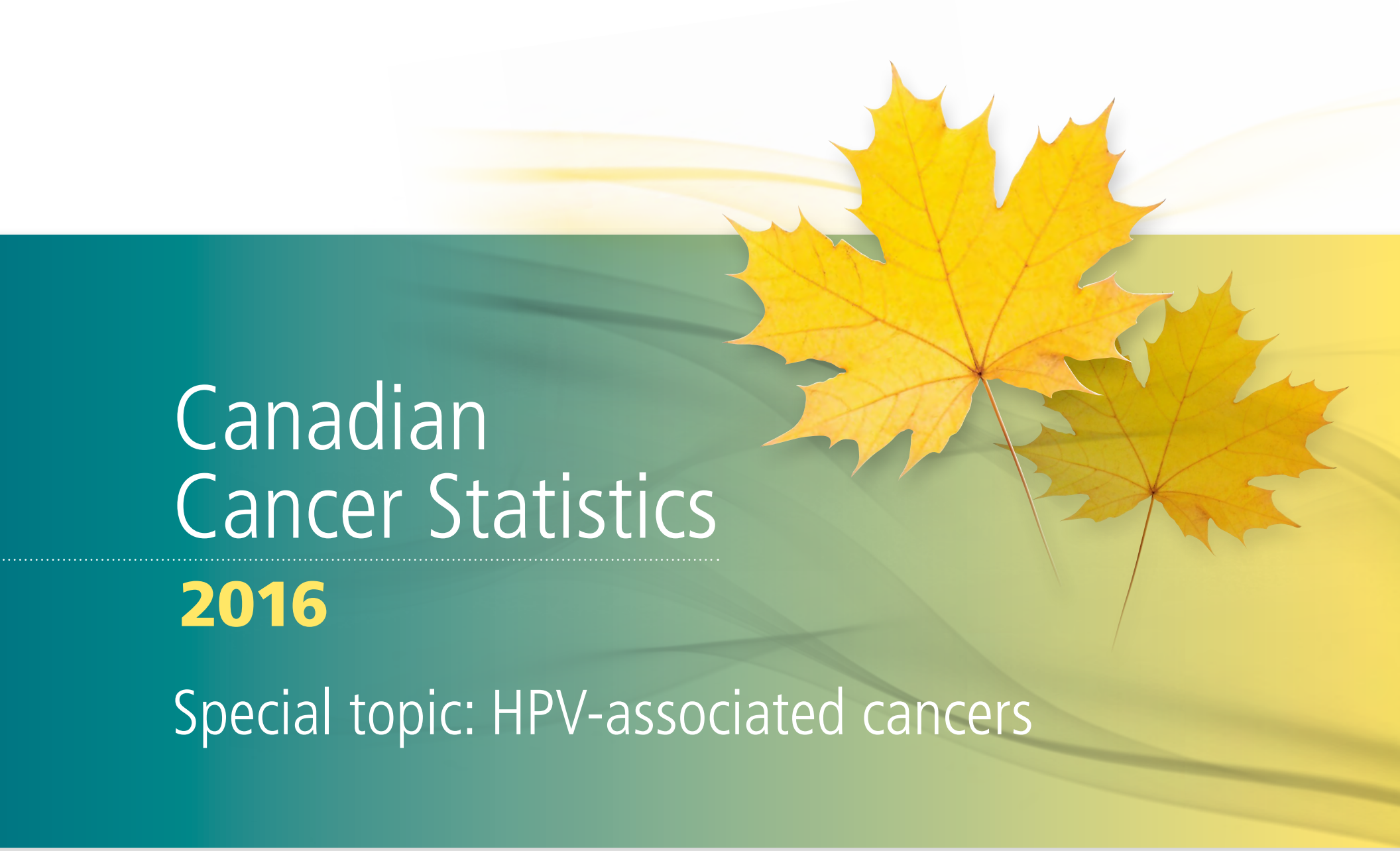

Canadian Cancer Statistics

2016

Special topic: HPV-associated cancers

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. Visit the website for the most up-to-date version of this publication and 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, complete the evaluation form or email stats@cancer.ca.

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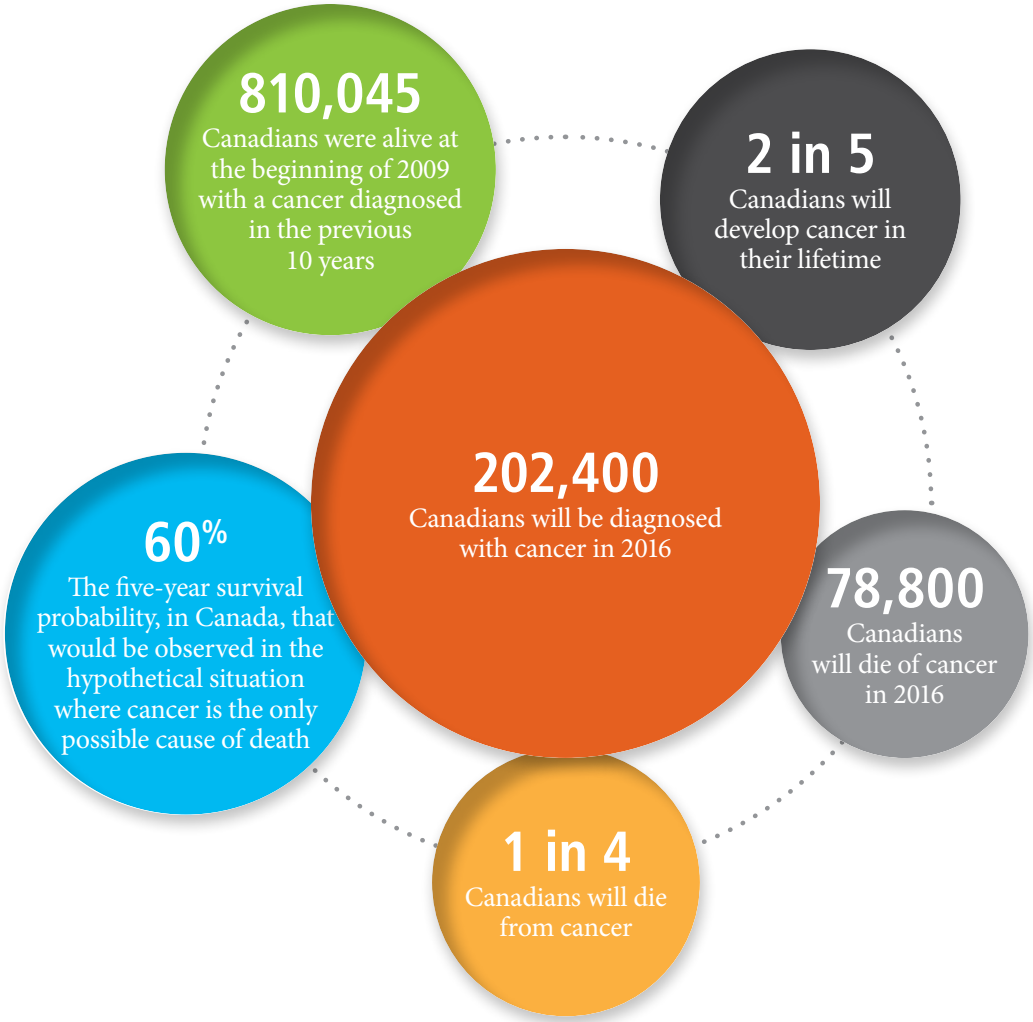
Executive summary

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 2016, it is estimated that 202,400 Canadians will develop cancer, and 78,800 will die of the disease. Half of new cancer cases will be lung and bronchus (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 mortality rate in men over the past 30 years, which helped drive a decline in the mortality rate for all cancers combined.

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 2012, cancer was the leading cause of disease-related death in children under the age of 15 years.

Overall, the five-year net survival for people diagnosed with cancer is about 60%, but it varies widely by the type of cancer. Some cancers have very high five-year net survival, including thyroid cancer (98%) and testicular cancer (96%). Other cancers have consistently low five-year net survival, such as cancer of the pancreas (8%) and esophagus (14%). Differences in net survival among cancer types are due to several factors, including stage and aggressiveness of the cancer at diagnosis, and the availability of early detection, diagnostic and treatment services.



As of January 2009, 810,045 Canadians had been diagnosed with cancer in 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 an in-depth analysis of the burden of human papillomavirus (HPV)-associated cancers in Canada (*Chapter 7: Special topic: HPV-associated cancers*). HPV is a group of more than 100 different types of viruses, of which more than 20 are known or probable carcinogens. Infection with HPV can cause cancer in anogenital regions and in the mouth and throat. In 2012, 3,760 Canadians were diagnosed with an HPV-associated cancer. Oropharyngeal and cervical cancers were the most commonly diagnosed, each accounting for approximately 35% of all HPV-associated cancers in Canada. Other HPV-associated cancers include anal, vaginal, vulvar and penile. Two-thirds of all HPV-associated cancers are diagnosed in females, although 80% of HPV-associated oropharyngeal cancer occurs in males. Five-year age-standardized net survival for HPV-associated cancers ranged from 57% for vaginal cancer to 75% for vulvar cancer. In 2012, over 1,100 Canadians died from an HPV-associated cancer.

Cervical cancer screening has been available across Canada for decades. This test can find precancerous conditions before they become cancer, and as a result, cervical cancer incidence rates decreased dramatically from 1992 to 2006, although the rate has been relatively stable since. On the other hand, the rates of vulvar, anal and oropharyngeal cancer (particularly in males), cancers for which screening is not available, have been increasing.

With two-thirds of HPV-associated cancers occurring in areas other than the cervix, and one-third occurring in males, cervical cancer screening alone is not sufficient to reduce the burden of HPV-associated cancer in Canada. HPV vaccines, which became available in 2006 to females and in 2012 to males, prevent infection from the most common types of HPV associated with cancers and are therefore a powerful tool for reducing the burden of cervical and non-cervical HPV-associated cancers. Currently, all provinces and territories offer free school-based HPV vaccination programs for girls, and some provinces have expanded their program to boys.

Measures of the cancer burden in Canada are vital for health policy, and they help decision-makers assess the type and allocation of health resources needed. The data are also essential to inform and evaluate primary and secondary cancer prevention activities and to allow the assessment of early detection and cancer treatment on the cancer trajectory. 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

This year marks the 30th edition of *Canadian Cancer Statistics,* an annual series that began in 1987. This edition was 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 United States Centers for Disease Control and Prevention, as well as researchers based in universities or 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 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* focuses on cancer survival in Canada by age, sex, province and over time.
- *Chapter 6* (a repeat from the 2014 and 2015 editions) describes the prevalence of cancer in Canada by examining the number of people diagnosed with cancer who are still alive and the number of tumours diagnosed among individuals living with or beyond cancer.
- *Chapter 7* is a special topic that explores the burden of HPV-associated cancers in Canada. It includes the number of people who are diagnosed with an HPV-associated cancer by type of cancer and how many people die as a result. In future editions, *Chapter 7* may feature other emerging or prominent issues related to cancer. These are selected annually based on criteria that include data availability, recent trends and feedback from our readers through evaluation forms.
- The appendices provide actual (not projected) data, including data on cancer types not presented elsewhere in the publication, as well as additional information on data sources and methods. Caveats to the analyses presented in this publication and a listing of previously covered special topics available in past editions are also provided.

How these statistics can be used

Cancer cases (incidence): the number of new cancers cases diagnosed in the population (mostly influenced by the size and demographics of the population); important for determining the amount and type of healthcare resources needed for cancer control and support activities.

Age-standardized incidence rate (ASIR): a measure of cancer incidence that is standardized to facilitate comparisons across populations and over time; can reflect changes in risk factors and show where progress is being made (or not) in cancer prevention.

Cancer deaths (mortality): reflects the absolute number of cancer-related deaths in the population (mostly influenced by the size and demographics of the population); important for determining the healthcare and support services needed, particularly for patients at the end of life.

Age-standardized mortality rate (ASMR): a measure of cancer deaths that is standardized to facilitate comparisons across populations and over time; can reflect changes in incidence rates and show where progress is being made in detection, diagnosis and treatment and indicate where more advances are required.

Net survival: a measure of cancer prognosis; useful for monitoring the effects of early detection, diagnosis and treatment on cancer outcomes.

Cancer prevalence: a measure of the number of people living with or beyond cancer in the population; useful for determining the healthcare and support services needed for cancer patients, cancer survivors and their families.

- 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 as well as the analyses on incidence for *Chapter 7* and parts of *Appendix I*. No new data were available to produce more recent estimates of survival (*Chapter 5*) and prevalence (*Chapter 6*) for this edition. Nonetheless, *Chapter 5* has been updated to incorporate methodological and conceptual advances. *Chapter 6* is repeated from the 2014 and 2015 editions. As such, the analytical techniques used and the interpretation of the prevalence results included reflect the state of knowledge at the time of the production of the 2014 edition. It was decided to include this chapter again to ensure a complete publication.

The Canadian Cancer Statistics Advisory Committee advises on the methodology and interpretation of data and writes the accompanying text. The Canadian Cancer Society supports the production of this publication with charitable funds.

New standard population

In each edition, incidence and mortality rates are standardized to a common age structure to account for differences in age distribution of the population and enable comparisons of rates over time and between populations. A notable change for this year's edition is that incidence and mortality rates are standardized to the 2011 Canadian population, whereas they were standardized to the 1991 Canadian population in previous editions (1995 to 2015). As a result, the age-standardized rates reported in this edition will appear much higher than those reported in the 2015 edition. This does not mean there has been a sudden increase in the number of cancer cases and cancer deaths, nor in the risk of developing or dying of cancer. Instead, it reflects the fact that the 2011 Canadian population has a much higher proportion of people in older age groups, in which cancer is more common, than the 1991 population. This updated approach was mutually agreed upon by key stakeholders in the cancer surveillance community in Canada to maximize the relevance and usefulness of these statistics. The rates in this publication cannot be compared to previous publications, nor should they be compared to rates standardized to different populations (e.g., between countries that use different standard populations).

Survival methodology

Chapter 5 reports estimates of net survival where previous editions reported relative survival. Until recently, it was commonly believed that relative and net survival referred to the same measure, and relative survival (defined as the ratio of all-cause observed survival to expected survival) was generally implicitly used to estimate net survival. However, traditional methods of estimating relative survival have recently been shown to produce biased estimates of net survival under certain circumstances.[1] This edition of the publication incorporates a refinement to the traditional relative survival methods to mitigate this bias. An additional refinement has also been made to more fully satisfy an assumption regarding the calculation of expected survival. As a result of these refinements, some survival estimates reported in this edition differ from last year's publication even though the same data were used. Estimates for all cancers combined were most affected. For example, five-year survival for all cancers combined for 2006 to 2008 reported in this edition is 60%, compared with 63% in the 2015 edition. This does not mean that there has been a sudden decrease in survival; rather, it reflects the methodological advances made to the analysis.

With this edition of the publication, survival estimates are now explicitly referred to as net survival and interpreted as such, in part, to differentiate them from the relative survival methods that may be used for purposes other than net survival. For further details on the survival methodology used, see *Appendix II: Data sources and methods.*

A note on data

The main sources of data for this publication are the Canadian Cancer Registry (CCR; primary source of recent cancer incidence data), National Cancer Incidence Reporting System (NCIRS; source for cancer incidence data prior to 1992), Canadian Vital Statistics Death database (CVS: D; source of cancer mortality data) and population life tables, censuses and forecasts on population growth.

