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Bowel Cancer in New South Wales

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Jennifer Duncombe, Diane Hindmarsh, Deborah Baker, Stephen Morrell,
Kris Rogers, Paul Jelfs, James F. Bishop

The NSW Government agency dedicated to the control and cure of cancer
through prevention, detection, innovation, research and information.

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Cancer Institute NSW
Level 1, Biomedical Building
Australian Technology Park
EVELEIGH NSW 2015
PO Box 41
Alexandria NSW 1435
Telephone (02) 8374 5600
Facsimile (02) 8374 5700
E–mail information@cancerinstitute.org.au
Homepage www.cancerinstitute.org.au
Online cancer statistics
www.statistics.cancerinstitute.org.au

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Foreword from the Minister

The NSW Government has made tackling cancer a top priority. NSW was the first State to develop and implement a Cancer Plan and the first State to create a dedicated, expert policy body to examine and refine our response to the disease.

The Government is now working on its second Cancer Plan, with primary focus on prevention, early detection, ongoing training for health professionals, more effective treatments and cutting-edge research.

An important part of the work the Government has requested from the Cancer Institute NSW is the collation and publication of data to guide policy around cancer care and control.

Bowel cancer is the second most common cancer in NSW and one where we hope to see substantial gains made. This report documents improvements that have already been realised through the dedicated work of cancer doctors, nurses and other professionals. We hope that by providing this Report for discussion we can assist those professionals, and our health system as a whole, in generating further improvements for the future.

I commend this report to you.

The Hon Verity Firth MP

Minister for Women
Minister for Science and Medical Research
Minister Assisting the Minister Health (Cancer)
Minister Assisting the Minister for Climate Change, Environment and Water (Environment)

Chief Cancer Officer's report

Australia has higher bowel cancer incidence rates than most developed countries including the USA, Canada and the United Kingdom[1]. Bowel cancer is the second most common cancer in both sexes and the second most common cause of cancer deaths in NSW.

This report *Bowel Cancer in New South Wales* provides a comprehensive overview of the risk factors, distribution of bowel cancer in our community and the outcomes. Risk factors for developing bowel cancer include diet with recent evidence that high body fat and red or processed meat may increase that risk[2]. Conversely a high intake of dietary fibre and physical activity may reduce risk and could reduce the incidence of this cancer in our community in the future.

Overall around 65% of bowel cancer patients are alive five years after their initial diagnosis with many cured of their disease. The chances of surviving bowel cancer are dependent on the extent of the cancer at diagnosis with 86% alive five years after the diagnosis if localised. However, only 12% were alive five years after a diagnosis of secondary or metastatic bowel cancer. It would be expected that the more widespread introduction of bowel cancer screening by testing for blood in bowel motions will increase the chances of identifying early cancer with better survival over the next decade.

Cancer treatment has also improved over recent years with substantial survival gains from the use of chemotherapy after optimal surgery for bowel cancer with radiotherapy also added after surgery for more aggressive rectal cancers. Recent advances with targeted new drugs offers further hope for even larger improvements in the future.

This report provides information on the considerable improvement in outcomes already achieved for bowel cancer with a reduction of around 20% in death rates over the last 10 years. However, it also provides a useful baseline to measure our ability to improve results further in coming years.

James F Bishop MD MMed MBBS FRACP FRCPA

Chief Cancer Officer
CEO, Cancer Institute NSW
Professor of Cancer Medicine, University of Sydney

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Mortality details are provided by the Registrar of Births, Deaths and Marriages (NSW), and population and demographic data, and coded cause of death by the Australian Bureau of Statistics. Some data used in this report was accessed via HOIST. The HOIST system refers to a data access, analysis and reporting facility established and operated by the Centre for Epidemiology and Research, Division of Population Health, NSW Health Department.

Executive Summary

'Bowel cancer' refers to cancer of the large bowel, which includes the colon, rectum and anus in this report. Bowel cancer is the second most common cause of cancer and cancer-related deaths in males and females in New South Wales (excluding nonmelanotic skin cancer). In 2004, around 12% of new cancer cases and deaths in males and 13% in females were attributed to bowel cancer. Older people and those with a personal or family history of bowel cancer generally have a higher risk of bowel cancer. Conversely, protective factors for bowel cancer may include: regular physical activity, a balanced diet and healthy weight range. Most bowel cancers are evident in the colon (61% males, 69% females), followed by the rectum (37% males, 29% females) and anus (2% males, 2% females).

Age and sex adjusted incidence is lower for major cities than other geographical areas in New South Wales. However, mortality is similar between all geographic groups. The most socioeconomically disadvantaged group has a lower incidence of bowel cancer, compared with other groups. However, mortality is similar between all socioeconomic groups. Australia has a consistently higher incidence and mortality rate than less developed and more developed countries. The rate of bowel cancer is higher in the Australian-born population, compared with the non-Australian-born population.

More than one-third of bowel cancer cases are diagnosed at the local stage (34.2%), almost 40% at the regional stage, and 17% at the distant stage. Higher five-year relative survival for patients with localised bowel cancer (85.7%), compared with regional (65.9%) and distant (11.9%) cancer, demonstrates that early detection is central to reducing incidence and mortality from bowel cancer. The National Bowel Cancer Screening Program (Australia) was introduced in 2006 and uses Faecal-Occult Blood Testing (FOBT) to screen the target population (55 and 65 years initially) in order to increase early detection.

Bowel cancer is the second most common cause of cancer and cancer-related deaths in males and females in New South Wales.

1. Introduction

Bowel cancer, defined for this report as cancers of the colon, rectum and anus, is a significant cause of mortality and morbidity in New South Wales. It is the second most common cause of cancer in males and females combined (excluding nonmelanotic skin cancer), with 4,517 new cases in NSW in 2004 (Tracey et al. 2006).

It is estimated that 1 in 17 males and 1 in 26 females will develop bowel cancer by 75 years of age.

Similarly, bowel cancer is second only to lung cancer (excluding nonmelanotic skin cancer), as the most common cause of cancer related deaths in males and females combined. In New South Wales in 2004 there were 1,610 deaths from bowel cancer (Tracey et al. 2006). Bowel cancer currently accounts for 13% of cancer cases and cancer deaths for females and 12% for males.

The likelihood of having bowel cancer increases with age. It is estimated that 1 in 17 males and 1 in 26 females will develop bowel cancer by 75 years of age. This risk increases to 1 in 10 males and 1 in 14 females with bowel cancer by 85 years of age (Tracey et al. 2006).

Survival for bowel cancer has improved in recent years, with mortality rates decreasing by 21% for men and 19% for women between 1995 and 2004 (Tracey et al. 2006). This could be due to a variety of factors, such as: increased awareness of the signs and symptoms of bowel cancer and improved screening and early detection methods.

Alternatively, environmental factors such as physical activity and a diet high in fruit and vegetables may play a protective role in the reduction of new cases and deaths from bowel cancer. Conversely, risk factors such as age, personal or family history and obesity have the potential to increase an individual's risk of bowel cancer.

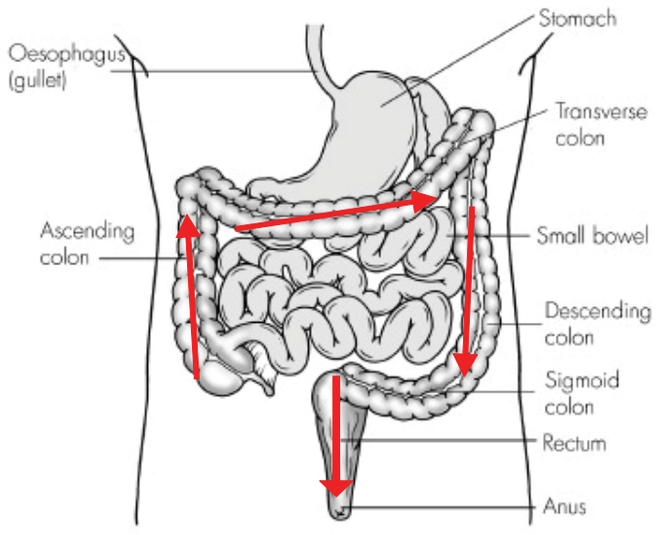
This report summarises information on the incidence and mortality of bowel cancer in New South Wales. It details trends and patterns over time and investigates variation between age groups, sex, geographic locations, socioeconomic status and cultural groups. The impact of environmental and hereditary risk factors such as family history and diet and exercise is also discussed. Findings for New South Wales are compared with other states and territories and national results where possible, and some international comparisons are also made. It is envisaged that this information will assist with the planning and provision of services to better diagnose, treat and support people with bowel cancer in New South Wales.

2. Identification and management of bowel cancer

2.1 Anatomy of the bowel

The bowel refers specifically to the colon, rectum and anus in this report, and is a major component of the digestive, or gastrointestinal, system (National Bowel Cancer Screening Program 2006). The digestive system breaks down food, retains nutrients and expels waste materials. The primary role of the colon is to absorb water. It is comprised of four parts: the ascending, transverse, descending and sigmoid colon. The colon links to the rectum, where waste is stored, and is then passed out of the body via the anus. Cancer of the bowel is also called 'colorectal' cancer.

FIGURE 1 Anatomy of the bowel



Source: CancerBackup (UK) 5/12/2006

2.2 Symptoms, screening and diagnosis of bowel cancer

2.2.1 *Overview*

If bowel cancer is found at a relatively early stage (Duke's stage A or B), there is a 90% chance that treatment will be effective (Australian Cancer Network Colorectal Cancer Guidelines Revision Committee 2005; Markowitz et al. 2002) (Table 1). However, patients with early stage bowel cancer rarely present with symptoms and therefore screening and diagnostic techniques need to be effective at detecting cancer while still asymptomatic in the early stages (Acheson & Scholefield 2002).

Symptoms of bowel cancer include blood in stools, anaemia or iron deficiency, change in bowel habits, abdominal pain and weight loss.

2.2.2 *Symptoms*

While symptoms of bowel cancer often go unnoticed or are not present, they may include:

- blood in stools or from the anus, often altered in colour to black or dark red
- anaemia or iron deficiency from blood loss
- a recent and persistent change in bowel habits, for example: looseness of stools or constipation, or mucus in bowel motions
- unexplained tiredness
- abdominal or stomach pain or cramps
- unexplained weight loss
- a feeling of not having emptied your bowel properly after a bowel movement.

Appearance of these signs or symptoms should be reported to a medical professional immediately (NSW Cancer Council 2007).

2.2.3 *Screening*

Bowel cancer screening techniques vary throughout the world (Weitz et al. 2005). Procedures include: faecal-occult blood test (FOBT), double-contrast barium enema, colonoscopy and flexible sigmoidoscopy. However, while none of these have been proven to be completely effective, with financial, physical and cultural constraints evident, randomised controlled trials have identified that FOBT can reduce bowel cancer mortality by 15–30% (GESA 2006;

Walsh & Terdiman 2003; Weitz et al. 2005). Historically, FOBT has been the procedure of choice for the screening of bowel cancer in Australia, as it is supported by clinical trial evidence. Physical discomfort and complications associated with colonoscopies have also resulted in FOBT as the generally preferred method for initial screen (Weitz et al. 2005). A colonoscopy is recommended if the FOBT is positive.

The National Bowel Cancer Screening Program aims to detect bowel cancer at an early stage via screening with the FOBT.

2.2.3.1 National Bowel Cancer Screening Program

With the introduction of the National Bowel Cancer Screening Program in 2006, FOBT is being used in Australia as a method of initial screening for the target population (National Bowel Cancer Screening Program 2006). The FOBT detects small amounts of blood in the stool, which may not be visible with the naked eye. The advantages of the FOBT are that it is inexpensive, quick and easy to use and non-invasive (Dorundi & Banerjea 2006). The FOBT has half the sensitivity of a flexible sigmoidoscopy and less than one-third of the sensitivity of a colonoscopy but with fewer complications (Markowitz et al. 2002). It is anticipated that undertaking a FOBT every two years may reduce the risk of death from bowel cancer by 15–30% (GESA 2006; Walsh & Terdiman 2003; Weitz et al. 2005).

The National Bowel Cancer Screening Program was established as a part of the Australian Government's Strengthening Cancer Care initiative (2005–2006), following the success of the Bowel Cancer Screening Pilot Program from 2002 to 2004. The Pilot program invited 56,907 men and women from Mackay, Adelaide and Melbourne to participate (National Bowel Cancer Screening Program 2006). The overall participation rate was 45.5%, which is comparable with other screening programs, and was higher for women (47.4%) than men (43.4%) (National Bowel Cancer Screening Program 2006). The primary reasons cited for participating in the pilot program were: precaution, prevention, early detection, health check important and peace of mind.

The National Bowel Cancer Screening Program is a nation-wide, population-based bowel cancer screening program that aims to detect bowel cancer at an early stage via screening with the FOBT. The National Bowel Cancer Screening Program is to be phased in over a number of years from 2006. This is to ensure that diagnosis and treatment services will be able to deal with any extra demand.

People turning 55 or 65 years of age between 2006 and 2008, and those in the pilot program, are being offered screening initially via an invitation through the mail. Patients with a positive FOBT result are asked to discuss the result with their General Practitioner, who will usually suggest further testing; most likely a colonoscopy. The National Bowel Cancer Screening Register plays an important role issuing invitations and reminder letters and recording and following up results. Together with closer screening of those with an increased risk due to hereditary factors, it is anticipated that screening will reduce mortality from bowel cancer by 15–30% (GESA 2006; Walsh & Terdiman 2003; Weitz et al. 2005).

The Australian government aims to complete an evaluation of the National Bowel Cancer Screening Program prior to the 2008–2009 Federal Budget. If successful on clinical grounds and approved for extension, people aged 55–74 years will be invited to participate, with additional age groups to be targeted over a number of years.

2.2.4 Diagnosis

The longer bowel cancer goes undetected, the greater the likelihood that the cancer will spread through the body. Staging is a measure of how far the disease has spread through the body and influences the type of treatment approach to be taken. There are a number of standards for measuring the stages of bowel cancer, however most have common features. In Australia and the UK, 'TNM (Tumour, Node, Metastases)' staging may be used by clinicians (Cancer Research UK 2007) (Table 1). However, in Australia, the alternative, 'Duke's' method of staging, may also be used (Table 2).

