Canadian Cancer Statistics

2015

Special topic: Predictions of the future burden of cancer in Canada

Government of Canada / Gouvernement du Canada

Canadian Cancer Society / Société canadienne du cancer

Produced by Canadian Cancer Society, Statistics Canada,
Public Health Agency of Canada, Provincial/Territorial Cancer Registries
cancer.ca/statistics

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This publication is available in English and French on the Canadian Cancer Society's website at cancer.ca/statistics. The website includes additional resources, such as individual figures from the publication and an archive of previous editions.

The development of this publication over the years has benefited considerably from the comments and suggestions of readers. The Advisory Committee appreciates and welcomes such comments. To be notified about next year's publication or to offer ideas on how the publication can be improved, please complete the evaluation form or email stats@cancer.ca.

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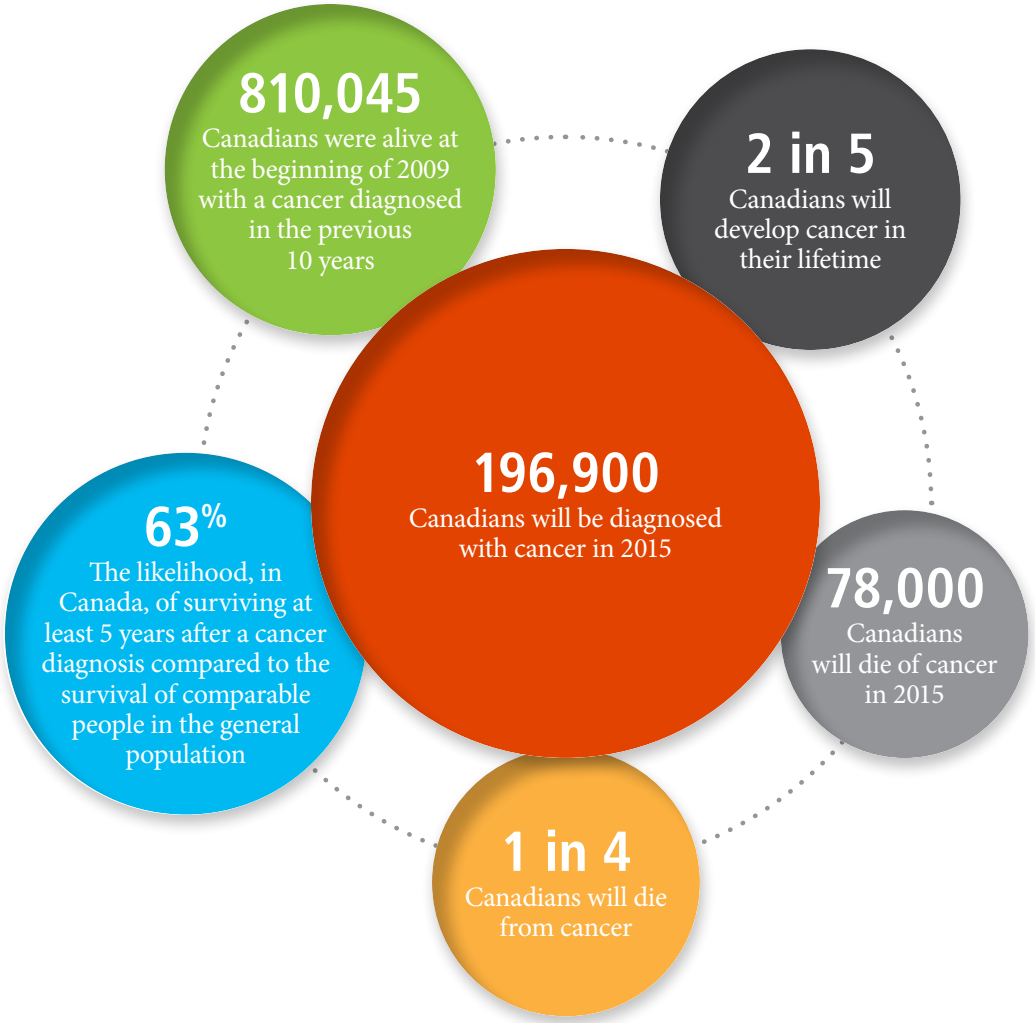
Executive summary

Canadian Cancer Statistics is an annual publication that provides estimates of the burden of cancer in Canada for the current year.

About 2 in 5 Canadians will develop cancer in their lifetime, and about 1 in 4 Canadians will die of cancer. In 2015, it is estimated that 196,900 Canadians will develop cancer, and 78,000 will die of cancer. More than half of new cancer cases (51%) will be lung, breast, colorectal and prostate cancer. Lung cancer is the leading cause of cancer death, causing more cancer deaths among Canadians than the other three major cancer types combined. Despite this large impact, there has been a substantial drop in the lung cancer death rate (especially for men) over the past 25 years, which has driven a decline in the overall cancer death rate.

Slightly more men than women get cancer in Canada, and the vast majority (89%) of Canadians who develop cancer are over the age of 50. However, cancer can occur at any age. Its impact at a younger age can be particularly devastating. According to Statistics Canada, in 2011, cancer was the leading cause of disease-related death in children under the age of 15 years.

Overall, the five-year relative survival ratio for people diagnosed with cancer is 63%, but it ranges widely by the type of cancer. Some cancers have very high five-year relative survival ratios, including thyroid cancer (98%). Other cancers have consistently low five-year relative survival ratios, such as pancreatic cancer (8%).



As of January 2009, 810,045 Canadians had been diagnosed with cancer within the previous 10 years and were still alive on that date. This means that about 2.4% of the Canadian population was living with, or beyond, a cancer diagnosis in the decade leading up to 2009.

This year's publication also features the future burden of cancer in Canada (*Chapter 7: Special topic: Predictions of the future burden of cancer in Canada*). The chapter is focused on cancer incidence up to 2032 and also considers the impact of changing risk factor prevalence and the economic impact of selected interventions. From 2003 to 2007 to 2028 to 2032, the average annual Canadian population is predicted to grow by 29%, but the proportion of Canadians (65+) is predicted to increase significantly as well, from 13% in 2003 to 2007 to 22% in 2028 to 2032.

By 2028 to 2032, the average annual number of new cancer cases is estimated to increase 79% compared to 2003 to 2007. The increase in the number of new cancer cases is primarily due to the aging Canadian population and, to a lesser extent, population growth and changes in the risk of developing cancer. The sheer number of expected cancer cases is yet another reason for highlighting the importance of prevention and planning for additional health resources for managing the future burden of cancer in Canada. Despite the increase in the number of new cases, the age-standardized incidence rate (a measure of cancer risk) is expected to decline somewhat in males (from 465 to 443 per 100,000) but increase in females (from 358 to 371 per 100,000).

Measuring the cancer burden in Canada is vital for health policy, and it helps decision-makers assess the type and allocation of health resources needed. The data are also essential in focusing prevention efforts, in both primary prevention of cancer and secondary prevention, and allowing more effective treatment of certain cancers through earlier detection. Finally, these statistics can be useful for prioritizing services to help Canadians and their families who have been affected by cancer and who may need supportive care after their treatment has ended. We hope that our readers think critically about what these numbers mean and how they can be used to improve survival, develop better overall care for those with cancer and reduce cancer incidence in Canada.

About this publication

Canadian Cancer Statistics is part of an annual series that began in 1987. It has been developed by cancer surveillance experts on the Canadian Cancer Statistics Advisory Committee who were brought together by the Canadian Cancer Society, the Public Health Agency of Canada and Statistics Canada. In addition to these organizations, members of this committee are from the Canadian Council of Cancer Registries, Canadian Partnership Against Cancer and the US Centers for Disease Control and Prevention, as well as researchers based in universities and provincial or territorial cancer agencies.

Purpose and intended audience

The aim of this annual publication is to provide detailed information regarding incidence, mortality, survival and other measures of cancer burden for the most common types of cancer. Data are presented by sex, age, province and territory. Trends over time are also examined. The publication is designed to help health professionals, policy-makers and researchers identify and make decisions about new areas for investigation. The media, educators and members of the public with an interest in cancer may also find this publication valuable.

Format

This publication is organized as follows:

- The *Introduction* provides an overview of cancer in Canada by describing the health and economic challenges posed by the disease, the potential role prevention can play in addressing the cancer burden and the value of surveillance in cancer control efforts in Canada.
- *Chapters 1* and *2* describe the incidence of cancer in Canada overall by age, sex, province and over time.
- *Chapters 3* and *4* examine the mortality associated with cancer in Canada by age, sex, province and over time.
- *Chapter 5* (mostly a repeat from 2014 edition) focuses on survival for cancer relative to the survival in the general population, in Canada by age, sex, province over time and international comparison.
- *Chapter 6* (a repeat from 2014 edition) describes the prevalence of cancer in Canada by examining the number of cancer cases and the number of people diagnosed with cancer who are still alive.
- *Chapter 7* is a special topic that explores the future burden of cancer in Canada. Changes in cancer incidence by age, sex and region are projected to 2028–2032. Changes in cancer prevalence as well as the economic impacts of selected interventions are also considered. In future editions, this chapter will feature other emerging or prominent issues related to cancer, which are selected annually based on criteria that include data availability, recent trends and feedback from our readers through evaluation forms.
- The appendices provide the actual (not projected) data for new cancer cases and deaths, as well as additional information on data sources and projection methods. They also discuss caveats to the analyses presented in this publication and provide a listing of previously covered special topics, which are available in past editions.
- The last section of this publication (*For further information*) includes contact information for the organizations leading the development of the publication and the provincial and territorial cancer registries.

The *Introduction* and *Chapters 1* to *7* conclude with a list of other relevant resources, including links to online databases for additional analyses.

Analysis and production

The Surveillance and Epidemiology Division of the Centre for Chronic Disease Prevention (CCDP) at the Public Health Agency of Canada conducted the data analyses on incidence, mortality, probability and trends presented in this publication. Provincial and territorial cancer registries were consulted regarding the cancer incidence and mortality estimates for their own jurisdictions. The Health Statistics Division of Statistics Canada conducted the analyses on survival and prevalence presented in this publication. However, updated survival and prevalence data were not available for this edition, and the analyses included here (*Chapters 5* and *6*) are repeated from the 2014 edition, with the exception of a section on international comparison (*Chapter 5*). As such, the analytical techniques used and the interpretation of the results included reflect the state of knowledge at the time of the production of the 2014 edition. It was decided to include these chapters again to ensure a complete publication.

The Canadian Cancer Society supports the production of this publication with charitable funds. Ms Monika Dixon coordinated the production process and provided administrative support from the initial planning through to release.

A note on data

The main sources of data for this publication are the Canadian Cancer Registry (CCR), National Cancer

Incidence Reporting System (NCIRS), Canadian Vital Statistics – Death database (CVS: D) and population life tables, censuses and forecasts.

- Provincial and territorial cancer registries collect clinical and demographic data on newly diagnosed cancer cases for people residing in the province or territory. These data are reported annually to Statistics Canada and added to the CCR.
- Provincial and territorial registrars of vital statistics collect demographic and cause-of-death information for people who die in their province or territory. These data are reported annually to Statistics Canada and added to the CVS: D.
- Cancer cases included in the analysis include only invasive primary cancers (with the exception of *in situ* bladder, which is considered invasive for surveillance reporting) and are defined according to ICD-O-3[1] and ICD-10[2] classifications, unless otherwise noted.
- Non-melanoma skin cancers (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous) are not included because most provincial and territorial cancer registries do not collect incidence data on this type of cancer. Canada-wide non-melanoma skin cancer estimates are based on data from four provinces only and are shown in select tables.
- This publication examines approximately 20 cancer types, which represent the vast majority of cancers that occur in Canada. Information on cancer types not covered here may be found through reports and databases from Statistics Canada and the Public Health Agency of Canada.

Actual and estimated data

This publication strives to provide the most up-to-date data. However, because time is required for reporting, collating, verifying, analyzing and publishing surveillance data, the most recent information available is several years behind the current year. Actual cancer incidence data reported in this publication are for the period 1986 to 2010. Data for 1992 to 2010 were obtained from the CCR, except for Quebec data from 2008 to 2010, which were received in a summary format from the Quebec Cancer Registry. Actual cancer mortality data are for the period 1986 to 2010 for all provinces and territories obtained from the CVS: D. Short-term statistical projections provide an estimate of cancer incidence and mortality for recent years (see *Appendix II: Data sources and methods*). Incidence and mortality are projected for each year from 2011–2015 for all provinces and territories.

Because the CCR is a dynamic database, estimates may be updated as new data become available. Projected data are derived using statistical models; therefore, they should be considered as estimates only and viewed with caution. Moreover, models can produce estimates that vary considerably from year to year. For this reason, using the estimates to track year-to-year changes (such as comparing estimates to those from prior editions of this publication) can be misleading and is discouraged.

Tables A1 and A2 list a larger number of cancer types than other tables in the publication. In addition, Tables A3 to A6 provide actual incidence and mortality counts and age-standardized rates for selected cancers by province and territory. Because of the small populations of the territories, only five-year averages (2006 to 2010 for both incidence and mortality) are provided.

For information on how to access the most recent available data, refer to the additional sources of information listed at the end of each chapter or contact the respective cancer registries (see a list of Canadian Cancer Registries).

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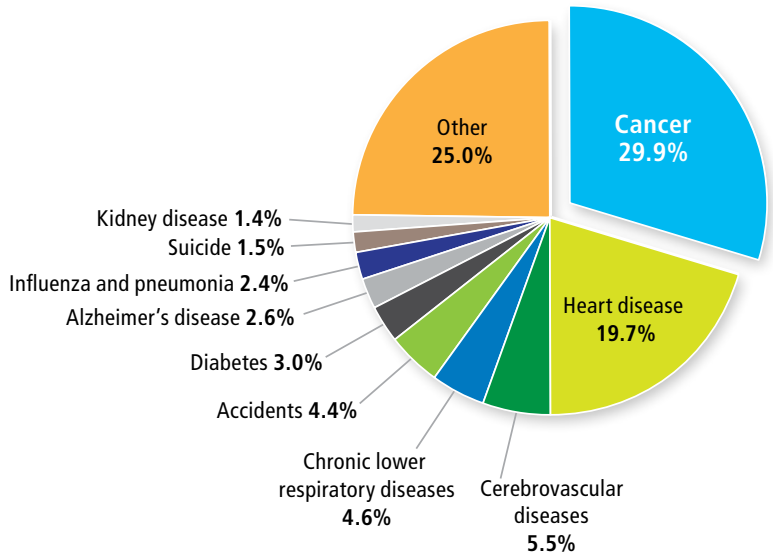
Introduction

Cancer in Canada

Almost half of all Canadians will develop cancer in their lifetime, and a quarter of all Canadians are expected to die of the disease. Cancer is the leading cause of death in Canada (Figure A), responsible for nearly 30% of all deaths, followed by cardiovascular diseases (heart disease and cerebrovascular diseases) and chronic lower respiratory diseases.[1]

Cancer is also the leading cause of premature death, as measured by potential years of life lost (PYLL). PYLL provides an alternative measure to death rates by taking into account average life expectancy and giving more weight to deaths that occur among younger people. In 2010, cancer represented approximately 40% of the PYLL compared to other leading causes of premature death in Canada (Figure B). Generally, PYLL is higher for cancers that are more common, have an earlier age of onset and more quickly lead to death. In both sexes combined, lung cancer was responsible for 27% of the premature deaths caused by cancer (see online Table W1). With regard to the most common cancers in women and men, the PYLL from female breast cancer (94,000) far exceeded that from prostate cancer (35,500), reflecting the relatively younger age at which women die from breast cancer.

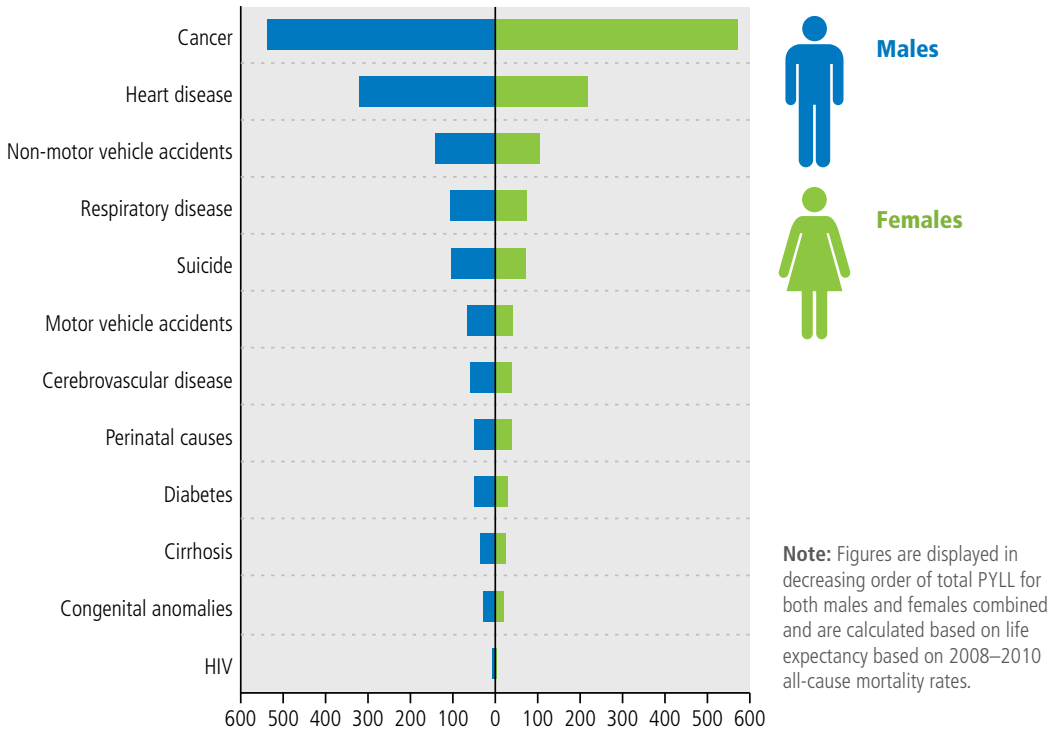
FIGURE A Proportion of deaths due to cancer and other causes, Canada, 2011



Note: The total of all deaths in 2011 in Canada was 242,074.
Adapted from: Statistics Canada. Leading Causes of Death in Canada, 2011, CANSIM Table 102-0522

Although many individuals who survive a cancer diagnosis continue to live productive and rewarding lives, the cancer experience presents many physical, emotional and spiritual challenges that can persist long after the disease is treated. In addition to being personally costly, cancer has major economic ramifications on Canadian society at large. It is difficult to obtain reliable measures of the true cost of cancer. Several analyses attempt to quantify this for Canada and have produced a wide range of estimates. According to one such analysis by the Public Health Agency of Canada, in 2008, cancer was the 7th most costly illness or injury in Canada accounting for $4.4 billion in economic costs. This includes $3.8 billion in direct healthcare costs (includes hospital, drug and physician costs) and $586 million in indirect costs from lost productivity due to illness or premature death. Cancer is the costliest illness in terms of lost productivity due to death; the value of lost productivity due to cancer death was estimated to be $166 million, representing 36.6% of the overall value of lost productivity due to death for all illnesses and injuries included in this analysis.[2] As described in *Chapter 7: Predictions of the future burden of cancer in Canada*, there will be an increasing number of cancers related to the growing and aging population, highlighting the importance of disease prevention measures and planning for additional health resources.

FIGURE B Selected causes of death and their associated potential years of life lost (PYLL), Canada, 2010



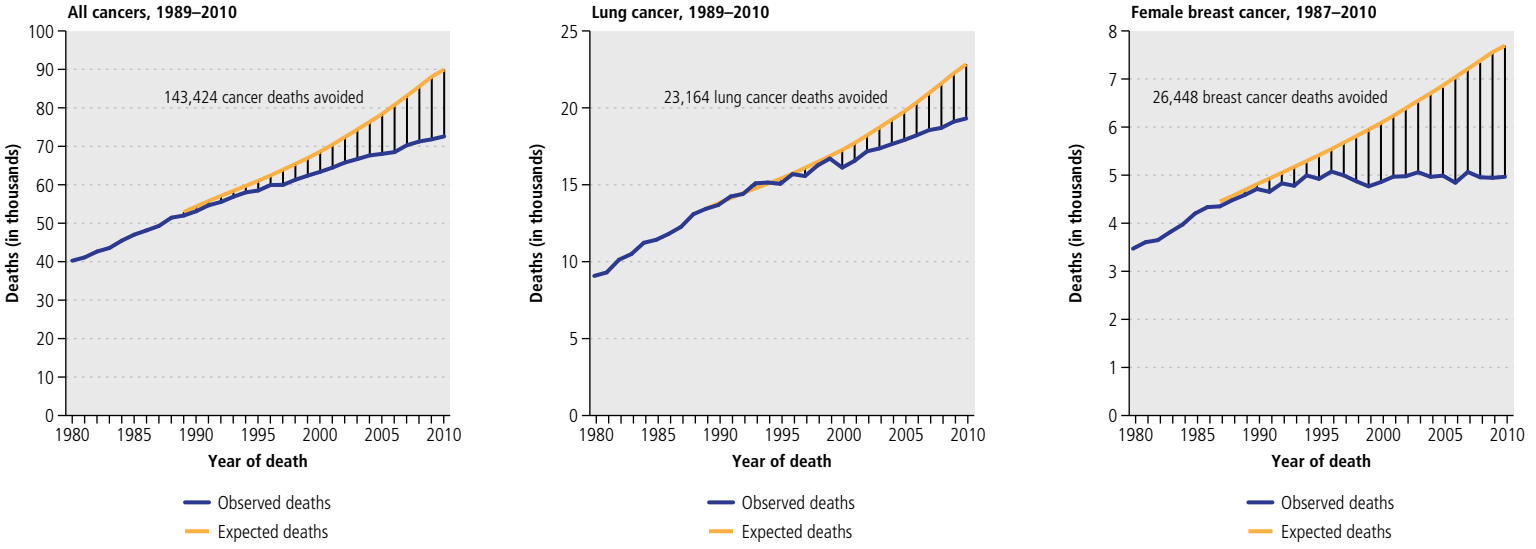
Note: Figures are displayed in decreasing order of total PYLL for both males and females combined and are calculated based on life expectancy based on 2008–2010 all-cause mortality rates.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

Despite these ongoing challenges, much progress has been made in the fight against cancer. Today, more is known about what causes cancer, how it develops and how best to treat it. More is also known about how we can improve the quality of life of people living with cancer and cancer survivors, as well as the lives of their families and caregivers. One example of progress is seen in the drop in the cancer mortality rate. It is estimated that since 1988 when the cancer mortality rate peaked in Canada, over 143,000 deaths have been avoided (Figure C) as a result of cancer prevention and control efforts. Many of the avoided deaths were related to lung and breast cancers. Over 23,000 deaths were avoided (mainly in men) since the lung cancer death rate peaked in 1988, largely reflecting the control of tobacco use among Canadians. Over 26,000 deaths have been avoided since the female breast cancer death rate peaked in 1986, reflecting, in part, the role of breast cancer screening in women and advances in breast cancer treatment (see *Chapter 3* for further details).

Cancer surveillance can help inform cancer prevention and control. Canada is one of the few nations in the world with a national population-based cancer registry that covers the entire population. The information gained from the national and provincial cancer registries is valuable for monitoring cancer patterns and serves as a source of data for cancer control planning, healthcare resource allocation and research. Surveillance data are also essential to help focus both primary prevention efforts (through reducing risk factors and promoting protective factors) and secondary prevention efforts (which have the goal of improving survival through the earlier detection of cancers and treatment of cancer precursors). To this end, the annual *Canadian Cancer Statistics* publication aims to provide the most current summary of key cancer surveillance indicators.

FIGURE C Number of cancer deaths avoided* since the cancer mortality rate peaked in Canada for all cancers combined, lung and female breast cancers



* For overall and lung cancer deaths, the orange line represents the number of deaths that would have occurred if the death rate had remained the same as in 1989. For breast cancer deaths, the orange line represents the number of deaths that would have occurred if the death rate had remained the same as in 1987.

Analysis by: Canadian Cancer Society
Data source: Canadian Vital Statistics Death database at Statistics Canada

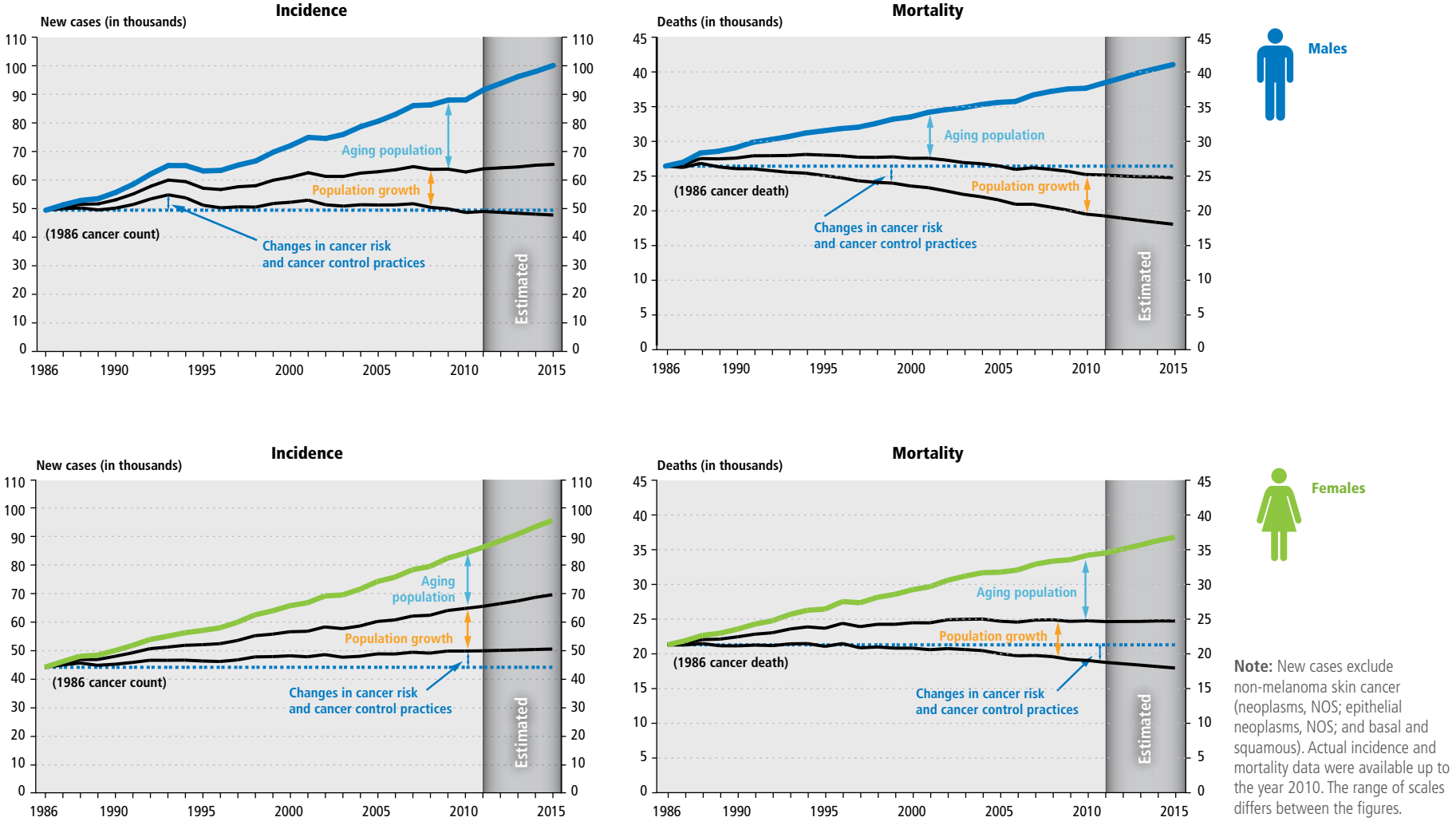
Data from the *Canadian Cancer Statistics* show that Canada compares favourably to other countries on several measures, such as relative survival and mortality rates. Comparable cancer indicators for different countries can be found through various international resources, including the GLOBOCAN database,[3] the *Cancer Incidence in Five Continents* publication,[4] the International Cancer Benchmarking Partnership[5] and the CONCORD studies on cancer survival.[6]

The World Health Organization suggests that prevention offers the most cost-effective, long-term strategy for controlling cancer and other non-communicable diseases.[7] Reducing the risk of cancer can be achieved through the following approaches, among other measures:

- Avoiding smoking – Tobacco is responsible for nearly one-quarter of cancer deaths worldwide, making it the single greatest avoidable risk factor for cancer.[7]
- Following a healthy lifestyle – Eating a diet high in vegetables, fruit and fibre and low in red and processed meat, maintaining a healthy body weight and being physically active can prevent about one-third of the 12 major cancers worldwide, according to the American Institute for Cancer Research and the World Cancer Research Fund.[8,9]
- Reducing alcohol consumption – Alcohol is a risk factor for many different types of cancer, and the risk of cancer increases with the amount of alcohol consumed.[7]
- Avoiding overexposure to sunlight and not using tanning beds or sun lamps – Limiting time in midday sun, wearing protective clothing, seeking shade and using sunscreen can help reduce the risk of skin cancer, while still allowing people to receive the health benefits of sun exposure.[7] Indoor tanning does not provide a safe alternative to the sun and should be avoided.
- Avoid infections, environmental and occupational carcinogens – Certain vaccines, testing and awareness can help reduce, respectively, the risk of some infections associated with cancer (e.g., human papillomavirus and hepatitis B and C), environmental causes of cancer (e.g., radon) and occupational carcinogens (e.g., industrial chemicals).[7]

Increases in the number of new cancer cases in Canada over the past 30 years can largely be attributed to the aging and growing population. In Figure D, the lowest solid line represents the total number of new cancer cases or cancer deaths that would have occurred each year if the population size and age structure remained the same as they were in 1986. Thus, this line measures the effect of changes in cancer risk and cancer control practices. There is very little change in cancer incidence as a result of changes in cancer risk or in cancer control practices. The uppermost line represents the number of new cases or deaths that actually occurred once the impact of population growth and aging are taken into account. According to Statistics Canada, the average annual Canadian population is projected to increase from 32.3 million in 2003 to 2007 to almost 42 million people by 2028 to 2032 (in a medium-growth scenario). The average annual number of Canadians aged 65+ is expected to more than double, from 4.2 million in 2003 to 2007 to 9.4 million in 2028 to 2032 (for population calculation method, see *Appendix II: Data sources and methods*). With such population factors expected to continue into the foreseeable future, the Canadian healthcare system is expected to face greater demand for cancer screening as well as diagnostic and treatment services.

FIGURE D Trends in new cases and deaths for all cancers and ages, attributed to changes in cancer risk and cancer control practices, population growth and aging of the population, both sexes, Canada, 1986–2015



Note: New cases exclude non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). Actual incidence and mortality data were available up to the year 2010. The range of scales differs between the figures.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry, National Cancer Incidence Reporting System, Canadian Vital Statistics Death databases at Statistics Canada and Quebec Cancer Registry (2008–2010)

For more information

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CHAPTER 1
Incidence: How many people in Canada get cancer?

Highlights

- It is expected that 2 in 5 Canadians will develop cancer in their lifetimes. Males have a 45% lifetime probability (or a 1 in 2.2 chance) of developing cancer. Females have a 42% lifetime probability (or a 1 in 2.4 chance) of developing cancer.
- An estimated 196,900 new cases of cancer are expected to be diagnosed in Canada in 2015. More than half of these cases (51%) will be lung, breast, colorectal and prostate cancers.
- From 2001 to 2010, the overall age-standardized incidence rate rose by 0.5% per year for females and decreased by 0.7% per year for males.
- Some of the overall increase in the incidence rate is related to increased detection, while decreases correspond in part to previous declines in major risk factors, such as tobacco use.
- Since 2006, lung cancer incidence in females is no longer increasing.
- Increases in the number of new cases over the past 30 years can largely be attributed to a growing and aging population, rather than to an increase in cancer risk. Given current population trends, increases in cancer incidence are expected to continue. Increases in incidence have implications for screening, diagnostic and treatment services.

Introduction

Each hour, an estimated 22 people will be diagnosed with cancer in Canada in 2015. The number of new cases of cancer each year (the incidence) is an important measure of cancer burden on the Canadian population and healthcare system. Trends in incidence rates can be used to predict the future burden of cancer. This information is essential in ensuring adequate screening, diagnostic and treatment services, as well as directing future cancer prevention, control and research programs.

Probability of developing cancer

The probability of developing a specific type of cancer depends on many factors, including the population characteristics (e.g., demographics), prevalence of risk factors (e.g., smoking, obesity), life expectancy and others. This probability reflects the average experience of people in Canada and does not take into account individual behaviours and risk factors.

The Canadian population is aging.[1] Like many other developed countries, Canada now has a greater proportion of people who are over 65 years of age. Seniors represent the fastest-growing age group in Canada. As a result, it is expected that a growing number of people will be diagnosed with diseases related to aging, such as cancer.

In Canada, 1 in 2.2 males and 1 in 2.4 females (approximately 2 in 5 Canadians) are expected to develop cancer in their lifetime (Figure 1.1).

FIGURE 1.1 Lifetime probability of developing cancer, Canada, 2010

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry, Vital Statistics Death databases at Statistics Canada and Quebec Cancer Registry (2008–2010)

Probability

The chance a person has of developing cancer measured over a period of time. The data here are presented over a lifetime, but probability can also be calculated as the chance of developing cancer at a specific point in time, such as by age 30 or over the next 10 years. The probability of developing cancer is expressed as a percentage or as a chance (e.g., a 1 in 5 chance).

The probability of developing cancer varies by cancer type for males and females.

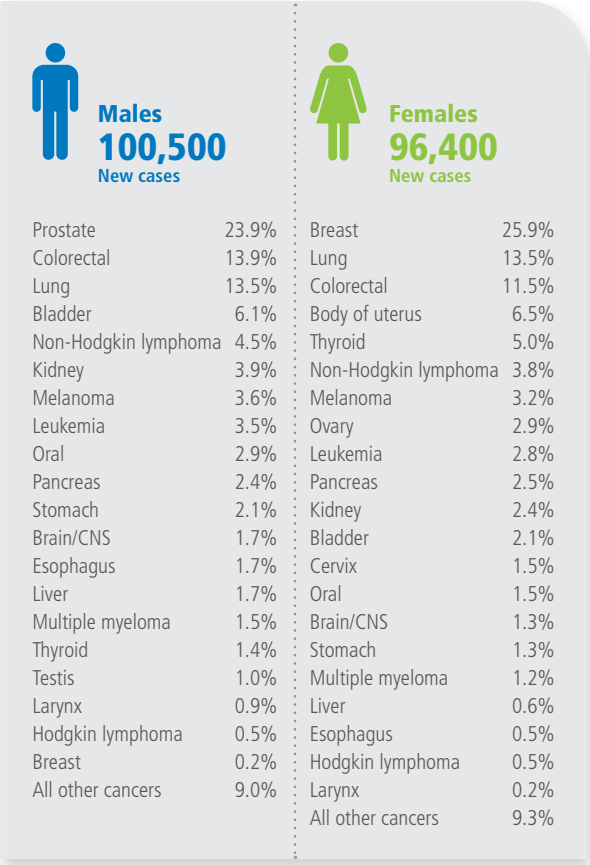
- As shown in Table 1.1, Canadian males are most likely to develop prostate cancer, with 1 in 8 males expected to be diagnosed with prostate cancer in their lifetime. After prostate cancer, males have the highest probability of developing lung cancer, with 1 in 12 males expected to be diagnosed in their lifetime, followed by colorectal cancer, with 1 in 14 males expected to develop colorectal cancer in their lifetime.
- Canadian females are most likely to develop breast cancer, with 1 in 9 females expected to develop breast cancer in their lifetime. One in 15 females is likely to be diagnosed with lung cancer, and 1 in 16 females is likely to be diagnosed with colorectal cancer during their lifetime.

New cases of cancer in 2015

An estimated 196,900 new cases of cancer, as well as an estimated 78,300 new cases of non-melanoma skin cancers (neoplasms, neoplasms of the skin (NOS); epithelial neoplasms, NOS; and basal and squamous), are expected to be diagnosed in 2015 (Table 1.2).

- Four cancers – prostate, breast, lung and colorectal – together are expected to account for more than half (51%) of all cancers diagnosed in Canada in 2015.
- As shown in Figure 1.2, the leading cancers are prostate cancer for males (24,000 expected new cases, or 24% of all new male cases) and breast cancer for females (25,000 expected new cases, or 26% of all new female cases).
- In males, colorectal cancer is now the second most common cancer followed by lung cancer, each accounting for approximately 14% of all new male cases. In females, lung cancer is the second most common cancer, representing 14% of all new female cases followed by colorectal cancer representing approximately 12% of all new female cases.

FIGURE 1.2 Percent distribution of estimated new cancer cases, by sex, Canada, 2015



CNS=central nervous system

Note: The complete definition of the specific cancers listed here can be found in Table A10.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry database at Statistics Canada and Quebec Cancer Registry (2008–2010)

Trends over time

Between 1986 and 2015, the number of new cancer cases rose steadily (Figure 1.3). However, age-standardized incidence rates (ASIR) have decreased for males and increased slightly for females.

- In males, brief peaks in the number of new cancer cases in the early 1990s and early 2000s reflect the underlying trend in the prostate cancer incidence rate, which is the leading type of cancer in Canadian men.
- Among females, the recent slight increase in the overall cancer incidence rate primarily reflects the steady rise in melanoma, thyroid and uterine cancer incidence rates.

Age-standardized incidence rate (ASIR)

The number of new cases of cancer per 100,000 people, standardized to the age structure of the 1991 Canadian population to account for changes in age distribution over time.

Annual percent change (APC)

The estimated change in the rate of new cases (incidence) from one year to the next over a defined period of time, reported as a percentage. Along with the changepoint (the year in which the APC changed), the APC is useful for examining trends.

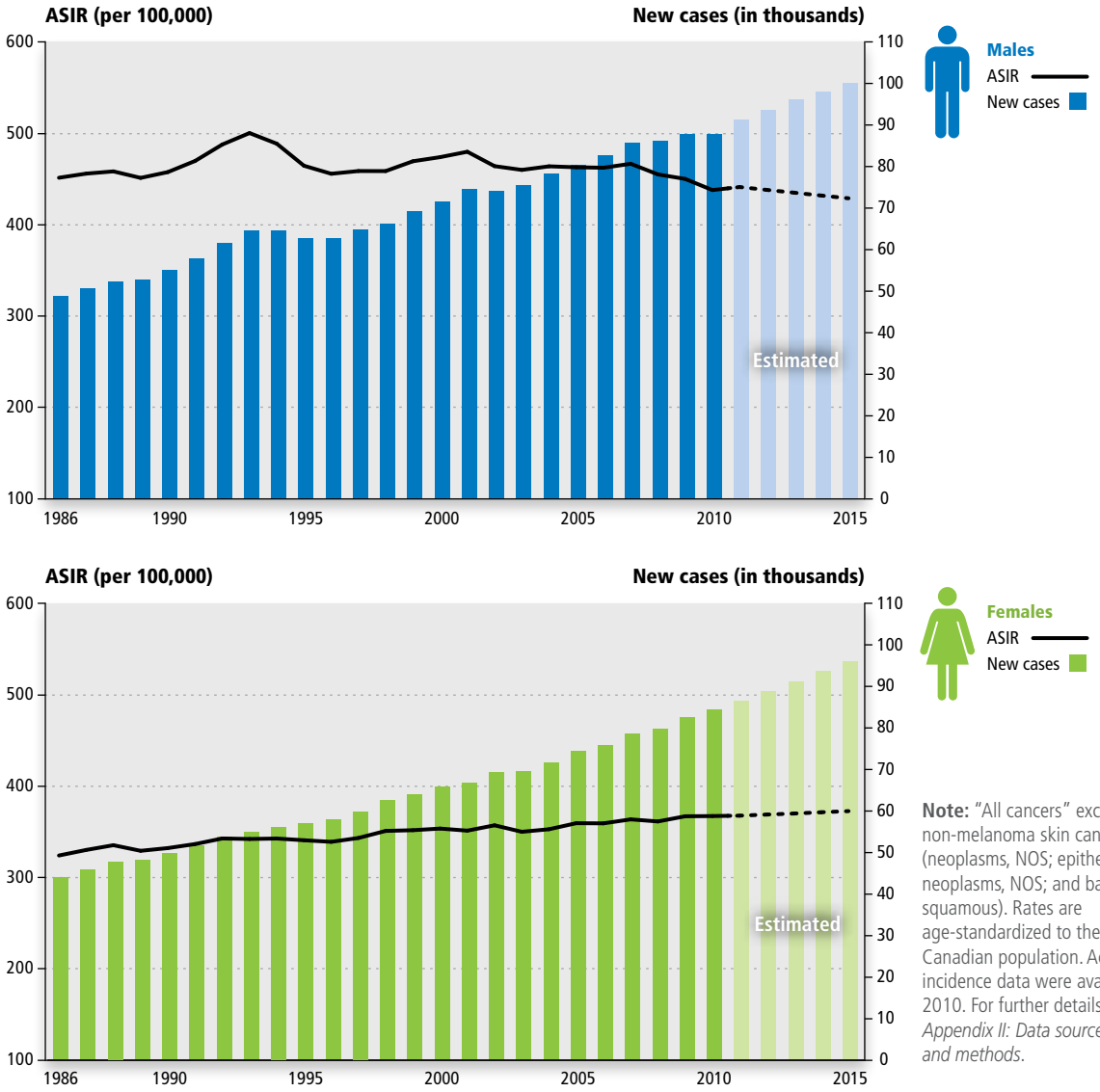
Incidence

The number of new cases of cancer in a given year.

Statistical significance

Refers to a number or a relationship that is unlikely to occur simply by chance; in other words, a statistic that is reliable.

FIGURE 1.3 New cases and age-standardized incidence rates (ASIR) for all cancers, Canada, 1986–2015



Note: "All cancers" exclude non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). Rates are age-standardized to the 1991 Canadian population. Actual incidence data were available to 2010. For further details, see *Appendix II: Data sources and methods*.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada

Data sources: Canadian Cancer Registry, National Cancer Incidence Reporting System databases at Statistics Canada and Quebec Cancer Registry (2008–2010)

View data

Trends for selected cancers

Tables 1.3 and 1.4 show the ASIR for selected cancers in males and females over 30 years. Table 1.5 shows the annual percent change (APC).

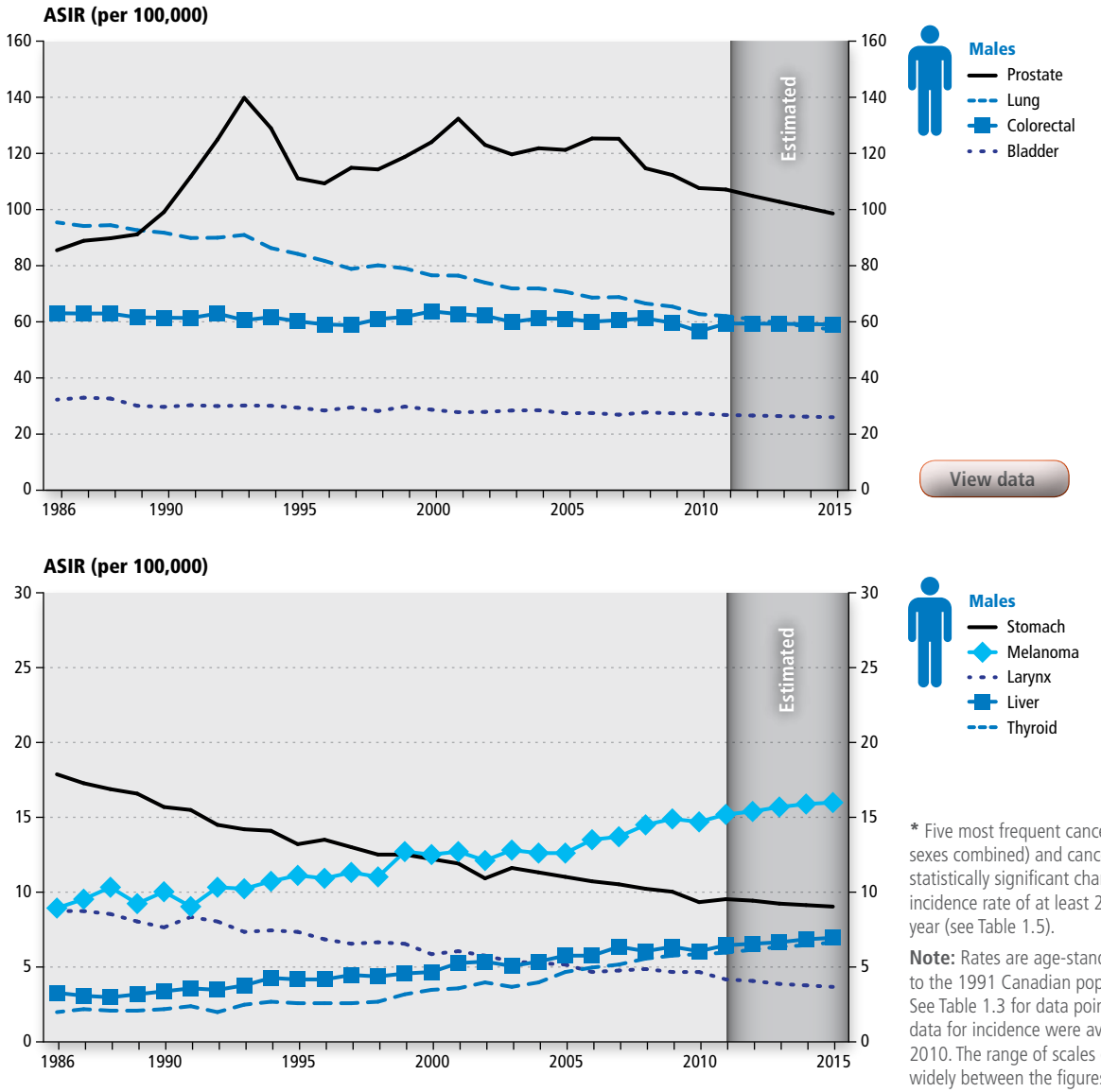
Figures 1.4 and 1.5 show, among males and females, the five most common cancers and those with the largest statistically significant increases or decreases in APC (of at least 2% per year). These cancers are discussed below.

Bladder cancer

Bladder cancer predominantly affects Canadians over the age of 70 years and occurs more commonly in the Atlantic provinces. Between 2001 and 2010, little or no change has been seen for the incidence rates for bladder cancer in males or females. The incidence of bladder cancer has decreased in most Western countries but increased in some eastern European and developing countries.[2] These patterns may in part reflect tobacco use,[2,3] which is estimated to account for between 34%–50% of all bladder cancers.[4,5]

Occupational exposure to certain chemicals is the second most important risk factor for bladder cancer. Exposure to aromatic amines (especially betanaphthylamine, benzidine, 4-aminobiphenyl and 4-o-toluidine), polyaromatic hydrocarbons (PAHs) and diesel engine exhaust is also found to increase the risk for bladder cancer.[6]

FIGURE 1.4 Age-standardized incidence rates (ASIR) for selected* cancers, males, Canada, 1986–2015



Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada

Data sources: Canadian Cancer Registry, National Cancer Incidence Reporting System databases at Statistics Canada and Quebec Cancer Registry (2008–2010)

* Five most frequent cancers (both sexes combined) and cancers with a statistically significant change in incidence rate of at least 2% per year (see Table 1.5).

Note: Rates are age-standardized to the 1991 Canadian population. See Table 1.3 for data points. Actual data for incidence were available to 2010. The range of scales differs widely between the figures. The complete definition of the specific cancers listed here can be found in Table A10.

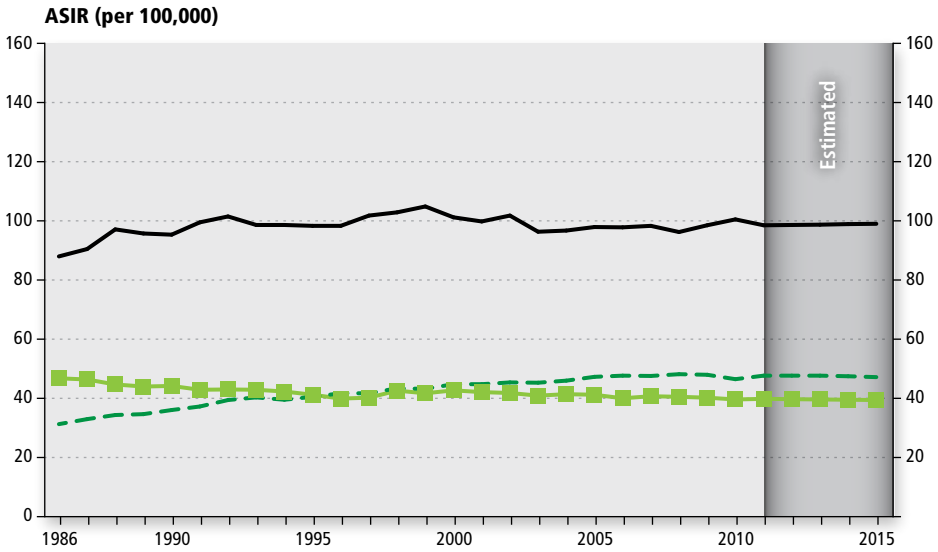
Body of uterus (uterine cancer)

The majority of cancers of the uterus occur in the endometrium or lining of the uterus. Incidence rates of uterine cancer have increased by 2.6% per year among women since 2004. This is consistent with recent reports from the United States.[7] Exposure to estrogen appears to increase risk for uterine cancer. Risk factors include exposure to unopposed estrogen therapies. Reduced risk appears associated with a lower cumulative exposure to estrogen and/or higher exposure to progesterone, such as increasing number of full term pregnancies and shorter menstrual lifespan.[8] Other risk factors include being overweight or obese, a genetic predisposition, diabetes, endometrial hyperplasia, chronic anovulation, previous pelvic radiation, estrogen-secreting ovarian tumours and hereditary non-polyposis colon cancer.

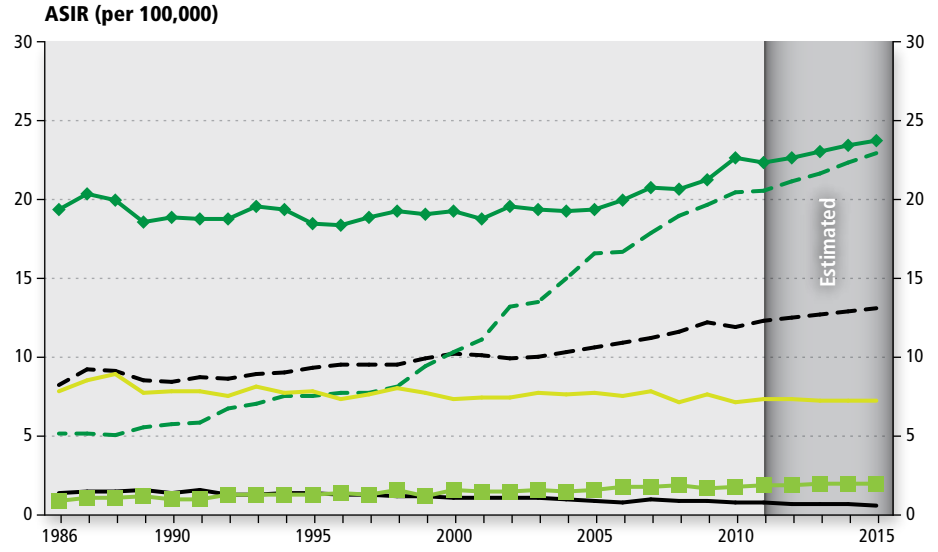
Breast cancer

The breast cancer incidence rate rose through the early 1990s. This increase in the incidence rate is due in part to increased opportunistic mammography screening that was done before organized provincial screening programs were implemented from 1988 onward. Since 1988, the rates have fluctuated. The reasons for these fluctuations are unclear, but they likely have to do with continued participation in mammography screening and long-term changes in hormonal factors, such as early age at menarche, breastfeeding, late age at menopause, oral contraceptive use and late age at full-term pregnancy.[9] Diabetes may also increase risk of breast cancer.[10] The recent decrease in incidence that occurred around 2002 may reflect the reduced use of hormone replacement therapy (HRT) among postmenopausal women.[11,12] Since 2004, breast cancer incidence rates have stabilized. This is consistent with recent reports from the United States.[13]

FIGURE 1.5 Age-standardized incidence rates (ASIR) for selected* cancers, females, Canada, 1986–2015



View data



Analysis by: Surveillance and Epidemiology Division, CCDPC, Public Health Agency of Canada
Data sources: Canadian Cancer Registry, National Cancer Incidence Reporting System databases at Statistics Canada and Quebec Cancer Registry (2008–2010)

* Five most frequent cancers (both sexes combined) and cancers with a statistically significant change in incidence rate of at least 2% per year (see Table 1.5).

Note: Rates are age-standardized to the 1991 Canadian population. See Table 1.4 for data points. Actual data for incidence were available to 2010. The range of scales differs widely between the figures. The complete definition of the specific cancers listed here can be found in Table A10.

Colorectal cancer

Starting from the mid-1980s, overall incidence rates for colorectal cancer declined for both sexes until the mid-1990s (although this decline was more prominent for females).[14] Incidence rates then rose through 2000, only to decline slightly thereafter, most likely due to increased use of colorectal cancer screening, which can identify and remove precancerous polyps, which can in turn reduce incidence. The decline in colorectal cancer incidence rates appears confined to older adults as rates are increasing among young adults under the age of 50 years in Canada and in the United States.[15-17] Diabetes may also increase risk for colorectal cancer.[10]

As of 2014, nine provinces had organized screening programs available, and the remaining province has announced the intention to implement one.[18,19] Participation rates vary within and between the existing organized programs and do not meet the target of 60%.[18] Colorectal cancer is linked to several modifiable risk factors including obesity, physical inactivity, consumption of red and processed meat and smoking.[20,21]

Larynx cancer

Incidence rates of larynx cancer decreased significantly from 2001 to 2010 for both males (2.9% per year) and females (3.5% per year). As cancer of the larynx is most strongly associated with smoking[22] and alcohol,[23] declines in incidence rates most likely reflect decreasing trends in these risk factors.[24,25]

Liver cancer

The incidence rate of liver cancer increased significantly for males (2.3% per year) and females (2.4% per year). These increases may be at least partially explained by rising immigration from regions of the world where risk factors for liver cancer, such as hepatitis B and C infection and exposure to aflatoxin, are more common.[26]

Lung cancer

In males, the incidence rate of lung cancer began to level off in the mid-1980s and has since been declining (almost 2.0% per year in recent years, Table 1.5). Among females, the incidence rate for lung cancer is no longer increasing since 2006. The incidence rate of lung cancer remains higher among males (58 per 100,000) than females (48 per 100,000), although rates among younger adults appear to be converging.[27]

The differences in lung cancer incidence rates among males and females reflect past differences in tobacco use. According to the 2013 Canadian Tobacco, Alcohol and Drugs Survey, the smoking prevalence for Canadians age 15 and over is 15% in both sexes combined.[24] In males, a drop in smoking began in the mid-1960s, preceding the drop in lung cancer incidence by about 20 years. In females, tobacco consumption began to drop in the mid-1980s, suggesting that lung cancer incidence rates in women should also begin to decrease in the next two decades.

Melanoma

Incidence rates of melanoma have increased in both men and women over the past several decades, with recent increases of 2.3% per year in men between 2001 and 2010, and 2.9% per year among women between 2001 and 2010. Exposure to ultraviolet (UV) radiation through exposure to sunlight, tanning beds and sun lamps appears to be a major risk factor for melanoma.[28]

Other risk factors include number and type of moles, having a fair complexion, personal and family history of skin cancer, a weakened immune system and a history of severe blistering sunburn.