- Provincial and territorial cancer registries collect clinical and demographic data on newly diagnosed cancer cases for people residing in their 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. The exception is *in situ* carcinoma of the bladder, which is considered invasive for surveillance reporting because of its high rate of progression and recurrence.[2]
- Non-melanoma skin cancers (neoplasms, not otherwise specified [NOS], epithelial neoplasms NOS, basal and squamous) are not included since most provincial and territorial cancer registries (PTCRs) do not collect incidence data on this type of cancer. These cancers are difficult to register because they may be diagnosed and/or treated in a variety of settings that do not report to the PTCRs, including dermatologist offices.
- This publication examines over 20 cancer types, which together represent the vast majority of cancers that occur in 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 1987 to 2012 (except for Quebec, for which data were available to 2010). Data for 1992 to 2012 were obtained from the CCR. Actual cancer mortality data are for the period 1987 to 2012 for all provinces and territories and were obtained from the CVS: D. Short-term statistical projections provide estimates of cancer incidence and mortality for recent years (see *Appendix II: Data sources and methods*). Incidence and mortality are projected for each year from 2013 to 2016 for all provinces and territories, except Quebec where incidence was projected for 2011 to 2016.

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 should be avoided.

Tables A1 and A2 in *Appendix I* list a higher number of cancer types than other tables in the publication. 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 (2008 to 2012 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, contact the respective cancer registries (see a list of Canadian Cancer Registries) or contact Statistics Canada's Research Data Centres network.

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2. Ranasinghe W, Hounsome L, Verne J, Persad RI. Impact of carcinoma in situ of the bladder in the UK. Trends in urology & men's health. 2013; 4(5):22–24.

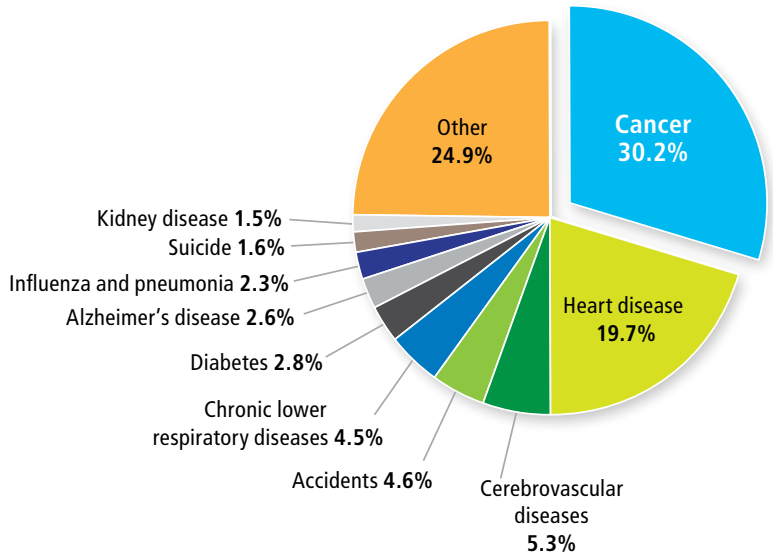
Introduction

Cancer in Canada

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

Cancer is also the leading cause of premature mortality, as measured by potential years of life lost (PYLL). PYLL is a summary measure of premature mortality that accounts for deaths that occur at younger ages and is influenced by deaths from diseases and injuries affecting children and young adults. During the period between 2010 and 2012, the PYLL for all cancers combined was almost 1,500,000, more than any of the 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 25% of the PYLL due to cancer. With regard to the most common cancers, males had higher PYLL values compared to females for both lung cancer (193,000 versus 176,000) and colorectal cancer (81,000 versus 59,000). For female breast cancer, the PYLL was almost 137,000, reflecting the fact that women die from breast cancer at a relatively young age. Conversely, the PYLL for prostate cancer was relatively low (24,000), reflecting the fact that deaths from prostate cancer tend to occur among those in the older age groups.

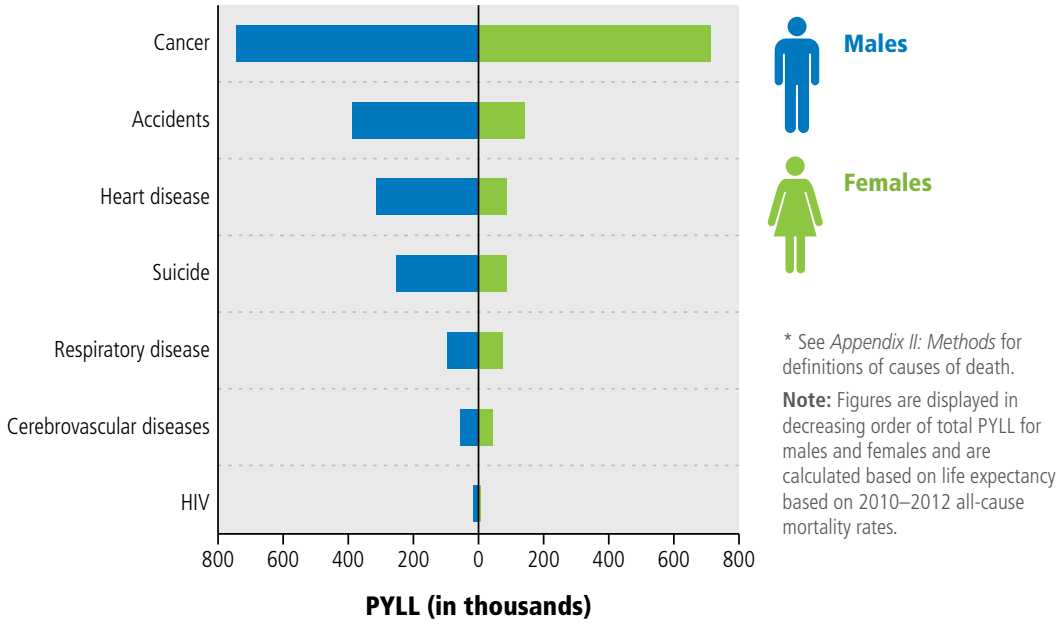
FIGURE A Proportion of deaths due to cancer and other causes, Canada, 2012



Note: The total of all deaths in 2012 in Canada was 246,596.
Data source: Canadian Vital Statistics Death database at Statistics Canada.[1]

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 the 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. In 2008, the Public Health Agency of Canada estimated that 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 (including hospital, drug and physician costs) and $586 million in indirect costs from lost productivity due to illness or premature death. Cancer was the costliest illness in terms of lost productivity due to death.[2]

FIGURE B Selected causes of death* and their associated potential years of life lost (PYLL), Canada, 2010–2012



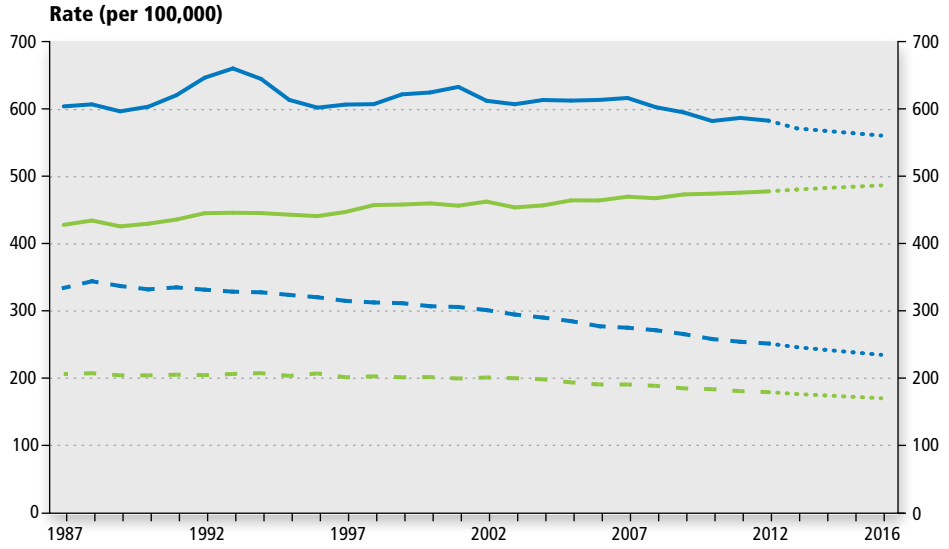
* See *Appendix II: Methods* for definitions of causes of death.

Note: Figures are displayed in decreasing order of total PYLL for males and females and are calculated based on life expectancy based on 2010–2012 all-cause mortality rates.

Analysis by: Statistics Canada, Mortality and potential years of life lost, by selected causes of death and sex, three-year average, census metropolitan areas, CANSIM 102-4313
Data source: Canadian Vital Statistics Death database at Statistics Canada

Despite 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 maintain and improve the quality of life of people living with cancer, cancer survivors, as well as the lives of their families and caregivers. This progress can be seen in trends in incidence rates over time and even more so in trends in mortality rates (Figure C). Incidence rates in males have been declining since the early 1990s, and mortality rates for all cancers combined have been decreasing for both sexes since peaking in 1988.

FIGURE C Age-standardized incidence and mortality rates for all cancers combined, by sex, Canada, 1987–2016



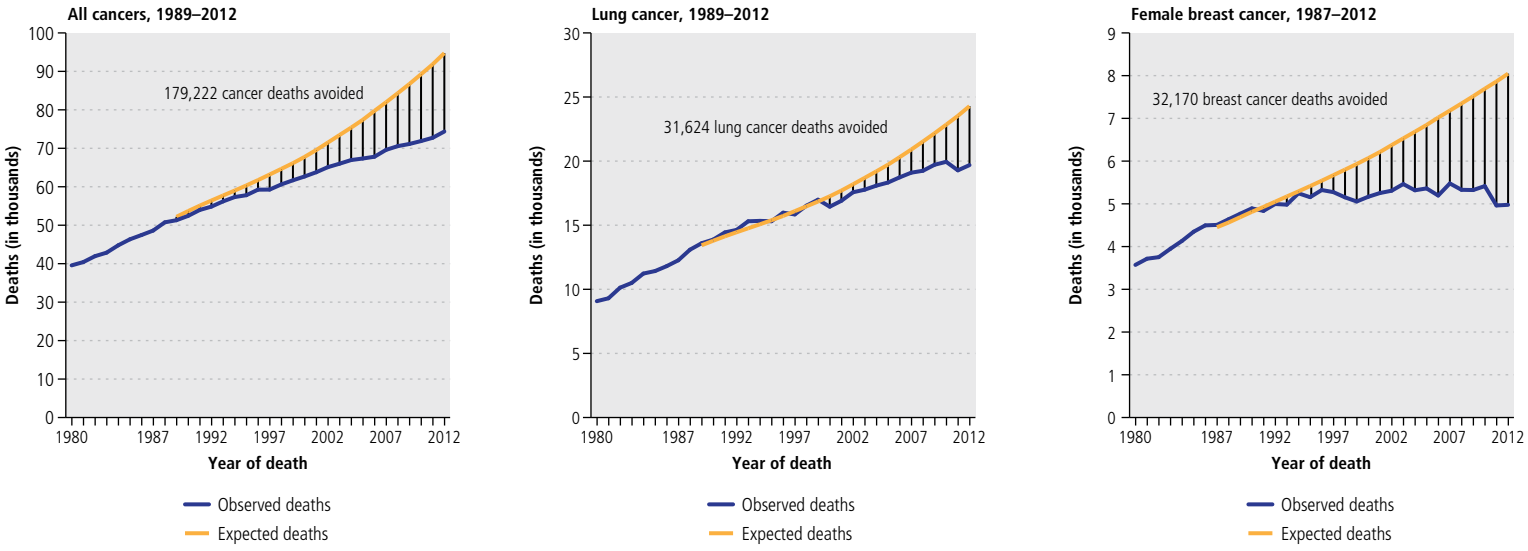
Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry, National Cancer Incidence Reporting system and Canadian Vital Statistics Death databases at Statistics Canada

Note: Rates are age-standardized to the 2011 Canadian population. Estimated rates were based on long-term historic data and may not always reflect recent changes in trends. Incidence excludes non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). Actual incidence data were available to 2012 for all provinces and territories except Quebec, for which data were available to 2010 and estimated thereafter. Actual mortality data were available to 2012. For further details, see *Appendix II: Data sources and methods*. Dotted lines represent estimated rates.

Since the peak in cancer mortality rate in Canada in 1988, it is estimated that nearly 180,000 deaths have been avoided (Figure D) as a result of cancer prevention and control efforts. Many of the avoided deaths were related to cancers of the breast and lung. Over 31,000 lung cancer deaths have been avoided, largely reflecting a reduction in smoking among Canadians. Over 32,000 breast cancer deaths have also been avoided, 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 provides the evidence base to inform cancer prevention and control activities and allocate resources. Canada is one of the few nations in the world with a complete, high-quality national population-based cancer registry system. 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 inform and evaluate both primary prevention efforts (e.g., efforts to reduce risk factors and promote protective factors) and secondary prevention efforts (e.g., screening and early detection). To this end, the annual Canadian Cancer Statistics publication provides the most current summary of key indicators of cancer surveillance and control.

FIGURE D 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 1988. 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 1986.

Note: Mortality rates were available to 2012 for all provinces and territories.

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

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] These studies indicate that Canada compares favourably to other countries on several measures, including survival and mortality rates.

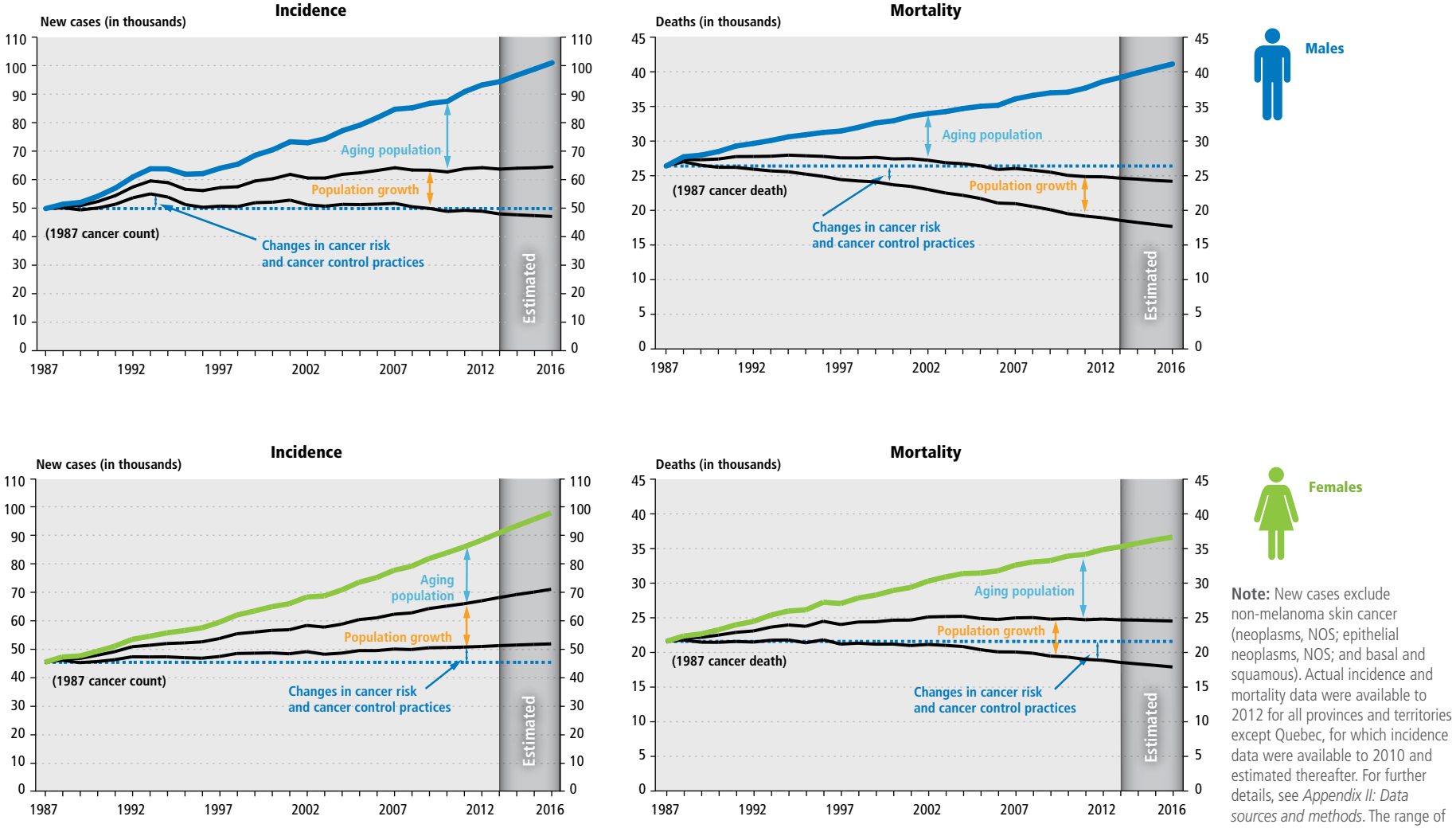
The World Health Organization suggests that prevention offers the most cost-effective, long-term strategy for controlling cancer and other non-communicable diseases.[7] Reducing the risk of cancer can be achieved through the following approaches, among other measures:

- 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 well, being active and having a healthy body weight 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. Eating well includes having a diet high in vegetables, fruit and fibre, and low in red and processed meat. Being active includes daily activities that get the heart going and reducing the amount of time spent sitting.[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.[8] Indoor tanning does not provide a safe alternative to the sun and should be avoided.
- Preventing cancer-related infections – Vaccines can protect against some infections associated with cancer, such as the human papillomavirus (HPV) and hepatitis B and C. Lifestyle can also play an important role in preventing infection.
- Reducing exposure to environmental and occupational carcinogens – The International Agency for Research on Cancer has classified almost 200 agents as known or probable carcinogens, including radon, asbestos, air pollution, arsenic and many industrial chemicals. Knowing if you are exposed to these agents (e.g., testing for radon) and taking action to reduce exposure (e.g., radon mitigation at home, protective equipment at work) can lower the risk of cancer.[10]

Increases in the number of new cancer cases and deaths in Canada over the past 30 years can largely be attributed to the aging and growing population. Figure E shows the trends in new cases and deaths attributed to the aging population, population growth and changes in cancer risk factors and cancer control practices. 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 1987. Changes in cancer risk and cancer control practices have a small impact on the overall number of cancer cases compared to the impact of the aging and growing population. However, changes in cancer risk and cancer control practices have contributed to a reduction in the number of Canadians who die from cancer. The middle line represents the number of cases or deaths that would have occurred each year if the annual rates were applied to a population that grew larger but maintained the same age distribution as 1987. 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.[11] With such population factors expected to continue into the foreseeable future, the Canadian healthcare system is expected to face greater demand for cancer services including diagnostics, treatment, palliative care and survivor supports and services.

FIGURE E 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 population, by sex, Canada, 1987–2016



Note: New cases exclude non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). Actual incidence and mortality data were available to 2012 for all provinces and territories except Quebec, for which incidence data were available to 2010 and estimated thereafter. For further details, see *Appendix II: Data sources and methods*. 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 and Canadian Vital Statistics Death databases at Statistics Canada

What is new or noteworthy this year?

This publication has been produced annually since 1987, and each year efforts are made to ensure the information provided is based on the most up-to-date data and most appropriate methodology available. The following are among the key changes this year:

- Incidence and mortality estimates for 2016 were based on actual data up to the year 2012 (except for Quebec, for which incidence data were to 2010).
- Data in *Appendix I* include actual data for the years 2010 (Quebec and Canada) and 2012 (remaining provinces and territories).
- Incidence and mortality rates were age-standardized to the 2011 Canadian population, whereas they had been age-standardized to the 1991 population in previous editions (1995 to 2015).
- New cancers are included in Tables 2.4 and 2.5 (larynx and Hodgkin lymphoma), Table 3.2 (thyroid, testis and Hodgkin lymphoma) and Tables 4.4 and 4.5 (thyroid, larynx, testis and Hodgkin lymphoma).
- The methodology and terminology related to cancer survival has been updated to reflect advancements in the field of study.
- *Chapter 7* is a special topic on the burden of HPV-associated cancers in Canada.

Other resources

- North American Association of Central Cancer Registries. Cancer in North America: 2009–2013. Available at: http://www.naaccr.org/CINA/Cina2016.v1.combined-incidence.pdf (accessed June 2016).
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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 202,400 new cases of cancer are expected to be diagnosed in Canada in 2016. Half of these (102,100 cases or 50.4% of the total) will include lung and bronchus (lung), breast, colorectal and prostate cancers.
- From 2001 to 2010, the age-standardized incidence rate rose by 0.5% per year for females and decreased by 0.6% per year for males for all cancers combined. The largest percent increase in that time period was in thyroid cancer (6.3% in males and 4.7% in females since 2005). The largest percent decrease was in laryngeal cancer (2.8% in males and 3.7% in females).
- Some of the increase in incidence rates is related to increased detection (e.g., for thyroid cancer), while decreases correspond, in part, to declines in major risk factors, such as smoking (e.g., for lung and laryngeal cancers).
- Increases in the number of new cases of cancer 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, the number of new cancer cases is expected to continue to grow. Increases in incidence have implications for screening, diagnostic and treatment services.

Introduction

Each hour in Canada in 2016, an estimated 23 people will be diagnosed with cancer. 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 are available, 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) and life expectancy. 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 than at any time in the past, and seniors (people 65 years of age and older) 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, including 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 of developing cancer measured over a period of time. The data here represent the lifetime probability of developing cancer from ages 0 to 90+. Probability can also be calculated as the chance of developing cancer by a certain age (e.g., age 30) or over a specific period of life (e.g., the next 10 years). The probability of developing cancer is expressed as a percentage or as a chance (e.g., 20% or 1 in 5 people over a lifetime).

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

- As shown in Table 1.1, Canadian males are more likely to develop prostate cancer than any other 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 more likely to develop breast cancer than any other cancer, with 1 in 9 females expected to develop breast cancer in their lifetime. One in 15 females is expected to be diagnosed with lung cancer, and 1 in 16 females is expected to be diagnosed with colorectal cancer during their lifetime.

New cases of cancer in 2016

An estimated 202,400 new cases of cancer are expected to be diagnosed in 2016 (Table 1.2).

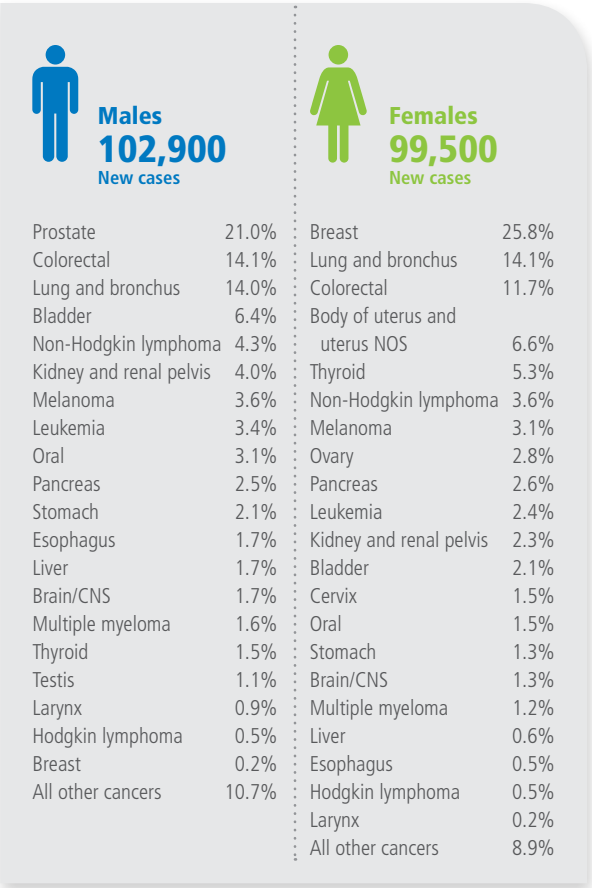
- Four cancers – prostate, breast, lung and colorectal – combined are expected to account for half (50%) of all cancers diagnosed in Canada in 2016.
- As shown in Figure 1.2, the leading cancers are prostate cancer for males (21,600 expected new cases, or 21% of all new male cases) and breast cancer for females (25,700 expected new cases, or 26% of all new female cases).
- In males, colorectal cancer and lung cancer are the most common cancers, 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.

Trends over time

Between 1987 and 2016, 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 continued slight increase in the overall age-standardized cancer incidence rate primarily reflects the steady rise in melanoma, thyroid and uterine cancer incidence rates.

FIGURE 1.2 Percent distribution of estimated new cancer cases, by sex, Canada, 2016



CNS=central nervous system, NOS=not otherwise specified

Note: The complete definition of the specific cancers listed here can be found in Table A8.

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

Incidence

The number of new cancer cases diagnosed in a given period of time, often a year.

Age-standardized incidence rate (ASIR)

The number of new cases of cancer per 100,000 people, standardized to the age structure of the 2011 Canadian population.

Age standardization is used to adjust for differences in age distributions over time, thereby allowing for more accurate comparisons. In this report, ASIR is also referred to as "incidence rate".

Annual percent change (APC)

The estimated change in the age-standardized incidence rate of from one year to the next, averaged over a defined period of time. The APC is reported as a percentage and is useful for examining trends.

Changepoint

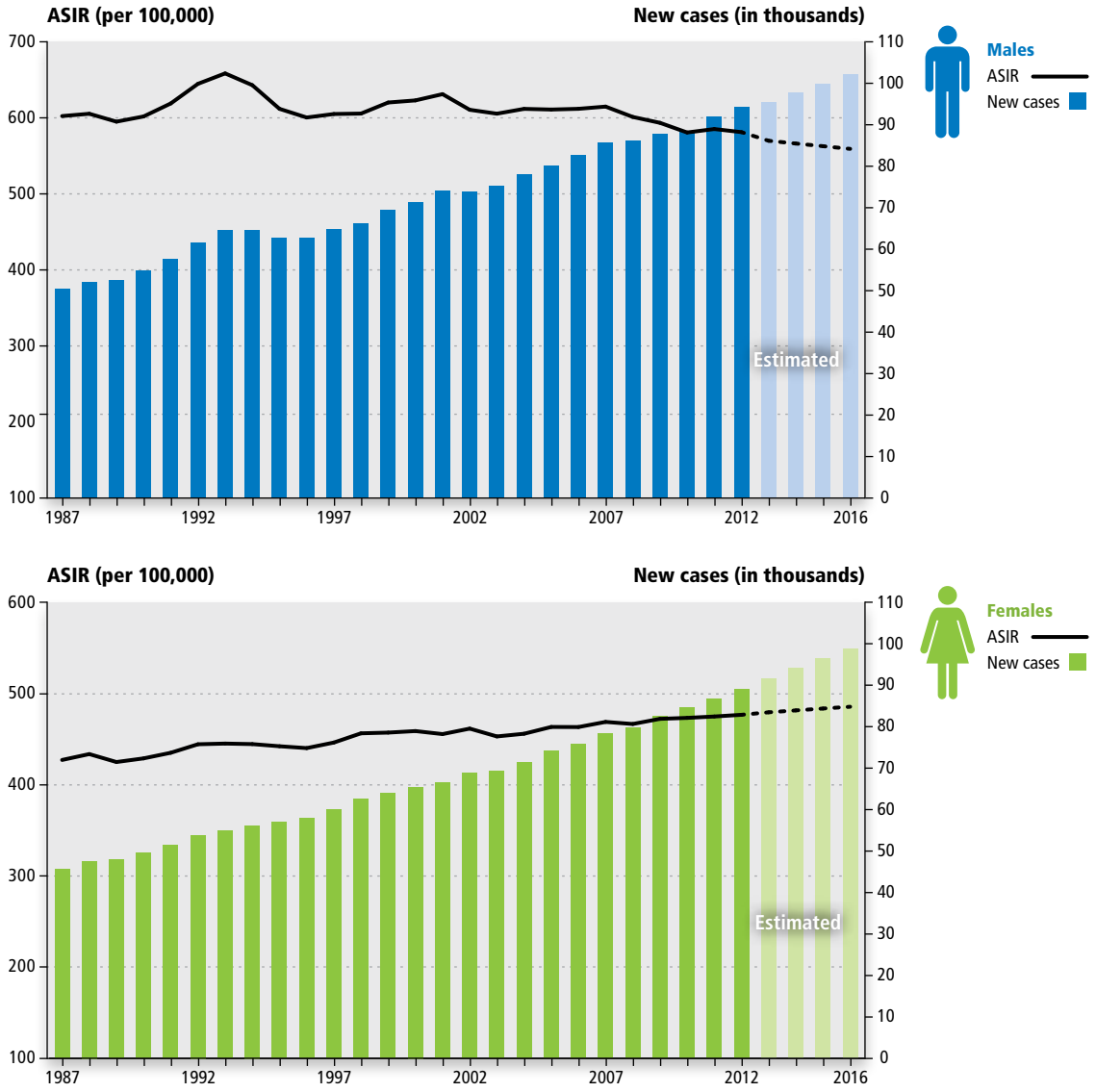
The year corresponding to a significant change in trend of age-standardized rates. The changepoint year is determined by an algorithm and may not correspond identically to patterns in the data in Tables 1.3 and 1.4.

Statistical significance

Refers to a result that is unlikely due to chance given a predetermined threshold (e.g., 1 out of 20 times, which is expressed as p=0.05).

Note: "All cancers" excludes non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). Rates are age-standardized to the 2011 Canadian population. Estimated rates were based on long-term historic data and may not always reflect recent changes in trends. Actual incidence data were available to 2012 for all provinces and territories except Quebec, for which data were available to 2010 and estimated thereafter. For further details, see *Appendix II: Data sources and methods*.

FIGURE 1.3 New cases and age-standardized incidence rates (ASIR) for all cancers, Canada, 1987–2016



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

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) between 2001 and 2010.