TABLE 1 TNM method

TX	Primary tumour cannot be assessed.
T0	No primary tumour identified.
Tis	Carcinoma in situ (tumour limited to mucosa).
T1	Involvement of submucosa, but no penetration through muscularis propia.
T2	Invasion into, but not penetration through, muscularis propia.
T3	Penetration through muscularis propia into subserosa (if present), or pericolic fat, but not into peritoneal cavity or other organs.
T4	Invasion of other organs or involvement of free peritoneal cavity.
NX	Nodal metastasis cannot be assessed.
N0	No nodal metastasis.
N1	1–3 pericolic/perirectal nodes involved.
N2	4 or more pericolic/perirectal nodes involved.
MX	Distant metastasis cannot be assessed.
M0	No distant metastases.
M1	Distant metastases.

Source: American Joint Committee on Cancer. 2002. AJCC Cancer Staging Manual, Sixth Edtion,; Springer-Verlag New York, New York.

TABLE 2 TNM stage groupings, Duke's stage, five-year survival and degree of spread

TNM Stage	TNM Group	Duke's stage	Five-year survival (%)	Degree of spread
0	Tis, N0, M0	-	-	
I	T1, N0, M0: T2, N0, M0	A	87.2	Local
IIA	T3, N0, M0	B	87.2	Local
IIB	T4, N0, M0	B	87.2	Local
IIIA	T1, N1, M0: T2, N1, M0	C	67.7	Regional
IIIB	T3, N1, M0: T4, N1, M0	C	67.7	Regional
IIIC	Any T, N2, M0	C	67.7	Regional
IV	Any T, any N, M1	D	12.1	Distant

Source: Adapted from American Joint Committee on Cancer. 2002. AJCC Cancer Staging Manual, Sixth Edtion,; Springer-Verlag New York, New York and Tracey et al. 2006.

Duke's method is used by clinicians to measure the spread of disease.

Duke's method is used by clinicians to measure the spread of disease. Pathologists refer to this as 'degree of spread' and classify the above stages into categories of: local, regional, distant and unknown. Following pathologists, the NSW Central Cancer Registry (CCR) codes and records stage of cancer according to degree of spread categories.

Patients with a positive FOBT result are recommended to undertake a colonoscopy, physical examination, abdominal ultrasound or CT scan to investigate the cause of the bleeding (National Bowel Cancer Screening Program 2006; Weitz et al. 2005). Results from the pilot study conducted from 2002–2004 suggest that about 1 in 14 people will have a positive FOBT result.

However, many of these may be due to causes other than cancer such as: benign polyps, haemorrhoids or inflammation of the bowel (National Bowel Cancer Screening Program 2006). Diagnosis typically involves a colonoscopy followed by a biopsy of potentially cancerous material, which is sent to a pathology laboratory for further testing (Weitz et al. 2005).

Regardless of cancer type, most patients will be offered surgery as the best approach to cure or control disease.

2.2.5 Treatment

Treatment for bowel cancer is tailored to the individual's cancer type, stage and location (DeVita, Hellman & Rosenberg 2004). However, treatment generally involves one or all of: surgery, chemotherapy and radiotherapy.

2.2.5.1 Surgery

Regardless of cancer type, most patients will be offered surgery as the best approach to cure or control disease. The aim of surgery is to 'remove the primary tumour and any regional spread that may have already occurred, without causing further dissemination of tumour, while at the same time preserving a reasonable quality of life for the patient' (NHMRC 2005).

For inoperable rectal cancers, the National Health and Medical Research Council (NHMRC) (2005) recommends radiotherapy or chemotherapy.

2.2.5.2 Radiotherapy

Radiotherapy eliminates cancer cells by using ionising radiation. While radiation is powerful, it only affects those tissues located within the treatment beam; therefore this is a useful agent for local control of cancer (NHMRC 2005).

The use of radiotherapy is somewhat limited in colon cancer compared to rectal cancer, due to the anatomy, natural history and biology of the organ (DeVita, Hellman & Rosenberg 2004). However, the NHMRC (2005) recommends radiotherapy routinely for high-risk rectal cancer.

Radiotherapy is often used in combination with chemotherapy; however, current evidence is varied. The NHMRC (2005) recommends that radiotherapy may be combined with chemotherapy for the treatment of recurrent and advanced rectal cancer.

2.2.5.3 Chemotherapy

Chemotherapy is cytotoxic drug treatment that affects cancer throughout the body (NHMRC 2005). Chemotherapy has been proven to increase survival for cancers, as it can access tumours that have penetrated the wall of the organ and metastasised to regional lymph nodes (NHMRC 2005). Adjuvant chemotherapy is usually given immediately after surgery in the above situation using a combination of drugs, usually 5-fluorouracil, oxaliplatin and folinic acid.

2.2.5.4 Follow-up

Following treatment for bowel cancer, patients are at a higher risk of developing a polyp or cancer of the bowel. Therefore, it is important to monitor the patient closely (DeVita, Hellman & Rosenberg 2004; NHMRC 2005). The NHMRC (2005) recommends that follow up should be intensive for patients with potentially curable disease; however, 'optimal investigation and pathways are yet to be firmly established'.

2.2.5.5 Recurrent bowel cancer

Recurrent bowel cancer can present in a number of ways and each has a different treatment pathway, dependant on discussions between the patient and their specialists (NHMRC 2005). Chemotherapy is usually used for the treatment of recurrent and advanced colon and rectal cancer, with radiotherapy often added in.

3. The Epidemiology of bowel cancer

3.1 Risk factors

A risk factor is a variable associated with an increased risk of disease that may, or may not, be causal. Risk factors may be classified as modifiable, where the risk can be reduced or increased by a change in behaviour, and non-modifiable. There are a number of well-established risk factors associated with bowel cancer, such as age. However, there is also increasing evidence for associations with a range of other risk factors, such as diet and physical activity. Interestingly, particular risk factors may impact different sections of the bowel.

3.1.1 Age

The risk of contracting bowel cancer is dramatically increased with age, and primarily affects people over the age of 50 (Tracey et al. 2006). Age is unmodifiable and is perhaps the most important risk factor associated with bowel cancer (Gross et al. 2006; O'Dwyer et al. 2007).

3.1.2 Personal and family history

3.1.2.1 Polyps

Cancer of the bowel typically develops from small, raised areas in the cells that line the bowel, called polyps (Markowitz et al. 2002). Polyps are generally not dangerous, and are common in older people, with nearly 80% of people over 70 years of age having at least one polyp (Cancerbackup 2006). However, some polyps become malignant. If malignant polyps are not detected, an invasive cancer may develop and could eventually spread to adjacent lymph nodes and other organs (Kaz & Brentnall 2006). Changes to polyps may take months or years and if detected early and removed, the risk of bowel cancer is greatly decreased.

3.1.2.2 Genetics

Hereditary conditions are responsible for approximately 5–10% of all cases of bowel cancer each year, most of which are the result of genetic conditions such as familial adenomatous polyposis (FAP) syndrome and hereditary non-polyposis colon cancer (HNPCC), and in these syndromes cancer may develop before the age of 50 (Kinzler &

Hereditary conditions are responsible for only 5–10 per cent of all cases of bowel cancer each year ... age is the main risk-factor.

Vogelstein 1996; Markowitz et al. 2002). However, there may be genetic susceptibility for bowel cancer even when there is no evidence of one of the above hereditary syndromes (Markowitz et al. 2002). Thus, a two to three fold increase in risk of bowel cancer can occur in immediate relatives of people affected by either bowel cancer or polyps before 60 years of age (Markowitz et al. 2002).

The NSW and ACT Hereditary Cancer Registries (HCR) were established in 1990 to provide information and support to people affected by hereditary cancer, their family members and health professionals. Services include: booklets and newsletters with current information about hereditary cancer, a reminder service to help registrants keep track of screening appointments, assistance with informing relatives of their risk of cancer and information about genetic services and tests. Almost 1000 people are currently registered with the HCR from around 500 families in NSW and the ACT.

3.1.2.2.1 Familial adenomatous polyposis (FAP) syndrome

Familial adenomatous polyposis (FAP) syndrome is caused by an inherited genetic abnormality. This is a mutation of the adenomatous polyposis coli (APC) gene, which causes hundreds of polyps to develop in the colon (Markowitz et al. 2002). Lee (2005) and others have suggested that FAP occurs from early adulthood onwards, while Markowitz et al. (2002) and Fingerote (2005) suggested that it starts developing from about 30 years of age. An individual with FAP left untreated, has a chance of bowel cancer of nearly 100% (Markowitz et al. 2002). Therefore, it is important to identify, monitor and treat people with familial adenomatous polyposis syndrome. Surgical removal of the bowel is recommended in most cases at an early age with the use of drugs only to be used 'as an adjunct to surgical management' (NHMRC 2005 pg. 100).

3.1.2.2.2 Hereditary non–polyposis colon cancer (HNPCC)

Hereditary non-polyposis colon cancer (HNPCC) is also an inherited genetic condition. Bowel cancer, associated with HNPCC, usually occurs in the ascending colon with far fewer polyps than FAP (Kinzler & Vogelstein 1996). HNPCC is a dominant condition caused by a mutation in one of a family of the mismatch repair (MMR) genes which affects the rate of cancer progression. If diagnosed with hereditary non-polyposis colon cancer, the lifetime chance of developing colon cancer is about 80% (Markowitz et al. 2002). While this is lower than familial adenomatous polyposis, people with hereditary non-polyposis colon cancer also have an increased risk of developing other cancers such as ovary, stomach and brain cancers (Kinzler & Vogelstein 1996; NHMRC 2005).

If diagnosed with hereditary non-polyposis colon cancer, the lifetime chance of developing colon cancer is about 80 per cent.

3.1.2.2.3 Other inherited syndromes

There are a number of other genetic conditions and inherited syndromes that may increase an individual's chance of developing bowel cancer. However, they are difficult to identify, measure and investigate. For example, a milder variant of familial adenomatous polyposis syndrome is attenuated familial adenomatous polyposis (AFAP). Attenuated familial adenomatous polyposis syndrome results in the development of fewer polyps than classic FAP. However, those with AFAP are still at a higher risk of developing colon cancer at a younger age than the general population. Other inherited syndromes recognised and on the NSW and ACT Hereditary Cancer Registry include: Juvenile Polyposis, Peutz-Jeghers Syndrome, MYH-associated Polyposis, Hyperplastic polyps and Mixed Polyposis.

3.1.2.2.4 Genetic testing

Diagnosis of the above genetic disorders is possible via blood testing (Kaz & Brentnall 2006). There are a number of methods that may be used to identify genetic mutations, but results may be inconclusive. For example, some mutations are not able to be detected with current technologies, as parts of DNA or genes are often rearranged, unrecognised or missing (Kaz & Brentnall 2006; Kinzler & Vogelstein 1996). Alternatively, the family mutation may reside in a gene not yet discovered to be associated with the genetic condition (NHMRC 2005). Some disorders are diagnosed through clinical testing, but this is only possible when symptoms are physically identifiable. Therefore, this method also potentially under-diagnoses a range of genetic abnormalities (Kinzler & Vogelstein 1996). There are calls for continual research to be done in the area of genetic testing for bowel cancer, to further current knowledge (Jarvinen 2003; Kaz & Brentnall 2006; Kinzler & Vogelstein 1996).

Isolated testing is not generally recommended as it may initiate a false negative or false positive result. Prior to genetic testing, a series of steps is recommended (Australian Cancer Network Colorectal Cancer Guidelines Revision Committee 2005):

- Establish a working diagnosis.
- Consider pre-genetic testing where HNPCC is suggested but not clear cut.
- Define the causative mutation in an affected individual.
- Offer predictive testing to at-risk members of the family.
- Provide appropriate genetic counselling and support for affected and unaffected family members.

Regular screening via flexible sigmoidoscopy or colonoscopy for patients and their families with one of these inherited conditions is strongly recommended to ensure that if cancer develops, it is treated early (Australian Cancer Network Colorectal Cancer Guidelines Revision Committee 2005).

3.1.3 Diet

Diet has been associated with an increased risk of cancer in developed countries such as Australia, with approximately 30% of total cancer cases attributed to dietary factors (Doll & Peto 1981). There is a substantial body of evidence surrounding dietary influences on bowel cancer. Key risk factors that may be causal for, or protective against, bowel cancer include: folate, fibre, meat, vitamin D, poultry and fish consumption and a high-fat diet.

High meat consumption – in particular, red meat – may substantially increase the risk of developing bowel cancer (Chan et al. 2005; Ghadirian et al. 1997; Tiemersma et al. 2002). However, the risk appears to vary by site, with Ghadirian et al. (1997) stating that the risk is increased in both the colon and rectum, and Kampman et al. (1995) finding a correlation with the colon only. Chao et al. (2005) found that a diet high in red meat affects only distal colonic cancer, while Sinha et al. (1999) stated that only well-done and very well-done red meat impacts on bowel cancer. These differential findings may be attributed to study limitations; most commonly, small sample size. However, a large European study recently found that red and processed meat consumption does, in fact, increase the risk of bowel cancer (EPIC 2004).

Previous evidence suggested that fibre, which largely comes from fruit and vegetables, is protective against bowel cancer. Some research indicates that fruit and vegetable consumption is a protective factor for rectal cancer only (Deneo-Pellegrini et al. 2002; Dixon et al. 2004; Slattery et al. 2004). Other studies report that fruit and vegetable consumption is protective against colon cancer only (Ghadirian et al. 1997; Kampman et al. 1995; Voorrips et al. 2000). Interestingly, Voorrips et al. (2000) found that Brassica (broccoli, cauliflower, Brussels sprouts) and leafy green vegetables may reduce the risk of developing bowel cancer over other fruits or vegetables. Recent evidence from a large European study demonstrated that fibre is protective for the development and malignancy of polyps (EPIC 2004; Bingham 2007).