Prostate cancer

The prostate-specific antigen (PSA) test is not currently recommended in Canada as a population-based screening test.[29] Despite uncertainty about the benefits and risks of prostate cancer testing, use of the PSA test is widespread.[30,31] In Canada, the incidence rate of prostate cancer peaked in 1993 and 2001. Each of these peaks was followed by a decline. These peaks are compatible with two waves of intensified screening activity using the PSA test. Since at least 2001, the age-standardized incidence rate has been declining (1.6% per year).

Stomach cancer

Incidence rates of stomach cancer continue to decline in both males (2.2% per year) and females (1.3% per year). Current rates are about half of what they were in 1985. This decline may be due to long-term improvements in diets[32] and decreases in smoking and heavy alcohol use.[33] The declining incidence rates of stomach cancer may also be related to the more recent recognition and treatment of infection with the bacterium *Helicobacter pylori*, an important risk factor for stomach cancer.[34]

Thyroid cancer

The incidence rate of thyroid cancer is the most rapidly increasing incidence rate among all major cancers not only in Canada but worldwide.[35] In Canada, there was a 6.3% per year increase in males since 2001 and a 4.4% per year increase in females between 2005 and 2010. The rise may be due to several reasons, including overdiagnoses. More frequent use of diagnostic testing, including ultrasound, computed tomography (CT) scanning and magnetic resonance imaging (MRI), may mean that more earlier stage, asymptomatic thyroid cancers are being diagnosed.[36] Exposure to diagnostic ionizing radiation has likely increased over time, and this could promote the initiation of new tumours.[37]

What do these statistics mean?

Generally, the incidence rate for all cancers combined in males has been stable over the past two decades. In contrast, the incidence rate for all cancers combined in females has continued to increase. This increase is in part driven by the rise in melanoma, thyroid, uterine and liver cancer incidence. While the incidence rates for individual cancer types can be better explained by changes in risk factors and prevention efforts, the overall trend reflects the cumulative impact of the changes seen for each type of cancer.

Given that so much of the increase in cancer incidence over the past 30 years is due to an aging and growing population, this increase can be expected to continue as the population continues to age (see *Chapter 7* for more details). With the rising incidence of cancer, there will be a commensurate increase in the need for diagnostic, treatment and support services, including palliative care in the healthcare system. It will also be important to promptly develop strategies to address the cancers that are now showing significant increase in incidence, such as liver and thyroid cancers.

Prevention efforts should be improved to reduce the impact of risk factors, such as tobacco use and obesity. In addition, a sustained focus on screening for breast, colorectal and cervical cancers will help catch and more effectively treat these cancers earlier in their course.

For more information

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Databases

- Statistics Canada. Table 103-0550 – New cases for ICD-O-3 primary sites of cancer (based on the July 2011 CCR tabulation file), by age group and sex, Canada, provinces and territories, annual, CANSIM (database).
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TABLE 1.1 Lifetime probability of developing cancer overall and by age group, Canada, 2010

	Lifetime probability of developing cancer		Lifetime probability (%) of developing cancer in next 10 years by age group					
	%	One in:	30–39	40–49	50–59	60–69	70–79	80–89
Males								
All cancers*	**44.7**	**2.2**	**0.7**	**1.7**	**5.8**	**14.0**	**20.6**	**20.4**
Prostate	12.8	8	—	0.2	1.6	4.8	5.6	4.1
Lung	8.4	12	—	0.1	0.7	2.2	4.0	3.7
Colorectal	7.2	14	0.1	0.2	0.7	1.9	3.1	3.2
Bladder	3.8	27	—	0.1	0.3	0.8	1.6	2.0
Non-Hodgkin lymphoma	2.3	43	0.1	0.1	0.3	0.6	0.9	0.9
Leukemia	1.9	53	—	0.1	0.2	0.4	0.7	0.8
Kidney	1.8	56	—	0.1	0.3	0.5	0.6	0.5
Melanoma	1.7	57	0.1	0.1	0.2	0.4	0.6	0.6
Oral	1.5	68	—	0.1	0.3	0.4	0.5	0.4
Pancreas	1.3	78	—	—	0.1	0.3	0.5	0.6
Stomach	1.2	81	—	—	0.1	0.3	0.5	0.6
Esophagus	0.9	116	—	—	0.1	0.2	0.3	0.4
Multiple myeloma	0.8	118	—	—	0.1	0.2	0.4	0.4
Brain/CNS	0.8	125	—	0.1	0.1	0.2	0.2	0.2
Liver	0.8	133	—	—	0.1	0.2	0.3	0.3
Larynx	0.6	173	—	—	0.1	0.2	0.2	0.2
Thyroid	0.5	188	0.1	0.1	0.1	0.1	0.1	0.1
Testis	0.4	245	0.1	0.1	—	—	—	—
Hodgkin lymphoma	0.2	432	—	—	—	—	—	—
Females								
All cancers*	**41.5**	**2.4**	**1.4**	**3.3**	**6.4**	**10.7**	**14.5**	**14.6**
Breast	11.7	9	0.4	1.4	2.2	3.2	3.3	2.6
Lung	6.9	15	—	0.2	0.7	1.8	2.9	2.2
Colorectal	6.3	16	0.1	0.2	0.6	1.2	2.2	2.7
Body of uterus	2.8	36	0.1	0.2	0.6	1.0	0.8	0.5
Non-Hodgkin lymphoma	2.0	50	—	0.1	0.2	0.5	0.7	0.7
Thyroid	1.8	56	0.3	0.4	0.4	0.3	0.3	0.1
Ovary	1.4	71	—	0.1	0.2	0.3	0.4	0.4
Leukemia	1.4	72	—	0.1	0.1	0.2	0.4	0.6
Melanoma	1.3	74	0.1	0.2	0.2	0.3	0.3	0.3
Pancreas	1.3	75	—	—	0.1	0.2	0.5	0.6
Bladder	1.2	84	—	—	0.1	0.2	0.4	0.5
Kidney	1.1	90	—	0.1	0.2	0.2	0.4	0.3
Oral	0.8	133	—	—	0.1	0.2	0.2	0.2
Stomach	0.7	135	—	—	0.1	0.1	0.2	0.4
Multiple myeloma	0.7	143	—	—	0.1	0.1	0.3	0.3
Cervix	0.7	152	0.1	0.2	0.1	0.1	0.1	0.1
Brain/CNS	0.7	153	—	—	0.1	0.1	0.2	0.2
Esophagus	0.3	348	—	—	—	0.1	0.1	0.1
Liver	0.3	373	—	—	—	0.1	0.1	0.1
Hodgkin lymphoma	0.2	498	—	—	—	—	—	—
Larynx	0.1	959	—	—	—	—	—	—

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry, Canadian Vital Statistics Death databases at Statistics Canada and Quebec Cancer Registry (2008–2010)

CNS=central nervous system

— Value less than 0.05

* "All cancers" include *in situ* bladder cancer except for Ontario and exclude non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). The complete definition of the specific cancers listed here can be found in Table A10.

Note: The probability of developing cancer is calculated based on age- and sex-specific cancer incidence and mortality rates for Canada in 2010 and on life tables based on 2008–2010 all-cause mortality rates. For further details, see *Appendix II: Data sources and methods.*

TABLE 1.2 Estimated new cases and age-standardized incidence rates (ASIR) for cancers by sex, Canada, 2015

	New cases (2015 estimates)			Cases per 100,000		
	Total*	Males	Females	Total	Males	Females
All cancers	**196,900**	**100,500**	**96,400**	**398.0**	**431.3**	**374.3**
Lung	26,600	13,600	13,000	51.9	57.6	47.5
Breast	25,200	220	25,000	52.1	0.9	99.7
Colorectal	25,100	14,000	11,100	49.0	59.5	39.7
Prostate	24,000	24,000	—	99.3	99.3	—
Bladder†	8,300	6,200	2,100	15.8	26.2	7.3
Non-Hodgkin lymphoma	8,200	4,500	3,700	16.8	19.8	14.2
Melanoma	6,800	3,700	3,100	14.4	16.1	13.2
Body of uterus	6,300	—	6,300	23.9	—	23.9
Thyroid	6,300	1,450	4,800	14.9	6.7	23.1
Kidney	6,200	3,900	2,300	12.7	16.7	9.0
Leukemia	6,200	3,500	2,700	12.9	15.7	10.5
Pancreas	4,800	2,400	2,400	9.3	10.3	8.4
Oral	4,400	2,900	1,450	8.8	12.4	5.6
Stomach	3,400	2,100	1,250	6.6	9.1	4.5
Brain/CNS	3,000	1,750	1,250	6.9	8.2	5.7
Ovary	2,800	—	2,800	10.8	—	10.8
Multiple myeloma	2,700	1,500	1,150	5.1	6.3	4.1
Esophagus	2,200	1,700	500	4.2	7.0	1.8
Liver	2,200	1,650	550	4.4	7.0	2.0
Cervix	1,500	—	1,500	7.5	—	7.5
Larynx	1,050	880	170	2.1	3.7	0.6
Testis	1,050	1,050	—	6.4	6.4	—
Hodgkins lymphoma	1,000	540	460	2.8	3.0	2.5
All other cancers	18,000	9,000	8,900	35.6	39.3	32.7
Non-melanoma skin	78,300	44,400	34,000	—	—	—

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry, National Cancer Incidence Reporting System databases at Statistics Canada and Quebec Cancer Registry (2008–2010)

— Not applicable; CNS=central nervous system

* Column totals may not sum to row totals due to rounding.

† At the time the data were received, Ontario did not report *in situ* bladder cancer; this should be considered when making comparisons across provinces.

Note: "All cancers" excludes the estimated new cases of non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). The complete definition of the specific cancers listed here can be found in Table A10.

TABLE 1.3 Age-standardized incidence rates (ASIR) for selected* cancers, males, Canada, 1986–2015†

	Cases per 100,000									
Year	All cancers	Prostate	Colorectal	Lung	Bladder	Melanoma	Stomach	Liver	Thyroid	Larynx
1986	453.9	86.1	63.5	96.1	32.5	9.0	18.0	3.3	2.0	8.8
1987	458.5	89.5	63.4	94.8	33.2	9.6	17.4	3.1	2.2	8.8
1988	460.9	90.4	63.4	95.1	32.9	10.4	17.0	3.0	2.1	8.6
1989	453.8	91.8	62.0	93.3	30.3	9.3	16.7	3.2	2.1	8.1
1990	460.2	99.8	61.9	92.4	29.9	10.1	15.8	3.4	2.2	7.7
1991	472.4	112.5	61.8	90.5	30.5	9.1	15.6	3.6	2.4	8.4
1992	490.5	125.8	63.4	90.6	30.2	10.4	14.6	3.5	2.0	8.1
1993	503.2	140.8	61.0	91.6	30.4	10.3	14.3	3.8	2.5	7.4
1994	491.5	129.9	62.1	86.9	30.3	10.8	14.2	4.3	2.7	7.5
1995	467.1	111.9	60.6	84.8	29.6	11.2	13.3	4.2	2.6	7.4
1996	458.3	110.1	59.5	82.3	28.6	11.0	13.6	4.2	2.6	6.9
1997	461.3	115.7	59.2	79.4	29.7	11.4	13.1	4.5	2.6	6.6
1998	461.3	115.1	61.4	80.7	28.4	11.1	12.6	4.4	2.7	6.7
1999	472.1	119.6	62.2	79.6	30.0	12.8	12.6	4.6	3.2	6.6
2000	476.6	124.9	64.2	77.1	28.9	12.6	12.3	4.7	3.5	5.9
2001	482.6	133.3	63.2	77.0	28.0	12.8	12.0	5.3	3.6	6.1
2002	466.7	123.9	62.6	74.5	28.1	12.2	11.0	5.4	4.0	5.8
2003	462.6	120.5	60.4	72.4	28.6	12.9	11.7	5.1	3.7	5.4
2004	466.5	122.7	61.6	72.4	28.7	12.7	11.4	5.4	4.0	5.3
2005	465.5	122.1	61.5	71.2	27.6	12.7	11.1	5.8	4.7	5.2
2006	465.0	126.2	60.5	69.1	27.7	13.6	10.8	5.8	5.0	4.7
2007	469.3	126.1	61.0	69.3	27.1	13.8	10.6	6.4	5.2	4.8
2008	457.6	115.5	61.6	67.0	27.9	14.6	10.3	6.1	5.6	4.9
2009	452.6	113.1	60.1	65.9	27.6	15.0	10.1	6.4	5.8	4.7
2010	440.4	108.4	57.0	63.2	27.5	14.8	9.4	6.1	5.9	4.7
2011†	443.7	107.9	59.8	62.5	27.0	15.3	9.6	6.5	6.0	4.2
2012†	440.5	105.6	59.8	61.3	26.8	15.5	9.5	6.6	6.2	4.1
2013†	437.5	103.5	59.7	60.0	26.6	15.8	9.3	6.7	6.4	3.9
2014†	434.3	101.4	59.6	58.8	26.4	16.0	9.2	6.9	6.5	3.8
2015†	431.3	99.3	59.5	57.6	26.2	16.1	9.1	7.0	6.7	3.7

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry, National Cancer Incidence Reporting System databases at Statistics Canada and Quebec Cancer Registry (2008–2010)

* Five most frequent cancers (both sexes combined) and cancers with a statistically significant change in incidence rate of at least 2% per year (see Table 1.5).

† Rates for these years are estimated based on all provinces and territories. Actual data were available to 2010. These estimates are based on long-term trends and may not reflect recent changes in trends.

Note: "All cancers" excludes non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). Rates are age-standardized to the 1991 Canadian population. The complete definition of the specific cancers listed here can be found in Table A10.

TABLE 1.4 Age-standardized incidence rates (ASIR) for selected* cancers, females, Canada, 1986–2015†

	Cases per 100,000									
Year	All cancers	Breast	Lung	Colorectal	Body of uterus	Thyroid	Melanoma	Bladder	Liver	Larynx
1986	325.4	88.6	31.5	47.1	19.5	5.2	8.3	7.9	0.9	1.4
1987	331.6	91.1	33.2	46.7	20.5	5.2	9.3	8.6	1.1	1.5
1988	336.8	97.8	34.6	45.0	20.1	5.1	9.2	9.0	1.1	1.5
1989	330.6	96.4	34.9	44.3	18.7	5.6	8.6	7.8	1.2	1.6
1990	333.6	96.0	36.3	44.5	19.0	5.8	8.5	7.9	1.0	1.4
1991	338.0	100.2	37.5	43.2	18.9	5.9	8.8	7.9	1.0	1.6
1992	344.2	102.2	39.7	43.3	18.9	6.8	8.7	7.6	1.3	1.3
1993	343.6	99.3	40.6	43.2	19.7	7.1	9.0	8.2	1.3	1.3
1994	344.1	99.3	39.8	42.6	19.5	7.6	9.1	7.8	1.3	1.4
1995	342.2	99.0	40.8	41.5	18.6	7.6	9.4	7.9	1.3	1.4
1996	340.5	99.0	42.0	40.2	18.5	7.8	9.6	7.4	1.4	1.3
1997	344.7	102.5	42.0	40.5	19.0	7.8	9.6	7.7	1.3	1.3
1998	352.5	103.6	43.7	42.9	19.4	8.2	9.6	8.1	1.6	1.2
1999	353.3	105.6	43.5	42.0	19.2	9.5	10.0	7.8	1.2	1.2
2000	355.1	101.9	45.1	43.0	19.4	10.4	10.3	7.4	1.6	1.1
2001	352.8	100.5	45.1	42.4	18.9	11.2	10.2	7.5	1.5	1.1
2002	358.7	102.5	45.7	42.1	19.7	13.3	10.0	7.5	1.5	1.1
2003	351.6	97.0	45.6	41.2	19.5	13.6	10.1	7.8	1.6	1.1
2004	354.4	97.4	46.3	41.7	19.4	15.1	10.4	7.7	1.5	1.0
2005	361.0	98.6	47.6	41.5	19.5	16.7	10.7	7.8	1.6	0.9
2006	360.9	98.5	48.0	40.3	20.1	16.8	11.0	7.6	1.8	0.8
2007	365.2	99.0	47.9	41.0	20.9	18.0	11.3	7.9	1.8	1.0
2008	363.0	96.9	48.5	40.8	20.8	19.1	11.7	7.2	1.9	0.9
2009	368.7	99.2	48.3	40.5	21.4	19.8	12.3	7.7	1.7	0.9
2010	368.9	101.2	46.8	39.9	22.8	20.6	12.0	7.2	1.8	0.8
2011†	369.3	99.2	48.0	40.1	22.5	20.7	12.4	7.4	1.9	0.8
2012†	370.5	99.3	48.0	40.0	22.8	21.3	12.6	7.4	1.9	0.7
2013†	371.7	99.4	48.0	39.9	23.2	21.8	12.8	7.3	2.0	0.7
2014†	373.1	99.6	47.8	39.8	23.6	22.5	13.0	7.3	2.0	0.7
2015†	374.3	99.7	47.5	39.7	23.9	23.1	13.2	7.3	2.0	0.6

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry, National Cancer Incidence Reporting System databases at Statistics Canada and Quebec Cancer Registry (2008–2010)

* Five most frequent cancers (both sexes combined) and cancers with a statistically significant change in incidence rate of at least 2% per year (see Table 1.5).

† Rates for these years are estimated based on all provinces and territories. Actual data were available to 2010. These estimates are based on long-term trends and may not reflect recent changes in trends.

Note: "All cancers" excludes non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). Rates are age-standardized to the 1991 Canadian population. The complete definition of the specific cancers listed here can be found in Table A10.

TABLE 1.5 Annual percent change (APC) in age-standardized incidence rates for selected cancers, by sex, Canada, 2001–2010

	Males		Females	
	APC†	Changepoint‡	APC†	Changepoint‡
All cancers	–0.7**		0.5**	
Lung	–1.9**		–0.4	2006
Breast	—		0.5	2004
Colorectal	–0.7**		–0.6**	
Prostate	–1.6**		—	
Bladder	–0.3		–0.4	
Non-Hodgkin lymphoma	0.3		0.4	
Melanoma	2.3**		2.9**	2004
Kidney	1.3**		1.1	
Thyroid	6.3**		4.4**	2005
Body of uterus	—		2.6**	2004
Leukemia	0.3		1.1**	
Pancreas	–0.3		–0.1	
Oral	1.2	2006	0.5	
Stomach	–2.2**		–1.3**	
Brain/CNS	–0.1		–0.2	
Ovary	—		–1.0**	
Multiple myeloma	0.6		0.3	
Liver	2.3**		2.4**	
Esophagus	1.5**		0.2	
Cervix	—		0.7	2005
Larynx	–2.9**		–3.5**	
Testis	1.7**		—	
Hodgkin lymphoma	–0.1		0.2	

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry database at Statistics Canada and Quebec Cancer Registry (2008–2010)

CNS=central nervous system

— Not applicable or small number of cancer cases

* Significant increase or decrease in APC, $p<0.05$.

** Significant increase or decrease in APC, $p<0.01$.

† APC is calculated assuming a piecewise log linear model. The model was fitted to the rates in 1986–2010. "All cancers" includes cancers not found in the table but excludes non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). When there is no changepoint in the most recent 10 years, the APC was obtained. If there is a changepoint, the APC was taken from the last segment. For further details, see *Appendix II: Data sources and methods*.

‡ Changepoint indicates the baseline year for the APC shown, if the slope of the trend changed after 2001.

CHAPTER 2
Incidence by sex, age and geography: Who gets cancer in Canada?

Highlights

- In general, cancer rates increase with age and are more common in males than females. Cancer incidence rates are slowly declining over time in males and slowly increasing in females.
- In 2015, it is estimated that 89% of all cancers will be diagnosed in Canadians over the age of 50, while 43% will occur in Canadians 70 years of age and older. Females have higher rates of cancer than males between the ages of 20 and 59, primarily due to breast and thyroid cancer. Cancer rates are higher in males in all other age groups.
- Cancer incidence rates generally increase from west to east across the country.

Introduction

Cancer strikes males and females, young and old, and those in different regions across Canada on a decidedly uneven basis. This chapter examines incidence by sex, age and geographic region to see how cancer affects people in Canada.

Incidence by sex

Prostate and breast cancer are the most frequently diagnosed cancers for males and females respectively, followed by lung and colorectal cancers. Overall, more males are diagnosed with cancer than females: 51% of all new cases are diagnosed in males; 49% of all new cases are diagnosed in females (Table 2.1).

Trends over time

Figure 2.1 shows that the incidence rates for both males and females changed between 1986 and 2015.

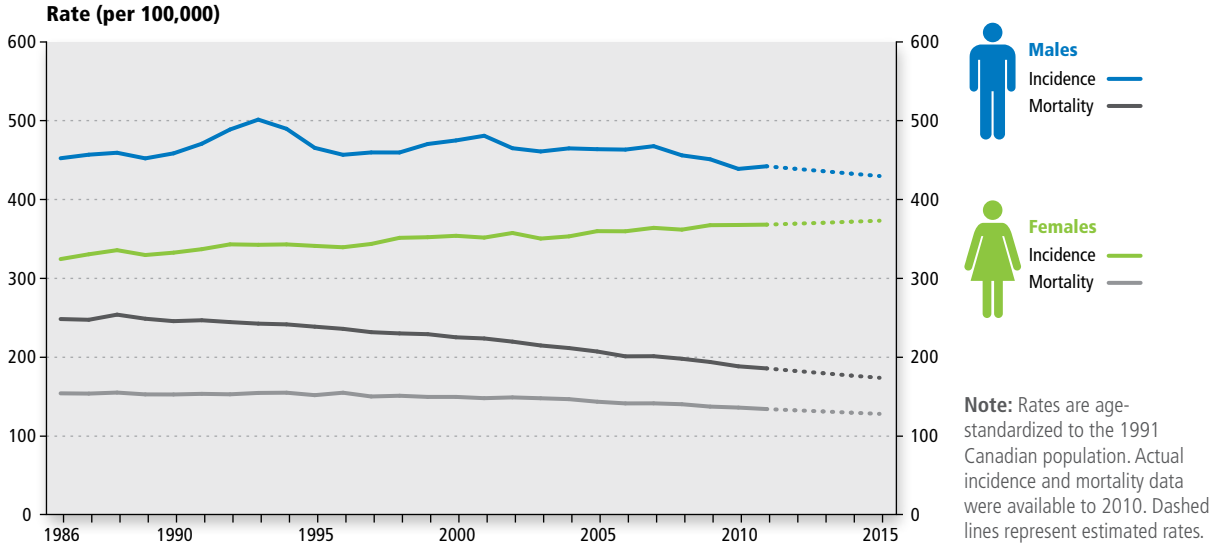
- The overall cancer incidence rate for males rose until the early 1990s. Since 1993, there has been a decline in cancer incidence rate in males, primarily due to the decline in lung cancer.
- Among females, the overall cancer incidence rate has been increasing slowly since the early 1990s. This increase primarily reflects the rise in lung cancer, but it also represents an increase in thyroid and uterine cancers, as well as melanoma.

Incidence by age

Cancer primarily affects Canadians over the age of 50: 89% of all new cases are diagnosed in people in this age group. For both males and females, the median age of cancer diagnosis is between 65 and 69 years of age. As shown in Table 2.1, it is estimated that in 2015:

- 43% of all new cases will occur in people aged 70 years or older.
- 28% of all new cases will occur in people aged 60–69 years.
- 18% of all new cases will occur in people aged 50–59 years.

FIGURE 2.1 Age-standardized incidence and mortality rates for all cancers combined, by sex, Canada, 1986–2015



Note: Rates are age-standardized to the 1991 Canadian population. Actual incidence and mortality data were available to 2010. Dashed lines represent estimated rates.

View data

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry, National Cancer Incidence Reporting system, Canadian Vital Statistics Death databases at Statistics Canada and Quebec Cancer Registry (2008–2010)

- Less than 1% of all new cases will occur in children and youth aged 0–19 years. Although this represents a small percentage of new cancer cases, a cancer diagnosis in this age group has a significant impact on both children and their families.

The largest proportion of new cases of lung, breast, prostate and colorectal cancers occurs in older adults (Table 2.2).

- Just over half of all newly diagnosed cases of lung and colorectal cancer will occur among people aged 70 years or older.
- The majority of breast cancers occur in females 50–69 years of age (52%). Approximately 30% of breast cancers are diagnosed in females aged 70 and over, while 18% occur in females under age 50.
- Prostate cancer is most common in males aged 60–69 years (40%).

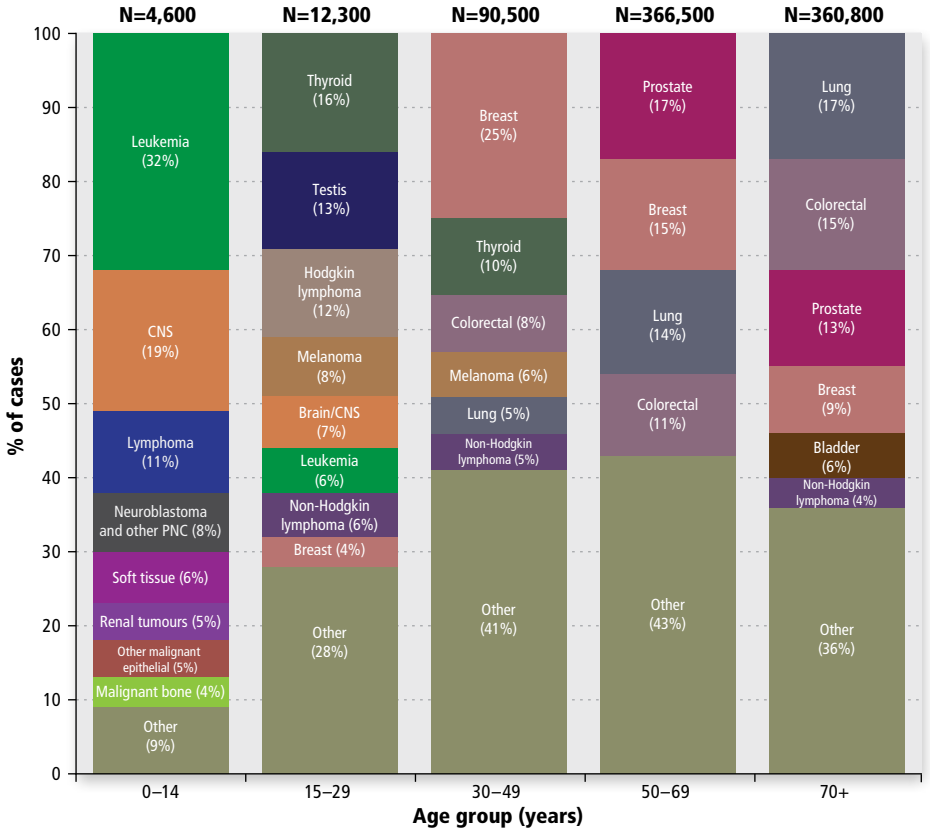
Children, adolescents and young adults

Cancers in children (0–14 years of age, see Table A7) differ from those occurring in adults in both their site of origin and their behaviour. Generally, tumours in children have shorter latency periods and are more aggressive and invasive than tumours in adults. Childhood tumours are more likely to be embryonic or hematopoietic in origin, most commonly leukemia, lymphoma and central nervous system (CNA) cancers. To account for these differences, a separate classification scheme of diagnostic groupings has been created.[1] Adolescents and young adults (15–29 years of age, see Table A8) represent a transitional phase where some tumours still closely resemble those found in childhood, while others have characteristics more common in adults. Consequently, diagnosis and treatment within this age group can be challenging and there have been limited advancements in overall survival in this age group in recent years.

Figure 2.2 shows that the distribution of new cancer cases varies between age groups:

- Between 2006 and 2010, the most commonly diagnosed cancer in children aged 0–14 was leukemia (32%), followed by cancers of the central nervous system (CNS) and lymphomas (19% and 11% respectively).
- New cancer cases among older adolescents and young adults aged 15–29 years old account for approximately 1.5% of all new cancer cases. The most commonly diagnosed cancers in this age group are thyroid (16%), testicular (13%), Hodgkin lymphoma (12%) and melanoma (8%).
- Among middle age and older adults, the distribution of cancers resembles patterns noted in previously

FIGURE 2.2 Distribution of new cancer cases for selected cancers by age group, Canada, 2006–2010



N is the total number of cases over 5 years (2006–2010) for each age group; CNS=central nervous system; PNC=peripheral nervous cell tumours.

Note: Cancers in children (ages 0–14 years) are classified according to ICCC-3.[1] The complete definition of the specific cancers listed here can be found in Table A10.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry database at Statistics Canada and Quebec Cancer Registry (2008–2010)

published reports. For both sexes combined, the most common cancers for ages 30–49, 50–69 and 70+ were breast (25%), prostate (17%) and lung (17%), respectively. After age 50, breast, colorectal, lung and prostate account for over 50% of all new cancer cases.

Trends over time

Trends in incidence rates over time vary by sex and age group (Figure 2.3).

- Incidence rates are higher in females between the ages of 20 and 59 primarily due to breast and thyroid cancers. Incidence rates are higher in males compared to females in all other age groups.
- Incidence rates in females have been stable or slowly increasing in every age category over time.
- Incidence rates in males have been stable or slowly increasing in all age groups under the age of 70.
- Incidence rates in males over 70 have been decreasing over time primarily due to the declining rate of lung cancer from decreased tobacco use in past decades.[2]

Incidence by geographic region

The estimated number of new cases for all cancers combined by province and territory for 2015 are shown in Figure 2.4, with data in Table 2.3. The age-standardized incidence rate (ASIR) shows a declining trend moving from east to west across Canada, with the highest incidence rates in the Atlantic provinces and Quebec and the lowest rates in Alberta and British Columbia.

Age-standardized incidence rate (ASIR)

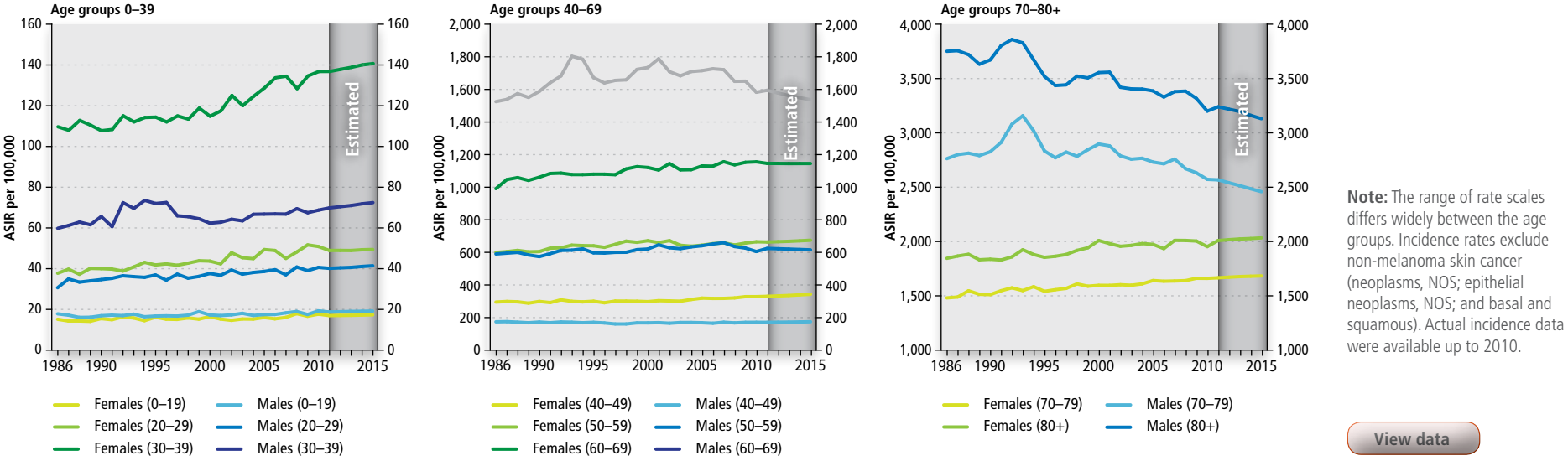
The number of new cases of cancer per 100,000 people, standardized to the age structure of the 1991 Canadian population to account for changes in age distribution over time.

In this section, age standardization is used to adjust for differences in age distributions among the provinces and territories, which allows for more accurate comparisons.

Province or territory

Refers to the province or territory of a person's permanent residence at the time of cancer diagnosis. The most recent actual data for provinces and territories are available to 2010 (see Tables A3 and A4 in *Appendix I: Actual data for new cases and deaths*).

FIGURE 2.3 Age-standardized incidence rates (ASIR) for all cancers, by age group, Canada, 1986–2015



Note: The range of rate scales differs widely between the age groups. Incidence rates exclude non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). Actual incidence data were available up to 2010.

View data

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry, National Cancer Incidence Reporting System databases at Statistics Canada and Quebec Cancer Registry (2008–2010)

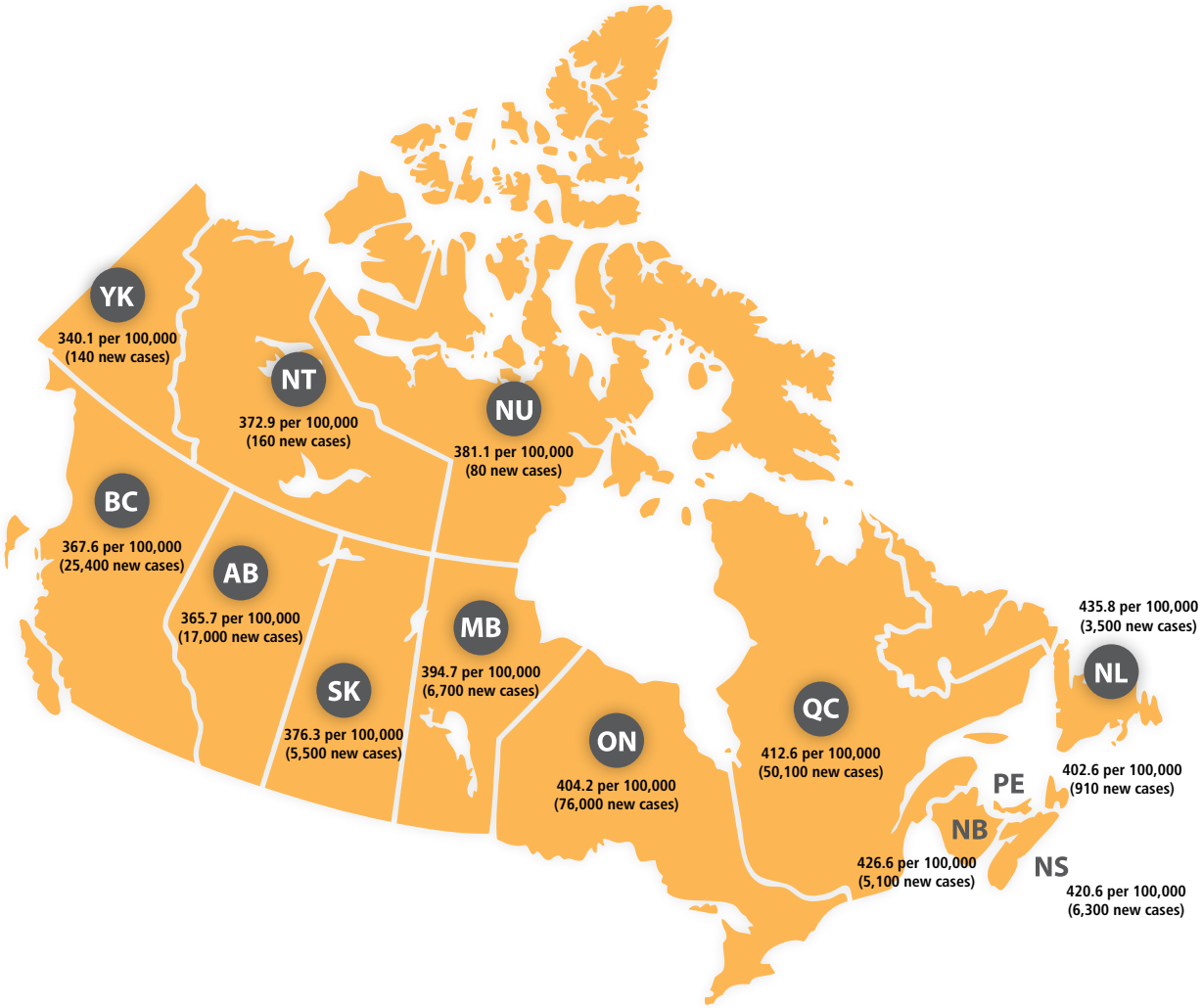
Estimated new cases (Table 2.4) and ASIR (Table 2.5) for specific cancer types by sex and province show that there are geographic differences in rates for males and females across Canada.

- Prostate cancer incidence rates vary greatly among the provinces, possibly due to variations in PSA testing across the country.
- Among males and females, lung cancer incidence rates are estimated to be highest in Quebec and lowest in British Columbia. This difference in incidence rates is linked in large part to the prevalence of smoking in each province.
- Colorectal cancer incidence rates for both males and females are highest in Newfoundland and Labrador. For females, high rates are also seen in Nova Scotia, Prince Edward Island and Manitoba. The lowest rates for both sexes are in British Columbia.
- Apart from Newfoundland and Labrador, breast cancer incidence rates appear to be fairly consistent across the country, with no discernible geographic pattern. The lower rate in Newfoundland and Labrador may be related to incomplete registration of all breast cancers.

Geographic variations in incidence rates may be due to differences in modifiable risk factors, such as unhealthy diet, smoking, obesity and physical inactivity. Differences in incidence rates may also be related to different provincial or territorial programs or procedures for the diagnosis and early detection of cancer, such as approved screening programs and the availability of diagnostic services.

Other factors may impact the interpretation of variations in projected rates among the provinces, including the following:

FIGURE 2.4 Geographic distribution of estimated new cancer cases and age-standardized incidence rates (ASIR) by province and territory, both sexes, Canada, 2015



Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry database at Statistics Canada and Quebec Cancer Registry (2008–2010)

- Cancer frequency – When a cancer is rare or the population is small, the estimated number of new cases of a cancer type may be subject to greater statistical variation.
- Cancer registration method – While the registration of new cancer cases is generally very good across the country, there are exceptions. Incomplete registration is mainly linked to the unavailability and inaccuracy of death certificate data and specific diagnostic information in some provinces.
- Method of projection – The selected method of projection (Nordpred Power5 regression model or five-year average) for provincial data can vary across provinces and across cancer types (see Tables A12 and A13 in *Appendix II: Data sources and methods*).
- Availability of *in situ* cases – The large variation seen in bladder cancer incidence rates among the provinces is likely due to differences in reporting of *in situ* cases, especially in Ontario, where such cases were not collected until recently and were not available in the data analyzed for this publication.

What do these statistics mean?

This chapter shows a distinct picture of cancer distribution in Canada by presenting incidence estimates by sex, age and geographic region. These data can support informed decision-making to ensure that healthcare services meet the needs of a specific population and identify opportunities to target prevention and cancer control initiatives. For example, nearly half of all people diagnosed with cancer will be over the age of 70, and it must be recognized that evidence-based treatment guidelines may vary by age.

The data indicate that females are more likely than males to be diagnosed with cancer in the prime of their lives (between the ages of 20 and 59 years), which reflects patterns for specific cancers, such as breast and thyroid. The priorities of people with cancer and their needs for services can be expected to vary at different points in the age continuum.

Finally, cancer incidence rates across the country vary, with higher rates in the east and lower rates in the west. To better target prevention efforts, these data can be correlated with data on risk factors such as tobacco and alcohol consumption, physical inactivity or obesity rates.

For further information

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- Greenberg ML, Barnett H, Williams J, editors. Atlas of Childhood Cancer in Ontario. Toronto: Pediatric Oncology Group of Ontario; 2015: http://www.pogo.ca/wp-content/uploads/2015/02/POGO_CC-Atlas-1985-2004_Full-Report_Feb-2015.pdf

Databases

- Statistics Canada. Table 103-0550 — New cases for ICD-O-3 primary sites of cancer (based on the July 2011 CCR tabulation file), by age group and sex, Canada, provinces and territories, annual, CANSIM (database).
- Statistics Canada. Table 103-0553 — New cases and age-standardized rate for ICD-O-3 primary sites of cancer (based on the July 2011 CCR tabulation file), by sex, Canada, provinces and territories, annual, CANSIM (database).

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1. Steliarova-Foucher E, Stiller CA, Lacour B, Kaatsch P. International classification of childhood cancer. 3rd ed. Cancer. 2005;103:1457–1467.
2. Health Canada. Canadian Tobacco Use Monitoring Survey (CTUMS). Ottawa; 2012.

TABLE 2.1 Estimated population and new cases for all cancers by age group and sex, Canada, 2015

Age	Population (in thousands)			New cases (2015 estimates)		
	Total*	Males	Females	Total*	Males	Females
All ages	**36,104**	**17,913**	**18,191**	**196,900**	**100,500**	**96,400**
0–19	7,991	4,102	3,889	1,500	810	690
20–29	4,938	2,512	2,426	2,200	1,050	1,200
30–39	4,950	2,480	2,470	5,400	1,800	3,600
40–49	4,846	2,436	2,409	12,800	4,400	8,400
50–59	5,383	2,688	2,695	34,700	16,500	18,200
60–69	4,132	2,012	2,120	54,900	30,700	24,200
70–79	2,350	1,100	1,250	48,000	27,000	21,000
80+	1,516	583	933	37,400	18,300	19,100

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry database, Census and Demographics Branch at Statistics Canada and Quebec Cancer Registry (2008–2010)

* Column totals may not sum to row totals due to rounding.

Note: "New cases" excludes non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous).

TABLE 2.2 Estimated new cases for the most common cancers by age group and sex, Canada, 2015

Age	Lung			Colorectal			Prostate	Breast
	Total*	Males	Females	Total*	Males	Females	Males	Females
All ages	**26,600**	**13,600**	**13,000**	**25,100**	**14,000**	**11,100**	**24,000**	**25,000**
0–19	10	5	5	10	5	5	—	5
20–29	25	10	15	80	40	40	—	120
30–39	90	30	60	310	160	150	5	1,050
40–49	640	270	370	2,000	570	520	460	3,300
50–59	3,700	1,700	1,950	3,700	2,100	1,550	4,400	6,200
60–69	7,900	4,100	3,800	6,700	4,100	2,600	9,600	6,800
70–79	8,400	4,500	3,900	7,000	4,100	2,900	6,400	4,500
80+	5,900	3,000	2,900	6,200	2,900	3,300	3,100	3,100

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry database at Statistics Canada and Quebec Cancer Registry (2008–2010)

— Fewer than 3 cases.

* Column totals may not sum to row totals due to rounding.

Note: The complete definition of the specific cancers listed here can be found in Table A10.

TABLE 2.3 Estimated population and new cases for all cancers by sex and geographic region, Canada, 2015

	Population (in thousands)			New cases (2015 estimates)		
	Total*	Males	Females	Total*	Males	Females
CANADA	**36,104**	**17,913**	**18,191**	**196,900**	**100,500**	**96,400**
British Columbia (BC)	4,888	2,423	2,465	25,400	13,400	12,000
Alberta (AB)	3,996	2,032	1,964	17,000	9,000	8,000
Saskatchewan (SK)	1,068	532	536	5,500	2,800	2,700
Manitoba (MB)	1,300	649	652	6,700	3,400	3,300
Ontario (ON)†	14,128	6,970	7,158	76,000	38,300	37,700
Quebec (QC)‡	8,214	4,078	4,136	50,100	24,900	25,200
New Brunswick (NB)	769	378	391	5,100	2,800	2,300
Nova Scotia (NS)	967	471	496	6,300	3,300	3,000
Prince Edward Island (PE)	149	73	76	910	510	400
Newfoundland and Labrador (NL)‡	510	249	261	3,500	1,950	1,550
Yukon (YT)	35	18	17	140	70	70
Northwest Territories (NT)	45	23	22	160	80	80
Nunavut (NU)	34	18	17	80	40	40

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry database, Census and Demographics Branch at Statistics Canada and Quebec Cancer Registry (2008–2010)

* Column totals may not sum to row totals due to rounding.

† At the time the data were received, Ontario did not report *in situ* bladder cancer; this should be considered when making comparisons across provinces.

‡ The number of cases for some cancers used to calculate the overall 2015 incidence estimates for this province was underestimated.

Note: New cases excludes non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous).

TABLE 2.4 Estimated new cases for selected cancers by sex and province, Canada, 2015

	Canada*	BC	AB	SK	MB	ON†	QC‡	NB	NS	PE	NL‡
Males											
All cancers	**100,500**	**13,400**	**9,000**	**2,800**	**3,400**	**38,300**	**24,900**	**2,800**	**3,300**	**510**	**1,950**
Prostate	24,000	3,800	2,200	690	740	9,700	4,600	780	710	140	540
Colorectal	14,000	1,750	1,250	430	540	5,100	3,700	370	510	65	330
Lung	13,600	1,550	1,100	360	430	4,600	4,300	430	480	75	280
Bladder	6,200	890	610	200	220	1,650	2,000	180	230	30	100
Non-Hodgkin lymphoma	4,500	640	440	140	150	1,750	1,000	110	140	15	85
Kidney	3,900	350	360	120	160	1,500	1,000	140	150	20	75
Melanoma	3,700	550	320	75	110	1,750	510	95	160	25	50
Leukemia	3,500	490	350	120	140	1,450	730	85	80	15	35
Oral	2,900	380	260	65	120	1,200	680	65	90	15	45
Pancreas	2,400	330	220	70	85	910	650	65	65	10	30
Stomach	2,100	270	200	65	90	780	540	55	65	10	55
Brain/CNS	1,750	200	150	45	50	740	440	35	50	5	25
Esophagus	1,700	210	200	40	50	700	350	45	55	10	20
Liver	1,650	250	150	25	40	700	410	20	40	5	15
Multiple myeloma	1,500	190	140	40	45	600	370	35	45	5	20
Thyroid	1,450	120	130	20	35	680	360	35	30	5	15
Testis	1,050	150	110	30	40	410	230	20	25	5	10
Females											
All cancers	**96,400**	**12,000**	**8,000**	**2,700**	**3,300**	**37,700**	**25,200**	**2,300**	**3,000**	**400**	**1,550**
Breast	25,000	3,400	2,300	710	860	9,800	6,100	570	780	110	360
Lung	13,000	1,600	1,050	410	460	4,400	4,000	380	480	60	190
Colorectal	11,100	1,400	910	340	430	4,100	2,900	260	410	55	230
Body of uterus	6,300	870	540	170	250	2,600	1,450	140	160	25	95
Thyroid	4,800	300	370	50	100	2,500	1,200	110	90	10	40
Non-Hodgkin lymphoma	3,700	510	360	110	140	1,450	810	95	120	15	70
Melanoma	3,100	460	260	65	80	1,500	440	90	140	15	35
Ovary	2,800	310	190	80	100	1,200	700	65	65	10	30
Leukemia	2,700	340	260	85	80	1,200	540	50	60	10	20
Pancreas	2,400	310	220	75	80	860	660	70	80	10	25
Kidney	2,300	200	220	75	80	950	580	80	100	15	50
Bladder	2,100	290	180	70	70	510	750	65	75	10	35
Cervix	1,500	180	170	45	50	640	290	30	45	10	30
Oral	1,450	180	110	35	55	610	350	30	40	10	15
Stomach	1,250	140	85	35	40	510	330	35	40	5	30
Brain/CNS	1,250	150	110	35	40	490	360	30	40	5	20
Multiple myeloma	1,150	140	110	35	35	480	270	30	30	5	15
Liver	550	85	55	10	15	190	160	5	10	—	5
Esophagus	500	75	50	15	15	200	110	10	20	—	5

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry database at Statistics Canada and Quebec Cancer Registry (2008–2010)

— Fewer than 3 cases.

CNS=central nervous system

* Column totals may not sum to row totals due to rounding. Canada totals include provincial and territorial estimates. Territories are not listed due to small numbers.

† At the time the data were received, Ontario did not report *in situ* bladder cancer; this should be considered when making comparisons across provinces.

‡ The number of cases for some cancers used to calculate the overall 2015 estimates for this province was underestimated.

Note: "All cancers" excludes non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). The complete definition of the specific cancers listed here can be found in Table A10.

TABLE 2.5 Estimated age-standardized incidence rates (ASIR) for selected cancers by sex and province, Canada, 2015

	Cases per 100,000										
	Canada*	BC	AB	SK	MB	ON†	QC‡	NB	NS	PE	NL‡
Males											
All cancers	**431**	**405**	**407**	**402**	**428**	**432**	**444**	**491**	**465**	**484**	**507**
Prostate	99	111	96	98	91	107	79	130	95	126	133
Colorectal	60	51	57	62	67	57	65	65	71	60	85
Lung	58	46	50	51	54	51	75	74	67	71	70
Bladder	26	26	28	28	28	18	36	32	33	30	26
Non-Hodgkin lymphoma	20	20	20	21	19	20	18	20	20	16	23
Kidney	17	11	16	18	20	17	18	24	22	20	19
Melanoma	16	17	14	11	14	20	10	17	23	24	14
Leukemia	16	16	16	18	18	17	14	16	12	14	10
Oral	12	11	11	9	14	13	12	11	13	14	12
Pancreas	10	10	10	10	11	10	11	11	9	12	7
Stomach	9	8	9	9	11	9	10	10	9	8	14
Brain/CNS	8	7	7	7	7	9	9	7	8	7	8
Esophagus	7	6	9	6	6	8	6	8	8	8	5
Thyroid	7	4	6	4	5	8	7	7	5	6	5
Liver	7	7	6	4	5	8	7	3	5	4	3
Testis	6	7	6	7	7	6	7	6	6	7	5
Multiple myeloma	6	6	6	6	6	7	7	6	6	7	5
Females											
All cancers	**374**	**337**	**333**	**357**	**371**	**385**	**396**	**373**	**387**	**338**	**375**
Breast	100	100	96	96	100	101	101	93	102	95	86
Lung	48	41	44	51	49	42	60	56	56	45	42
Colorectal	40	36	37	42	44	39	41	39	49	44	53
Body of uterus	24	24	22	22	28	26	22	21	20	19	23
Thyroid	23	11	17	9	15	31	25	22	16	10	13
Non-Hodgkin lymphoma	14	14	15	15	15	15	13	15	16	13	16
Melanoma	13	14	11	9	10	16	8	16	20	16	9
Ovary	11	9	8	10	12	13	11	11	8	10	8
Leukemia	11	10	11	11	9	13	9	9	8	8	6
Kidney	9	5	9	10	9	10	9	13	13	11	12
Pancreas	8	8	9	9	8	8	9	10	9	8	5
Cervix	7	6	8	9	7	8	6	7	8	10	10
Bladder	7	7	7	9	7	5	11	10	9	7	8
Oral	6	5	4	5	6	6	6	5	5	7	4
Brain/CNS	6	5	5	5	5	6	7	6	6	5	5
Stomach	5	4	3	4	4	5	5	5	5	4	8
Multiple myeloma	4	4	4	5	3	4	4	4	4	4	3
Liver	2	2	2	1	2	2	2	1	1	—	1
Esophagus	2	2	2	2	1	2	1	2	2	—	1

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry database at Statistics Canada and Quebec Cancer Registry (2008–2010)

CNS=central nervous system

* Canada totals include provincial and territorial estimates. Territories are not listed due to small numbers.

† At the time the data were received, Ontario did not report *in situ* bladder cancer; this should be considered when making comparisons across provinces.

‡ The number of cases for some cancers that were used to calculate the overall 2015 estimates for this province was underestimated.

Note: "All cancers" excludes non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). Rates are age-standardized to the 1991 Canadian population. The complete definition of the specific cancers listed here can be found in Table A10.

CHAPTER 3
Mortality: How many people in Canada die of cancer?

Highlights

- An estimated 78,000 Canadians are expected to die of cancer in 2015.
- It is expected that 1 in 4 Canadians will die of cancer. Males have a 29% lifetime probability (approximately a 1 in 3.5 chance) of dying from cancer. Females have a 24% lifetime probability (approximately a 1 in 4.1 chance) of dying from cancer.
- Between 2001 and 2010, overall age-standardized mortality rates declined by 1.8% per year for males. A similar decline of 1.2% per year for females was seen between 2002 and 2010. On average, mortality rates declined by at least 2% per year for the following: colorectal, lung and oral cancers in males; breast and cervical cancers in females; and larynx, non-Hodgkin lymphoma and stomach cancers in both sexes.
- Between 2001 and 2010, liver cancer mortality rates increased in both males and females.
- Between 2005 and 2010, uterine cancer mortality rates increased by 2.8%.

Introduction

Each hour, an estimated nine people will die of cancer in Canada, in 2015. Monitoring cancer deaths over time allows us to measure progress in reducing cancer deaths and contemplate the implications of changing patterns on the Canadian healthcare system.

Probability of dying from cancer

In Canada, approximately 1 in 4 Canadians are expected to die from cancer (data not shown). The chance of dying from cancer differs slightly by sex (see Figure 3.1).

As shown in Table 3.1, males have a 29% chance (or 1 in 3.5 chance) of dying from cancer. Lung cancer is the most likely cause of cancer death, with a 1 in 13 chance. Prostate cancer is the next most likely cause of cancer death, with a 1 in 27 chance. Colorectal cancer is the third most likely cause of cancer death, with a 1 in 29 chance.

Table 3.1 also shows that females in Canada have a 24% chance (or a 1 in 4.1 chance) of dying from cancer. Lung cancer is the most likely cause of cancer death in females, with a 1 in 17 chance. Females have a 1 in 30 chance of dying from breast cancer, followed by a 1 in 32 chance of dying from colorectal cancer.

FIGURE 3.1 Lifetime probability of dying from cancer, Canada, 2010

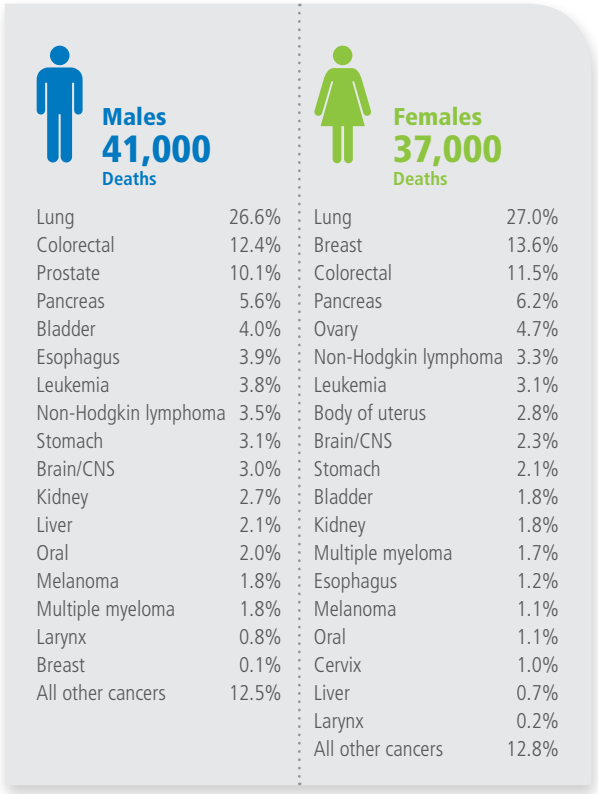
Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

Deaths from cancer in 2015

An estimated 78,000 Canadians are expected to die from cancer in 2015 (Table 3.2).

- Lung, colorectal, breast and prostate cancers account for approximately 50% of all cancer deaths combined in each sex (Figure 3.2). Although it is much less commonly diagnosed than many other cancers, pancreatic cancer is the fourth leading cause of cancer death in both sexes because of its low survival rate.
- Lung cancer is the leading cause of cancer death for both sexes. It is responsible for approximately equal proportions of all cancer deaths in both males and females.
- Colorectal cancer is the second most common cause of cancer death for males and the third most common cause of cancer death for females.
- Breast cancer is the second most common cause of cancer death in females.
- Prostate cancer is the third most common cause of cancer death in males.