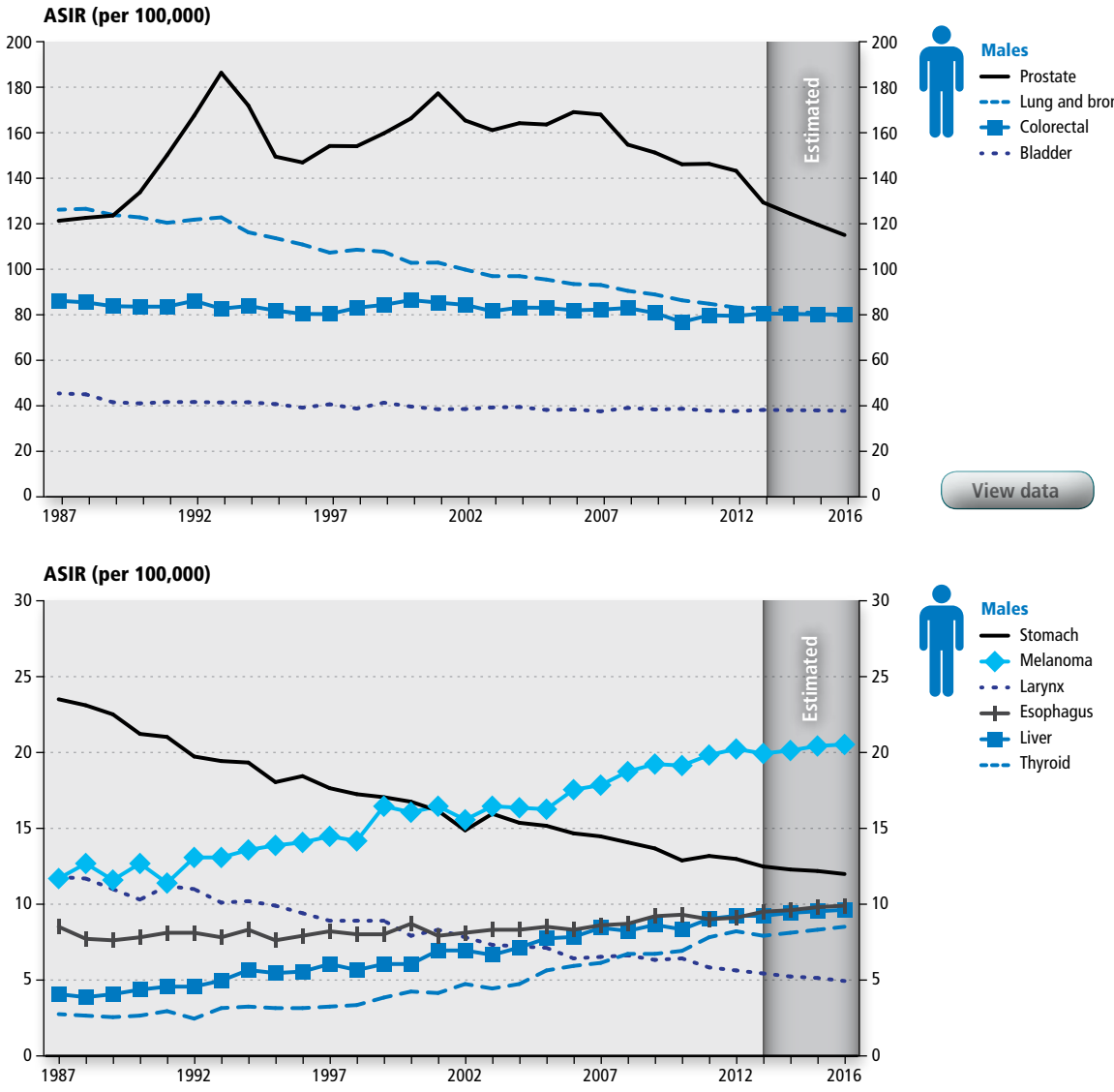
Figures 1.4 and 1.5 show, among males and females, the five most common cancers (lung, colorectal, prostate, female breast and bladder). The tables also show the trends for those cancers with statistically significant increases or decreases in APC of at least 2% per year (uterus in females, stomach and esophagus in males and melanoma, larynx and thyroid in both sexes).

Additional discussion of these cancers is provided below.

Bladder cancer

Bladder is the 5th most common cancer accounting for over 4% of all cancers. Bladder cancer predominantly affects Canadians over the age of 70 years. Between 2001 and 2010, little or no change was observed in 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 reductions in smoking,[2,3] which is estimated to account for between 34% and 50% of all bladder cancers.[4,5]

FIGURE 1.4 Age-standardized incidence rates (ASIR) for selected* cancers, males, Canada, 1987–2016



* 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 2011 Canadian population. See Table 1.3 for data points. Estimated rates were based on long-term historic data and may not always reflect recent changes in trends. Actual incidence data were available to 2012 for all provinces and territories except Quebec, for which data were available to 2010 and estimated thereafter. For further details, see *Appendix II: Data sources and methods*. The range of scales differs widely between the figures. The complete definition of the specific cancers listed here can be found in Table A8.

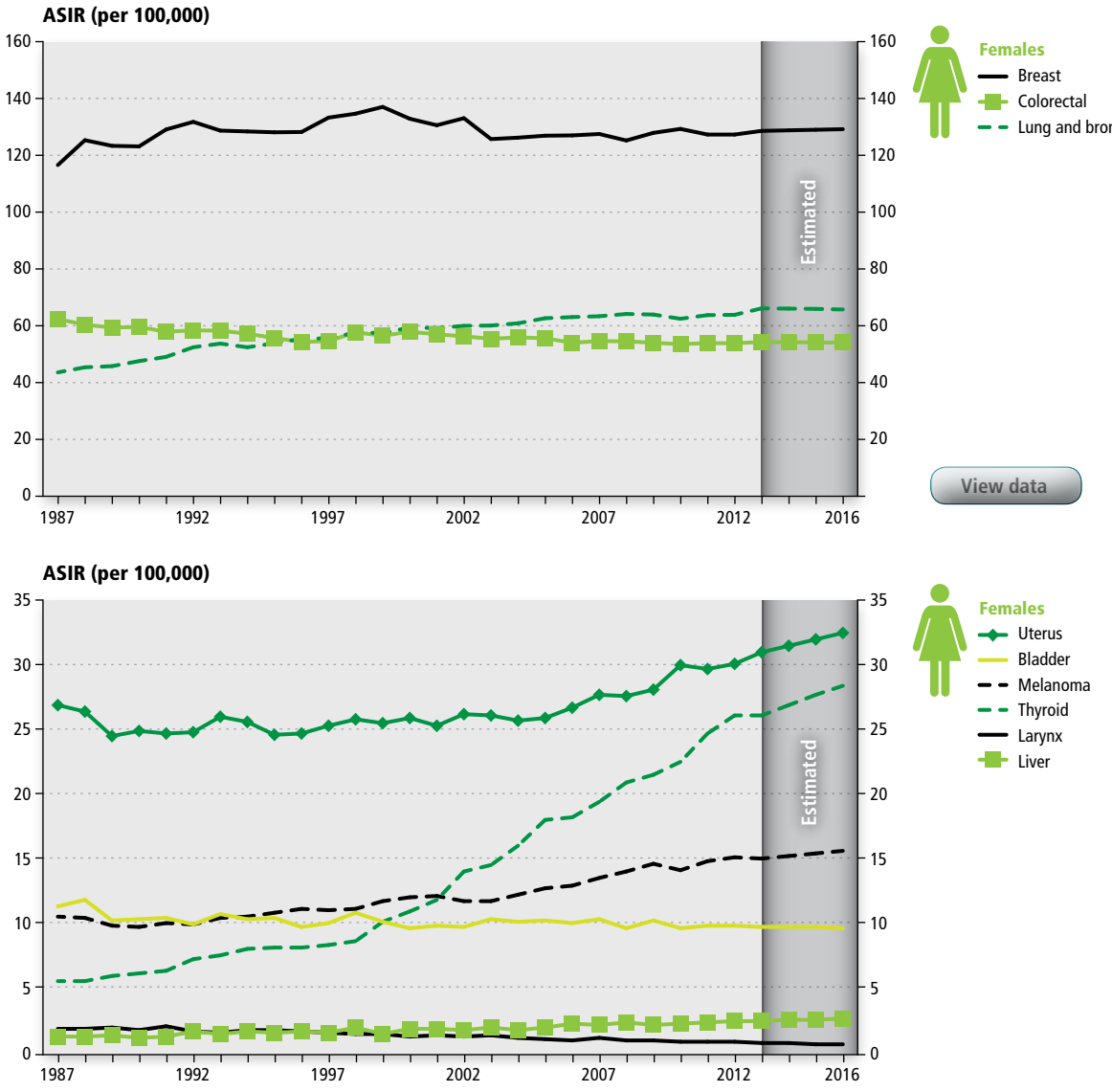
Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry and National Cancer Incidence Reporting System databases at Statistics Canada

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]

Body of uterus and uterus NOS (uterine cancer)

The majority of uterine cancers occur in the endometrium or lining of the uterus. Incidence rates of uterine cancer increased by 2.5% per year among women between 2005 and 2010. This is consistent with recent reports from the United States.[7] Exposure to estrogen appears to increase the risk of uterine cancer. Reduced risk is associated with a lower cumulative estrogen exposure and/or higher exposure to progesterone, such as with increased 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.

FIGURE 1.5 Age-standardized incidence rates (ASIR) for selected* cancers, females, Canada, 1987–2016



* 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 2011 Canadian population. See Table 1.4 for data points. Estimated rates were based on long-term historic data and may not always reflect recent changes in trends. Actual incidence data were available to 2012 for all provinces and territories except Quebec, for which data were available to 2010 and estimated thereafter. For further details, see *Appendix II: Data sources and methods*. The range of scales differs widely between the figures. The complete definition of the specific cancers listed here can be found in Table A8.

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

Colorectal cancer

Colorectal is the 2nd most common cancer accounting for 13% of all cancers. 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).[9] Incidence rates then rose through 2000, only to decrease slightly thereafter, most likely due to increased use of colorectal cancer screening, which can identify and remove precancerous polyps and reduce cancer 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.[10-13] Diabetes may also increase risk for colorectal cancer.[14] Colorectal cancer is also linked to several modifiable risk factors, including obesity, physical inactivity, consumption of red and processed meat and smoking.[15,16]

As of 2016, all 10 provinces had implemented or are in the process of implementing organized colorectal cancer screening programs.[17,18] Participation rates vary within and between the existing organized programs and none of them meets the target of 60%.[17]

Esophageal cancer

Incidence rates of esophageal cancer increased significantly for males at an average rate of 2.8% from 2006 to 2010; the rate for females has not changed significantly. Tobacco use (smokeless and smoking),[19] obesity, gastroesophogeal reflux disease[20] and alcohol consumption[21] are established risk factors for this cancer. Rates of increase in Canada for some of these risk factors (particularly obesity and gastroesophageal reflux disease) may be contributing to the rising incidence of esophageal cancer.[20]

Female breast cancer

Breast cancer is the 3rd most common cancer accounting for 13% of all cancers and 26% of cancers among women. The breast cancer incidence rate rose in the 1990s. This increase 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 are likely attributable to 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.[22] Diabetes may also increase the risk of breast cancer.[14] The sharp decrease in incidence that occurred around 2002 may reflect the reduced use of hormone replacement therapy (HRT) among postmenopausal women at that time.[23,24] From 2004 through 2010, the breast cancer incidence rate mostly stabilized. This is consistent with data from the United States.[25]

Larynx cancer

Incidence rates of laryngeal cancer decreased significantly from 2001 to 2010 for both males (2.8% per year) and females (3.7% per year). As cancer of the larynx is most strongly associated with smoking[19] and alcohol,[21] declines in incidence rates most likely reflect decreasing trends in smoking .[26,27]

Liver cancer

The incidence rate of liver cancer increased significantly for males (2.9% per year) and females (2.7% 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.[28]

Lung and bronchus (lung) cancer

Lung is the most common cancer accounting for 14% of all cancers. In males, the incidence rate of lung cancer began to level off in the mid-1980s and has since been declining (1.7% per year between 2006 and 2010). Among females, the incidence rate for lung cancer is no longer increasing as of 2006. The incidence rate of lung cancer remains higher among males (79 per 100,000) than females (66 per 100,000), although rates among younger adults appear to be converging.[29]

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.[26] In males, a drop in the prevalence of daily smokers began in the mid-1960s in Canada, preceding the drop in lung cancer incidence by about 20 years. In females, the drop in smoking was not until mid-1980s, suggesting that lung cancer incidence rates in women may also begin to decrease in the coming years.

Melanoma

Incidence rates of melanoma have increased in both men and women over the past several decades, with recent increases of 2.4% per year in men between 2001 and 2010, and 2.8% per year among women between 2004 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.[30]

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

Prostate is the 4th most common cancer accounting for 11% of all cancers and 21% of cancers among men. Since at least 2001, the age-standardized prostate cancer incidence rate has been declining (1.5% per year). The incidence rate had 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 prostate-specific antigen (PSA) test. While the PSA test is not currently recommended in Canada as a population-based screening test,[31] its use as a screening test is widespread.[32,33]

Prostate cancer incidence rates have also been decreasing lately in the United States, but at a faster pace than in Canada. From 2011 to 2012, the rate in the United States decreased by 19.1%[34] compared with 12.3% in Canada. In the United States, the decline in the rate for 2012 coincides with a significant drop in self-reported PSA screening rates, possibly related to revised guidelines released by the United States Preventive Services Task Force.[35,36]

Stomach cancer

Incidence rates of stomach cancer continue to decline in both males (2.1% per year) and females (1.0% per year since 2003). Current rates are about half of what they were in 1985. This decline may be due to long-term improvements in diet[37] and decreases in smoking and heavy alcohol use.[38] 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.[39]

Thyroid cancer

Thyroid cancer has undergone the most rapidly increasing incidence rate among all major cancers not only in Canada but worldwide.[40] In Canada, there was a 6.3% per year increase in males between 2001 and 2010 and a 4.7% per year increase in females between 2005 and 2010.

A new study, led by researchers from the International Agency for Research on Cancer (IARC), shows that a large proportion of thyroid cancers in developed countries are likely due to increased surveillance and use of diagnostic technologies, like the introduction of neck ultrasonography in the 1980s and of computed tomography (CT) scanning and magnetic resonance imaging (MRI) in the 1990s.[41] This may mean that more earlier stage, asymptomatic thyroid cancers are being diagnosed.[41,42]

The potential for overdiagnosis and overtreatment in thyroid cancer may have important implications for the individual and health system resources. For example, potentially unnecessary treatment resulting from enhanced surveillance of the thyroid gland is associated with substantial side effects and may not result in reductions in mortality rates. Also, increasing exposure to diagnostic ionizing radiation could promote the initiation of new tumours.[43]

What do these statistics mean?

The incidence rate for all cancers combined in males has been stable over the past two decades while the incidence rate in females has continued to slowly increase. This increase is in part driven by the rise in melanoma, thyroid, uterine and liver cancer incidence.

Although incidence rates have not changed dramatically during the past 30 years, the number of new cancer cases continues to increase with the aging and growing population.[44] With the rising number of new cancer cases, there will be a commensurate increase in the need for diagnostic, treatment and support services, including palliative care. It will also be important to promptly develop strategies to address the cancers that are showing significant increases in incidence rates, such as liver, thyroid and melanoma as well as some cancers associated with the human papillomavirus (HPV; see *Chapter 7: HPV-associated cancers)*.

An increased focus on prevention efforts should be employed to minimize the impact of risk factors on cancer before they develop. In addition, a sustained focus on screening and early detection should be maintained to diagnose and treat these cancers earlier in their course when the chance of cure is higher. Effective screening, reduction of exposure to risk factors, along with proven vaccines can help prevent cancers before they start.

Other resources

Publications

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- Navaneelan T, Janz T. Cancer in Canada: Focus on lung, colorectal, breast and prostate. Health at a Glance, Statistics Canada. (Catalogue no. 82-624-X), 2011.
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Databases

- Statistics Canada. Table 103-0550. New cases of primary cancer (based on the August 2015 CCR tabulation file), by cancer type, age group and sex, Canada, provinces and territories, annual, CANSIM (database).
- Statistics Canada. Table 103-0554. New cases and 2011 age-standardized rate for primary cancer (based on the August 2015 CCR tabulation file), by cancer type and sex, Canada, provinces and territories, annual, CANSIM (database).
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TABLE 1.1 Lifetime probability (%) of developing cancer overall and at selected ages, Canada, 2010

	Lifetime probability of developing cancer		Probability (%) of developing cancer in next 10 years at selected ages					
	%	One in:	30	40	50	60	70	80
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 and bronchus	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 and renal pelvis	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 and bronchus	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 and uterus NOS	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 and renal pelvis	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)

— Value less than 0.05

CNS=central nervous system; NOS=not otherwise specified

*"All cancers" includes *in situ* bladder cancer except for Ontario and excludes non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous).