A diet that includes lean poultry and raw or cooked fish has been shown to reduce the risk of bowel cancer (Tiemersma et al. 2002; Yang et al. 2003). In particular, the European Prospective Investigation into Cancer and Nutrition (2004).

A diet that includes lean poultry and raw or cooked fish has been shown to reduce the risk of bowel cancer.

found fish to be strongly associated with decreased risk of developing bowel cancer. However, some evidence states that salted and dried fish may increase the likelihood of developing cancer of the bowel (Yang et al. 2003). Likewise, a diet high in fat may increase the risk of developing bowel cancer. This may be particularly associated with red and processed meat consumption, however there is limited evidence at this stage (Sandhu 2005).

Folate may be a protective factor for bowel cancer, with increased dietary folate reducing the risk of bowel cancer (Levi et al. 2001; Terry et al. 2002a). However, Glynn et al. (1996) found a protective effect for colonic cancer only. Vitamin D may also be protective, with reductions in bowel cancer, particularly rectal cancer, with increased Vitamin D intake (Pritchard et al. 1996). However, current evidence for these effects is limited and requires further investigation.

3.1.4 Physical activity

Physical activity is an important, modifiable risk factor for bowel cancer, where those undertaking physical activity may have a reduced risk (Giacosa et al. 1999). There is also evidence for a significant dose-response relationship between physical activity and bowel cancer (Colditz et al. 1997). The site-specific effect is evident here also, with Samad et al. (2005) demonstrating a statistically significant protective effect of physical activity for colon cancer, but not rectal cancer. It is important to note that the intensity and duration of activity that confers benefit is uncertain and more research is needed in this area.

3.1.5 Overweight and obesity

The influence of overweight and obesity on the risk of bowel cancer is fairly well-documented, albeit varied. Overweight and obesity appears to be primarily associated with cancer of the colon (Engeland et al. 2005). Doria-Rose et al. (2006) found no relationship between weight and rectal cancer, but showed that underweight and obese post-menopausal women have an increased rate of death from colonic cancer. Results also demonstrate a relationship between increased Body Mass Index (BMI) and proximal colonic cancer (Lin et al. 2004) and high body fatness and increased adenoma growth (Almendingen et al. 2002). A low-energy diet may also be a protective factor for bowel cancer (Rouillier et al. 2005).

Overweight and obesity appears to be primarily associated with cancer of the colon only.

3.1.6 Smoking

Tobacco smoking is associated with a number of cancers, including bowel cancer. Current evidence shows that the risk of developing bowel cancer is increased in those who smoke tobacco, with the risk increasing as duration of smoking increases (Colangelo et al. 2004; Sanjoaquin et al. 2004; Slattery et al. 2004). Current evidence is inconsistent, with other studies showing no clear association, or only a weak association between smoking and bowel cancer (Sharpe et al. 2002; Wakai et al. 2003). Smoking may have differential effects on the bowel, as studies have shown that smoking increases the risk of rectal cancer, but not colon cancer (Terry et al. 2002b). This may explain why studies that have looked at this association using colon and rectal cancer combined found less of an association. Additionally, women over 50 years of age or who are post-menopausal and who smoke have an especially high risk of cancer of the bowel (Colangelo et al. 2004; Limburg et al. 2003).

3.1.7 Alcohol

There is also some evidence for an association between high alcohol consumption and bowel cancer, including a dose response relationship (Glynn et al. 1996; Otani et al. 2003). However, findings are limited at this stage and warrant further investigation.

4. Methods

This report brings together data from a number of routine collections which have been used to examine trends in bowel cancer. This chapter gives a brief description of the major data sources used, the statistical methods used in the analysis and interpretation of these data. Data were obtained from the Health Outcomes and Information Statistical Toolkit (HOIST) system of the New South Wales Department of Health and the New South Wales Central Cancer Registry (NSW CCR).

4.1 Cases

Cases were selected from the NSW CCR based on the ICD-10 topography codes C18 to C21 (Appendix 1). Notification of cancer cases has been a statutory requirement in New South Wales since 1972 by public and private hospitals, departments of radiation oncology, nursing homes, pathology laboratories, outpatient departments and day procedure centres.

Some changes may occur in the data between extraction dates from the NSW CCR due to changes in coding, addition of further information or delayed registration of cases. Data in this report were extracted as of June 2006, and incidence and mortality figures to the end of 2004 are included. Percentage increases in the number of cases were calculated using the method presented in Cancer in Australia, 2001 (Australian Institute of Health and Welfare p. 108; AACR 2004).

Cases were allocated to the 2005 area health services based on residential address at the time of diagnosis. However individuals may not necessarily be treated in the health area to which they are allocated.

Where data are similar between years, sex or age, or the population is small, they have been aggregated.

4.1.1 Accessibility and Remoteness

This report uses the Accessibility / Remoteness Index for Areas (ARIA-Plus) values assigned to Local Government Areas (LGA's) by the Australian Bureau of Statistics (ABS) which were based on the 2001 census information. ARIA-Plus is endorsed by the ABS as the standard measure of remoteness (GISCA 2006). The mean ARIA-Plus index for the LGA was used for all cases within a given LGA. These were categorised into the five ARIA-Plus remoteness categories using the standard cut-off values used by the ABS (see glossary). An issue with comparisons based on remoteness is that populations within remote areas are very small. As a result, the 'remote' and 'very remote' areas were combined, however the population is still relatively small, and hence estimates may be inaccurate. This is reflected by wide error bars in figures for the remote and very remote area. Due to similar patterns in males and females, these data are aggregated into 'persons'.

Notification of cancer cases has been a statutory requirement in New South Wales since 1972.

4.1.1.1 Local Government Area (LGA)

Local Government Area data was obtained from the Cancer Institute NSW's statistics module, available at: http://www.statistics.cancerinstitute.org.au/.

4.1.2 Socioeconomic status

Socioeconomic status was estimated using the Index of Relative Socioeconomic Disadvantage (IRSD), one of four Socio Economic Indexes for Areas (SEIFA) created by the ABS from the 2001 census. The IRSD index for each LGA from the 2001 census was categorised into population-weighted quintiles for presentation purposes. Due to similar patterns in males and females, these data are aggregated into 'persons'.

4.1.3 Degree of spread

Degree of spread was based on the stage at first presentation, a variable that indicates the maximum extent of the cancer within four months of the date of diagnosis. It is derived by the NSW CCR from the maximum extent of disease across all reports and notifications dated within four months of the date of diagnosis.

Degree of spread was based on the stage at first presentation.

Due to similar patterns in males and females, these data are aggregated into 'persons'.

4.1.4 Country of birth

Country of birth was aggregated into 'English speaking country of birth' (New Zealand, UK, Ireland, USA, Canada and South Africa), 'non-English-speaking country of birth' and 'Australian-born'. Approximately 10% of cases did not have a country of birth recorded on the NSW CCR. These cases contributed to the overall analysis, but were not included in the analysis by country of birth.

Population estimates were based on country of birth population figures, obtained from HOIST and aggregated into the same categories as the data.

4.2 Population

Population estimates for NSW as a whole, for each of the health areas, as well as on the basis of accessibility and remoteness (ARIA), socioeconomic status (IRSD) and country of birth were obtained from the Australian Bureau of Statistics (ABS) via HOIST.

4.3 Standardisation

Directly age-standardised rates are presented on an age-standardised basis using the Australian standard population in 2001 (obtained from the ABS) as the standard population.

4.4 Survival

Relative survival estimates were based on methods by Bremmer, Gefeller and Hakulinen (2005) and modified for use in the Cancer Incidence and Mortality Report by the Cancer Institute NSW (Tracey et al. 2006). Population survival rates were obtained from the NSW Life Tables, 2002–2004 produced by the ABS and downloaded from the ABS website (cat. no. 3302.1.55.001 Life tables, New South Wales, 2002–2004). Records with age over 100 were recoded to an age of 100, and cases that were only based on information on the death certificate or from post-mortem were excluded. Relative survival rates were estimated from people who were diagnosed between 1999 and 2003, with follow-up to the end of 2004. Deaths from all causes were included, and those that have not been matched to a death record were censored at the end of 2004.

Potential years of life lost (PYLL) were calculated by summing the difference between the age of death and 75 years for all people who died from bowel cancer in 2004. Those aged 75 or over did not contribute to the total. This total was divided by the total population aged 75 and below to give a rate per 1000 lives.

4.5 Projections

Projections for bowel cancer were based on mathematical modelling of trends in the past. It is assumed that these trends will continue in the future. The validity of projections declines with time, where 2007 data are likely to be closer to the observed than those for 2010. Future projections data were obtained from Aitken et al. (2007, in press).

4.6 Modelling

Statistical modelling was undertaken where cancer incidence or mortality was categorised into sections of the state (ARIA, IRSD, AHS and country of birth). Although the confidence bands around directly standardised rates provide some measure as to whether any pair of groups differs, statistical modelling can also determine whether there are significant differences between subsets of the groups.

The method used for this statistical modelling was Poisson regression. The total number of cases (or deaths) between 2000 and 2004 was modelled with age group and the categories as the explanatory variables and the logarithm of the population was an offset. For analyses based on ARIA, IRSD and AHS categories, the analysis was restricted to cases or deaths over 30 years of age, and five-year age groups used. Analysis based on country of birth used 10-year age groups and restricted the analysis to cases or deaths in those aged over 40 years of age.

Statistical modelling can also determine whether there are significant differences between subsets of the groups.

4.7 Data Interpretation

Although all care was taken in the calculations for this report, the numbers of cases are subject to change due to revisions made by the NSW CCR. This is due to routine data cleaning and quality assurance, as well as adjustments with the availability of new information. As a result, figures in this report may differ slightly to those in other reports. Updated populations are received at different times, which will mean that directly standardised rates may differ slightly from values given in other reports. Any trends in persons over the age of 80 were largely disregarded, as the numbers are quite small and may vary significantly.

5. **Bowel cancer** incidence and mortality

5.1 Overview

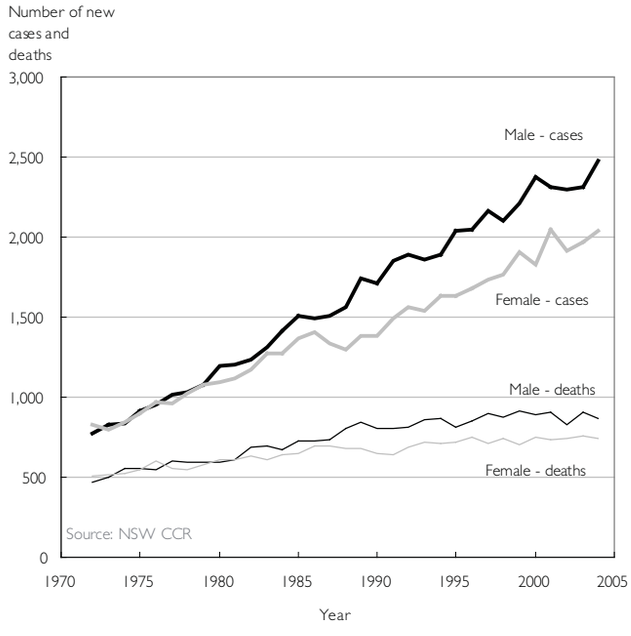
This chapter focuses on incidence and mortality of bowel cancer in New South Wales. It covers various aspects of the patterns of bowel cancer, including trends over time. These results will be useful as benchmarks to measure the impact of the National Bowel Cancer Screening Program that commenced in 2006.

In 2004 bowel cancer accounted for 12 per cent of all new cases of cancer in males and 13.7 per cent in females.

5.2 New cases of bowel cancer

- In 2004, there were 2,479 new cases of bowel cancer diagnosed in males and 2,038 in females.
- Bowel cancer accounted for 12% of all new cases of cancer in males in 2004, and 13.7% in females (Tracey et al. 2006). It is the second most common cancer in both males and females in NSW (excluding nonmelanotic skin cancer).
- The number of new cases per year has risen consistently for males at about 54 cases per year, giving an average annual rate of increase of 3.7%.
- Apart from a period between 1986 and 1988 when there was a substantial drop in the number of new cases, bowel cancer in females has increased by around 44 new cases per year. This is an average increase of 2.8% per year.
- The decline in new cases in 1986 may be explained by the change in pathology reporting, which made it possible to exclude 'in situ' cancer cases from the NSW CCR. However, this does not explain why the decrease is greater in females than males.
- Before 1984, the number of new cases diagnosed was fairly similar between males and females. Since then, the number of new cases in males has been consistently higher than in females.
- With the introduction of an organised screening program, such as the National Bowel Cancer Screening Program, initial incidence rates of bowel cancer may increase sharply. This is because detection of early stage bowel cancer prior to the onset of symptoms will be increased. Over time, these rates should stabilise and become more consistent.

FIGURE 2 New cases and deaths from bowel cancer, NSW, 1972–2004



5.3 Deaths from bowel cancer

- There were 868 deaths from bowel cancer in males and 742 in females in 2004. This equates to 12.2% of all cancer deaths for males and 13.4% for females (Tracey et al. 2006). It is the second most common cause of death from (non-gender-specific) cancer in NSW (excluding nonmelanotic skin cancer).

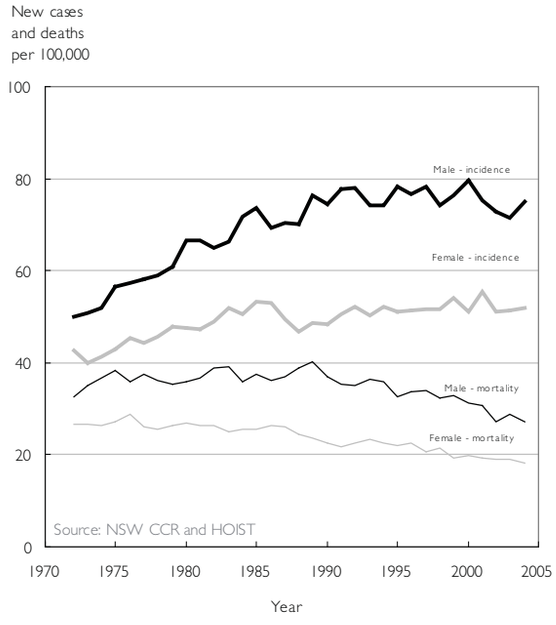
- The number of deaths from bowel cancer has been consistent for about 10 years in females and for about 15 years in males.
- The average risk of being diagnosed with bowel cancer by the age of 75 is 1 in 17 for males and 1 in 26 for females (Tracey et al. 2006).
- The average risk of death from bowel cancer by the age of 75 is 1 in 65 for males and 1 in 100 for females (AIHW 2005).
- An increase in early diagnosis due to the National Bowel Cancer Screening Program should be followed by a reduction in mortality; however such an effect may take a while to become noticeable.

