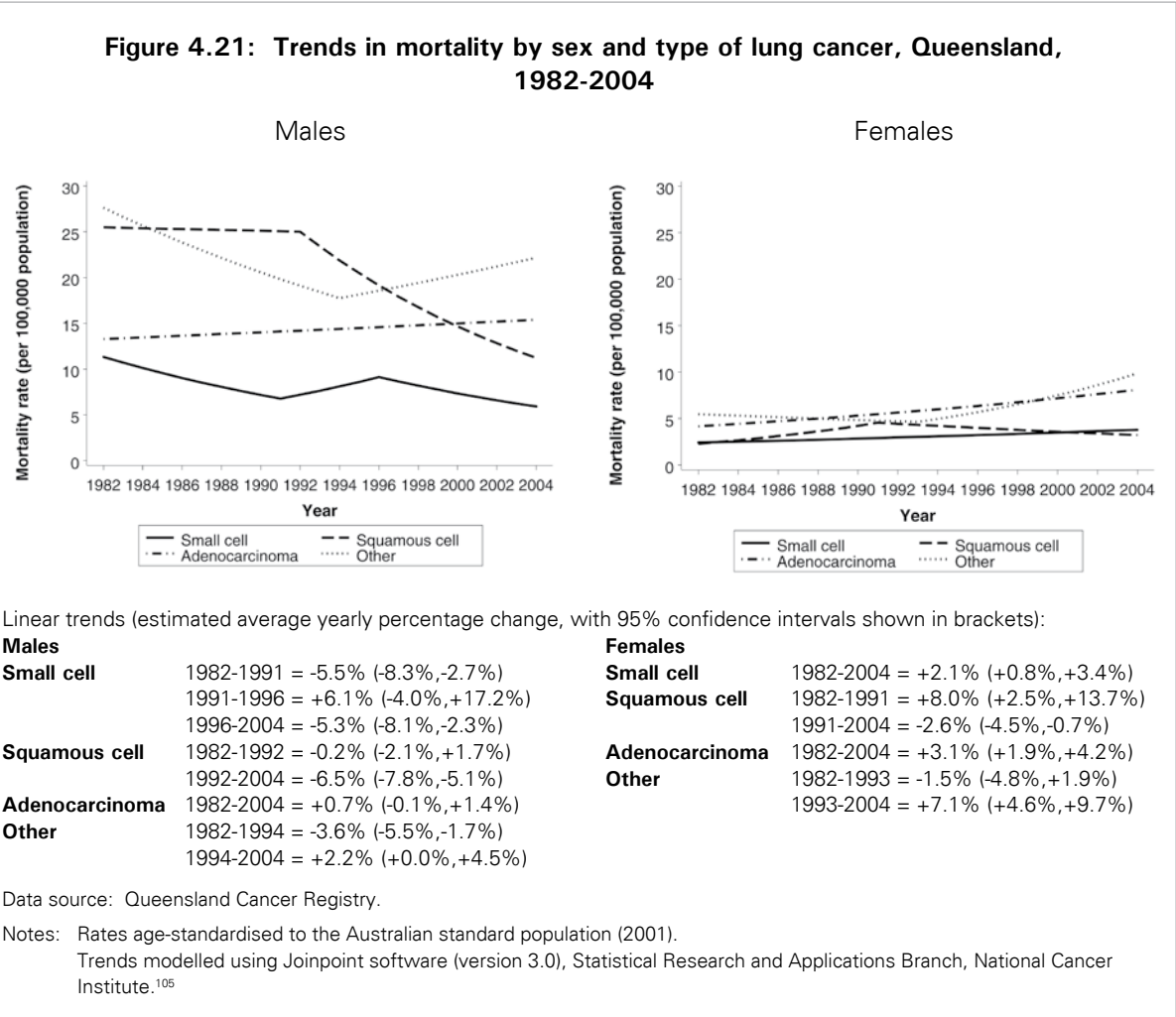
Current patterns of tobacco usage hold the key to making accurate predictions about future lung cancer mortality trends.²²⁹

Based on an adapted age-period-cohort model, which included information on the average tar content of cigarettes and adult tobacco consumption per capita with a 25-year lag period, researchers have predicted that lung cancer mortality rates for males in Australia will continue to decrease through to the year 2035, while female mortality rates should peak between 2005 to 2009 before starting to slowly decrease.²³⁰ As a result, lung cancer mortality rates in Australia for males and females are expected to continue to converge, although at a slower pace, with female rates forecast to remain lower than male rates for at least the next 25 to 30 years.²³⁰

4.6.4 Mortality trends by lung cancer morphology

The overall decreasing trend in the lung cancer mortality rate for males in Queensland was mainly being driven by squamous cell carcinomas, and to a lesser extent small cell lung cancers. The mortality rates for males from these lung cancer subtypes have been decreasing by 6.5% per year since 1992 and 5.3% per year since 1996 respectively (Figure 4.21). In contrast, mortality rates for males have been fairly stable for adenocarcinoma, while death rates have been increasing by 2.2% per year for other types of lung cancer since 1994.

Among females, mortality rates due to squamous cell carcinomas have been decreasing by 2.6% per year since the early 1990s, but were climbing for the remaining lung cancer subtypes. These increases were 2.1% per year for small cell lung cancers, 3.1% per year for adenocarcinomas and 7.1% per year (since 1993) for other types of lung cancer.



5 Prevalence

Whereas incidence measures how many people are diagnosed with a certain disease over a given time period (usually one year), the prevalence of a disease measures how many people are still alive having been previously diagnosed with that disease.

Prevalence is a function of both incidence and survival (see Comment 5.1). Limited duration prevalence includes all the people alive on a given date who had a diagnosis of the disease within a certain timeframe. For instance, 5-year prevalence would include those diagnosed with the disease between 1st January 2000 and 31st December 2004 who were still alive at the end of that period. Prevalence can either be expressed as a count or a rate (e.g. per 100,000 population). For further information on the prevalence calculations used in this report, see Appendix B.

The different measures of limited duration prevalence presented here (i.e. 1-year, 5-year, 10-year, 15-year and 20-year prevalence) are valuable for informing health care planners, oncology practitioners and providers of other support services of the likely short-, medium- and longer-term requirements for persons diagnosed with lung cancer.

Comment 5.1 – The relationship between incidence, survival and prevalence

Given the high incidence of lung cancer, its prevalence is relatively low. This is mainly because survival for lung cancer is poor in comparison to most other types of cancer (see Section 3.2).

For example, between 2000 and 2004 the incidence of lung cancer among males in Queensland was more than twice as high as the incidence for bladder cancer. However, at the end of 2004, the 5-year prevalence of lung cancer was 35% lower than the prevalence for bladder cancer. This large change between the respective incidence and prevalence counts can be explained by the 5-year survival rates among males of 76% for bladder cancer compared to only 11% for lung cancer during that time period.

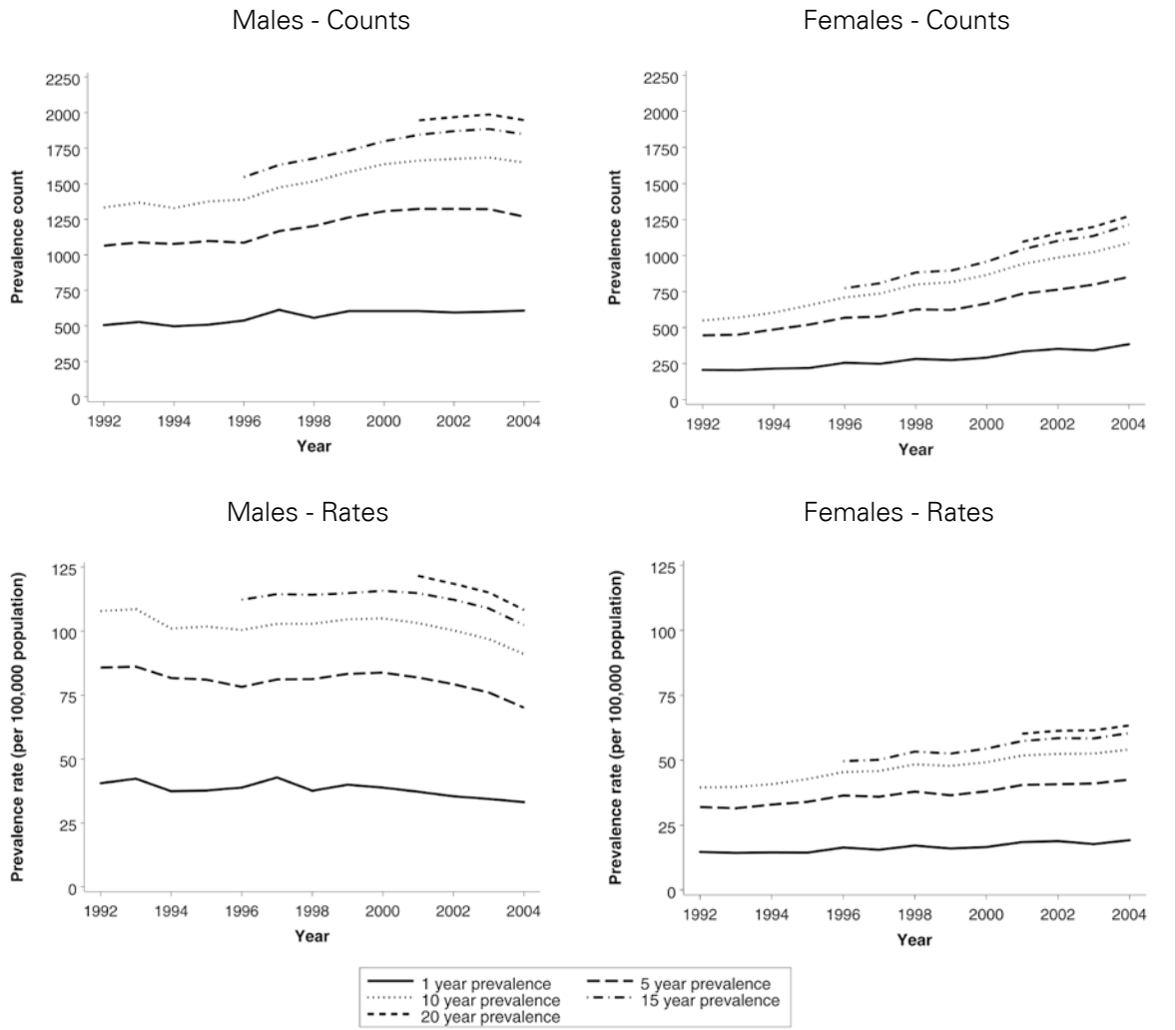
5.1 How many people living in Queensland have been diagnosed with lung cancer?