FIGURE 3.2 Percent distribution of estimated cancer deaths, by sex, Canada, 2015



CNS=central nervous system

Note: The complete definition of the specific cancers listed here can be found in Table A10.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

Age-standardized mortality rate (ASMR)

The number of cancer deaths per 100,000 people, standardized to the age structure of the 1991 Canadian population to account for changes in age distribution over time.

Annual percent change (APC)

The estimated change in the rate of cancer deaths (mortality) from one year to the next over a defined period of time, reported as a percentage. Along with the changepoint (the year in which the APC changed), the APC is useful for examining trends.

Mortality

The number of deaths due to cancer in a given year.

Probability

The chance a person has of dying from cancer measured over a period of time. The probability of dying from cancer is expressed as a percentage or as a chance (e.g., a 1 in 5 chance).

Statistical significance

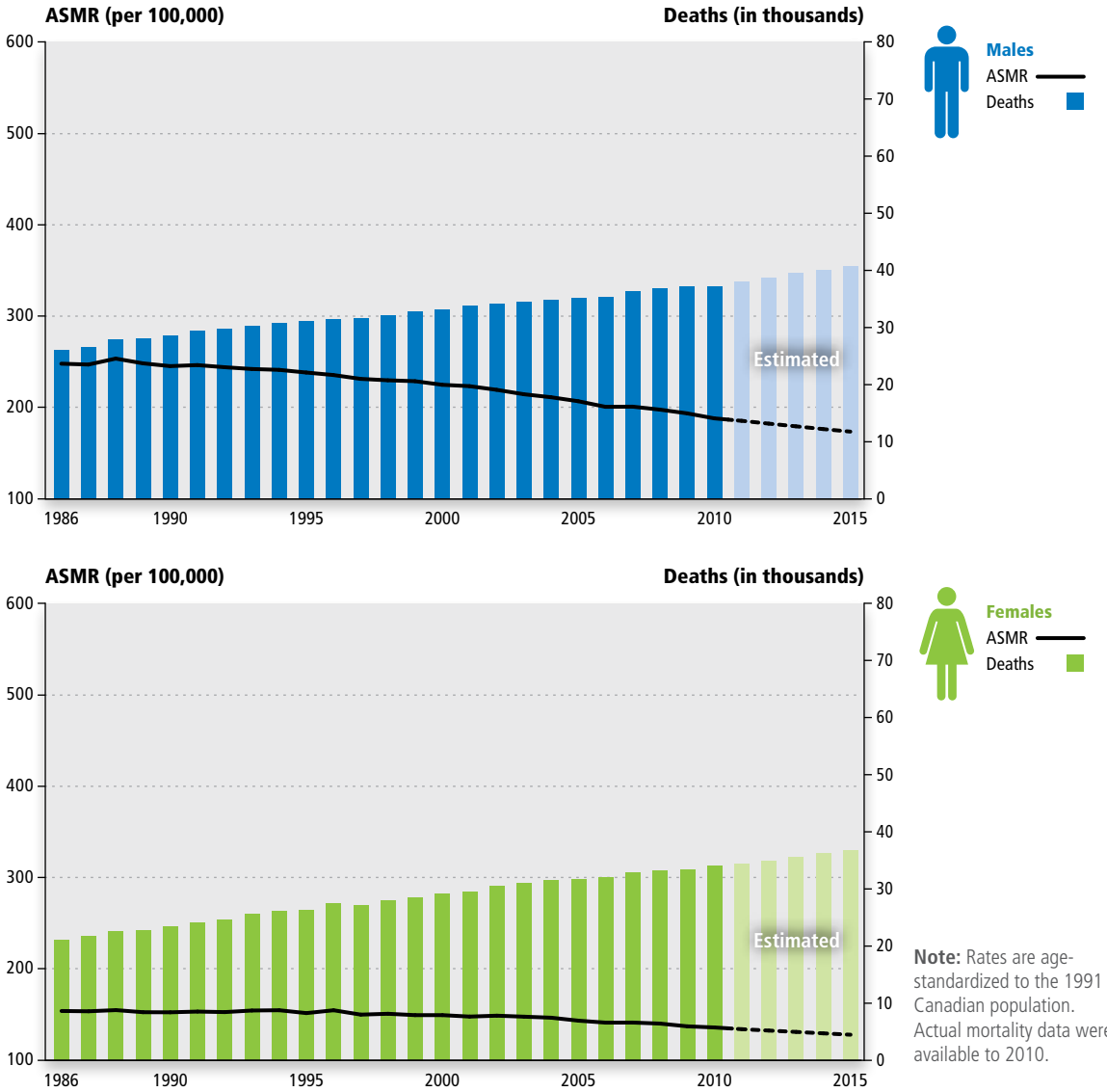
Refers to a number or a relationship that is unlikely to occur simply by chance; in other words, a statistic that is reliable.

Trends over time

Over the past several decades, the number of cancer deaths per year continues to increase in both sexes. During this period, age-standardized mortality rates (ASMR) for some cancers have varied between the sexes (Figures 3.3–3.5).

- For males, the mortality rate for all cancers has been decreasing after it reached a peak in 1988. This is largely due to decreases in mortality rates for lung cancer and, to a lesser extent, decreases in deaths from colorectal and prostate cancers.
- For females, the cancer mortality rate for all cancers has also declined, but to a lesser degree than for males. The ASMR for females has dropped since the mid-1990s as a result of declines in the mortality rates for breast and colorectal cancers.
- Since the early 2000s, the mortality rate for non-Hodgkin lymphoma has declined for both sexes.
- Cancer mortality rates continue to increase for liver cancer in both sexes.

FIGURE 3.3 Deaths and age-standardized mortality rates (ASMR) for all cancers, Canada, 1986–2015



Note: Rates are age-standardized to the 1991 Canadian population. Actual mortality data were available to 2010.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

View data

Trends for selected cancers

Tables 3.3 and 3.4 show the ASMR from 1986 to 2015 for selected cancers in males and females. Table 3.5 shows the annual percent change (APC). Figures 3.4 and 3.5 show, among males and females, the five most common cancers and those with the largest statistically significant decreases or increases in APC (of at least 2% per year). These cancers are discussed below.

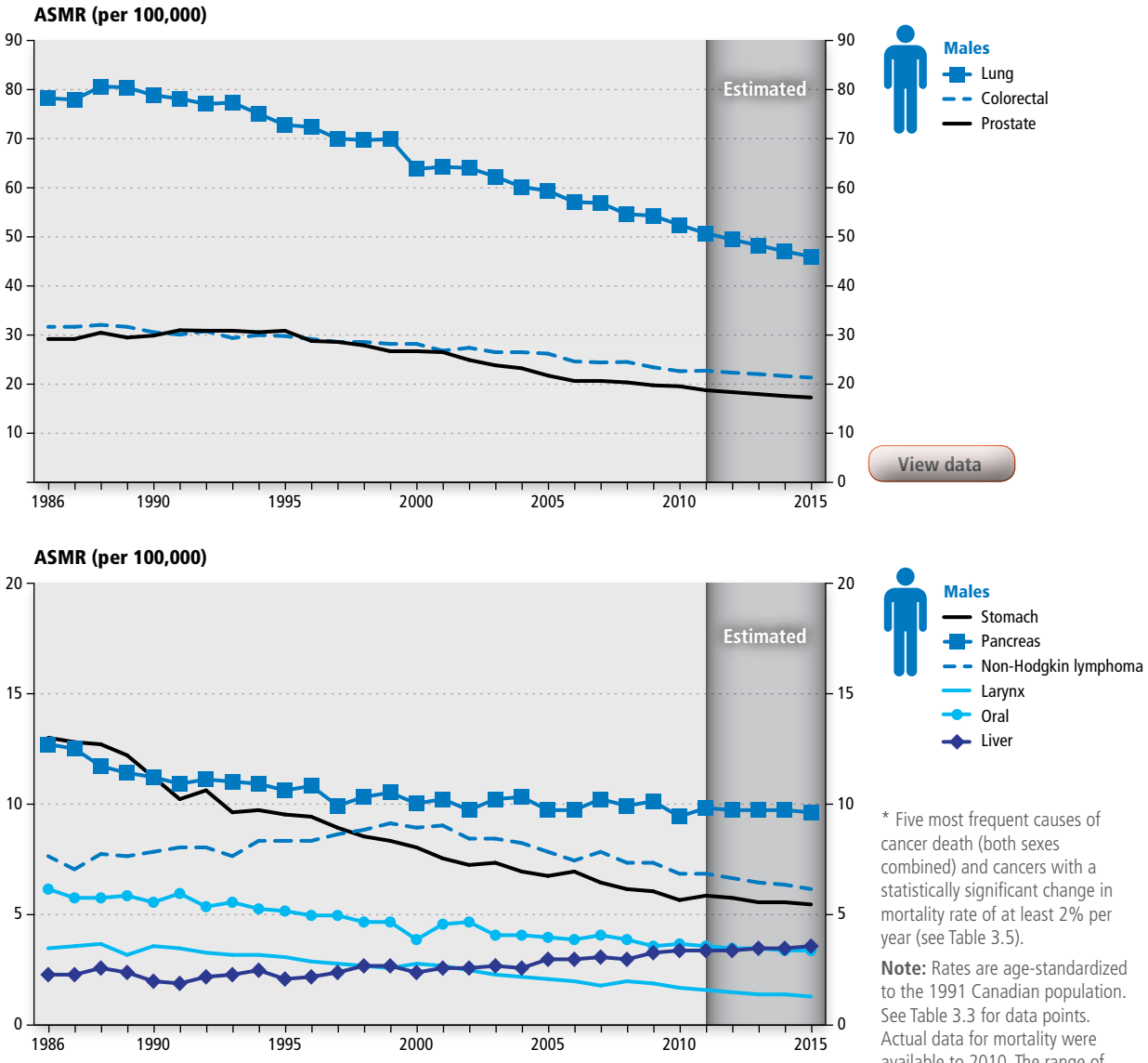
Body of uterus (uterine cancer)

The mortality rate for uterine cancer among females increased by 2.8% per year between 2005 and 2010. The increase in the mortality rate has followed the increase in the incidence rate of uterine cancer over the same period of time.

Breast cancer

The female breast cancer death rate has been declining since the mid-1980s. After its peak in 1986, the age-standardized mortality rate has fallen 44%, from 32.0 deaths per 100,000 in 1986 to a projected rate of 17.9 deaths per 100,000 in 2015. The downward trend has accelerated to 2.5% per year since 2001, which is likely due to a combination of increased mammography screening[1] and the use of more effective therapies following breast cancer surgery.[2,3] Mammographic screening between ages 40 through 79 reduced subsequent mortality rates from breast cancer.[4] However, most provincial screening programs target women >50 ages, reflecting the uncertainty about the role of mammography in the reduction in breast cancer mortality in younger women. One Canadian study found no benefit to mammography in women between 40–50 years of age[5] while other studies report a benefit.[6,7] Both pre-diagnosis and post-diagnosis physical activity was associated with reduced breast

FIGURE 3.4 Age-standardized mortality rates (ASMR) for selected* cancers, males, Canada, 1986–2015



Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

* Five most frequent causes of cancer death (both sexes combined) and cancers with a statistically significant change in mortality rate of at least 2% per year (see Table 3.5).

Note: Rates are age-standardized to the 1991 Canadian population. See Table 3.3 for data points. Actual data for mortality were available to 2010. The range of scales differs widely between the figures. The complete definition of the specific cancers listed here can be found in Table A10.

mortality,[8,9] while high body mass index was associated with a poor prognosis in women of all ages.[10] The breast cancer mortality rate in Canada is the lowest it has been since 1950, with similar declines observed in the United States, United Kingdom and Australia.[11]

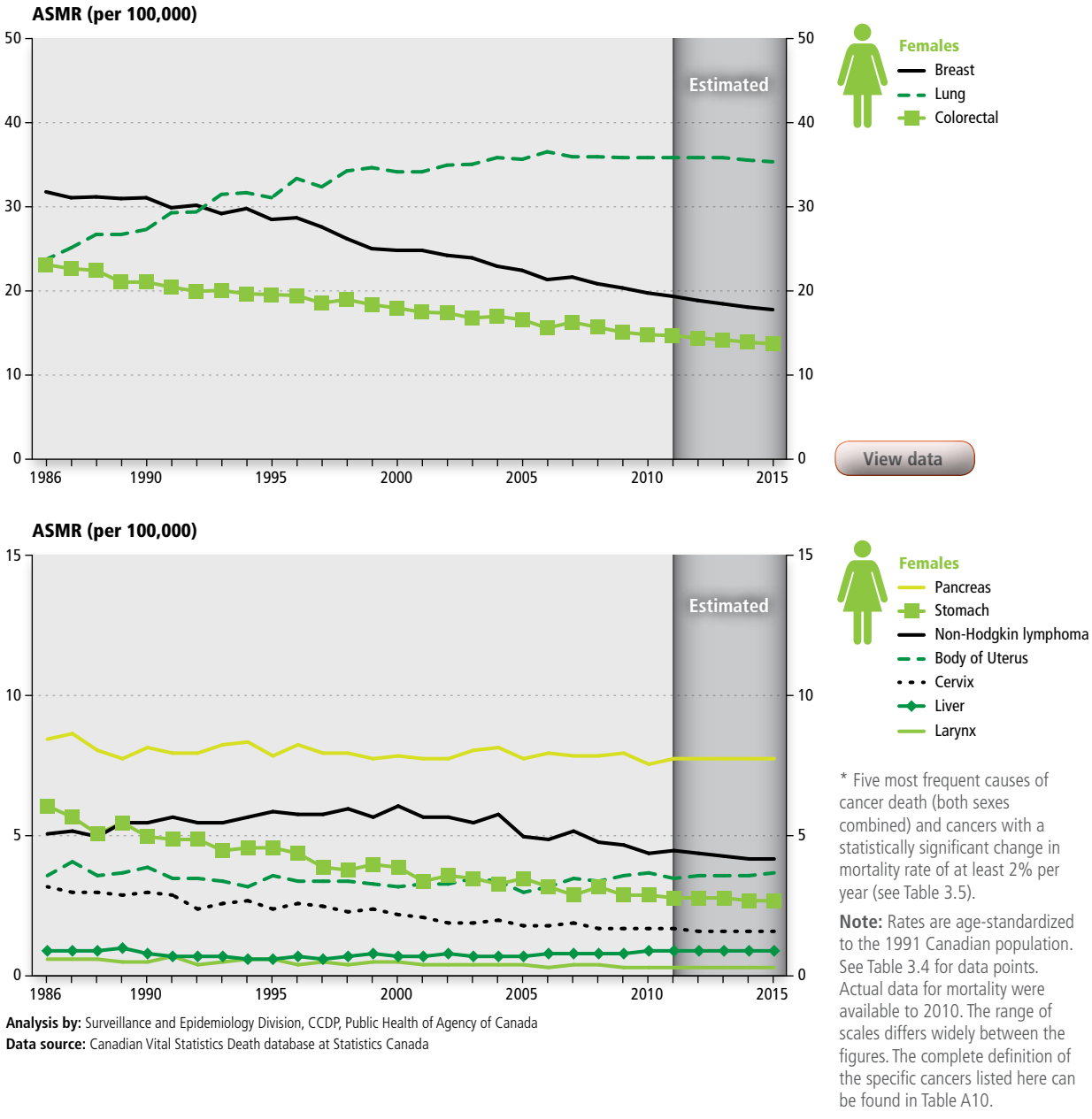
Cervical cancer

The mortality rate for cervical cancer decreased by 2.3% per year between 2001 and 2010. The decrease in mortality rate has followed the reduction in the cervical cancer incidence rate over the same period of time. The latter is largely the result of Pap test screening,[12] which has helped detect precancerous and malignant lesions at an earlier stage when treatment is more effective. Screening appears to play more of a role in reducing cervical cancer mortality among women over the age of 30 years.[13,14]

Colorectal cancer

The death rate from colorectal cancer continues to decline for both males (2.5% per year since 2004) and females (1.8% per year since 2001). The declines in colorectal cancer death rates are consistent with a relatively large contribution from screening and with a smaller impact of risk factor reductions and improved treatments.[15] In Canada, higher colorectal cancer death rates have been seen in areas of lower income despite universal access to healthcare.[16] Physical activity is associated with a reduction in colorectal cancer mortality.[9,17]

FIGURE 3.5 Age-standardized mortality rates (ASMR) for selected* cancers, females, Canada, 1986–2015



Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health of Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

* Five most frequent causes of cancer death (both sexes combined) and cancers with a statistically significant change in mortality rate of at least 2% per year (see Table 3.5).

Note: Rates are age-standardized to the 1991 Canadian population. See Table 3.4 for data points. Actual data for mortality were available to 2010. The range of scales differs widely between the figures. The complete definition of the specific cancers listed here can be found in Table A10.

Larynx cancer

Deaths due to larynx cancer have been declining by more than 4% per year in both males and females since 2001. The trend in mortality rates has followed the reduction in the larynx cancer incidence rate during the same time period. Sustained reductions in tobacco use following the release of the first US Surgeon General's Report in 1964 has had a major impact on the morality rates of tobacco-related cancers, including those of the larynx.

Liver cancer

Between 2001 and 2010, the mortality rate of liver cancer has increased significantly for both males (3.1% per year) and females (2.2% per year). The upward trend in mortality rates has followed the increase in liver cancer incidence rates.

Lung cancer

In males, the mortality rate of lung cancer began to level off in the late 1980s and has been declining ever since. The mortality rate for females shows a slight but statistically significant increase (0.4% per year between 2001 and 2010). However, the death rate in females is expected to begin to decline in the future, similar to the trend in the female lung cancer death rate seen in the United States.[18] Despite the converging trends, males are projected to continue to have a higher mortality rate of lung cancer (46.3 per 100,000) than females (35.6 per 100,000) in 2015. Sustained reductions in tobacco use following the release of the first US Surgeon General's Report in 1964 have had a major impact on lung cancer death rates in North America. However, tobacco control efforts are still needed to further reduce the burden of lung cancer[19] as approximately 15% of the Canadian population continues to smoke.[20]

While smoking remains the most important risk factor for lung cancer, asthma may be a risk factor for lung cancer mortality among nonsmokers.[21] And areas with higher residential measurement of radon appear to have higher lung cancer mortality rates.[22]

Non-Hodgkin lymphoma (NHL)

Mortality rates for NHL have declined by more than 2% per year for both males and female since 2001. Declines in mortality may reflect recent improvements in treatment, such as immunotherapy (e.g., rituximab). In addition, the introduction of highly active antiretroviral therapy (HAART) in the late 1990s[23] for HIV infection has resulted in a decline of aggressive forms of non-Hodgkin lymphoma attributable to HIV infection.

Oral cancer

Mortality rates for cancers of oral cavity and pharynx have declined by 2.4% per year for males between 2001 and 2010. The age-standardized mortality rate has fallen 45%, from 6.2 deaths per 100,000 in 1986 to a projected rate of 3.4 deaths per 100,000 in 2015. Mortality rates in females are stable between 2001 and 2010. These rates likely reflect patterns of smoking prevalence.[24]

Pancreatic cancer

Although it is much less commonly diagnosed than many other cancers, pancreatic cancer is the fourth leading cause of cancer death in both sexes because of its low survival rate. Mortality rates for pancreatic cancer have been stable in males and females. The mortality rates for pancreatic cancer closely reflect the incidence rates for this cancer due to the low survival.[25] In other countries, trends in pancreatic cancer mortality rates have shown wide variation in the past decade. For example, the United Kingdom experienced decreases,[26] while the United States showed increases of pancreatic cancer mortality rates.[27]

Prostate cancer

The mortality rate for prostate cancer rose slowly from 1986 to the mid-1990s, when it began to decline. Since 2006, the decline in mortality rate for prostate cancer has slowed. Nevertheless, the decline likely reflects improved treatment following the introduction of hormonal therapy for early and advanced-stage disease[28,29] and advances in radiation therapy.[30] The role that screening with the prostate-specific antigen (PSA) test played in the reduced mortality rate remains unclear. In 2009, two large randomized trials in the United States and Europe that studied the use of PSA testing in males over the age of 55 reported conflicting results.[31,32] The ongoing follow-up of the men in these studies may help clarify the role of PSA testing in reducing deaths from prostate cancer. Diabetes[33,34] and increasing body mass index[35] may increase risk of death among men diagnosed with prostate cancer.

Stomach cancer

Between 2001 and 2010, mortality rates for stomach cancer declined for both males (3.0% per year) and females (2.3% per year). Mortality rates for both males and females are less than half of what they were in 1986. The trend in mortality rates has followed the reduction in the stomach cancer incidence rate during the same time period and may reflect a reduction in tobacco use.[36]

What do these statistics mean?

While the overall incidence rate of cancer has been slightly increasing in Canada, the overall cancer mortality rate has been decreasing. A decrease in the mortality rate for a specific cancer can result from a decrease in the incidence rate or improvement in the survival rate. For example, the relatively large reduction in mortality rates from lung, oral and larynx cancers reflect the reduction in smoking rates that led to a large reduction in cancer incidence rates, particularly among males. The decrease in the mortality rate for a specific cancer can also reflect the availability of better treatment options leading to improved or longer survival, particularly for cancers that are detected at an early stage of disease when they are most amenable to treatments. Although the ASMR for cancer mortality continues to decline, the actual number of cancer deaths continues to increase due to the growth and aging of the population. This has implications for health policy and resource planning.

For further information

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Databases

- Statistics Canada. Table 102-0522 – Deaths, by cause, Chapter II: Neoplasms (C00 to D48), age group and sex, Canada, annual (number), CANSIM (database).
- Statistics Canada. Table 102-4309 – Mortality and potential years of life lost, by selected causes of death and sex, three-year average, Canada, provinces, territories, health regions and peer groups, occasional (number unless otherwise noted), CANSIM (database).
- Statistics Canada, Table 102-0551 – Deaths and mortality rate, by selected grouped causes, age group and sex, Canada, CANSIM (database).
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TABLE 3.1 Lifetime probability of dying from cancer overall and by age group, Canada, 2010

	Lifetime probability of dying from cancer		Lifetime probability (%) of dying from cancer in next 10 years by age group					
	%	One in:	30–39	40–49	50–59	60–69	70–79	80–89
Males								
All cancers	**28.6**	**3.5**	**0.1**	**0.4**	**1.8**	**5.3**	**11.2**	**16.5**
Lung	7.7	13	—	0.1	0.5	1.8	3.5	3.9
Colorectal	3.5	29	—	0.1	0.2	0.6	1.4	2.1
Prostate	3.7	27	—	—	—	0.3	1.1	2.9
Pancreas	1.4	72	—	—	0.1	0.3	0.6	0.7
Brain/CNS	0.7	153	—	—	0.1	0.2	0.3	0.2
Esophagus	0.9	106	—	—	0.1	0.2	0.4	0.4
Non-Hodgkin lymphoma	1.0	99	—	—	0.1	0.2	0.4	0.6
Leukemia	1.0	96	—	—	—	0.2	0.4	0.7
Stomach	0.8	118	—	—	0.1	0.2	0.3	0.5
Kidney	0.7	139	—	—	0.1	0.1	0.3	0.4
Bladder	1.2	82	—	—	—	0.1	0.4	0.8
Oral	0.5	200	—	—	0.1	0.1	0.2	0.2
Liver	0.4	224	—	—	0.1	0.1	0.2	0.2
Melanoma	0.4	227	—	—	—	0.1	0.2	0.2
Multiple myeloma	0.5	195	—	—	—	0.1	0.2	0.3
Larynx	0.2	412	—	—	—	0.1	0.1	0.1
Females								
All cancers	**24.3**	**4.1**	**0.2**	**0.6**	**1.8**	**4.1**	**7.7**	**11.0**
Lung	5.9	17	—	0.1	0.5	1.3	2.4	2.3
Breast	3.3	30	—	0.2	0.4	0.6	0.9	1.3
Colorectal	3.1	32	—	0.1	0.2	0.3	0.8	1.6
Pancreas	1.4	70	—	—	0.1	0.2	0.5	0.7
Ovary	1.1	91	—	—	0.1	0.2	0.4	0.4
Brain/CNS	0.5	197	—	—	0.1	0.1	0.1	0.2
Non-Hodgkin lymphoma	0.8	118	—	—	—	0.1	0.3	0.5
Leukemia	0.8	132	—	—	—	0.1	0.2	0.4
Body of uterus	0.6	156	—	—	0.1	0.1	0.2	0.3
Stomach	0.5	182	—	—	—	0.1	0.2	0.3
Cervix	0.2	475	—	—	—	—	0.1	0.1
Kidney	0.4	234	—	—	—	0.1	0.1	0.2
Multiple myeloma	0.4	239	—	—	—	0.1	0.2	0.2
Bladder	0.5	210	—	—	—	—	0.1	0.3
Esophagus	0.3	324	—	—	—	0.1	0.1	0.2
Oral	0.3	346	—	—	—	—	0.1	0.1
Melanoma	0.2	456	—	—	—	—	0.1	0.1
Liver	0.1	684	—	—	—	—	0.1	0.1
Thyroid	0.1	1,068	—	—	—	—	—	0.1

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

CNS=central nervous system

— Value less than 0.05

Note: The probability of dying from cancer represents the proportion of Canadians who die of cancer in a cohort based on age- and sex-specific cancer mortality rates for Canada in 2010 and on life tables based on 2008–2010 all-cause mortality rates. For further details, see *Appendix II: Data sources and methods*. The complete definition of the specific cancers listed here can be found in Table A10.

TABLE 3.2 Estimated deaths and age-standardized mortality rates (ASMR) for cancers by sex, Canada, 2015

	Deaths (2015 estimates)			Deaths per 100,000		
	Total*	Males	Females	Total	Males	Females
All cancers	**78,000**	**41,000**	**37,000**	**148.0**	**174.2**	**128.2**
Lung	20,900	10,900	10,000	40.2	46.3	35.6
Colorectal	9,300	5,100	4,200	17.4	21.6	13.8
Breast	5,100	60	5,000	9.7	0.2	17.9
Pancreas	4,600	2,300	2,300	8.7	9.7	7.8
Prostate	4,100	4,100	—	17.4	17.4	—
Leukemia	2,700	1,550	1,150	5.2	6.8	3.9
Non-Hodgkin lymphoma	2,700	1,450	1,200	5.1	6.2	4.2
Bladder	2,300	1,600	680	4.1	6.8	2.1
Brain/CNS	2,100	1,250	860	4.4	5.5	3.4
Esophagus	2,100	1,600	460	3.9	6.7	1.5
Stomach	2,000	1,300	760	3.9	5.5	2.6
Kidney	1,800	1,150	660	3.4	4.7	2.3
Ovary	1,750	—	1,750	6.2	—	6.2
Multiple myeloma	1,400	740	640	2.6	3.1	2.2
Oral	1,200	810	390	2.3	3.4	1.4
Melanoma	1,150	750	420	2.3	3.2	1.5
Liver	1,100	860	270	2.2	3.6	0.9
Body of uterus	1,050	—	1,050	3.7	—	3.7
Larynx	380	310	75	0.7	1.3	0.3
Cervix	380	—	380	1.6	—	1.6
All other cancers	9,900	5,100	4,700	18.3	22.0	15.4

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

CNS=central nervous system

— Not applicable

* Column totals may not sum to row totals due to rounding.

Note: "All other cancers" includes 500 deaths from non-melanoma skin cancer. The complete definition of the specific cancers listed here can be found in Table A10.

TABLE 3.3 Age-standardized mortality rates (ASMR) for selected* cancers, males, Canada, 1986–2015

Year	Deaths per 100,000									
	All cancers	Lung	Colorectal	Prostate	Pancreas	Non-Hodgkin lymphoma	Stomach	Liver	Oral	Larynx
1986	249.0	78.8	31.9	29.4	12.8	7.7	13.1	2.3	6.2	3.5
1987	248.1	78.5	31.9	29.4	12.6	7.1	12.9	2.3	5.8	3.6
1988	254.6	81.2	32.3	30.7	11.8	7.8	12.8	2.6	5.8	3.7
1989	249.4	81.0	31.9	29.7	11.5	7.7	12.3	2.4	5.9	3.2
1990	246.4	79.4	30.8	30.1	11.3	7.9	11.3	2.0	5.6	3.6
1991	247.5	78.7	30.3	31.2	11.0	8.1	10.3	1.9	6.0	3.5
1992	245.2	77.6	31.0	31.1	11.2	8.1	10.7	2.2	5.4	3.3
1993	243.2	77.9	29.6	31.1	11.1	7.7	9.7	2.3	5.6	3.2
1994	242.3	75.6	30.2	30.8	11.0	8.4	9.8	2.5	5.3	3.2
1995	239.3	73.3	30.0	31.1	10.7	8.4	9.6	2.1	5.2	3.1
1996	236.6	72.9	29.4	29.0	10.9	8.4	9.5	2.2	5.0	2.9
1997	232.3	70.5	28.8	28.8	10.0	8.7	9.0	2.4	5.0	2.8
1998	230.7	70.2	28.8	28.1	10.4	8.9	8.6	2.7	4.7	2.7
1999	229.8	70.4	28.4	26.9	10.6	9.2	8.4	2.7	4.7	2.6
2000	225.8	64.3	28.4	26.9	10.1	9.0	8.1	2.4	3.9	2.8
2001	224.3	64.7	27.0	26.7	10.3	9.1	7.6	2.6	4.6	2.7
2002	220.3	64.5	27.6	25.1	9.8	8.5	7.3	2.6	4.7	2.5
2003	215.4	62.7	26.7	24.0	10.3	8.5	7.4	2.7	4.1	2.3
2004	212.1	60.6	26.7	23.4	10.4	8.3	7.0	2.6	4.1	2.2
2005	207.7	59.8	26.4	21.9	9.8	7.9	6.8	3.0	4.0	2.1
2006	201.5	57.5	24.8	20.8	9.8	7.5	7.0	3.0	3.9	2.0
2007	201.7	57.3	24.6	20.8	10.3	7.9	6.5	3.1	4.1	1.8
2008	198.4	55.0	24.7	20.5	10.0	7.4	6.2	3.0	3.9	2.0
2009	194.3	54.7	23.6	19.9	10.2	7.4	6.1	3.3	3.6	1.9
2010	188.8	52.8	22.8	19.7	9.5	6.9	5.7	3.4	3.7	1.7
2011†	186.1	51.1	22.9	18.9	9.9	6.9	5.9	3.4	3.6	1.6
2012†	183.0	49.8	22.5	18.5	9.8	6.7	5.8	3.4	3.5	1.5
2013†	180.0	48.6	22.2	18.1	9.8	6.5	5.6	3.5	3.5	1.4
2014†	177.0	47.4	21.8	17.7	9.8	6.4	5.6	3.5	3.4	1.4
2015†	174.2	46.3	21.5	17.4	9.7	6.2	5.5	3.6	3.4	1.3

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

* Five most frequent causes of cancer death (both sexes combined) and cancers with a statistically significant change in mortality rate of at least 2% per year (see Table 3.5).

† Rates for these years are estimated based on all provinces and territories. Actual mortality data were available to 2010. These estimates are based on long-term trends and may not reflect recent changes in trends. The complete definition of the specific cancers listed here can be found in Table A10.

Note: Rates are age-standardized to the 1991 Canadian population.

TABLE 3.4 Age-standardized mortality rates (ASMR) for selected* cancers, females, Canada, 1986–2015

Year	Deaths per 100,000										
	All cancers	Lung	Breast	Colorectal	Pancreas	Non-Hodgkin lymphoma	Body of uterus	Stomach	Cervix	Liver	Larynx
1986	154.4	23.9	32.0	23.3	8.5	5.1	3.6	6.1	3.2	0.9	0.6
1987	154.0	25.3	31.3	22.8	8.7	5.2	4.1	5.7	3.0	0.9	0.6
1988	155.3	26.9	31.4	22.6	8.1	5.0	3.6	5.1	3.0	0.9	0.6
1989	153.0	26.9	31.2	21.2	7.8	5.5	3.7	5.5	2.9	1.0	0.5
1990	152.9	27.5	31.3	21.2	8.2	5.5	3.9	5.0	3.0	0.8	0.5
1991	153.7	29.5	30.1	20.6	8.0	5.7	3.5	4.9	2.9	0.7	0.7
1992	153.1	29.6	30.4	20.1	8.0	5.5	3.5	4.9	2.4	0.7	0.4
1993	154.9	31.7	29.4	20.2	8.3	5.5	3.4	4.5	2.6	0.7	0.5
1994	155.2	31.9	30.0	19.8	8.4	5.7	3.2	4.6	2.7	0.6	0.6
1995	152.0	31.3	28.7	19.7	7.9	5.9	3.6	4.6	2.4	0.6	0.6
1996	155.2	33.6	28.9	19.6	8.3	5.8	3.4	4.4	2.6	0.7	0.4
1997	150.4	32.6	27.8	18.7	8.0	5.8	3.4	3.9	2.5	0.6	0.5
1998	151.3	34.5	26.4	19.1	8.0	6.0	3.4	3.8	2.3	0.7	0.4
1999	149.8	34.9	25.2	18.5	7.8	5.7	3.3	4.0	2.4	0.8	0.5
2000	149.8	34.4	25.0	18.1	7.9	6.1	3.2	3.9	2.2	0.7	0.5
2001	148.2	34.4	25.0	17.6	7.8	5.7	3.3	3.4	2.1	0.7	0.4
2002	149.2	35.2	24.4	17.5	7.8	5.7	3.3	3.6	1.9	0.8	0.4
2003	148.1	35.3	24.1	16.9	8.1	5.5	3.5	3.5	1.9	0.7	0.4
2004	147.0	36.1	23.1	17.1	8.2	5.8	3.4	3.3	2.0	0.7	0.4
2005	143.7	35.9	22.6	16.7	7.8	5.0	3.0	3.5	1.8	0.7	0.4
2006	141.5	36.8	21.5	15.7	8.0	4.9	3.2	3.2	1.8	0.8	0.3
2007	141.6	36.2	21.8	16.4	7.9	5.2	3.5	2.9	1.9	0.8	0.4
2008	140.5	36.2	21.0	15.8	7.9	4.8	3.4	3.2	1.7	0.8	0.4
2009	137.5	36.1	20.5	15.2	8.0	4.7	3.6	2.9	1.7	0.8	0.3
2010	136.2	36.1	19.9	14.9	7.6	4.4	3.7	2.9	1.7	0.9	0.3
2011†	134.3	36.1	19.5	14.8	7.8	4.5	3.5	2.8	1.7	0.9	0.3
2012†	132.8	36.1	19.0	14.5	7.8	4.4	3.6	2.8	1.6	0.9	0.3
2013†	131.3	36.1	18.6	14.3	7.8	4.3	3.6	2.8	1.6	0.9	0.3
2014†	129.7	35.8	18.2	14.0	7.8	4.2	3.6	2.7	1.6	0.9	0.3
2015†	128.2	35.6	17.9	13.8	7.8	4.2	3.7	2.7	1.6	0.9	0.3

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

* Five most frequent causes of cancer death (both sexes combined) and cancers with a statistically significant change in mortality rate of at least 2% per year (see Table 3.5).

† Rates for these years are estimated based on all provinces and territories. Actual data were available to 2010. These estimates are based on long-term trends and may not reflect recent changes in trends. The complete definition of the specific cancers listed here can be found in Table A10.

Note: Rates are age-standardized to the 1991 Canadian population.

TABLE 3.5 Annual percent change (APC) in age-standardized mortality rates (ASMR) for selected cancers, by sex, Canada, 2001–2010

	Males		Females	
	APC†	Changepoint‡	APC†	Changepoint‡
All cancers	**–1.8****		**–1.2****	**2002**
Lung	–2.3**		0.4*	
Colorectal	–2.5**	2004	–1.8**	
Breast	—		–2.5**	
Pancreas	–0.4		–0.2	
Prostate	–1.6**	2006	—	
Leukemia	–1.5**		–0.6	
Non-Hodgkin lymphoma	–2.6**		–2.8**	
Bladder	–0.1		0.5	
Stomach	–3.0**		–2.3**	
Esophagus	0.3		–0.8	
Brain/CNS	0.6		—	
Kidney	–0.7		–0.8	
Ovary	—		–1.9**	2004
Multiple myeloma	–1.7*		–1.9**	
Oral	–2.4**		–0.9	
Liver	3.1**		2.2**	
Melanoma	1.8*		0.5	
Body of uterus	—		2.8*	2005
Larynx	–4.6**		–4.1*	
Cervix	—		–2.3**	

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

CNS=central nervous system

— Not applicable or small number of deaths

* Significant increase or decrease in APC, $p<0.05$

** Significant increase or decrease in APC, $p<0.01$

† APC is calculated assuming a piecewise log linear model. The model was fitted to the rates in 1986–2010. When there is no changepoint in the most recent 10 years, the APC was obtained by running a separate changepoint analysis on the most recent 10 years. If there is a changepoint, the APC was taken from the last segment. For further details, see *Appendix II: Data sources and methods*. The complete definition of the specific cancers listed here can be found in Table A10.

‡ Changepoint indicates the baseline year for the APC shown, if the slope of the trend changed after 2001.

CHAPTER 4
Mortality by sex, age and geography: Who dies of cancer in Canada?

Highlights

- Overall, mortality rates in both sexes have been decreasing since 1988.
- In 2015, it is estimated that 53% of all cancer deaths will occur among males and 47% among females. The mortality rate has been decreasing to varying degrees for all age groups in males and for the under 70 age groups in females.
- In 2015, almost all cancer deaths in Canada (96%) will occur in people over the age of 50 years. Most of these cancer deaths (62%) will occur in people aged 70 years and over.
- Mortality rates generally increase from west to east across the country.

Introduction

As with new diagnoses of cancer, cancer deaths are not distributed equally across sexes, ages and provinces or territories. Examining deaths of cancer by sex, age or geographic region provides a better sense of who is dying from cancer and can help direct cancer control services to address the needs of specific populations.

Mortality by sex

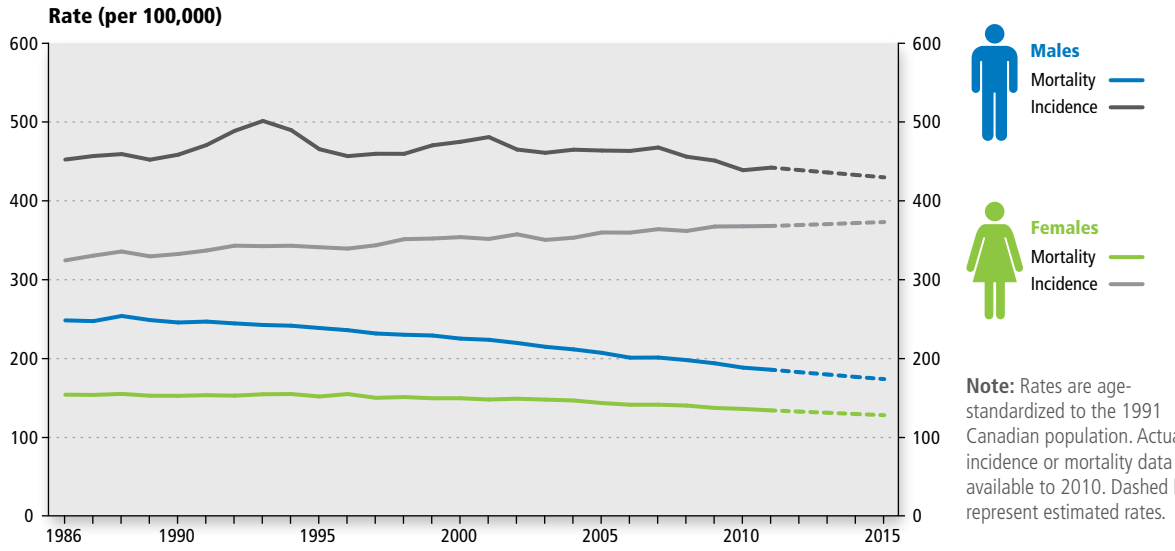
In 2015, it is estimated that 53% of all cancer deaths will occur among males and 47% among females. However, the distribution of cancer deaths between the sexes differs according to age. Among people aged 30–49 years, females represent a larger proportion of total cancer deaths than males (Table 4.1). This is mainly due to the relatively higher number of deaths from female breast cancer compared to prostate cancer and the higher number of deaths among females at younger ages for lung cancer and in the oldest age group for colorectal cancer (Table 4.2).

Trends over time

Figure 4.1 shows the long-term trend in mortality rates by sex. The mortality rate for all cancers combined has been decreasing for both sexes since peaking in 1988.

The decrease in mortality rate in males is largely due to reductions in lung cancer deaths (closely linked to decreases in smoking prevalence). The decrease in cancer deaths in females is attributed to declines in breast cancer mortality (most likely due to improvements in early detection and screening as well as advances in treatment and related improvements in treatment outcomes).[1,2]

FIGURE 4.1 Age-standardized incidence and mortality rates for all cancers combined, by sex, Canada, 1986–2015



Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry, National Cancer Incidence Reporting System, Canadian Vital Statistics Death databases at Statistics Canada and Quebec Cancer Registry (2008–2010)

Mortality by age

In 2015, almost 96% of cancer deaths in Canada will occur in people aged 50 years and older, with the median age range for cancer deaths estimated to be 70–74 years for both sexes (Table 4.1).

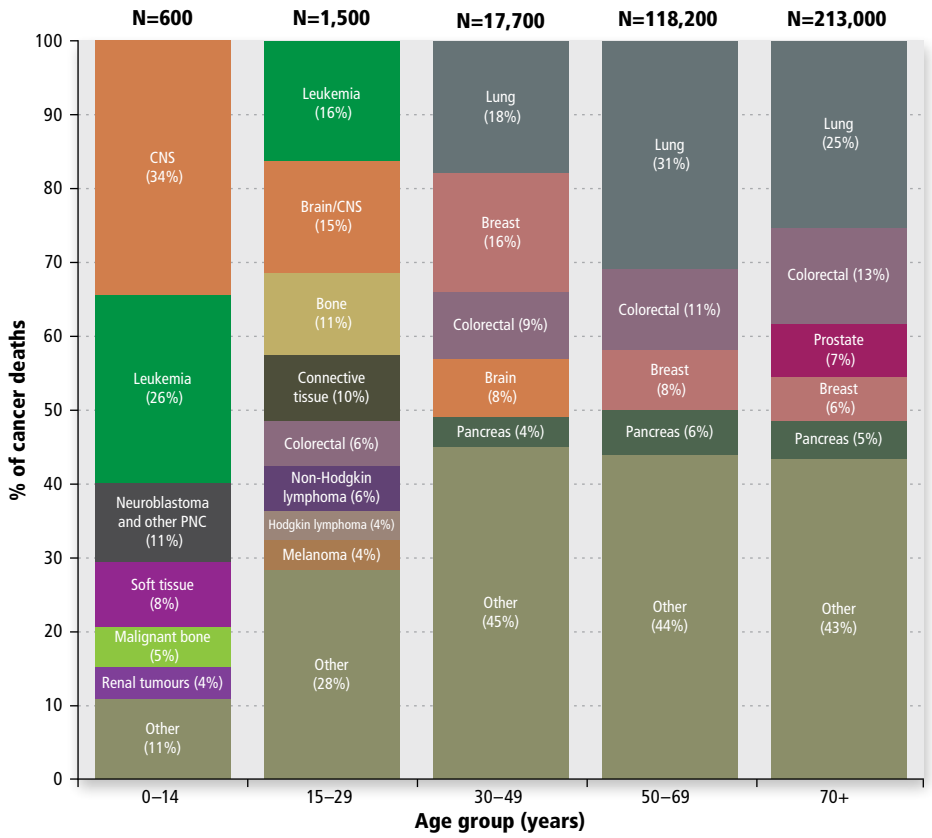
In 2015 it is estimated that:

- Canadians aged 70 years or older will account for 48,100 cancer deaths (or 62% of all cancer deaths).
- Canadians aged 60–69 years will account for an additional 17,600 deaths (or 23% of all cancer deaths).
- Canadians aged 50–59 years will account for 8,800 deaths (or 11% of all cancer deaths).

Older adults account for the largest proportion of deaths from the most common cancers (see Table 4.2):

- While the majority of new breast cancer cases (70% of the total cases) occur in females under the age of 70 (see *Chapter 2*), breast cancer deaths are proportionately lower (48% of the total breast cancer deaths) in that younger age group than in females aged 70 years and older. Breast cancer, however, represents a higher proportion of total female cancer deaths in the younger age groups (22% of cancer deaths in 30–59 year old women versus 12% of cancer deaths for women 60+). The reasons for increased mortality observed for younger women are complex but has been linked to aggressive tumor biology[3,4] and delayed diagnosis.[5]
- Similarly, prostate cancer will be diagnosed most frequently in males aged 60–69 years, but most prostate cancer deaths will occur in males aged 80 years and older. These mortality patterns likely reflect the often slow progression of the disease.

FIGURE 4.2 Distribution of cancer deaths for selected cancers by age group, Canada, 2006–2010



N is the total number of deaths over 5 years (2006–2010) for each age group; CNS=Central nervous system; PNC=Peripheral nervous cell tumours.

Note: Childhood cancers (ages 0–14) are classified according to ICCC-3.[6] and the data are shown for 2005–2009. The complete definition of the specific cancers listed here can be found in Table A10.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

- Unlike many other cancers where the number of deaths increases with age, deaths for lung cancer peak in people aged 70–79 years for both males and females. This peak occurs because the largest proportion of new cases is in the same age group (see *Chapter 2*) and survival is poor, so that deaths typically occur within a short period after diagnosis (see *Chapter 5*).

Cancer deaths among adolescents and young adults

- Cancer deaths among older adolescents and young adults (aged 15–29 years) accounted for less than 0.5% of all cancer deaths in Canada. An average of 290 people in Canada between the ages of 15 and 29 die from cancer each year (see Appendix Table A9). Adolescent and young adult males are more likely to die of cancer than females of that age group. The

male death rates are higher for every major cancer except for tongue, stomach, liver, melanoma and genitourinary.

- The leading causes of cancer deaths among children, adolescents and young adults were cancers of the central nervous system (CNS) and leukemia. These two types of cancer accounted for 60% of all childhood cancer deaths (ages 0–14) and 31% of all adolescent and young adult cancer deaths (ages 15–29) (Figure 4.2).

Trends over time

Cancer mortality rates have decreased to varying degrees over time for all age groups in males and for the under-70 age groups in females (Figure 4.3).

Age-standardized mortality rate (ASMR)

The number of cancer deaths per 100,000 people, standardized to the age structure of the 1991 Canadian population to account for changes in age distribution over time.

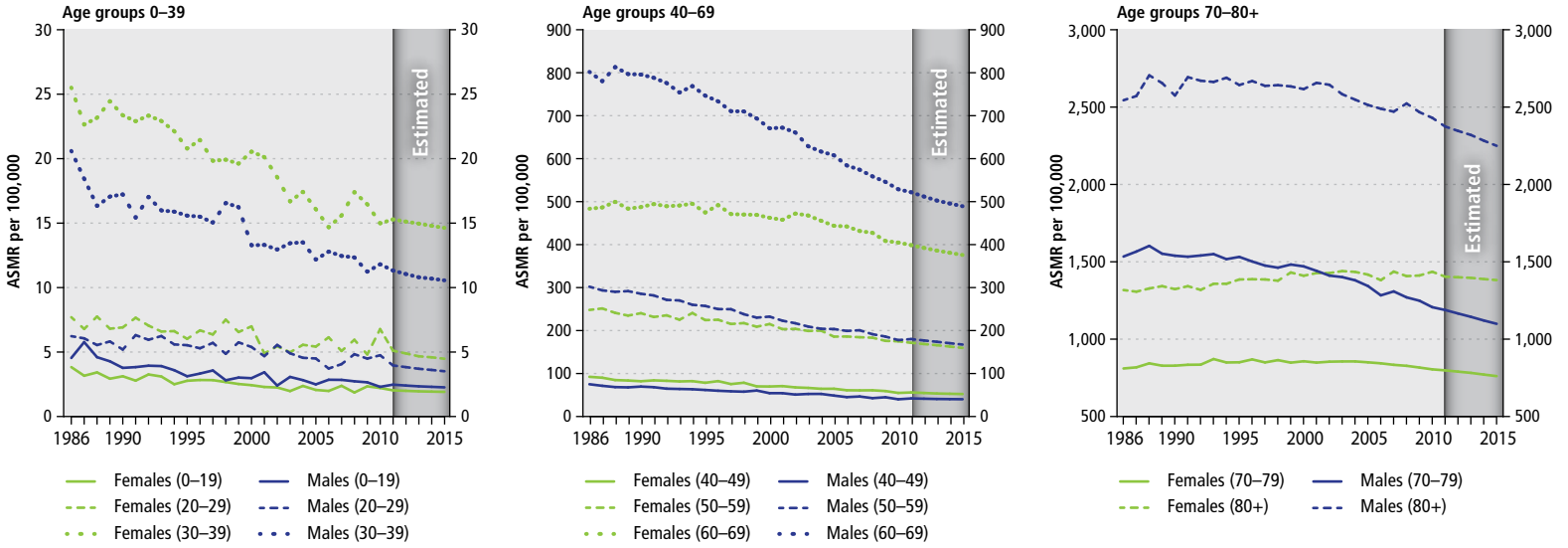
In this section, age standardization is used to adjust for differences in age distributions among the provinces and territories, which allows for more accurate comparisons.

Province or territory

Refers to the province or territory of a person's usual place of residence at the time of their death.

The most recent actual data for provinces and territories are available to 2010 (see Tables A5 and A6 in *Appendix I: Actual data for new cases and deaths)*.

FIGURE 4.3 Age-standardized mortality rates (ASMR) for all cancers, by age group, Canada, 1986–2015



Note: The range of rate scales differs widely between the age groups. Actual mortality data were available up to 2010.

View data

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

- The age-standardized mortality rates for males aged 60–69, for example, has dropped by 39% from 802 per 100,000 in 1986 to 489 per 100,000 in 2015.
- By comparison, the mortality rate for females of the same age group (60–69) dropped by 22% over the same time period (from 483 to 376 per 100,000).

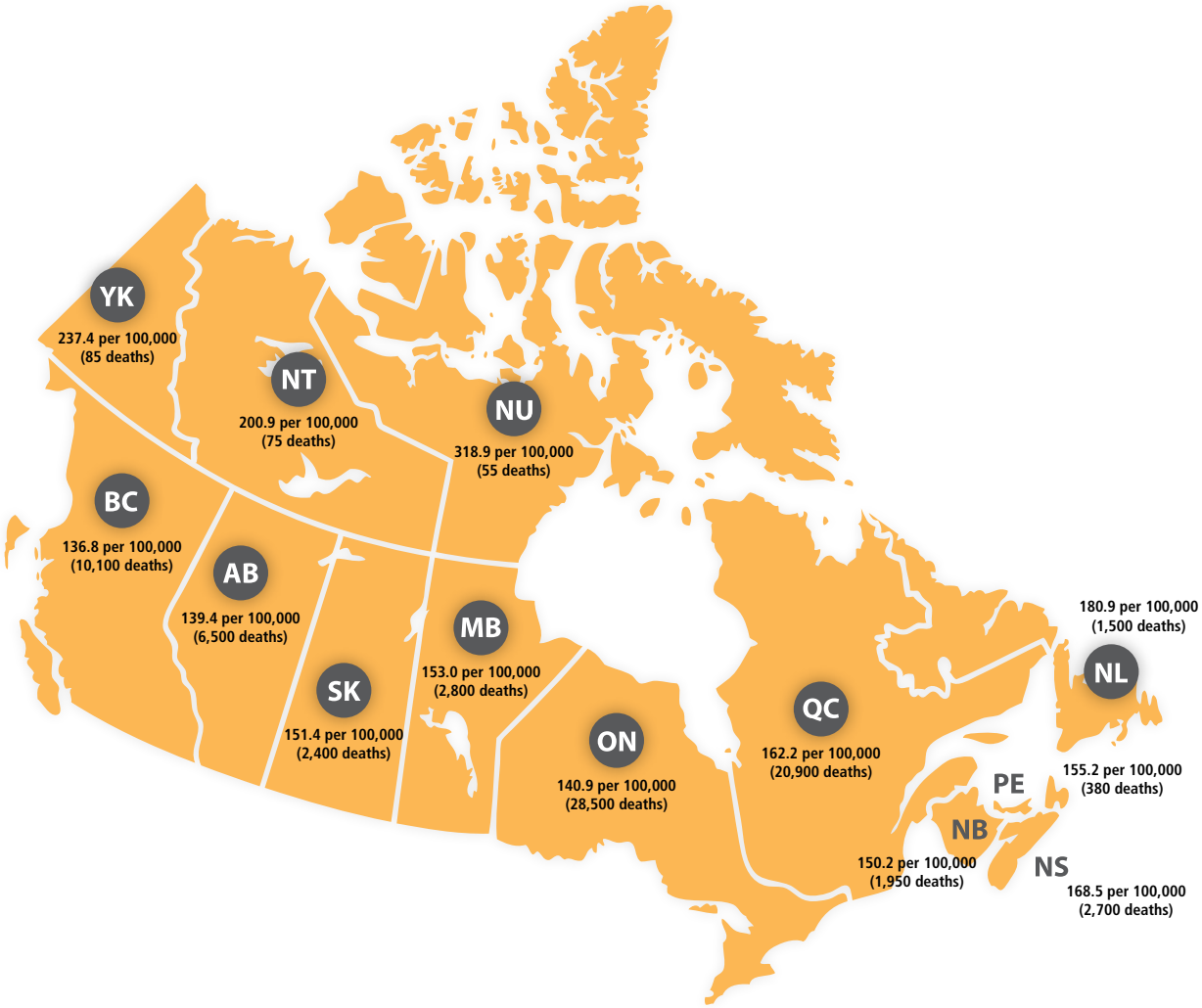
Mortality by geographic region

The estimated number of cancer deaths for all cancers and both sexes combined by province and territory are shown in Table 4.3, with age-standardized mortality rates (ASMR) shown in Figure 4.4. Similar to the pattern for incidence rates, the mortality rate for all cancers combined generally increases from west to east across the country. These patterns most likely reflect differences in incidence (due to regional variations in risk factors such as smoking or obesity) but also potentially differences in access to and outcomes of cancer control activities (e.g., screening, diagnosis, treatment and follow-up).

Estimated deaths (Table 4.4) and ASMR (Table 4.5) for specific cancer types show that there are several geographic differences:

- Lung cancer mortality rates for both males and females are highest in Quebec and the Atlantic provinces. The mortality rates for this cancer are lowest in British Columbia for both sexes and in Ontario and Alberta for females. This pattern closely mirrors variations in past tobacco smoking prevalence in these provinces.
- Colorectal cancer mortality rates are highest in Newfoundland and Labrador for both males and females (which also has the highest incidence rate of colorectal cancer for males and females).
- The prostate cancer mortality rate is highest in Prince Edward Island, Saskatchewan and Manitoba. The mortality rate for prostate cancer is lowest in

FIGURE 4.4 Geographic distribution of estimated cancer deaths and age-standardized mortality rates (ASMR) by province and territory, both sexes, Canada, 2015



Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

New Brunswick and Quebec (which also has the lowest incidence rate of prostate cancer among the provinces).

Interprovincial variations in mortality rates could reflect variation in prevalence of risk factors, the availability and use of screening and early detection services, and access to treatment.

What do these statistics mean?