5.4 Age-standardised incidence and mortality of bowel cancer

- In 2004, the age-standardised incidence rate of bowel cancer was 75 new cases per 100,000 for males and 52 for females.
- In the period between 1972 and 1990, the age-standardised incidence rate in males increased from 49.9 new cases per 100,000 to the current rate of 74.4 (a 50% increase). In the same period, rates in females increased from 42.7 new cases per 100,000 to 48.4 (a 13% increase).
- Since the mid-1990s, age-standardised incidence rates for bowel cancer have been reasonably stable in both males and females.
- The age-standardised mortality rate from bowel cancer in 2004 was 27.1 deaths per 100,000 for males and 18.1 for females.
- The age-standardised mortality rates have declined, particularly since the late 1980's. There has been an average annual decline in the mortality rates for both males and females of approximately 17% in the last 10 years.

Since the mid-1990s, age-standardised incidence rates for bowel cancer have been stable ... mortality rates have declined since the late 1980s.

FIGURE 3 Trends in bowel cancer: age-standardised incidence and mortality rates, NSW, 1972–2004



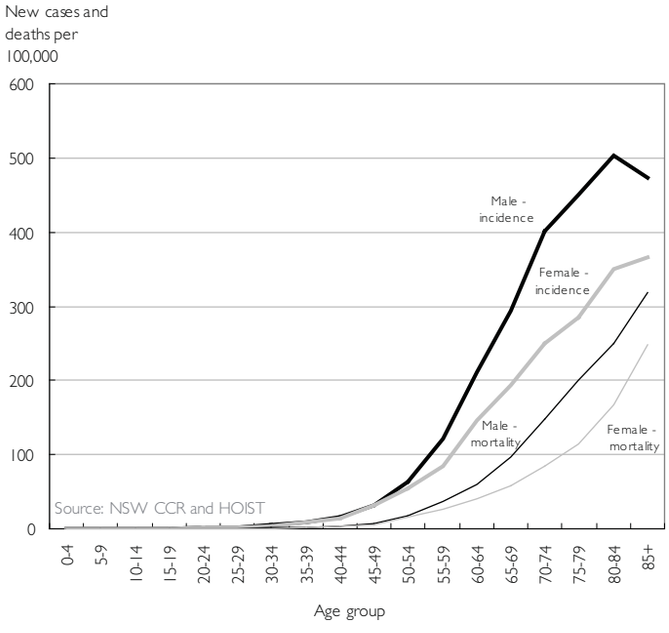
5.5 Trends in age-specific incidence and mortality of bowel cancer

- Age-specific incidence rates are higher in males than females.
- Of all the males diagnosed with bowel cancer between 2000 and 2004, 6.6% were younger than 50 and 15.3% were between 50 and 60 years of age. More than half were over 70.

Age-specific incidence rates are higher in males than females.

- Of all cases of bowel cancer in females from 2000 to 2004, 7.3% were younger than 50 and 13.6% were aged between 50 and 60 years. The proportion of new cases in females over the age of 70 was 56.1%.

FIGURE 4 Trends in bowel cancer: age-specific incidence and mortality rates, NSW, 2000–2004



5.6 Median age at diagnosis and death for bowel cancer

- The median age at diagnosis for bowel cancer in 2004 was 69 years for males and 72 years for females. It has increased by four years since registration began in 1972, with the greatest increase occurring in the early 1990s.
- The median age at death for bowel cancer in 2004 was 73 years in males and 77 years in females. This is an increase of five years, with the greatest increase appearing to occur since the mid-1990s.
- A rising median age at death suggests that survival for bowel cancer has increased.

FIGURE 5 Trends in median age at diagnosis for bowel cancer, NSW, 1972–2004

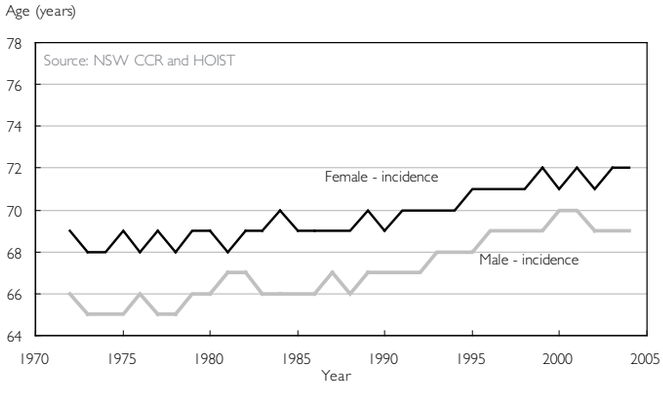
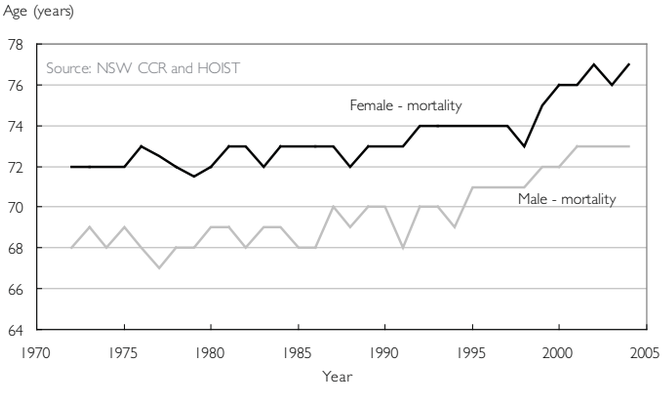


FIGURE 6 Trends in median age at death for bowel cancer, NSW, 1972–2004



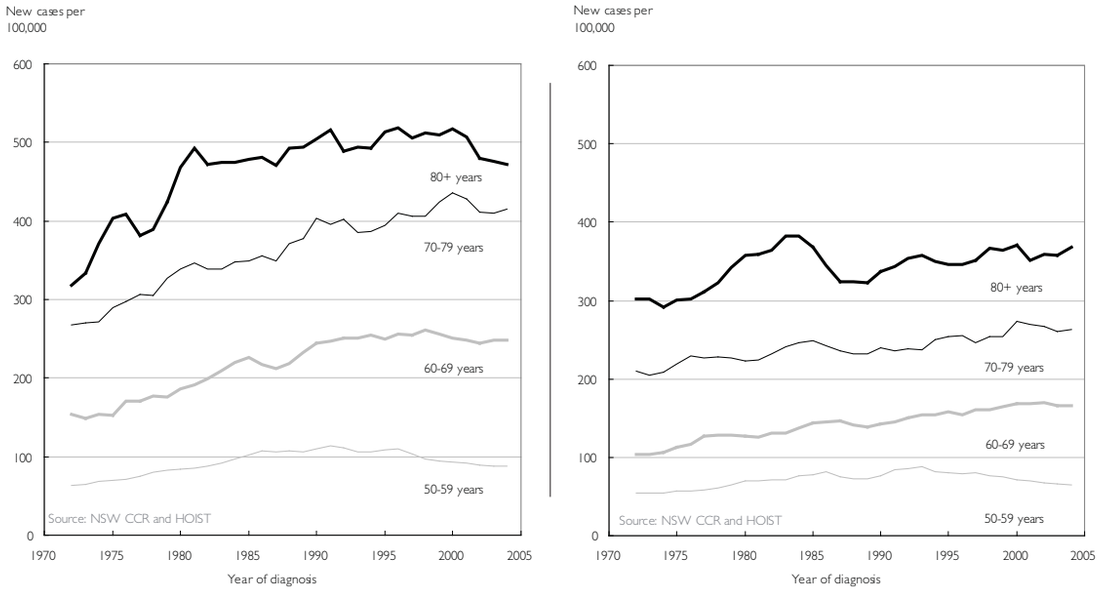
5.7 Trends in age-specific incidence and mortality rates for bowel cancer

5.7.1 Incidence of bowel cancer

- Age-specific incidence rates are much higher in males than females.
- The age-specific rate in the 50–59 year age group has fallen gradually since the early 1990s in both males and females; however for older age groups the rates are either increasing or have stabilised.
- The most obvious feature is the substantial rise in the age-specific rate of bowel cancer in males and females aged 80+ from the late 1970s to the early 1980s. This is possibly due to non-reporting issues.

The age-specific rate in the 50–59 year age group has fallen gradually since the early 1990's in both males and females.

FIGURE 7 Trends in age-specific incidence rates for bowel cancer, males and females, NSW, 1972–2004



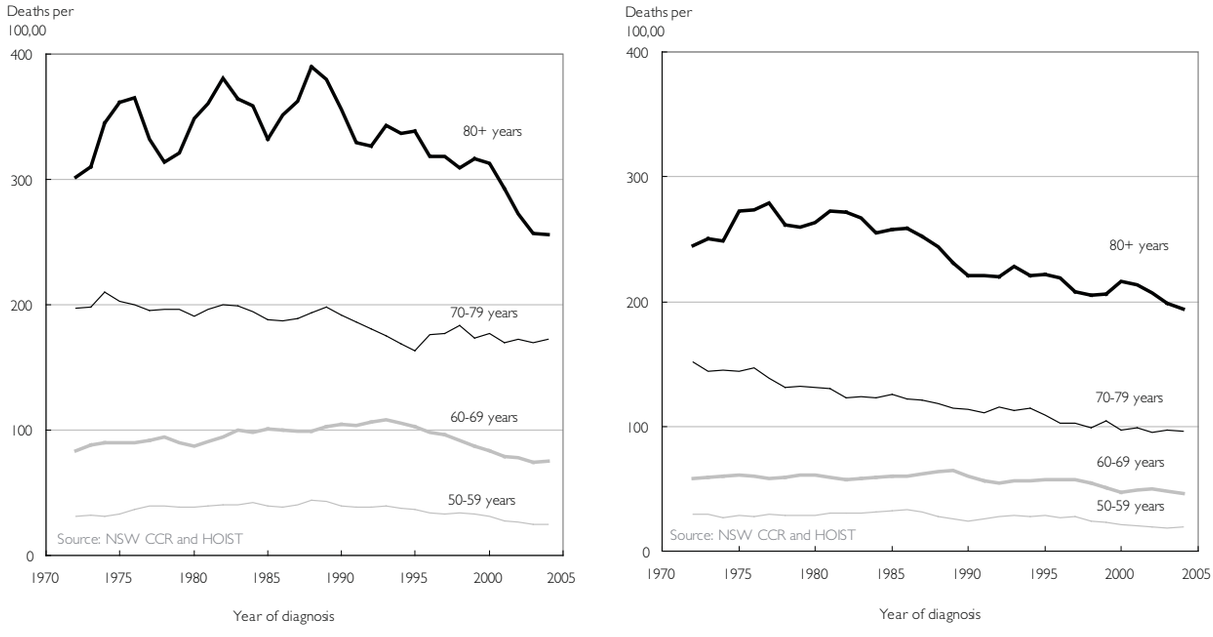
Note: these graphs are based on three-year moving averages

Generally, there has been a reduction in the age-specific mortality rates for each age group in male and females, except for males aged 60–69.

5.7.2 Mortality from bowel cancer

- Generally, there has been a reduction in the age-specific mortality rates for each age group in male and females.
- The reduction has been most noticeable in the older age groups (from 70 years onward). This may be due to better treatment and early detection outcomes.
- The most noticeable departure from the general downward trend is in males aged 60–69, where mortality rates increased until the early 1990's.

FIGURE 8 Trends in age-specific mortality rates for bowel cancer, males and females, NSW, 1972–2004



6. Trends in subtypes, degree of spread, stage at diagnosis and survival of bowel cancer

6.1 Trends in the subtypes of bowel cancer

6.1.1 Overview

- Of the 2,479 new cases of bowel cancer in males in 2004, 1,525 were located in the colon, 910 in the rectum and 44 in the anus.
- Of the 2,038 new cases of bowel cancer in females in 2004, there were 1,468 located in the colon, 524 in the rectum and 46 located in the anus.

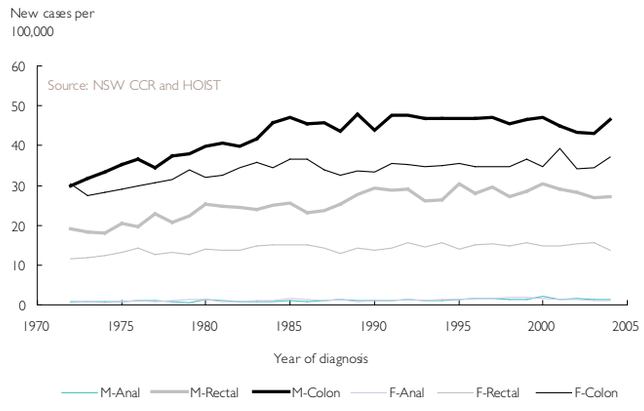
6.1.2 Anal cancer

- Anal cancer averages 2% of all bowel cancers in both males and females.
- The rates of anal cancer are very low, and are similar between genders, with less than two new cases per 100,000 in both males and females.

6.1.3 Rectal cancer

- Rectal cancers average 37% of all bowel cancer cases for males and 29% for females.
- Rectal cancer cases were increasing in males until the early 1990s. They have since stabilised and are at around 27 to 30 new cases per 100,000.
- The female rectal cancer rate has been approximately 15 new cases per 100,000 since the early 1980s; just less than half the rate in males.