As at the end of 2004, there were 1948 males and 1273 females living in Queensland who had been diagnosed with lung cancer at some time in the previous 20 years. This equated to 20-year prevalence rates of 108 per 100,000 males and 63 per 100,000 females.

Most of these 20-year prevalent lung cancer cases had been diagnosed since the start of 1995 (85% for both sexes), and around two-thirds had been diagnosed since the beginning of 2000 (65% for males and 67% for females), reflecting the poor longer-term survival of people diagnosed with lung cancer.

Across each of the limited duration prevalence measures shown, prevalence rates were decreasing for males and steadily climbing for females (Figure 5.1). This was consistent with incidence rate trends (see section 2.5) and translated into lung cancer prevalence counts being fairly steady for males in recent years (due to population growth and ageing), while prevalence counts for females were increasing rapidly. For example, 5-year prevalence counts for females almost doubled between 1992 (445 prevalent cases) and 2004 (852 prevalent cases).

Figure 5.1: Trends in limited duration prevalence of lung cancer (counts and rates) by sex, Queensland, 1992-2004



Data source: Queensland Cancer Registry.

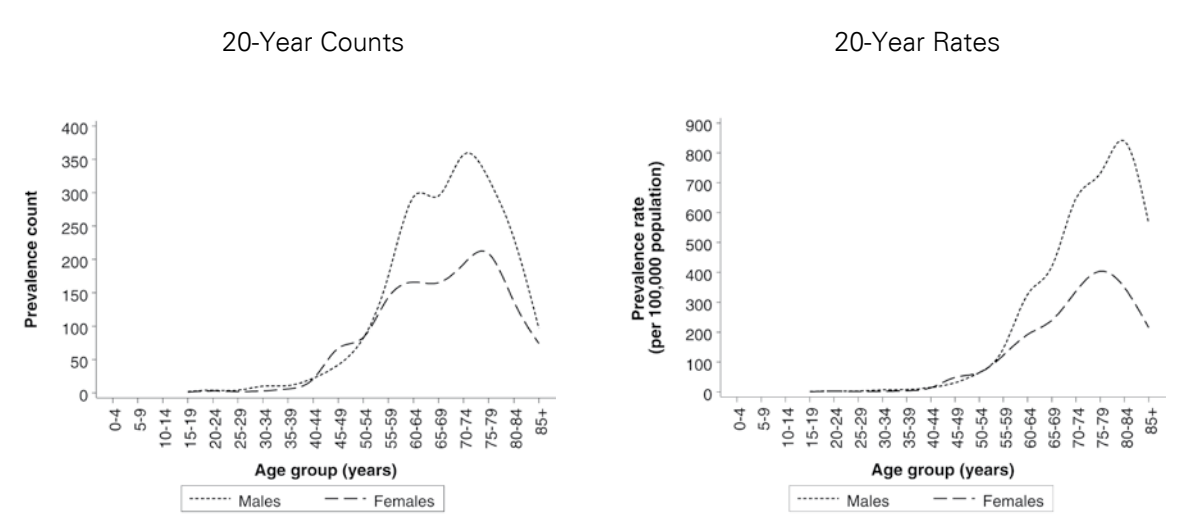
Notes: Prevalence data are as at 31st December of the year shown.

Rates age-standardised to the Australian standard population (2001).

5.2 Does the prevalence of lung cancer vary by age group?

Lung cancer prevalence rose sharply as age group increased, especially amongst males (Figure 5.2). Of the residents living in Queensland at the end of 2004, the number who had been diagnosed with lung cancer during the previous 20 years peaked at 357 among males in the 70-74 age group and at 209 among females in the 75-79 age group. The 20-year lung cancer prevalence rate was highest for males aged 80-84 years (840 per 100,000 population) and females aged 75-79 (404 per 100,000 population). This compared to 20-year prevalence rates of less than 10 per 100,000 population among both males and females aged less than 40 years.

Figure 5.2: Age-specific 20-year prevalence of lung cancer by sex, Queensland, 2004



Data source: Queensland Cancer Registry.
Note: Prevalence data are as at 31st December 2004.

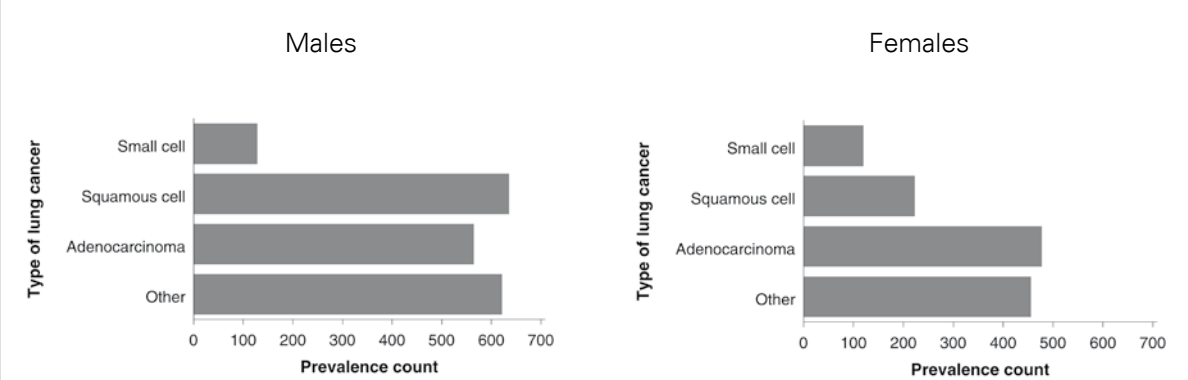
5.3 What types of lung cancer are people living with?

The distribution of 20-year prevalence by lung cancer morphology group and sex is illustrated in Figure 5.3. Squamous cell carcinoma accounted for a greater proportion of 20-year prevalence for lung cancer among males living in Queensland (33%) compared to either adenocarcinoma (29%) or small cell lung cancers (7%). This was most likely due to the relatively higher incidence of squamous cell carcinoma in the past (see Section 2.2) and also because survival for squamous cell carcinoma was better than for the other main subtypes of lung cancer (see Section 3.1.3).

The mix of lung cancers for females living in Queensland was very different to males (Figure 5.3), with the most prevalent form being adenocarcinoma (37% of the 20-year prevalence for lung cancer among females). This was more than double the 20-year prevalence count of squamous cell carcinomas among females (17%), and four times the prevalence count for small cell lung cancers (9%).

The combined grouping of other types of lung cancer accounted for 32% of the 20-year prevalence of lung cancer among males and 36% among females.

Figure 5.3: 20-year prevalence counts by type of lung cancer and sex, Queensland, 2004



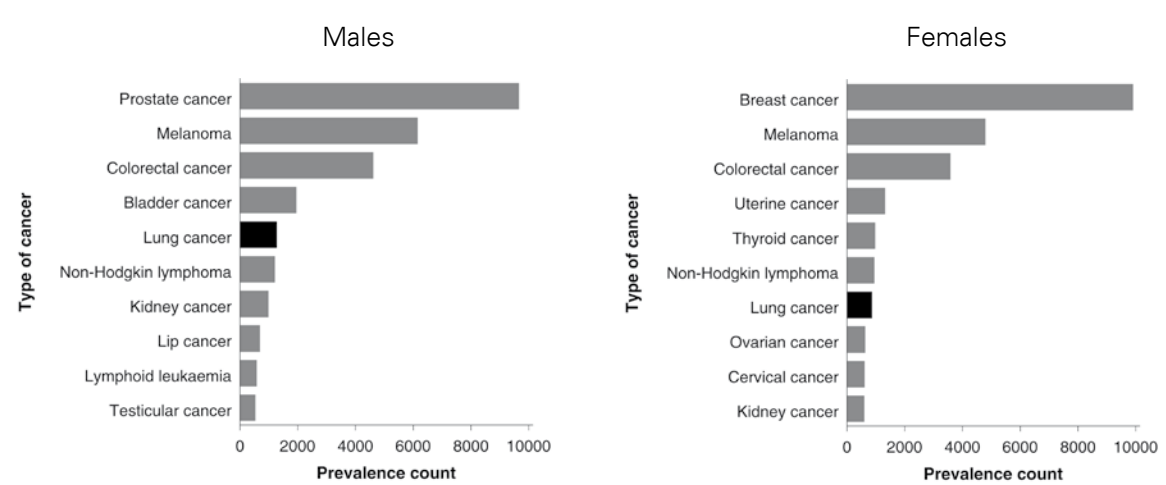
Data source: Queensland Cancer Registry.
Note: Prevalence data are as at 31st December 2004.

5.4 How does the 5-year prevalence of lung cancer compare with other cancers?

In terms of 5-year prevalence, lung cancer (1269 cases) was the fifth most prevalent type of cancer for males living in Queensland at the end of 2004 (Figure 5.4), with the highest prevalence counts occurring for prostate cancer (9658 cases), melanoma (6146 cases) and colorectal cancer (4610 cases). Among females, the most prevalent types of cancer were breast cancer (9904 cases), melanoma (4791 cases) and colorectal cancer (3580 cases), with lung cancer ranked seventh (852 cases).

For 20-year cancer prevalence in Queensland, lung cancer ranked eighth among males and tenth among females (data not shown).

Figure 5.4: 5-year prevalence counts for the most prevalent types of cancer by sex, Queensland, 2004



Data source: Queensland Cancer Registry and Queensland Health.
Note: Prevalence data are as at 31st December 2004.

When 5-year cancer prevalence was examined by age group, lung cancer was the fifth most prevalent type of cancer among males aged 65 years and over and among females aged 65-79 years.