Differences in cancer mortality rates by age, sex and geography can be driven by a broad range of factors. These factors include those that are inherent to the epidemiology of different cancers, particularly the age at which the cancer tends to occur in populations of males versus females (e.g., prostate cancer deaths typically occur in older males compared to breast cancer deaths that occur in relatively younger females). Modifiable and non-modifiable risk factors such as smoking, alcohol consumption, obesity and environmental carcinogen exposure have a major impact on mortality rates as they do on incidence rates. Lung cancer mortality in men has dropped substantially over the last 20 years because of the sharp decline in smoking rates,[7] while lung cancer mortality in females has continued to increase slightly due to the later peak in smoking prevalence among women.[8] Other factors, however, may be differences in access to cancer control interventions (such as screening and early detection) as well as variations in practice patterns between provinces and within age and sex groupings across provinces. There are likely also age and sex differences in response rate to cancer treatment,[9] which may contribute to variations in the mortality rate.

For further information

Publications

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- Greenberg ML, Barnett H, Williams J, editors. Atlas of Childhood Cancer in Ontario. Toronto: Pediatric Oncology Group of Ontario; 2015: http://www.pogo.ca/wp-content/uploads/2015/02/POGO_CC-Atlas-1985-2004_Full-Report_Feb-2015.pdf.

Databases

- Statistics Canada. Table 102-0552 — Deaths and mortality rate, by selected grouped causes and sex, Canada, provinces and territories, annual, CANSIM (database).
- Statistics Canada. Table 102-4309 — Mortality and potential years of life lost, by selected causes of death and sex, three-year average, Canada, provinces, territories, health regions and peer groups, occasional (number unless otherwise noted), CANSIM (database).

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7. Reid JL, Hammond D, Rynard VL, Burkhalter R. Tobacco use in Canada: patterns and trends, 2014 edition. Propel Centre for Population Health Impact, University of Waterloo; 2014.
8. Corsi DJ, Boyle MH, Lear SA, Chow CK, Teo KK, Subramanian SV. Trends in smoking in Canada from 1950 to 2011: progression of the tobacco epidemic according to socioeconomic status and geography. Cancer Causes & Control. 2014;25(1):45–57.
9. Schmetzer O, Flörcken A. Sex differences in the drug therapy for oncologic diseases. Handbook of Experimental Pharmacology. 2012;(214):411–42.

TABLE 4.1 Estimated population and deaths for all cancers by age group and sex, Canada, 2015

Age	Population (in thousands)			Deaths (2015 estimates)		
	Total*	Males	Females	Total*	Males	Females
All ages	**36,104**	**17,913**	**18,191**	**78,000**	**41,000**	**37,000**
0–19	7,991	4,102	3,889	170	90	75
20–29	4,938	2,512	2,426	200	110	90
30–39	4,950	2,480	2,470	640	270	370
40–49	4,846	2,436	2,409	2,300	1,050	1,300
50–59	5,383	2,688	2,695	8,800	4,500	4,300
60–69	4,132	2,012	2,120	17,600	9,700	7,900
70–79	2,350	1,100	1,250	21,500	12,000	9,500
80+	1,516	583	933	26,600	13,300	13,300

* Column totals may not sum to row totals due to rounding.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Vital Statistics Death database and Census and Demographics Branch at Statistics Canada

TABLE 4.2 Estimated deaths for the most common cancers by age group and sex, Canada, 2015

Age	Lung			Colorectal			Prostate	Breast
	Total*	Males	Females	Total*	Males	Females	Males	Females
All ages	**20,900**	**11,000**	**10,000**	**9,300**	**5,100**	**4,200**	**4,100**	**5,000**
0–19	—	—	—	—	—	—	—	—
20–29	5	—	5	15	10	5	—	5
30–39	40	15	25	60	30	30	—	100
40–49	400	190	210	250	130	120	10	360
50–59	2,500	1,250	1,250	940	560	380	140	850
60–69	5,600	3,000	2,600	1,900	1,200	720	540	1,100
70–79	6,700	3,600	3,100	2,400	1,450	980	1,100	1,000
80+	5,700	2,900	2,800	3,700	1,700	2,000	2,300	1,600

— Fewer than 3 deaths.

* Column totals may not sum to row totals due to rounding.

Note: The complete definition of the specific cancers listed here can be found in Table A10.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

TABLE 4.3 Estimated population and deaths for all cancers by sex and geographic region, Canada, 2015

	Population (in thousands)			Deaths (2015 estimates)		
	Total*	Males	Females	Total*	Males	Females
CANADA	**36,104**	**17,913**	**18,191**	**78,000**	**41,000**	**37,000**
British Columbia (BC)	4,888	2,423	2,465	10,100	5,400	4,700
Alberta (AB)	3,996	2,032	1,964	6,500	3,500	3,000
Saskatchewan (SK)	1,068	532	536	2,400	1,250	1,150
Manitoba (MB)	1,300	649	652	2,800	1,400	1,400
Ontario (ON)	14,128	6,970	7,158	28,500	15,200	13,300
Quebec (QC)	8,214	4,078	4,136	20,900	10,600	10,300
New Brunswick (NB)	769	378	391	1,950	970	960
Nova Scotia (NS)	967	471	496	2,700	1,450	1,250
Prince Edward Island (PE)	149	73	76	380	190	190
Newfoundland and Labrador (NL)	510	249	261	1,500	840	670
Yukon (YT)	35	18	17	85	45	40
Northwest Territories (NT)	45	23	22	75	40	35
Nunavut (NU)	34	18	17	55	30	25

* Column totals may not sum to row totals due to rounding.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Vital Statistics Death database and Census and Demographics Branch at Statistics Canada

TABLE 4.4 Estimated deaths for selected cancers by sex and province, Canada, 2015

	Canada*	BC	AB	SK	MB	ON	QC	NB	NS	PE	NL
Males											
All cancers	**41,000**	**5,400**	**3,500**	**1,250**	**1,400**	**15,200**	**10,600**	**970**	**1,450**	**190**	**840**
Lung	10,900	1,250	830	290	360	3,700	3,500	340	350	60	230
Colorectal	5,100	670	420	160	180	1,850	1,300	120	200	25	140
Prostate	4,100	600	400	170	180	1,600	890	95	130	25	65
Pancreas	2,300	360	180	65	75	840	590	60	75	10	40
Esophagus	1,600	250	170	50	65	620	310	45	60	10	25
Bladder	1,600	260	130	55	55	600	390	35	55	5	30
Leukemia	1,550	200	120	55	60	620	370	35	55	5	20
Non-Hodgkin lymphoma	1,450	190	120	55	45	540	370	45	55	5	20
Stomach	1,300	130	130	35	55	470	340	35	45	5	45
Brain/CNS	1,250	150	120	30	35	500	310	30	45	5	20
Kidney	1,150	130	95	40	55	410	270	35	50	5	25
Liver	860	160	70	10	25	350	210	10	20	—	10
Oral	810	110	75	20	30	320	180	20	25	5	15
Melanoma	750	90	60	20	20	330	170	15	30	—	15
Multiple myeloma	740	95	60	25	30	280	190	20	30	5	10
Females											
All cancers	**37,000**	**4,700**	**3,000**	**1,150**	**1,400**	**13,300**	**10,300**	**960**	**1,250**	**190**	**670**
Lung	10,000	1,250	780	290	350	3,400	3,000	260	360	50	170
Breast	5,000	610	400	160	200	1,900	1,350	110	150	25	100
Colorectal	4,200	560	330	120	160	1,500	1,150	100	160	20	100
Pancreas	2,300	300	210	70	75	810	630	70	75	10	30
Ovary	1,750	250	150	55	80	660	400	45	55	5	30
Non-Hodgkin lymphoma	1,200	160	100	40	45	440	320	35	50	5	20
Leukemia	1,150	150	95	40	45	440	270	30	40	10	15
Body of uterus	1,050	110	85	25	35	420	280	20	35	5	15
Brain/CNS	860	130	65	25	25	310	240	20	30	5	15
Stomach	780	85	65	20	25	280	230	25	25	5	25
Bladder	680	90	50	15	20	260	190	10	20	5	10
Kidney	660	70	60	20	25	250	160	20	25	5	15
Multiple myeloma	640	75	60	20	25	240	170	20	20	—	10
Esophagus	460	75	45	15	15	180	90	10	20	—	10
Melanoma	420	55	35	10	10	190	85	10	10	—	5
Oral	390	50	35	10	15	150	100	10	15	—	5
Cervix	380	40	40	20	20	150	70	10	15	—	10

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

CNS=central nervous system

— Fewer than 3 deaths.

* Column totals may not sum to row totals due to rounding. Canada totals include provincial and territorial estimates. Territories are not listed due to small numbers.

Note: The complete definition of the specific cancers listed here can be found in Table A10.

TABLE 4.5 Estimated age-standardized mortality rates (ASMR) for selected cancers by sex and province, Canada, 2015

	Deaths per 100,000										
	Canada*	BC	AB	SK	MB	ON	QC	NB	NS	PE	NL
Males											
All cancers	**174**	**159**	**165**	**178**	**174**	**169**	**188**	**170**	**204**	**177**	**224**
Lung	46	37	39	41	45	41	61	59	50	58	59
Colorectal	22	20	19	22	22	20	23	21	29	22	38
Prostate	17	17	19	22	21	17	16	16	19	23	19
Pancreas	10	10	8	9	9	9	10	11	10	10	10
Esophagus	7	7	7	7	8	7	5	7	8	9	7
Bladder	7	8	6	7	7	7	7	6	8	7	8
Leukemia	7	6	6	8	8	7	7	6	8	7	6
Non-Hodgkin lymphoma	6	6	6	8	6	6	7	8	8	6	6
Stomach	5	4	6	5	7	5	6	6	6	5	12
Brain/CNS	5	5	5	5	4	6	6	5	6	6	5
Kidney	5	4	4	6	7	5	5	6	7	7	7
Liver	4	5	3	1	3	4	4	2	3	—	2
Oral	3	3	3	3	4	3	3	4	4	5	4
Melanoma	3	3	3	3	3	4	3	3	4	—	4
Multiple myeloma	3	3	3	3	4	3	3	3	4	5	3
Females											
All cancers	**128**	**119**	**119**	**132**	**139**	**119**	**144**	**136**	**142**	**140**	**148**
Lung	36	32	32	34	36	32	44	38	41	40	39
Breast	18	16	16	19	20	18	19	17	18	22	22
Colorectal	14	13	13	13	15	13	15	14	18	16	21
Pancreas	8	7	8	8	7	7	9	9	8	7	7
Ovary	6	7	6	6	8	6	6	7	6	5	7
Non-Hodgkin lymphoma	4	4	4	5	4	4	4	5	5	5	4
Leukemia	4	4	4	5	4	4	4	4	4	6	3
Body of uterus	4	3	3	3	3	4	4	3	4	3	4
Brain/CNS	3	4	3	3	3	3	4	4	4	4	4
Stomach	3	2	2	2	3	2	3	4	3	3	5
Bladder	2	2	2	2	2	2	2	2	2	3	2
Kidney	2	2	2	3	3	2	2	3	3	4	4
Multiple myeloma	2	2	2	2	2	2	2	3	2	—	3
Esophagus	2	2	2	2	2	2	1	2	2	—	2
Melanoma	2	1	1	1	1	2	1	1	2	—	1
Oral	1	1	1	1	2	1	1	1	1	—	1
Cervix	2	1	2	3	2	2	1	2	2	—	2

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

CNS=central nervous system

— Fewer than 3 deaths.

* Canada totals include provincial and territorial estimates. Territories are not listed due to small numbers.

Note: Rates are age-standardized to the 1991 Canadian population. The complete definition of the specific cancers listed here can be found in Table A10.

CHAPTER 5
Relative survival: What is the likelihood of surviving cancer?

This section of the publication has been reproduced, as is, from the corresponding section in last year's publication (*Canadian Cancer Statistics 2014*). As such, the analytical techniques used and the interpretation of the results reflect the state of knowledge at the time of the production of that publication.

There is one notable change to the content of this chapter from last year's publication. In the past year, a large international study of cancer survival called CONCORD-2 was published that included data from Canada. A brief summary of the study and of some of its findings appear in the International comparison section near the end of this chapter.

Highlights

- For 2006 to 2008, the five-year relative survival ratio (RSR) for people diagnosed with cancer was 63%.
- Five-year RSRs are highest for thyroid (98%), testicular (97%) and prostate (96%) cancers. They are lowest for pancreatic (8%), esophageal (14%) and lung (17%) cancers.
- Five-year relative survival generally decreases with age.
- People diagnosed with cancer today have a better five-year relative survival than they did just over a decade ago. Between 1992 to 1994 and 2006 to 2008, the five-year relative survival for all cancers combined increased by 7.3 percentage points from 55.5% to 62.8%.
- Five-year conditional RSRs demonstrate that survival of people diagnosed with cancer generally improves with time since diagnosis. Between 2006 and 2008, the five-year RSR for all cancers combined increased from 63% when measured from the date of diagnosis to 81% when measured among those who survived the first year after a cancer diagnosis.
- Differences in age-standardized five-year RSRs across geographic regions and types of cancer help point to areas where greater effort is required to detect, diagnose and effectively treat cancer earlier.

Introduction

Five-year relative survival ratios (RSRs) provide a measure of disease severity and prognosis. Relative survival estimates, when examined across cancer types and geographic regions, can be used to establish priorities for improving prognosis. Examining these estimates over time, and in conjunction with cancer incidence and mortality trends, can also give important information about progress in cancer treatment and control.[1]

Several factors can work together to influence the likelihood of surviving cancer. These factors include stage of the cancer at diagnosis and aggressiveness of the tumour, as well as the availability and quality of early detection, diagnostic and treatment services. In addition, factors such as age, sex, existence of other health conditions, socio-economic status and lifestyle can also affect survival.

The RSR is a useful "average" indicator of survival[2] and does not reflect any individual's prognosis. It is based on the experiences of a group of people rather than a specific person's chance of surviving for a given period of time. Moreover, confidence intervals around survival estimates represent statistical variation rather than the range of possible prognoses for individual people with cancer.

Confidence interval (CI)

A range of values that provides an indication of the precision of an estimate. Confidence intervals are usually 95%, which means that one can be 95% confident the range contains the true value for the estimate of interest.

Five-year relative survival ratio (RSR)

The ratio of the observed survival in a group of people diagnosed with cancer to the expected survival in a comparable group of people – free from the cancer under study – in the general population.[3] In practice, the expected survival is typically estimated from general population life tables, which include those persons previously diagnosed with cancer. Relative survival estimates the excess mortality that may be attributed to the diagnosis. For example, a five-year RSR of 63% for a particular cancer means that people with that cancer have a 63% likelihood of surviving at least five years after diagnosis compared to their counterparts in the general population.

Relative survival is the preferred measure for assessing population-based cancer survival.

RSRs can be measured over various timeframes, but as is standard in other reports, five years has been chosen as the primary duration of analysis for this publication.

Observed survival proportion (OSP)

The proportion of people with cancer who are alive after a given period of time (e.g., five years) after diagnosis.

It is also important to remember that survival ratios do not distinguish among people who are free from cancer, in a state of relapse or still undergoing treatment. In addition, because survival statistics describe the survival experience of people diagnosed in the past, they do not reflect more recent advances in detection and treatment that could lead to improved cancer survival. Finally, five-year RSRs are different from five-year observed survival proportions (OSPs), which refer to the proportion of people with cancer, who are alive five years after their diagnosis. The current estimate for observed survival for all cancers combined is 56% (Table 5.1).

Five-year relative survival

Table 5.1 shows the estimated five-year RSRs for people diagnosed with selected cancers in Canada between 2006 and 2008.

- For all cancers combined, the five-year RSR is 63%.
- The five-year RSRs are highest for thyroid (98%), testicular (97%) and prostate (96%) cancers.
- The five-year RSRs are lowest for pancreatic (8%), esophageal (14%) and lung (17%) cancers.
- For most of the cancers examined, the five-year RSRs tend to be higher among females.

Other time periods commonly used to measure relative survival include 1, 3 and 10 years. For colorectal and lung cancers, RSRs demonstrate a general pattern of substantial decline in the first year after diagnosis (one-year RSR), a more gradual fall over the next two years (three-year RSR) and then smaller declines over the intervals from 3 to 5 years and to 10 years (Figure 5.1).

Survival by sex

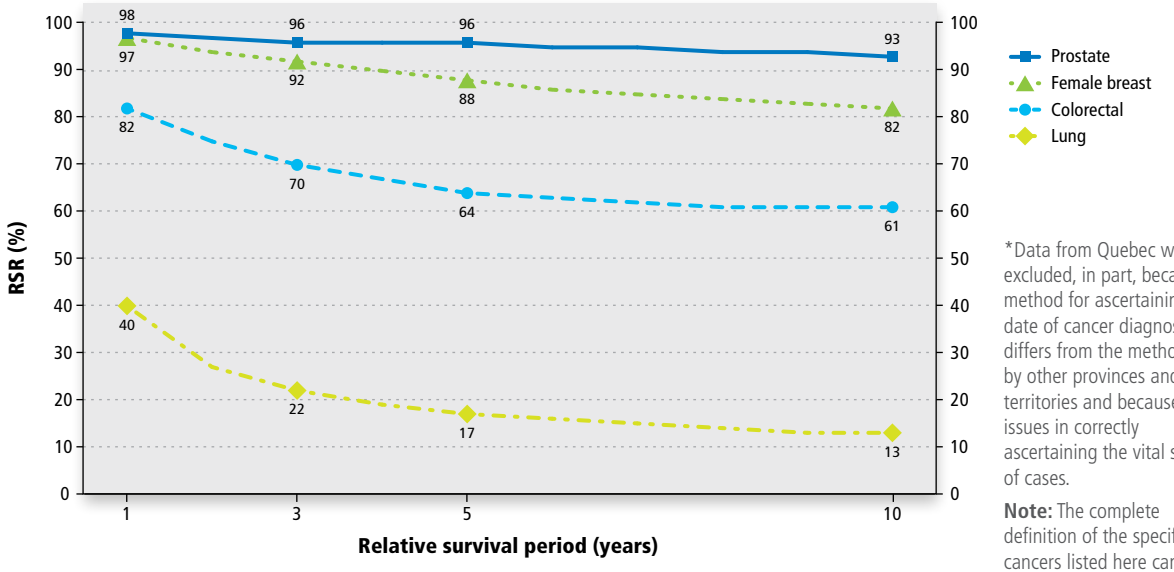
Table 5.1 shows that the five-year RSR differed by more than five percentage points for four of the cancers examined. In all four cancer types, relative survival was better for females than for males: melanoma (92% vs. 85%), breast (88% vs. 80%), oral (68% vs. 61%) and lung (20% vs. 14%).

Survival by province

Five-year RSRs are age-standardized to allow comparisons across provinces. Table 5.2 shows age-standardized five-year RSRs for the four most common cancer types (prostate, breast, colorectal and lung cancers). The following exceptions and caveats should be considered when examining these data:

- Cancer cases in Newfoundland and Labrador may be under-reported due to incomplete linkage of cancer incidence data with death data. Such under-reporting is likely to result in overestimation of survival because these missed cases tend to have less favourable survival. Consequently, survival ratios for Newfoundland and Labrador are not shown.
- Territorial estimates are not presented because there were too few cancer cases to calculate reliable estimates. Territorial cases are, however, included in the estimates for all of Canada.
- RSRs for Prince Edward Island are less precise than for other provinces because of the relatively small number of cancer cases in this province.

FIGURE 5.1 One-, three-, five- and ten-year relative survival ratios (RSRs) for the most common cancers, ages 15–99 at diagnosis, Canada (excluding Quebec*), 2006–2008



*Data from Quebec were excluded, in part, because its method for ascertaining the date of cancer diagnosis differs from the method used by other provinces and territories and because of issues in correctly ascertaining the vital status of cases.

Note: The complete definition of the specific cancers listed here can be found in Table A10.

Analysis by: Health Statistics Division, Statistics Canada
Data sources: Canadian Cancer Registry database and life tables at Statistics Canada

- Despite these constraints, several patterns are worth mentioning:
  - The highest RSRs for prostate cancer are in Ontario (97%), New Brunswick (95%) and Nova Scotia (95%). The lowest RSRs for prostate cancer are in Manitoba (90%), Saskatchewan (91%) and Alberta (92%).
  - There is little provincial variation in RSRs for breast cancer.
  - The RSRs for colorectal cancer range from 60% to 62% in all provinces except Ontario (67%).

The RSRs for lung cancer range from a low of 14% in Alberta and Nova Scotia to a high of 20% in Manitoba.

- The variation across provinces may be related to differences in the following factors:
  - the availability and patterns of use of screening, early detection and diagnostic services that affect how early cancer is diagnosed
  - the availability of and access to specialized cancer treatments
  - population attributes (such as socio-economic status and lifestyle factors) that affect survival
  - provincial resources available to ensure registration of all cancers and up-to-date vital status information on registered cases

Age-standardized relative survival ratio (RSR)

The RSR that would have occurred if the age distribution of the group of people with cancer under study had been the same as that of the standard population (e.g., all people diagnosed with that cancer in Canada between 2001 and 2005).

Survival by age at diagnosis

Relative survival is generally poorer among those diagnosed with cancer at an older age. Poorer survival among older people may be because they receive less therapy due to the presence of other diseases or conditions that reduce the body's ability to tolerate and respond to cancer treatments. Older people may also receive less aggressive treatment, independent of any other conditions, due to their advanced age.[4]

Table 5.3 shows the five-year RSRs for the four most common cancers by age group.

- RSRs for prostate cancer are consistently high (>95%) among males diagnosed between the ages of 40 and 79 years; lower RSRs are seen at older ages.
- The highest RSRs for female breast cancer (87%–90%) are among people diagnosed between the ages of 40 and 79 years. Lower RSRs are seen for women at both younger (85%) and older (79%) ages.
- RSRs for colorectal cancer are consistent at 68% among people diagnosed between the ages of 15 and 69 years; RSRs then decrease with advancing age.
- For lung cancer, the RSR decreases with advancing age. People aged 15–39 years at diagnosis have the highest RSR at 45%, while people aged 80–99 years have the lowest RSR at 10%.

Trends over time

Age-standardized RSRs are used to examine changes in relative survival over time. Figure 5.2 shows that there was substantial improvement in five-year relative survival between 1992 to 1994 and 2006 to 2008 for the most commonly diagnosed cancers of today.

- The RSR for all cancers combined has risen by 7.3 percentage points to 62.8% in 2006 to 2008 from 55.5% in 1992 to 1994.
- The largest increases between the two time periods among the cancers presented are seen for non-Hodgkin lymphoma (16 percentage points) and leukemia (15 percentage points); multiple myeloma increased by 14 percentage points.
- A few factors have contributed to the increased relative survival for non-Hodgkin lymphoma. First is the advance in therapy, particularly the introduction of antibody therapy with rituximab. Second is the recent decrease in the number of cases of non-Hodgkin lymphoma related to human immunodeficiency virus (HIV). The lower number of cases related to HIV is a consequence of improved treatment, specifically with highly active antiretroviral therapy (HAART) developed in the late 1990s.[5]
- Age-standardized RSRs for prostate and colorectal cancers each increased by nine percentage points. Survival improvements in prostate and colorectal cancers are due to increased use of screening and early detection that have helped identify cancers at a treatable stage.
- There has been virtually no change (less than one percentage point) for cancers of the bladder and body of uterus between 1992 to 1994 and 2006 to 2008.

Five-year conditional relative survival

The five-year conditional RSR for people with cancer who have already survived one to three years after their diagnosis is often more meaningful for clinical management and prognosis than the five-year RSR measured from the date of diagnosis. Since the risk of death due to cancer is often greatest in the first few years after diagnosis, prognosis can substantially improve among people surviving one or more years. Thus, the five-year RSR measured at diagnosis no longer applies.[6,7]

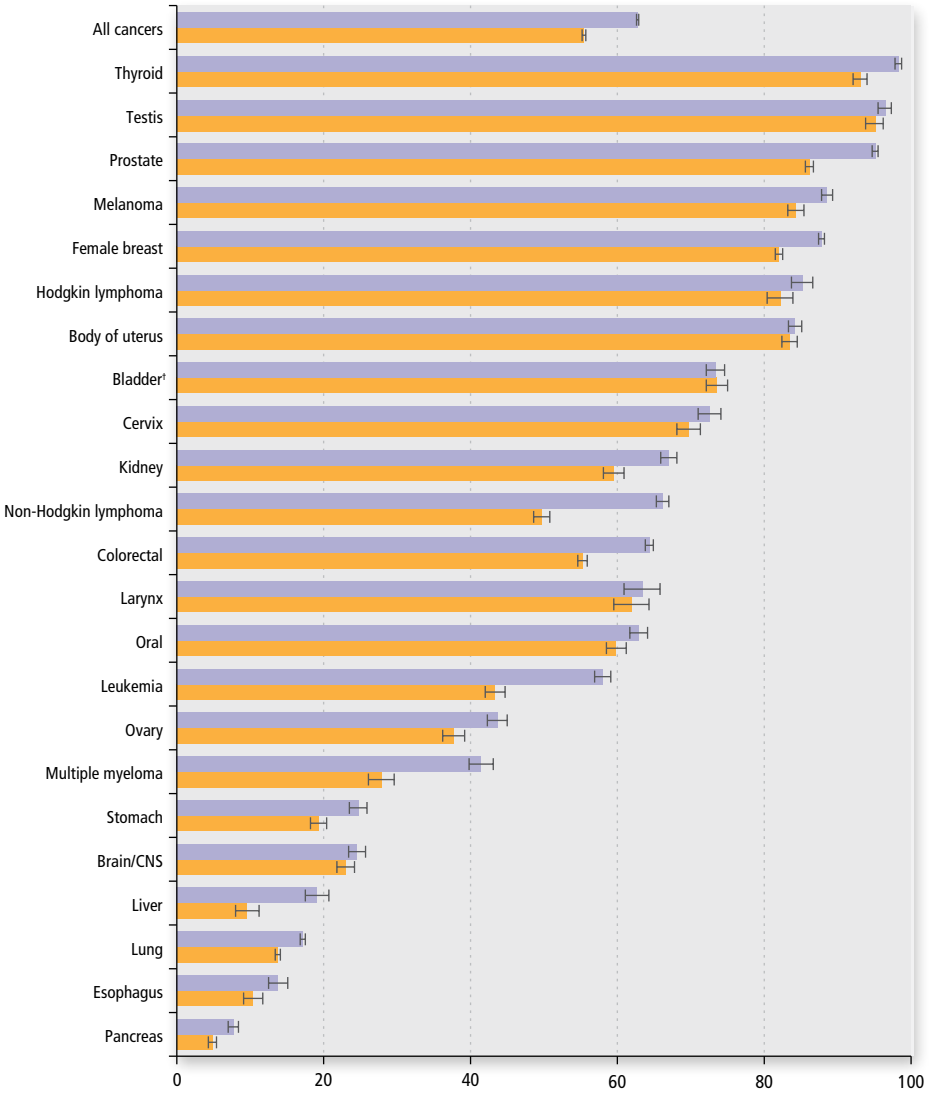
Table 5.4 presents five-year RSRs estimated from the date of cancer diagnosis and five-year conditional RSRs calculated using people who have survived the first, second, third, fourth and fifth year after a cancer diagnosis. Five-year conditional RSRs demonstrate that the survival experience of people diagnosed with cancer generally improves with time since diagnosis.

- The five-year RSR for all cancers combined increased from 63% when measured from the date of diagnosis to 81% when measured among those who survived the first year after a cancer diagnosis.

Conditional relative survival

A measure that reflects the likelihood a person will survive an additional number of years (e.g., five years) once he or she has already survived a fixed number of years since a cancer diagnosis, compared to the expected survival in a comparable group of people – free from the cancer under study – in the general population. In practice, the expected survival is typically estimated from general population life tables, which include those persons previously diagnosed with cancer.

FIGURE 5.2 Age-standardized five-year relative survival ratio (RSR) for selected cancers, Canada (excluding Quebec*), 2006–2008 versus 1992–1994



CNS=central nervous system

* Data from Quebec were excluded, in part, because the method for ascertaining the date of cancer diagnosis differs from the method used by other provinces/territories and because of issues in correctly ascertaining the vital status of cases.

† Excludes data from Ontario, which does not currently report *in situ* bladder cancers.

Note: These data are based on people aged 15–99 years at diagnosis. "All cancers" excludes adolescent (15–19 years) bone cancers, which are dissimilar to those diagnosed in older adults, and non-melanoma skin cancers (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). Error bars refer to 95% confidence intervals. The complete definition of the specific cancers listed here can be found in Table A10.

View data

Analysis by: Health Statistics Division, Statistics Canada
Data sources: Canadian Cancer Registry database and life tables at Statistics Canada

- Each additional year survived resulted in further, although less dramatic, increases in the five-year conditional RSR.
- The impact of time survived on the five-year conditional RSR varied by type of cancer. Cancers with low initial five-year RSRs (such as stomach, brain, liver, lung, esophagus and pancreas) showed the most dramatic increases in five-year conditional RSRs.
- Conversely, since the potential for improvement is limited for cancers that have an excellent prognosis at diagnosis, cancers with high initial five-year RSRs (such as thyroid, testis and prostate) showed little improvement in five-year conditional RSRs.

Five-year childhood cancer (0–14 years) survival

Table 5.5 shows the estimated five-year OSPs for children, by childhood cancer diagnostic group and selected subgroups,[8] diagnosed with cancer in Canada between 2004 and 2008. Only OSPs are reported as the estimates of observed and relative survival for the age range 0–14 years are essentially the same. In general, survival for childhood cancer is higher than it is among adults. However, the rarity of childhood cancer results in less precise estimates, even when more years of data are considered.

- For all cancers combined, the five-year OSP is 83%.
- Among specific diagnostic groups, five-year OSPs are highest for retinoblastoma and for other malignant epithelial neoplasms – both at 94%. The five-year OSP is also over 90% for lymphomas, germ cell tumours and other and unspecified neoplasms.
- Among specific diagnostic groups, five-year OSPs are lowest for malignant bone tumours (70%), soft tissue (72%) and central nervous system (74%) cancers.

International comparison

A large international cancer survival study, called CONCORD-2,[9] was published in November 2014 in the prestigious medical journal *The Lancet*. The study was led by the Cancer Research UK Cancer Survival group at the London School of Hygiene and Tropical Medicine in London, UK. The study reports trends in five-year survival between 1995 and 2009 for cancer patients diagnosed with one of 10 common cancers: breast (women only), cervix, colon, leukemia, liver, lung, ovary, prostate, rectum and stomach. It also reported survival for 75,000 children diagnosed with the most common childhood cancer, acute lymphoblastic leukemia. The data came from 279 cancer registries in 67 countries, including data from close to 1.4 million Canadians.

The goal of the study was to produce comparable estimates of five-year relative net survival across many jurisdictions. Such studies serve to stimulate discussion as to why cancer survival might differ between regions and motivate investigations into possible improvements to cancer control programs.

Some Canadian-specific highlights from the 2005 to 2009 period of this study include:

Canada was one of the only countries in the study for which the data covered 100% of its population. As such, data from all regions of Canada were reflected in the national survival estimates.

In comparing five-year survival estimates across G7 countries (Canada, United Kingdom, United States, Germany, France, Italy and Japan), it was observed that Canada had the second highest survival for childhood leukemia, the second highest survival for prostate cancer and the 3rd highest survival for lung cancer.

Canada ranked 5th in colon cancer survival, ahead of France and the United Kingdom.

Breast cancer survival tended to be similar among most G7 nations. However, the United States showed higher survival than the other countries and the United Kingdom much lower.

It is important to note that the specific survival estimates reported in the CONCORD-2 study cannot be directly compared to the numbers given in other sections of this publication. This is due to differences in the methodology used between the CONCORD-2 study and this publication – particularly the standard populations used to age-standardize the estimates. As such, comparisons can be made only across regions within the same study. The CONCORD program[10] has undertaken other cancer survival projects that have studied the survival experience of Canadians with cancer including the International Cancer Benchmarking Project.[11]

What do these statistics mean?

People diagnosed with cancer today have a better chance of surviving the next five years after their diagnosis than they did just over a decade ago. Despite this improvement in survival, some cancers continue to have lower RSRs than others because of the aggressiveness of the disease, the late stage at which they tend to be diagnosed or the lack of effective treatment options.

Among the most common cancers, there is variation in age-standardized five-year RSRs across provinces for prostate, lung and colorectal cancers, while there is little provincial variation for breast cancer. These differences in five-year RSRs across geographic regions and types of cancer help point to areas where greater effort is required to detect, diagnose and treat cancer at an early stage, or where more research is needed to develop better treatments. Cancer stage at diagnosis is an important prognostic indicator that is available for the most common cancers from most provincial cancer registries. It is anticipated that cancer stage at diagnosis and its impact on survival will be reported in this publication in future years.

For more information

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Databases

- Statistics Canada. Table 103-1559 – Five-year survival estimates for all primary sites of cancer combined, ICD-O-3 (October 2011 CCR file), by age group and sex, population aged 15 to 99, 1 year of cases, Canada (excluding Quebec), annual (percent), 1992 to 2003, CANSIM (database).
- Statistics Canada. Table 103-1560 – Five-year survival estimates for all primary sites of cancer combined, ICD-O-3 (October 2011 CCR file), by age group and sex, population aged 15 to 99, 3 years of cases, Canada (excluding Quebec), annual (percent), 1992/1994 to 2001/2003, CANSIM (database).
- Statistics Canada. Table 103-1573 – Five-year survival estimates for primary sites of cancer, ICD-O-3 (October 2011 CCR file), by sex, population aged 15 to 99, 1 year of cases, selected provinces, annual (percent), 1992 to 2003, CANSIM (database).
- Statistics Canada. Table 103-1574 – Five-year survival estimates for primary sites of cancer, ICD-O-3 (October 2011 CCR file), by sex, population aged 15 to 99, 3 years of cases, selected provinces, annual (percent), 1992/1994 to 2001/2003, CANSIM (database).
- Statistics Canada. Table 103-1571 – Age-standardized five-year survival estimates for primary sites of cancer, ICD-O-3 (October 2011 CCR file), by sex, 1 year of cases, Canada and selected provinces, annual (percent), 1992 to 2003, CANSIM (database).
- Statistics Canada. Table 103-1572 – Age-standardized five-year survival estimates for primary sites of cancer, ICD-O-3 (October 2011 CCR file), by sex, 3 years of cases, Canada and selected provinces, annual (percent), 1992/1994 to 2001/2003, CANSIM (database).

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TABLE 5.1 Five-year relative and observed survival for selected cancers by sex, ages 15–99 years at diagnosis, Canada (excluding Quebec*), 2006–2008

	Relative survival ratio (%) (95% CI)			Observed survival proportion (%) (95% CI)		
	Both sexes	Males	Females	Both sexes	Males	Females
All cancers	**63 (63–63)**	**63 (62–63)**	**64 (64–64)**	**56 (56–56)**	**54 (53–54)**	**58 (58–58)**
Thyroid	98 (98–99)	95 (94–97)	99 (99–100)	95 (95–96)	90 (89–92)	96 (96–97)
Testis	—	97 (96–98)	—	—	95 (94–96)	—
Prostate	—	96 (95–96)	—	—	81 (81–82)	—
Melanoma	89 (88–89)	85 (84–86)	92 (91–93)	80 (79-80)	75 (74–76)	85 (84–86)
Breast	88 (87–88)	80 (74–86)	88 (87–88)	80 (80-81)	66 (61–71)	80 (80–81)
Hodgkin lymphoma	85 (83–87)	83 (81–86)	87 (85–90)	83 (81-84)	81 (78-83)	85 (83–87)
Body of uterus	—	—	85 (84–86)	—	—	78 (77–79)
Bladder†	74 (72–75)	74 (73–76)	72 (69–74)	60 (59-61)	60 (58–61)	61 (59–63)
Cervix	—	—	74 (72–75)	—	—	71 (69–73)
Kidney	68 (66–69)	67 (65–68)	69 (67–71)	60 (59-61)	59 (58–60)	62 (61–64)
Non-Hodgkin lymphoma	66 (65–67)	65 (63–66)	68 (67–70)	59 (58-60)	57 (56–58)	62 (60–63)
Colorectal	64 (64–65)	64 (63–65)	65 (64–66)	54 (54-55)	54 (53–54)	55 (54–56)
Larynx	63 (61–66)	63 (60–66)	64 (58–69)	55 (53-57)	55 (52–57)	57 (51–62)
Oral	63 (62–65)	61 (60–63)	68 (65–70)	57 (55-58)	55 (53–56)	61 (59–62)
Leukemia	59 (58–60)	60 (58–61)	59 (57–61)	52 (51-53)	52 (50–53)	52 (50–53)
Ovary	—	—	45 (44–46)	—	—	42 (41–43)
Multiple myeloma	43 (41–44)	44 (42–47)	41 (38–43)	37 (35-38)	38 (36–40)	36 (33–38)
Stomach	25 (24–26)	23 (22–24)	28 (26–30)	21 (20-22)	19 (18–21)	24 (23–26)
Brain/CNS	25 (24–27)	23 (22–25)	28 (26–30)	24 (23-26)	22 (21–24)	27 (25–29)
Liver	20 (18–22)	20 (18–22)	19 (16–23)	18 (17–19)	18 (17–20)	17 (14–20)
Lung	17 (17–17)	14 (14–15)	20 (19–21)	15 (15–15)	12 (12–13)	18 (17–18)
Esophagus	14 (13–15)	13 (12–15)	15 (13–18)	12 (11–13)	12 (10–13)	13 (11–15)
Pancreas	8 (7–8)	8 (7–9)	8 (7–9)	7 (6–7)	7 (6–8)	7 (6–8)

Analysis by: Health Statistics Division, Statistics Canada
Data sources: Canadian Cancer Registry database and life tables at Statistics Canada

CI=confidence interval; CNS=central nervous system

— Not applicable.

* Data from Quebec were excluded, in part, because the method for ascertaining the date of cancer diagnosis differs from the method used by other provinces/territories and because of issues in correctly ascertaining the vital status of cases.

† Excludes data from Ontario, which does not currently report *in situ* bladder cancers.

Note: "All cancers" excludes adolescent (15–19 years) bone cancers, which are dissimilar to those diagnosed in older adults, and non-melanoma skin cancers (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). The complete definition of the specific cancers listed here can be found in Table A10.

TABLE 5.2 Age-standardized five-year relative survival ratios (RSRs) for the most common cancers by province, Canada (excluding Quebec*), 2006–2008

Province	Relative survival ratio (%) (95% CI)			
	Prostate	Female breast	Colorectal	Lung
Canada*	**95 (95–95)**	**88 (87–88)**	**64 (64–65)**	**17 (17–18)**
British Columbia (BC)	93 (92–94)	88 (87–89)	61 (60–63)	16 (15–16)
Alberta (AB)	92 (91–93)	86 (85–88)	62 (60–64)	14 (13–15)
Saskatchewan (SK)	91 (89–93)	86 (84–88)	61 (59–64)	16 (14–18)
Manitoba (MB)	90 (88–92)	85 (83–87)	60 (58–63)	20 (19–22)
Ontario (ON)	97 (97–98)	88 (88–89)	67 (66–68)	19 (18–19)
New Brunswick (NB)	95 (93–97)	89 (87–91)	62 (59–65)	16 (14–17)
Nova Scotia (NS)	95 (93–97)	87 (86–89)	61 (58–63)	14 (12–15)
Prince Edward Island (PE)	93 (89–97)	87 (81–92)	61 (54–67)	—

Analysis by: Health Statistics Division, Statistics Canada
Data sources: Canadian Cancer Registry database and life tables at Statistics Canada

CI=confidence interval

— Estimate cannot be calculated.

* Data from Quebec were excluded, in part, because the method for ascertaining the date of cancer diagnosis differs from the method used by other provinces and territories and because of issues in correctly ascertaining the vital status of cases.

Note: These data are based on people aged 15–99 years at diagnosis. Survival ratios for Newfoundland and Labrador are not shown as they are artefactually high. The complete definition of the specific cancers listed here can be found in Table A10.

TABLE 5.3 Five-year relative survival ratios (RSRs) for the most common cancers by age group, Canada (excluding Quebec*), 2006–2008

Age	Relative survival ratio (%) (95% CI)			
	Prostate	Female breast	Colorectal	Lung
15–39	—	85 (84–87)	68 (64–71)	45 (38–52)
40–49	96 (94–97)	90 (89–90)	68 (66–70)	23 (21–25)
50–59	98 (97–98)	89 (88–90)	68 (67–69)	21 (20–22)
60–69	99 (98–99)	90 (90–91)	68 (67–69)	19 (18–20)
70–79	96 (95–97)	87 (86–89)	65 (64–66)	16 (15–17)
80–99	81 (79–84)	79 (77–81)	57 (55–58)	10 (9–11)

Analysis by: Health Statistics Division, Statistics Canada
Data sources: Canadian Cancer Registry database and life tables at Statistics Canada

CI=confidence interval

— Estimate is not shown due to a small number of cases.

* Data from Quebec were excluded, in part, because the method for ascertaining the date of cancer diagnosis differs from the method used by other provinces/territories and because of issues in correctly ascertaining the vital status of cases.

Note: The complete definition of the specific cancers listed here can be found in Table A10.

TABLE 5.4 Five-year relative survival ratios (RSRs) conditional on having survived the specified number of years, for selected cancers, ages 15–99 years at diagnosis, Canada (excluding Quebec*), 2006–2008

	Conditional RSR (%) (95%CI)					
	Survived years					
	0	1	2	3	4	5
All cancers	**63 (63–63)**	**81 (81–81)**	**87 (87–87)**	**90 (90–90)**	**92 (92–92)**	**93 (93–93)**
Thyroid	98 (98–99)	100 (99–100)	100 (100–101)	100 (99–100)	100 (99–100)	99 (99–100)
Testis	97 (96–98)	98 (97–99)	99 (99–100)	99 (99–100)	100 (99–100)	100 (99–100)
Prostate	96 (95–96)	97 (97–97)	98 (97–98)	98 (97–98)	98 (97–98)	98 (97–98)
Melanoma	89 (88–89)	91 (90–92)	93 (92–94)	95 (94–96)	96 (95–97)	97 (96–98)
Female breast	88 (87–88)	89 (89–90)	90 (90–91)	92 (91–92)	93 (92–93)	94 (93–94)
Hodgkin lymphoma	85 (83–87)	93 (91–94)	94 (93–96)	94 (93–96)	96 (94–97)	96 (95–97)
Body of uterus	85 (84–86)	90 (90–91)	94 (93–95)	96 (95–97)	98 (97–99)	99 (98–100)
Bladder†	74 (72–75)	82 (80–83)	85 (84–87)	88 (86–89)	89 (87–91)	89 (88–91)
Cervix	74 (72–75)	82 (80–84)	88 (87–90)	92 (90–93)	94 (93–95)	97 (96–98)
Kidney	68 (66–69)	82 (81–83)	87 (85–88)	89 (88–90)	91 (90–92)	93 (91–94)
Non-Hodgkin lymphoma	66 (65–67)	82 (81–83)	85 (84–86)	87 (85–88)	88 (87–89)	89 (88–90)
Colorectal	64 (64–65)	77 (76–77)	83 (82–83)	88 (87–88)	91 (90–92)	94 (93–95)
Larynx	63 (61–66)	71 (68–74)	77 (74–80)	80 (77–83)	82 (79–85)	84 (80–86)
Oral	63 (62–65)	75 (73–76)	82 (81–84)	86 (84–87)	87 (86–89)	89 (87–90)
Leukemia	59 (58–60)	80 (78–81)	83 (82–85)	84 (83–86)	85 (84–87)	85 (83–86)
Ovary	45 (44–46)	57 (55–58)	65 (63–67)	72 (70–74)	79 (77–81)	85 (83–87)
Multiple myeloma	43 (41–44)	52 (49–54)	54 (51–56)	55 (53–58)	59 (55–62)	62 (58–65)
Stomach	25 (24–26)	51 (49–53)	71 (69–74)	83 (80–86)	91 (88–94)	94 (91–97)
Brain/CNS	25 (24–27)	50 (47–52)	65 (62–68)	73 (70–75)	76 (74–79)	79 (77–82)
Liver	20 (18–22)	42 (39–45)	55 (51–59)	67 (62–71)	77 (71–82)	83 (77–88)
Lung	17 (17–17)	39 (38–40)	55 (54–57)	65 (64–66)	70 (69–72)	75 (73–76)
Esophagus	14 (13–15)	34 (31–37)	55 (50–59)	68 (63–74)	75 (69–81)	80 (74–86)
Pancreas	8 (7–8)	30 (28–33)	53 (48–57)	67 (62–72)	78 (72–83)	82 (75–87)

Analysis by: Health Statistics Division, Statistics Canada
Data sources: Canadian Cancer Registry database and life tables at Statistics Canada

CI=confidence interval; CNS=central nervous system

* Data from Quebec were excluded, in part, because the method for ascertaining the date of cancer diagnosis differs from the method used by other provinces/territories and because of issues in correctly ascertaining the vital status of cases.

† Excludes data from Ontario, which does not currently report *in situ* bladder cancers.

Note: "All cancers" excludes adolescent (15–19 years) bone cancers, which are dissimilar to those diagnosed in older adults, and non-melanoma skin cancers (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). The complete definition of the specific cancers listed here can be found in Table A10.

TABLE 5.5 Five-year observed survival proportions (OSP) by diagnostic group and selected subgroup, ages 0–14 years at diagnosis, Canada (excluding Quebec*), 2004–2008

Diagnostic group	OSP (%) (95% CI)
All groups	83 (82–84)
I. Leukemias, myeloproliferative diseases, and myelodysplastic diseases	88 (86–90)
a. Lymphoid leukemias	91 (89–93)
b. Acute myeloid leukemias	73 (65–79)
II. Lymphomas and reticuloendothelial neoplasms	92 (88–94)
a. Hodgkin lymphomas	98 (94–99)
b. Non-Hodgkin lymphomas (except Burkitt lymphoma)	88 (81–93)
c. Burkitt lymphoma	92 (79–97)
III. CNS and miscellaneous intracranial and intraspinal neoplasms	74 (70–77)
b. Astrocytomas	84 (80–88)
c. Intracranial and intraspinal embryonal tumours	55 (47–63)
IV. Neuroblastoma and other peripheral nervous cell tumours	77 (71–82)
V. Retinoblastoma	94 (86–98)
VI. Renal tumours	84 (78–89)
a. Nephroblastoma and other non-epithelial renal tumours	85 (78–90)
VII. Hepatic tumours	—
VIII. Malignant bone tumours	70 (62–77)
IX. Soft tissue and other extraosseous sarcomas	72 (65–77)
a. Rhabdomyosarcomas	70 (60–78)
X. Germ cell tumours, trophoblastic tumours, and neoplasms of gonads	91 (84–95)
b. Malignant extracranial and extragonadal germ cell tumours	96 (76–99)
c. Malignant gonadal germ cell tumours	95 (82–99)
XI. Other malignant epithelial neoplasms and malignant melanomas	94 (88–97)
XII. Other and unspecified malignant neoplasms	91 (80–96)

Analysis by: Health Statistics Division, Statistics Canada
Data source: Canadian Cancer Registry database at Statistics Canada

CI=confidence interval; CNS=central nervous system

— Estimate is not shown due to a small number of cases.

* Data from Quebec were excluded, in part, because the method for ascertaining the date of cancer diagnosis differs from the method used by other provinces/territories and because of issues in correctly ascertaining the vital status of cases.

CHAPTER 6
Prevalence: How many people diagnosed with cancer are alive today?

This section of the publication has been reproduced, as is, from the corresponding section in last year's publication (*Canadian Cancer Statistics 2014*). As such, the analytical techniques used reflect the state of knowledge at the time of the production of that publication.

Highlights

- At the beginning of 2009, a substantial number of people in Canada – just over 810,000 – had been diagnosed with cancer in the previous 10 years, (10-year person-based prevalence). Among these people, nearly 841,000 cancers were recorded (10-year tumour-based prevalence).
- Breast and prostate cancer accounted for 40% of the 10-year tumour-based prevalent cases.
- The 10-year tumour-based prevalence peaked among males aged 70–79 years and females aged 60–69 years. This sex difference is due to the high prevalence of prostate and breast cancers in each of these age groups.
- The majority of 10-year tumour-based prevalent cases were diagnosed in the previous five years. Such affected individuals were either undergoing treatment, recovering from its effects or still dealing with the physical and emotional consequences of cancer. This has significant implications for the planning and development of interdisciplinary healthcare services.

Introduction

The ongoing rise in the annual number of new cancer diagnoses (due to a growing and aging population), combined with an improving survival rate for most types of cancer, has meant that a substantial number of people are living with and beyond their cancer diagnosis. This prevalent population of people with cancer and cancer survivors is likely to have unique healthcare needs during the course of their cancer journey. Thus, prevalence statistics are required to estimate the needs for ongoing healthcare[1] and support services that improve the quality of life for people with cancer, cancer survivors and their families.

Recent diagnoses of cancer (within the past two years) include individuals who are either receiving primary treatment or recovering from its effects. People diagnosed in the more distant past (beyond two years) have likely completed their treatment but may still need clinical follow-up and supportive care.

Person-based estimates of prevalence are intuitively easier to understand than tumour-based estimates, although they may underestimate the true impact of cancer because one person can have more than a single diagnosis of a primary cancer.

Prevalence

Population-based cancer prevalence can be measured by the number of living individuals previously diagnosed with cancer or by the number of cancer cases diagnosed in such individuals. Tumour-based estimates refer to the number of cancers diagnosed among individuals living with or beyond cancer on a specified date (index date). Person-based estimates refer to the number of individuals living with or beyond cancer on an index date.

It is also possible to examine limited-duration prevalence. In limited-duration prevalence, tumour- or person-based prevalence estimates are limited to, respectively, cancers or persons diagnosed within a specified period prior to the index date. Limited-duration prevalence is generally measured in two-, five- or 10-year periods prior to an index date.

Tumour-based prevalence

Among Canadians alive on January 1, 2009, close to 841,000 cancers had been diagnosed in the previous 10 years (Table 6.1). These cases can be analyzed according to the type of cancer, the sex and age of the person and the amount of time since diagnosis.

Prevalence by type of cancer

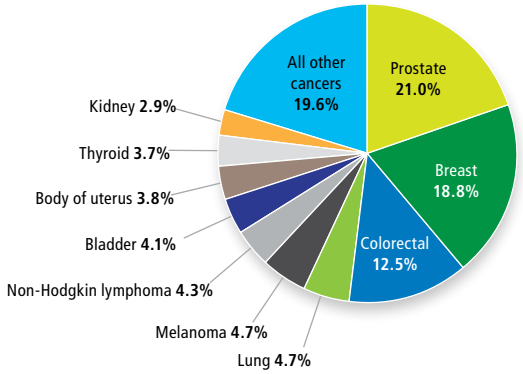
Figure 6.1 shows that prostate and breast cancers together accounted for 40% of all 10-year prevalent cancers. Other common cancers included colorectal cancer (13% of all 10-year prevalent cases), lung cancer (5%), melanoma (5%), non-Hodgkin lymphoma (4%) and bladder cancer (4%).

Prevalence reflects both the frequency of occurrence and prognosis for particular cancers. For example, even though the colorectal cancer incidence rate is lower than that of lung cancer, the colorectal 10-year cancer prevalence is 2.7 times greater, reflecting the poorer prognosis for lung cancer. Similarly, while melanoma accounts for 3% of all newly diagnosed cancer cases, it represents 5% of all 10-year prevalent cancer cases because of its high survival.

Prevalence by sex

Table 6.1 shows that 10-year tumour-based prevalence counts are similar among males and females for several types of cancer including lung, colorectal, non-Hodgkin lymphoma, melanoma, pancreas, brain, multiple myeloma and Hodgkin lymphoma. On the other hand, large differences were seen between the sexes for other types of cancer, including bladder, thyroid, oral, stomach, liver, esophagus and larynx. These sex differences primarily result from differences in cancer incidence rather than observed survival.

FIGURE 6.1 Distribution of 10-year tumour-based prevalence for selected cancers, Canada,* January 1, 2009



* During the estimation process, cases from Quebec were excluded because of issues in correctly ascertaining the vital status of cases. The presented estimates, however, are for all of Canada, including Quebec. These estimates assume that sex- and age-specific tumour-based prevalence proportions in Quebec are similar to the rest of Canada. Estimates for lung and bladder cancers may be lower than in previous editions of this publication because of the different method used to estimate Quebec's prevalence prior to 2013. For further details, see *Appendix II, Data sources and methods.*

Note: The complete definition of the specific cancers listed here can be found in Table A10.

Analysis by: Health Statistics Division, Statistics Canada
Data source: Canadian Cancer Registry database at Statistics Canada

Prevalence by age

Table 6.2 shows that the number of 10-year prevalence cases is generally highest in the 70–79 year age group. Exceptions include female breast cancer and all cancers combined among females – both of which peaked in the 60–69 year age group – as well as colorectal cancer among females (80 years or older age group).

Prevalence by duration

Of the approximately 841,000 10-year prevalent cancer cases at the beginning of 2009, 29% had been diagnosed within the previous two years (2007 to 2008), 32% within the previous two to five years and 38% within the previous five to 10 years (Table 6.1). These data have implications for planning healthcare and supportive services.

- In the first couple of years post diagnosis, individuals are likely receiving or recovering from treatment for their cancer.
- The third to fifth year after a cancer diagnosis is a period that typically requires close clinical follow-up for recurrence and supportive care.
- Individuals alive five to 10 years after a cancer diagnosis have likely completed their treatment but some may still require clinical monitoring.

Figure 6.2 shows that the prevalence of certain types of cancer depends on the length of the period considered. For example:

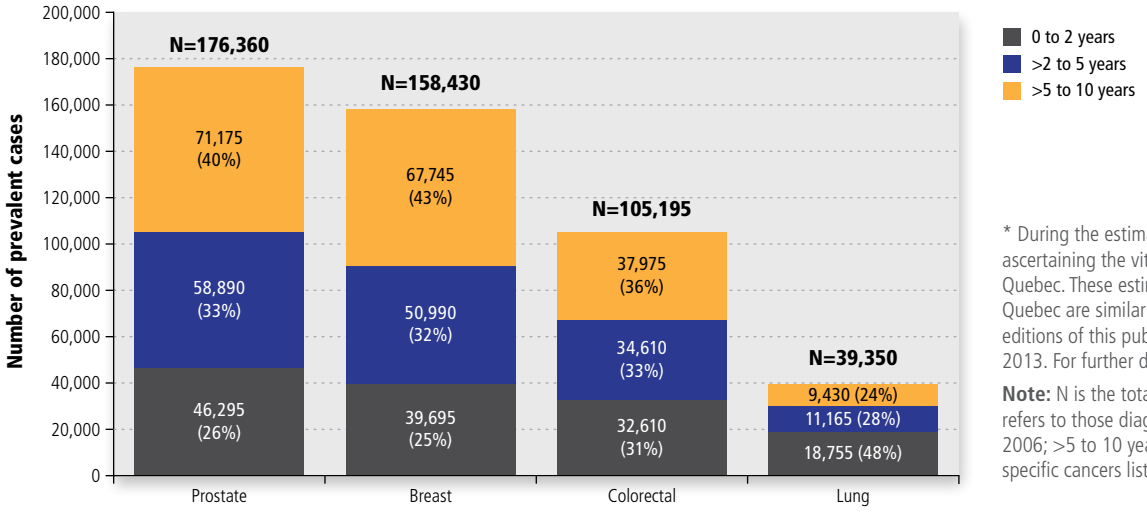
- The prevalence of breast cancer and prostate cancer rises with longer duration compared to other common cancers, such as colorectal and lung cancers.
- The poor prognosis for lung cancer cases means that proportionately fewer individuals with this cancer are alive beyond two years after diagnosis compared to most other cancers.