FIGURE 9 Trends in the subtypes of bowel cancer, NSW, 1972–2004



Colon cancers average 61 per cent of total bowel cases for males and 69 per cent for females.

6.1.4 Colon cancer

- Colon cancers average 61% of total bowel cases for males and 69% for females.
- The number of colon cancers increased in both males and females until about 1986. These rates have varied slightly in recent years, but remain around 46 new cases per 100,000 in males and 35 in females.
- The rate of distal colon cancer (cancer in the descending and sigmoid colon and associated flexures) reached a peak in the mid-1980s and has since stabilised. The rate of distal cancer is higher in males (17.8 new cases per 100,000 in 2004) than females (10.9).
- The rate of proximal colon cancer (cancer in the ascending and transverse colon and associated flexures) has increased consistently in both males and females. However, it has increased at a higher rate in females to the point where the rate in females (22.6 new cases per 100,000 in 2004) is very similar to the rate in males (24.0) for this type of colon cancer.
- The rates of other colon cancer types (of unknown or unspecified origin or involving an overlapping area of the colon) have halved since the late 1980s. The rates in 2004 were 4.7 new cases per 100,000 in males and 3.6 in females.

FIGURE 10 Trends in the subtypes of colon cancer only, NSW, 1972–2004

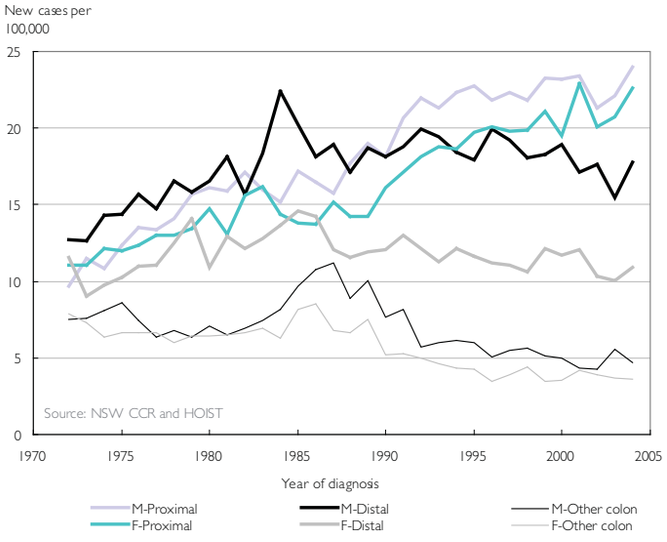
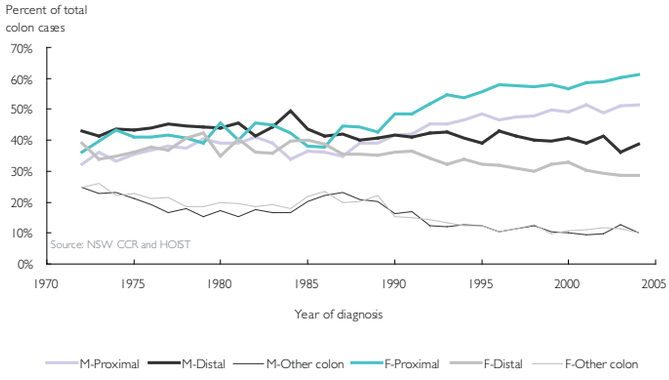


FIGURE 11 Trends in subtypes of colon cancers as a percentage of total colon cases, NSW, 1972–2004



Currently only one-third of new cases are diagnosed at the local stage of spread ...
15 per cent are not diagnosed until the cancer has metastasised.

- Before 1986, about 37% of colon cancers were located in the proximal area of the colon in males, and 41% in females. In 2004, the proportions of colon cancers located in the proximal area were 51% and 61% for males and females respectively.
- The proportion of distal cancers has fallen about 5% in males and about 10% in females.
- The difference in the proportions by subtypes might indicate a difference or change in risk factors in males and females over time.

6.2 Trends in bowel cancer incidence by degree of spread

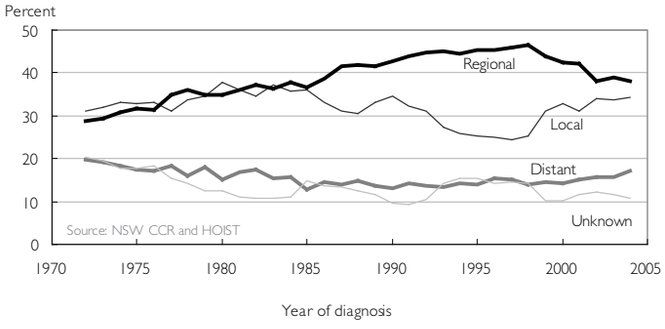
NOTE: Degree of spread is defined in this report as the maximum extent of disease within four months of the first date of diagnosis.

- Currently about one third of new cases are diagnosed at the local stage of spread and 40% diagnosed at the regional stage. Fifteen per cent are not diagnosed until the cancer has already metastasised (distant stage), and another 12% are unable to be assessed in terms of degree of spread.
- The proportion of new cases that are diagnosed with distant degree of spread has been fairly stable (15%) for around 20 years. It is expected that the proportion of new cases that are diagnosed at the distant stage will be reduced further as the National Bowel Screening Program progresses.
- From 1993 to 1998 there was a reduction in the proportion of cases diagnosed with a local degree of spread, which coincides with the increase in the proportion of cases of unknown stage. It is likely that this is due to a reporting artefact as a result of a change in coding practices during this time. This is currently being investigated by the NSW CCR.

- The proportion of regional cases increased steadily from the 1970s to the late 1990s, where it peaked at about 47%. However, between 1998 and 2003, the proportion of cases diagnosed with a regional degree of spread dropped consistently each year. Currently, the rate of regionally diagnosed cases is 38.8%.
- It is expected that there will be reductions in the proportions of bowel cancers with regional and distant spread at diagnosis once the National Screening Program becomes established. However, there may be an initial rise in incidence as the screening program detects cases that would otherwise have been diagnosed later.

More than 70 per cent of cases are diagnosed at the local or regionalised stage of diagnosis for proximal and distal colon cancer and bowel cancer.

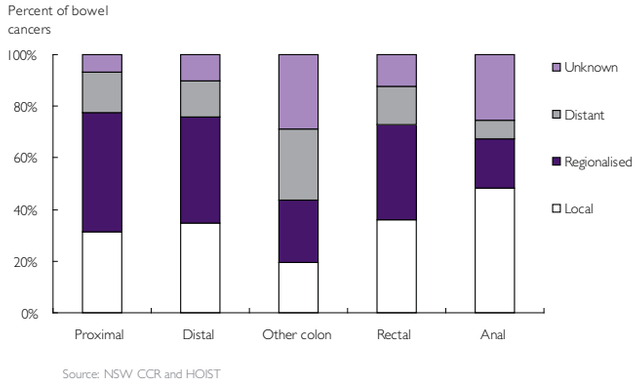
FIGURE 12 Trends in the incidence of bowel cancer by degree of spread, NSW, 1972–2004



6.3 Stage of diagnosis by subtype of bowel cancer

- More than 70% of cases are diagnosed at the local or regionalised stage of diagnosis for proximal and distal colon cancer and bowel cancer.
- More than 50% of colon cancers that cannot be classed as either proximal or distal colon cancer are diagnosed with either distant or unknown degree of spread.
- Cases of anal cancer have a higher rate of unknown stage of diagnosis than all except 'other colon cancer'. However, the proportion of cases diagnosed at the distant degree of spread is small in comparison.

FIGURE 13 Stage of diagnosis by subtype of bowel cancer, NSW, 2000–2004



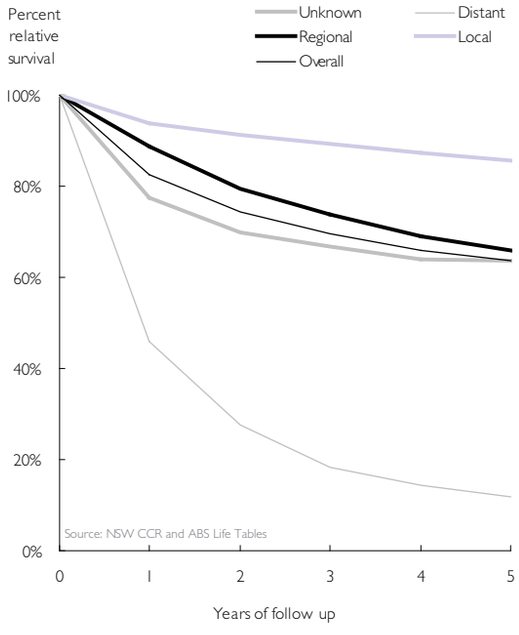
6.4 Relative bowel cancer survival by degree of spread at first diagnosis

- Five-year relative survival is 65.0% (Tracey et al 2006) when degree of spread (stage) at diagnosis is not considered; however relative survival is strongly affected by the degree of spread of the disease.

Relative survival is strongly affected by the degree of spread of the disease ... early diagnosis is associated with improved survival.

- Five-year relative survival for patients diagnosed with distant degree of spread is 12.1%, compared with 67.0% for those diagnosed with regional disease and 87.2% for those diagnosed with localised bowel cancer
- Therefore, early diagnosis of bowel cancer is associated with substantial improvement in survival outcomes for patients.

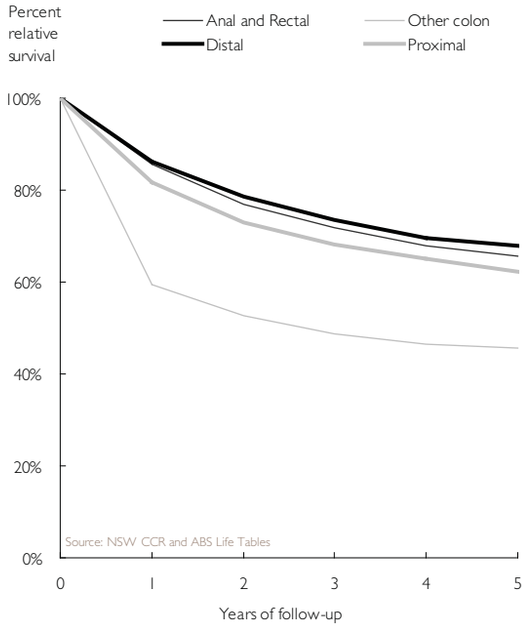
FIGURE 14 Relative survival of bowel cancer by degree of spread at first diagnosis, NSW, 1999–2003 (with follow up to the end of 2004)



6.5 Relative bowel cancer survival by subtype of bowel cancer

- The five-year relative survival rate for anal and rectal cancer is 65.7%.
- Those with proximal colon cancer have a slightly lower five-year relative survival rate (62.1%) compared with 67.9% for distal colon cancer patients.
- The subgroup with the lowest five-year survival rate is the 'other colon' group. This includes cancer cases diagnosed in the colon that are either not specified or where the lesion overlaps between the proximal and distal sections of the colon. Twenty-seven per cent of cases diagnosed as 'other colon' are allocated at distant stage, which means that they have already metastasised. This compares with 15.6% for proximal colon cancer, 14.2% for distal colon cancer and 14.8% for rectal cancer. Anal cancer is categorised as distant in only 7.4% of cases.
- In 2004, bowel cancer accounted for 5,120 person-years of life lost (PYLL) before the age of 75 in males and 4072 PYLL in females. This equates to 1.6 PYLL per 1000 population for males and 1.2 for females.

FIGURE 15 Relative survival of bowel cancer by subtype of bowel cancer, NSW, 1999–2003 (with follow up to the end of 2004)

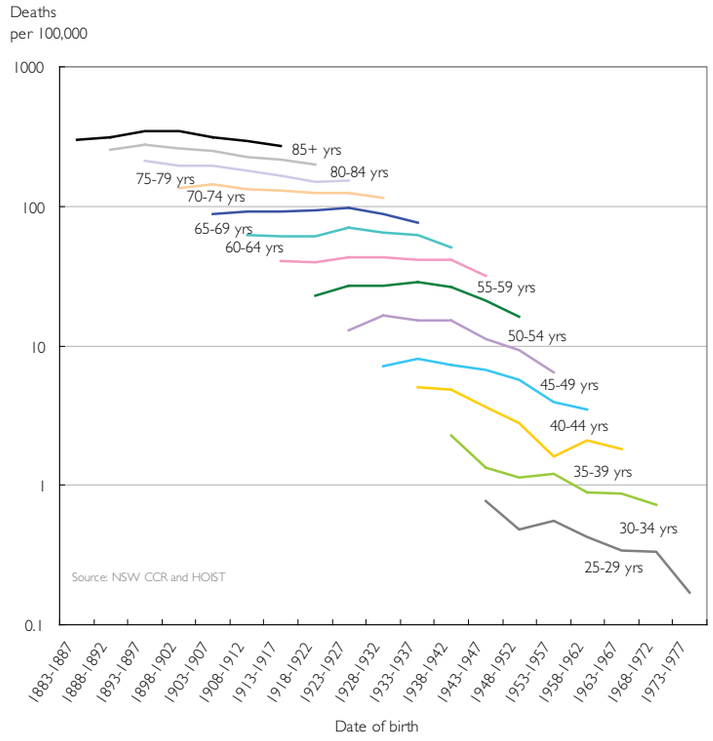


6.6 Trends in age-specific bowel cancer mortality rates by birth cohort

- Analysis by birth cohort can help to determine whether the incidence and/or mortality can be attributed to a common feature of an entire group of the population who were born around the same time – a 'generational effect'. If such a generational or cohort effect is suspected, then its cause can be determined and may include environmental, lifestyle or social factors.
- When arranged by five-year age groups of birth cohorts (groupings), the age-specific mortality rates show slight declines the 1938 to 1942 cohorts.
- Since the 1943 to 1947 birth cohort, the decline in age-specific rates has been more pronounced. This may be a period effect, but is more likely a change to diet and treatment options.

If such a generational or cohort effect is suspected, then its cause can be determined and may include environmental, lifestyle or social factors.