6 Geographical and socio-demographic differences

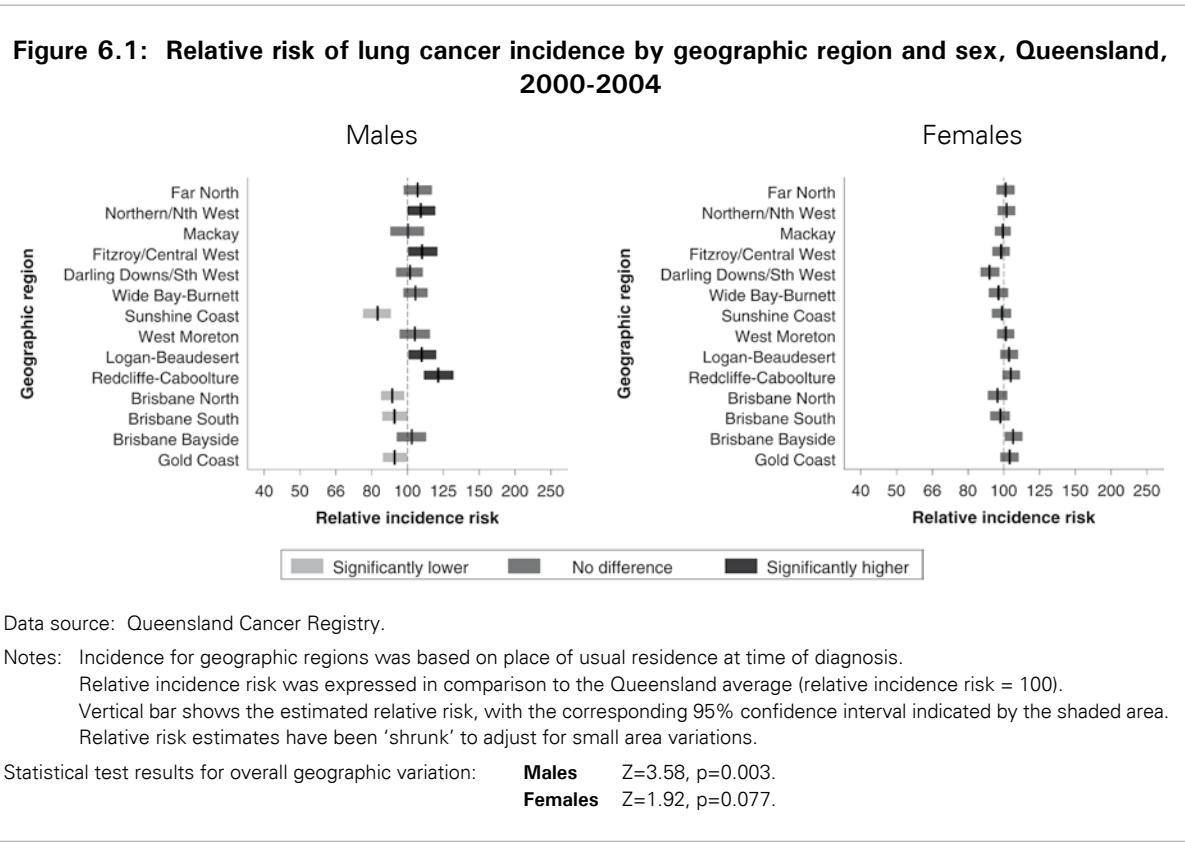
The final chapter of this report provides information on lung cancer incidence, survival and mortality, categorised by geographic region, accessibility/remoteness, and socio-economic status (see Appendix B for further details).

An understanding of differences in cancer data by geographic locality or socio-demographic characteristics is important when planning the allocation of health resources and services. This information may also be useful for researchers as a starting point for more detailed studies into the possible causes of any disparities in cancer incidence or survival.

6.1 Are there differences in lung cancer incidence within Queensland?

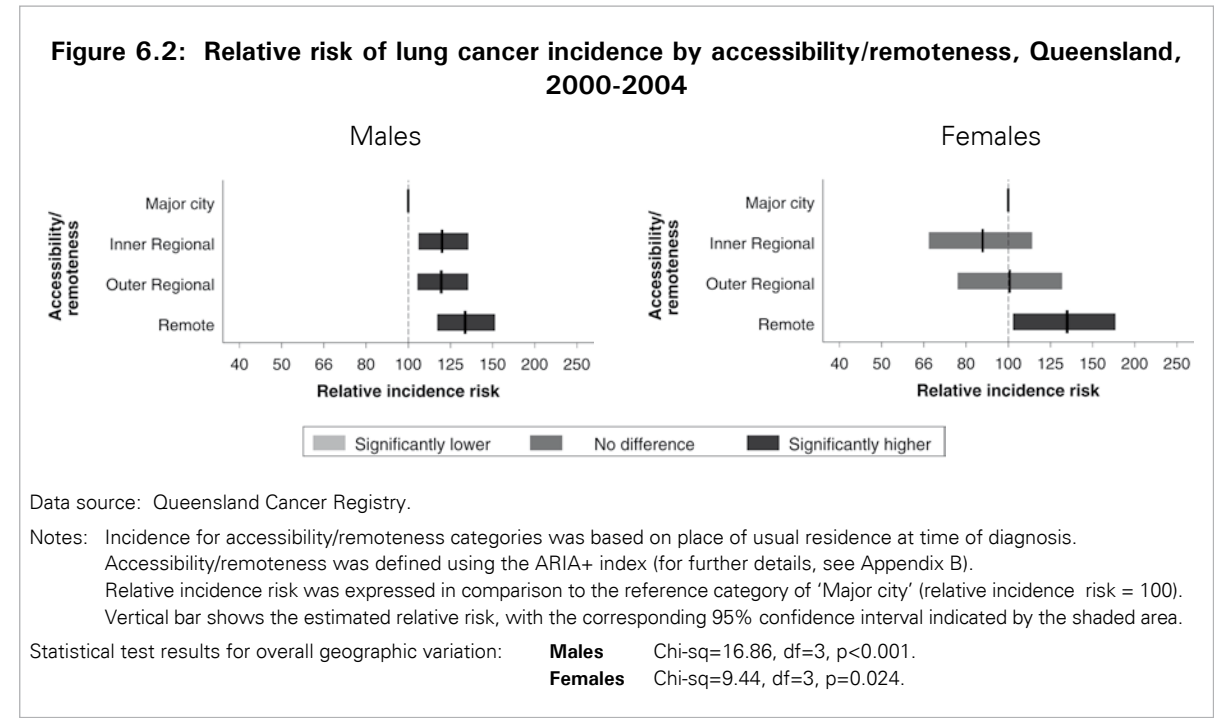
6.1.1 Lung cancer incidence by geographic region

There were significant differences in lung cancer incidence by geographic region in Queensland for males but not for females (Figure 6.1). The lung cancer incidence risk was significantly lower than the Queensland average for males living in the Sunshine Coast (17% lower), Brisbane North (9% lower), Brisbane South and Gold Coast (both 7% lower) regions, and significantly higher in the Northern/North-West (9% higher), Fitzroy/Central West, Logan-Beaudesert (both 10% higher) and Redcliffe-Caboolture (21% higher) areas.



6.1.2 Lung cancer incidence by accessibility/remoteness

People living in remote parts of Queensland were much more likely to be diagnosed with lung cancer than those living in a major city (Figure 6.2). Males in remote areas had a 34% higher risk and females a 35% higher risk of developing lung cancer compared to their counterparts in major cities (i.e. South-East Queensland). Males in inner regional and outer regional areas were also at increased risk, with lung cancer incidence risks 20% higher than in major cities for both of these areas. There was no difference in the lung cancer incidence risk between females living in a major city and those from inner regional or outer regional areas.



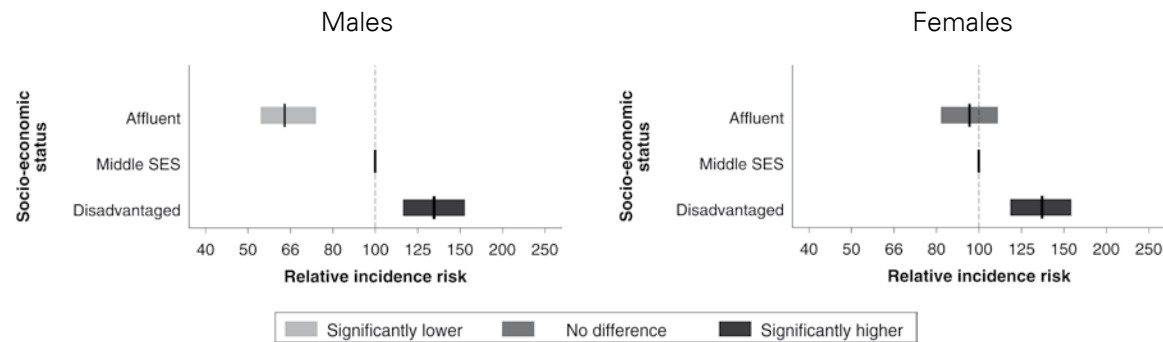
A report on lung cancer in New South Wales also found that incidence was highest in remote areas among both males and females.¹¹¹

6.1.3 Lung cancer incidence by socio-economic status

Persons living in the most socio-economically disadvantaged areas of Queensland were at greater risk of being diagnosed with lung cancer. Males from disadvantaged areas had a 35% higher risk and females a 37% higher risk of developing lung cancer compared to those in the middle SES category. In contrast, the relative risk of lung cancer incidence for males residing in the most advantaged areas of Queensland was 36% lower than that of males in the middle SES group. There was no difference between the affluent and middle SES groups for females (Figure 6.3).

Studies in many other countries have commonly reported that lung cancer was more likely to occur among people of lower socio-economic status.^{55,233,234}

Figure 6.3: Relative risk of lung cancer incidence by socio-economic status, Queensland, 2000-2004



Data source: Queensland Cancer Registry.

Notes: Incidence for socio-economic status categories was based on place of usual residence at time of diagnosis. Socio-economic status was defined using the SEIFA index of relative socio-economic disadvantage (for further details, see Appendix B). Relative incidence risk was expressed in comparison to the reference category of 'Middle SES' (relative incidence risk = 100). Vertical bar shows the estimated relative risk, with the corresponding 95% confidence interval indicated by the shaded area.

Statistical test results for overall geographic variation: **Males** Chi-sq=43.44, df=2, p<0.001. **Females** Chi-sq=20.74, df=2, p<0.001.

Comment 6.1 – Why are people living in rural/remote or socio-economically disadvantaged areas more likely to be diagnosed with lung cancer?

Differences in lung cancer incidence by socio-economic status are most likely due to differences in the prevalence of smoking.⁵⁵ Studies in Queensland and throughout Australia have consistently reported substantially higher rates of smoking among people living in lower SES areas.²³⁵⁻²³⁷ The 2004/05 Australian National Health Survey found that 33% of males and 28% of females from low SES areas were daily smokers, as opposed to 16% of males and 11% of females living in high SES areas.²³⁷ Some researchers have suggested that the association between smoking and SES is indicative of underlying environmental influences.²³⁶

While there is also some recent evidence to suggest that persons living in rural or remote areas were more likely to smoke than those in urban areas,^{237,238} these differences have not always been replicated in other surveys.^{235,236} This may in part be explained by changes in the measures used to define rurality and accessibility over the last few years.