Person-based prevalence

Among Canadians alive on January 1, 2009, just over 810,000 had been diagnosed with cancer in the previous 10 years (Table 6.3). This number represents approximately 1 in 41 Canadians or 2.4% of the Canadian population (Table 6.4). More specifically, in the 10 years prior to January 1, 2009, among those alive:

- 1 in 94 males had been diagnosed with prostate cancer.
- 1 in 107 females had been diagnosed with breast cancer.
- 1 in 297 males and 1 in 351 females had been diagnosed with colorectal cancer.
- 1 in 907 males and 1 in 813 females had been diagnosed with lung cancer.

FIGURE 6.2 Tumour-based prevalence for the most common cancers by duration, Canada,* January 1, 2009



* During the estimation process, cases from Quebec were excluded because of issues in correctly ascertaining the vital status of cases. The presented estimates, however, are for all of Canada, including Quebec. These estimates assume that sex- and age-specific tumour-based prevalence proportions in Quebec are similar to the rest of Canada. Estimates for lung cancer may be lower than in previous editions of this publication because of the different method used to estimate Quebec's prevalence prior to 2013. For further details, see *Appendix II, Data sources and methods*.

Note: N is the total number of prevalent tumour cases for each cancer type. In the legend, 0 to 2 years refers to those diagnosed in 2007 and 2008; >2 to 5 years refers to those diagnosed between 2004 and 2006; >5 to 10 years refers to those diagnosed between 1999 and 2003. The complete definition of the specific cancers listed here can be found in Table A10.

Analysis by: Health Statistics Division, Statistics Canada
Data source: Canadian Cancer Registry database at Statistics Canada

Some of the individuals included in these numbers were cancer-free, while others were newly or recently diagnosed and were undergoing treatment.

What do these statistics mean?

Knowing the prevalence of cancer is important for estimating and planning healthcare services for cancer. For example, those diagnosed with cancer within the past two years have different needs than those diagnosed between two and five, five and 10 or more than 10 years ago.[1,2]

Earlier chapters and other sources[3] have shown ongoing increases in the number of newly diagnosed cancer cases in Canada and increases in survival from cancer.[4,5] The combined result of these factors is a rise in the number of people living with or beyond a cancer diagnosis. Long after the need for cancer treatment has passed, individuals may still require rehabilitation and supportive care services to address the physical, emotional and spiritual consequences of cancer. The growing demand for such services and the increased complexity of survivors' health needs are just two factors that need to be considered when planning and developing interdisciplinary healthcare.

For more information

Publications

- Ellison LF, Wilkins K. Cancer prevalence in the Canadian population. Health Reports. 2009;20(1):7–19. Available at: http://www.statcan.gc.ca/pub/82-003-x/2009001/article/10800-eng.pdf (accessed Apr. 28, 2015).
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1. De Angelis R, Grande E, Inghelmann R, Francisci S, Micheli A, Baili P, et al. Cancer prevalence estimates in Italy from 1970 to 2010. Tumori. 2007;93(4):392–7.
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3. Statistics Canada. Table 103-0550 – New cases for ICD-O-3 primary sites of cancer (based on the July 2011 CCR tabulation file), by age group and sex, Canada, provinces and territories. CANSIM (database). http://www5.statcan.gc.ca/cansim/a26?lang=eng&retrLang=eng&id=1030550&paSer=&pattern=&stByVal=1&p1=1&p2=37&tabMode=dataTable&csid= (Accessed Jan. 2014)
4. Ellison LF, Wilkins K. An update on cancer survival. *Health Rep.* 2010;21(3):55–60.
5. Statistics Canada. Cancer Survival Statistics (Catalogue 82-226-x). Ottawa, ON: Minister of Industry; 2012.

TABLE 6.1 Tumour-based prevalence for selected cancers by prevalence duration and sex, Canada,* January 1, 2009

	10-year (diagnosed since 1999)			5-year (diagnosed since 2004)			2-year (diagnosed since 2007)		
	Total	Males	Females	Total	Males	Females	Total	Males	Females
All cancers	**840,985**	**423,760**	**417,225**	**520,025**	**266,175**	**253,855**	**247,310**	**127,775**	**119,535**
Prostate	176,365	176,365	—	105,180	105,180	—	46,295	46,295	—
Breast	158,430	1,045	157,380	90,685	640	90,050	39,695	285	39,410
Colorectal	105,195	56,650	48,545	67,215	36,860	30,360	32,610	18,130	14,480
Melanoma	39,495	19,895	19,600	23,365	11,985	11,380	10,640	5,530	5,105
Lung†	39,350	18,435	20,920	29,920	14,165	15,755	18,755	9,100	9,650
Non-Hodgkin lymphoma	36,220	19,140	17,080	23,145	12,440	10,705	10,760	5,900	4,865
Bladder†	34,255	25,650	8,610	21,130	15,945	5,180	9,940	7,530	2,410
Body of uterus	31,610	—	31,610	18,540	—	18,540	8,450	—	8,450
Thyroid	30,930	6,515	24,410	19,240	4,125	15,120	8,625	1,935	6,695
Kidney	24,175	14,435	9,740	15,195	9,205	5,995	7,480	4,500	2,980
Leukemia	22,510	13,040	9,470	14,620	8,505	6,120	7,150	4,180	2,970
Oral	19,510	12,835	6,675	12,145	8,070	4,080	5,960	4,005	1,950
Ovary	10,695	—	10,695	7,025	—	7,025	3,535	—	3,535
Cervix	10,200	—	10,200	5,500	—	5,500	2,480	—	2,480
Testis	7,935	7,935	—	4,210	4,210	—	1,755	1,755	—
Multiple myeloma	7,460	4,100	3,360	5,615	3,110	2,510	2,885	1,560	1,320
Stomach	7,420	4,625	2,790	5,170	3,250	1,920	3,045	1,955	1,095
Brain/CNS	7,385	4,015	3,370	4,790	2,680	2,110	2,735	1,580	1,155
Hodgkin lymphoma	7,160	3,890	3,270	3,905	2,100	1,805	1,685	900	785
Larynx†	5,575	4,625	955	3,415	2,830	585	1,645	1,375	275
Pancreas	3,750	1,845	1,905	3,140	1,560	1,575	2,320	1,165	1,155
Liver	2,985	2,245	745	2,295	1,725	575	1,455	1,080	370
Esophagus	2,740	2,035	710	2,165	1,610	555	1,485	1,130	355

Analysis by: Health Statistics Division, Statistics Canada
Data source: Canadian Cancer Registry database at Statistics Canada

CNS=central nervous system

— Not applicable

* During the estimation process, cases from Quebec were excluded because of issues in correctly ascertaining the vital status of cases. The presented estimates, however, are for all of Canada, including Quebec. These estimates assume that sex- and age-specific tumour-based prevalence proportions in Quebec are similar to the rest of Canada.

† Prevalence estimates for lung, bladder and larynx cancers may be lower than in previous editions of this publication because a different method was used to estimate Quebec's prevalence prior to 2013. For further details, see *Appendix II: Data sources and methods*.

Note: The complete definition of the specific cancers listed here can be found in Table A10.

TABLE 6.2 Age distribution for 10-year tumour-based prevalence for the most common cancers by sex, Canada,* January 1, 2009

	All cancers			Lung†			Colorectal			Prostate	Breast
	Total N=840,985	Males N=423,760	Females N=417,225	Total N=39,350	Males N=18,435	Females N=20,920	Total N=105,195	Males N=56,650	Females N=48,545	Males N=176,365	Females N=157,380
Age (years)	%	%	%	%	%	%	%	%	%	%	%
0–19	0.9	1.0	0.8	0.1	0.1	0.1	0.0	0.0	0.0	0.0	0.0
20–29	1.3	1.2	1.3	0.2	0.2	0.2	0.2	0.2	0.2	0.0	0.2
30–39	3.0	2.2	3.9	0.5	0.5	0.6	0.8	0.8	0.9	0.0	2.0
40–49	8.0	5.0	11.1	3.3	2.7	3.9	4.1	3.9	4.3	0.7	11.9
50–59	17.1	13.9	20.5	13.8	12.0	15.5	13.1	13.5	12.6	10.2	24.3
60–69	25.9	27.7	24.0	29.7	30.1	29.4	24.4	27.0	21.4	31.8	26.1
70–79	26.3	31.3	21.2	33.7	35.7	31.9	30.7	32.6	28.4	38.5	20.4
80+	17.4	17.7	17.2	18.6	18.8	18.4	26.6	21.8	32.1	18.8	15.2

Analysis by: Health Statistics Division, Statistics Canada
Data source: Canadian Cancer Registry database at Statistics Canada

N is the total number of prevalent tumour cases for each cancer type by sex.

* During the estimation process, cases from Quebec were excluded because of issues in correctly ascertaining the vital status of cases. The presented estimates, however, are for all of Canada, including Quebec. These estimates assume that sex- and age-specific tumour-based prevalence proportions in Quebec are similar to the rest of Canada.

† Prevalence estimates for lung cancer may be lower than in previous editions of this publication because a different method was used to estimate Quebec's prevalence prior to 2013. For further details, see *Appendix II: Data sources and methods*.

Note: "All cancers" excludes non-melanoma skin cancers (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). Due to rounding, columns may not total 100%. The complete definition of the specific cancers listed here can be found in Table A10.

TABLE 6.3 Person-based prevalence for selected cancers by prevalence duration and sex, Canada,* January 1, 2009

	10-year (diagnosed since 1999)			5-year (diagnosed since 2004)			2-year (diagnosed since 2007)		
	Total	Males	Females	Total	Males	Females	Total	Males	Females
All cancers	**810,045**	**406,065**	**403,980**	**506,200**	**258,070**	**248,130**	**242,810**	**125,040**	**117,770**
Prostate	176,355	176,355	—	105,180	105,180	—	46,295	46,295	—
Breast	158,405	1,045	157,360	90,680	635	90,040	39,690	285	39,410
Colorectal	104,130	55,985	48,145	66,615	36,460	30,155	32,385	17,955	14,420
Melanoma	39,495	19,895	19,600	23,360	11,985	11,375	10,640	5,530	5,105
Lung†	39,115	18,335	20,775	29,780	14,105	15,675	18,680	9,065	9,610
Non-Hodgkin lymphoma	36,175	19,110	17,060	23,100	12,410	10,685	10,720	5,875	4,850
Bladder†	34,245	25,640	8,605	21,115	15,940	5,180	9,940	7,530	2,410
Body of uterus	31,605	—	31,605	18,535	—	18,535	8,445	—	8,445
Thyroid	30,845	6,500	24,350	19,190	4,100	15,085	8,605	1,925	6,680
Kidney	24,165	14,420	9,740	15,195	9,200	5,995	7,480	4,495	2,980
Leukemia	22,510	13,040	9,470	14,620	8,500	6,115	7,150	4,180	2,970
Oral	19,320	12,730	6,590	12,055	8,020	4,040	5,925	3,985	1,935
Ovary	10,690	—	10,690	7,025	—	7,025	3,535	—	3,535
Cervix	10,190	—	10,190	5,495	—	5,495	2,480	—	2,480
Testis	7,935	7,935	—	4,210	4,210	—	1,755	1,755	—
Multiple myeloma	7,455	4,100	3,360	5,615	3,105	2,505	2,885	1,560	1,320
Stomach	7,415	4,620	2,790	5,170	3,245	1,920	3,045	1,955	1,090
Brain/CNS	7,375	4,015	3,365	4,785	2,675	2,105	2,735	1,580	1,155
Hodgkin lymphoma	7,160	3,890	3,270	3,905	2,095	1,805	1,685	900	785
Larynx†	5,575	4,620	950	3,415	2,825	585	1,645	1,370	275
Pancreas	3,750	1,845	1,905	3,135	1,560	1,575	2,320	1,165	1,155
Liver	2,985	2,240	745	2,295	1,720	575	1,450	1,080	370
Esophagus	2,740	2,035	710	2,165	1,610	555	1,485	1,130	355

Analysis by: Health Statistics Division, Statistics Canada
Data source: Canadian Cancer Registry database at Statistics Canada

CNS=central nervous system

— Not applicable

* During the estimation process, cases from Quebec were excluded because of issues in correctly ascertaining the vital status of cases. The presented estimates, however, are for all of Canada, including Quebec. These estimates assume that sex- and age-specific person-based prevalence proportions in Quebec are similar to the rest of Canada.

† Prevalence estimates for lung, bladder and larynx cancers may be lower than in previous editions of this publication because a different method was used to estimate Quebec's prevalence prior to 2013. For further details, see *Appendix II: Data sources and methods*.

Note: "All cancers" excludes non-melanoma skin cancers (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). The complete definition of the specific cancers listed here can be found in Table A10.

TABLE 6.4 Ten-year person-based prevalence proportions for the most common cancers by sex, Canada,* January 1, 2009

	Percentage of Canadian population			One in:		
	Total	Males	Females	Total	Males	Females
All cancers	**2.4**	**2.4**	**2.4**	**41**	**41**	**42**
Prostate	—	1.1	—	—	94	—
Lung†	0.1	0.1	0.1	857	907	813
Female breast	—	—	0.9	—	—	107
Colorectal	0.3	0.3	0.3	322	297	351

Analysis by: Health Statistics Division, Statistics Canada
Data source: Canadian Cancer Registry database at Statistics Canada

— Not applicable.

* During the estimation process, cases from Quebec were excluded because of issues in correctly ascertaining the vital status of cases. The presented estimates, however, are for all of Canada, including Quebec. These estimates assume that sex- and age-specific person-based prevalence proportions in Quebec are similar to the rest of Canada.

† "One in:" estimates for lung cancer indicate a lower prevalence proportion for males than in previous editions of this publication because a different method was used to estimate Quebec's prevalence prior to 2013. For further details, see *Appendix II: Data sources and methods*.

Note: "All cancers" excludes non-melanoma skin cancers (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). The complete definition of the specific cancers listed here can be found in Table A10.

CHAPTER 7
Special topic: Predictions of the future burden of cancer in Canada

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Highlights

How many new cancer cases will there be in the future?

- Between 2003 to 2007 and 2028 to 2032, it is estimated that the average annual population of Canada will grow by 29% or about 9.5 million residents. Over this period, the proportion of Canadians aged 65 and older will grow from approximately 1 in 8 to 1 in 4.
- By 2028 to 2032, the average annual number of new cancer cases is estimated to increase 79% (84% in males and 74% in females) compared to 2003 to 2007. This translates to 277,200 new cases in 2028 to 2032 (148,370 in males and 128,830 in females) up from 154,975 cases in 2003 to 2007 (80,810 in males and 74,165 in females). During the same period, the number of new cancer cases is expected to more than double in those aged 65 and over.
- The expected increase in the number of new cancer cases in both males and females will primarily be due to the aging of the Canadian population and, to a lesser extent, population growth. Changes in the risk of cancer will constitute a relatively small component of the projected increase in new cases among females, but will mitigate the overall expected increase in new cases among males.
- If current trends hold true in the future, it is expected that for the major cancer types by 2028 to 2032:
  - The number of new lung cancer cases will increase to 32,365 from 22,110 in 2003 to 2007.
  - Prostate cancer cases will increase to 42,225 from 21,460.
  - Female breast cancer cases will increase to 31,255 from 20,110.
  - Colorectal cancers will increase to 35,075 from 19,630.

Will the risk of cancer change?

- It is estimated that the age-standardized cancer incidence rate for males will decline (from 465 to 443 per 100,000) and increase for females (from 358 to 371 per 100,000).
- The projected incidence rates for various cancer types are expected to change to varying degrees up to 2028–2032 when examined by their predominant risk factors:
  - Incidence rates for most smoking-related cancers will decrease over time.
  - Incidence rates for melanoma (associated with UV overexposure) are expected to decline in the long term for both sexes.
  - Other major cancer risk factors such as excess weight, physical inactivity, poor diet, alcohol consumption and infection are expected to impact different cancers to varying degrees.
- The pattern of cancer incidence rates across Canada will remain similar to today – future rates for most cancer types are expected to be highest in eastern Canada and lowest in British Columbia.

What are the implications?

- Projection of cancer incidence can provide an evidence base for planning strategies, resources and infrastructure at both national and provincial levels for better cancer control.
- Cancer risk will play a smaller but still important role in the future burden of cancer compared to population growth and aging. As a result, there will be a need for continued strengthening of cancer prevention and early detection to lessen the future incidence of cancer.
- The anticipated growth in new cases implies a growing cancer survivor population, which may require planning of appropriate strategies and services related to continuing care.

Introduction

Growth and aging of the Canadian population are expected to contribute to a substantial increase in the cancer burden. While short-term projections like those presented in other chapters of this publication are useful for estimating the current impact of cancer on Canadians, long-term projections are useful in a variety of ways. For example, defining the expected societal burden of cancer can provide evidence-based input in the planning of cancer control programs, whether for prevention, early detection, treatment, psychosocial, palliative and medical care, or for research and surveillance. Furthermore, estimating the geographic variability in future cancer incidence can help in developing priorities for public health policy at both the national and regional levels.

The future incidence of cancer can be examined using the estimated age-standardized rate and the number of new cancer cases. Changes in rates convey changes in risk of developing cancer over time. In contrast, the future number of new cases is a consequence of changes in the cancer rates as well as in the population size and age structure.

Future predictions depend on several assumptions. Most notable are that:

- past trends will continue into the future
- the prevalence of most risk factors are stable or will change little over the projection period.

However, changes in medical practice, advances in diagnostic procedures, changes in histological classification and completeness of cancer registration can all lead to short-term changes in incidence, which are difficult to foresee or incorporate into prediction models. Generally, the accuracy of projections for the most common cancers is of greatest concern because these have the biggest influence over the total projected number of cases.

The Public Health Agency of Canada has completed a study on projected incidence counts and rates through 2028 to 2032 for 25 types of cancer (excluding non-melanoma skin cancer) in Canada by sex, age and geographic region using national cancer data from 1983 to 2007.[1] This chapter is partly based on that study. At the time of writing of that study, the most current available national data were for cancer diagnoses in the year 2007. As a result, five-year periods up to 2003 to 2007 are used as the baseline periods for long-term projections in this chapter. Estimates of future numbers of new cancer cases and rates are provided for five-year periods from 2008–2012 to 2028–2032.

The projection methods are described in *Appendix II: Data sources and methods*. The Public Health Agency of Canada mainly uses a statistical projections package, Nordpred, to extrapolate current trends in cancer rates into the future. The package requires input of past numbers of cancer cases aggregated by 5-year time periods and produces projections for 5-year durations, as mentioned above. The projections also depend on accurate national population projections, which are prepared by Statistics Canada. Rates were age-adjusted by standardizing to the 1991 Canadian standard population (i.e., the standard currently used by Statistics Canada and the Public Health Agency of Canada). Standardizing to a more current population may produce different rates than those presented here.

Microsimulation model

Microsimulation models are computer models that simulate large populations using, for example, characteristics of representative individuals. These models allow one to explore the potential variation in projection outputs that result from varying scenarios for model inputs such as screening participation, cancer incidence and survival from cancer, among others.

Nordpred software

A software for predicting trends in cancer incidence and the chosen software for the majority of the current analyses.

Medium growth

The medium growth scenario combines assumptions of fertility and immigration similar to recent years along with moderate growth in life expectancy (as opposed to low or high rates for each of these factors).

Low-dose computed tomography (LDCT)

A type of scanning technology that combines special x-ray equipment with sophisticated computers to produce multiple, cross-sectional images or pictures of the inside of the body. LDCT uses less ionizing radiation than a conventional computed tomography (CT) scan.

This chapter also uses the Canadian Partnership Against Cancer's Cancer Risk Management Model (CRMM) to develop a series of microsimulation modelling scenarios that show the impact of selected cancer control interventions. The CRMM is a web-based, decision-support modelling platform that projects population-based health and economic impacts of cancer control interventions in Canada.[2-5] The microsimulation projections allow health system leaders, researchers and policy makers to test "what-if" scenarios related to potential cancer control interventions. Users can access the CRMM via a web interface and develop customized scenarios to inform current and future health policy decisions. The model incorporates the risk of developing and dying from cancer, as well as screening and clinical management data with health care costs and labour data to allow assessment of both health outcomes and economic impact.

The "in-depth" analyses using the CRMM were conducted for 3 types of cancer – lung, colorectal and cervical – to assess the potential impacts of:

- low-dose computed tomography (LDCT) screening of current and former heavy smokers on future lung cancer incidence, mortality and prevalence and the costs associated with the intervention
- fecal immunochemical blood screening on future colorectal cancer incidence, mortality and prevalence and the costs associated with the intervention
- human papillomavirus (HPV) vaccination and routine Pap screening in conjunction with HPV DNA testing on future cervical cancer incidence, mortality, and prevalence and costs associated with the interventions.

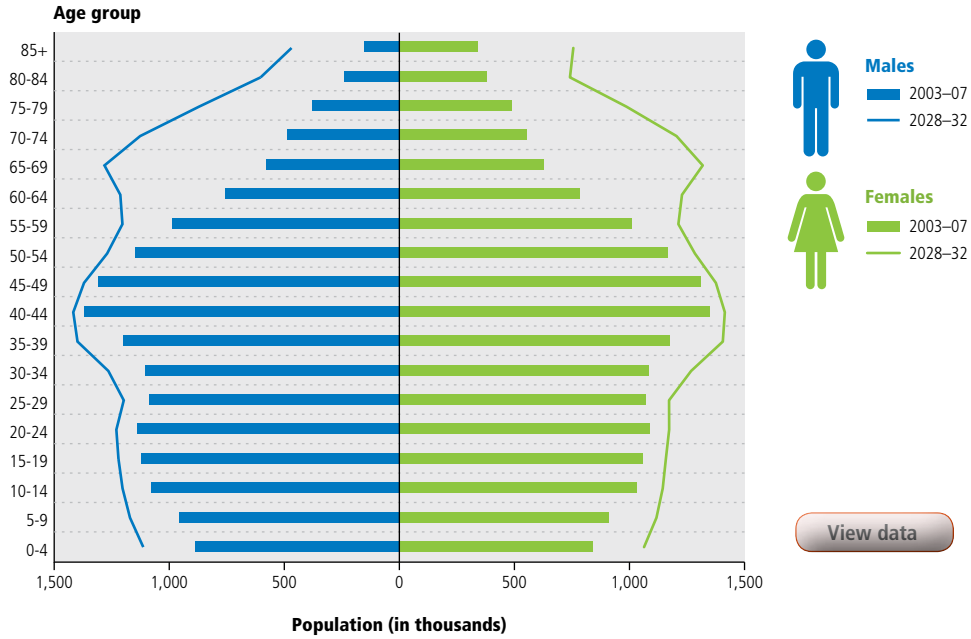
Because of differences in modelling approaches and model assumptions, the estimates provided by the CRMM may not be consistent with those derived from the PHAC models (see *Appendix II: Data sources and methods* for details on the different methods). However, both approaches permit one to make inferences about the future burden of cancer. The main difference is that the PHAC models assume that past trends estimated from data will continue into the future with varying degrees whereas the CRMM permits one to explore what might happen to cancer burden if one or more interventions (such as cancer screening or vaccination) are adopted in our population.

Projected trends in population

Cancer counts are affected by demographic changes such as population growth and changes in the age distribution of the population. Figure 7.1 shows the projected population distribution in males and females in 2003–2007 and 2028–2032. Under Statistics Canada's medium growth scenario (M1), it is estimated that over this period the average annual Canadian population will grow by 29% or about 9.5 million people.

By 2028–32, people aged 65 and over are expected to represent 1 in 4 Canadians, up from 1 in 8 in the years 2003–2007. Moreover, it is expected that the growth in population in males age 65 or older will be greater than

FIGURE 7.1 Current and projected average annual population, by sex and age, Canada, 2003–07 and 2028–32



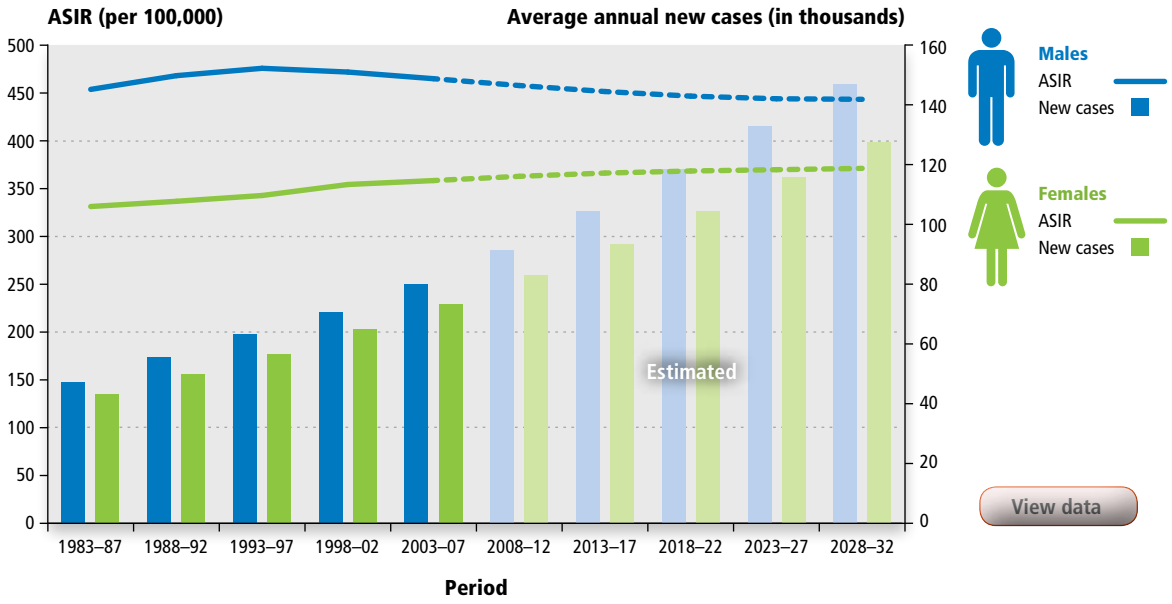
Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Statistics Canada; Demographic estimates compendium 2010; CANSIM table 051-0001; Population Projections for Canada, Provinces and Territories 2009 to 2036 (Catalogue no. 91-520-X)

in females (increases of 137% vs. 109%). The increase in population in the 65 years and over age group is expected in several Western countries, but the extent of increase will vary. Canada is expected to have greater growth than others because of its larger baby boom population.[6]

It is also important to note that the overall population change may not be uniform across Canada. Some provinces and territories are forecasted to grow more than others. Generally population growth from 2003–2007 to 2028–2032 is forecast to be lower than the Canadian average in Atlantic Canada, Quebec, Saskatchewan and the Territories and above average for Alberta and British Columbia. Ontario and Manitoba are forecast to grow approximately in line with the Canadian average over this period.[1]

Although all regions will experience a substantial increase in the number of seniors over the period 2003–2007 to 2028–2032, it will not be uniform. Manitoba, Saskatchewan, Quebec, Nova Scotia and New Brunswick will experience lower than average growth in the senior population, whereas Alberta and the Territories are forecast to see a substantial percentage increase in those aged 65 and older. Consequently, these different changes will contribute to differences in the predicted increase in cancer burden, both across and within each province and territory.

FIGURE 7.2 Average annual new cases and age-standardized incidence rates (ASIRs) for all cancers, Canada, 1983–2032



Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry and National Cancer Incidence Reporting System databases at Statistics Canada

Projected trends in cancer incidence counts and rates

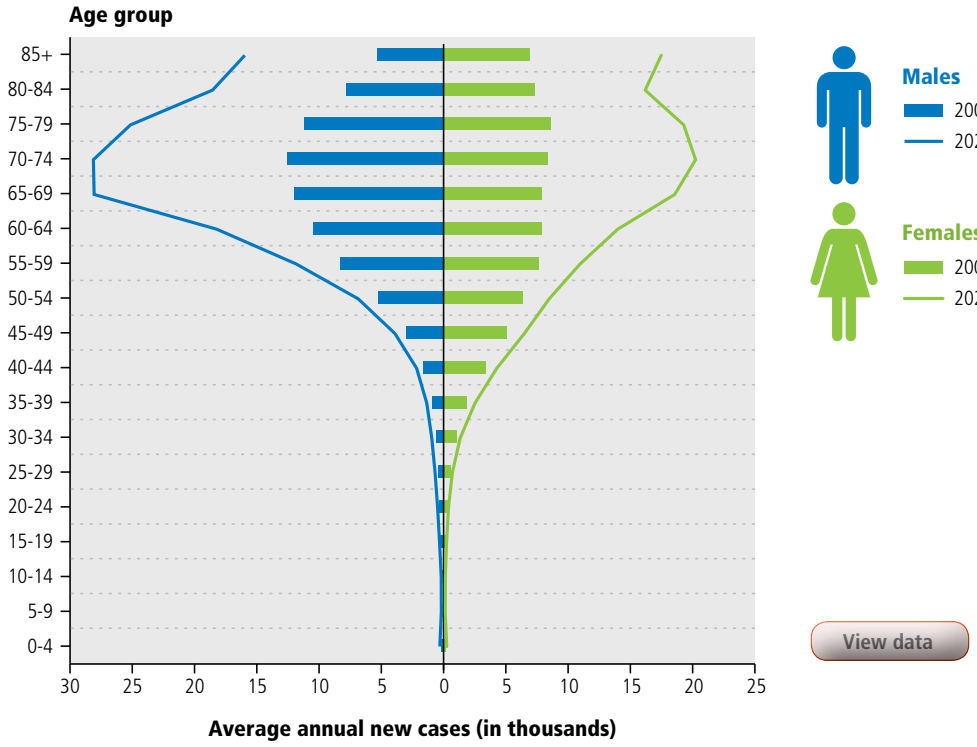
New cancer cases are predicted to increase in both sexes (Figure 7.2). The annual number of new cases is predicted to increase by 84% (from 80,810 in 2003–2007 to 148,370 in 2028–2032) in males (Table 7.1) and by 74% (from 74,165 to 128,830) among females (Table 7.2). These changes translate to an overall 79% increase in new cases for both sexes combined.

Consistent with the projected change in age distribution in the population described above, the greatest number of new cancer cases is expected in the 65 years and over age group (Figure 7.3). Together, these age groups are expected to have more than a doubling of new cases by 2028–2032 (188,720 average annual cases) compared to 2003–2007 (88,210 cases).

An analysis of the drivers of change illustrates that the projected rise in the number of all new cancer cases in both males and females will primarily come from the aging of the Canadian population and, to a lesser extent, from an increase in population size (Figure 7.4). Changes in the risk of cancer (i.e., exposure to risk factors and diagnostic practices) will constitute a relatively small component of the projected increase in new cases among females, but will mitigate the overall expected increase in new cases among males.

The age-standardized incidence rate (ASIR) for all cancers combined in males began decreasing from 1993–1997 to 2003-2007 (Figure 7.2), while in females it increased over this period. For the projected period of 2003–2007 to 2028–2032, the ASIRs for all cancers combined are predicted to continue decreasing among males by 5% (from 465 to 443 per 100,000) and continue increasing among females by 4% (from 358 to 371 per 100,000).

FIGURE 7.3 Current and projected distribution of new cancer cases, by sex and age, Canada, 2003–07 and 2028–32



Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry and National Cancer Incidence Reporting System databases at Statistics Canada

Counts and rates by cancer type

Figure 7.5 shows that the relative percentage change in new cancer cases in both sexes combined is expected to differ by cancer type. Recent patterns in incidence rates and the ages at which different cancers tend to arise have an influence on the expected change of each type of cancer. Cancer screening can also have a strong influence on rates of new cancer diagnoses. Its influence is reflected in current incidence rates for individual cancer types but may not be adequately captured in the projections of future cases. For example, this may be the case for colorectal cancer, for which the future impact of the recent implementation of population-based screening is not well known and also for lung cancer, for which the possible future implementation of lung cancer screening in individuals at high risk for the disease is not reflected in current projections for lung cancer (see In-Depth boxes for projections of screening-based scenarios).

The number of new cases in 2028–2032 will continue to be highest in the four major cancer types – prostate, lung, colorectal and breast. However, aside from prostate cancer, the percentage change in new cases compared to 2003–2007 is expected to be greatest for many of the less common cancer types such as liver (162% increase), thyroid (144%), multiple myeloma (110%), pancreas (99%) and leukemia (94%).

Notably, larynx cancer is the only cancer type with an expected decline in new cases (average annual 5% decrease).

Frequency distribution

The relative frequencies of major cancers are not expected to change significantly over time. Figure 7.6 shows the frequency distribution of cancers by sex for the periods of 2003–2007, 2018–2022 and 2028–2032.

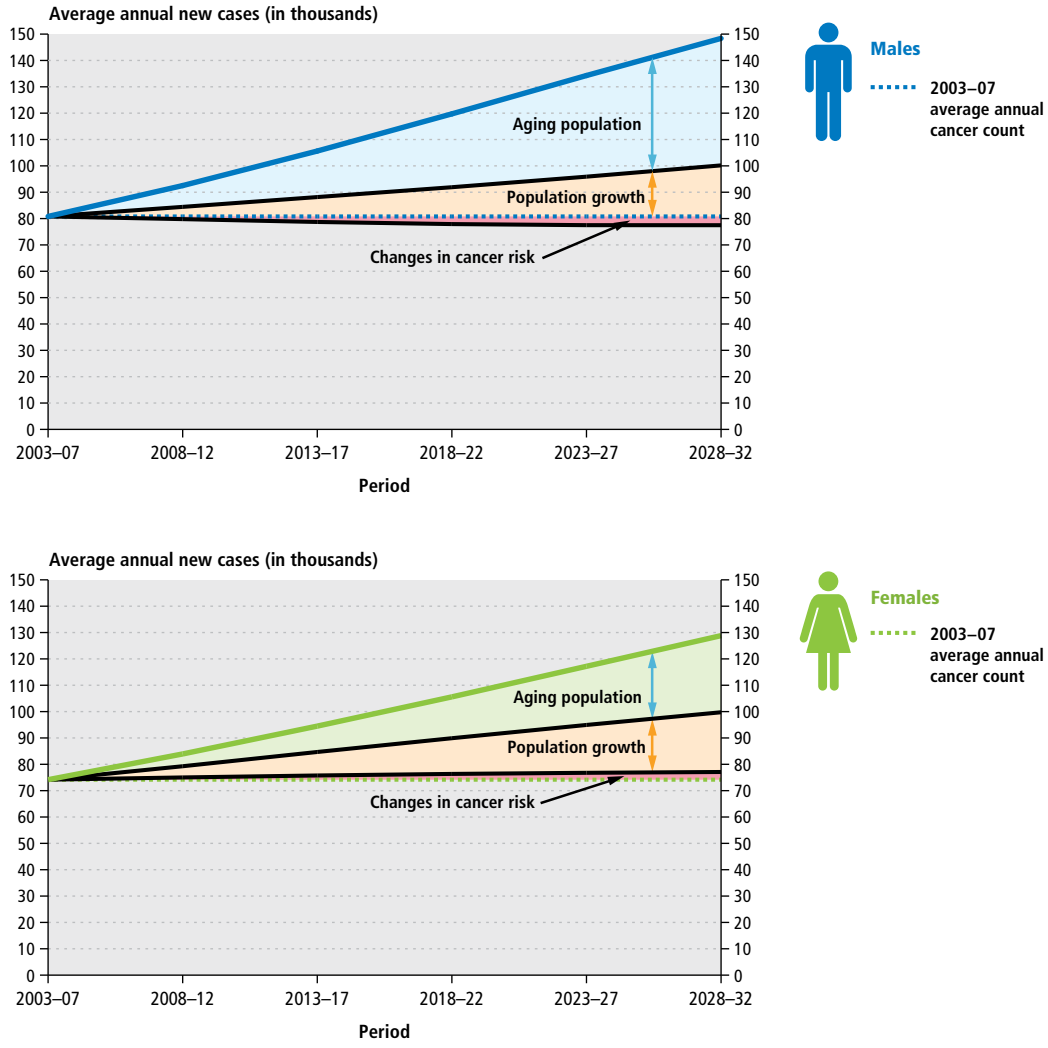
Prostate, colorectal, lung and bladder cancers are expected to be the four most common cancers diagnosed in males in all periods. However, colorectal cancer is projected to overtake lung cancer as the second most frequently diagnosed cancer in males by 2018–2022. This change may be explained by the decreasing incidence of lung cancer due to declining smoking rates in males.

In females, four cancers – breast, lung, colorectal and uterine – are the leading cancer types in the three periods examined in this analysis. The distribution of common cancers in females is expected to remain unchanged over time except for thyroid cancer, which is expected to outrank non-Hodgkin lymphoma as the fifth most common cancer in females by 2018–2022.

Rates

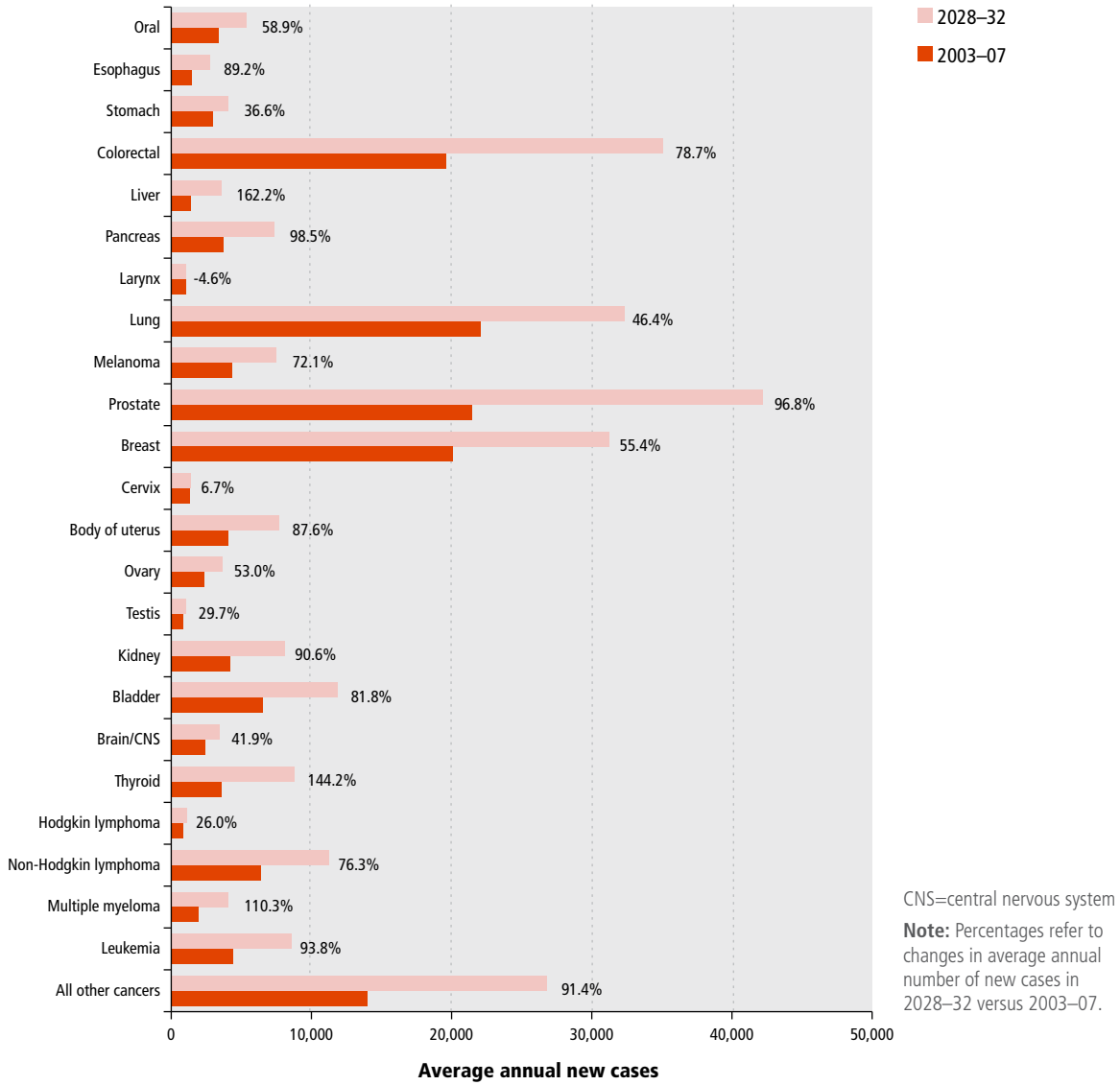
While counts of new cases provide a measure of cancer burden, the change in rates provides a population measure of the changing risk for developing cancer. It is possible for the trends in counts and rates to be different. Even if incidence rates are stable or declining, because the number of people in the age group that is most often diagnosed with cancer is going up rapidly, the number of new cancer cases will also trend upward. As alluded to previously, as the baby boom population in Canada continues to move into the period of life at higher risk of cancer, the number of new cancer cases is expected to rise.

FIGURE 7.4 Trends in average annual new cases for all cancers and ages, attributed to changes in cancer risk, population growth, and aging population, Canada, 2003–2032



Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry and National Cancer Incidence Reporting System databases at Statistics Canada

FIGURE 7.5 Average annual new cases by cancer type and percentage change, Canada, 2028–32 versus 2003–07



CNS=central nervous system

Note: Percentages refer to changes in average annual number of new cases in 2028–32 versus 2003–07.

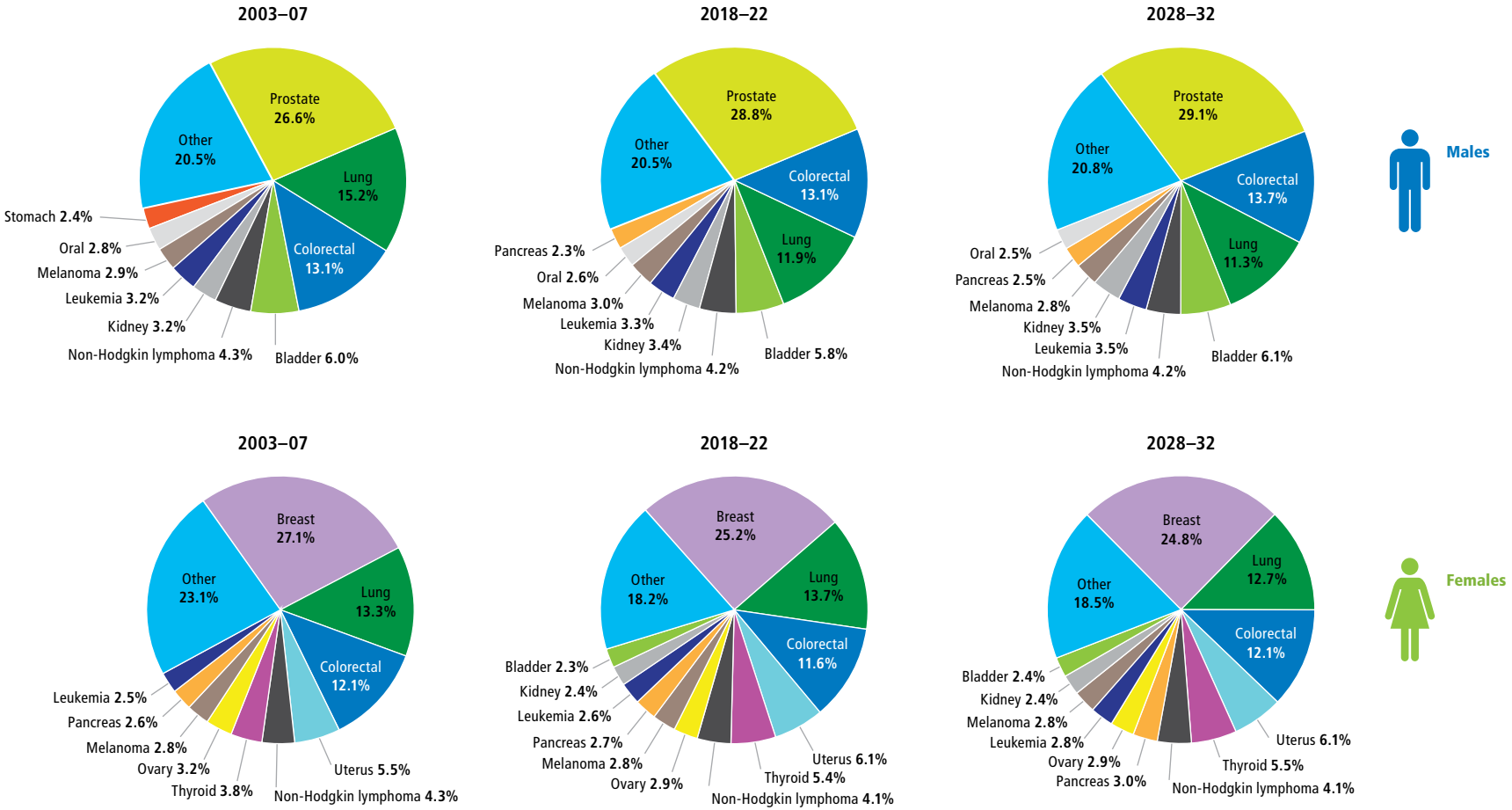
Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry and National Cancer Incidence Reporting System databases at Statistics Canada

View data

For all cancers combined, the ASIR in 2028 to 2032 is expected to decline in males (5% lower than 2003–2007) but increase in females (4% higher than 2003–2007). Much of the expected decline in ASIR for all cancers combined in males may be attributed to the decreasing ASIR for lung cancer. The greatest declines in ASIR for males are expected for larynx and stomach cancers. The largest increases in ASIR for males are expected for thyroid and liver cancer, while smaller increases will occur for the cancer types previously mentioned with high numbers of future new cases (i.e., multiple myeloma, pancreas and leukemia).

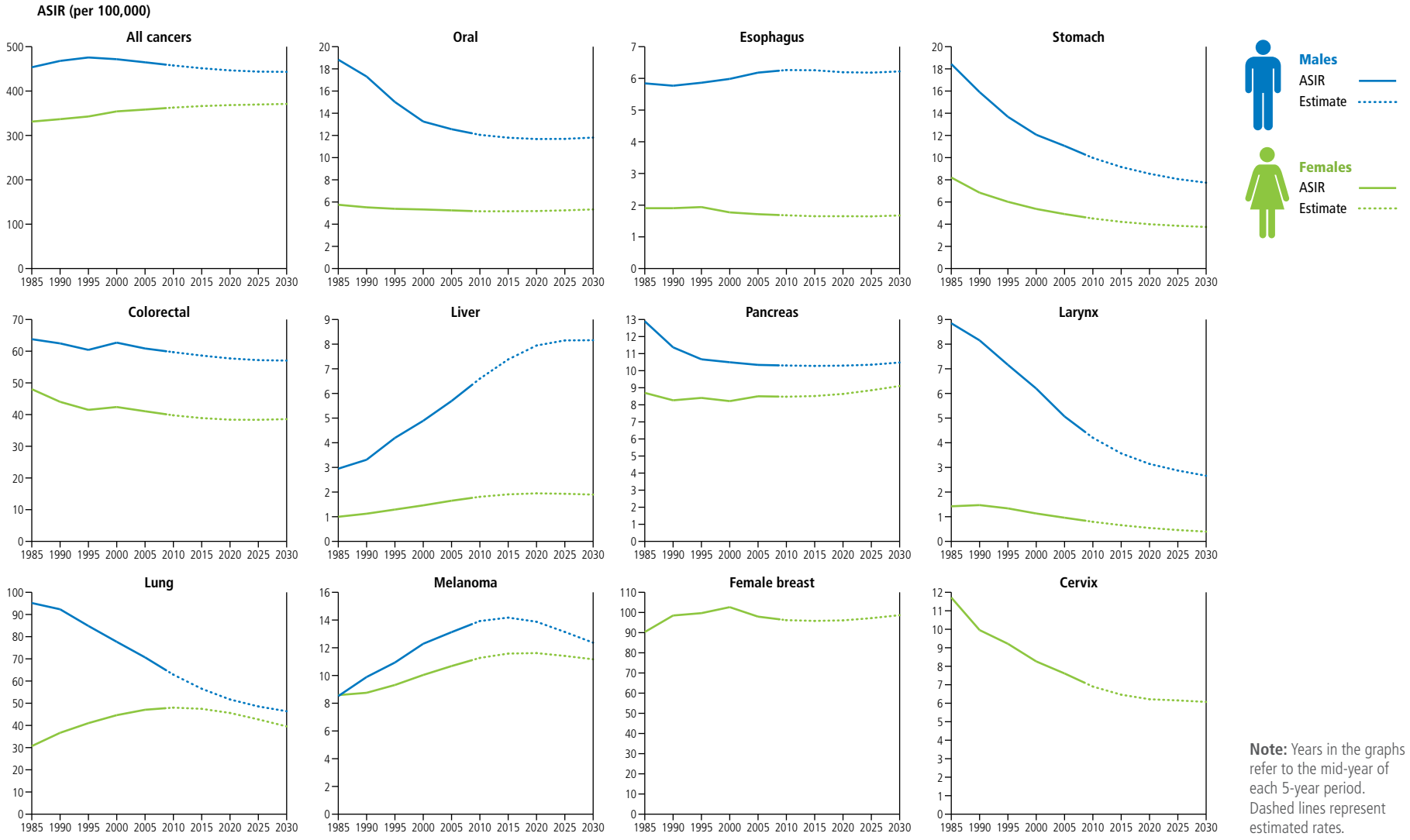
The ASIR of lung cancer in females is projected to rise by 2% from 2003–2007 to 2008–2012 and then decrease by 18% to 2028–2032 (Figure 7.7). The breast cancer ASIR is expected to change the least (an increase of only 0.7%) of all cancers in females. Most of the increase in female ASIR for all cancers combined may be attributed to the collective effects of higher future ASIRs for thyroid, liver and uterus cancer. Smaller increases will occur for the cancer types previously mentioned with high numbers of future new cases (i.e., multiple myeloma, pancreas and leukemia). Notable decreases in ASIR for females are expected for larynx, stomach and cervix cancers.

FIGURE 7.6 Projected change in distribution of cancers in males and females, Canada, 2003–07, 2018–22 and 2028–32



Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry and National Cancer Incidence Reporting System databases at Statistics Canada

FIGURE 7.7 Age-standardized incidence rates (ASIRs) for selected cancers, Canada, 1985–2030

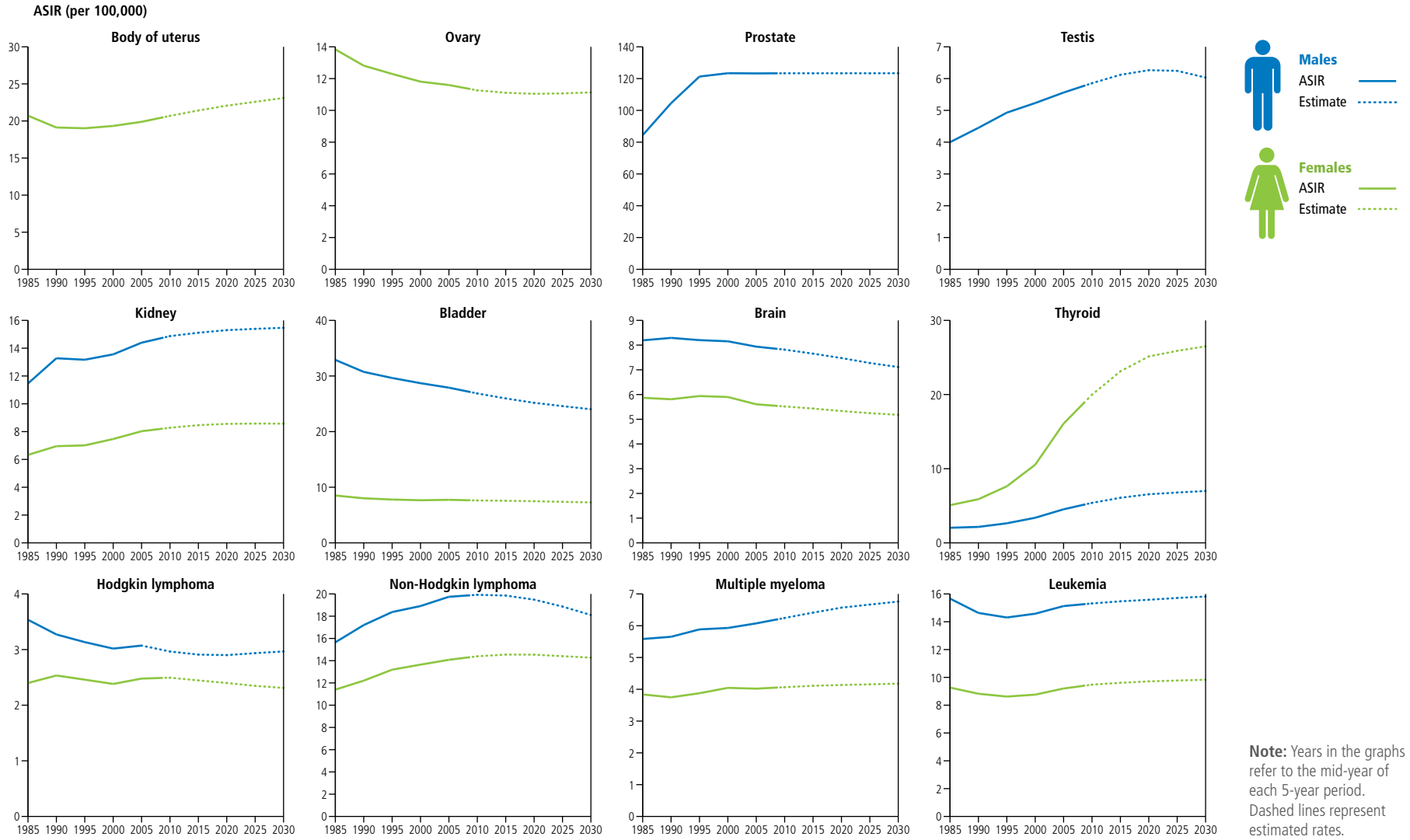


Note: Years in the graphs refer to the mid-year of each 5-year period. Dashed lines represent estimated rates.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry and National Cancer Incidence Reporting System databases at Statistics Canada

View data

FIGURE 7.7 Age-standardized incidence rates (ASIRs) for selected cancers, Canada, 1985–2030 *(continued)*

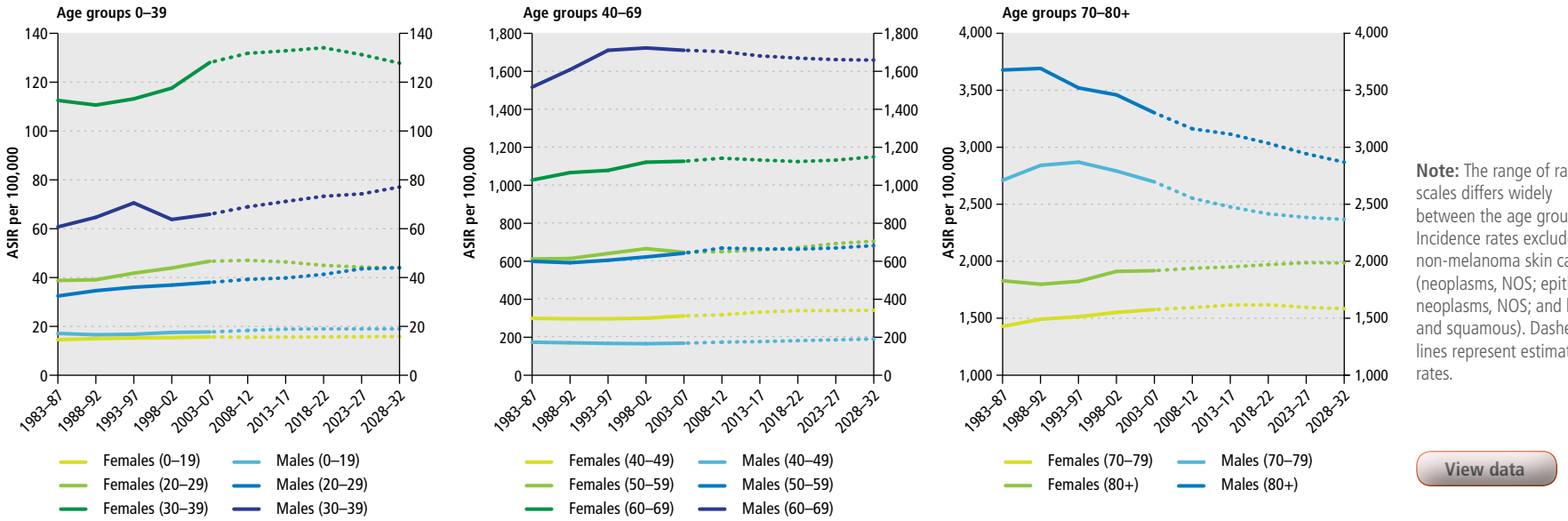


Note: Years in the graphs refer to the mid-year of each 5-year period. Dashed lines represent estimated rates.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry and National Cancer Incidence Reporting System databases at Statistics Canada

View data

FIGURE 7.8 Age-standardized incidence rates (ASIRs) for all cancers by age group, Canada, 1983–2032



Note: The range of rate scales differs widely between the age groups. Incidence rates exclude non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). Dashed lines represent estimated rates.