FIGURE 16 Trends in age-specific mortality rates from bowel cancer by birth cohort, NSW



7. Geographic patterns of bowel cancer

7.1 Overview

Here, geographic patterns of bowel cancer are measured by ARIA and in Area Health Services, States and Territories and internationally. It is important to measure the spread and patterns of bowel cancer in different geographic areas, as there are often disparities in access to services, screening programs, and prevention initiatives.

After adjusting for age and sex, the incidence of bowel cancer in major cities in NSW is significantly lower than in the other areas.

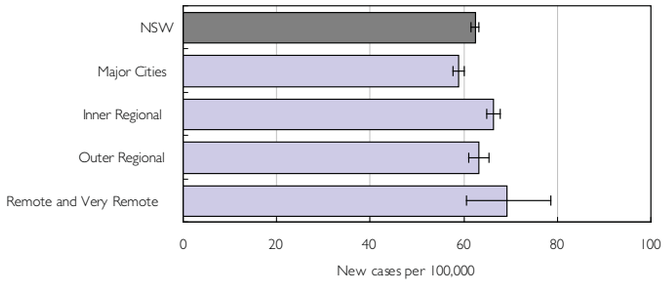
By investigating these disparities and reorienting services, programs and initiatives, it is anticipated that bowel cancer outcomes, such as incidence and mortality rates, will be improved.

7.2 Accessibility and remoteness

7.2.1 *Incidence of bowel cancer by accessibility and remoteness*

- The directly standardised incidence rate for bowel cancer in major city areas of NSW between 2000 and 2004 was 58.8 new cases per 100,000, compared with 66.4, 63.2 and 69.1 per 100,000 in the inner regional, outer regional and remote and very remote areas respectively.
- After adjusting for age and sex, the incidence of bowel cancer in major cities in NSW is significantly lower than in the other areas ($p<0.001$). The age and sex adjusted incidence rates in inner regional, outer regional, and remote and very remote areas do not differ significantly ($p=0.62$). Differences in bowel cancer incidence rates between areas may be due to risk factors such as smoking and diet.

FIGURE 17 Age-standardised incidence rates of bowel cancer by ARIA, NSW, 2000–2004

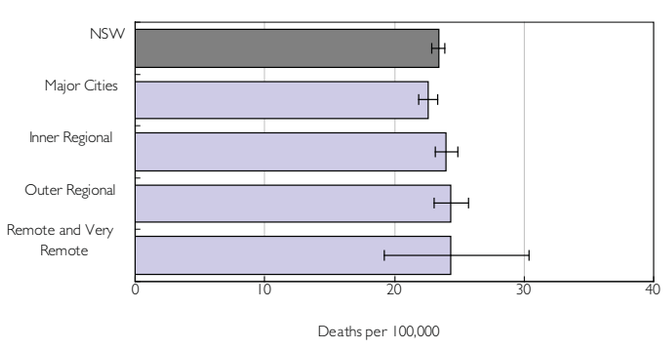


Source: NSW CCR and HOIST

7.2.2 *Mortality from bowel cancer by accessibility and remoteness*

- The age-standardised mortality rate in major cities was 22.6 deaths per 100,000 for the period from 2000 to 2004, compared with 24.0 deaths per 100,000 for inner regional areas, and 24.4 in outer regional and the remote and very remote areas of NSW.
- After adjusting for age and sex, mortality rates for bowel cancer do not differ significantly between ARIA categories ($p= 0.12$).
- Regional and remote areas do not have significantly higher mortality rates, although they do have significantly higher incidence rates.

FIGURE 18 Age-standardised mortality rates of bowel cancer by ARIA, NSW, 2000–2004



Source: NSW CCR and HOIST

7.3 Area Health Services

7.3.1 Incidence of bowel cancer by Area Health Service (AHS)

- The standardised incidence rate for the health areas for bowel cancer between 2000 and 2004 ranged from 56.4 new cases per 100,000 in Sydney South West AHS, to 66.4 in Hunter New England AHS.
- After adjusting for age and sex, incidence rates for Sydney West and Sydney South West AHS are significantly lower than for the remainder of the health areas ($p<0.001$).
- There is no significant difference between the remaining six health areas ($p=0.4$).
- South West and Sydney South West AHS both have sizable populations of overseas-born residents. Overseas-born residents have been found to have a significantly lower rate of bowel cancer probably due in part to the healthy migrant effect. The healthy migrant effect is associated with the stringent health care checks that are required before migration to Australia.

7.3.1.1 Incidence of bowel cancer by Local Government Area (LGA)

- In Sydney South West AHS, there are a number of LGAs that have significantly lower age-standardised incidence rates for bowel cancer than the New South Wales average (62.2, 95% CI: 61.3-63.0). These include: Campbelltown (47.4, 41.3-54.1), Canterbury (55.3, 49.9-61.2), Fairfield (54.3, 49.2-59.7), Liverpool (48.4, 42.6-54.8) and Marrickville (52.2, 44.6-60.7).
- Evans – parts A and B (25.8, 95% CI: 10.7-51.5), in Greater Western AHS, has a significantly lower incidence of bowel cancer than the New South Wales average.
- Wollongong (68.1, 95% CI: 63.2-73.2), in South Eastern Sydney & Illawarra AHS, has a significantly higher bowel cancer incidence rate than the New South Wales average.

After adjusting for age and sex, incidence rates for Sydney West and Sydney South West AHS are significantly lower than for the remainder of the health areas.

- Parramatta (52.2, 95% CI: 47.3-58.0), in Sydney West AHS, has a significantly lower incidence of bowel cancer than the New South Wales average.
- Grafton (83.8, 95% CI: 67.4-103.1), in North Coast AHS, has a significantly higher bowel cancer incidence rate than the New South Wales average.
- Goulburn (88.8, 95% CI: 72.6-107.6), Gunning (127.0, 67.2-216.3) and Deniliquin (94.4, 69.2-125.2) in Greater Southern AHS, all have a significantly higher bowel cancer incidence rate than the New South Wales average. Narrandera (29.8, 15.2-52.2) and Wakool (23.9, 10.3-47.1) have significantly lower bowel cancer incidence rates. Due to small numbers, these confidence intervals are quite large.

FIGURE 19 Age-standardised incidence rates of bowel cancer by Area Health Service, NSW, 2000–2004

Source: NSW CCR and HOIST

7.3.2 Mortality from bowel cancer by AHS

- The mortality rates for bowel cancer between 2000 and 2004 ranged from 21.9 deaths per 100,000 in Sydney South West AHS to 26.0 in Hunter New England AHS.
- There is greater variation in mortality rates between health areas than there are in incidence rates.

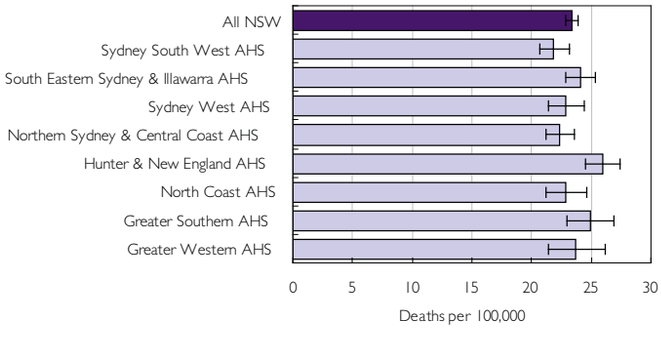
There is greater variation in mortality rates between health areas than there are in incidence rates.

- Sydney West and Sydney South West AHS's both have relatively low mortality rates. While mortality rates in these areas do not differ significantly from the Northern Sydney & Central Coast AHS and the North Coast AHS ($p=0.21$), incidence rates are significantly different ($p<0.001$).
- Other sections of this report show that there are differences in incidence and mortality rates with socioeconomic status and remoteness (ARIA). Some differences between health areas will be due to differences in these factors.

7.3.2.1 Mortality from bowel cancer by LGA

- Canterbury (18.8, 95% CI: 15.7-22.3) and Campbelltown (17.9, 14.2-22.2), in Sydney South West AHS, have significantly lower age-standardised mortality rates for bowel cancer than the New South Wales average (23.3, 22.8-23.8).
- Wollongong (27.0, 95% CI: 23.9-30.3), in South Eastern Sydney & Illawarra AHS, has a significantly higher than average bowel cancer mortality rate.
- Northern Sydney & Central Coast AHS has one LGA that has a significantly lower bowel cancer mortality rate than the New South Wales average: Hornsby (20.4, 95% CI: 17.3-23.8).
- Gunnedah (36.3, 95% CI: 23.9-52.9) and Singleton (41.4, 28.6-58.0) LGA's, in Hunter & New England AHS, have significantly higher than average mortality rates for bowel cancer.
- Grafton (36.7, 95% CI: 26.3-49.8) and Ulmarra (48.6, 27.7-78.6), both in North Coast AHS, have significantly higher mortality rates than the New South Wales average.
- Berrigan (9.5, 95% CI: 3.5-20.6), in Greater Southern AHS, has a significantly lower bowel cancer mortality rate than the New South Wales average, while Bland (51.0, 31.4-78.2) and Wagga Wagga (31.1, 24.8-38.6) have significantly higher rates.
- Forbes (39.6, 95% CI: 25.2-59.2), in Greater Western AHS, has a significantly higher bowel cancer mortality rate than the New South Wales average.

FIGURE 20 Age-standardised mortality rates from bowel cancer by Area Health Service, NSW, 2000–2004



Source: NSW CCR and HOIST

7.4 States and Territories

7.4.1 Incidence of bowel cancer in states and territories

- The incidence rate of bowel cancer in the states and territories of Australia from 1997 to 2001 ranges from 74.6 to 80.6 new cases per 100,000 for males and 50.5 to 59.1 for females in all states except the Northern Territory. In the Northern Territory, rates are 53.9 and 41.6 per 100,000 for males and females respectively, considerably lower than in the remainder of the states.
- Males have a higher incidence rate of bowel cancer in the all states and territories than females.

FIGURE 21 Age-standardised incidence rates of bowel cancer by State and Territory, Australia, 1997–2001

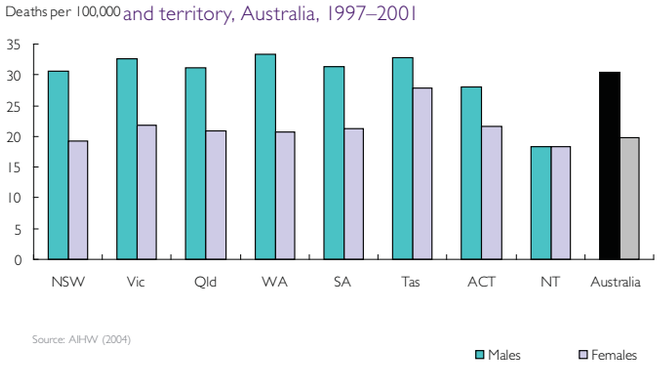
7.4.2 Mortality from bowel cancer in states and territories

- The mortality rate of bowel cancer in the states of Australia from 1997 to 2001 ranged from 28.1 to 33.3 deaths per 100,000 for males in all states except the Northern Territory. In the Northern Territory, the mortality rate was 18.3.
- In females the mortality rate ranged from 19.2 to 21.8 deaths per 100,000, except for 27.9 in Tasmania, and 18.3 in Northern Territory.

Low mortality rates in Northern Territory reflect low incidence rates.

- Low mortality rates in the Northern Territory reflect low incidence rates. However, incidence rates differ between male and females, while mortality rates do not. These rates are based on very low numbers of cases in the Northern Territory, with an average of 13 people dying from bowel cancer each year between 1997 and 2001.
- The mortality rate for females in Tasmania is very high compared to the other states and territories. Closer inspection shows that Tasmania also has the highest female incidence rate for bowel cancer, albeit not significantly higher than other states. The mortality to incidence ratio for Tasmania is substantially higher than for many other states; 44% and 47.2% for males and females respectively, compared to the national averages of 38.6% for males and 35.6% for females.
- In comparison, the mortality to incidence ratio for New South Wales is 39.9% (males) and 36.5% (females), only slightly higher than the national average.

FIGURE 22 Age-standardised mortality rates from bowel cancer by state and territory, Australia, 1997–2001



7.5 International patterns

7.5.1 Overview

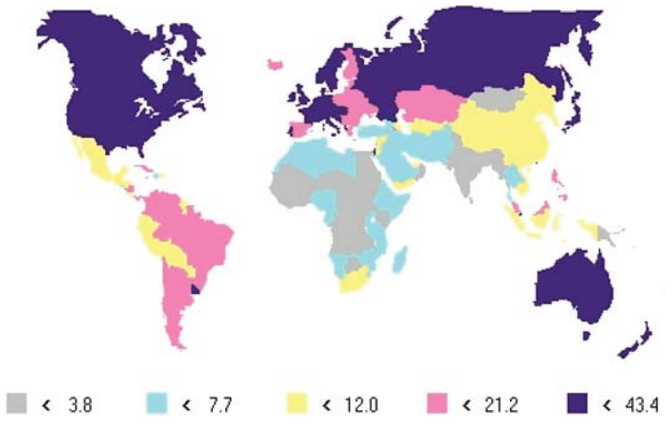
The distribution of bowel cancer varies throughout the world, with developed countries demonstrating higher rates than developing countries. The reasons for this are unclear, but factors that may play a role include: a western-style diet and mortality from other causes at a younger age in developing countries (Murray & Lopez 1997). The incidence and mortality may vary due to variable case definitions and differences in methods of registration, data completeness and accuracy across registries.

More developed countries such as USA, Canada, United Kingdom and Australia, have among the highest rates of bowel cancer in the world.