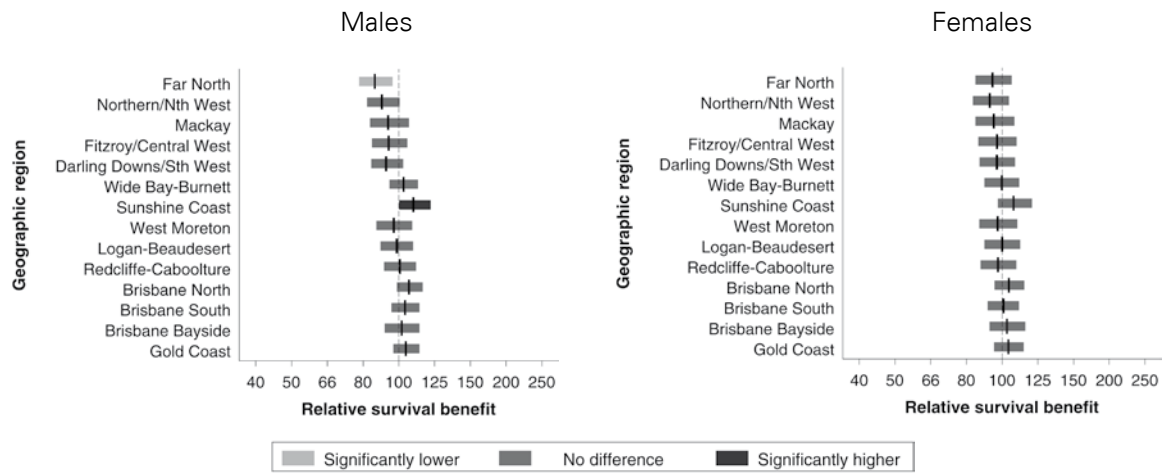
Several other factors apart from smoking, such as differences in diet, physical activity and occupational exposure to carcinogens or second-hand tobacco smoke, may also contribute to geographic and SES disparities in lung cancer incidence.^{55,233,234} This point is emphasised by studies in both Norway and Canada which have found that the risk of lung cancer remains higher among persons of lower SES even after adjusting for smoking.^{233,234}

6.2 Are there differences in lung cancer survival within Queensland?

6.2.1 Lung cancer survival by geographic region

Figure 6.4 shows variation in 5-year relative survival from lung cancer by geographic region in Queensland. Males in the Far North region had poorer 5-year survival compared to the State average (13% lower relative survival benefit) while male residents of the Sunshine Coast had better survival (10% higher relative survival benefit). There was no evidence of significant differences in lung cancer survival by geographic region for females.

Figure 6.4: Relative benefit of 5-year survival for lung cancer by geographic region, Queensland, 2000-2004



Data source: Queensland Cancer Registry.

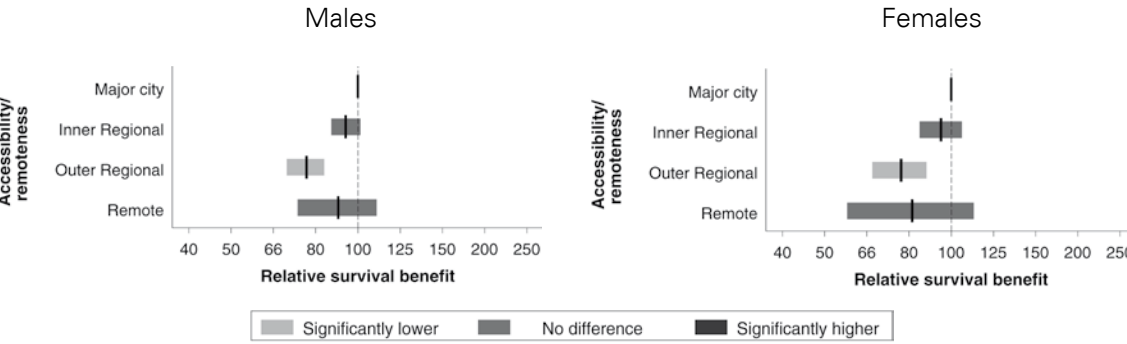
Notes: Relative survival calculated using the period approach, for persons aged 0-89 years at time of diagnosis. Data are for 'at risk' cases in the period 2000-2004. Survival for geographic regions was based on place of usual residence at time of diagnosis. 5-year relative survival benefit was expressed in comparison to the Queensland average (relative survival benefit = 100). Vertical bar shows the estimated relative benefit, with the corresponding 95% confidence interval indicated by the shaded area. Relative benefit estimates have been 'shrunk' to adjust for small area variations.

Statistical test results for overall geographic variation: **Males** Z=2.96, p=0.011. **Females** Z=1.43, p=0.177.

6.2.2 Lung cancer survival by accessibility/remoteness

In terms of lung cancer survival and accessibility/remoteness, 5-year survival was lowest in outer regional areas. Both males and females from outer regional parts of Queensland had a 5-year relative survival benefit that was 23% lower than their counterparts in the major cities (Figure 6.5).

Figure 6.5: Relative benefit of 5-year survival for lung cancer by accessibility/remoteness, Queensland, 2000-2004



Data source: Queensland Cancer Registry.

Notes: Relative survival calculated using the period approach, for persons aged 0-89 years at time of diagnosis. Data are for 'at risk' cases in the period 2000-2004. Survival for accessibility/remoteness categories was based on place of usual residence at time of diagnosis. Accessibility/remoteness was defined using the ARIA+ index (for further details, see Appendix B). 5-year relative survival benefit was expressed in comparison to the reference category of 'Major city' (relative survival benefit = 100). Vertical bar shows the estimated relative benefit, with the corresponding 95% confidence interval indicated by the shaded area.

Statistical test results for overall geographic variation: **Males** Chi-sq=33.74, df=3, p<0.001. **Females** Chi-sq=15.00, df=3, p=0.002.

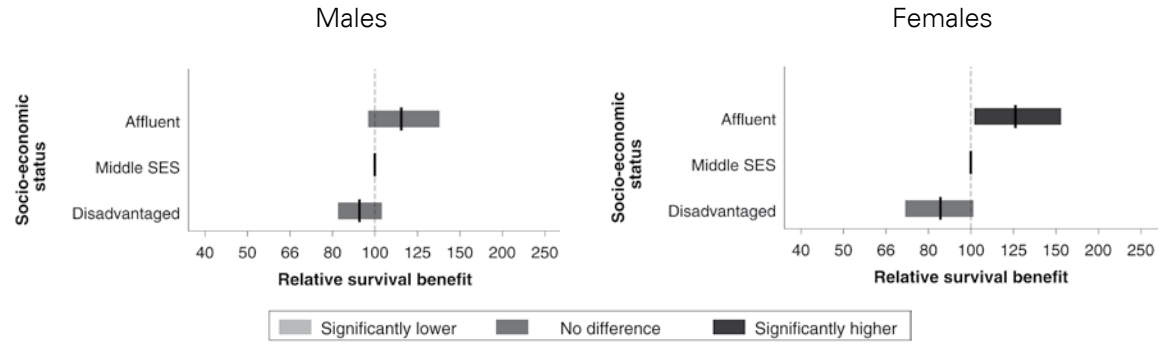
A study in New South Wales on the effect of remoteness on cancer survival reported very similar results for lung cancer to those for Queensland.²³⁹ Data from the Australian Institute of Health and Welfare also showed similar results, with patients in capital cities having the highest 5-year lung cancer survival rates and those from small rural centres having the lowest survival rates.²⁴⁰

6.2.3 Lung cancer survival by socio-economic status

Both male and female lung cancer patients in the most disadvantaged areas tended to have the poorest survival rates while those in the most affluent parts of Queensland were more likely to have higher survival rates (Figure 6.6). In particular, females living in the most affluent areas of Queensland had a 5-year relative survival benefit that was 26% higher than females in the middle SES group.

Results published for Australia have also shown that 5-year survival from lung cancer was highest amongst those in the upper SES categories, although more so among males than females.²⁴⁰ Studies of lung cancer survival by SES across several other countries have, however, reported mixed results.^{241,242}

Figure 6.6: Relative benefit of 5-year survival for lung cancer by socio-economic status, Queensland, 2000-2004



Data source: Queensland Cancer Registry.

Notes: Relative survival calculated using the period approach, for persons aged 0-89 years at time of diagnosis. Data are for 'at risk' cases in the period 2000-2004. Survival for socio-economic status categories was based on place of usual residence at time of diagnosis. Socio-economic status was defined using the SEIFA index of relative socio-economic disadvantage (for further details, see Appendix B). 5-year relative survival benefit was expressed in comparison to the reference category of 'Middle SES' (relative survival benefit = 100). Vertical bar shows the estimated relative benefit, with the corresponding 95% confidence interval indicated by the shaded area.

Statistical test results for overall geographic variation: **Males** Chi-sq=4.67, df=2, p=0.097. **Females** Chi-sq=8.75, df=2, p=0.013.

Comment 6.2 – Issues affecting the survival of lung cancer patients living in rural/remote or socio-economically disadvantaged areas

Research from the United States and Europe has linked lung cancer survival rates to both access to cancer treatment services and the type of treatment services provided.²⁴³⁻²⁴⁷

Within the Australian context, these issues are particularly relevant for those who are living in rural or remote locations that are a long distance from oncology treatment centres.^{239,248} It is also possible that lack of access to adequate cancer treatment may, at least in part, help to explain poorer lung cancer survival amongst those who are socio-economically disadvantaged.^{249,250} For example, studies in Western Australia have found that socio-economic or locational disadvantage reduced the likelihood of a patient receiving lung cancer surgery,²⁵¹ and that people treated for lung cancer in a rural or public hospital had poorer survival than those treated in metropolitan areas or in a private hospital.²⁵²