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*. The complete definition of the specific cancers listed here can be found in Table A8.

TABLE 1.2 Estimated new cases and age-standardized incidence rates (ASIR) for cancers by sex, Canada, 2016

	New cases (2016 estimates)			Cases per 100,000		
	Total*	Males	Females	Total	Males	Females
All cancers	**202,400**	**102,900**	**99,500**	**518.6**	**562.4**	**488.2**
Lung and bronchus	28,400	14,400	14,000	71.4	78.9	66.2
Colorectal	26,100	14,500	11,600	66.1	79.5	54.5
Breast	26,000	230	25,700	68.0	1.3	130.1
Prostate	21,600	21,600	—	—	114.7	—
Bladder†	8,700	6,600	2,100	22.0	36.9	9.8
Non-Hodgkin lymphoma	8,000	4,400	3,600	20.6	24.2	17.5
Thyroid	6,800	1,550	5,300	18.6	8.4	28.6
Melanoma	6,800	3,700	3,100	17.8	20.5	15.8
Body of uterus and uterus NOS	6,600	—	6,600	—	—	32.7
Kidney and renal pelvis	6,400	4,100	2,300	16.4	22.1	11.4
Leukemia	5,900	3,500	2,400	15.3	19.5	11.8
Pancreas	5,200	2,600	2,600	13.1	14.3	12.0
Oral	4,600	3,200	1,450	11.9	17.2	7.1
Stomach	3,400	2,200	1,300	8.8	11.9	6.0
Brain/CNS	3,000	1,750	1,300	8.0	9.5	6.7
Ovary	2,800	—	2,800	—	—	13.8
Multiple myeloma	2,700	1,600	1,150	6.9	8.7	5.4
Liver	2,400	1,800	590	6.1	9.7	2.8
Esophagus	2,300	1,800	530	5.9	9.8	2.4
Cervix	1,500	—	1,500	—	—	8.0
Testis	1,100	1,100	—	—	6.1	—
Larynx	1,050	890	170	2.7	4.8	0.8
Hodgkin lymphoma	1,000	550	460	2.8	3.1	2.5
All other cancers	19,900	11,000	8,900	51.0	61.5	42.3

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

— Not applicable; CNS=central nervous system; NOS=not otherwise specified

* 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 non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). Rates are age-standardized to the 2011 Canadian population. The complete definition of the specific cancers listed here can be found in Table A8.

TABLE 1.3 Age-standardized incidence rates (ASIR) for selected* cancers, males, Canada, 1987–2016†

Year	Cases per 100,000										
	All cancers	Prostate	Colorectal	Lung and bronchus	Bladder	Melanoma	Stomach	Esophagus	Liver	Thyroid	Larynx
1987	605.9	121.0	85.6	125.9	44.6	11.6	23.5	8.4	4.1	2.6	11.7
1988	608.9	122.3	84.9	126.3	44.2	12.6	23.1	7.6	3.9	2.5	11.6
1989	598.5	123.3	83.2	123.6	40.7	11.5	22.5	7.5	4.1	2.4	10.9
1990	605.4	133.6	83.0	122.5	40.2	12.6	21.2	7.7	4.4	2.5	10.2
1991	622.6	150.0	83.0	120.1	40.8	11.3	21.0	8.0	4.6	2.8	11.1
1992	648.6	167.5	85.6	121.5	40.8	13.0	19.7	8.0	4.6	2.3	10.9
1993	662.4	186.5	82.1	122.5	40.6	13.0	19.4	7.7	5.0	3.0	10.0
1994	646.8	172.0	83.3	115.9	40.7	13.5	19.3	8.2	5.7	3.1	10.1
1995	615.5	149.4	81.3	113.3	39.9	13.8	18.0	7.5	5.5	3.0	9.8
1996	604.0	146.8	79.8	110.5	38.3	14.0	18.4	7.8	5.6	3.0	9.3
1997	608.6	154.1	79.7	106.9	39.8	14.4	17.6	8.1	6.1	3.1	8.8
1998	609.2	154.0	82.5	108.2	37.9	14.1	17.2	7.9	5.7	3.2	8.8
1999	623.8	159.7	83.8	107.3	40.5	16.4	17.0	7.9	6.1	3.7	8.8
2000	626.6	166.3	85.9	102.4	38.8	16.0	16.7	8.6	6.1	4.1	7.8
2001	634.9	177.4	84.8	102.5	37.6	16.4	16.1	7.8	7.0	4.0	8.2
2002	614.2	165.4	83.8	99.4	37.7	15.5	14.8	8.0	7.0	4.6	7.7
2003	609.1	161.1	81.0	96.5	38.4	16.4	15.9	8.2	6.7	4.3	7.2
2004	615.4	164.2	82.6	96.5	38.6	16.3	15.3	8.2	7.2	4.6	7.1
2005	614.5	163.6	82.5	95.0	37.3	16.2	15.1	8.4	7.8	5.5	7.0
2006	615.5	169.1	81.4	93.0	37.5	17.5	14.6	8.2	7.9	5.8	6.3
2007	618.4	168.0	81.7	92.6	36.7	17.8	14.4	8.5	8.5	6.0	6.4
2008	604.7	154.7	82.4	90.0	38.2	18.7	14.0	8.6	8.3	6.6	6.5
2009	596.9	151.2	80.2	88.4	37.5	19.2	13.6	9.1	8.7	6.6	6.2
2010	584.1	146.0	76.2	85.8	37.8	19.1	12.8	9.2	8.4	6.8	6.3
2011†	588.7	146.2	79.2	84.3	37.0	19.8	13.1	8.9	9.1	7.7	5.7
2012†	584.6	143.1	78.9	82.6	36.8	20.2	12.9	9.0	9.3	8.1	5.5
2013‡	573.2	129.1	80.0	82.2	37.3	19.9	12.4	9.4	9.3	7.8	5.3
2014‡	569.5	124.1	79.8	81.0	37.2	20.1	12.2	9.5	9.5	8.0	5.1
2015‡	566.0	119.3	79.6	80.0	37.1	20.4	12.1	9.7	9.6	8.2	5.0
2016‡	562.4	114.7	79.5	78.9	36.9	20.5	11.9	9.8	9.7	8.4	4.8

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

* 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).

† Actual incidence data were available to 2012 for all provinces and territories except Quebec, for which data were available to 2010 and estimated thereafter.

‡ Rates were estimated based on long-term historic data and may not always reflect recent changes in trends. For further details, see *Appendix II: Data sources and methods*.

Note: "All cancers" excludes non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). Rates are age-standardized to the 2011 Canadian population. The complete definition of the specific cancers listed here can be found in Table A8.

TABLE 1.4 Age-standardized incidence rates (ASIR) for selected* cancers, females, Canada, 1987–2016†

	Cases per 100,000									
Year	All cancers	Breast	Lung and bronchus	Colorectal	Body of uterus and uterus NOS	Thyroid	Melanoma	Bladder	Liver	Larynx
1987	429.5	117.4	43.9	62.8	27.1	5.7	10.7	11.5	1.4	2.0
1988	435.9	126.2	45.7	60.8	26.6	5.7	10.6	12.0	1.4	2.0
1989	427.2	124.2	46.1	59.8	24.7	6.1	10.0	10.4	1.5	2.1
1990	431.2	124.0	47.9	60.0	25.1	6.3	9.9	10.5	1.3	1.9
1991	437.4	130.0	49.4	58.3	24.9	6.5	10.2	10.6	1.4	2.2
1992	446.8	132.7	52.8	58.8	25.0	7.4	10.1	10.1	1.8	1.8
1993	447.5	129.6	54.1	58.7	26.2	7.7	10.6	10.9	1.6	1.7
1994	447.0	129.3	52.8	57.6	25.8	8.2	10.7	10.5	1.8	1.9
1995	444.6	129.0	54.2	56.1	24.8	8.3	11.0	10.6	1.7	1.9
1996	442.5	129.1	55.8	54.7	24.9	8.3	11.3	9.9	1.8	1.8
1997	448.7	134.2	56.0	55.0	25.5	8.5	11.2	10.2	1.7	1.7
1998	458.9	135.6	58.0	58.1	26.0	8.8	11.3	11.0	2.1	1.6
1999	459.7	138.0	57.9	56.9	25.7	10.3	11.9	10.3	1.6	1.6
2000	461.4	133.8	59.8	58.3	26.1	11.1	12.2	9.8	2.0	1.4
2001	458.0	131.5	59.6	57.4	25.5	12.0	12.3	10.0	2.0	1.5
2002	464.1	134.0	60.4	56.7	26.4	14.2	11.9	9.9	1.9	1.4
2003	455.4	126.6	60.5	55.8	26.3	14.7	11.9	10.5	2.1	1.5
2004	458.4	127.1	61.3	56.3	25.9	16.2	12.4	10.3	1.9	1.3
2005	465.9	127.8	63.1	56.0	26.1	18.2	12.9	10.4	2.1	1.2
2006	465.8	127.9	63.5	54.4	26.9	18.4	13.1	10.2	2.4	1.1
2007	471.4	128.4	63.8	55.0	27.9	19.6	13.7	10.5	2.3	1.3
2008	469.1	126.1	64.6	54.9	27.8	21.1	14.2	9.8	2.5	1.1
2009	474.8	128.8	64.4	54.4	28.3	21.7	14.8	10.4	2.3	1.1
2010	475.9	130.2	62.9	53.9	30.2	22.7	14.3	9.8	2.4	1.0
2011†	477.4	128.2	64.2	54.3	29.9	24.9	15.0	10.0	2.5	1.0
2012†	479.3	128.2	64.3	54.2	30.3	26.3	15.3	10.0	2.6	1.0
2013‡	482.0	129.5	66.6	54.7	31.2	26.3	15.2	9.9	2.6	0.9
2014‡	484.2	129.7	66.5	54.6	31.7	27.1	15.4	9.9	2.7	0.9
2015‡	486.2	129.9	66.4	54.5	32.2	27.9	15.6	9.9	2.7	0.8
2016‡	488.2	130.1	66.2	54.5	32.7	28.6	15.8	9.8	2.8	0.8

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

* 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).

† Actual incidence data were available to 2012 for all provinces and territories except Quebec, for which data were available to 2010 and estimated thereafter.

‡ Rates were estimated based on long-term historic data and may not always reflect recent changes in trends. For further details, see *Appendix II: Data sources and methods*.

Note: "All cancers" excludes non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). Rates are age-standardized to the 2011 Canadian population. The complete definition of the specific cancers listed here can be found in Table A8.

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	–0.6**		0.5**	
Lung and bronchus	–1.7**		0.0	2006
Breast	0.3		0.3	2004
Colorectal	–0.7**		–0.6**	
Prostate	–1.5**		—	
Bladder	–0.1		–0.2	
Non-Hodgkin lymphoma	0.4		0.4	
Melanoma	2.4**		2.8**	2004
Kidney and renal pelvis	1.5**		1.3*	
Thyroid	6.3**		4.7**	2005
Body of uterus and uterus NOS	—		2.5**	2005
Leukemia	0.6*		1.1**	
Pancreas	–0.2		0.0	
Oral	0.3	2002	0.6	
Stomach	–2.1**		–1.0*	2003
Brain/CNS	–0.1		–0.1	
Ovary	—		–1.0**	
Multiple myeloma	0.6		0.2	
Liver	2.9**		2.7**	
Esophagus	2.8*	2006	-0.1	
Cervix	—		0.5	2005
Larynx	–2.8**		–3.7**	
Testis	1.6**		—	
Hodgkin lymphoma	–0.1		0.0	

Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry database at Statistics Canada

CNS=central nervous system; NOS=not otherwise specified

— Not applicable

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

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

† APC is calculated by fitting a piecewise log linear model to the rates in 1992–2010. When there is no changepoint in the most recent 10 years, the APC is obtained by running a separate joinpoint analysis on the most recent 10 years. If there is a changepoint, the APC is taken from the last segment and the related changepoint is reported. "All cancers" includes cancers not found in the table but excludes non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). For further details, see *Appendix II: Data sources and methods*. The complete definition of the specific cancers listed here can be found in Table A8.

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

Note: Rates are age-standardized to the 2011 Canadian population.

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 generally declining over time in males and increasing in females due to increases in the rates of selected cancers in recent years.
- In 2016, it is estimated that 89% of all cancers will be diagnosed in Canadians age 50 years and over, while 44% 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 increased risk of breast and thyroid cancer. Cancer rates are higher in males in all other age groups.
- Across Canada, cancer incidence rates are generally lowest in the west and higher in the east.

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

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). Prostate and breast cancer are the most frequently diagnosed cancers for males and females respectively, followed by colorectal and lung and bronchus (lung) cancers (Table 1.2).

Trends over time by sex

Figure C (*Introduction)* shows the trend in cancer incidence rates by sex from 1987 to 2016.

- 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 (Table 1.3).
- Among females, the overall cancer incidence rate has been increasing slowly since the early 1990s. This increase primarily reflects the rise in lung cancers to 2006, as well as an increase in thyroid and body of uterus and uterus NOS (uterine) cancers and melanoma (Table 1.4).

For more detailed information on trends in specific cancer incidence rates by sex, see the trends sections in *Chapter 1*.

Incidence by age

Cancer primarily affects Canadians age 50 and over—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 2016:

- 44% 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.
- 17% of all new cases will occur in people aged 50–59 years.
- 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 (51%). Approximately 32% of breast cancers are diagnosed in females aged 70 and over, while 17% occur in females under age 50.
- Prostate cancer is most common in males aged 60–69 years (40%).

Trends over time by age

Trends in incidence rates over time vary by sex and age group (Figure 2.1).

- For all years presented, incidence rates are higher in females between the ages of 20 and 59 primarily due to breast cancer. 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 60; the recent trend in incidence rates for ages 60–69 appears to be decreasing slightly.
- Incidence rates in males over 70 have been decreasing over time primarily due to the declining rate of lung cancer, which is the result of decreased tobacco use in past decades.[1]

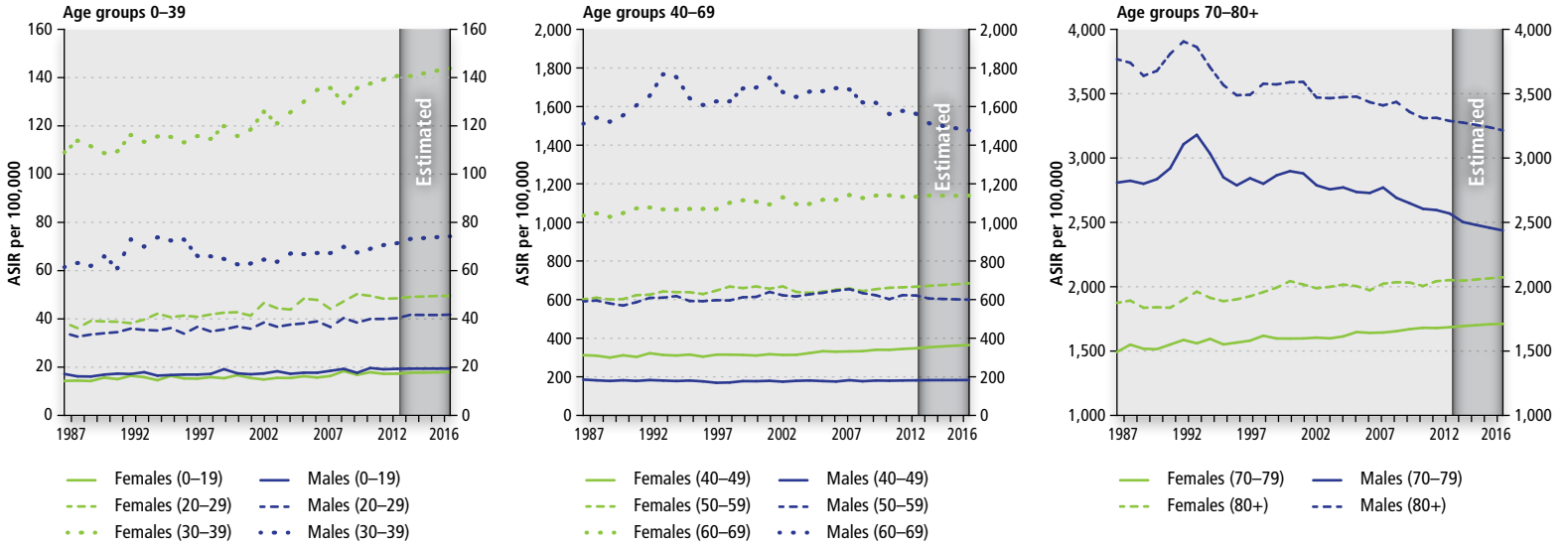
Children, adolescents and young adults

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 (CNS) cancers. To account for these differences, a separate classification scheme of diagnostic groupings has been created.[2]

Adolescents and young adults (15–29 years of age) 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 in this age group can be challenging and there have been limited advancements in overall survival in this age group in recent years.[3,4]

FIGURE 2.1 Age-standardized incidence rates (ASIR) for all cancers, by age group, Canada, 1987–2016



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). Rates were estimated based on long-term historic data and may not always reflect recent changes in trends. Rates are age-standardized to the 2011 Canadian population. Actual incidence data were available to 2012 for all provinces and territories except Quebec, for which data were available to 2010 and estimated thereafter. For further details, see *Appendix II: Data sources and methods*.