7.5.2 International patterns of the incidence of bowel cancer

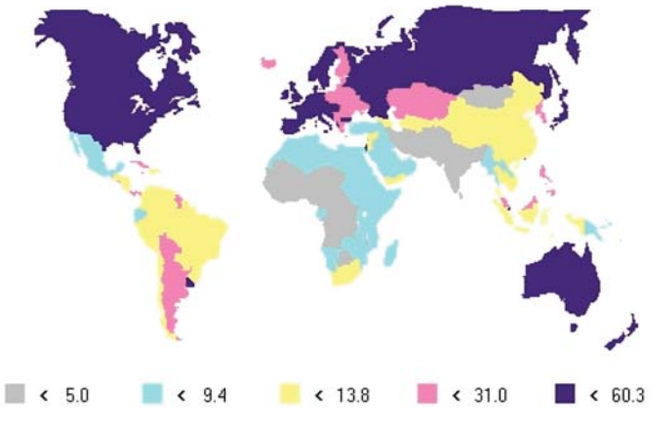
- Males and females have a very similar distribution of bowel cancer incidence. However, males have a consistently higher rate of bowel cancer.
- More developed countries such as USA, Canada, United Kingdom and Australia, have among the highest rates of bowel cancer in the world.
- Conversely, developing countries such as Africa and Asia, have a far lower incidence of bowel cancer; approximately half the rate of more developed countries. However, this number may be underestimated due to poor registration in developing countries.
- Australia and New South Wales have higher rates than comparable developed countries such as the UK, Canada and the USA.

FIGURE 23 Age-standardised bowel cancer incidence rates, worldwide, females, 2000



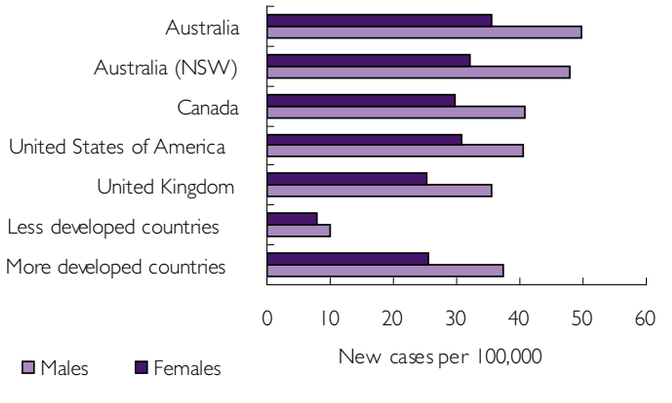
Source: GLOBALCAN 2000

FIGURE 24 Age-standardised incidence rates, worldwide, males, 2000



Source: GLOBALCAN 2000

FIGURE 25 Age-standardised incidence rates of bowel cancer by country, worldwide, 2002



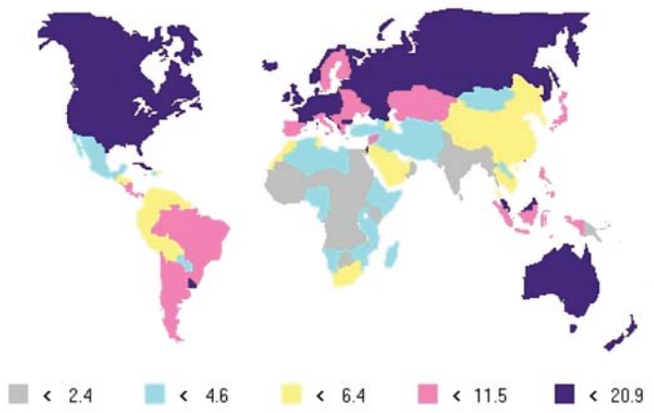
Source: GLOBALCAN 2000

7.5.3 International patterns of mortality from bowel cancer

- Mortality from bowel cancer has a similar worldwide distribution to incidence.
- Mortality rates are generally lower than incidence rates and decrease with increasing incidence.
- This may be explained by more established early detection and treatment programs in more developed countries.

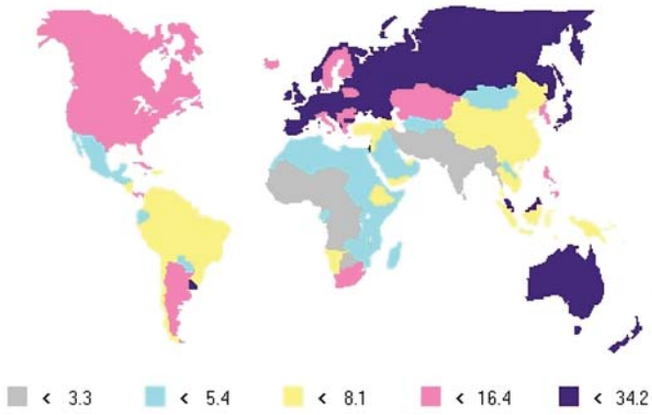
Mortality from bowel cancer has a similar worldwide distribution to incidence.

FIGURE 26 Age-standardised bowel cancer mortality rates, worldwide, females, 2000



Source: GLOBALCAN 2000

FIGURE 27 Age-standardised bowel cancer mortality rates, worldwide, males, 2000



Source: GLOBALCAN 2000

8. Patterns in bowel cancer by socioeconomic disadvantage, country of birth and Aboriginality

8.1 Bowel cancer and socioeconomic disadvantage

8.1.1 Overview

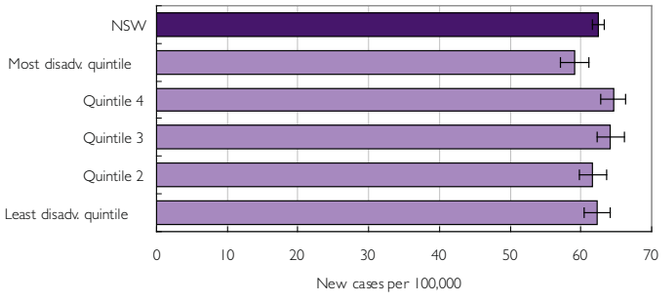
Socioeconomic disadvantage is measured in this instance by the Index of Relative Socio-economic Disadvantage, a continuous variable. In this report, these values have been classified into five groups (quintiles) that range from the most to the least disadvantaged. Similar to geographic patterns, measuring bowel cancer in relation to socioeconomic disadvantage is an important indicator of access to services, screening programs and prevention initiatives. If disparities between socioeconomic quintiles are identified, services, programs and initiatives may be required to improve bowel cancer outcomes.

The incidence rate of bowel cancer is significantly lower in the most disadvantaged quintile compared with the remainder of the groups.

8.1.2 Age-standardised incidence rates by socioeconomic disadvantage

- The incidence rate of bowel cancer is significantly lower in the most disadvantaged quintile compared with the remainder of the groups ($p<0.001$). The variation observed between the remaining quintiles of disadvantage is not significantly different or no greater than would be expected by chance.
- A possible reason for the lower incidence rate is that those in the most disadvantaged quintile have different risk factors to those within the other quintiles.

FIGURE 28 Age-standardised incidence rates of bowel cancer by socioeconomic disadvantage, NSW, 2000–2004

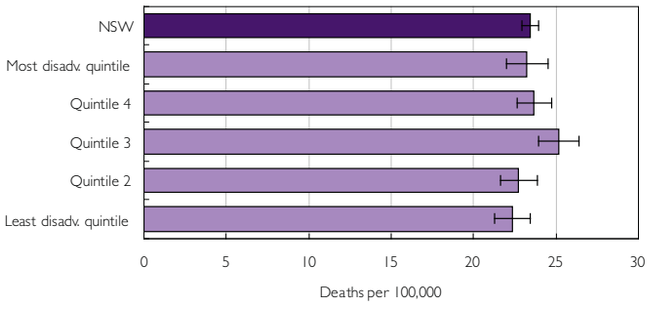


Source: NSW CCR and HOIST

8.1.3 Age-standardised mortality rates by socioeconomic disadvantage

- There is a significantly higher mortality rate from bowel cancer in the central quintile of disadvantage compared with all other quintiles ($p<0.001$). The remainder of the quintile groups have similar mortality rates from bowel cancer.
- Although incidence in the most disadvantaged quintile is significantly lower, the mortality rate of this group is not significantly different to that of the other groups.

FIGURE 29 Age-standardised mortality rates of bowel cancer by socioeconomic disadvantage, NSW, 2000–2004



Source: NSW CCR and HOIST

8.2 Bowel cancer and country of birth

8.2.1 Overview

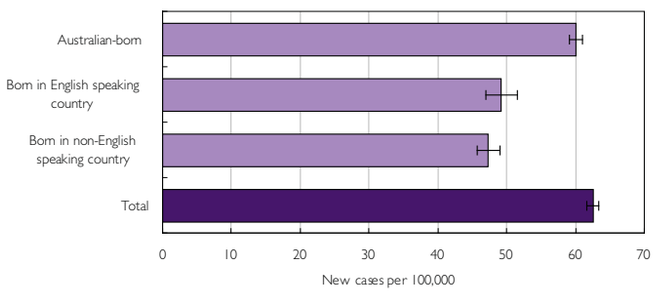
In this instance, country of birth refers to those people: living in Australia who are Australian born, or born in English speaking or non-English speaking countries. This analysis is important, as it demonstrates the impact of bowel cancer on different cultural groups in Australia.

8.2.2 Incidence of bowel cancer by country of birth

- Of 21,564 new cases of bowel cancer between 2000 and 2004, 24% were diagnosed in people of non-Australian birth. Just under two-thirds (66%) were diagnosed in Australian-born people. Ten per cent were of unknown origin. The rate in those born in non-English speaking countries was 47.3 new cases per 100,000, compared to 49.2 new cases per 100,000 for people born in English-speaking countries, and 60.1 in Australian-born residents.
- The rate of bowel cancer in the Australian-born population is significantly higher than the rate in the population of non-Australian-born residents ($p<0.001$).
- Although the incidence rates differ slightly between those from English-speaking countries and those from non-English-speaking countries, modelling indicates that these rates are not significantly different ($p=0.59$). One explanation may be the 'healthy migrant' effect, as migrants normally have to pass a health check to gain entry to Australia.
- In addition, it is known that the underlying incidence rate of bowel cancer differs between people of different ethnic origins, with whites of European descent having the highest incidence (Anderson et al. 2003). The race effect is modified by environment, with rates in people-groups who migrate to westernized countries increasing over time (Kune et al. 1986).

The rate of bowel cancer in the Australian-born population is significantly higher than the rate in the population of non-Australian-born residents.

FIGURE 30 Age-standardised incidence of bowel cancer by country of birth, 2000–2004



Source: NSW CCR and HOIST

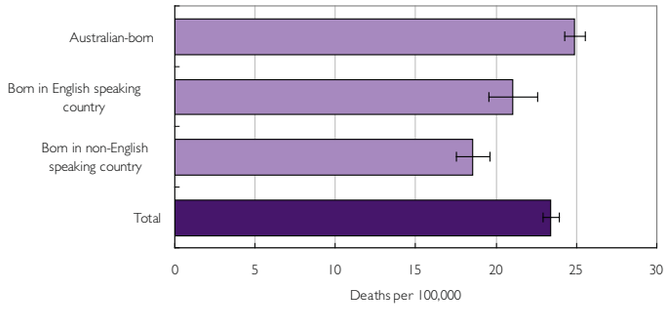
8.2.3 Mortality from bowel cancer by country of birth

- Australian-born people have the highest rate of mortality, with a standardised mortality rate of 24.9 deaths per 100,000. This compares with an age-standardised mortality rate of 18.6 deaths per 100,000 in people from non-English speaking countries and 21.0 in people born in English speaking countries.
- The death rate from bowel cancer in Australian born residents is significantly higher than for those that are born overseas ($p<0.001$). While incidence rates were not significantly different between those born overseas, the rate of mortality in those born in non-English speaking countries is significantly lower than the mortality rate in those born in English speaking countries ($p=0.028$).

- As the incidence rate in the Australian-born population is higher, it would be expected that the mortality rate would also be higher in those born in Australia.
- The lower mortality rate in non-English speaking compared to English speaking migrants, may be due to the healthy migrant effect, treatment access, following up a treatment plan or early detection of the cancer. Further research is required here.

It is important that the relationship between Aboriginality and cancer is investigated further to improve health outcomes.

FIGURE 31 Age-standardised mortality from bowel cancer by country of birth, 2000–2004



Source: NSW CCR and HOIST

8.3 Bowel cancer in Aboriginal Australians

Cancer is a significant burden of disease in Aboriginal people in Australia. Interestingly, studies have indicated that incidence rates for many cancers are similar to non-Aboriginal Australians (Condon et al. 2004). There are a number of reasons for this, including under-reporting and poor identification of Aboriginal status, and inadequate data collection (Valery et al. 2006). This is true of the Aboriginal data available on the NSW CCR and is currently being investigated by the Cancer Institute NSW.

Mortality rates for all cancer in Aboriginal Australians are substantially higher than for non-Aboriginal people (Condon et al. 2004; Valery et al. 2006). Higher mortality rates may be due to environmental risk factors such as smoking and diet, and lack of services and facilities for screening and primary health care (Centre for Epidemiology and Research 2006b).

However, Condon et al. 2004 found that Aboriginal people in the Northern Territory had 'persistently low' rates of bowel cancer (p.506). This is repeated in New South Wales data, which demonstrates that there is little difference between Aboriginal and non-Aboriginal bowel cancer incidence rates (Centre for Epidemiology and Research 2006b). However, this data must be interpreted with caution, as the identification of Aboriginal people in the NSW CCR data is likely to be incomplete.

It is important that the relationship between Aboriginality and cancer is investigated further to improve health outcomes for Aboriginal people. There are a number of Aboriginal Health projects currently underway, including the NSW Aboriginal Chronic Conditions Area Health Service Standards. These were released in 2005 with the aim of improving health outcomes for Aboriginal people in NSW. They encourage a multi-faceted approach to chronic Aboriginal health problems, including cancer (NSW Department of Health 2005).