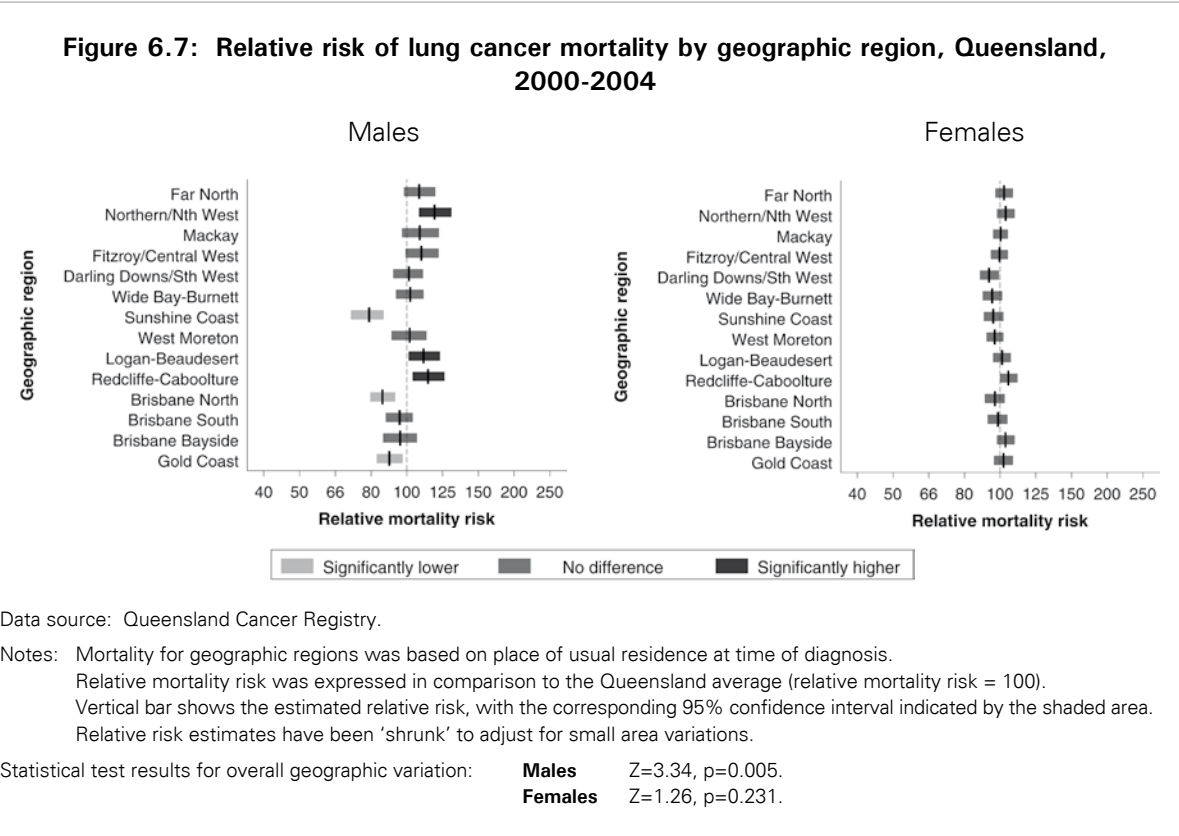
It should, however, be noted that findings on the relationship between access to care and locational or socio-economic disadvantage have been mixed, with some studies finding little difference in equity of access to lung cancer treatment by either SES or distance to the place of treatment.²⁵³⁻²⁵⁵ It is also important to recognise that while earlier diagnosis of lung cancer is likely to improve survival,²⁵⁶ most treatments for late stage lung cancers are aimed at prolonging life rather than providing a cure for the disease^{257,258} (see also Comment 3.3 and Comment 3.4).

Besides distance and financial considerations, potential barriers to accessing treatment for lung cancer among disadvantaged sectors of the community may include attitudes and beliefs about cancer, cultural considerations and communication difficulties.^{242,248}

6.3 Are there differences in lung cancer mortality within Queensland?

6.3.1 Lung cancer mortality by geographic region

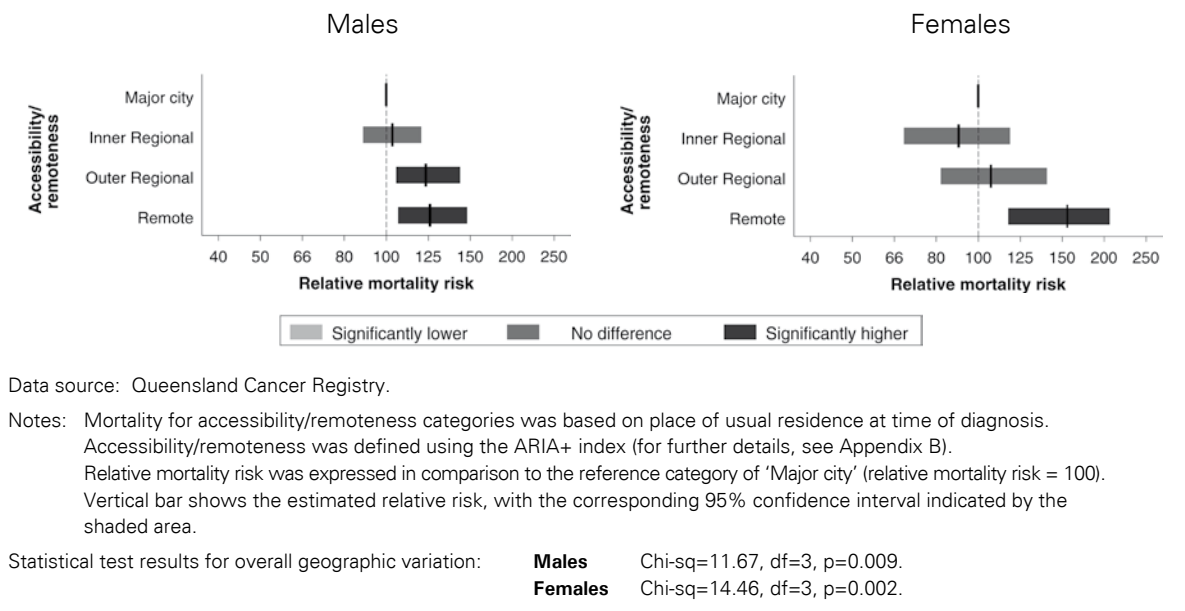
The differences observed in lung cancer mortality by geographic region in Queensland were very similar to those for incidence. Among males, there was a higher relative risk of dying from lung cancer in the Northern-North West (19% higher), Redcliffe-Caboolture (15% higher) and Logan-Beaudesert (12% higher) regions and a lower risk in the Sunshine Coast (21% lower), Brisbane North (14% lower) and Gold Coast (10% lower) regions. The adjusted risk of lung cancer mortality within each geographic area was close to the State average among females (Figure 6.7).



6.3.2 Lung cancer mortality by accessibility/remoteness

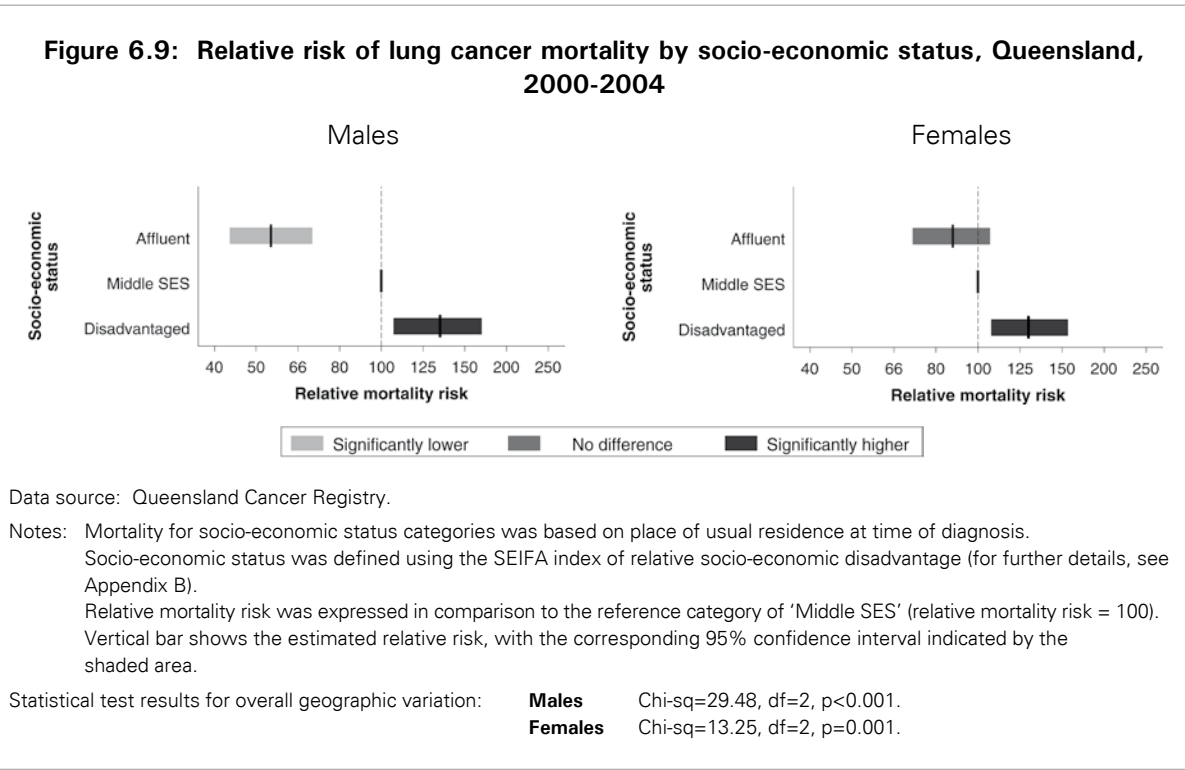
Males in remote and outer regional areas were more likely to die from lung cancer than males in the major cities of Queensland, with relative risks that were 26% and 24% higher respectively (Figure 6.8). The relative differential in lung cancer mortality was even greater for females in remote areas, who had an increased risk of 56% compared to those residing in South-East Queensland.

Figure 6.8: Relative risk of lung cancer mortality by accessibility/remoteness, Queensland, 2000-2004



6.3.3 Lung cancer mortality by socio-economic status

There was a strong relationship between lung cancer mortality and socio-economic status in Queensland for both sexes (Figure 6.9). Males living in the most affluent parts of Queensland had a relative risk of lung cancer mortality that was 44% lower than males in the middle SES category, while males in the most disadvantaged areas had a risk 35% higher than the middle SES group. Although the mortality differences were smaller for females (no significant difference for affluent areas compared to the middle SES group, while those from disadvantaged areas had a 30% higher risk) the overall geographic variation by SES was still highly significant.



Comment 6.3 – Lung cancer among Indigenous Australians

Although there are some limitations regarding the accuracy of information about cancer for Indigenous Australians, the available data suggests that Indigenous people have significantly higher lung cancer incidence and mortality rates than the non-Indigenous population.²⁵⁹⁻²⁶³ For instance, the risk of lung cancer among people living in rural and remote Indigenous communities in Queensland was estimated to be about 60% higher than the general population.²⁶⁰

The primary reason for elevated lung cancer rates among Indigenous people is likely to be related to smoking.^{259,260} After adjusting for age, Indigenous adults were more than twice as likely to be smokers compared to non-Indigenous adults.²⁶⁴ Smoking rates among Indigenous males have only shown a slight improvement over the last 10 to 15 years, while the prevalence of smoking has remained steady among Indigenous females.^{264,265} In 2004-05, it was estimated that 53% of Indigenous males and 51% of Indigenous females throughout Australia aged 18 years or over were current smokers.²⁶⁴

A recent study reported that Indigenous Australians have lower survival from cancer in general compared to the non-Indigenous population,²⁶⁶ and the available data also suggests that survival specific to lung cancer is poorer.^{259,262} Lung cancer survival among Indigenous people may be impacted by a combination of more advanced disease at diagnosis, the presence of other chronic diseases, socio-economic and cultural factors, as well as the possibility of sub-standard treatment being provided.^{262,266,267}

Appendix A – Other sources of information**A.1 Related publications on cancer in Queensland**

Queensland Cancer Registry, 2007. *Cancer in Queensland: Incidence and Mortality, 1982 to 2004*. QCR, Queensland Cancer Fund and Queensland Health: Brisbane. (www.health.qld.gov.au/hic/qcr2005/qcr82-04.pdf)

Dinh M, Khor S, Coory M, 2005. *Mortality and incidence trends for leading cancers in Queensland, 1982 to 2003*. Information Circular 71. Health Information Branch, Queensland Health: Brisbane. (www.health.qld.gov.au/publications/infocirc/info71.pdf)

Youlden D, Baade P, Coory M, 2005. *Cancer Survival in Queensland, 2002*. Queensland Health and Queensland Cancer Fund: Brisbane. (www.cancerqld.org.au/pdf/research/survival.asp.pdf)

Baade P, Fritschi L, Aitken J, 2005. *Geographical differentials in cancer incidence and survival in Queensland: 1996-2002*. Viertel Centre for Research in Cancer Control, Queensland Cancer Fund: Brisbane. (www.cancerqld.org.au/downloads/Geographical_differentials_report.pdf)

Baade PD, Steginga SK, Aitken JF, 2005. *Current status of prostate cancer in Queensland, 1982 to 2002*. Viertel Centre for Research in Cancer Control, Queensland Cancer Fund: Brisbane. (www.cancerqld.org.au/downloads/prostate_report.pdf)

A.2 Internet resources

These internet resources are provided as a source of additional information to complement this report. Due to continuing research, information concerning the detection and treatment of lung cancer is constantly being updated. The Cancer Council Queensland does not specifically endorse the information contained on these websites, and it is not intended to take the place of medical advice. Readers are encouraged to discuss any specific issues with their medical practitioner.