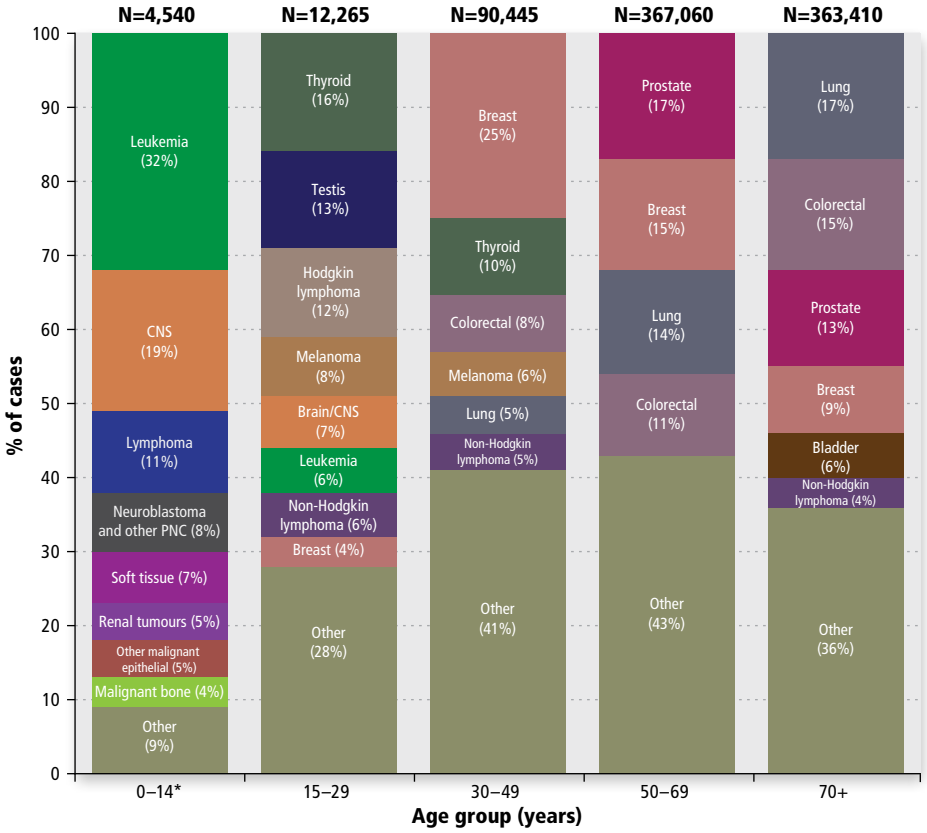
Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data sources: Canadian Cancer Registry and National Cancer Incidence Reporting System databases at Statistics Canada

View data

Figure 2.2 shows that the distribution of the types 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 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 individuals aged 30 and over, the distribution of cancers shifts more towards tumours that are epithelial in origin and arise frequently within solid organs in the body. 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 (Table 2.1).

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.

* Cancers in children (ages 0–14 years) are classified according to ICCC-3. The complete definition of the specific cancers listed here can be found in Table A8.

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

Incidence by geographic region

The estimated number of new cases for all cancers combined by province and territory for 2016 is shown in Figure 2.3, with data in Table 2.3. The age-standardized incidence rates (ASIR) for females are lowest in British Columbia and Alberta and highest in Newfoundland and Labrador and Quebec. Newfoundland and Labrador and Quebec also had the highest rates for males, with British Columbia and Saskatchewan reporting the lowest rates.

Incidence

The number of new cases of cancer in a given period of time, often a year.

Age-standardized incidence rate (ASIR)

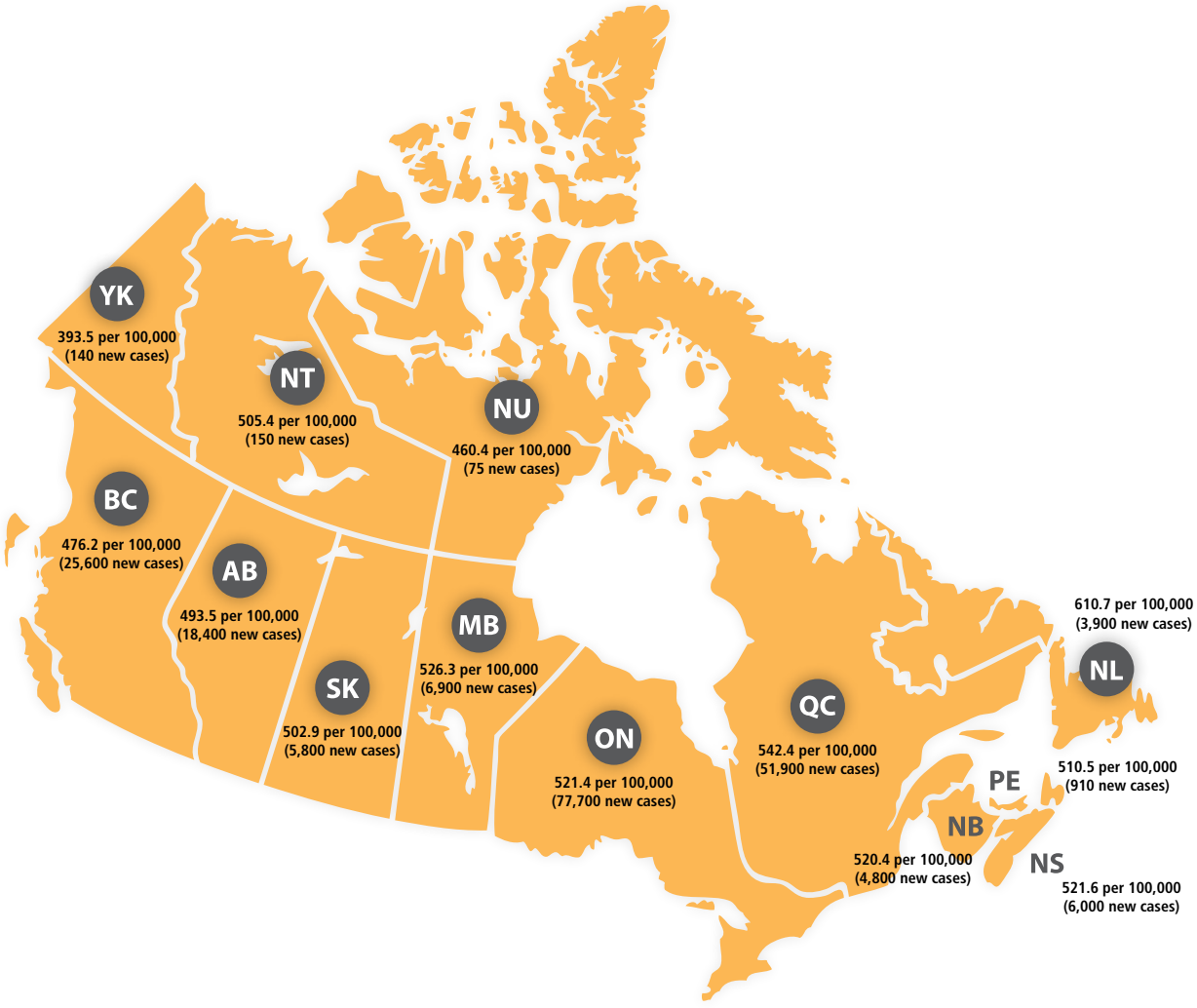
The number of new cases of cancer per 100,000 people, standardized to the age structure of the 2011 Canadian population.

Age standardization is used to adjust for differences in age distributions over time and across provinces and territories, thereby allowing for more accurate comparisons between populations. In this report, ASIR is also referred to as "incidence rate".

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 all provinces and territories are available to 2012, except Quebec, for which the most recent data are to 2010 (see Tables A3 and A4 in *Appendix I: Actual data for new cases and deaths).*

FIGURE 2.3 Geographic distribution of estimated new cancer cases and age-standardized incidence rates (ASIR) by province and territory, both sexes, Canada, 2016



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

Note: Rates are age-standardized to the 2011 Canadian population.

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 considerably among the provinces, possibly due to variations in PSA testing across the country.
- Among males, lung cancer incidence rates are highest in Newfoundland and Labrador and Quebec. Rates for females are highest in Quebec and Nova Scotia. British Columbia and Alberta have the lowest lung cancer incidence rates in Canada for both males and females. This difference in incidence rates is linked in large part to the prevalence of smoking in each province.[1]
- Colorectal cancer incidence rates for both males and females are highest in Newfoundland and Labrador. For females, the second highest rates were observed in Nova Scotia, while the second highest rates among males were seen in Manitoba. The lowest rates for males and females are expected in British Columbia and Alberta.
- Breast cancer incidence rates appear to be fairly consistent across the country, with no discernible geographic pattern.

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 organized screening programs and the availability of diagnostic services.

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

- Cancer frequency – When a cancer is rare or the population is small, the estimated number of new cases of a cancer type is 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 linked to the number of data sources that registries are able to access, as well as the availability and accuracy of death certificate information and specific diagnostic information in some provinces and territories.
- 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 A10 and A11 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 reported for the period being examined.

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. Incidence rates in females are also increasing in every age category, while incidence rates are decreasing in older males. 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 generally 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.

Other resources

Publications

- Ellison LF, Janz T. "Childhood cancer incidence and mortality in Canada." Health at a Glance. 2015. Statistics Canada Catalogue no. 82-624-X. Available at: http://www.statcan.gc.ca/pub/82-624-x/2015001/article/14213-eng.pdf (accessed May 2016).
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Databases

- Statistics Canada. Table 103-0550. New cases of primary cancer (based on the August 2015 CCR tabulation file), by cancer type, age group and sex, Canada, provinces and territories, annual, CANSIM (database).
- Statistics Canada. Table 103-0554. New cases and 2011 age-standardized rate for primary cancer (based on the August 2015 CCR tabulation file), by cancer type and sex, Canada, provinces and territories, annual, CANSIM (database).

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1. Reid JL, Hammond D, Rynard VL, Burkhalter R. Tobacco Use in Canada: Patterns and Trends, 2015 Edition. Waterloo, ON: Propel Centre for Population Health Impact, University of Waterloo. Available at: http://tobaccoreport.ca/2015/TobaccoUseinCanada_2015.pdf (accessed May 2016).
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3. Lewis DR, Seibel NL, Smith AW, Stedman, MR. Adolescent and Young Adult Cancer Survival. J Natl Cancer Inst Monogr. 2014;49:228–235.
4. De P, Ellison LF, Barr RD et al. Canadian adolescents and young adults with cancer: Opportunity to improve coordination and level of care. CMAJ. 2011;183:E187–E194.

TABLE 2.1 Estimated population and new cases for all cancers by age group and sex, Canada, 2016

Age	Population (in thousands)			New cases		
	Total*	Males	Females	Total*	Males	Females
All ages	**36,229**	**17,968**	**18,261**	**202,400**	**102,900**	**99,500**
0–19	7,893	4,050	3,842	1,450	780	690
20–29	4,949	2,513	2,436	2,300	1,050	1,200
30–39	4,959	2,469	2,489	5,400	1,850	3,600
40–49	4,782	2,389	2,392	12,900	4,300	8,600
50–59	5,372	2,691	2,681	34,900	16,400	18,500
60–69	4,273	2,100	2,173	56,400	31,400	25,000
70–79	2,468	1,158	1,310	50,400	28,000	22,400
80+	1,534	597	937	38,700	19,100	19,500

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 Census and Demographics Branch at Statistics Canada

* 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, 2016

Age	Lung and bronchus			Colorectal			Prostate	Breast
	Total*	Males	Females	Total*	Males	Females	Males	Females
All ages	**28,400**	**14,400**	**14,000**	**26,100**	**14,500**	**11,600**	**21,600**	**25,700**
0–19	10	5	5	15	5	10	—	5
20–29	20	10	10	85	45	40	—	140
30–39	90	35	60	320	170	150	5	1,050
40–49	630	270	360	1,100	570	520	420	3,300
50–59	3,700	1,700	2,000	3,800	2,200	1,600	3,900	6,200
60–69	8,500	4,400	4,200	6,900	4,300	2,700	8,700	6,900
70–79	9,200	4,900	4,400	7,400	4,300	3,100	5,700	4,900
80+	6,200	3,200	3,000	6,500	3,000	3,500	2,900	3,200

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

— 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 A8.