View data

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry and National Cancer Incidence Reporting System databases at Statistics Canada

Rates by sex and age

Currently, cancer is more frequently diagnosed in females than males between the ages of 20 and 49. However, this pattern is expected to change for males and females over time for those aged 20–29, for whom ASIRs are predicted to converge (Figure 7.8).

The continuing gap in ASIRs between sexes in the age group 30–49 can be attributed to the high incidence of breast cancer in females, which accounts for 35–38% of all female cancers in these age groups. Cancers of the thyroid and cervix also explain the higher incidence rate in young females compared to males of the same age.

The ASIRs for the age group 50–59 will continue to be very close between the sexes. The male ASIRs for the age groups 60 years and older have been dropping over time and are expected to continue to do so. The decrease in lung cancer rates in this age range and the decrease in prostate cancer rates among individuals aged over 70 have contributed to the overall decline.

Females aged 60–69 will experience notable increases in ASIR while those aged 70 and older will see a smaller increase (unlike their male counterparts who will experience declines in rates).

Counts and rates by geographic region

Differences in incidence rates by regions are influenced by variation in the prevalence of risk factors, availability of screening and diagnostic services, different rates of participation in cancer screening programs (e.g., mammographic screening for breast cancer) and variation in cancer registry practices. Differences in demographics by region also impact the numbers of new cases diagnosed as larger and older populations will give rise to more cancers.

While new cases for some cancer types are expected to rise universally across most regions (e.g., liver, thyroid cancers), others will differ by geographic region (Table 7.3). For example, new cases of esophageal cancer are anticipated to rise substantially in Alberta and Newfoundland by 2028–2032, but this cancer will experience a smaller change elsewhere. Similarly, uterus cancer is expected to have a bigger increase in new cases in Ontario and British Columbia than in other provinces. Population growth may partially explain the larger increase in cases of uterus cancer in Ontario and British Columbia.

The ASIRs for all cancers combined are projected to be highest for males in the Atlantic region, highest for females in Quebec over the next 15 years but in Ontario thereafter, and lowest in British Columbia.[1] By 2028–2032, the Atlantic region is projected to have the lowest national rates for breast, uterus and ovarian cancers, and for liver and leukemia in both sexes. The historically higher smoking rates in Quebec and Atlantic Canada likely account for the higher incidence rates of lung cancer in these regions.

Low expected incidence rates of prostate cancer and melanoma in Quebec are likely the result of the registry relying on hospitalization data and missing cancers diagnosed and treated outside the hospitals.[7] The high incidence rates of liver and esophageal cancers in British Columbia could partly be explained by high numbers of immigrants from South Asia and China where hepatitis B virus (HBV) is endemic and higher rates of esophageal cancer in China and Central Asia.[8]

In-depth: Projected impact of screening and adjunct smoking cessation program on lung cancer in current and former heavy smokers

Incidence

Annual population-based lung cancer screening with low-dose computed tomography (LDCT) has the potential to detect lung cancer early among 55–74 year old current or former heavy smokers (30 pack-years). However, like many screening modalities, LDCT can lead to over-diagnosis – that is, detecting cancers that would not have been diagnosed in the person's lifetime in the absence of screening. The CRMM projected that early detection combined with the existing high prevalence of detectable lung cancer cases at the beginning of such a screening program would lead to an increase in new cases detected in the first several years of screening and a higher than expected number of new cases while screening continues (Figure 7.9). The result would be similar with 30% LDCT alone or when coupled with an adjunct smoking cessation program that has a 22.5% success rate. The impact of smoking cessation on incidence is muted because it takes 20–30 years in the simulation for risk to return to baseline levels of the population.

Mortality

Participation rates of 30% in LDCT lung cancer screening with an adjunct smoking cessation program with a 22.5% success rate is expected to result in a modest reduction in lung cancer deaths in Canada (Table 7.5), from 20,680 to 20,650 deaths in 2015 and 24,600 to 24,270 deaths in 2030. Although there is a relatively long lag time between smoking cessation and a reduction in the incidence of lung cancer, the short-term benefits of smoking cessation are expected to be realized through its impact on other causes of mortality and reflected in life-years gained (i.e., increased longevity). The CRMM projects an increase in life-years of 8,700 and 5,500 by 2030 due to lung cancer screening with and without smoking cessation, respectively.

Prevalence

The future prevalence of lung cancer, defined as the number of individuals ever having been diagnosed with lung cancer, will be influenced by smoking patterns (amount and duration smoked) in prior years, the increased number of cancers detected by screening, the increased life-years gained due to the detection of lung cancer at earlier more treatable stages of disease and better survival due to treatment. The prevalence (person-years) of lung cancer in Canada would increase by 50% by 2030 (72,760 to 109,000) if LDCT screening were implemented with an adjunct smoking cessation program compared to an increase of 31% if these interventions were not implemented (Table 7.5).

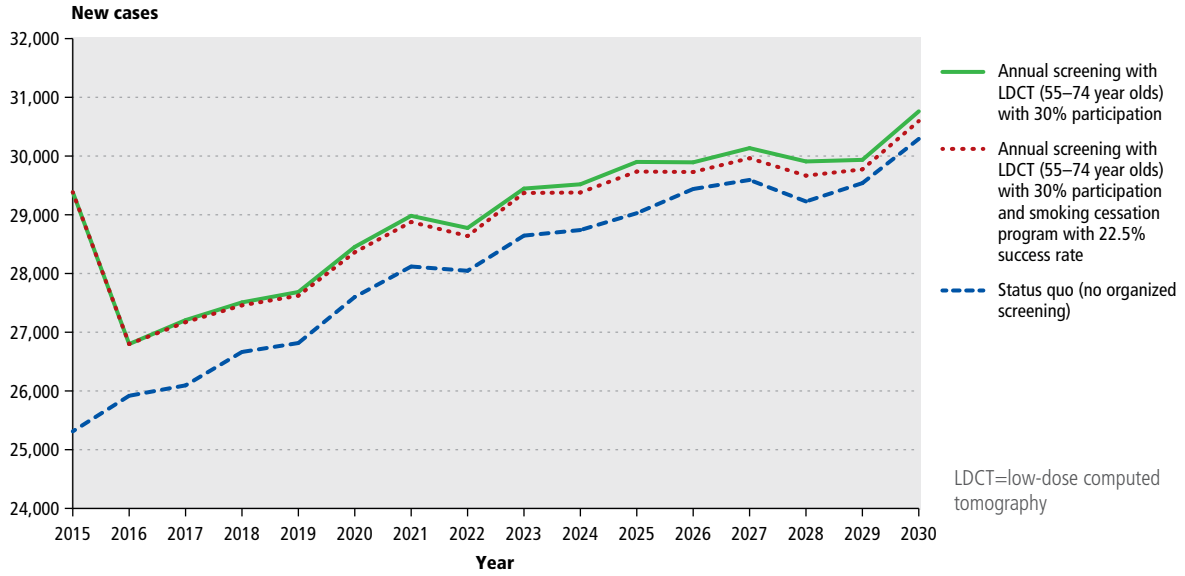
Costs

The CRMM projected the total cost of treatment, screening and smoking cessation programs under different scenarios in Canada (Table 7.5):

- $592 million in 2015 if there is no LDCT screening, rising to $829 million by 2030
- $930 million in 2015 if there is annual screening with LDCT for individuals 55–74 years (30% participation rate and adjunct smoking cessation), rising to $942 million by 2030

The incremental cost-effectiveness ratios (ICERs) for lung cancer screening were calculated to be $32,000 and $78,000 per health-related quality-adjusted life-year (QALY) for annual screening with and without smoking cessation, respectively. Both costs and QALYs were discounted at a rate of 3%.

FIGURE 7.9 Projected number of new cases of lung cancer under selected screening strategies, Canada, 2015–2030



Analysis by: Statistics Canada
Data source: Canadian Partnership Against Cancer, Cancer Risk Management Model version 2.2.1.0

View data

The influence of selected risk factors and interventions on the burden of cancer

Major modifiable cancer risk factors include smoking, body weight (i.e., being overweight or obese), physical inactivity, diet/nutrition, UV exposure, alcohol consumption, infections, medicinal drugs, occupational and environmental contaminants. The major categories of modifiable risks and their relation to various cancer types examined in this chapter are shown in Table 7.4. The proportion of new cancer cases attributed to each risk factor varies by cancer type. In addition to modifiable risks, non-modifiable risk factors, such genetic susceptibility to cancer, may account for part of the risk of developing cancer.

As shown in Table 7.4, most cancer types examined in this chapter have multiple and overlapping risk factors. While the prevalence of some of these risk factors has increased over time in the Canadian population, others have decreased. Given these trends, it is difficult to attribute a change in a cancer's ASIR to a single risk factor. Moreover, the role of current exposure to various risk factors on future rates of cancer is limited by the fact that exposures may change in the future.

Smoking

Smoking is an established risk factor for 18 different cancer types[9], including some of those listed in Table 7.4. The strongest association of smoking is with lung cancer. Lung cancer rates have been declining in males and stabilizing in females between 2001 and 2010. The trends reflect different periods when smoking began to decline in each sex (see discussion in *Chapter 1*). Considering the lag between a decline in smoking rates and subsequent declines in lung cancer incidence, it is likely that the lung cancer ASIR in females will begin to drop more noticeably over the longer term, as reflected by the projections up to 2032 (Figure 7.7).

In-depth: Projected impact of screening on colorectal cancer

Incidence

The CRMM projected that, in the absence of organized screening, the number of colorectal cancer cases is expected to increase due to the aging of the population from approximately 25,000 cases in 2015 to over 35,000 cases by 2030 (Figure 7.10). Screening detection and removal of polyps can reduce the number of new cases of colorectal cancer in the future. Screening can be undertaken using recommended tests in organized programs for average-risk individuals – the fecal immunochemical test (FIT) or guaiac fecal occult blood test (gFOBT). Colonoscopy is undertaken as a follow-up test to a positive FIT or gFOBT result in average-risk patients or as a primary screening test in high-risk individuals (e.g., those with a family or personal history of colorectal cancer). For the purpose of this analysis, the results for FIT are presented because most provinces are using the FIT for average-risk programmatic screening.

Mortality

Screening impacts the number of deaths from colorectal cancer by reducing incidence through detection and removal of polyps and from detection and treatment of cancers at earlier stages when they have a better prognosis. Between 2015 and 2030, a biennial FIT screening program with a participation rate of 30% could lead to 21,000 cumulative deaths averted compared to 40,000 cumulative deaths averted with a participation rate of 80%.

Prevalence

The CRMM projected a net increase in prevalence from 2015 to 2030 with FIT due to the detection of cancers at earlier stages and improved survival among patients.

Costs

The incremental cost of screening would range from an estimated $214 million to $369 million in 2015 and $277 million to $747 million in 2030 (undiscounted), depending on the participation rate of screening with biennial FIT (see Table below). However, the increased screening costs would be partially offset by treatment savings due to the avoidance of expensive treatments for advanced disease estimated at between $25 million and $30 million in 2015 and $228 million and $490 million in 2030.

Both screening strategies projected increased demand for colonoscopy resources to perform follow-up of positive FIT results and follow-up of persons identified as moderate or high-risk for cancer. This potential increase in resource requirements is an important consideration when implementing a FIT screening program.

For the scenario where the FIT participation rate is 30%, 1.6 million annual FIT screens are projected to result in an increase of 90,000 annual colonoscopies. With an 80% FIT participation rate, 3.8 million FIT screens would result in 210,000 additional colonoscopies per year.

	2015			2030		
($millions)	No organized screening	FIT 30%	FIT 80%	No screening	FIT 30%	FIT 80%
Cost of screening	$103	$317	$472	$177	$455	$925
Cost of treatment	$1,340	$1,315	$1,310	$2,256	$2,028	$1,766
Total cost	$1,443	$1,632	$1,782	$2,433	$2,483	$2,691

Note: Values are undiscounted.

Despite their much higher ASIR, the rate in males is expected to continue its decline, but at an increasingly slower rate of decline, up to 2028–2032, eventually nearing the much lower rate of females.

Reductions in smoking may also contribute to some degree to the expected reductions between 2003–2007 and 2028–2032 in male oral cancer, female esophageal cancer and cervical cancer, as well as larynx, stomach and bladder cancers in both sexes (Tables 7.1 and 7.2).

Sun and UV

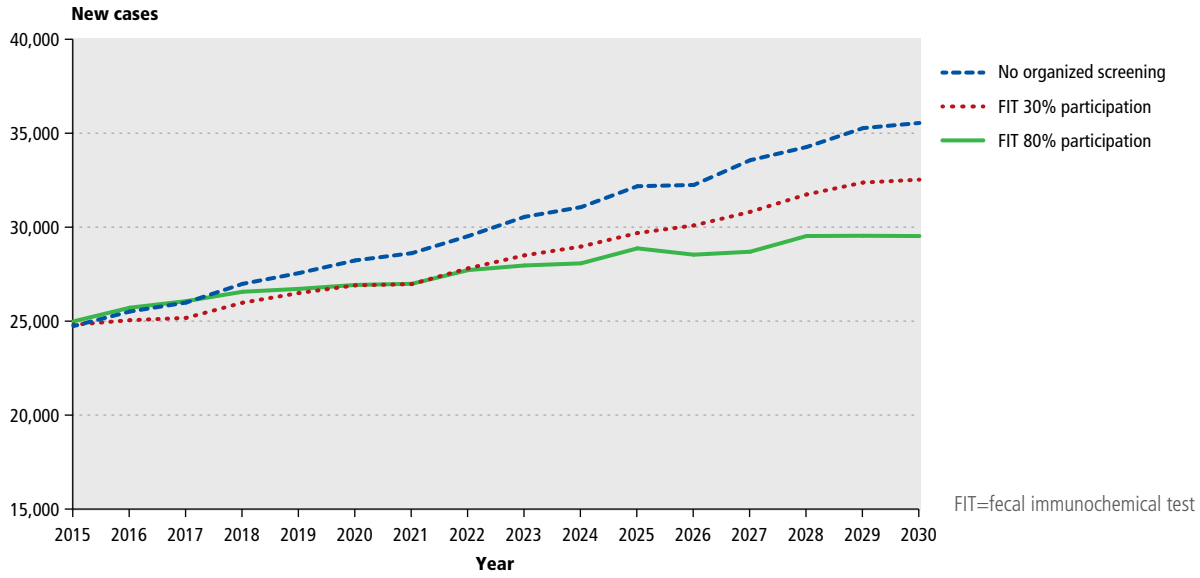
Melanoma is the least common but most deadly form of skin cancer. It is related to UV radiation, mainly from overexposure to the sun or from the use of indoor tanning equipment. About 90% of melanomas are due to sun exposure.[10]

Between 2003–2007 and 2028–2032, there is expected to be a 72% increase in the number of new melanoma cases (Tables 7.1 and 7.2).

The increase in melanoma incidence rates is projected to slow down in both sexes, and rates are expected to decrease after 10–15 years (Figure 7.7). This may be a result of the assumption that the risk of melanoma will continue to decrease in the more recent birth cohorts.

National trends are heavily influenced by provincial data. Therefore, projected melanoma rates in Canada are likely to be underestimated because of the current under-registration of this cancer in Quebec.[7]

FIGURE 7.10 Projected number of new cases of colorectal cancer under selected screening strategies and levels of participation, Canada, 2015–2030



FIT=fecal immunochemical test

Analysis by: Statistics Canada
Data source: Canadian Partnership Against Cancer, Cancer Risk Management Model version 2.2.1.0

View data

Other risk factors

Various other risk factors may account for the observed and expected trends in cancer incidence. Five such lifestyle factors are discussed in detail here – excess weight, physical inactivity, poor diet, alcohol and infections (Table 7.4).

The rising trend in excess weight among Canadians[11] may partly account for the positive trend in many cancers associated with weight. In 2013, 20.7% of youth (aged 12–17 years) were considered overweight or obese – a proportion that has changed little since 2005.[12] Among adults, 62.0% of males and 45.1% of females were considered overweight or obese in 2013.

A diet low in fibre, vegetables and fruit, and high in red or processed meat, as well as certain preservation methods for food (i.e., Chinese-style salted fish) are established risk factors for several cancers including colorectal, stomach and oral cavity. Diet also affects body weight as the foods people eat help them get to and stay at a healthy weight. For example, eating plenty of fibre can help maintain a healthy body weight.

In 2013, 40.8% of Canadians reported consuming vegetables and fruit five or more times per day, which is an amount considered to be beneficial for disease prevention.[12] Part of the ongoing and predicted decrease in stomach cancer is likely to be linked to changes in diet and food preservation methods.

Alcohol consumption is an established risk factor for cancers of the oral cavity (including pharynx), larynx, esophagus, female breast, colon, rectum and liver. Research suggests that more than 60% of alcohol-attributable cancers occur in the oral cavity, pharynx

and esophagus in males and about 60% of alcohol-attributable cancers occur in the breast in females.[13] It has also been shown that as the amount of alcohol consumed increases, the risk also increases in a dose-dependent manner for oral, pharynx, larynx, esophageal, breast and colorectal cancers. Alcohol consumption together with tobacco smoking increases the risk of head and neck cancers (i.e., cancers of the oral cavity, pharynx and larynx) more than either risk factor alone.

According to the 2012 Canadian Alcohol and Drug Use Monitoring Survey, 78.4% of Canadians reported drinking alcohol in the past year, with more males than females reporting drinking (82.7% versus 74.4% respectively).[14] A survey of Canadians' perceptions of the health impacts of alcohol consumption shows that 67% of respondents were not aware that drinking alcohol is associated with an elevated risk of cancer.[15] Canada's Low-Risk Alcohol Drinking Guidelines[16,17] may also confuse Canadians because they are different from the drinking guidelines for cancer prevention. It is estimated that restricting alcohol drinking to no more than 2 drinks a day for males and 1 drink a day for females could avoid about 90% of cancers attributable to alcohol in males and over 50% in females.[18]

Bacterial and viral infections are established risk factors for several cancer types, most notably, the cervix and parts of the oral cavity and pharynx (caused by the human papillomavirus (HPV)), stomach (caused by *Helicobacter pylori (H.pylori)*), liver (caused by the hepatitis B (HBV) and C (HCV) viruses), and lymphomas (caused by Epstein-Barr virus, Human immunodeficiency virus (HIV), and Human T-cell lymphotropic virus (HTLV-1)).

In-depth: Projected impact of screening and HPV vaccination on cervical cancer

Incidence

According to the CRMM, it is anticipated that there will be an increasing upward trend in the number of new cervical cancer cases over time with the aging population. Despite the status quo of cytology testing 21–69 year olds every 3 years and 70% participation of 12 year-old girls in HPV vaccination programs, newly diagnosed cervical cancers are expected to increase from about 1,500 cases in 2015 to approximately 2,200 cases in 2030. As vaccinated cohorts become eligible for screening, different screening protocols may be considered that incorporate HPV DNA testing. By 2030, screening all women with a triennial cytology and one-time HPV DNA test at age 30 or screening unvaccinated women with a triennial cytology test and vaccinated women with an HPV DNA test every 10 years would result in similar health outcomes as compared to the status quo.

Mortality

Over time, cervical cancer deaths are projected to increase with the status quo due to the aging population. Regardless of the screening protocol assessed in this comparison, cervical cancer deaths are projected to increase from approximately 430 deaths in 2015 to 620 deaths in 2030.

Prevalence

Prevalence is measured as the sum of person-years alive for those who have ever been diagnosed with cervical cancer. Prevalence could increase if more cancers were detected by aggressive screening and/or screening with improved accuracy. Prevalence might also decline over time from the prevention of HPV infections through vaccination programs or if precancerous lesions were treated before progressing to cancer. With time, the increase in cervical cancer prevalence would slow down as the proportion of vaccinated females in the population becomes more prevalent regardless of screening strategy.

Costs

If screening programs implement a one-time HPV DNA test that is not tailored to vaccination status (i.e., all women screened with cytology testing receive a one-time HPV DNA test), the cost of screening is expected to increase, on average, by $35 million annually. However, if screening were to be tailored to individuals' vaccination status such that the vaccinated women were screened with an HPV DNA test every 10 years and unvaccinated women were screened with cytology testing every three years, the total cost of screening and treatment would be reduced by $33 million annually on average (undiscounted).

The tailored screening program (cytology for unvaccinated + HPV DNA for vaccinated) would generate a net saving in total healthcare costs as early as 2015 (Figure 7.11). As more and more females are vaccinated over time, the cost savings for the tailored screening program would continue to increase. By contrast, the untailored program would still be more costly than the status quo strategy in 2030.

The projected rising trend in liver cancer incidence in Canada may be linked to the ongoing increase and continued high incidence of hepatitis C virus infection,[19] the aging of the population previously infected and increasing immigration from areas where the prevalence of chronic hepatitis B infection and aflatoxin exposure are high.[20,21] The persisting decrease in incidence of stomach cancer may be partly explained by increased recognition and treatment of infection with *H. pylori*.[22,23]

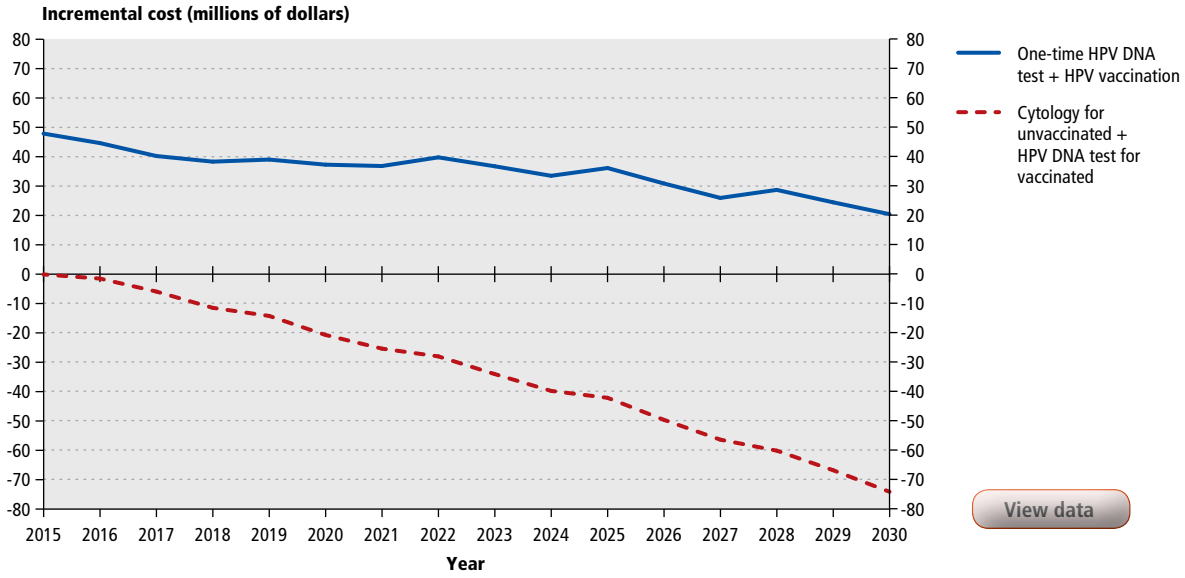
The expected downward trend in the cervical cancer ASIR continues the past trend and can be attributed to screening with the Papanicolaou (Pap) test and its successful identification and treatment of precancerous lesions. This downward trend in ASIR is expected to be sustained as the impact of HPV vaccination is realized over the coming years.[24] Potential reductions in the ASIR for cancers in other areas of the body such as the anus and oropharynx may also occur.

Comparisons of projections to other countries

The impending future impact of cancer has been described in many countries with regard to incidence,[25,26] deaths,[27] prevalence[28] and costs of care.[29] Using a constant-rate projection method, increases in cancer cases of 75% and 54% among males and females, respectively, from 2008 to 2030 have been projected in the very high human-development-index regions, including Canada.[30] In this and other studies described below, there is a consistent attribution of demographic changes to the expected rise in cancer incidence.

One study projected cancer incidence in the United Kingdom (UK) for 2008–2030 based on 1975–2007 data and using a method similar to the Nordpred approach.[31] As in Canada, almost no change is projected in the ASIR of all cancers combined to 2030 in the UK, although the number of new cases are expected to rise 55% for males and 35% for females compared to 2007. The projected change in the ASIR will differ by cancer type. Among the major cancer types, the ASIR for colorectal cancer is projected to decrease 6% for both sexes in Canada, whereas the rates in the UK are expected to decrease by a similar amount in males but increase by 2% in females. For lung cancer, the ASIR is projected to decrease by 34% in males and 16% in females in Canada, compared with a predicted decrease of 8% in males and increase of 7% in females in the UK. Breast cancer incidence rate among females is not predicted to change substantially in both countries. In both sexes in the UK, oral cancer and melanoma are expected to increase. In the UK, it has been estimated that 40% of total cancer risk is attributed to five lifestyle factors – tobacco, diet, excess weight, alcohol and physical inactivity.[32]

FIGURE 7.11 Projected incremental (relative to status quo screening with vaccination) total healthcare costs (vaccination, screening, pre-cancer and cancer treatment) by year, Canada, 2015–2030



Analysis by: Statistics Canada
Data source: Canadian Partnership Against Cancer, Cancer Risk Management Model version 2.2.1.0

In Switzerland, researchers used Nordpred to estimate a 30% increase in new cases in males and 20% increase in females over the period 2005–2009 to 2015–2019.[33] But similar to the findings in Canada, the study predicted that population size and structure will be responsible for most of the observed increase and the amount of change in the future will differ by cancer type. The largest increases are expected in males for melanoma, thyroid, NHL and prostate cancers and in females for lung, oral, thyroid, and NHL, reflecting some of the findings in Canada.

In Ireland, new cancer cases are projected to increase between 2010 to 2040 by 107% for males and 84% for females.[34] The greatest increases are expected for skin (both melanoma and NMSC) and cancers of the upper gastrointestinal tract such as esophagus and pancreas.

In Australia, the ASIR for liver, thyroid, melanoma, testis and female lung is expected to increase the most by 2020,[35] reflecting the situation in Canada. In addition, as in Canada, ASIR for stomach cancer and several smoking-related cancers, in particular bladder and male lung, is expected to decline.

What do these statistics mean?

Comparing long-term cancer projections with current rates provides a useful benchmark for evaluating existing preventive and treatment interventions. Future predictions are also important for future healthcare planning including staff training and recruitment, resource allocation and developing infrastructure. It helps health planners and policy-makers anticipate the resources needed to screen, diagnose and treat newly diagnosed cancer patients, provide palliative and end-of-life services and provide ongoing care to cancer survivors.

Long-term cancer incidence projections inherently carry some uncertainty. The reliability of projections depends on the accuracy of the population forecasts. The predicted populations were based on the assumptions on rates of fertility, mortality, interprovincial and international migration, among others.[36] Assumptions are also required for the extrapolation from current cancer trends – specifically, that past trends will continue into the future. Although this assumption seems reasonable based on historical data, it is likely that increasing focus on lifetime cancer prevention, especially reducing risk factors while promoting protective behaviours and secondary prevention through screening and early detection, will exert an influence on future incidence rates of modifiable cancers. Prevention is expected to have differential impacts on various cancer types. For those cancer types with organized screening programs, for example, the decline in future cancer cases is likely to be bolstered by enhancing screening opportunities today.

However, soon after screening is established, changes in cancer rates can occur quite quickly and projections for cancers potentially affected by screening need to be interpreted cautiously. For example, the effect of colorectal cancer screening is only partly captured in the projected trend for this cancer because screening programs have only recently been implemented across Canada and continue to ramp up. Similarly, if organized lung cancer screening for high-risk smokers is adopted in provinces, the effects of screening will not be reflected in the estimates for lung cancer shown in the current analysis. Other future influences on cancer rates include potential changes in testing, such as HPV DNA testing for cervical cancer screening. The expansion of such screening programs may bring some transient increases in cancer incidence.

An increased uptake in the use of more sensitive diagnostic tests can also increase the potential for diagnosing cancers that might have otherwise remained undetected throughout an individual's life in the absence of these tests. This contributes to an increase in cancer rates that is difficult to separate from the increase brought on by the cancer's true risk factors. Therefore, for some cancers, a recently increasing trend may be a combination of both recent changes in diagnostic technology and true risk and might not be expected to continue to increase along the same trend in the future. Thyroid cancer incidence has increased dramatically in recent years and is one such cancer where the rise is believed to be partly due to changes in diagnostic technology. For this cancer, it is challenging to predict whether the recent increases in risk will continue throughout the entire projection period. However, recent trends have shown a sustained increase.

Based on this analysis, the projected aging and growth of the population is expected to cause a progressive and significant increase in the total number of new cases of cancer in Canada over the next 15 years. The analysis indicates the average annual number of new cancer cases in Canada is predicted to increase overall by 79% (84% in males and 74% in females) from 2003–07 to 2028–32. The changes in the size and age structure of the population constitute a large component of the projected increase in new cancer cases.

Historical and ongoing declines in smoking have resulted in significant reductions in the lung cancer incidence and mortality rates in males (see *Chapters 1* and *3*), which have also substantially contributed to the avoided deaths from all cancers combined (see *Introduction*). These efforts have been significant, and it is important to reflect that the expected cancer burden in 2030 would have been far more significant had these efforts to reduce the rates of smoking-related cancers not been so successful.

The incidence rates are projected to decrease for many cancers associated with other lifestyle risk factors,

while the rates are estimated to increase for thyroid, liver, uterus, pancreas and kidney cancers. These increases may be driven by changes in the prevalence of or exposure to risk factors and/or changes in diagnostic practices. As such, prevention efforts to reduce known modifiable risk factors for these cancers must continue where possible. Furthermore, additional etiological research is needed to better understand the reason for these changes in order to help guide risk reduction efforts.

Smoking, sun/UV overexposure, excess weight, physical inactivity, poor diet, alcohol consumption and infections continue to be important cancer prevention targets for the purpose of reducing incidence and disease-related costs. Research suggests that the annual economic burden of tobacco smoking, excess weight and physical inactivity in Canada were $50.3 billion in 2012 ($15.3 billion in direct and $34.9 billion in indirect costs).[37] If there are no changes in the prevalence of these risk factors, then by 2031 the cost is predicted to increase to $59.2 billion. The projected burden of cancer also has implications for secondary prevention. Risk reduction could be further strengthened when combined with improved uptake of population-based cancer screening through organized programs. If the numbers of cancers diagnosed in our population are to increase so dramatically, an important goal should be to detect them at their earliest possible stage. This will reduce the mortality risk associated with these diagnoses and permit them to be treated at a more cost-effective stage.

The growing number of new cancer cases from an aging Canadian population is expected to contribute to more cancer survivors if survival rates also continue to improve, as would be expected with advances in early detection and treatment. Future analyses would benefit from estimates of the long-term prevalence of cancer, as has been undertaken in other countries.[28] The growing number of cases and prevalence of cancer survivors will have an increasingly important impact on the demand for healthcare services and management of follow-up care, as patients survive longer. Cancer diagnosis, treatment and follow-up is multidisciplinary, complex and requires significant numbers of medical specialists. Thus in addition to planning for infrastructure to treat cancer (such as cancer centres and equipment within them), it is necessary to anticipate the demand for medical specialists trained in managing cancer.[38]

Additionally, analyses and projections of the costs associated with the increasing cancer burden can help guide healthcare planners to devise appropriate strategies for allocating limited resources appropriately.[25] Recent studies[39,40] have suggested that costs of treating cancer are increasing and that for some cancers, these increases are quite significant. A recent study using data from the province of Ontario[39] demonstrated rising costs for several common cancers and suggests that the determinants of these increasing trends are multi-faceted. Rising costs were attributed to both the utilization and costs of providing major types of cancer treatments, but also to how services such as post-treatment home care are utilized.

Together, these results suggest that the expected effect of future changes in Canada's demographic profile and cancer trends should be addressed from multidisciplinary perspectives, embracing prevention and early detection, research and surveillance, treatment and psychosocial, palliative and medical care. The findings also emphasize the need to strengthen cancer control strategies, leverage resources to better meet future healthcare needs and evaluate existing interventions.

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Disclaimer

Some analyses in this chapter are based on the Canadian Partnership Against Cancer's Cancer Risk Management Model. The Cancer Risk Management Model was made possible by a financial contribution from Health Canada, through the Canadian Partnership Against Cancer. The assumptions and calculations underlying the simulation results were not prepared by the Canadian Partnership Against Cancer and the Partnership is not responsible for the use and interpretation of these data.

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TABLE 7.1 Changes in average annual new cases and age-standardized incidence rates (ASIRs) for cancers in males, Canada, 2003–07 to 2028–32

	Average annual new cases			ASIR (per 100,000)		
	2003–07	2028–32	Change (%)	2003–07	2028–32	Change (%)
All cancers	**80,810**	**148,370**	**83.6**	**464.8**	**443.2**	**-4.6**
Oral	2,285	3,595	57.5	12.6	11.8	-6.0
Esophagus	1,095	2,110	92.7	6.2	6.2	0.6
Stomach	1,925	2,680	39.1	11.1	7.7	-30.0
Colorectal	10,620	19,815	86.6	60.8	57.0	-6.3
Liver	1,025	2,845	177.8	5.7	8.2	43.3
Pancreas	1,810	3,635	100.7	10.3	10.5	1.4
Larynx	900	900	0.0	5.1	2.7	-47.5
Lung	12,245	16,420	34.1	70.7	46.4	-34.4
Melanoma	2,320	4,065	75.4	13.1	12.4	-5.8
Prostate	21,460	42,225	96.8	123.3	123.3	0.1
Testis	825	1,070	29.7	5.6	6.0	8.5
Kidney	2,580	5,020	94.7	14.4	15.5	7.4
Bladder	4,815	8,825	83.4	27.9	24.0	-13.9
Brain/CNS	1,365	1,965	43.8	7.9	7.1	-10.4
Thyroid	795	1,895	138.8	4.5	7.0	54.5
Hodgkin lymphoma	490	615	26.6	3.1	3.0	-3.4
Non-Hodgkin lymphoma	3,455	6,050	75.0	19.7	18.1	-8.3
Multiple myeloma	1,065	2,395	125.1	6.1	6.8	11.3
Leukemia	2,570	5,095	98.3	15.1	15.8	4.5
All other cancers	7,005	13,390	91.1	40.7	38.7	-5.1

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry and National Cancer Incidence Reporting System databases at Statistics Canada

CNS=central nervous system

Note: Counts are rounded to the nearest 5. ASIR and percentage change for counts and ASIR are calculated before rounding. Rates are age-standardized to the 1991 Canadian population.

TABLE 7.2 Changes in average annual new cases and age-standardized incidence rates (ASIRs) for cancers in females, Canada, 2003–07 to 2028–32

	Average annual new cases			ASIR (per 100,000)		
	2003–07	2028–32	Change (%)	2003–07	2028–32	Change (%)
All cancers	**74,165**	**128,830**	**73.7**	**358.3**	**371.0**	**3.6**
Oral	1,085	1,760	62.4	5.2	5.3	1.6
Esophagus	385	690	79.5	1.7	1.7	-2.3
Stomach	1,080	1,425	31.6	4.9	3.7	-23.7
Colorectal	9,010	15,260	69.4	41.0	38.6	-6.1
Liver	350	760	116.6	1.6	1.9	15.1
Pancreas	1,900	3,730	96.2	8.5	9.1	7.1
Larynx	195	145	-25.9	1.0	0.4	-58.8
Lung	9,865	15,945	61.6	47.1	39.6	-15.9
Melanoma	2,055	3,465	68.7	10.7	11.2	4.6
Breast	20,110	31,255	55.4	97.9	98.7	0.7
Cervix	1,345	1,435	6.8	7.6	6.1	-20.2
Body of uterus	4,105	7,700	87.6	19.9	23.1	16.2
Ovary	2,385	3,650	53.1	11.6	11.1	-4.0
Kidney	1,665	3,070	84.4	8.0	8.6	6.8
Bladder	1,705	3,030	78.0	7.7	7.3	-6.1
Brain/CNS	1,055	1,470	39.1	5.6	5.2	-7.6
Thyroid	2,810	6,910	145.9	16.1	26.5	64.8
Hodgkin lymphoma	395	500	26.3	2.5	2.3	-6.8
Non-Hodgkin lymphoma	2,915	5,180	77.7	14.1	14.3	1.4
Multiple myeloma	875	1,685	92.2	4.0	4.2	4.0
Leukemia	1,875	3,520	87.6	9.2	9.8	6.9
All other cancers	6,995	13,405	91.6	32.3	34.6	7.0

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry and National Cancer Incidence Reporting System databases at Statistics Canada

CNS=central nervous system

Note: Counts are rounded to the nearest 5. ASIR and percentage change for counts and ASIR are calculated before rounding. Rates are age-standardized to the 1991 Canadian population.

TABLE 7.3 Changes in average annual new cases for cancers in both sexes, by province/territory, 2003–07 to 2028–32

Cancer type	British Columbia			Alberta			Saskatchewan		
	Average annual new cases			Average annual new cases			Average annual new cases		
	2003–07	2028–32	Change (%)	2003–07	2028–32	Change (%)	2003–07	2028–32	Change (%)
All cancers	**19,380**	**33,630**	**73.5**	**13,425**	**28,140**	**109.7**	**4,955**	**7,450**	**50.3**
Oral	420	655	55.5	275	480	76.1	95	95	1.5
Esophagus	225	450	102.9	130	350	167.8	40	70	66.2
Stomach	360	535	48.2	245	360	47.9	85	85	-0.7
Colorectal	2,410	4,625	92.0	1,555	3,590	130.7	665	1,120	68.8
Liver	215	580	170.2	130	405	205.9	25	50	83.7
Pancreas	495	985	98.7	335	740	120.3	130	225	75.1
Larynx	110	150	37.7	65	105	54.9	30	40	42.6
Lung	2,660	4,140	55.6	1,675	3,155	88.3	670	850	26.9
Melanoma	695	1,270	83.1	430	675	56.4	115	160	37.6
Breast	2,555	4,405	72.4	1,770	3,035	71.3	615	825	34.8
Cervix	155	150	-4.1	150	185	23.6	40	50	21.4
Body of uterus	520	1,080	107.7	380	720	89.6	130	200	54.7
Ovary	285	415	44.7	175	300	68.6	75	90	23.2
Prostate	2,860	5,580	95.0	2,055	3,865	88.2	850	1,400	64.8
Testis	105	175	65.3	100	125	22.7	25	25	1.4
Kidney	410	695	69.8	395	800	103.5	140	215	53.9
Bladder	915	1,605	75.2	590	1,325	125.2	215	380	73.9
Brain/CNS	280	395	41.0	205	340	67.7	70	90	30.4
Thyroid	250	455	82.8	335	755	124.3	60	85	43.2
Hodgkin lymphoma	95	125	27.0	90	140	56.3	25	30	8.4
Non-Hodgkin lymphoma	855	1,520	77.7	555	1,090	97.1	205	320	54.1
Multiple myeloma	215	455	110.8	165	380	131.5	60	100	70.1
Leukemia	560	1,140	103.7	425	910	114.7	170	240	42.7
All other cancers	1,710	3,230	88.7	1,180	2,615	121.9	425	640	50.3

CNS=central nervous system

Note: New cases are rounded to the nearest 5. Percentage change was calculated before rounding. "Territories combined" refers to Yukon, Northwest Territories and Nunavut.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry and National Cancer Incidence Reporting System databases at Statistics Canada

TABLE 7.3 Changes in average annual new cases for cancers in both sexes, by province/territory, 2003–07 to 2028–32 *(continued)*

Cancer type	Manitoba			Ontario			Quebec		
	Average annual new cases			Average annual new cases			Average annual new cases		
	2003–07	2028–32	Change (%)	2003–07	2028–32	Change (%)	2003–07	2028–32	Change (%)
All cancers	**5,540**	**8,255**	**49.1**	**58,810**	**110,945**	**88.6**	**39,905**	**65,995**	**65.4**
Oral	140	190	35.3	1,330	2,250	69.0	830	1,310	57.8
Esophagus	50	80	62.1	570	1,060	86.6	335	615	84.5
Stomach	120	155	31.5	1,105	1,635	48.4	815	935	14.8
Colorectal	740	1,235	66.5	7,235	13,290	83.7	5,185	8,470	63.4
Liver	45	115	148.7	505	1,395	174.8	385	870	127.7
Pancreas	135	220	61.1	1,245	2,460	97.3	1,075	1,865	73.4
Larynx	30	30	-3.5	390	460	17.3	375	305	-18.3
Lung	810	1,110	37.4	7,390	10,810	46.3	6,955	9,870	41.9
Melanoma	125	155	23.4	2,015	3,650	81.0	560	745	32.9
Breast	730	1,000	37.5	7,705	12,730	65.2	5,175	7,095	37.1
Cervix	45	45	-6.0	530	610	15.3	300	300	0.0
Body of uterus	175	285	63.4	1,620	3,295	103.4	980	1,560	59.3
Ovary	90	115	23.1	980	1,665	69.6	615	730	19.0
Prostate	665	1,010	51.6	8,875	19,085	115.1	4,225	7,855	85.9
Testis	30	40	35.2	325	450	37.9	175	240	35.1
Kidney	185	300	60.5	1,510	3,120	106.9	1,175	2,115	79.9
Bladder	245	445	82.4	1,830	3,370	84.2	2,135	4,205	96.7
Brain/CNS	70	100	37.9	940	1,325	40.6	665	945	41.7
Thyroid	80	150	84.9	1,840	5,015	172.8	795	2,000	152.0
Hodgkin lymphoma	30	45	36.6	355	510	44.9	220	265	18.3
Non-Hodgkin lymphoma	245	370	50.6	2,500	4,435	77.4	1,505	2,480	64.7
Multiple myeloma	65	110	68.0	795	1,705	114.1	500	1,005	100.2
Leukemia	170	270	58.5	1,780	3,770	112.0	1,055	1,830	72.9
All other cancers	500	715	43.3	5,375	11,530	114.6	3,830	7,025	83.4

CNS=central nervous system

Note: New cases are rounded to the nearest 5. Percentage change was calculated before rounding. "Territories combined" refers to Yukon, Northwest Territories and Nunavut.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry and National Cancer Incidence Reporting System databases at Statistics Canada

TABLE 7.3 Changes in average annual new cases for cancers in both sexes, by province/territory, 2003–07 to 2028–32 *(continued)*

Cancer type	New Brunswick			Nova Scotia			Prince Edward Island		
	Average annual new cases			Average annual new cases			Average annual new cases		
	2003–07	2028–32	Change (%)	2003–07	2028–32	Change (%)	2003–07	2028–32	Change (%)
All cancers	**4,100**	**6,970**	**69.9**	**5,430**	**8,560**	**57.6**	**785**	**1,340**	**71.1**
Oral	80	115	41.3	110	180	61.8	15	25	69.4
Esophagus	40	75	81.9	60	100	67.9	5	10	68.6
Stomach	85	90	6.2	95	105	10.3	10	20	61.0
Colorectal	495	875	77.6	755	1,260	67.3	100	175	74.0
Liver	20	40	96.5	30	60	109.6	5	10	169.2
Pancreas	115	225	96.3	130	195	50.2	20	35	87.0
Larynx	30	30	1.2	35	40	6.5	5	10	51.6
Lung	665	960	44.8	830	1,085	30.8	110	140	25.3
Melanoma	125	210	68.0	200	335	65.4	30	40	38.3
Breast	490	700	42.8	645	910	41.3	90	155	72.9
Cervix	35	35	-0.5	50	50	-6.0	10	10	0.9
Body of uterus	95	140	50.4	125	190	53.4	20	30	61.5
Ovary	65	100	62.0	65	105	65.1	10	10	46.8
Prostate	645	1,230	91.2	790	1,465	84.9	135	260	88.0
Testis	15	20	17.1	25	40	39.3	5	5	25.3
Kidney	145	290	101.1	185	335	82.5	25	45	91.4
Bladder	190	355	86.1	245	450	84.4	35	45	41.1
Brain/CNS	65	75	19.6	75	105	42.9	10	15	41.8
Thyroid	100	290	196.0	90	175	91.8	10	15	78.3
Hodgkin lymphoma	20	25	17.7	30	35	22.7	0	5	31.0
Non-Hodgkin lymphoma	170	275	62.9	210	350	68.1	30	50	67.9
Multiple myeloma	50	90	78.3	55	100	82.3	10	25	97.5
Leukemia	95	180	92.5	130	205	58.9	25	35	48.8
All other cancers	270	465	73.5	455	715	57.0	65	140	114.3

CNS=central nervous system

Note: New cases are rounded to the nearest 5. Percentage change was calculated before rounding. "Territories combined" refers to Yukon, Northwest Territories and Nunavut.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry and National Cancer Incidence Reporting System databases at Statistics Canada

TABLE 7.3 Changes in average annual new cases for cancers in both sexes, by province/territory, 2003–07 to 2028–32 *(continued)*

Cancer type	Newfoundland and Labrador			Territories combined		
	Average annual new cases			Average annual new cases		
	2003–07	2028–32	Change (%)	2003–07	2028–32	Change (%)
All cancers	**2,370**	**4,040**	**70.3**	**270**	**625**	**131.5**
Oral	55	70	30.7	10	20	84.0
Esophagus	20	45	103.7	5	5	163.7
Stomach	80	75	-9.2	5	20	142.3
Colorectal	445	890	99.1	50	135	180.9
Liver	10	30	145.4	0	0	70.6
Pancreas	30	95	208.3	5	10	148.6
Larynx	20	25	17.6	0	0	69.7
Lung	300	495	64.7	50	85	80.6
Melanoma	65	100	52.6	5	10	49.1
Breast	300	470	56.9	40	75	100.8
Cervix	25	15	-36.9	5	5	0.2
Body of uterus	60	100	59.3	5	15	137.1
Ovary	25	30	40.7	0	5	19.3
Prostate	335	585	75.0	25	75	172.1
Testis	10	10	-1.0	0	0	10.8
Kidney	75	120	66.1	5	10	122.4
Bladder	105	195	81.6	5	15	124.3
Brain/CNS	40	50	26.0	5	5	35.2
Thyroid	45	80	76.0	5	10	119.4
Hodgkin lymphoma	10	10	3.1	0	0	28.1
Non-Hodgkin lymphoma	85	140	63.8	10	25	160.5
Multiple myeloma	20	35	71.0	0	5	252.6
Leukemia	35	45	44.3	10	15	109.7
All other cancers	170	305	77.4	20	45	136.7

CNS=central nervous system

Note: New cases are rounded to the nearest 5. Percentage change was calculated before rounding. "Territories combined" refers to Yukon, Northwest Territories and Nunavut.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry and National Cancer Incidence Reporting System databases at Statistics Canada

TABLE 7.4 Modifiable risk factors associated with selected cancer types

Cancer type	Risk factor								
	Smoking	Overweight / obesity	Physical inactivity	Poor diet	Sun overexposure / indoor tanning	Alcohol consumption	Infections (viruses and bacteria)	Pharmaceuticals	Occupational / environmental exposures (non-solar)
Bladder	■								■
Body of uterus		■	■					■	
Breast		■	■			■		■	■
Brain/CNS									■
Cervix	■						■	■	
Colorectal	■	■	■	■		■			■
Esophagus	■	■		■		■			■
Hodgkin lymphoma							■		
Kidney	■	■							■
Larynx	■					■			■
Leukemia	■							■	■
Liver	■	■				■	■	■	■
Lung	■								■
Melanoma					■				■
Multiple myeloma									
Non-Hodgkin lymphoma							■		
Oral	■			■		■	■		■
Ovary	■	■						■	■
Pancreas	■	■							
Prostate		■							
Stomach	■			■			■		
Testis									
Thyroid									■

CNS=central nervous system

Note: Only cancer types with an established association with a risk factor are listed, based on assessments by World Cancer Research Fund/American Institute for Cancer Research and its Continuous Update Project (2007–2015) and International Agency for Cancer Research (volumes 1 to 111).

TABLE 7.5 Projections for selected measures for lung cancer for status quo (no organized screening) versus 30% participation to LDCT screening and 22.5% smoking cessation success rate, by province/territory, Canada, 2015 and 2030

	New cases				Deaths from lung cancer			
	No organized screening		LDCT+smoking cessation		No organized screening		LDCT+smoking cessation	
	2015	2030	2015	2030	2015	2030	2015	2030
CANADA	**25,312**	**30,292**	**29,386**	**30,596**	**20,679**	**24,603**	**20,646**	**24,272**
British Columbia	3,064	3,820	3,458	3,820	2,435	3,099	2,430	3,054
Alberta	2,285	2,927	2,622	2,954	1,834	2,368	1,839	2,345
Saskatchewan	793	988	923	1,018	574	751	571	783
Manitoba	946	1,128	1,058	1,163	806	838	803	823
Ontario	8,812	10,614	10,197	10,721	7,021	8,680	7,009	8,456
Quebec	6,954	7,959	8,241	8,064	5,898	6,604	5,896	6,529
New Brunswick	846	1,005	998	1,008	709	791	706	813
Nova Scotia	996	1,180	1,178	1,188	866	933	858	916
Prince Edward Island	102	130	117	127	100	102	97	107
Newfoundland and Labrador	479	509	556	497	407	419	407	427
Yukon	12	12	12	15	12	10	12	10
Northwest Territories and Nunavut	22	20	25	22	17	7	17	7

	Prevalence (person-years)				Total costs of screening, treatment and adjunct smoking cessation program (in millions)			
	No organized screening		LDCT+smoking cessation		No organized screening		LDCT+smoking cessation	
	2015	2030	2015	2030	2015	2030	2015	2030
CANADA	**70,608**	**92,379**	**72,759**	**109,092**	**591.6**	**828.9**	**929.9**	**941.7**
British Columbia	8,535	11,407	8,749	13,172	70.5	104.5	110.6	116.9
Alberta	5,822	8,343	5,985	9,790	52.2	80.5	83.3	90.3
Saskatchewan	1,957	2,843	2,020	3,368	17.7	26.2	28.9	30.2
Manitoba	2,652	3,618	2,718	4,227	21.9	29.7	32.3	33.5
Ontario	24,851	32,537	25,587	38,218	204.5	292.9	325.0	335.8
Quebec	19,749	24,497	20,431	29,429	166.4	217.8	260.1	246.4
New Brunswick	2,494	3,383	2,570	4,021	19.8	27.7	29.7	31.9
Nova Scotia	2,938	3,661	3,036	4,312	24.2	31.6	36.4	35.7
Prince Edward Island	262	328	274	375	2.4	3.4	4.1	4.0
Newfoundland and Labrador	1,263	1,651	1,301	2,057	11.1	13.6	18.0	15.8
Yukon	48	51	48	55	0.3	0.4	0.6	0.6
Northwest Territories and Nunavut	38	60	40	68	0.4	0.4	0.9	0.6

LDCT=low-dose computed tomography

Note: LDCT screening eligible population is 55–74 year olds, 30 pack-year smokers (current smokers or former smokers who have quit within past 15 years); costs are undiscounted.

Analysis by: Statistics Canada
Data source: Canadian Partnership Against Cancer, Cancer Risk Management Model version 2.2.1.0

TABLE 7.6 Projections for selected measures for various screening scenarios for colorectal cancer, by province/territory, Canada, 2015 and 2030

	New cases						Deaths from colorectal cancer					
	2015			2030			2015			2030		
	No organized screening	30% FIT	80% FIT	No organized screening	30% FIT	80% FIT	No organized screening	30% FIT	80% FIT	No organized screening	30% FIT	80% FIT
CANADA	**24,810**	**24,883**	**25,070**	**35,619**	**32,602**	**29,611**	**9,563**	**9,124**	**8,822**	**14,401**	**12,513**	**10,065**
British Columbia	2,927	2,974	2,942	4,536	4,149	3,845	1,245	1,150	1,143	1,856	1,627	1,297
Alberta	2,011	2,028	2,003	3,283	3,044	2,690	771	746	716	1,255	1,120	921
Saskatchewan	773	791	771	1,068	1,015	891	312	294	304	434	382	332
Manitoba	926	936	918	1,205	1,100	971	327	319	294	544	484	364
Ontario	9,286	9,222	9,476	13,378	12,261	11,148	3,515	3,391	3,266	5,502	4,718	3,830
Quebec	6,532	6,557	6,544	8,925	8,026	7,395	2,455	2,335	2,290	3,416	2,982	2,353
New Brunswick	584	609	634	928	861	741	252	222	185	389	344	287
Nova Scotia	963	966	963	1,215	1,115	998	377	362	352	571	489	389
Prince Edward Island	137	140	142	220	205	177	57	55	50	100	80	62
Newfoundland and Labrador	594	589	606	791	758	691	232	232	205	317	272	215
Yukon	22	22	25	30	32	30	2	0	0	7	5	5
Northwest Territories and Nunavut	55	50	45	40	35	35	17	17	17	10	10	10

	Total costs of screening and treatment (in millions)					
	2015			2030		
	No organized screening	30% FIT	80% FIT	No organized screening	30% FIT	80% FIT
CANADA	**1,442.8**	**1,632.0**	**1,782.2**	**2,433.0**	**2,482.2**	**2,691.0**
British Columbia	177.3	203.9	224.0	309.4	321.8	356.0
Alberta	121.0	138.7	152.7	219.8	228.5	251.1
Saskatchewan	44.8	51.2	54.7	71.6	73.1	78.9
Manitoba	52.6	59.5	63.8	81.5	83.8	90.3
Ontario	528.7	600.5	664.9	918.2	945.1	1,032.7
Quebec	379.9	423.7	456.5	617.5	612.0	654.9
New Brunswick	34.7	39.8	44.5	61.2	62.4	64.4
Nova Scotia	55.5	61.3	65.0	81.3	81.1	87.1
Prince Edward Island	8.5	9.6	10.4	14.8	14.6	14.6
Newfoundland and Labrador	36.3	39.8	41.4	53.3	55.0	55.6
Yukon	0.8	1.0	1.2	2.2	2.5	2.8
Northwest Territories and Nunavut	2.9	3.0	3.1	2.1	2.2	2.6

FIT=fecal immunochemical test

Note: Screening eligible population is 50–74 year olds; costs are discounted at 3%.