The Cancer Council New South Wales – Understanding Lung Cancer (www.cancerCouncil.com.au/editorial.asp?pageid=43)
A publication containing comprehensive information for people with lung cancer, their relatives and friends. (Australia)

The Australian Lung Foundation (www.lungnet.com.au/home/default.htm)
Provides information on support groups and more detailed lung cancer information for consumers on request, as well as information for health professionals. (Australia)

American Cancer Society (www.cancer.org/docroot/home/index.asp)
Resources provided for consumers and health care professionals, including information on diagnosis, treatment options, and statistics. (United States)

CancerHelp UK – Lung Cancer (www.cancerhelp.org.uk/help/default.asp?page=2787)
Comprehensive website covering all facets of lung cancer information for people with lung cancer, their relatives and friends, including links to further internet sites. (United Kingdom)

QuitNow (www.quitnow.info.au/internet/quitnow/publishing.nsf/Content/home)
Information and support to quit smoking for consumers and health professionals. (Australia)

Appendix B – Methods

B.1 Lung cancer classifications

Throughout this report the definitions of cancer type are the same as those currently used by the QCR, as shown in their annual data report.⁴³ These definitions are based on the World Health Organization’s International Classification of Diseases for Oncology, 3rd edition (ICD-O-3).²⁶⁸ For example, lung cancer was defined using the ICD-O-3 codes C33-C34.

There are no uniform definitions available for lung cancer morphology subgroups. The definitions used in this report were based on the classifications used by the National Cancer Institute (for small cell lung cancer)²⁶⁹ and the International Agency for Research on Cancer (for squamous cell carcinoma and adenocarcinoma),²⁷⁰ in conjunction with advice received from the Queensland Cancer Registry and West Australian Cancer Registry. The ICD-O morphology codes used to define each lung cancer subgroup are shown in Table B1.

Table B1: Definitions used for lung cancer morphology subgroups

Morphology group	ICD-O morphology codes
Small cell lung cancer	80413,80423,80433,80443,80453 ^a
Squamous cell carcinoma	80500-80899 ^b
Adenocarcinoma	81400-81499, 81600-81629, 81900-82219, 82600-83379, 83500-85519, 85700-85769, 89400-89419 ^b
Other types of lung cancer	All other lung cancer morphology codes

Sources:
a. National Cancer Institute (NCI).²⁶⁹
b. International Agency for Research on Cancer (IARC).²⁷⁰

B.2 Data sources

Australian Bureau of Statistics (ABS)
Estimated resident population data were obtained from the Australian Bureau of Statistics.²⁷¹ These data include estimated population counts by age group, sex, year and geographical area of residence. Population data were primarily used in this report as the denominator for calculating rates and for age-standardisation (see Appendix B.3).

De-identified unit record mortality data for all causes of death for Queensland residents were also purchased from the Australian Bureau of Statistics. Permission was required from the Registrar of Births, Deaths and Marriages in every State and Territory in Australia to access data for Queensland residents who died interstate. Note that cancer mortality data are available from both the Australian Bureau of Statistics and the Queensland Cancer Registry. Differences in coding practices and residential criteria can result in slight differences in the counts and rates calculated from these two data sources.

Australian Institute of Health and Welfare (AIHW)
National and interstate lung cancer incidence data for the period 1999-2003 were published by the Australian Institute of Health and Welfare.¹⁰⁴ The corresponding lung cancer mortality data were obtained from the online Australian Cancer Incidence and Mortality (ACIM) books.²⁷² These are interactive on-line Excel workbooks containing incidence data from 1982 to 2003 and mortality data from 1968 to 2005, by age and sex for the major cancers. Incidence trend data for Australia were also sourced from the ACIM books.²⁷²

Long-term mortality data for Australia, used in the age-period-cohort modelling (see Appendix B.3), were obtained from the General Record of Incidence of Mortality (GRIM) on-line books produced by the AIHW.²²⁸ The GRIM books are interactive spreadsheets containing national mortality data and include information on cause of death, year of registration of death, age group and sex. Data on lung cancer deaths for Australia were available for the period 1945-2005.

National Cancer Centre (Japan)
Data on cancer incidence in Japan were estimated by the Centre for Cancer Control and Information Services, National Cancer Centre, using information collected by a network of population-based cancer registries. National estimates were available from 1975 to 2001. There are currently fifteen cancer registries in Japan, but only those registries with data of sufficient quality (including Miyagi, Yamagata, Kanagawa, Niigata, Fukui, Shiga, Osaka, Okayama, Saga and Nagasaki) were used in the national incidence calculations.²⁷³ Together, these 10 registries cover 24% of Japan’s population.

National Cancer Institute (United States)
The Surveillance, Epidemiology, and End Results (SEER) Program of the National Cancer Institute is the principal source of cancer incidence and survival data in the United States.²⁷⁴ Incidence trend data from SEER were available from 1975 to 2004 for nine cancer registry areas: the states of Connecticut, Iowa, New Mexico, Utah, and Hawaii, the metropolitan areas of Detroit, San Francisco-Oakland and Atlanta in addition to the 13-county Seattle-Puget Sound area. These SEER-9 cancer registries cover approximately 10% of the population in the USA.²⁷⁵ Another eight registries have been added more recently, but have not been included in the incidence trend data shown in this report.

National Cancer Registry of Ireland
The National Cancer Registry of Ireland (NCRI) collects population-based cancer statistics throughout the Republic of Ireland.²⁷⁶ A de-identified unit record dataset can be downloaded from the NCRI website (www.ncri.ie/ncri/index.shtml), which contains details on the type of cancer, year of diagnosis, age group, sex and morphology code. Incidence data were available from 1994 to 2002.

Public Health Agency of Canada
Incidence trends for Canada were sourced from the Canadian Council of Cancer Registries (CCCR) and downloaded from the on-line surveillance data provided by the Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada.²⁷⁷ The CCCR is a collaboration of the 13 Canadian provincial and territorial cancer registries and the Health Statistics Division of Statistics Canada, and collects information on all cancers diagnosed throughout the country. Aggregated data by type of cancer, age group, sex and incidence year were available between 1992-2003.

Queensland Cancer Registry (QCR)
The majority of data reported in this publication was acquired directly from the Queensland Cancer Registry after obtaining approval via Government gazettal, in accordance with the *Public Health Act 2005*. The data files provided by the QCR were either confidentialised or aggregated so that no individuals could be identified from the data.

The QCR is a population-based cancer registry that maintains a record of all cases of cancer diagnosed in Queensland since 1982. The Cancer Council Queensland has managed the processing operations of the QCR on behalf of Queensland Health since October 2000. At the time of preparation of this report, the latest data available from the QCR was for the 2004 calendar year.⁴³

Details of all cancers diagnosed in Queensland are legally required to be included in the QCR under the *Public Health Act 2005*. Notifications of patients with cancer are received from all public and private hospitals and nursing homes. Queensland pathology laboratories are also required to provide copies of pathology reports for cancer specimens. Information regarding the deaths of persons with cancer is provided to the QCR from the Registrar of Births, Deaths and Marriages.

Non-melanoma skin cancers were not included in the comparisons of cancer types throughout this report. This is because non-melanoma skin cancers are not registered by the QCR (similar to the practice in most other cancer registries), since many are treated in doctors’ surgeries using techniques that preclude histological confirmation.

The information in this report does not include any adjustment for stage of cancer (a measure of how far the cancer has spread at the time of diagnosis). As is the case for all cancer registries in Australia, complete clinical staging data are not routinely collected by the QCR (although New South Wales collects a measure of the degree of spread). The absence of information on cancer stage makes it difficult to distinguish between early/late diagnosis and better/worse management of the cancer as possible reasons for any observed differences in lung cancer survival.

Further details about the QCR can be found in their annual report.⁴³

Queensland Health

Additional extracts of de-identified QCR data for other types of cancer were requested from Queensland Health. Specifically, information on median age at death and diagnosis for each cancer type was obtained from the Epidemiology Services Unit, Health Information Centre, Queensland Health. De-identified data required for survival and prevalence calculations were provided by the Client Services Unit, Health Information Centre, Queensland Health.

Thames Cancer Registry (South-East England)

Incidence trend data for South-East England was obtained from the Thames Cancer Registry (TCR), which covers the residential population of London, Hertfordshire, Essex, Surrey, Sussex and Kent (about 24% of the total United Kingdom population).²⁷⁸ It is one of 12 population-based cancer registries in the UK and has collected cancer incidence data since 1960.²⁷⁹ Aggregated data for lung cancer patients, including information on year of diagnosis (1960 to 2003), age group and sex, were obtained through a specific request to the TCR.

World Health Organization (WHO)

Mortality and population data used for calculating international trends in lung cancer deaths were extracted from the World Health Organization (WHO) mortality database.²²³ Data were available by cause of death, year of death, age group and sex. Records were selected when the death was coded to lung cancer using the ninth and tenth revisions of the International Classification of Diseases (ICD9: 162 and ICD10: C33-C34).

Lung cancer mortality trends were calculated from the WHO data between 1982 to 2004 for 21 selected countries (including Australia) which had sufficient quality and quantity of information for analysis (note that the years of data available varied between countries). The selected countries averaged at least 300 deaths due to lung cancer per year for males and 250 deaths per year for females, and at least 80% of all deaths were registered. One exception was China, which was chosen due to the high numbers of deaths caused by lung cancer, even though the WHO mortality data were from a sample of less than 10% of all deaths (from selected urban and rural areas).