9. Projections of the future of bowel cancer

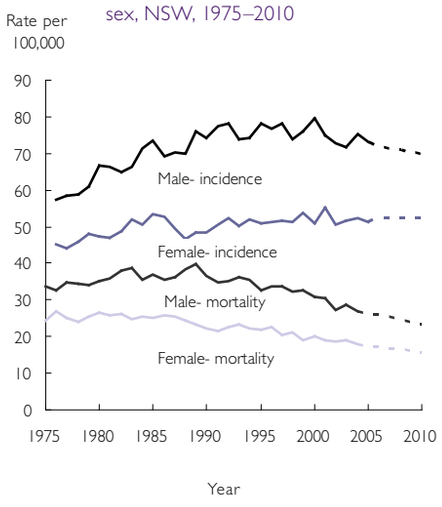
9.1 Overview

Projections of cancer cases are important as they help health services plan for the future burden of disease (Tracey et al. 2005). Projected numbers for bowel cancer in New South Wales in the future are expected to change with the progression of the National Bowel Cancer Screening Program.

9.2 Projected numbers of bowel cancer in New South Wales

- It is expected that the incidence of bowel cancer in males in New South Wales will decrease by about 5% from 2004–2010 and 3% from 2007–2010.
- The incidence of bowel cancer in females in New South Wales is projected to remain stable until 2010, with minimal changes in rates.
- Future projections for mortality from bowel cancer in males and females in New South Wales is expected to decrease by 3% from 2004–2010.

FIGURE 32 Actual and projected bowel cancer incidence and mortality, by sex, NSW, 1975–2010



Source: Aitken R, Morrell S, Barraclough H, Baker D, Clements M, Jelfs P, Bishop JF. 2007. Cancer Incidence and mortality projections in New South Wales, 2007 to 2010. Sydney: Cancer Institute NSW (in press)

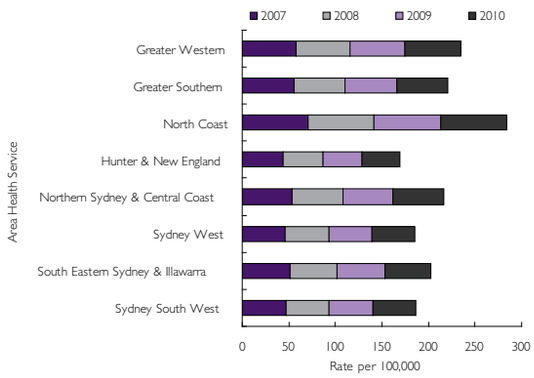
9.3 Projected numbers of bowel cancer by Area Health Service and sex

- In both males and females, Greater Western and North Coast Area Health Services have consistently higher projected rates of bowel cancer than other areas.
- In males, Greater Western, Hunter & New England and Sydney West Area Health Services have slightly increasing incidence rates from 2007–2010, while the remainder of the areas have decreasing incidence rates.
- In females, all areas except Greater Western AHS have decreasing incidence rates.

FIGURE 33 Projected incidence of bowel cancer by Area Health Service, males, NSW, 2007–2010

Source: Aitken R, Morrell S, Barraclough H, Baker D, Clements M, Jelfs P, Bishop JF. 2007. Cancer Incidence and mortality projections in New South Wales, 2007 to 2010. Sydney: Cancer Institute NSW (in press)

FIGURE 34 Projected incidence of bowel cancer by Area Health Service, females, NSW, 2007–2010



Source: Aitken R, Morrell S, Barraclough H, Baker D, Clements M, Jelfs P, Bishop JF. 2007. Cancer Incidence and mortality projections in New South Wales, 2007 to 2010. Sydney: Cancer Institute NSW (in press)

10. Conclusions

Early detection of bowel cancer is important for improved survival from this cancer.

The incidence of bowel cancer in New South Wales is steadily increasing each year. While the reasons for this are not clear, several factors may be contributing to this, including the ageing New South Wales population, and an increase in behaviours associated with modifiable risk factors such as poor diet. There have been slightly more cases of bowel cancer diagnosed in males than females since 1984. We know that males are more likely to smoke, more likely to be overweight and obese, and less likely to eat fruit and vegetables than females (Centre for Epidemiology and Research 2006a).

New South Wales has incidence and mortality rates that are comparable to other states and territories in Australia. However, when compared to other countries, Australia has high incidence and mortality rates. This is particularly evident when comparing New South Wales data with developing countries that have far lower rates of bowel cancer. The available evidence suggests that Aboriginal Australians may have lower rates of bowel cancer than their non-Aboriginal counterparts, but data are incomplete.

The five-year survival rate for people diagnosed with local, regional and distant metastases in New South Wales is 85.7%, 65.9% and 11.9% respectively. This demonstrates that early detection of bowel cancer is important for improved survival from this cancer. With the introduction of the National Bowel Cancer Screening Program in 2006, it is expected that there will be an increase in cases diagnosed, as a result of early detection of cases from the future. Over the next decade, when bowel cancer screening becomes available to the majority of the population, noticeable decreases in bowel cancer mortality should be observed.

11. Appendix: ICD–10 codes and definitions

The International Statistical Classification of Diseases and Related Health Problems (version 10) (ICD-10) is a standard measure of classifying disease. It was developed by the World Health Organisation (NCCH 2000). The ICD-10 codes for bowel cancer used in this report are outlined here.

C18	**Malignant neoplasm of colon**
C18.0	Caecum
C18.1	Ileocaecal valve
C18.2	Appendix
C18.3	Ascending colon
C18.4	Hepatic flexure
C18.5	Transverse colon
C18.6	Splenic flexure
C18.7	Descending colon
	Sigmoid colon
	Sigmoid (flexure) excluding rectosigmoid junction (allocate to C19)
C18.8	Overlapping lesion of colon
C18.9	Colon unspecified
	Intestine NOS
C19	**Malignant neoplasm of rectosigmid junction**
	Colon with rectum
	Rectosigmoid (colon)
C20	**Malignant neoplasm of rectum**
	Rectal ampulla
C21	**Malignant neoplasm of anus and anal canal**
C21.0	Anus, unspecified
C21.1	**Excludes:** anal margin, skin and perianal skin (all allocated to either C43.5 or C44.5)
C21.1	Anal cancer
	Anal sphincter
C21.2	Cloacogenic zone
C21.8	Overlapping lesion of rectum, anus and anal canal
	Anorectal junction Anorectum Malignant neoplasm of rectum, anus and anal canal whose point of origin cannot be classified to any one of the categories C20–C21.2

12. Abbreviations

ABS	Australian Bureau of Statistics
AFAP	attenuated familial adenomatous polyposis
AHS	Area Health Service
AIHW	Australian Institute of Health and Welfare
BMI	body mass index
CT scan	computerised tomography scan
DNA	deoxyribonucleic acid
BMI	body mass index
FAP	familial adenomatous polyposis
FOBT	faecal occult blood test
HOIST	Health Outcomes and Information Statistical Toolkit
HNPCC	hereditary nonpolyposis colorectal cancer
IARC	International Agency for Research in Cancer
ICD	International Classification of Diseases
IRSD	Index of Relative Socioeconomic Disadvantage
LGA	Local Government Area
MMR	mismatch repair
MRI	magnetic resonance imaging
NHMRC	National Health and Medical Research Council
NSW	New South Wales
NSW CCR	New South Wales Central Cancer Registry
NSW DOH	New South Wales Department of Health
PYLL	potential years of life lost
TNM	tumour, node, metastases
UK	United Kingdom
USA	United States of America

13. Glossary

Age Specific Rate

A rate for a specified 5-year age group. The numerator and denominator refer to the same age group. It is usually expressed per 100,000 people in the population per year.

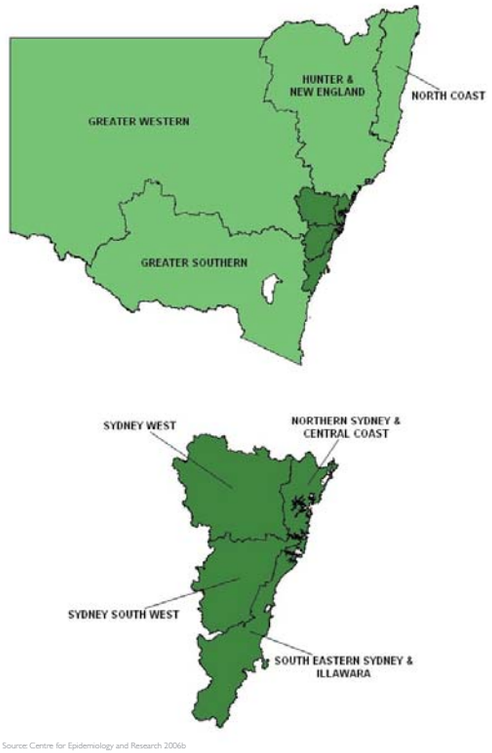
Age-standardised rate

Standardisation is a set of techniques used to remove as far as possible the effects of differences in age or other confounding variables when comparing two or more rates. In this report age-standardised rates were calculated by the direct method using the mid-year population of Australia in 2001 or the 'world' population as standard.

Area Health Service (AHS)

Public sector health services in NSW are administered by eight area health services (AHS). Four of these areas include parts of the Sydney metropolitan area, and the remaining four are strictly rural. The current boundaries for the AHSs were established in January 2005.

FIGURE 35 Area Health Service boundaries, NSW



Source: Centre for Epidemiology and Research 2006b

Accessibility and Remoteness Index of Australia (ARIA)

The Accessibility/Remoteness Index of Australia. In this document we use the ARIA+ version of the scale, which has been endorsed by the ABS as the standard measure of remoteness. ARIA+ is based on distance to 5 categories of 'service centre', with the smallest service centres having between 1000 and 4999 people. An ARIA+ score ranging from 0 (metropolitan) to 15 (very remote) is allocated to each locality, interpolated to create a 1km grid across all of Australia and then aggregated to the required geographical unit (in our case, LGA). Each LGA was given a mean score (index value). The mean scores are allocated to one of five categories of remoteness on the basis of cut–off points determined by the ABS as shown in table 3. For further information about calculations for ARIA+ see (GISCA 2006) and (ABS 2001a).

TABLE 3 Allocation of index scores to remoteness category

ARIA+ category	**Average ARIA index values in range**
Major city	0 to 0.2
Inner regional	>0.2 to 2.4
Outer regional	>2.4 to 5.92
Remote	>5.92 to 10.53
Very remote	>10.53

Source: GISCA (2006)

It is important to remember that the ARIA+ index does not provide specific information on accessibility to health services. It is assumed however that there is a strong relationship between population size and service availability, particularly education and health services.

Bowel cancer

In this report, bowel cancer refers to invasive malignancy diagnosed in the ascending, transverse and descending colon, the rectum and/or the anus.

Cancer incidence

Cancer cases diagnosed in a defined population during a specified period. It is often used to denote numbers or rates.

Cancer mortality

Deaths from cancer in a defined population during a specified period. It may be used to denote numbers or rates. Deaths not attributed to cancer were not included in these calculations.

Cases

These are individual cancers. A person may have more than one cancer giving rise to multiple cases in the same person. Second cases in one person are only counted if they are of different cell type or originate in a different organ.

Confidence interval

A range of values around the best estimate of a rate that takes into account variability.

Degree of spread

The maximum extent of disease within four months of the first date of diagnosis.

Health Outcomes and Information Statistical Toolkit (HOIST)

Health Outcomes Indicator Statistical Toolbox (HOIST) refers to a data access, analysis and reporting facility established and operated by Epidemiology and Surveillance Branch, Public Health Division, NSW Health Department.

Index of Relative Socioeconomic Disadvantage (IRSD)

Index of Relative Socioeconomic Disadvantage (see SEIFA for more information).

Local Government Areas (LGA)

NSW Local Government Areas (LGA's) are spatial units which represent each of the incorporated local government council areas in NSW. The number, names and geographical boundaries of LGA's in NSW has changed over time. In 2006 there were 152 Local Government Areas in NSW (ABS 2006), compared with 174 LGA's in 2001 (ABS 2001b). Two parts of NSW are not covered by the LGA structure: Lord Howe Island and Unincorporated Far West. These areas come under direct state government jurisdiction.

Lifetime risk

The risk that a person will be diagnosed with or die from cancer during their life. In this report it is calculated from the age-specific rates which applied during 2004 and assumes that the person remains at risk to the age of 75. It is the cumulative risk calculated from birth to the 75th birthday.

Population weighted quintiles

Quintiles divide a range of values into 5 equal parts. A population weighted quintile is where the quintiles are based on the population of each area. In this case we take the IRSD of the 174 LGA's (plus Unincorporated Far West) and instead of dividing these 174 into 5 equal parts, we assume that everyone in each LGA has the same IRSD score, and hence divide the population of NSW into 5 parts. It still gives the cut point on the basis of the IRSD.

Potential Years of Life Lost (PYLL)

PYLL provides a measure of the effect on society due to premature deaths caused by bowel cancer. It is a measure of premature mortality. It is the sum of the number of years between the age at death due to bowel cancer (in this case) and 75 years of age.

Relative survival

This is the ratio of observed survival to that which would be expected in the absence of the cancer.

Socio-Economic Index For Areas (SEIFA)

Socio–Economic Index For Areas. These are indexes that use data from the census to determine the socioeconomic status of residents in small geographical areas called census collector districts. They are then aggregated (on a population-weighted basis) to other geographical levels including the local government area level. They have been calculated by the ABS since the 1986 census. In 2001 four such indexes were available: socio-economic disadvantage, socio–economic advantage/disadvantage, Index of economic resources and index of education and occupation (Trewin 2003). Each index concentrates on a different aspect of 'disadvantage'. The Index of Relative Socio-economic Disadvantage (IRSD) was chosen for this report to be consistent with other reports that use these indexes such as the Chief Health Officer's Report (Population Health Division 2006).

Each of the SEIFA indices is adjusted to give a mean of 1000 for Australia and standard deviation of 100. For the IRSD, a lower value of the index indicates greater disadvantage in the area. It is an area-based assessment, and so should not be used to label individuals within any area.

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Contact Directory

Cancer Institute NSW
Level 1, Biomedical Building
Australian Technology Park
1 Central Avenue
Eveleigh NSW 2015
Australia

PO Box 41
Alexandria NSW 1435

Tel: + 61 2 8374 5600
Fax: + 61 2 8374 5700
Email: information@cancerinstitute.org.au
Web: www.cancerinstitute.org.au

Service and business hours: 8.30am – 5.00pm