Analysis by: Statistics Canada
Data source: Canadian Partnership Against Cancer, Cancer Risk Management Model version 2.2.1.0

APPENDIX I: Actual data for new cases and deaths

TABLE A1 Actual data for new cases of cancer, Canada, 2010 (based on September 2012 CCR file and Quebec 2010; see Statistics Canada CANSIM Table 103-0553 for availability of later data releases)

Cancer	ICD-O-3 Site/Type*	Total	Males	Females
All cancers	**All invasive sites**	**172,910**	**88,245**	**84,665**
Oral (buccal cavity and pharynx)	**C00–C14**	**3,945**	**2,685**	**1,260**
Lip	C00	290	200	85
Tongue	C01–C02	1,040	695	345
Salivary gland	C07–C08	450	260	195
Mouth	C03–C06	775	445	330
Nasopharynx	C11	250	175	75
Oropharynx	C10	220	175	45
Other and unspecified	C09,C12–C14	925	730	190
Digestive organs	**C15–C26,C48**	**35,405**	**19,640**	**15,765**
Esophagus	C15	1,795	1,360	435
Stomach	C16	3,010	1,900	1,105
Small intestine	C17	740	410	330
Large intestine	C18,C26.0	14,250	7,140	7,110
Rectum	C19–C20	7,035	4,335	2,700
Anus	C21	580	195	385
Liver	C22.0	1,685	1,265	415
Gallbladder	C23	500	165	335
Pancreas	C25	3,915	1,940	1,975
Other and unspecified	C22.1,C24,C26.8–.9,C48	1,900	920	975
Respiratory system	**C30–C34,C38.1–.9,C39**	**25,280**	**13,840**	**11,440**
Larynx	C32	1,155	970	180
Lung	C34	23,780	12,660	11,110
Other and unspecified	C30–31,C33,C38.1–.9,C39	350	205	150
Bone	**C40–C41**	**340**	**195**	**150**
Soft tissue (including heart)	**C38.0,C47,C49**	**1,175**	**665**	**510**
Skin (melanoma)	**C44 Type 8720–8790**	**5,495**	**2,965**	**2,535**
Breast	**C50**	**23,170**	**215**	**22,955**
Genital organs	**C51–C63**	**33,520**	**23,375**	**10,145**
Cervix	C53	1,415	—	1,415
Body of uterus	C54	5,105	—	5,105
Uterus, part unspecified	C55	175	—	175
Ovary	C56	2,520	—	2,520
Prostate	C61	22,185	22,185	—
Testis	C62	975	980	—
Other and unspecified	C51–52,C57,C58,C60,C63	1,145	215	930
Urinary organs	**C64–C68**	**12,750**	**8,920**	**3,830**
Bladder	C67	7,265	5,485	1,780
Kidney	C64–C65	4,980	3,110	1,870
Other urinary	C66,C68	505	325	180
Eye	**C69**	**355**	**185**	**170**
Brain and central nervous system	**C70–C72**	**2,615**	**1,470**	**1,145**
Endocrine glands	**C37,C73–C75**	**5,350**	**1,275**	**4,065**
Thyroid	C73	5,040	1,125	3,915
Other endocrine	C37,C74–C75	305	155	150
Hodgkin lymphoma†	**Type 9650–9667**	**915**	**495**	**420**
Non-Hodgkin lymphoma†	**See Table A10**	**7,085**	**3,825**	**3,260**
Multiple myeloma†	**Type 9731,9732,9734**	**2,355**	**1,295**	**1,060**
Leukemia†	**See Table A10**	**5,130**	**2,960**	**2,175**
Mesothelioma†	**Type 9050–9055**	**515**	**415**	**95**
All other and unspecified cancers	**See Table A10**	**7,520**	**3,820**	**3,700**

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada

Data sources: Canadian Cancer Registry database at Statistics Canada and Quebec Cancer Registry (2008–2010)

— Not applicable

* Fritz A, Percy C, Jack A, Shanmugaratnam K, Sobin L, Parkin D, et al. Editors. *International Classification of Diseases for Oncology, Third Edition*. Geneva: World Health Organization; 2000.

† For incidence, ICD-O-3 histology types 9590–9992 (leukemia, lymphoma and multiple myeloma), 9050–9055 (mesothelioma) and 9140 (Kaposi sarcoma) are excluded from other specific organ sites.

Note: Numbers are for invasive cancers and *in situ* bladder cancers (except for Ontario) but exclude non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous).

TABLE A2 Actual data for cancer deaths, Canada, 2010 (see Statistics Canada CANSIM Table 102-0522 for availability of later data releases)

	ICD-10*	Total	Males	Females
All cancers	**C00–C97**	**71,885**	**37,540**	**34,340**
Oral (buccal cavity and pharynx)	**C00–C14**	**1,150**	**750**	**400**
Lip	C00	10	5	—
Tongue	C01–C02	295	195	105
Salivary gland	C07–C08	125	60	55
Mouth	C03–C06	190	105	90
Nasopharynx	C11	100	65	40
Oropharynx	C10	120	80	35
Other and unspecified	C09,C12–C14	310	230	80
Digestive organs	**C15–C25,C26.0,C26.8–.9,C48**	**19,390**	**10,785**	**8,610**
Esophagus	C15	1,795	1,365	430
Stomach	C16	1,885	1,140	745
Small intestine	C17	205	100	105
Large intestine	C18,C26.0	6,605	3,370	3,235
Rectum	C19–C20	1,940	1,170	770
Anus	C21	95	30	65
Liver	C22.0,C22.2–.7	900	695	210
Gallbladder	C23	265	75	190
Pancreas	C25	3,870	1,925	1,950
Other and unspecified	C22.1,C22.9,C24,C26.8–.9,C48	1,825	910	915
Respiratory system	**C30–C34,C38.1–.9,C39**	**19,860**	**10,945**	**8,915**
Larynx	C32	410	340	70
Lung	C34	19,310	10,525	8,780
Other and unspecified	C30–31,C33,C38.1–.9,C39	140	80	60
Bone	**C40–C41**	**185**	**120**	**60**
Soft tissue (including heart)	**C38.0,C47,C49**	**475**	**235**	**240**
Skin (melanoma)	**C43**	**980**	**650**	**330**
Breast	**C50**	**5,025**	**50**	**4,975**
Genital organs	**C51–C63**	**7,085**	**3,925**	**3,165**
Cervix	C53	370	—	375
Body of uterus	C54	510	—	510
Uterus, part unspecified	C55	410	—	405
Ovary	C56	1,640	—	1,635
Prostate	C61	3,835	3,835	—
Testis	C62	45	40	—
Other and unspecified	C51–52,C57,C58,C60,C63	285	50	235
Urinary organs	**C64–C68**	**3,725**	**2,505**	**1,225**
Bladder	C67	1,955	1,380	575
Kidney	C64–C65	1,585	1,005	585
Other urinary	C66,C68	190	125	65
Eye	**C69**	**40**	**20**	**20**
Brain and central nervous system	**C70–C72**	**1,905**	**1,075**	**825**
Endocrine glands	**C37,C73–C75**	**305**	**135**	**175**
Thyroid	C73	185	65	120
Other endocrine	C37,C74–C75	120	70	50
Hodgkin lymphoma	**C81**	**135**	**85**	**50**
Non-Hodgkin lymphoma	**C82–C85,C96.3**	**2,505**	**1,365**	**1,140**
Multiple myeloma	**C90.0, C90.2**	**1,220**	**660**	**565**
Leukemia	**C91–C95, C90.1**	**2,375**	**1,360**	**1,015**
Mesothelioma	**C45**	**455**	**375**	**85**
All other and unspecified cancers	**See Table A10**	**5,060**	**2,505**	**2,555**

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

— Not applicable

*World Health Organization. *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision*. Volumes 1 to 3. Geneva, Switzerland: World Health Organization; 1992.

TABLE A3 Actual data for new cases for the most common cancers by sex and geographic region, Canada, 2010* (based on September 2012 Canadian Cancer Registry file and Quebec 2010; see Statistics Canada CANSIM Table 103-0553 for availability of later data releases)

	New cases													
	Canada†	BC	AB	SK	MB	ON‡	QC§	NB	NS	PE	NL§	YT	NT	NU
Males														
All cancers	**88,200**	**11,000**	**7,700**	**2,500**	**3,000**	**33,700**	**22,800**	**2,400**	**2,900**	**420**	**1,650**	**50**	**60**	**25**
Prostate	22,200	2,900	2,100	610	740	9,300	4,500	670	720	130	480	15	15	—
Lung	12,700	1,350	910	350	400	4,400	4,200	370	440	80	230	5	10	10
Colorectal	11,500	1,400	1,000	360	450	4,000	3,100	300	450	55	280	5	10	5
Bladder	5,500	770	500	190	200	1,550	1,750	180	210	15	100	5	—	—
Non-Hodgkin lymphoma	3,800	550	330	130	140	1,500	880	95	140	15	60	—	5	—
Kidney	3,100	280	260	95	150	1,150	860	120	120	20	75	—	—	—
Melanoma	3,000	430	270	60	90	1,400	470	65	130	25	40	—	—	—
Leukemia	3,000	350	300	110	120	1,200	680	90	55	10	35	—	—	—
Oral	2,700	370	260	75	110	1,050	670	45	75	5	35	—	5	—
Pancreas	1,950	250	180	55	85	690	570	40	60	5	20	—	5	—
Stomach	1,900	220	160	60	70	710	500	50	55	15	65	—	—	—
Brain/CNS	1,500	190	120	40	45	570	400	25	60	—	30	—	—	—
Esophagus	1,350	180	120	45	45	560	310	40	55	5	15	—	—	—
Multiple myeloma	1,300	190	120	40	40	520	320	30	35	5	20	—	—	—
Liver	1,250	200	120	20	25	520	330	15	30	—	10	—	—	—
Thyroid	1,150	100	100	20	30	500	300	35	30	5	15	—	—	—
Testis	980	130	120	30	35	380	220	25	30	5	10	—	—	—
Females														
All cancers	**84,700**	**10,200**	**7,000**	**2,400**	**3,000**	**33,000**	**22,500**	**1,950**	**2,800**	**380**	**1,300**	**55**	**55**	**25**
Breast	23,000	3,000	2,100	660	790	9,000	5,700	530	720	130	340	15	20	5
Lung	11,100	1,300	880	350	430	3,900	3,400	270	420	50	150	10	5	10
Colorectal	9,800	1,150	770	340	400	3,600	2,700	260	380	40	210	5	10	5
Body of uterus	5,300	680	440	160	220	2,100	1,300	130	160	15	110	5	—	—
Thyroid	3,900	240	320	60	90	2,000	950	95	90	10	45	—	—	—
Non-Hodgkin lymphoma	3,300	430	290	110	140	1,300	740	75	95	15	60	—	—	—
Melanoma	2,500	390	230	70	75	1,150	400	50	120	10	25	—	—	—
Ovary	2,500	290	170	65	90	1,050	670	55	70	15	35	—	—	—
Leukemia	2,200	250	190	75	75	960	520	55	45	5	10	—	—	—
Pancreas	1,950	220	160	60	80	760	550	55	60	10	25	—	—	—
Kidney	1,850	140	160	65	75	700	550	55	85	10	40	—	—	—
Bladder	1,800	210	150	70	60	510	600	55	75	5	35	—	—	—
Cervix	1,400	180	150	45	40	580	320	25	35	5	40	—	—	—
Oral	1,250	150	100	30	60	490	340	25	45	5	15	—	—	—
Brain/CNS	1,150	120	80	25	35	490	330	15	30	—	20	—	—	—
Stomach	1,100	130	85	25	40	460	310	20	25	—	20	—	—	—
Multiple myeloma	1,050	140	80	35	40	430	260	20	30	5	20	—	—	—
Esophagus	440	60	30	5	10	200	100	10	20	—	5	—	—	—
Liver	420	60	35	10	5	160	130	5	15	—	—	—	—	—

CNS=central nervous system

— Fewer than 3 cases per year.

* 2006–2010 average for Yukon, Northwest Territories and Nunavut. The numbers of cases from death certificate only for Ontario in 2008–2010, Quebec in 2010, and Newfoundland and Labrador in 2008–2010 are estimated.

† Row totals may not equal the total for Canada due to rounding and difference in the most recent year of data presented. Canada totals include provincial and territorial estimates.

‡ Ontario did not report on *in situ* bladder cases at the time the data were obtained. If Ontario *in situ* cases were included, it is estimated that the total number of Ontario bladder cancers would be 2,400 among men and 830 among women.

§ The number of cases for some cancers used to calculate the overall 2015 estimates for this province was underestimated.

Note: "All cancers" excludes the estimated new cases of non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). The complete definition of the specific cancers listed here can be found in Table A10.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry database at Statistics Canada and Quebec Cancer Registry (2008–2010)

TABLE A4 Actual age-standardized incidence rates (ASIR) for the most common cancers by sex and geographic region, Canada, 2010*
(based on September 2012 Canadian Cancer Registry file and Quebec 2010; see Statistics Canada CANSIM Table 103-0553 for availability of later data releases)

	Cases per 100,000													
	Canada†	BC	AB	SK	MB	ON‡	QC§	NB	NS	PE	NL§	YT	NT	NU
Males														
All cancers	**440**	**390**	**420**	**406**	**439**	**444**	**468**	**477**	**476**	**459**	**485**	**324**	**418**	**381**
Prostate	108	103	113	98	105	121	89	130	114	132	133	90	101	25
Lung	63	48	52	57	57	58	85	74	70	83	64	46	69	170
Colorectal	57	50	56	58	64	52	64	59	72	57	82	46	83	60
Bladder	28	27	28	30	27	21	36	36	34	17	30	24	—	—
Non-Hodgkin lymphoma	19	20	18	22	19	20	18	20	22	17	19	—	17	—
Leukemia	15	13	17	17	17	17	15	19	9	9	12	—	—	—
Kidney	15	10	13	16	20	15	17	24	18	21	20	—	—	—
Melanoma	15	15	14	9	12	18	10	13	22	29	13	—	—	—
Oral	13	12	12	12	15	13	13	10	11	9	10	—	24	—
Pancreas	10	8	10	8	12	9	12	7	9	9	6	—	12	—
Stomach	9	8	9	10	9	9	10	10	9	13	20	—	—	—
Brain/CNS	8	7	6	7	6	8	9	6	10	—	10	—	—	—
Esophagus	7	6	6	7	6	7	6	7	9	5	4	—	—	—
Multiple myeloma	6	6	6	6	6	7	6	6	6	3	5	—	—	—
Testis	6	6	7	6	7	6	6	8	8	10	4	—	—	—
Liver	6	7	6	4	4	7	7	3	5	—	4	—	—	—
Thyroid	6	4	5	4	5	7	6	7	5	7	6	—	—	—
Females														
All cancers	**369**	**330**	**342**	**348**	**373**	**377**	**389**	**351**	**388**	**365**	**356**	**333**	**384**	**369**
Breast	101	100	100	95	101	103	101	96	104	115	89	91	96	51
Lung	47	40	44	48	51	43	57	45	57	45	38	65	60	149
Colorectal	40	34	37	44	45	38	43	42	50	38	54	45	89	74
Body of uterus	23	22	21	22	28	24	22	22	22	15	28	22	—	—
Thyroid	21	9	16	11	14	28	21	20	15	12	16	—	—	—
Non-Hodgkin lymphoma	14	14	14	15	16	15	13	13	13	15	16	—	—	—
Melanoma	12	14	11	11	10	14	8	10	19	13	7	—	—	—
Ovary	11	9	8	10	12	12	12	10	9	13	9	—	—	—
Leukemia	10	8	9	10	9	11	9	12	6	8	3	—	—	—
Kidney	8	5	8	9	9	8	9	9	11	8	11	—	—	—
Pancreas	8	7	7	8	9	8	9	9	8	9	6	—	—	—
Cervix	8	7	8	8	6	8	7	7	6	9	14	—	—	—
Bladder	7	6	7	9	7	5	10	10	10	6	8	—	—	—
Brain/CNS	5	4	4	3	5	6	6	3	4	—	6	—	—	—
Oral	5	5	5	4	7	6	6	5	6	7	3	—	—	—
Stomach	4	4	4	4	4	5	5	3	3	—	5	—	—	—
Multiple myeloma	4	4	4	5	4	5	4	4	4	4	6	—	—	—
Esophagus	2	2	1	1	1	2	2	2	2	—	1	—	—	—
Liver	2	2	2	1	1	2	2	1	2	—	—	—	—	—

CNS=central nervous system

— Rate cannot be calculated because there were fewer than 3 cases per year.

* 2006–2010 average for Yukon, Northwest Territories and Nunavut. The numbers of cases from death certificate only for Ontario in 2008–2010, Quebec in 2010 and Newfoundland and Labrador in 2008–2010 are estimated.

† Canada totals include provincial and territorial estimates.

‡ Ontario did not report on *situ* bladder cancers at the time the data were obtained; this should be considered when making comparisons across provinces.

§ The number of cases for some cancers used to calculate the overall 2015 estimates for this province was underestimated.

Note: Rates for "All cancers" exclude non-melanoma skin cancer (basal and squamous). Rates are age-standardized to the 1991 Canadian population. The complete definition of the specific cancers listed here can be found in Table A10.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry database at Statistics Canada and Quebec Cancer Registry (2008–2010)

TABLE A5 Actual data for cancer deaths for the most common cancers by sex and geographic region, Canada, 2010*
(see Statistics Canada CANSIM Table 102-0552 and CANSIM Table 102-0522 and for availability of later data releases)

	Deaths													
	Canada†	BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	YT	NT	NU
Males														
All cancers	**37,500**	**4,800**	**3,000**	**1,200**	**1,350**	**13,900**	**10,200**	**930**	**1,300**	**160**	**710**	**35**	**25**	**20**
Lung	10,500	1,200	770	290	340	3,700	3,300	290	350	60	200	5	5	10
Colorectal	4,500	560	360	150	190	1,650	1,200	120	160	10	130	5	5	5
Prostate	3,800	540	370	180	180	1,450	810	80	130	15	55	5	—	—
Pancreas	1,900	280	160	50	65	680	530	45	55	10	40	—	—	—
Bladder	1,400	200	110	55	45	530	330	35	45	—	25	—	—	—
Esophagus	1,350	200	130	45	55	530	280	35	65	5	15	—	—	—
Non-Hodgkin lymphoma	1,350	200	110	40	40	510	370	30	40	5	20	—	—	—
Leukemia	1,350	190	100	50	40	550	330	30	40	—	25	—	—	—
Stomach	1,150	120	85	35	40	420	330	25	40	5	40	—	—	—
Brain/CNS	1,100	140	110	25	35	410	280	25	40	5	10	—	—	—
Kidney	1,000	120	75	35	45	370	250	30	45	5	25	—	—	—
Oral	750	90	55	10	15	320	200	15	25	5	10	—	—	—
Liver	690	110	50	15	15	300	170	—	25	—	5	—	—	—
Multiple myeloma	660	85	50	20	25	260	160	15	25	5	5	—	—	—
Melanoma	650	85	60	20	20	280	140	15	30	—	5	—	—	—
Females														
All cancers	**34,300**	**4,400**	**2,600**	**1,100**	**1,350**	**12,800**	**9,200**	**870**	**1,200**	**150**	**600**	**30**	**20**	**15**
Lung	8,800	1,150	660	280	340	3,100	2,500	240	330	45	130	10	5	5
Breast	5,000	590	390	180	190	1,900	1,300	120	190	20	110	5	5	—
Colorectal	4,000	520	320	130	150	1,400	1,100	95	150	25	85	5	5	5
Pancreas	1,950	250	160	70	75	720	510	60	60	5	30	—	—	—
Ovary	1,650	260	130	40	70	630	380	25	55	10	30	—	—	—
Non-Hodgkin lymphoma	1,150	160	80	35	45	460	270	30	40	—	15	—	—	—
Leukemia	1,000	150	80	45	35	400	240	25	20	5	5	—	—	—
Body of uterus	920	120	55	25	35	360	250	20	35	—	20	—	—	—
Brain/CNS	830	120	60	20	25	310	220	15	30	5	15	—	—	—
Stomach	740	70	60	20	20	300	210	25	30	—	20	—	—	—
Kidney	580	65	40	15	25	230	150	20	20	—	15	—	—	—
Bladder	580	75	40	20	20	210	170	15	15	—	10	—	—	—
Multiple myeloma	560	80	30	15	25	210	150	20	20	—	10	—	—	—
Esophagus	430	60	35	15	15	180	85	10	15	—	10	—	—	—
Oral	400	45	30	15	20	150	120	15	10	—	—	—	—	—
Cervix	370	50	30	15	15	170	70	10	10	—	10	—	—	—
Melanoma	330	40	25	5	10	160	80	10	5	5	—	—	—	—
Liver	210	25	15	0	5	100	50	5	5	—	—	—	—	—

CNS=central nervous system

— Fewer than 3 deaths per year.

* 2006–2010 average for Yukon, Northwest Territories and Nunavut.

† Row totals may not equal the total for Canada due to rounding. Canada totals include provincial and territorial estimates.

Note: The complete definition of the specific cancers listed here can be found in Table A10.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

TABLE A6 Actual age-standardized mortality rates (ASMR) for the most common cancers by sex and geographic region, Canada, 2010*
(see Statistics Canada CANSIM Table 102-0552 and CANSIM Table 102-0522 for availability of later data releases)

	Deaths per 100,000													
	Canada†	BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	YT	NT	NU
Males														
All cancers	**189**	**167**	**171**	**185**	**194**	**183**	**211**	**190**	**213**	**181**	**217**	**258**	**223**	**366**
Lung	53	42	44	46	49	48	68	60	58	67	61	57	55	182
Colorectal	23	20	20	23	27	22	25	25	27	13	40	30	39	66
Prostate	20	19	23	26	25	20	18	17	23	19	18	31	—	—
Pancreas	10	10	9	8	9	9	11	9	9	12	12	—	—	—
Bladder	7	7	7	8	6	7	7	8	8	—	8	—	—	—
Esophagus	7	7	7	7	8	7	6	7	10	8	4	—	—	—
Non-Hodgkin lymphoma	7	7	6	7	6	7	8	6	7	4	6	—	—	—
Leukemia	7	7	6	7	6	7	7	7	7	—	8	—	—	—
Stomach	6	4	5	5	5	6	7	5	6	6	12	—	—	—
Brain/CNS	5	5	5	4	5	5	6	5	7	8	4	—	—	—
Kidney	5	4	4	5	7	5	5	6	7	6	7	—	—	—
Oral	4	3	3	2	2	4	4	3	4	3	3	—	—	—
Liver	3	4	3	2	2	4	3	—	4	—	2	—	—	—
Multiple myeloma	3	3	3	3	4	3	3	3	4	7	2	—	—	—
Melanoma	3	3	3	3	3	4	3	3	5	—	2	—	—	—
Females														
All cancers	**136**	**129**	**125**	**142**	**146**	**132**	**145**	**140**	**155**	**134**	**151**	**219**	**185**	**277**
Lung	36	34	33	36	39	33	42	40	44	40	33	64	46	132
Breast	20	18	18	23	21	20	21	19	24	16	27	23	20	—
Colorectal	15	15	14	16	15	13	16	14	18	19	21	26	41	48
Pancreas	8	7	7	9	8	7	8	9	7	6	7	—	—	—
Ovary	7	8	7	6	8	7	6	4	7	8	7	—	—	—
Non-Hodgkin lymphoma	4	5	4	4	4	5	4	5	5	—	4	—	—	—
Leukemia	4	4	4	5	4	4	4	5	3	6	1	—	—	—
Body of uterus	4	4	3	3	4	4	4	3	4	—	6	—	—	—
Brain/CNS	4	4	3	3	3	4	4	3	5	5	5	—	—	—
Stomach	3	2	2	2	2	3	3	4	4	—	4	—	—	—
Kidney	2	2	2	2	3	2	2	2	3	—	4	—	—	—
Bladder	2	2	2	2	2	2	2	2	2	—	2	—	—	—
Multiple myeloma	2	2	1	2	3	2	2	3	3	—	2	—	—	—
Esophagus	2	2	2	2	2	2	1	2	2	—	3	—	—	—
Oral	2	1	1	2	2	1	2	2	1	—	—	—	—	—
Cervix	2	2	1	3	2	2	1	2	2	—	2	—	—	—
Melanoma	1	1	1	1	1	2	1	1	1	5	—	—	—	—
Liver	1	1	1	0	1	1	1	1	1	—	—	—	—	—

CNS=central nervous system

— Rate cannot be presented because there were fewer than 3 deaths per year.

* 2006–2010 average for Yukon, Northwest Territories, Nunavut.

† Canada totals include provincial and territorial estimates.

Note: Rates are age-standardized to the 1991 Canadian population. The complete definition of the specific cancers listed here can be found in Table A10.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

TABLE A7 New cases and average annual age-standardized incidence rates (ASIR) by diagnostic group, in children (0–14 years), Canada, 2006–2010

Diagnostic group	New cases* (both sexes)	ASIR (per 1,000,000) per year
Total (5 years)	**4,550**	**163.2**
Average per year	**910**	
I. Leukemia	**1,465**	**53.4**
a. Lymphoid	1,145	41.8
b. Acute myeloid	200	7.1
III. Central nervous system	**860**	**30.9**
a. Ependymoma	100	3.6
b. Astrocytoma	370	13.2
c. Intracranial & intraspinal embryonal	190	6.8
II. Lymphoma	**500**	**17.5**
a. Hodgkin lymphoma	185	6.3
b. Non-Hodgkin lymphoma	160	5.6
c. Burkitt lymphoma	45	1.6
IV. Neuroblastoma & other PNC	**355**	**13.2**
a. Neuroblastoma	355	13.0
IX. Soft tissue	**295**	**10.5**
a. Rhabdomyosarcoma	145	5.1
VI. Renal tumours	**235**	**8.8**
a. Nephroblastoma	225	8.4
XI. Other malignant epithelial	**210**	**7.0**
b. Thyroid	90	3.1
d. Malignant melanoma	50	1.7
VIII. Malignant bone	**200**	**6.8**
a. Osteosarcoma	100	3.4
c. Ewing sarcoma	80	2.7
X. Germ cell and other gonadal	**140**	**4.9**
c. Gonadal germ cell tumours	55	1.9
V. Retinoblastoma	**120**	**4.4**
XII. Other and unspecified cancers	**90**	**3.2**
VII. Hepatic tumours	**70**	**2.7**

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry database at Statistics Canada and Quebec Cancer Registry (2008–2010)

PNC=peripheral nervous cell tumours

* Steliarova-Foucher E, Stiller C, Lacour B, Kaatsch P. *International Classification of Childhood Cancer, Third Edition*. Diagnostic groups are listed in descending order of disease incidence. Only selected subgroups within each diagnostic group are listed.

Note: Rates are age-standardized to the 1991 Canadian population and are expressed per million per year due to disease rarity.

TABLE A8 New cases and average annual age-standardized cancer incidence rates (ASIR) by sex and diagnostic group in adolescents and young adults (15–29 years), Canada, 2006–2010

Diagnostic group	Males		Females	
	New cases*	ASIR per 1,000,000 per year	New cases*	ASIR per 1,000,000 per year
Total (5 years)	**5,765**	**344.9**	**6,540**	**409.0**
Average per year	**1,153**		**1,308**	
Leukemias	**460**	**26.5**	**305**	**18.3**
Acute lymphoid leukemia	175	9.5	90	5.2
Acute myeloid leukemia	160	9.7	130	8.1
Chronic myeloid leukemia	60	3.6	45	2.7
Other and unspecified leukemia	65	3.8	40	2.4
Lymphomas	**1,195**	**69.8**	**1,005**	**60.8**
Non-Hodgkin lymphoma	445	26.3	285	17.6
Hodgkin lymphoma	745	43.5	720	43.2
CNS and other intracranial and intraspinal neoplasms	**470**	**27.9**	**425**	**25.4**
Specified low-grade astrocytic tumours	85	4.8	80	4.6
Glioblastoma and anaplastic astrocytoma	85	5.2	65	4.1
Other glioma	130	7.7	100	6.1
Osseous and chondromatous neoplasms	**240**	**13.3**	**165**	**9.6**
Osteosarcoma	90	5.1	60	3.2
Ewing tumour	85	4.6	55	3.2
Soft tissue sarcomas	**270**	**16.2**	**245**	**14.7**
Specified (excluding Kaposi sarcoma)	130	7.8	125	7.6
Germ cell and trophoblastic neoplasms	**1,700**	**103.7**	**150**	**9.1**
Germ cell and trophoblastic neoplasms of gonads	1,600	97.7	130	7.7
Other nongonadal	65	3.8	20	1.2
Melanoma and skin carcinomas	**305**	**18.9**	**665**	**42.3**
Melanoma	300	18.8	665	42.1
Carcinomas	**905**	**55.6**	**3,155**	**202.3**
Thyroid carcinoma	340	21.0	1,590	100.4
Other sites in lip, oral cavity and pharynx	65	4.2	105	6.4
Carcinoma of breast	0	—	475	31.5
Carcinoma of kidney	65	4.3	55	3.3
Carcinoma of gonads	10	0.6	110	6.9
Carcinoma of cervix and uterus	—	—	420	27.9
Carcinoma of colon and rectum	185	11.4	180	11.5
Miscellaneous specified neoplasms, NOS	**110**	**6.3**	**165**	**10.3**
Other specified neoplasms, NOS	40	2.4	110	6.6
Unspecified malignant neoplasms	115	6.7	260	16.2

CNS=central nervous system

— Not applicable.

* AYA Site Recode ICD-O-3/WHO 2008 Definition. Surveillance, Epidemiology, and End Results Program (SEER).

Note: Rates are age-standardized to the 1991 Canadian population and are expressed per million per year due to disease rarity. Cases were classified according to the SEER adapted classification scheme for tumours of adolescents and young adults (AYA). Only selected subgroups within each diagnostic group are listed.

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry database at Statistics Canada and Quebec Cancer Registry (2008–2010)

TABLE A9 Deaths and average annual age-standardized cancer mortality rates (ASMR) by sex and diagnostic group in adolescents and young adults (15–29 years), Canada, 2006–2010

Diagnostic group	Males		Females	
	Deaths	ASMR per 1,000,000 per year	Deaths	ASMR per 1,000,000 per year
Total (5 years)	**855**	**50.7**	**605**	**37.5**
Average per year	**170**		**120**	
Oral (buccal cavity and pharynx)	**15**	**0.8**	**5**	**0.4**
Lip	0	0.0	0	0.0
Tongue	0	0.1	0	0.2
Salivary gland	0	0.0	0	0.0
Mouth	5	0.1	0	0.1
Nasopharynx	10	0.5	5	0.2
Oropharynx	0	0.1	0	0.0
Other and unspecified	0	0.0	0	0.0
Digestive organs	**85**	**5.3**	**75**	**5.1**
Esophagus	10	0.5	0	0.2
Stomach	10	0.6	20	1.3
Small intestine	0	0.1	0	0.1
Large intestine	30	1.9	25	1.6
Rectum	15	0.9	15	0.8
Anus	0	0.1	0	0.0
Liver	5	0.3	10	0.5
Gallbladder	0	0.0	0	0.0
Pancreas	5	0.3	5	0.3
Other and unspecified	10	0.5	5	0.4
Respiratory system	**20**	**1.2**	**15**	**0.9**
Larynx	0	0.0	0	0.0
Lung	15	0.9	15	0.9
Other and unspecified	5	0.3	5	0.1
Bone	**95**	**5.5**	**60**	**3.8**
Soft tissue (including heart)	**95**	**5.6**	**50**	**2.7**
Melanoma	**30**	**1.7**	**30**	**1.9**
Breast	**0**	**0.0**	**35**	**2.2**
Genital organs	**55**	**3.3**	**60**	**3.7**
Cervix	—	—	25	1.7
Body of uterus	—	—	0	0.0
Uterus, part unspecified	—	—	0	0.2
Ovary	—	—	30	1.8
Prostate	0	0.0	—	—
Testis	55	3.3	—	—
Other and unspecified	0	0.1	0	0.1

continued...

TABLE A9 Deaths and average annual age-standardized cancer mortality rates (ASMR) by sex and diagnostic group in adolescents and young adults (15–29 years), Canada, 2006–2010 *(continued)*

Diagnostic group	Males		Females	
	Deaths	ASMR per 1,000,000 per year	Deaths	ASMR per 1,000,000 per year
Urinary organs	**10**	**0.6**	**10**	**0.7**
Bladder	0	0.2	0	0.1
Kidney	10	0.4	10	0.6
Other urinary	0	0.0	0	0.0
Eye	**0**	**0.0**	**0**	**0.1**
Brain and central nervous system	**140**	**8.3**	**80**	**5.0**
Endocrine glands	**20**	**1.0**	**15**	**0.9**
Thyroid	5	0.1	0	0.1
Other endocrine	20	1.0	15	0.9
Hodgkin lymphoma	**40**	**2.4**	**25**	**1.4**
Non-Hodgkin lymphoma	**60**	**3.7**	**30**	**1.7**
Multiple myeloma	**0**	**0.0**	**0**	**0.0**
Leukemia	**140**	**8.4**	**85**	**5.2**
Mesothelioma	**5**	**0.1**	**0**	**0.1**
All other and unspecified cancers	**45**	**2.8**	**25**	**1.6**

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

— Not applicable.

Note: Rates are age-standardized to the 1991 Canadian population and are expressed per million per year due to disease rarity. For ICD-10 codes, see Table A2.

APPENDIX II: Data sources and methods

Data sources

Incidence data: The Canadian Cancer Registry (CCR)

Actual cancer incidence data used in this publication cover the period of 1986 to 2010. Data for 1992 to 2010 were obtained from the CCR[1] (September 2012 CCR Tabulation Master File), except for Quebec 2008 to 2010 data, which were received in a summary format from the Quebec Cancer Registry. Data for earlier years (before 1992) were retrieved from the predecessor to the CCR, the National Cancer Incidence Reporting System (NCIRS). The NCIRS is a fixed, tumour-oriented database containing cases diagnosed as far back as 1969.

- Incidence data originate with the provincial and territorial cancer registries, which provide data annually to Statistics Canada for inclusion in the CCR.
- The CCR is a person-oriented database that includes clinical and demographic information about residents of Canada newly diagnosed with cancer.
- The Health Statistics Division at Statistics Canada maintains the CCR. It links data internally to identify duplicate person and tumour records. The Health Statistics Division also links cancer data with mortality data (described below) to ensure the completeness and correctness of vital status information. Both linking procedures optimize the accuracy of incidence, prevalence and survival statistics.
- Cancer diagnoses are classified according to the *International Classification of Diseases for Oncology, Third Edition* (ICD-O-3).[2]
- International Agency for Research on Cancer (IARC) rules[3] for multiple primaries were used for cases from the CCR, whereas during the period covered by the NCIRS, registries other than Quebec and Ontario used multiple primary rules that allowed a small percentage of additional cases.

Mortality data: The Canadian Vital Statistics — Death database (CVS: D)

The actual cancer mortality data cover the period of 1986 to 2010 and were obtained from the CVS: D.[4,5]

- Death records originate with the provincial and territorial registrars of vital statistics and are provided regularly to Statistics Canada for inclusion in the CVS: D.
- The CVS: D includes demographic and cause of death information for all Canadian residents and non-residents who died in Canada between 1950 and 2010. Information on non-residents is not used for this publication.
- Data are also included for Canadian residents who died in a small number of states within the United States from which abstracted death data were received. Starting with the 2010 data year, this information is no longer available.
- The Health Statistics Division at Statistics Canada maintains the CVS: D.
- Cause of death is classified according to the *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision* (ICD-10).[6]
- Cancer deaths are those for which some form of cancer, as certified by a physician, is the underlying cause of death.

Population data: The Census of Canada

- Population estimates for Canada and the provinces and territories are based on censuses conducted every five years from 1986 to 2011.
- Intercensal estimates prepared by Statistics Canada are used for the years between these censuses, and postcensal estimates are used for 2012 to 2013.[7]
- Projected population estimates are used for 2014 and 2015, as prepared by Statistics Canada under assumptions of medium growth (scenario M1).[8] The scenario M1 incorporates medium-growth and historical trends (1981 to 2008) of interprovincial migration.
- All population estimates include non-permanent residents and are adjusted for net census undercoverage and Canadians returning from abroad.

Life tables

- Life tables are required to estimate relative survival. Sex-specific provincial life tables are produced by Statistics Canada.
- Expected survival data for the years 2006, 2007 and 2008 were respectively derived from 2005 to 2007,[9] 2006 to 2008[10] and 2007 to 2009[11] complete life tables. The methodology used to produce these life tables[12] was retroactively used to produce annual life tables from 1991 to 1993 to 2004 to 2006.[13]
- As complete life tables were not available for Prince Edward Island or the territories, expected survival proportions for these areas were derived, up to the age of 99 years, from abridged life tables for Canada[13] and the affected jurisdictions[9-11,13] and complete Canadian life tables[9-11,13] using a method suggested by Dickman et al.[14] Where this was not possible (i.e., ages 100–109 years), complete Canadian life table values were used.

Cancer definitions

- Cancers are generally defined according to the groupings of ICD-O-3[2] for incidence and ICD-10[6] for mortality (Table A10).
- Some definitions have changed slightly over time. Changes occurring since the 2004 edition of this publication are outlined in Tables A11-1 and A11-2.
- For children aged 0–14 years, cancers were classified and reported according to the *International Classification of Childhood Cancer, Third Edition* (ICCC-3).[15] This system is most appropriate for reporting childhood cancers because it acknowledges the major differences between cancers that develop during childhood and those that occur later in life. The category "intracranial and intraspinal" excludes non-malignant tumours.
- For cancer incidence of adolescents and young adults aged 15–29, cancers were classified and reported according to the Surveillance, Epidemiology, and End Results Program (SEER) adapted classification scheme for tumours of adolescents and young adults (AYA).[16]
- Bladder cancer includes bladder *in situ* carcinomas, which are considered invasive for the purpose of incidence reporting and are included for provinces and territories. Such cases were not collected until recently in Ontario and were not available for the years of data reported in this publication.

Methods

Incidence and mortality rates

Records from each province or territory were extracted from the relevant incidence or mortality files and then classified by year of diagnosis or death and by sex, five-year age group (0–4, 5–9,…, 80–84 and 85+ years) and cancer type.

- Rates for each category were calculated by dividing the number of cases or deaths in each category (i.e., province or territory, year, sex, age group, cancer type) by the corresponding population figure. These formed the basis for calculations of age-standardized rates and for estimates beyond the most recent year of actual data.
- For the sections *Incidence and mortality by sex, age and geography*, age-specific rates were computed for broader age groups (0–19, 20–29,…, 70–79 and 80+ years) in the same way.
- Age-standardized incidence rates (ASIR) and mortality rates (ASMR) were calculated using the direct method, which involves weighting the age-specific rates for each five-year age group according to the age distribution of the 1991 Canadian population:

1991 Canadian standard population

Age group	Population (per 100,000)
0–4	6,946.4
5–9	6,945.4
10–14	6,803.4
15–19	6,849.5
20–24	7,501.6
25–29	8,994.4
30–34	9,240.0
35–39	8,338.8
40–44	7,606.3
45–49	5,953.6
50–54	4,764.9
55–59	4,404.1
60–64	4,232.6
65–69	3,857.0
70–74	2,965.9
75–79	2,212.7
80–84	1,359.5
85+	1,023.7
Total	**100,000**

Note: The Canadian population distribution is based on the final postcensal estimates of the July 1, 1991, Canadian population, adjusted for census undercoverage. The age distribution of the population has been weighted and normalized.

Data source: Census and Demographics Branch, Statistics Canada

Figure C (*Introduction*) shows the number of deaths avoided since the mortality rate for all cancers combined peaked in 1988.

- The year 1988 was chosen as the baseline year when the overall cancer mortality rate was at its highest for Canadian men and women.
- The age-specific cancer mortality rates from 1988 for males and females in each five-year age group were applied to the age-specific populations for each of the subsequent calendar years up to 2010 to obtain the expected number of deaths for each of those years if the 1988 death rates had prevailed.

- To obtain the excess deaths that would have occurred, the expected deaths for each year were summed and then the observed number of deaths for each year was subtracted from this total.
- Similar charts are included for lung cancer and breast cancer in women.

Figure D (*Introduction*) shows the relative contributions to the changes in the total number of new cases and deaths that can be attributed to changes in cancer risk and cancer control practices, population size and aging of the population.

- The lowest solid line represents the total number of new cancer cases (or deaths) that would have occurred each year if the population size and age structure had remained the same as they were in 1986. This line reflects the impact of changes in cancer risk and cancer control practices.
- The middle line represents the number of new cases (or deaths) that would have occurred if the age structure of the population had remained the same as it was in 1986. This line reflects the impact of changes in cancer risk and cancer control practices, together with population growth.
- The top line represents the number of new cases (or deaths) that actually occurred and thus reflects the combined impact of changes in risk and cancer control practices population growth and aging of the population.

The series shown in Figure D were calculated as follows:

- Uppermost series: the annual number of Canadian cancer cases or deaths, for males or females
- Next-to-uppermost series: annual total population multiplied by the annual age-standardized rate, using the 1986 population distribution for males or females as the standard weights
- Next-to-baseline series: the 1986 total population multiplied by the annual age-standardized rate, using the 1986 population distribution for males or females as the standard weights
- Baseline (dotted line): the observed number of Canadian cancer cases or deaths during 1986, for males or females

Estimation of incidence (new cases) and mortality (deaths) for 2015

Two methods were used to estimate incidence and mortality data: the Nordpred Power5 regression model and five-year averaging.

Nordpred Power5 modelling

The Nordpred Power5 regression model was the primary method for estimating the number of new cases and deaths in 2015 for each cancer type by sex (except new cases of prostate cancer and nonmelanoma skin cancer; see *Prostate cancer incidence* and *Non-melanoma skin cancer incidence* below) reported in Tables 1.2 and 3.2. Nordpred is based on an age-period-cohort Poisson regression model but has enhancements that overcome difficulties in the standard Poisson model and improve projection accuracy.[17] Nordpred was developed into a software package[18] and is now one of the most frequently used methods for cancer projections worldwide.[19-23] The Nordpred Power5 regression model was used when the average annual number of cases for a type of cancer for the most recent five years was greater than 50. The assumption underlying the Nordpred Power5 regression model is that the annual number of new cases and deaths are independent Poisson random variables with mean values equal to the product of the population size for a particular year and the (true) annual rate.

- A separate Nordpred Power5 regression model was fit for each province, sex and type of cancer for the period of 1986 to 2010 for both incidence and mortality.
- The Nordpred Power5 regression model is $R_{ap} = (A_a + D \cdot p + P_p + C_c)^5$ where a, p and c represent age, period and cohort respectively in five-year groups. Input data were aggregated into five-year calendar periods and 18 five-year age groups (described above). Cohorts were created synthetically by subtracting age from period. R_{ap} is the incidence/mortality rate in age group a in calendar period p, A_a is the age component for age group a, and D is the common linear drift parameter of period and cohort.[24] P_p is the nonlinear period component of period p, and C_c is the nonlinear cohort component of cohort c.
- Nordpred uses a goodness-of-fit test to choose the number of five-year periods to be included in the dataset used for calculating future values (projection base).
- The software determines whether the average trend across all observed values, or the slope for the last 10 years of observed values, is used for projection, based on a significance test for departure from linear trend. This approach serves as an approximate way of looking for significant changes in the observed trend. The software also allows the user to make this selection.
- For each age group, a minimum of five cases in each five-year period was required. For age groups below this limit, the average number of cases in the last two periods is used to calculate future rates.
- To allow for a damping of the impact of current trends in the future time periods, a "cut-trend" option is used, which is a vector of proportions indicating how much to cut the trend estimate for each five-year projection period. A gradual reduction

in the drift parameter of 25% and 50% in the second and third five-year period respectively was used as the default in this publication.

- Age was included in all models as a factor. Age-specific incidence rate trends were then extrapolated to 2015. The predicted numbers of cancer cases in 2015 were calculated by multiplying these extrapolated incidence rates by the sex-, age- and province-specific population projections for the same year.
- The Nordpred "recent" and "cut-trend" options were modified from the default values for selected types of cancer, including thyroid cancer incidence and prostate cancer mortality, since recent trends are not expected to continue with as large an annual percent change. The values were chosen so that estimates were consistent with the most recent data available to the provincial cancer registries.

Five-year averaging

New cases and deaths in 2015 for each type of cancer were also estimated based on the average of the five most recent years of data. This method may be more realistic for cancers for which there are recent changes in trend (the Nordpred Power5 regression model results in poor estimates for these cancers because it is based on a medium- or longer-term trend) or when frequencies are low and result in unstable estimates using the Nordpred model. The average of rates for the most recent five years was calculated for each sex, five-year age group, cancer type and province. The predicted numbers were then obtained by multiplying these rates by the corresponding projected population sizes.

Selection of "best" estimates

Estimates from the two methods were compared for each sex, cancer type and geographic region for all ages combined. The "best" estimate for each category was selected in consultation with individual provincial or territorial cancer registries, according to the following guidelines:

- The Nordpred model was preferred except when frequencies were low.
- Five-year average estimates were used when the average annual number of cases during the most recent five years was less than or equal to 50.
- Five-year average estimates were used for the territories and are reported only for "all cancers" because of small sample sizes.
- The absolute value of the difference between the age-standardized rates estimated by the two methods was calculated and expressed relative to the five-year average estimate. For example, if the Nordpred Power5 regression model estimated a rate of 4.0 and the five-year average estimated a rate of 4.5, the relative difference would be $|4.0 - 4.5| \div 4.5$, or 11.1%.
- Provinces closely examined estimates for cancers where the absolute value of the relative difference exceeded 15%. Such situations may be indicative of important deviations from the long-term trend.
- Provinces provided feedback based on the availability of in-house projections, knowledge of local trends or access to more current data, which permitted an assessment of the estimates produced by the two different estimation methods.
- Estimates for Canada as a whole were computed as sums of the estimates for the individual provinces and territories.

Tables A12 and A13 indicate the cancer types that were reported according to the five-year average method for 2015. In these situations, the age-standardized rates for 2015 reported in this publication were calculated using the most recent five years of actual data.

All cancers combined

Provincial estimates of incidence counts for "all cancers" for males were computed as the sum of the "best" estimates for prostate cancer and all cancers excluding prostate, as estimated by the Nordpred modelling.

Prostate cancer incidence

The results of the Nordpred Power5 regression model are not satisfactory for prostate cancer. An annual age-specific trend Power5 projection model was fitted to a minimum of seven and a maximum of nine years of data, as selected by a goodness-of-fit test. The model is $R_{ap} = (A_a + D_a \cdot p)^5$, where a is age, p is period, A_a is the age effect of age group a and D_a is the slope parameter at the a_{th} age group, which takes the differentiation in trend from different 10-year age groups into consideration.

New cases of prostate cancer in 2015 were also estimated based on the most recent year of data available. This method may be more realistic when there are recent changes in trend (the age-specific trend model results in poor estimates for prostate cancers because it is based on a medium-term trend). The predicted numbers were then obtained by multiplying these rates by the corresponding projected population sizes.

Non-melanoma skin cancer incidence

Only a few provinces routinely collect data on the incidence of basal cell and squamous cell carcinoma of the skin (generally referred to as non-melanoma skin cancer, or NMSC). The numbers of NMSC in all of Canada, by sex, were estimated using these data.

- Counts of NMSC for 2002 to 2011 by year, sex and age group were provided by the Alberta Cancer Registry, the Manitoba Cancer Registry, the New Brunswick Cancer Registry and the Newfoundland and Labrador Cancer Registry. Linear regressions using a logarithmic transformation of the annual rates for each province and age group (0–39, 40–59, 60–79 and 80+ years) were conducted and projected to 2015. For Newfoundland and Labrador, data starting from 2006 were used for the projection because of the detection of a change in trend by changepoint analysis. The predicted numbers of NMSC cases for all of Canada were calculated by multiplying the projected incidence rates for each of the four provinces by the sex- and age-specific Canadian population projections for 2015.
- Reported new cases of NMSC for all of Canada are the average of 2015 estimates from Alberta, Manitoba, New Brunswick and Newfoundland and Labrador registries.

Rounding for reporting

- Predicted estimates of incidence and mortality presented in this publication have been rounded as follows:
  - Numbers between 0 and 99 were rounded to the nearest 5.
  - Numbers between 100 and 999 were rounded to the nearest 10.
  - Numbers between 1,000 and 1,999 were rounded to the nearest 50.
  - Numbers greater than or equal to 2,000 were rounded to the nearest 100.
- Percentages, age-standardized rates and age-specific rates were rounded to the nearest 10th, except in Tables 2.5, 4.5, A4 and A6, where space restrictions forced rounding to the nearest whole number.
- Age-specific and sex-specific numbers or rates were combined before rounding, so it is possible that the totals in the tables do not add up. However, any such discrepancies are within the precision of the rounding units described above.
- Estimates of incidence counts presented in Tables A1, A3, A7, A8 and Figures 1.3 and prevalence counts in Tables 6.1, 6.2, 6.3, 7.5, 7.6 and Figures 6.2 and 7.6 have been randomly rounded either up or down to a multiple of 5.

Precision of 2015 estimates

Estimates of precision (standard errors, coefficients of variation and confidence intervals) for 2015 counts and rates are available on request from the Surveillance and Epidemiology Division (Centre for Chronic Disease Prevention, Public Health Agency of Canada). The precision of an estimate depends primarily on the number of observed cases and the population size for each combination of cancer type, age, sex and province or territory.

Annual percent change (APC) in cancer incidence and mortality rates

The estimated APC was calculated for each cancer type by fitting a piecewise linear regression model, assuming a constant rate of change in the logarithm of the annual ASIR or ASMR in each segment. The models incorporated estimated standard errors of the ASIR or ASMR. The tests of significance used a Monte Carlo Permutation method. The estimated slope from this model was then transformed back to represent an annual percentage increase or decrease in the rate.

- Joinpoint analysis was applied to annual age-standardized rates over the period of 1986 to 2010 for both incidence and mortality to determine years in which the APC changed significantly. Such years are referred to as *changepoints*.
- The minimum time span on which to report a trend was set at five years. Thus, the most recent possible trend period in this study was 2006 to 2010.
- If no changepoint was detected within the periods of 2001 to 2010, then the APC was estimated by fitting a model within these time periods, in the same way as described above.

- If a changepoint was detected within this decade, then the APC was estimated from the trend in the last segment. Both the changepoint year and the APC for the years beyond the changepoint are indicated in Tables 1.5 and 3.5.

Probability of developing or dying from cancer

Probabilities of developing or dying from cancer were calculated according to the age- and sex-specific cancer incidence and mortality rates for Canada in 2010 and life tables based on all-cause mortality rates from 2008 to 2010. The methodology used was that of Zdeb[25] and Seidman et al.[26]

- The method used for the probability of developing cancer assumes that current age-specific incidence rates will prevail throughout the future lifetime of a person as they advance in age. Since this assumption may not be true, the probabilities should be regarded only as approximations.
- The probability of dying from cancer represents the proportion of people who die of cancer in a cohort subjected to the mortality conditions prevailing in the population at large in 2010. It was estimated by determining the proportion of deaths attributed to specific types of cancer for each sex and age group, multiplying this proportion by the corresponding number of deaths in the life table and summing the life table deaths over all age groups for each sex to obtain the probability of dying from each cause.

Potential Years of Life Lost (PYLL)

The indicator was calculated by obtaining deaths for ages <1, 1–4, 5–9, . . . 90+ for Canada in 2010 and life expectancy at the midpoints of the age groups. The PYLL is the total number of years of life lost obtained by multiplying, for each age group, the number of deaths by the life expectancy of survivors.[27]

Survival

This section of the publication has been reproduced, as is (with the exception of a new section on international comparisons), from the corresponding section in last year's publication (2014). As such, the analytical techniques used reflect the state of knowledge at the time of the production of that publication.

- Analyses were based on all primary cancers. The effect of including multiple cancers in survival analyses has been studied both internationally[28,29] and in Canada.[30]
- Analyses were based on those individuals aged 15–99 years at diagnosis excluding adolescent (15–19 years) bone cancers, which are dissimilar to those diagnosed in older adults. An exception was the analysis of childhood cancers, which was based on children under the age of 15 years at diagnosis.
- Deaths of people diagnosed with cancer are identified through record linkage of the CCR to the CVS: D and from information reported by provincial or territorial cancer registries. For deaths reported by a registry but not confirmed by record linkage, it was assumed that the individual died on the date submitted by the reporting province or territory. At the time of the analysis, registration of new cases and follow-up for vital status were complete through December 31, 2008.
- Persons whose diagnosis was established through death certificate only or autopsy only were excluded.
- Relative survival ratios (RSRs) were estimated by comparing the actual survival experience of persons diagnosed with cancer to that expected in the general population of people in Canada of the same age, sex, province of residence and time period. They were computed as ratios and expressed as percentages.
- Analyses were based on a publicly available algorithm,[31] with some minor adaptations. Expected survival proportions were derived using the Ederer II approach,[32] from sex-specific provincial life tables produced by Statistics Canada.
- Only observed survival proportions are reported for the analysis of childhood cancers as the estimates of observed and relative survival for the 0–14 year age range are essentially the same.
- Survival analyses were conducted using both period and cohort analysis methods.[33] The period approach to survival analysis provides up-to-date predictions of cancer survival.[34] With this method, follow-up data do not relate to a fixed cohort of people with cancer. Rather, estimates of period survival are based on the assumption that persons diagnosed in the period of interest will experience the most recently observed conditional probabilities of survival.
- When survival is generally improving, a period estimate tends to be a conservative prediction of the survival that is eventually observed.
- Conditional five-year relative survival is calculated as per five-year RSRs but using only the data of people who have already survived specified amounts of time since diagnosis.[35,36]

- As an indication of the level of statistical uncertainty in the survival estimates, confidence intervals formed from standard errors estimated using Greenwood's method[37] are provided. To avoid implausible lower intervals less than zero or upper limits greater than one for observed survival estimates, asymmetric confidence intervals based on the log (–log) transformation were constructed. RSR confidence intervals were derived by dividing the observed survival limits by the corresponding expected survival proportion.
- Age-standardized estimates were calculated using the direct method by weighting age-specific estimates for a given cancer to the age distribution of persons diagnosed with that cancer from 2001 to 2005. Confidence intervals for age-standardized RSRs were formed by multiplying the corresponding age-standardized observed upper and lower limits by the ratio of the age-standardized relative survival point estimate to the age-standardized observed survival point estimate.

Prevalence

This section of the publication has been reproduced, as is, from the corresponding section in last year's publication (2014). As such, the analytical techniques used reflect the state of knowledge at the time of the production of that publication.

The primary type of prevalence reported in this publication is tumour-based. Two-, five- and 10-year limited duration prevalence estimates are based on the number of cancers diagnosed in the previous two, five and 10 years among people who are alive.

Estimating prevalence requires current, accurate information about both the incidence and vital status of cases. Because of issues in correctly ascertaining the vital status of persons diagnosed while residing in Quebec, the following approach was used:

- Cancer site-, sex- and age-specific limited duration, tumour-based, prevalence estimates for all of Canada, excluding Quebec, were determined directly using the counting method.[38,39] Specifically, all primary invasive cancers (including *in situ* bladder cancers) diagnosed among persons residing outside of Quebec in the relevant time period and alive on January 1, 2009, were counted, regardless of whether they were first or subsequent primaries.
- Sex- and age-specific population estimates for January 1, 2009, were derived by averaging the 2008 and 2009 mid-year population estimates for all of Canada, excluding Quebec.
- Cancer site-, sex- and age-specific limited duration prevalence proportions for all of Canada, excluding Quebec, were then estimated by dividing counts by the appropriate population estimates.
- Cancer site-, sex- and age-specific counts for all of Canada, including Quebec, were then obtained by applying the prevalence proportions to Canadian sex- and age-specific population estimates, which included Quebec, and then summing across the strata.
- Person-based limited duration prevalence counts are estimated as the number of individuals represented in the tumour-based limited duration prevalence counts. For example, a person diagnosed with two primary cases of cancer A and one of cancer B in the 10 years preceding the index date would be counted once under cancer A, once under cancer B and once under all cancers combined for 10-year person-based prevalence. In terms of 10-year tumour-based prevalence, the same person would contribute twice to cancer A, once to cancer B and three times to all cancers combined.
- Age-specific prevalence estimates were obtained using the age attained as of January 1, 2009.
- The indirect approach for estimating cancer prevalence in Quebec is different from that used in previous versions of this publication. The current approach's primary assumption is that sex- and age-specific limited duration cancer prevalence proportions, calculated using cancer cases and population estimates from all of Canada excluding Quebec, are an accurate estimate of cancer prevalence proportions within Quebec.