Recent international lung cancer incidence and mortality rates were also sourced through the WHO. Data were obtained from the GLOBOCAN 2002 database, which is administered by the WHO International Agency for Research on Cancer (IARC).⁹² This database contains estimates of incidence, mortality and prevalence as at 2002 by cancer site, broad age group and sex for many countries. The quality of the data for each country mainly depends on the coverage of the cancer registry and mortality data (i.e. entire population or selected regions), and the recency of the data used to calculate the 2002 estimates.

B.3 Methods and measures

Most of the data analysis contained in this report was performed using SAS software v9.1.²⁸⁰ Shrunk estimates were modelled using SAS software v8.2,²⁸¹ and the yearly percentage changes for incidence and mortality trends were calculated using Joinpoint software v3.0.¹⁰⁵

Age-Period-Cohort models

Trends in incidence and mortality can often be characterised by at least one of the following effects: age, period or cohort.²³⁰ Age effects are present for nearly every type of disease, with rates generally increasing as age increases. Period effects are typically those that affect the whole population (all ages) at any one time. An example for lung cancer may relate to changes in the type of cigarettes available for sale, or the introduction of legislation banning smoking in public places. Cohort effects generally occur when people born at different times experience varying levels of exposure to a specific factor (e.g. smoking) that influences mortality. For example, people born during the 1950s would have had different influences and exposures during their teenage and early adult life compared to people born during the 1920s. These influences can either increase or decrease the risk of lung cancer among the various birth cohorts.

We used Australian lung cancer mortality data from 1945 to 2005 for the APC models. These data were obtained from the General Record of Incidence of Mortality (GRIM) books published by the Australian Institute of Health and Welfare.²²⁸ As Queensland mortality data were only available from 1968, use of the Australian data enabled a longer time series, and greater numbers of deaths, to investigate the age, period and cohort patterns more accurately.

Age-standardised rates

Age-standardised rates attempt to adjust for variation in age structures in different populations (either different geographical areas or the same population across time). There are two methods of age-standardisation – direct and indirect.

Directly standardised rates were used for comparing incidence or mortality rates across states or countries and for calculating incidence, mortality or prevalence trends. The method involves applying age-specific rates from the population of interest to a standard population, which in this report was the Australian Standard Population 2001 (see below), unless otherwise specified.

Indirect standardisation was used for calculating incidence and mortality rates in the chapter on geographical differences (Chapter 6). This approach was used because the age-specific rates may be less stable when the population of interest is smaller e.g. in the Northern/North-West area. Using this method, the age-specific rates for the standard population (in this case, Queensland) were applied to the population of interest. The standardised incidence or mortality ratio was then derived by dividing the observed count by the expected value that was calculated in the previous step. These indirectly standardised ratios were then used to compute the relative risk of incidence or mortality.

Five-year age groups up to 85 years and over were used for all of the age-standardisation, except for the data obtained from GLOBOCAN 2002, where only broad age groups were available (i.e. 0-14 years, 15-44 years, 45-54 years, 55-64 years, 65+ years).

Australian Standard Population (2001)

The standard population currently used for direct age-standardisation within Australia is the 2001 Australian resident population, which is released by the Australian Bureau of Statistics.²⁸²

Confidence intervals

All estimates are calculated with some degree of imprecision. The level of accuracy is typically reported in terms of a confidence interval, which specifies a range of values in which the true data point is expected to occur with a given level of certainty. For example, a 5-year survival rate may be estimated as 11.1% with a 95% confidence interval of 10.3%-12.0%. This means that there is a 95% probability that the true survival rate will be somewhere between 10.3% and 12.0%.

Due to the intended non-statistical audience of this report, confidence intervals have generally not been included. However, detailed data tables (which include the confidence intervals), are available from the authors on request (see contact details at the front of the report).

Incidence

The incidence of a particular disease (e.g. lung cancer) is the number of new cases diagnosed in a specified population during a given time period (usually one year). Incidence is also commonly expressed as a rate (e.g. per 100,000 population). Since the risk of most cancers varies with age, it is common practice to age-standardise incidence rates to allow for more valid comparisons between populations (see “Age-standardised rates”).

Mortality

Mortality measures the number of deaths caused by a given condition (e.g. lung cancer) within a specified population over a defined time period (usually one year). Similar to incidence, mortality can also be expressed as a rate (per 100,000 population), and these rates are often age-standardised to account for variation in the age structures of different populations (see “Age-standardised rates”).

Premature mortality

Premature mortality (measured by years of life lost, or YLL) is based on how much of their “expected” lifetime a person loses when they die. For example, a person who dies at 40 years of age would lose a greater number of years of (expected) life than a person who dies at age 70.

The calculation of premature mortality in this report was based on the average YLL per death by age group and sex that were used in the 2003 Australian Burden of Disease and Injury study (using a 3% discount rate and no age weighting).¹⁹⁰ This information was then applied to mortality data from the Queensland Cancer Registry to ascertain the total YLL per year and the average YLL per death by type of cancer and by the lung cancer morphology groups.

Prevalence

Although incidence is an important measure when describing the short-term impact of lung cancer, it describes only the number of newly diagnosed cancers. People who had been diagnosed previously are not included in incidence counts for subsequent years, even though they may still be alive and require continuing medical treatment and support.

Health care planners and cancer support personnel need to know how many people remain alive following a diagnosis of lung cancer. Prevalence is one measure that can provide this information. The prevalence of lung cancer represents the number of people who had a diagnosis of lung cancer in the past and were still alive at a specified point in time. The prevalence of a cancer is impacted by the number of new cancers (incidence) and the length of time patients survive after being diagnosed. Even though two types of cancer might have similar incidence, if one cancer has low survival rates and another cancer has higher survival rates, then the prevalence of the second cancer will be greater.

In this report we have presented “limited duration” prevalence, which counts cases who remain alive at a given time point (e.g. 31st December 2004) as prevalent when they were diagnosed within a specific time period (e.g. during the previous 10 years). Limited duration prevalence estimates are presented for 1-, 5-, 10-, 15- and 20-year time periods. Any persons diagnosed with cancer before 1982 (when the Queensland Cancer Registry started) were not included in the prevalence estimates. For example, 10-year limited duration prevalence for lung cancer could not be calculated for Queensland prior to the end of 1991.

Relative risk of incidence or mortality

Geographical differences in incidence and mortality were assessed using age-adjusted Poisson models. In each model the age-specific counts of incidence or mortality were regressed against age group and geographical area (both as categorical variables). A log-link function was used in the Poisson models, with the offset variable being the log of the age-specific population. Relative risks for incidence or mortality were then calculated by taking the exponential of the regression parameter estimate for the geographical categories, and corresponding 95% confidence intervals were obtained from the standard error of the parameter estimate.

A further adjustment was made to the relative risk estimates for geographic regions (14 areas) to take into account the possible effects of small numbers (see “Shrunken estimates”). This adjustment was not considered appropriate for the analyses by remoteness/accessibility (four categories) or socio-economic status (three categories).

Relative risks that were significantly greater than 100 indicate an increased risk of lung cancer diagnosis or death compared to the reference group, and values significantly less than 100 suggest a reduced risk of diagnosis or death.

Assessment of the overall effect of the geographical differences was made by calculating the difference in model deviance between the full model (including age and geographical area) and the age model alone. This difference in deviance was then compared to the chi-squared statistic with the appropriate degrees of freedom. To test for trend associations, geographical area was included in the model as a continuous variable.

Shrunken estimates

The rationale of splitting Queensland into only 14 geographic regions and combining five years of data was to increase the number of cases of lung cancer available for analysis in each area. However, the number of cases was still small in some areas, particularly in the more rural and remote regions. These small numbers can make the estimates unstable and the resulting interpretation difficult.

For this reason a mathematical method was used to make allowance for these small numbers when looking at the variation across geographical regions. This method “shrinks” the estimates for each region towards the Queensland average. The degree of “shrinkage” generally increased as the area-specific count became smaller.

This approach, known as the Empirical Bayes (EB) method, was the same as that used by The Cancer Council New South Wales in a report on cancer incidence, mortality and survival by Area Health Services.²⁸³ A detailed description of the EB method is available both in that report and a related research paper.²⁸⁴

Survival

Survival time is defined as the length of time between when a person is diagnosed with a disease and when they die. However, since the eventual survival time of everyone diagnosed with cancer is not known (for example they may still be alive), statistical adjustments are required to take into account those unknown or “censored” survival times.

In this report, relative survival was used to estimate the proportion of people who survived for different lengths of time. Relative survival compares the survival of people who have a particular disease or condition against the expected survival of a comparable group from the general population, taking into account age, sex and year of diagnosis. The method does not require knowledge of the specific cause of death, only information about whether the patient has died. Relative survival is the most commonly presented measure of cancer survival when using data from population-based cancer registries.²⁸⁵ For this report, patients who were still alive at 31st December 2004 were considered censored.

Relative survival estimates can be calculated using either the period or cohort methods.²⁸⁶ Relative survival estimates shown in this report were produced using the period approach. Although previous cancer survival estimates for Queensland have been based on the more traditional cohort method,¹⁴⁰ the period approach is gaining popularity and is recognised as providing more up-to-date survival estimates.²⁸⁷ Nonetheless, differences between the two methods are small when comparing a short survival timeframe (e.g. 5 years), although they become more pronounced as the timeframe increases.²⁸⁶

A suite of programs developed by Paul Dickman from the Karolinska Institutet in Sweden²⁸⁸ were used to generate the relative survival estimates. These programs use a life table (or actuarial) method for calculating observed survival. This approach involves dividing the total period of

“observation” into a series of discrete time intervals. The survival probabilities were then calculated for each of these intervals, and these were multiplied together to get the estimate for observed survival. Expected survival (based on total Queensland mortality data obtained from the Australian Bureau of Statistics) was calculated based on the Ederer II method.²⁸⁹ Three-year averages for expected survival were used to minimise the effects of year to year variation. Relative survival was then obtained from the ratio of observed survival to expected survival.

Note that differences in survival within Queensland, throughout Australia and internationally need to be interpreted with caution. It is possible that differences may be real; for example there may be a higher proportion of lung cancers diagnosed at a more advanced stage in some areas or variation in the use of radical treatments.¹⁷⁶ However, there are also a range of other reasons that may artificially alter survival times, such as differing data collection, coding or statistical practices.^{140,176,179}

Survival benefit

Modelling of the variation in relative survival estimates within Queensland was performed with a generalised linear model using exact survival times and a Poisson assumption (with logarithmic link and offset).²⁸⁵ The models were also adjusted for age. Differences in survival were expressed in terms of a survival benefit (along with 95% confidence intervals), which was based on survival estimates up to and including 5-year survival.

A further adjustment was made to the survival benefit estimates by geographic region (14 areas) to take into account the possible effects of small numbers (see “Shrunken estimates”). This adjustment was not considered appropriate for the analyses by remoteness/accessibility (four categories) or socio-economic status (three categories).