TABLE 2.3 Estimated population and new cases for all cancers by sex and geographic region, Canada, 2016

	Population (in thousands)			New cases		
	Total*	Males	Females	Total*	Males	Females
CANADA	**36,229**	**17,968**	**18,261**	**202,400**	**102,900**	**99,500**
British Columbia (BC)	4,750	2,358	2,392	25,600	13,200	12,400
Alberta (AB)	4,272	2,172	2,100	18,400	9,900	8,600
Saskatchewan (SK)	1,135	572	563	5,800	2,900	2,800
Manitoba (MB)	1,306	650	656	6,900	3,400	3,400
Ontario (ON)†	13,929	6,839	7,090	77,700	39,400	38,300
Quebec (QC)†	8,342	4,148	4,194	51,900	25,800	26,100
New Brunswick (NB)	760	376	384	4,800	2,600	2,300
Nova Scotia (NS)	946	463	482	6,000	3,000	3,000
Prince Edward Island (PE)	150	73	77	910	470	440
Newfoundland and Labrador (NL)	521	256	265	3,900	2,000	1,900
Yukon (YT)	38	19	19	140	70	70
Northwest Territories (NT)	44	23	21	150	75	75
Nunavut (NU)	37	19	18	75	40	35

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

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

† The number of cases for some cancers used to calculate the overall 2016 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, 2016

	Canada*	BC	AB	SK	MB	ON†	QC‡	NB	NS	PE	NL‡
Males											
All cancers	**102,900**	**13,200**	**9,900**	**3,000**	**3,400**	**39,400**	**25,800**	**2,600**	**3,000**	**470**	**2,100**
Prostate	21,600	3,300	2,600	660	710	7,900	4,700	530	590	95	440
Colorectal	14,500	1,800	1,300	480	560	5,400	3,700	360	470	70	360
Lung and bronchus	14,400	1,550	1,050	380	430	5,300	4,400	410	470	65	330
Bladder	6,600	1,050	660	250	220	1,750	2,100	190	240	35	110
Non-Hodgkin lymphoma	4,400	560	460	120	150	1,700	1,050	120	140	20	80
Kidney and renal pelvis	4,100	430	380	130	180	1,450	1,050	130	150	20	110
Melanoma	3,700	580	360	75	100	1,750	550	95	150	20	55
Leukemia	3,500	460	430	130	150	1,350	750	100	90	10	45
Oral	3,200	430	290	95	150	1,250	680	65	95	20	55
Pancreas	2,600	350	230	80	95	960	680	65	70	10	35
Stomach	2,200	260	190	70	85	790	560	60	60	10	65
Liver	1,800	290	170	30	45	740	450	20	45	5	20
Esophagus	1,800	240	200	45	50	760	370	40	60	10	20
Brain/CNS	1,750	200	160	45	50	680	460	35	45	5	30
Multiple myeloma	1,600	200	150	40	50	630	390	40	45	10	25
Thyroid	1,550	130	150	25	35	670	420	35	35	—	25
Testis	1,100	150	120	35	40	440	240	20	25	5	5
Larynx	890	95	70	25	30	330	290	25	35	5	25
Hodgkin lymphoma	550	60	65	25	15	210	160	10	15	—	10
Females											
All cancers	**99,500**	**12,400**	**8,600**	**2,800**	**3,400**	**38,300**	**26,100**	**2,300**	**3,000**	**440**	**1,900**
Breast	25,700	3,500	2,400	720	880	9,900	6,300	570	790	120	440
Lung and bronchus	14,000	1,550	1,100	420	490	5,200	4,200	320	480	55	230
Colorectal	11,600	1,400	900	360	410	4,500	3,000	260	420	55	260
Body of uterus and uterus NOS	6,600	790	610	180	260	2,800	1,450	140	160	20	120
Thyroid	5,300	380	370	70	140	2,500	1,550	110	110	10	110
Non-Hodgkin lymphoma	3,600	480	340	120	130	1,450	820	95	120	15	80
Melanoma	3,100	530	290	65	110	1,350	460	90	140	20	45
Ovary	2,800	320	210	80	100	1,150	700	55	70	10	45
Pancreas	2,600	290	240	75	85	1,000	680	60	80	10	35
Leukemia	2,400	320	240	85	80	1,000	540	70	55	10	25
Kidney and renal pelvis	2,300	200	220	80	95	870	600	80	100	5	60
Bladder	2,100	290	190	75	70	520	780	65	80	10	30
Cervix	1,500	180	170	50	50	630	280	30	45	5	30
Oral	1,450	180	110	35	55	600	360	30	40	5	20
Stomach	1,300	150	95	35	40	530	320	30	30	—	35
Brain/CNS	1,300	150	110	35	40	520	370	30	35	—	20
Multiple myeloma	1,150	160	110	35	35	470	270	25	35	5	20
Liver	590	80	55	10	15	210	180	10	10	—	5
Esophagus	530	80	45	10	15	210	110	10	20	—	10
Hodgkin lymphoma	460	55	45	15	15	170	100	5	10	—	5
Larynx	170	25	15	5	5	60	60	5	5	—	5

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

— Fewer than 3 cases.

CNS=central nervous system; NOS=not otherwise specified

* Column totals may not sum to row totals due to rounding. Canada totals include provincial and territorial estimates. Territories are not listed separately 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 2016 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 A8.

TABLE 2.5 Estimated age-standardized incidence rates (ASIR) for selected cancers by sex and province, Canada, 2016

	Cases per 100,000										
	Canada*	BC	AB	SK	MB	ON†	QC‡	NB	NS	PE	NL‡
Males											
All cancers	**562.4**	**509.9**	**557.4**	**543.8**	**563.8**	**567.4**	**584.0**	**581.1**	**554.2**	**567.6**	**663.3**
Prostate	114.7	123.5	144.9	119.6	114.0	110.8	104.6	114.3	103.2	105.9	131.9
Colorectal	79.5	68.7	74.4	88.2	91.4	78.5	82.9	82.9	87.0	81.7	116.1
Lung and bronchus	78.9	59.6	64.1	70.4	70.9	75.9	98.7	93.3	86.1	72.7	106.0
Bladder	36.9	40.2	39.7	46.1	36.9	26.0	48.4	44.2	43.6	40.1	36.0
Non-Hodgkin lymphoma	24.2	22.1	25.7	23.0	25.2	24.7	23.6	27.3	26.7	21.6	28.2
Kidney and renal pelvis	22.1	16.7	21.0	24.1	30.1	20.9	23.9	28.7	27.3	25.1	35.3
Melanoma	20.5	22.7	20.2	14.2	17.2	25.2	12.5	21.7	29.2	25.4	17.4
Leukemia	19.5	18.3	24.2	24.0	24.7	19.5	17.4	23.4	17.1	14.0	14.8
Oral	17.2	17.0	15.5	17.8	25.1	18.2	15.2	14.9	17.6	21.0	18.0
Pancreas	14.3	13.8	13.4	14.8	15.7	13.9	15.5	15.3	13.4	16.4	12.0
Stomach	11.9	10.2	10.9	13.5	14.0	11.5	12.8	13.5	11.3	11.6	21.8
Esophagus	9.8	9.2	11.2	8.4	8.2	10.9	8.2	9.9	11.5	11.1	6.5
Liver	9.7	11.3	9.2	5.4	7.0	10.5	9.9	4.2	7.7	8.1	6.3
Brain/CNS	9.5	8.2	8.3	8.2	7.8	9.9	10.4	8.7	9.6	8.9	10.3
Multiple myeloma	8.7	7.5	8.8	7.3	8.3	9.2	8.9	8.9	8.5	9.7	7.5
Thyroid	8.4	5.4	7.4	4.6	5.5	9.6	9.7	8.5	6.5	—	9.1
Testis	6.1	6.6	5.3	6.3	6.0	6.4	5.9	5.7	5.4	6.0	3.2
Larynx	4.8	3.7	3.8	4.7	5.3	4.7	6.5	6.5	6.4	7.0	7.7
Hodgkin lymphoma	3.1	2.5	2.8	3.9	2.7	3.1	3.8	2.4	3.2	—	3.0
Females											
All cancers	**488.2**	**449.4**	**442.5**	**472.8**	**502.0**	**489.1**	**520.8**	**473.0**	**498.6**	**466.9**	**568.8**
Breast	130.1	132.2	125.6	125.1	132.8	129.2	132.7	121.0	135.1	132.2	134.5
Lung and bronchus	66.2	53.1	56.8	69.4	69.7	63.3	80.5	61.6	74.4	59.3	64.5
Colorectal	54.5	49.0	47.0	59.1	57.6	54.4	56.3	52.0	65.9	57.8	76.5
Body of uterus and uterus NOS	32.7	29.0	31.8	30.7	39.5	36.7	29.2	28.5	26.5	21.8	35.2
Thyroid	28.6	15.2	18.2	12.9	21.6	34.3	35.9	24.8	20.9	11.3	36.0
Non-Hodgkin lymphoma	17.5	17.0	17.5	19.3	18.8	17.9	16.0	19.9	19.0	19.4	24.4
Melanoma	15.8	20.2	14.8	11.5	16.7	17.6	9.9	20.1	24.0	24.3	14.3
Ovary	13.8	11.9	10.9	13.9	14.6	15.3	14.0	11.8	11.4	12.3	13.4
Pancreas	12.0	9.8	12.7	12.0	12.0	12.4	12.6	12.0	12.0	11.7	9.7
Leukemia	11.8	11.3	12.5	14.2	11.7	12.6	10.4	15.1	9.1	10.4	8.4
Kidney and renal pelvis	11.4	7.2	11.5	13.7	14.1	11.0	11.8	16.4	17.3	8.8	17.4
Bladder	9.8	10.0	9.9	12.0	9.8	6.1	14.6	12.8	12.3	11.3	9.9
Cervix	8.0	7.1	8.2	9.6	8.4	8.8	6.6	7.2	8.3	9.0	10.7
Oral	7.1	6.8	5.7	5.5	7.7	7.7	7.2	6.4	6.2	6.3	5.6
Brain/CNS	6.7	5.8	5.3	6.0	5.9	6.8	7.8	6.3	6.3	—	6.4
Stomach	6.0	5.3	4.8	5.7	5.6	6.6	6.0	5.6	5.2	—	10.4
Multiple myeloma	5.4	5.4	5.7	5.8	4.8	5.7	5.1	5.5	5.2	6.4	5.4
Liver	2.8	2.9	2.8	1.8	2.4	2.6	3.2	1.5	1.6	—	1.9
Hodgkin lymphoma	2.5	2.2	2.1	2.4	2.2	2.4	2.5	1.7	2.5	—	2.2
Esophagus	2.4	2.7	2.2	2.0	1.9	2.6	2.0	2.0	3.4	—	2.3
Larynx	0.8	0.9	0.7	1.0	0.9	0.7	1.1	0.9	1.4	—	1.1

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

— ASIR based on fewer than 3 cases.

CNS=central nervous system; NOS=not otherwise specified

* Canada totals include provincial and territorial estimates. Territories are not listed separately 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 2016 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 2011 Canadian population. The complete definition of the specific cancers listed here can be found in Table A8.

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

Highlights

- An estimated 78,800 Canadians are expected to die of cancer in 2016.
- 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.
- More people are expected to die from lung cancer (20,800 in 2016) than from colorectal, breast and pancreatic cancers combined (19,000 in 2016).
- Cancer mortality rates are continuing to decline, most notably in lung and prostate in males, breast, ovarian and oral in females, and colorectal, larynx, non-Hodgkin lymphoma and stomach in both males and females.
- Between 2003 and 2012, cancer mortality rates increased for body of uterus (2.2% since 2006) and for liver in males (by 3.6%) and females (by 2.8%).

Introduction

Each hour, an estimated nine people will die of cancer in Canada in 2016. 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 is 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 during their lifetime. Lung cancer is the most likely cause of cancer death, with a 1 in 13 chance, followed by prostate (1 in 27) and colorectal cancer (1 in 29).

Table 3.1 also shows that females in Canada have a 24% chance (or a 1 in 4.1 chance) of dying from cancer during their lifetime. 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

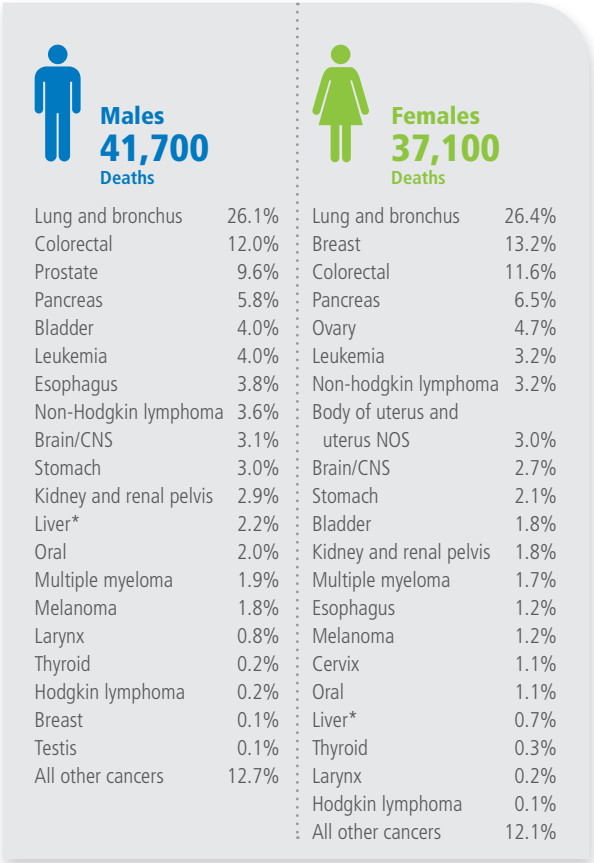
Analysis by: Surveillance and Epidemiology Division, CCDP, Public Health Agency of Canada
Data source: Canadian Vital Statistics Death database at Statistics Canada

Deaths from cancer in 2016

An estimated 78,800 Canadians are expected to die from cancer in 2016 (Table 3.2).

- Lung, colorectal, breast and prostate cancers account for 50% of all cancer deaths for both sexes combined (Figure 3.2). Although it is much less commonly diagnosed than many other cancers, because of its low survival rate, pancreatic cancer is the fourth leading cause of cancer death in both sexes accounting for 6% of all cancer deaths.
- Lung cancer is the leading cause of cancer death for both sexes accounting for approximately 26% 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. It accounts for 12% of all cancer deaths.
- Breast cancer is the second most common cause of cancer death in females accounting for 13% of all female cancer deaths.
- Prostate cancer is the third most common cause of cancer death in males accounting for 10% of all male cancer deaths.

FIGURE 3.2 Percent distribution of estimated cancer deaths, by sex, Canada, 2016



CNS=central nervous system; NOS=not otherwise specified
* Liver cancer deaths are underestimated; see *Appendix II: Data and methods issues*.

Note: The complete definition of the specific cancers listed here can be found in Table A8.

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

Probability

The chance a person has of dying from cancer measured over a period of time. The data here represent the lifetime probability of dying from cancer from ages 0 to 90+. Probability can also be calculated as the chance of developing cancer by a certain age (e.g., age 30) or over a specific period of life (e.g., the next 10 years). The probability of dying from cancer is expressed as a percentage or as a chance (e.g., a 1 in 5 chance).

Deaths

The number of deaths due to cancer in a given period of time, often a year.

Age-standardized mortality rate (ASMR)

The number of cancer deaths per 100,000 people, standardized to the age structure of the 2011 Canadian population.

Age standardization is used to adjust for differences in age distributions over time, thereby allowing for more accurate comparisons. In this report, ASMR is also referred to as "mortality rate".

Annual percent change (APC)

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

Changepoint

The year corresponding to a significant change in trend of age-standardized rates. The changepoint year is determined by an algorithm and may not correspond identically to patterns in the data in Tables 3.3 and 3.4.