Data and methods issues

Incidence

Although the Canadian Council of Cancer Registries and its Standing Committee on Data Quality make every effort to achieve uniformity in defining and classifying new cancer cases, reporting procedures and completeness still vary across the country. The standardization of case-finding procedures, including linkage to provincial or territorial mortality files, has improved the registration of cancer cases and comparability of data across the country. Some specific issues remain:

- Benign tumours and carcinomas *in situ* are not routinely captured or reported except for *in situ* carcinomas of the bladder. All cancer registries except Ontario report *in situ* bladder cancers to the CCR.
- There may be under-reporting of cancer cases in Newfoundland and Labrador due to incomplete linkage of cancer data with death data. This under-reporting could result in death counts or rates exceeding those for incidence in a specific year; this especially affects highly fatal cancers. The number of "death certificate only" (DCO) cases for 2008 to 2010 in Newfoundland and Labrador was estimated from 2007 data.
- In Quebec, cases diagnosed through DCO are incompletely captured prior to 2000. In addition, because of the registry's dependence on hospital data for the period included in the present report, the numbers of cases of some cancers are underestimated, particularly for those where pathology reports represent the main source of diagnostic information. Prostate cancer, melanoma and bladder cancer are affected in particular.[40] The 2015 estimates for these sites may be an underestimate because an increase in cases in the registry is expected with the inclusion of pathology reports starting with 2011 data.
- The number of DCO cases for 2010 in Quebec was estimated from the average of 2005 to 2009 data.
- The number of DCO cases for 2008, 2009 and 2010 in Ontario was estimated from the average of 2003 to 2007 data.
- The number of DCO cases is less than 2% of total cases.
- Non-melanoma skin cancers are excluded since most provincial and territorial cancer registries do not collect information on these cases. These cancers are difficult to register completely because they may be diagnosed and treated in a variety of settings and are numerous. Estimates based on four registries that include these cancers (see *Non-melanoma skin cancer incidence* above) are therefore likely to be underestimates.

Mortality

Although procedures for registering and allocating cause of death have been standardized both nationally and internationally, some lack of specificity and uniformity is inevitable. The description of cancer type provided on the death certificate is usually less accurate than that obtained by the cancer registries from hospital and pathology records.

Although there have been numerous small changes in definitions over the years (see Tables A11-1 and A11-2), there is one major earlier change of note:

- In the versions of this publication published before 2003, mortality due to colorectal cancer was based on the International Classification of Diseases, Ninth Revision (ICD-9),[41] codes 153–154, to be consistent with other publications. However, this underestimates colorectal cancer mortality by about 10% because most deaths registered as ICD-9 code 159.0 (intestine not otherwise specified) are cases of colorectal cancer.
- Starting in the 2003 edition of this publication, these deaths were included in the definition of colorectal cancer. As a consequence, mortality figures for colorectal cancer appearing in this publication cannot be directly compared with those appearing in publications prior to 2003.

Survival

Cases diagnosed in the province of Quebec were excluded from survival analyses, in part because the method of ascertaining the date of diagnosis of cancer cases in this province clearly differed from that of the other provincial cancer registries[42] and because of issues in correctly ascertaining the vital status of cases.

Prevalence

Because of issues in correctly ascertaining the vital status of persons diagnosed while residing in Quebec, prevalence data for this province were determined indirectly (see the *Methods* section above). Prevalence estimates were derived using the corresponding observed prevalence proportion calculated for the rest of Canada, stratified on age group, sex and cancer type.

Chapter 7: Special topic: Predictions of the future burden of cancer in Canada Public Health Agency of Canada modelling

Data

The observed cancer incidence data used for the projections cover 1983 to 2007, which represents the most recent period for which data are available for all parts of Canada when this study was undertaken. We extracted data from the Canadian Cancer Registry (CCR) for 1992 to 2007 and from the National Cancer Incidence Reporting System (NCIRS) for the earlier years. While the CCR is a person-oriented database, the NCIRS is an event-oriented database with cases diagnosed from 1969 to 1991. The cases in the NCIRS were coded in or converted to the *International Classification of Diseases, Ninth Revision* (ICD-9).[41] Projections were prepared for the most frequent invasive primary cancers (including *in situ* bladder cancers but excluding non-melanoma skin cancer (i.e., basal and squamous carcinoma). We generally defined cancer cases based on the *International Classification of Diseases for Oncology, Third Edition* (ICD-O-3) and classified them using Surveillance, Epidemiology, and End Results (SEER) Program Incidence Site Recode shown in Box 1.[2,43] Cases retrieved from the NCIRS used equivalent ICD-9 codes. Changes in cancer definition over time were derived following the methods outlined in the *Canadian Cancer Statistics*.[44]

BOX 1 Cancer definitions for incidence in Chapter 7

Cancer	ICD-O-3 site/histology type[a] (incidence)
Oral	C00–C14
Esophagus	C15
Stomach	C16
Colorectal	C18–C20, C26.0
Liver	C22.0
Pancreas	C25
Larynx	C32
Lung	C34
Melanoma	C44 (Type 8720–8790)
Breast	C50
Cervix	C53
Body of uterus	C54–C55
Ovary	C56.9
Prostate	C61.9
Testis	C62
Kidney	C64.9, C65.9
Bladder (including *in situ*)	C67
Central nervous system	C70–C72
Thyroid	C73.9
Hodgkin lymphoma[b]	Type 9650–9667
Non-Hodgkin lymphoma[b]	Type 9590–9596, 9670–9719, 9727–9729 Type 9823, all sites except C42.0,.1,.4 Type 9827, all sites except C42.0,.1,.4
Multiple myeloma[b]	Type 9731, 9732, 9734
Leukemia[b]	Type 9733, 9742, 9800–9801, 9805, 9820, 9826, 9831–9837, 9840, 9860–9861, 9863, 9866–9867, 9870–9876, 9891, 9895–9897, 9910, 9920, 9930–9931, 9940, 9945–9946, 9948, 9963–9964 Type 9823 and 9827, sites C42.0,.1,.4
All other cancers	All sites C00–C80, C97 not listed above
Mesothelioma[b]	9050-9055
Kaposi sarcoma[b,c]	9140
Small intestine	C17
Anus	C21
Gallbladder	C23
Other digestive system	C22.1, C24, C26.8–9, C48
Other respiratory system	C30–31, C33, C38.1–9, C39
Bone and joints	C40–41
Soft tissue (including heart)	C38.0, C47, C49
Other skin	C44 excl. 8050:8084, 8090:8110, 8720:8790
Other female genital system	C51–52, C57–58
Penis	C60
Other male genital system	C63
Ureter	C66
Other urinary system	C68
Eye	C69
Other endocrine	C37.9, C74, C75
Other, ill-defined, and unknown	Type 9740, 9741, 9750–9758, 9760–9769, 9950–9962, 9970–9989; C76.0–76.8 (type 8000–9589); C80.9 (type 8000–9589); C42.0–42.4 (type 8000–9589); C77.0–C77.9 (type 8000–9589)
All cancers	All invasive sites

[a] ICD-O-3 refers to the *International Classification of Diseases for Oncology, Third Edition*.[2] Cancers are classified by SEER Incidence Site Record.[43]

[b] Histology types 9590–9989 (leukemia, lymphoma and multiple myeloma), 9050–9055 (mesothelioma) and 9140 (Kaposi sarcoma) are excluded from other specific organ sites.

[c] Data are not available for Ontario and Canada.

Population estimates for Canada and the provinces/territories are based on quinquennial censuses conducted from 1981 to 2006. We used intercensal estimates prepared by Statistics Canada for the years between these censuses and postcensal estimates for 2007 to 2010.[45] Projected population estimates were used for 2010 to 2032, as prepared by Statistics Canada under assumptions of medium growth (scenario M1).[8] The scenario M1 incorporates medium growth and historical trends (1981 to 2008) of interprovincial migration. For the total population, the low and high growth scenarios are about 6% below and above the M1 scenario, but this range is reduced to 3% for ages 65 or older.

Data on cancer incidence counts and population estimates were summarized into 5-year age groups (0–4, 5–9, …, 80–84, 85+) and 5-year periods of diagnosis (1983 to 1987, 1988 to 1992, 1993 to 1997, 1998 to 2002, 2003 to 2007) by sex and province/territories as a whole. The projected population figures were similarly aggregated for 5 projection quinquennia (2008 to 2012, 2013 to 2017, 2018 to 2022, 2023 to 2027, 2028 to 2032). The single-year data from 1994 to 2007 were used for projecting prostate cancer incidence. Rates for each category were calculated by dividing the number of cases in each category (a combination of cancer site, sex, region, period and age group) by the corresponding population figure. These age-specific rates were standardized to the 1991 Canadian population, using the direct method,[46] to obtain the age-standardized incidence rates (ASIR).

Methods

There are several methods for projecting cancer burden, differing in terms of the type of statistical model, selection of the data used for model fitting and the method of extrapolating the model components into the future. The model type diverges from simple linear or log-linear regression of age-specific rates or counts against time[47-49] to age-period-cohort (APC) modelling.[17,46,50] Within the framework of APC models, effects of age, period and cohort are addressed in heterogeneous ways such as generalized linear models[51,52] including their derivative, Nordpred method, based on a step function on 5-year intervals,[17,23] generalized additive models[53,54] with polynomial[17,55] or spline smoothing methods,[56] and Bayesian models[57] with Markov chain Monte Carlo (MCMC) simulation.[58] The link function is either common exponential[46,50,57] or non-canonical power.[17,23] A model is fitted to all available data or their subset for an adequate fit through a goodness-of-fit test.[17,23] The assumptions used for extrapolating the observed trends include keeping current rates unchanged in future,[59] continuing overall historical trend,[47,57] extending only the most recent trend[17,23] and adjusting the extent to which the observed trends are likely to influence the future.[17,23] To develop the most accurate profile of future cancer burden, the Public Health Agency of Canada used the major projection models to produce projections of current rates as would have been forecast 15 or 20 years ago based on the long-term data series in Canada, then compared the projected rates with those observed and concluded with a cancer-dependent modelling approach.

Projection models

The following models were considered for our projections:

- Nordpred power-5 models
- Bayesian Markov chain Monte Carlo (MCMC) method
- five-year average model
- age-specific trend power-5 model fitting single-year data for short-term projections of prostate cancer
- relative percent adjustment method

These models are described in further detail as follows:

1. Nordpred power-5 models (NP_ADPC and NP_ADP)

The Nordpred APC model,[17,23,60] based on a standard APC Poisson regression model,[24,50,51] uses the power-5 link function instead of the traditional logarithmic link to reduce the exponential changes and summarizes the linear trends in period and cohort over the observed data into a drift component. The model can be written as

$$\text{case}_{ap} \sim \text{Poisson}(\mu_{ap}),$$

$$R_{ap}\left(or, \left(\frac{\mu_{ap}}{n_{ap}}\right)\right) = (A_a + D \cdot p + P_p + C_c)^5, \qquad \text{(NP\_ADPC)}$$

where R_{ap} is the incidence rate in age group a in calendar period p, which is the mean count μ_{ap} of case_{ap} divided by the corresponding population size n_{ap}, A_a is the age component for age group a, D is the common linear drift parameter of period and cohort,[24] P_p is the non-linear period component of period p and C_c is the non-linear cohort component of cohort c. Cohorts were calculated as $c = A + p - a$, with A = total number of age groups (=18).

Nordpred also arithmetically attenuates the drift into the future to damp the impact of past trends in the future, chooses data for model fitting and chooses the drift for extrapolations. Nordpred with its standard drift reduction and with various increased or decreased reductions of the default "cut trend" vector was the primary method used in the projections in this study. In addition, for cancers with average annual counts of fewer than 50 over the last 5 observation years when cohort effects were not present based on a significance test, a Nordpred model without cohort component (denoted as NP_ADP) was also considered.

2. Bayesian Markov chain Monte Carlo (MCMC) method

Instead of a maximum likelihood approach, we applied a Bayesian framework to the APC model. Bayesian models for cancer projection estimate the age-specific rates from their posterior distribution by using MCMC techniques.[57,58] We considered this approach for situations where there are too few observed cases to properly estimate model parameters via the Nordpred method or where projections from Nordpred seem unlikely. We considered 2 Bayesian approaches.

2.1. Bray approach (B_APC)

For the classical APC Poisson model,[24] Bray specified a second-order autoregressive prior model to smooth age, period and cohort effects and to extrapolate period and cohort effects.[57,58] The model can be written as:

$$\text{case}_{ap} \sim \text{Poisson}(\mu_{ap}),$$

$$\log\left(\frac{\mu_{ap}}{n_{ap}}\right) = A_a + P_p + C_c,$$

Supposing that we compute N-period projections based on P-period observed data, there are total $C = A + P - 1$ cohorts. With the Nordpred model, an individual cohort c can be calculated as $c = A + p - a$. The prior distributions are defined as follows. For the A age effects:

$$A_1 \sim normal(0,1000000\frac{1}{\tau_A});$$

$$A_2 \mid A_1 \sim normal(0,1000000\frac{1}{\tau_A});$$

$$A_a \mid A_{1,\ldots,a-1} \sim normal(2A_{a-1} - A_{a-2}, \frac{1}{\tau_A}), 3 \le a \le A.$$

For the $P + N$ period effects:

$$P_1 \sim normal(0,1000000\frac{1}{\tau_P});$$

$$P_2 \mid P_1 \sim normal(0,1000000\frac{1}{\tau_P});$$

$$P_p \mid P_{1,\ldots,p-1} \sim normal(2P_{p-1} - P_{p-2}, \frac{1}{\tau_P}), 3 \le p \le P + N.$$

For the $C + N$ cohort effects:

$$C_1 \sim normal(0,1000000\frac{1}{\tau_C});$$

$$C_2 \mid C_1 \sim normal(0,1000000\frac{1}{\tau_C});$$

$$C_c \mid C_{1,\ldots,c-1} \sim normal(2C_{c-1} - C_{c-2}, \frac{1}{\tau_C}), 3 \le c \le C + N.$$

The variance parameters τ_A, τ_P and τ_C (determining the smoothness of age, period and cohort effects, respectively) are given the same gamma prior,

$$\tau \sim \text{gamma}(0.001, 0.001).$$

Fitted and projected rates are derived by combining the simulated age, period and cohort effects based on

$$R_{ap} = \exp(A_a + P_p + C_c).$$

Three MCMC chains were run for a "burn-in" of 50,000 iterations. Parameter estimates (posterior medians) were based on an additional 50,000 iterations for each chain, thinned to every thirtieth sample (150,000 samples). Chain convergence was assessed via the Gelman-Rubin statistic, examination of sample autocorrelation and visual inspection. All Bayesian modelling was implemented in WinBUGS.[61] Additional details can be found elsewhere.[62]

2.2. To stabilize regional estimates, initial or "prior" distributions based on national data were assumed for regional parameters and then updated using the actual regional data. The model can be written as:

$$\text{case}_{ap} \sim \text{Poisson}(\mu_{ap}),$$

$$\log\left(\frac{\mu_{ap}}{n_{ap}}\right) = A_a + P_p,$$

We first used the model to estimate national-level age and period coefficients, denoted as $\hat{A}_a$ and $\hat{P}_p$, respectively. Regional age A_a and period P_p effects were then given normally distributed priors with means equal to the corresponding national estimates,

$$A_a \sim \text{normal}(\hat{A}_a, \frac{1}{\tau_A}),$$

$$P_p \sim \text{normal}(\hat{P}_p, \frac{1}{\tau_P}),$$

where variance parameters , were given the same gamma prior,

$$\tau \sim \text{gamma}(0.001, 0.001)$$

Following Spiegelhalter et al.,[63] corner constraints were imposed on the first age effect ($A_1 = 0$) to facilitate computations.

3. Five-year average model (AVG)

The 5-year average model assumes that the age-specific average rates of cancer incidence in the most recent 5 years of observed data will remain constant in future years, so that future numbers of cancer would be affected only as a consequence of demographic changes in the population.

4. Age-specific trend power-5 model fitting single-year data for short-term projections of prostate cancer (ADa)

Trends in prostate cancer incidence since the early 1990s have been subject to over-diagnosis (the detection of latent cancer that would never have been diagnosed in the absence of screening) because of the rapid dissemination of the PSA test.[64] The projections of period analysis from Nordpred seem unlikely. Therefore, an age-specific trend power-5 model based on yearly data was fitted to a minimum of 8 years of observations from 1994 to 2007 for projections of prostate cancer incidence in the first 5 (2008 to 2012) future years: $R_{ap} = (A_a + D_a \cdot p)^5$, where D_a is the slope parameter in age group a, which takes the differentiation in trend from different age groups into consideration. This model also allowed for the "spike" value in the year 2001. Another peak year was in 1993, which was excluded from the modelling.

5. Relative percent adjustment method – regional projections derived from scaling down national-level projections (SD)

For a cancer type in a region with average annual counts over the last observed 5 years of fewer than 10, the age-specific counts were also calculated by adjusting the national estimates (based on a modified method used in the Cancer Registry of Norway).[65] Let w denote the relative difference of the averages of the ASIR in the last 5 observation years between the region and the whole country, that is,

$$w = \sum_{t=2003}^{2007} ASIR_{Rt} \Big/ \sum_{t=2003}^{2007} ASIR_{Nt},$$

then the cancer incidence rate in a region R, age group a and period p,

$$R_{Rap} = R_{Nap} * w = (C_{Nap} / P_{Nap}) * w,$$

where R_{Nap}, C_{Nap} and P_{Nap} are the national cancer incidence rate, count and population size at age group a and period p, respectively. For example, if the region had 5% lower rates than the national average in the last 5 observation years, the age-specific rates in each future period were adjusted down by 5% for that region. We therefore have the corresponding number of new cancer cases,

$$C_{Rap} = R_{Rap} * P_{Rap}.$$

Comparison of models

Projected average annual numbers of cancer cases from the models described above based on observed incidence counts in 1972 to 1991 were compared with observed values in 1992 to 2007 in Canada. Quebec was excluded from the comparison because of data quality issues prior to 1983.[66,67] Median absolute relative difference between predicted and observed values, |observed-predicted|/observed, was calculated to examine each model's overall tendency to overestimate or underestimate the actual number of cancer cases. The absolute difference was used when comparing for rare cancers. We compared median prediction errors for each model across combinations of cancer type, geographical area and sex. We also separately compared model performance for each cancer type, across all geographic areas and sexes. Friedman's test was used to test for statistical difference in medians between different projection models.[68]

Projection validation and adjustment

The model selection was performed by assessment of the models and integrating these model comparison results with those from other published studies. However, a model created on cohorts in early periods may give inaccurate predictions when applied to contemporary cohorts. Owing to limitations in the availability of different long-term datasets used for validating the selected models, we examined the projections from the selected models using our knowledge of data quality, trends in cancer rates in different regions, risk factors or interventions to ensure the estimates are appropriate. When the estimated trends seemed unlikely, we used such knowledge to adjust the extrapolation methods of the fitted models or used Bayesian simulations instead of the generalized linear models.

Selected models by cancer

The following projection methods were used in this study.

- Common cancers (average annual count over the latest 5 observation years for a national or regional series, N > 50): NP_ADPC model with varied "recent" and "drift" values.
- Less common cancers (10<N ≤ 50): NP_ADPC or NP_ADP model (based on the significance of the cohort effect and comparison with AVG results) with varied "recent" and "drift" values. The simple age-effect only AVG model has been proven to be the best approach for rare cancers in our model evaluation and other studies[69] and has been used in recent reports.[70] With this, we adopted either NP_ADPC or NP_ADP, from which the projections were closer to the AVG results, instead of basing them solely on linear extrapolation of the 5-year average rate into the future. One exception is that B_APC was applied to multiple myeloma in males in New Brunswick.
- Rare cancers (N ≤ 10): NP_ADPC, NP_ADP, B_APC, B_AP or SD model, whichever projections were closer to the AVG results.
- Prostate cancer: ADa + AVG, defined as
  - using ADa to project for the first 5 future years and then
  - using the age-specific average rates of the predicted 5-year data to estimate counts for the second to fifth 5-year periods.
- "All cancers" for males: The estimates of incidence counts were computed as the sum of the estimates for prostate cancer and for all cancers excluding prostate, as estimated by NP_ADPC modelling.

Data issues and limitations

Our model comparison exercise, based on the more recent observed data that were not available when the present study was undertaken, addressed the accuracy of the projection methods used in this study. For example, Box 2 presents the medians of the absolute relative differences between the observed and projected average annual number of cases at the national level only and across the provinces in 1992 to 2010 by length of projection for the combinations of cancer type (excluding prostate cancer), sex and province (excluding Quebec because of data quality issues prior to 1983).[66,67] The projected numbers were calculated by the projection method used in this study (denoted as PHACpred, which, for this comparison, includes only the Nordpred APC models (NP_ADPC) with the Nordpred standard drift (D) reduction and its modifications), and the 3 versions of NP_ADPC with its default drift reduction – using the average trend over the whole observation period for projections (M0F), using the slope between the 2 most recent periods for projections (M0T), and automatically determining whether the recent trend (or the average trend) is projected based on a significance test for departure from a linear trend (M0A). The medians are shown with and without all male cancers combined. Box 2 shows that the medians from PHACpred are the smallest in the 4 models for any length of projection period. The differences in the medians among the 4 models or between PHACpred and M0A are not statistically significant when across the provinces (each $p \geq 0.05$), but are statistically significant for national-level 15- and 20-year projections. The performances of M0F and M0T were published for the population of the 4 Nordic countries.[17] In this study, Moller et al.[17] made projection model comparisons for 20 cancer sites in each sex for Denmark, Finland, Norway and Sweden for 1983 to 1997 based on 1958 to 1977 data. The respective median deviations (over the combinations of site, sex and country) of M0F and M0T are 13% and 12% for 10-year projections and 20% and 18% for 20-year projections. The median numbers are similar to ours for M0T model in the scenario from across the provinces, but M0F seems to perform better for our specified data. Consequently, we can see that our PHACpred multiple modelling approach produced more accurate projections than the default Nordpred method applied uniformly.

Although the standardization of case ascertainment, definition and classification has improved the registration of cancer cases and comparability of data across the country, reporting procedures, accuracy and completeness still vary.[44] International Agency for Research on Cancer (IARC) rules[3] for multiple primaries were used for cases from the CCR, whereas during the period covered by the NCIRS, registries other than Quebec and Ontario used multiple primary rules that allowed a small percentage of additional cases.

Non-melanoma skin cancer is difficult to register completely because it is quite plentiful and may be diagnosed and treated in a variety of settings. Most provincial and territorial cancer registries do not register these cases. For this reason, non-melanoma skin cancer is excluded from our analysis.

BOX 2 Median of absolute relative difference (%) between observed and projected number of average annual cancer cases in 1992–2010, Canada[a]

Projection method	Length of projection					
	10 years		15 years		20 years	
	National level	Across provinces	National level	Across provinces	National level	Across provinces
Exclusion of prostate cancer						
M0F	10.6	11.1	13.6	15.5	10.3	15.2
M0T	7.8	11.8	10.6	16.1	14.9	18.3
M0A	7.8	11.6	10.6	14.6	16	16.3
PHACpred	5.8	10.9	6.9	13.9	7.6	15.1
p-value[b] of differences among the 4 models	0.02	0.36	<0.01	0.12	<0.01	0.06
p-value of differences between PHACpred and M0A	0.12	0.35	<0.01	0.4	<0.01	0.53
Exclusion of prostate cancer and all male cancers combined						
M0F	10.6	11.7	14.3	15.8	10.4	15.8
M0T	7.8	12.3	10.9	16.7	15.2	18.9
M0A	8.5	11.8	12	15.5	16.1	17.1
PHACpred	6.3	11.3	7	14.4	7.6	15.5
p-value of differences among the 4 models	0.03	0.34	<0.01	0.17	<0.01	0.05
p-value of differences between PHACpred and M0A	0.12	0.42	<0.01	0.52	<0.01	0.61

[a] Excluding Quebec, see *Methods*.

[b] p-value of Friedman's test.

Note:
1. Comparisons were presented for the combination of cancer site, sex and area, for which the Nordpred APC models (NP_ADPC) with varied drift reductions (denoted as PHACpred) were used for projections.
2. Three versions of NP_ADPC with its default drift reduction: using the average trend over the whole observation period for projections (M0F), using the slope between the two most recent periods for projections (M0T), and automatically determining whether the recent trend (or the average trend) is projected based on a significance test for departure from linear trend (M0A).

For the observed data years covered by this analysis, death certificate only (DCO) cases were not reported to CCR by Quebec and Newfoundland and Labrador, with the exception of the 2000 to 2006 Quebec data and 2007 Newfoundland and Labrador data. The number of DCO cases for 2007 in Quebec was estimated by averaging the numbers in 2002 to 2006. This missing reporting has likely led to underestimates of the incidence rates in these provinces, especially for highly fatal cancers such as lung and pancreas. In Canada, the number of DCO cases is less than 2% of the total new cancer cases. In addition, the incidence of some cancers in Quebec, particularly for those that rely more heavily on pathological diagnosis, are underestimated as a result of the registry's dependence on hospitalization data. Prostate cancer, melanoma and bladder cancer estimates are affected.[40] Owing to changes to the Quebec registry that increase registration for data after 2007, the number of melanoma cases is underestimated in the current report.

The principal projection models used are based on decomposition of the observed incidence data into 3 time dimensions of age, period and cohort. While the effects of risk factors, screening and intervention were not incorporated into the models because of insufficient data in most circumstances, they have been modelled indirectly to some extent, through the period and cohort effects in the model.[23] However, the models will be insensitive to any recent changes not foreshadowed in the observed time series of cancers because of the long latency between exposure and cancer outcomes.

The observed incidence rates for the cancers of female genital system also reflect the fact that many females who underwent a hysterectomy or bilateral salpingo-oophorectomy were not at risk of developing the disease. The prevalence of hysterectomy was high in the Atlantic provinces and Quebec based on the 2003 Canadian Community Health Survey (Cycle 2.1) (data not shown). Using all females as the denominator in the rate calculation can result in artefactual differences in regional rates. In addition, changes in trends of the rates of these procedures can impact the cancer projections. For example, if surgery rates decrease more than expected based on current trends, the incidence rates of cervical, uterine and ovarian cancers would be greater than our projections.

It is useful to acknowledge that forecasting prostate cancer incidence is subject to some uncertainty as a result of over-diagnosis of this cancer because of the PSA test. The common Nordpred approach would predict extreme increases in prostate cancer incidence rates, so this necessitated a model adjustment and/or exclusion of the observed data for certain periods. We used the 2-step approach of the short-term modelling projection following by the long-term constant-rates projection for projecting prostate cancer incidence in this study. The method that future numbers of cancer would be affected only by the demographic changes has been adopted for prostate cancer projection in several publications.[65,22,70] Quon et al.[70] assumed that the age-specific incidence rates of prostate cancer in the current year would remain in the future in their "best-case" scenario and predicted that the number of new prostate cancers will increase to 35,121 cases by 2021 in Canada. This is consistent with our estimate of 34,460 new cases annually in 2018 to 2022. Moller et al.[65,22] used the 5-year average method for their projections of prostate cancer incidence in England and Norway. These constant-rate projection methods would result in underestimates of the future burden of prostate cancer if the prevalence of screening is increased or the diagnosis is improved. The future use of the PSA test will principally determine the accuracy of our projections for prostate cancer incidence.

Projection of thyroid cancer should be interpreted with caution. Even though we used the long-term trends instead of the more recent rapid increasing trends for thyroid cancer projection, the future increasing of the rates may not be as large as projected.

Canadian Partnership Against Cancer modelling

The Cancer Risk Management Model (CRMM), developed by the Canadian Partnership Against Cancer and Statistics Canada, was designed to evaluate the impact of healthcare policy changes in the Canadian system.[71,72] The CRMM incorporates the risk of developing and dying from cancer and other causes, as well as screening and clinical management with healthcare costs and labour data, and can be used to assess both health outcomes and economic impact. The cancers evaluated in this report are lung, colorectal and cervix.

The CRMM is a discrete event micro-simulation model that operates in a competing risk, continuous time framework and is supported by a user-friendly web-enabled platform to enable browsing and custom scenario development by registered users (cancerview.ca).

All CRMM simulation results are based on version 2.2.1.0 of 32 million simulated cases (scaled to Canadian population size).

Data

The CRMM simulates and projects a representative sample of the Canadian population using Statistics Canada's official demographic projections. CRMM takes into account births, mortality, immigration and inter-provincial migration to represent the age-sex-provincial structure of the population.

The Canadian Cancer Registry is a fundamental source of cancer data used to inform the incidence and staging of colorectal, lung and cervical cancers. Smoking behaviour was simulated to match Canadian survey data across time by age, sex and province from the Canadian Health Survey (1979), National Population Health Survey (1994) and Canadian Community Health Survey (2008), and the model was assessed against tobacco manufacturer's data. Healthcare costs were obtained predominantly from Ontario sources and included the Ontario Health Insurance Plan Schedule of Benefits for physician fees, the Ontario Case Costing Initiative for hospital costs and Cancer Care Ontario's New Drug Funding Program and are in 2008 dollars. Sources for economic data included census and other simulation models at Statistics Canada. Additional parameters were obtained from the literature, including survival data, data to inform natural history of cancer progression, end-of-life care costs and efficacy of screening.

Methods

Lung cancer simulations

The CRMM simulates the hazard of developing lung cancer using a risk equation from the literature[53] that combines the risk associated with cumulative lifetime radon and smoking exposure and was aligned with the number of cases reported to the Canadian Cancer Registry by age, sex and province. Recent trends in smoking were assumed to continue into future years. Radon exposure is based on estimates from Health Canada Survey for selected locations.

Screening populations at high risk of lung cancer with three annual screens using low-dose computed tomography (LDCT) was shown in the National Lung

Screening Trial (NLST) to reduce lung cancer mortality by 20% after approximately 6 years of follow-up. The CRMM includes a screening module that can be used to assess LDCT for a variety of screening strategies including thresholds of risk for eligibility to program, age to start and end screening, screening frequency, and participation and cost assumptions. The simulation has been assessed against the NLST results.[73]

The screening scenarios presented here aligned with the NLST eligibility criteria, that is, persons aged 55–74 with at least a 30 pack-year smoking history in current smokers or in former smokers who quit within the last 15 years. The participation rates were set at 30% starting in 2015 and remained at those levels to 2030 under an annual screening program. Additionally, the simulation can evaluate the potential benefit of achieving smoking cessation through an adjunct program. In this scenario, the smoking cessation success rate among screeners has been set to 22.5% at a cost of $350.

Colorectal cancer simulations

The CRMM simulates the natural history of colorectal cancer that is benchmarked to incidence and staging reported in the Canadian Cancer Registry.[74] The model simulates growth of polyps in seven different sites within the proximal and distal colon, which can grow in size and become cancerous. Cancers can progress from stage I to stage IV. Polyp prevalence was estimated from the literature. Survival data were obtained through chart review and benchmarked to the Canadian Mortality Database. Screening efficacy has been estimated through a variety of sources, including randomized control-led trials[75-77] and through model calibration to a variety of published studies including the Prostate, Lung, Colorectal and Ovarian (PLCO) randomized trial.[78]

Cancers can be diagnosed clinically or through screening and are staged and treated at diagnosis with follow-up protocols in place. Simulated patients have a risk of relapse and death from colorectal cancer, which varies by stage at diagnosis. Population-based screening strategies can be evaluated for various screening modalities including fecal occult blood test (guaiac or immunological), flexible sigmoidoscopy or colonoscopy, or combined modalities. In this report, fecal immunochemical blood test (FIT) was evaluated compared to no organized screening with 30% and 80% participation rates.

Participation rates

Both screening scenarios evaluated assumed that participation to organized screening started in 2007 using fecal immunochemical blood testing and participation ramped up gradually to 30% by 2015. From 2015 to 2030, the alternative screening scenarios were evaluated at constant 30% participation or gradually increasing to 80% participation by 2030.

Screening can detect polyps and cancers

The efficacy of screening modalities is expressed through the test's sensitivity to detect polyps and cancer, as well as the test's specificity (Box 3):

BOX 3 Sensitivity and specificity of screening tests for colorectal cancer screening

Polyp or Cancer state	FIT*	Colonoscopy	
		Distal	Proximal
Polyp less or equal to 5 mm in size	0.025	0.75	0.65
Polyp between 6 and 9 mm in size	0.05	0.85	0.85
Polyp greater or equal to 10 mm in size	0.15	0.95	0.875
Cancer	0.75	0.95	0.99
Specificity of the screening test			
First screening round	0.95	0.90	
Subsequent screening round	0.95	0.90	

FIT=fecal immunochemical test
*FIT cut-off of 100 ng/ml

HPV/Cervical cancer simulations

CRMM HPV/Cervical cancer model consists of two complementary components: Human Papillomavirus Microsimulation Model (HPVMM) and CRMM. Information in HPVMM communicates with the subsequent CRMM to model a life-course HPV/Cervical cancer-related event such as sexual debut, virus infection/transmission, HPV natural history (cervical intraepithelial neoplasia, warts), screening, cervical cancer incidence, treatment, progression and death.

HPVMM

HPVMM is an interacting-agent model that simulates lifetimes of hypothetical persons to model sexual network, virus transmission and vaccination strategies. HPVMM was developed based on a published model by Van de Velde et al (2010).[79] The interacting nature of the model allows males and females aged 10 years and older to form relationships with variable durations over time. HPV strains propagate within this population through the sexual relationship, effectively taking account of herd immunity associated with vaccinations.

HPVMM assumes that the population being simulated is stationary (the population does not grow nor shrink over time) and that the characteristics ruling individual's sexual behaviours (e.g., sexual debut, partnership formation/separation, sexual acts) and virus transmissions (e.g., virus infection, clearance) are constant over time. Under these assumptions, HPVMM generates HPV prevalence and incidence to be constant over time at the steady-state level in the absence of a vaccination program.

Six HPV serotypes are currently modelled: 6, 11, 16, 18, other carcinogenic types combined and other non-carcinogenic combined. Bivalent and quadrivalent vaccines are currently available for assessment. HPVMM allows 100 years of projection to assess the effect of various vaccination strategies on HPV prevalence and incidence.

HPVMM utilizes various data for building the model. Information on demography is based on Canadian Vital Statistics. Parameters associated with sexual network and virus transmission are based on Van de Velde et al (2010),[79] literature, clinical trials and Statistics Canada surveys. Input parameters, particularly those associated with sexual behaviour and virus transmissions, are subject to a high degree of uncertainty due to limited information available. Therefore, extensive parameter estimation was performed to find feasible parameters sets (solutions) that are consistent with observed data on sexual behaviours and HPV prevalence. The parameter estimation was done by running thousands of simulations repeatedly, each time with a different combination of input parameters systematically drawn from the range of pre-specified input parameter values through Latin Hypercube Sampling. Projections from HPVMM, therefore, can be presented as a range of outputs (i.e., confidence intervals) that account for the possible variations in outputs resulting from uncertain input parameter values.

HPVMM was run with 250,000 interacting agents with 100-year burn-in to obtain equilibrium sexual network and HPV prevalence levels. All HPVMM simulation results are based on version 1.7.1.0., and results are scaled to reflect the population size of Canadians aged 10 years and older in 2011.

CRMM

CRMM is a non-interacting agent model that simulates the representative Canadian population dynamics and models HPV natural history, screening, treatment of abnormal lesions/warts, cervical cancer incidence and progression, cancer treatment and cervical cancer death. By communicating results from HPVMM, the natural history of HPV is simulated through infection status (susceptible / immune / infected) and cervical abnormality (cervical intraepithelial neoplasia, adenocarcinoma in situ, genital warts), which allows the abnormal lesions to progress or regress. Eligible women follow cervical cancer screening protocols, which can detect abnormal lesions through various screening/diagnostic modalities. A small proportion of women with abnormal lesions could develop cervical cancers. Upon the cancer detection (through screening or clinical detection), a cancer stage is assigned and women follow a detailed sequence of cancer treatments based on their cancer stages. Cancers can be cured, relapse and/or result in death from cervical cancer (or from other causes).

The model is consistent with recent and past observed practice/data with respect to the screening and follow-up strategies. A wide variety of future screening strategies can be evaluated by altering primary screening modalities (standard or liquid-based cytology, HPV DNA or combinations) and follow-up protocols based on target age, time and vaccination status.

Input data come from a variety of sources. Information associated with natural history and screening is based on literature. Incidence, staging and survival are based on Canadian Cancer Registry of various years as well as literature. Screening and treatment costs are based on publicly available sources such as Ontario Case Costing Initiative and provincial formularies.

The model was validated extensively so that the model reflects observed data. Incidence of cervical cancer was validated against age-specific incidence derived from the Canadian Cancer Registry over time. Additional model assessment was conducted so that model outcomes associated with natural history and screening are consistent with published data.

Scenarios

Box 4 below summarizes scenario being evaluated.

Default scenario

Default (status quo) scenario assumes the following:

- Vaccination
  - vaccinating 12-year-old girls annually with 70% vaccination rate with quadrivalent vaccine
  - vaccination program beginning in 2007 without a ramp-up in vaccination rates
  - vaccines are perfect (i.e., 100% efficacious with no waning over time)
- Cervical cancer screening
  - cytology as a primary screening modality (mixture of standard and liquid-based)
    - reflects Canadian historical screening behaviours (from 1955 to 2012)
    - triennial screening for women aged 21–69 (2013 and onwards)
  - follow-up protocols based on current practice

Alternative scenarios

Alternative scenarios assessed in this analysis include combinations of various vaccination and cervical cancer screening strategies.

Alternative cervical cancer screening programs are constructed by changing future screening patterns (2013 and after) in terms of primary screening modality and target population (vaccinated versus unvaccinated).

BOX 4 Scenario description for cervical cancer models

Scenario #	Scenario name	HPVMM*		CRMM description†	
		Target pop	Vaccination rate	Target pop	Primary screening modality & frequency
1	Status quo (Cytology + HPV Vaccination)	Girls	70%	Age 21–69	Cytology, every 3 years
2	Cytology + One-time HPV DNA test + Vaccination	Girls	70%	Age 21–69	Cytology, every 3 years
				Age 30	HPV DNA (one-time)‡§
3	Cytology for unvaccinated + HPV DNA test for vaccinated	Girls	70%	Age 21–69 who have never been vaccinated	Cytology, every 3 years
				Age 21–69 who have been vaccinated	HPV DNA, every 10 years§

* Vaccination program starts in 2007.

† Screening modalities specified here begin in year 2013. Default historical practice patterns apply for years prior to 2013. Screening participation rate is 70% for all screening strategies.

‡ One-time HPV DNA test is implemented when a woman's initial or next regular screening is scheduled between age 30 and 35. Each eligible woman has only one chance of attempting to receive the primary HPV DNA test.

§ Ontario follow-up protocol (i.e., a second HPV DNA test if the first one was positive and the triage cytology was negative) applies as a follow-up to the primary HPV DNA testing.[80]

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TABLE A10 Cancer definitions

Name used in the text	ICD-O-3 names (incidence)	ICD-O-3 Site/Type (incidence)	ICD-10 names (mortality)	ICD-10 Site/Type (mortality)
Oral	Lip, base of tongue, other unspecified parts of tongue, gum, floor of mouth, palate, other and unspecified parts of mouth, parotid gland, other and unspecified major salivary glands, tonsil, oropharynx, pyriform sinus, hypopharynx, other and ill-defined sites in lip, oral cavity and pharynx	C00–C14	Malignant neoplasms of lip, oral cavity and pharynx	C00–C14
Esophagus	Esophagus	C15	Malignant neoplasm of oesophagus	C15
Stomach	Stomach	C16	Malignant neoplasm of stomach	C16
Colorectal	Colon, rectosigmoid junction, rectum, intestinal tract NOS	C18–C20, C26.0	Malignant neoplasm of colon, rectosigmoid junction, rectum, and intestinal tract - part unspecified	C18–C20, C26.0
Liver	Liver	C22.0	Malignant neoplasm of liver	C22.0, C22.2–C22.7
Pancreas	Pancreas	C25	Malignant neoplasm of pancreas	C25
Larynx	Larynx	C32	Malignant neoplasm of larynx	C32
Lung	Bronchus and lung	C34	Malignant neoplasm of bronchus and lung	C34
Melanoma	Skin (melanoma)	C44 (Type 8720–8790)	Malignant melanoma of skin	C43
Breast	Breast	C50	Malignant neoplasm of breast	C50
Cervix	Cervix uteri	C53	Malignant neoplasm of cervix uteri	C53
Body of uterus	Corpus uteri, uterus NOS	C54–C55	Malignant neoplasm of corpus uteri and uterus - part unspecified	C54–C55
Ovary	Ovary	C56.9	Malignant neoplasm of ovary	C56
Prostate	Prostate gland	C61.9	Malignant neoplasm of prostate	C61
Testis	Testis	C62	Malignant neoplasm of testis	C62
Bladder (including *in situ* for incidence)	Bladder	C67	Malignant neoplasm of bladder	C67
Kidney	Kidney NOS, renal pelvis	C64.9, C65.9	Malignant neoplasm of kidney and of renal pelvis	C64–C65
Brain/CNS	Meninges, brain, spinal cord, cranial nerves and other parts of central nervous system	C70–C72	Malignant neoplasm of meninges, brain, spinal cord, cranial nerves and other parts of central nervous system	C70–C72
Thyroid	Thyroid gland	C73.9	Malignant neoplasm of thyroid gland	C73
Hodgkin lymphoma*	Hodgkin lymphoma	Type 9650–9667	Hodgkin lymphoma	C81
Non-Hodgkin lymphoma*	Non-Hodgkin lymphoma	Type 9590–9597, 9670–9719, 9724–9729, 9735, 9737, 9738 Type 9811-9818, 9823, 9827, 9837 all sites except C42.0, 42.1, 42.4	Follicular lymphoma, non-follicular lymphoma, mature T/NK-cell lymphomas, other and unspecified types of non-Hodgkin lymphoma, and true histiocytic lymphoma	C82–C85, C96.3
Multiple myeloma*	Myeloma, plasmacytoma	Type 9731, 9732, 9734	Multiple myeloma, extramedullary plasmacytoma	C90.0, C90.2

CNS=central nervous system

* For incidence, histology types 9590–9992 (leukemia, lymphoma and multiple myeloma), 9050–9055 (mesothelioma) and 9140 (Kaposi sarcoma) are excluded from other specific organ sites.

Note: ICD-O-3 refers to the *International Classification of Diseases for Oncology, Third Edition*.[2] ICD-10 refers to the *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision*.[4]

TABLE A10 Cancer definitions *(continued)*

Name used in the text	ICD-O-3 names (incidence)	ICD-O-3 Site/Type (incidence)	ICD-10 names (mortality)	ICD-10 Site/Type (mortality)
Leukemia*	Lymphoid leukaemia, myeloid leukaemia, monocytic leukaemia, other leukaemias of specified cell type, and leukaemia of unspecified cell type	Type 9733, 9742, 9800–9801, 9805-9809, 9820, 9826, 9831–9836, 9840, 9860–9861, 9863, 9865–9867, 9869–9876, 9891, 9895–9898, 9910, 9911, 9920, 9930–9931, 9940, 9945–9946, 9948, 9963–9964 Type 9811-9818, 9823, 9827, 9837 sites C42.0, 42.1, 42.4	Lymphoid leukaemia, myeloid leukaemia, monocytic leukaemia, other leukaemias of specified cell type, and leukaemia of unspecified cell type	C91–C95, C90.1
All other cancers		All sites C00–C80, C97 not listed above		All sites C00–C80, C97 not listed above
All other and unspecified cancers		Type 9140, 9740, 9741, 9750–9759, 9760–9769, 9950–9962, 9966, 9970–9989, 9991, 9992 C76.0–C76.8 (type 8000–9592) C80.9 (type 8000–9592) C42.0–C42.4 (type 8000–9592) C77.0–C77.9 (type 8000–9592) C44.0–C44.9 excluding type 8050–8084, 8090–8110, 8720–8790, 9590–9992	Malignant neoplasm: spleen, other malignant neoplasms of skin, Kaposi sarcoma, malignant neoplasms of ill-defined, secondary and unspecified sites, malignant immunoproliferative diseases, multifocal and multisystemic (disseminated) Langerhans-cell histiocytosis [Letterer-Siwe disease], malignant mast cell tumour, other specified malignant neoplasms of lymphoid, haematopoietic and related tissue, histiocytic sarcoma, malignant neoplasm of lymphoid, haematopoietic and related tissue, unspecified	C26.1, C44, C46, C76–C80, C88, C96.0–.2, C96.7–.9, C97
All cancers		All invasive sites		All invasive sites

CNS=central nervous system

* For incidence, histology types 9590–9992 (leukemia, lymphoma and multiple myeloma), 9050–9055 (mesothelioma) and 9140 (Kaposi sarcoma) are excluded from other specific organ sites.

Note: ICD-O-3 refers to the *International Classification of Diseases for Oncology, Third Edition*.[2] ICD-10 refers to the *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision*.[4]

TABLE A11-1 Recent cancer definition changes in incidence

	New definitions	Year changed	Old definitions
Bladder	ICD-O-3 C67 (including *in situ* cancers, except for Ontario since this province does not report *in situ* bladder cancer)	2006	ICD-O-3, C67 (not including *in situ* cancers)
Colorectal	ICD-O-3 C18–C20, C26.0	2011	ICD-O-3 C18–C21, C26.0
Kidney	ICD-O-3 C64–C65	2008	ICD-O-3 C64–C66, C68
Lung	ICD-O-3 C34	2008	ICD-O-3 C33-C34 (before 2006) ICD-O-3 C34 (in 2006) ICD-O-3 C33–C34 (in 2007)
Ovary	ICD-O-3 C56	2006	ICD-O-3 C56, C57.0–C57.4

Note: According to ICD-O-3, incidence for bladder, colorectal, kidney, lung and ovary cancers excludes histology types 9590–9992 (leukemia, lymphoma and multiple myeloma), 9050–9055 (mesothelioma) and 9140 (Kaposi sarcoma). ICD-O-3 refers to the *International Classification of Diseases for Oncology, Third Edition*.[2]

TABLE A11-2 Recent cancer definition changes in mortality

	New definition	Year changed	Old definitions
Colorectal	ICD-10 C18–C20, C26.0	2012	ICD-10 C18–C21, C26.0
Kidney	ICD-10 C64–C65	2008	ICD-10 C64–C66, C68
Leukemia	ICD-10 C91–C95, C90.1	2008	ICD-10 C91–C95
Liver	ICD-10 C22.0, C22.2–C22.7	2007	ICD-10 C22 (before 2006) ICD-10 C22.0, C22.2–C22.9 (in 2006)
Lung	ICD-10 C34	2008	ICD-10 C33–C34 (before 2006) ICD-10 C34 (in 2006) ICD-10 C33–C34 (in 2007)
Multiple myeloma	ICD-10 C90.0, C90.2	2008	ICD-10 C88, C90 (before 2007) ICD-10 C90 (in 2007)
Ovary	ICD-10 C56	2006	ICD-10 C56, C57.0–C57.4
All other and unspecified cancers	ICD-10 C44, C46, C76–C80, C88,C96.0–C96.2, C96.7–C96.9, C97	2007	ICD-10 C44, C46, C76–C80,C96.0–C96.2, C96.7–C96.9, C97

Note: ICD-10 refers to the *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision*.[4]

TABLE A12 Use of five-year average method* for incidence projection by cancer type, sex and province, 2015

	BC		AB		SK		MB		ON		QC		NB		NS		PE		NL	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
All cancers																●				
Lung																				
Breast																		●		●
Colorectal																		●		
Prostate†					■								■						■	
Bladder																	■	●		●
Non-Hodgkin lymphoma															■		■	●		
Melanoma																	■	●	■	●
Kidney								●									■	●		●
Thyroid					■	●	■						■		■		■	●	■	●
Body of uterus																		●		
Leukemia														●			■	●	■	●
Pancreas																	■	●	■	●
Oral						●		●						●		●	■	●	■	●
Stomach						●		●						●		●	■	●		●
Brain/CNS					■	●	■	●					■	●	■	●	■	●	■	●
Ovary																		●		●
Multiple myeloma					■	●	■	●					■	●	■	●	■	●	■	●
Liver					■	●	■	●					■	●	■	●	■	●	■	●
Esophagus					■	●	■	●					■	●	■	●	■	●	■	●
Cervix						●		●						●		●		●		●
Larynx		●		●	■	●	■	●					■	●	■	●	■	●	■	●
Testis					■		■						■		■		■		■	
Hodgkin lymphoma		●	■	●	■	●	■	●					■	●	■	●	■	●	■	●

M=males; F=females. BC=British Columbia; AB=Alberta; SK=Saskatchewan; MB=Manitoba; ON=Ontario; QC=Quebec; NB=New Brunswick; NS=Nova Scotia; PE=Prince Edward Island; NL=Newfoundland and Labrador.

CNS=central nervous system

* Nordpred Power5 regression model is the default for all provinces except when the average annual cases for the most recent five years is less than or equal to 50, when the five-year average estimate is the default.

† An annual age-specific trend Power5 projection model is the default for prostate cancer. In place of the five-year average as an alternative, the last available year of data was used for prostate cancer to better capture recent changes observed for this cancer.

Note: For territories (not shown), five-year average method was used for "All cancers" because of small numbers.

TABLE A13 Use of five-year average method* for mortality projection by cancer type, sex and province, 2015

	BC		AB		SK		MB		ON		QC		NB		NS		PE		NL	
	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F	M	F
All cancers																				
Lung																	■	●		
Colorectal																	■	●		
Breast																		●		
Pancreas																	■	●	■	●
Prostate																	■			
Leukemia						●		●					■	●	■	●	■	●	■	●
Non-Hodgkin lymphoma					■	●							■	●	■	●	■	●	■	●
Bladder				●	■	●	■	●					■	●	■	●	■	●	■	●
Stomach				●	■	●	■	●					■	●	■	●	■	●	■	●
Esophagus					■	●		●					■	●	■	●	■	●	■	●
Brain/CNS					■	●	■	●					■	●	■	●	■	●	■	●
Kidney				●	■	●	■	●					■	●	■	●	■	●	■	●
Ovary														●				●		●
Multiple myeloma					■	●	■	●					■	●	■	●	■	●	■	●
Oral				●	■	●	■	●					■	●	■	●	■	●	■	●
Liver					■	●	■	●					■	●	■	●	■	●	■	●
Melanoma		●	■	●	■	●	■	●					■	●	■	●	■	●	■	●
Body of uterus						●		●						●		●		●		●
Larynx		●	■	●	■	●	■	●		●		●	■	●	■	●	■	●	■	●
Cervix						●		●						●		●		●		●

M=males; F=females. BC=British Columbia; AB=Alberta; SK=Saskatchewan; MB=Manitoba; ON=Ontario; QC=Quebec; NB=New Brunswick; NS=Nova Scotia; PE=Prince Edward Island; NL=Newfoundland and Labrador.

CNS=central nervous system

* Nordpred Power5 regression model is the default for all provinces except when the average annual deaths for the most recent five years is less than or equal to 50, when the five-year average estimate is the default.

Note: For territories (not shown), five-year average method was used for "All cancers" because of small numbers.

APPENDIX III: Previous special topics, abbreviations and index

Previous special topics

Special topics are related to current or ongoing issues in cancer surveillance or cancer control. In particular, they aim to provide an in-depth look at the Canadian context. The following previous special topics are available at cancer.ca/statistics:

2014	Skin cancers
2013	Liver cancer
2011	Colorectal cancer
2010	End-of-life care Cancer in depth: esophagus cancer Cancer in depth: kidney cancer
2009	Cancer in adolescents and young adults (15–29 years)
2008	Childhood cancer (ages 0–14)
2007	Breast cancer
2006	Progress in cancer control: screening
2005	Progress in cancer prevention: modifiable risk factors
2004	International variation in cancer incidence, 1993–1997 Economic burden of cancer in Canada, 1998
2003	Non-Hodgkin's lymphoma
2002	Cancer incidence in young adults Five-year relative cancer survival in Canada, 1992
2001	Colorectal cancer
2000	Progress in cancer control
1999	Factors contributing to the population burden of cancer incidence and mortality A new national cancer surveillance system for Canada
1998	International comparisons
1997	Ten years of Canadian cancer statistics
1996	Prostate cancer Direct costs of cancer in Canada, 1993 Evaluation of cancer estimates: 1987–1991
1995	Prevalence of cancer Colorectal cancer
1993	Female breast cancer
1991	Smoking and lung cancer Cancer among the Inuit and Indians
1990	Cancer of the female breast and genital organs – recent trends Hodgkin's disease and cancer of the testis Cancer mortality by income quintile Economic cost of illness in Canada Cancer control
1989	Cancer incidence and mortality: an international comparison
1988	Tobacco consumption from smoking and mortality from lung cancer Cancer mortality: an international comparison

Abbreviations

AAPC	Average annual percent change
APC	Annual percent change
ASIR	Age-standardized incidence rate
ASMR	Age-standardized mortality rate
CCR	Canadian Cancer Registry
CI	Confidence interval
CRMM	Cancer Risk Management Model
CNS	Central nervous system
CVS: D	Canadian Vital Statistics – Death database
DCO	Death certificate only
HAART	Highly active antiretroviral therapy
HIV	Human immunodeficiency virus
ICCC-3	International Classification of Childhood Cancer, Third Edition
ICD-10	International Statistical Classification of Diseases and Related Health Problems, Tenth Revision
ICD-O-3	International Classification of Diseases for Oncology, Third Edition
LDCT	Low-dose computed tomography
NCIRS	National Cancer Incidence Reporting System
NMSC	Non-melanoma skin cancer
OSP	Observed survival proportion
PSA	Prostate-specific antigen
PYLL	Potential years of life lost
RSR	Relative survival ratio
SEER	Surveillance, Epidemiology, and End Results Program

Index of tables and figures

Tables

Appendix tables

Figures

For further information

Partner organizations

Canadian Council of Cancer Registries

Cancer incidence data are supplied to Statistics Canada by provincial and territorial cancer registries. Detailed information regarding the statistics for each province or territory is available from the relevant registry.

Public Health Agency of Canada

phac-aspc.gc.ca (select "surveillance")

More detailed information on the methodology used in this publication is available from the Chronic

Disease Surveillance and Monitoring Division,
CCDP, Public Health Agency of Canada,
785 Carling Avenue, Ottawa, Ontario, K1A 0K9.
Email: ccs-ssc@phac-aspc.gc.ca

Chronic Disease Infobase Cubes (infobase.phac-aspc.gc.ca) is an interactive online tool for easy access to cancer surveillance data. It allows you to generate tables, chart and maps according to a choice of parameters, such as cancer type, geographic area and time period.

Statistics Canada

statcan.gc.ca (search "cancer")

More detailed information on the survival and/or prevalence methodology used in this publication is available from the Health Statistics Division, Statistics Canada, National Enquiries Line (1-800-263-1136) or through Client Services in the Health Statistics Division (613-951-1746).

Custom tabulations are available on a cost-recovery basis upon request. Analytical articles appear regularly in *Health Reports*, Statistics Canada, Catalogue no. 82-003. Detailed standard tables are available on the Statistics Canada website (statcan.gc.ca).

Canadian Cancer Society

cancer.ca

For general information about cancer (such as cancer prevention, screening, diagnosis, treatment or care), contact the Canadian Cancer Society's Cancer Information Service at 1-888-939-3333 or the Canadian Cancer Society, National Office or divisional offices.

For information about research funded by the Canadian Cancer Society, visit cancer.ca/research or contact the Canadian Cancer Society Research Institute, National Office, at research@cancer.ca.

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gnb.ca/0051/cancer/index-e.asp

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Questions about cancer?

When you want to know more about cancer, call the Canadian Cancer Society's Cancer Information Service.

1-888-939-3333 Monday to Friday
cancer.ca

Canadian Cancer Society
Société canadienne du cancer