A survival benefit significantly greater than 100 corresponds to improved survival compared to the reference group, while a survival benefit significantly less than 100 indicates poorer survival. Note that geographical differences in survival benefit within Queensland were based on the place of diagnosis, not the place of death.

Yearly percentage change (YPC)

This is the yearly increase or decrease in the incidence or mortality trends over the specified period. Negative YPC values describe a decreasing trend and positive YPC values describe an increasing trend. A trend is taken to be statistically significant if the 95% confidence interval does not include zero.

YPC values were calculated using a statistical method called joinpoint analysis, with software developed by the Statistical Research and Applications Branch of the National Cancer Institute.¹⁰⁵ The joinpoint method evaluates changing trends (both the direction and the magnitude of the trend) over successive segments of time. A joinpoint is the point at which the linear trends change significantly.

The analysis begins with the assumption of constant change over time (i.e. no joinpoint). Up to three joinpoints were tested in each model, depending on the number of years of data available and the stability of the yearly estimates. The selected trend line was the one with the fewest joinpoints which provided the best fit to the observed data, based on Monte Carlo permutation tests.¹⁰⁵

B.4 Geographical and socio-demographic areas

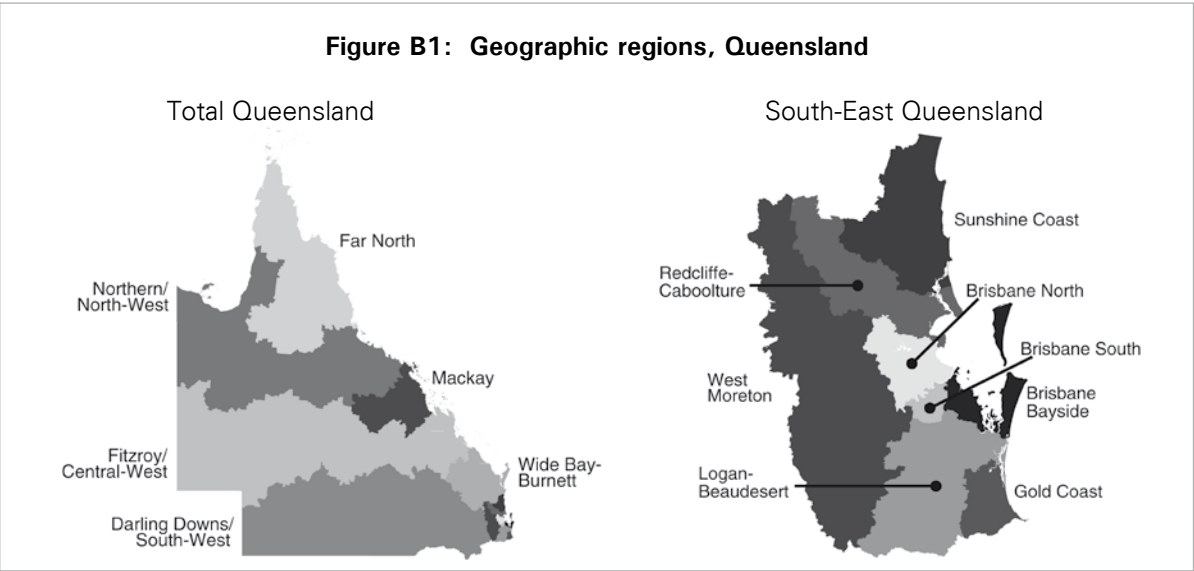
Three area-based measures were analysed in this report: geographic region (14 areas), accessibility/remoteness (four categories) and socio-economic status (three categories). Each of these measures was defined to cover Queensland completely and without overlap, and was based on the person’s place of usual residence when they were diagnosed with lung cancer.

Statistical local areas (SLAs) were the building blocks used to create the area-based groupings. SLAs are part of the Australian Standard Geographic Classification used by the Australian Bureau of Statistics.²⁹⁰ They correspond either to Local Government Areas (LGAs) or suburbs in larger LGAs (such as Brisbane City). In 2004 there were 481 SLAs in Queensland.²⁹⁰

For each of the area definitions, the data from the relevant SLAs in a specific category were first combined, and then all analyses were undertaken on the combined data. Lung cancer records that had missing or undefined SLAs (about 0.4% of all records between 2000 and 2004) were excluded from any of the geographic or socio-demographic analyses.

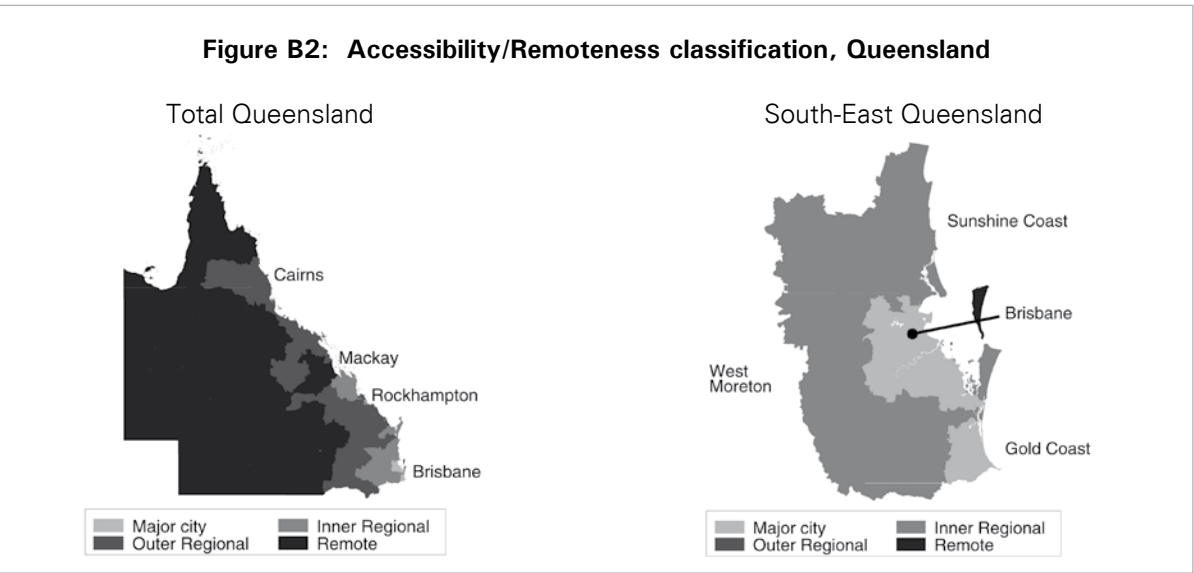
Geographic region

The geographic regions were a set of 14 distinct areas that cover Queensland (see Figure B1). These areas corresponded closely to the Health Service Districts that were used by Queensland Health (with some Districts aggregated).²⁹¹ Total Queensland was used as the reference group for the analyses by geographic regions.



Accessibility/Remoteness

Categories of accessibility/remoteness in Queensland were defined by the ARIA+ (Accessibility/Remoteness Index for Australia) classification (Figure B2).⁴¹



The ARIA+ classification is an enhancement of the original ARIA scheme, and defines remoteness on the basis of five categories: major city, inner regional, outer regional, remote and very remote. For the purposes of this report we have combined remote and very remote as the “Remote” category. Full details of the differences between the ARIA+, ARIA and other geographical remoteness classifications have been described elsewhere.²⁹²

The grouping of “Major city” had the largest population and so was chosen as the reference category for the analyses by remoteness/accessibility.

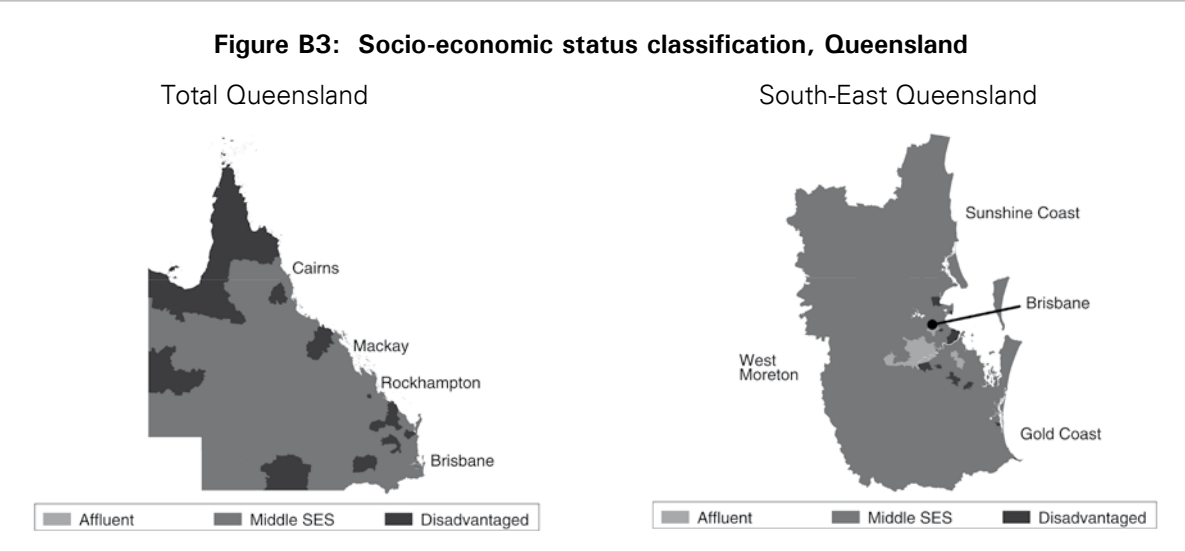
Socio-economic status (SES)

Socio-economic status was defined according to the SLA where the person was living at the time of their diagnosis with lung cancer. This approach was used because data on occupation of cancer patients collected by the Queensland Cancer Registry were not reported well enough to provide an index of SES. Other standard approximations of SES (e.g. income, education) were not collected by the QCR.

Using the ABS Socio-Economic Indexes for Areas (SEIFA) index of relative socio-economic disadvantage,⁴² the SLAs were ranked from the most to the least disadvantaged. Four SEIFA indexes are available. The index of relative socio-economic disadvantage was based on the percentage of people in the SLA with low income, low educational attainment and who were unemployed or employed in relatively unskilled occupations. The top 10% of SLAs were assigned to the disadvantaged group, the bottom 10% to the affluent group, with the remaining 80% placed in the middle SES category (see Figure B3). Note that the middle 80% of SLAs were not subdivided further due to many SLAs in Queensland including neighbourhoods with markedly different socio-economic characteristics.

Further details of the SEIFA indexes are reported elsewhere,⁴² with only minor changes to these published groups made to incorporate recent SLA boundary changes.

The middle SES category was the largest group, so it was used as the reference category for the analyses by socio-economic status.



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