Statistical significance

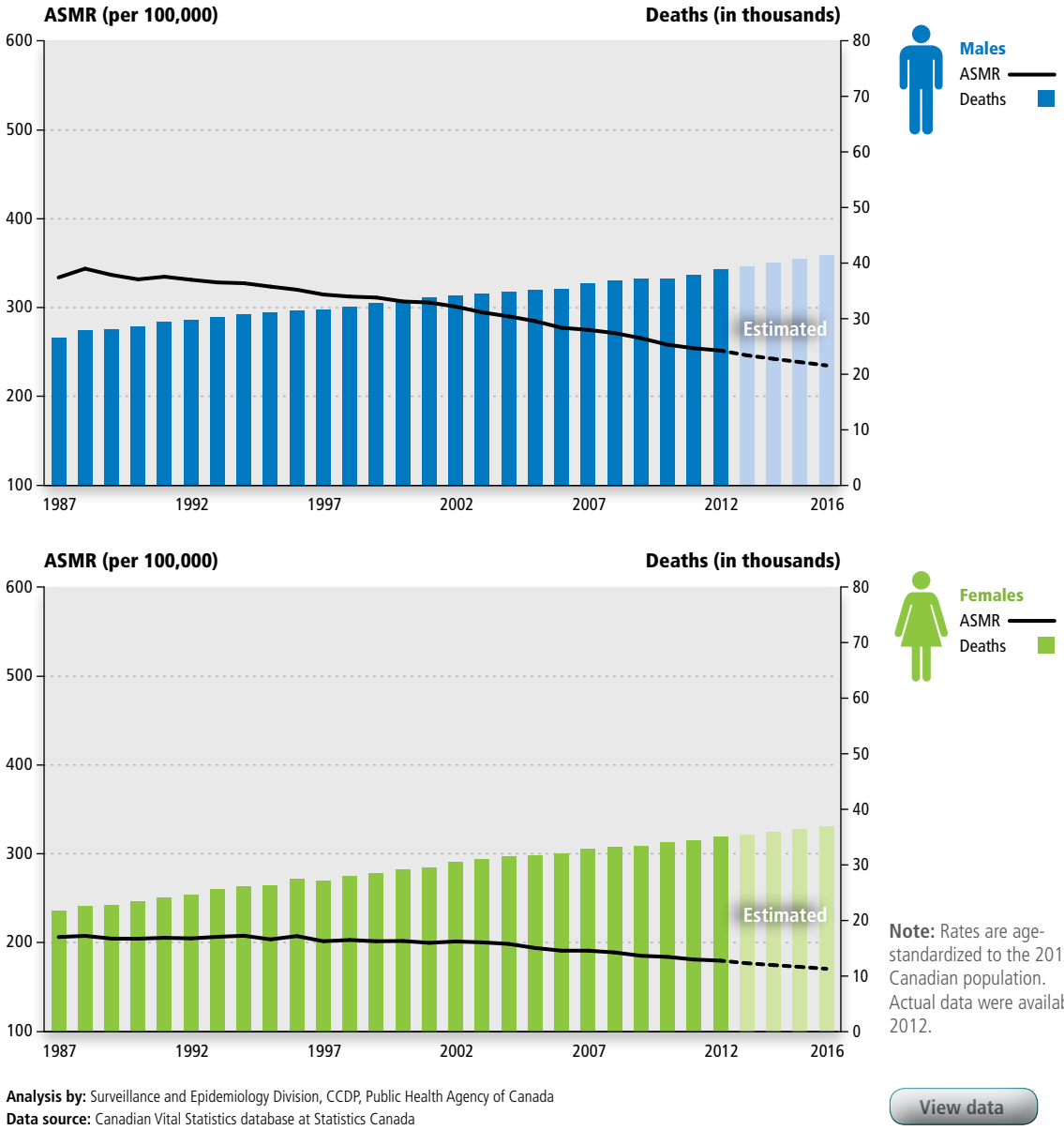
Refers to a result that is unlikely due to chance given a predetermined threshold (e.g., 1 out of 20 times, which is expressed as p=0.05).

Trends over time

While the number of deaths from cancer continues to increase, the age-standardized mortality rate (ASMR) from all cancers combined has been decreasing in both sexes over the past several decades (Figure 3.3). During this period, the ASMR for some cancers varied between the sexes (Figures 3.4 and 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 since 2003 (to 2012).

FIGURE 3.3 Deaths and age-standardized mortality rates (ASMR) for all cancers, Canada, 1987–2016



Note: Rates are age-standardized to the 2011 Canadian population. Actual data were available to 2012.

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

View data

Trends for selected cancers

Tables 3.3 and 3.4 show the ASMR from 1987 to 2016 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 cancers responsible for the most number of cancer deaths (lung, colorectal, prostate, breast and pancreas). The tables also provide time trends for those cancers with statistically significant increases or decreases in APC of at least 2% per year (stomach, non-Hodgkin lymphoma, larynx, liver and uterine cancers).

Further discussion of mortality rates for these cancers is provided later in the following text.

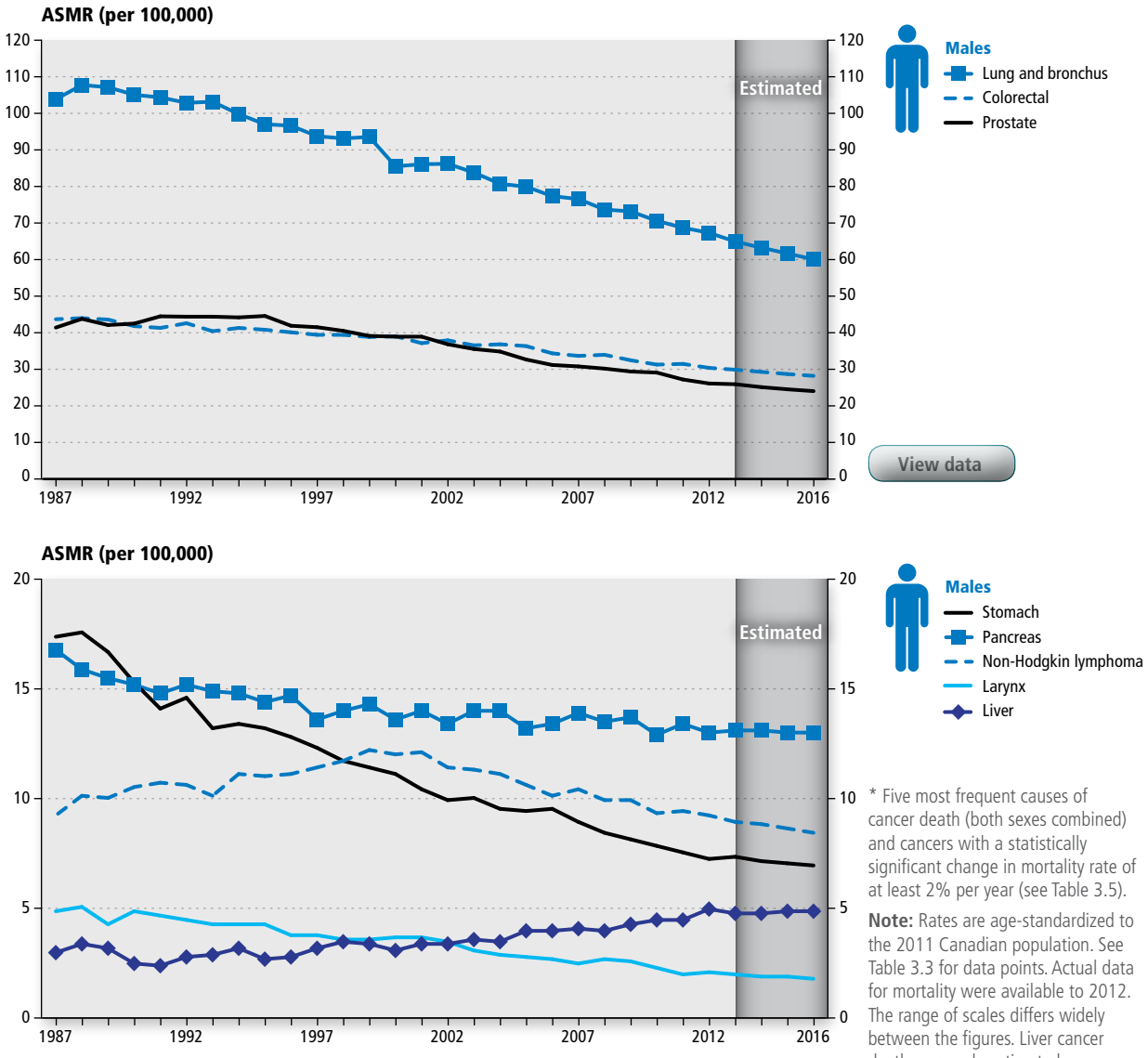
Body of uterus and uterus NOS (uterine cancer)

The mortality rate for uterine cancer among females increased by 2.2% per year between 2006 and 2012. The increase in the mortality rate has followed the increase in the incidence rate of uterine cancer over the same period of time.

Colorectal cancer

The mortality rate from colorectal cancer declined significantly between 2003 and 2012 for both males (2.3% per year) and females (2.0% per year). A part of this decline is likely driven by the decrease in incidence reported in *Chapter 1*. Given that organized screening in Canada began late in that time period, it is unlikely to explain the decreases reported here. It is more likely that this decline in mortality rates has been driven mostly by improved diagnosis and treatment.[1] In Canada, higher colorectal cancer mortality rates have been seen in areas of lower income despite universal access to healthcare.[2] Physical activity is associated with a reduction in colorectal cancer mortality.[2,3]

FIGURE 3.4 Age-standardized mortality rates (ASMR) for selected* cancers, males, Canada, 1987–2016



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 2011 Canadian population. See Table 3.3 for data points. Actual data for mortality were available to 2012. The range of scales differs widely between the figures. Liver cancer deaths are underestimated; see *Appendix II: Data and methods issues*. The complete definition of the specific cancers listed here can be found in Table A8.

Female breast cancer

The female breast cancer mortality rate has been declining since the mid-1980s. After its peak in 1986, the ASMR has fallen 44%, from 41.7 deaths per 100,000 in 1987 to a projected rate of 23.4 deaths per 100,000 in 2016. The downward trend has accelerated to 2.6% per year between 2003 and 2012, which is likely due to a combination of increased mammography screening[4] and the use of more effective therapies following breast cancer surgery.[5,6]

Both pre-diagnosis and post-diagnosis physical activity is associated with reduced breast cancer mortality,[7,8] while high body mass index is associated with a poor prognosis in women of all ages.[9] 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.[10]

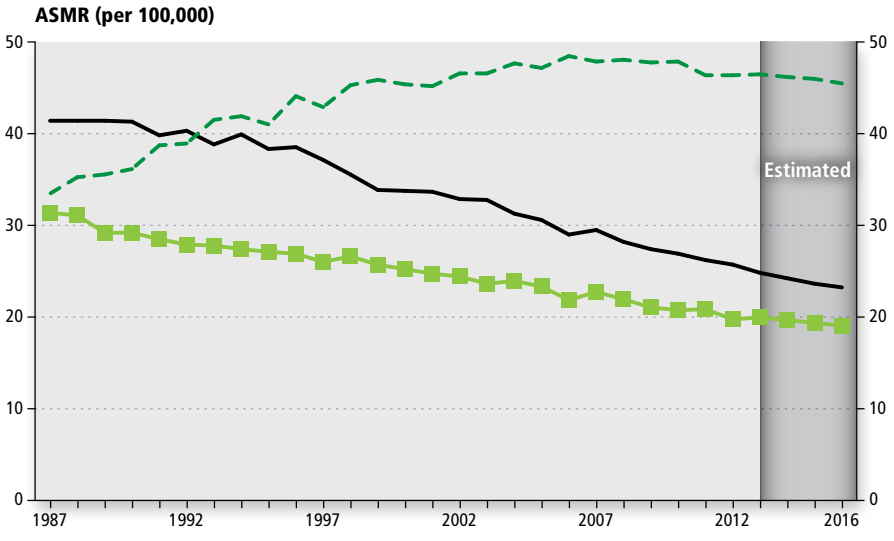
Larynx cancer

Deaths due to larynx cancer have declined by 4.3% per year in both males and females between 2003 and 2012. 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 have had a major impact on the mortality rates of tobacco-related cancers, including those of the larynx.

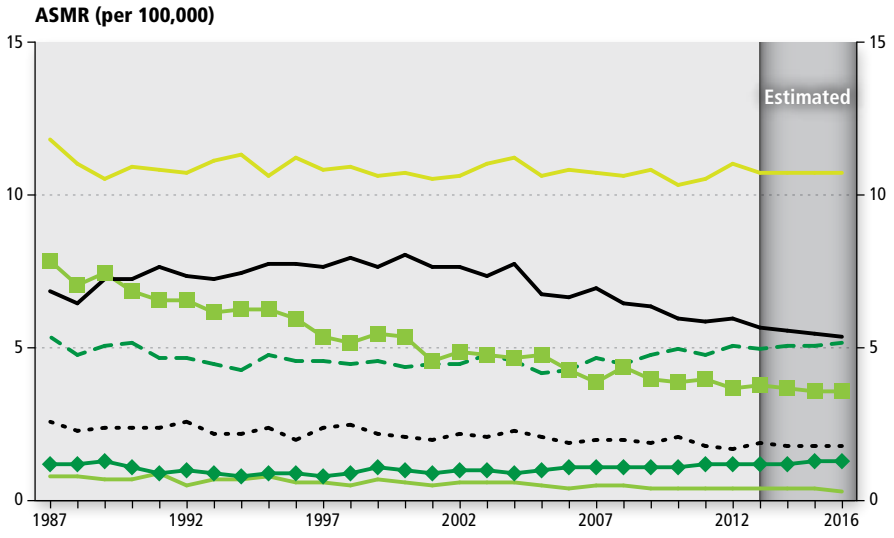
Liver cancer

Between 2003 and 2012, the mortality rate of liver cancer has increased significantly for both males (3.6% per year) and females (2.8% per year). The upward trend in mortality rates has followed the increase in liver cancer incidence rates. Causes of this increase are not well known, although risk factors for liver cancer include chronic hepatitis B infections and cirrhosis from heavy alcohol consumption.

FIGURE 3.5 Age-standardized mortality rates (ASMR) for selected* cancers, females, Canada, 1987–2016



View data



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 2011 Canadian population. See Table 3.4 for data points. Actual data for mortality were available to 2012. The range of scales differs widely between the figures. Liver cancer deaths are underestimated; see *Appendix II: Data and methods issues*. The complete definition of the specific cancers listed here can be found in Table A8.

Lung and bronchus (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 0.8% decrease between 2006 and 2012, but the change is not yet statistically significant. Despite the converging trends, males are projected to continue to have a higher mortality rate of lung cancer (61 per 100,000) than females (46 per 100,000) in 2016. Sustained reductions in tobacco use have had a major impact on lung cancer mortality rates in North America. However, tobacco control efforts are still needed to further reduce the burden of lung cancer[11] as approximately 15% of the Canadian population continues to smoke on a daily basis.[12]

While smoking remains the most important risk factor for lung cancer, asthma may be a risk factor for lung cancer mortality among nonsmokers.[13] Areas with higher residential measurement of radon also appear to have higher lung cancer mortality rates.[14]

Non-Hodgkin lymphoma (NHL)

Between 2003 and 2012, mortality rates for NHL have declined by 2.2% and 2.8% per year for males and females respectively. 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[15] 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 the oral cavity and pharynx have declined by 2.2% per year for females and 1.2% per year for males between 2003 and 2012. The ASMR in females has fallen 30%, from 2.6 deaths per 100,000 in 1987 to a projected rate of 1.8 deaths per 100,000 in 2016. These rates likely reflect patterns of smoking prevalence.[16]

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. Recent estimates suggest a small but statistically significant decrease (0.6% per year) in mortality rates for men and (0.4% per year) for women, between 2003 and 2012. The mortality rates for pancreatic cancer closely reflect the incidence rates for this cancer due to the low survival.[17] In other countries, trends in pancreatic cancer mortality rates have shown wide variation in the past decade. For example, the United Kingdom experienced decreases,[18] while the United States showed increases of pancreatic cancer mortality rates.[19]

Prostate cancer

The mortality rate for prostate cancer rose slowly from 1987 to 1997 and has been declining since. Between 2003 and 2012, mortality rates decreased by an average of 3.1% per year. The decline likely reflects improved treatment following the introduction of hormonal therapy for early and advanced-stage disease[20,21] and advances in radiation therapy.[22] 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.[23,24] 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[25,26] and increasing body mass index[27] may increase risk of death among men diagnosed with prostate cancer.

Stomach cancer

Between 2003 and 2012, mortality rates for stomach cancer declined for both males (3.6% per year) and females (2.7% per year). Mortality rates for both males and females are less than half of what they were in 1987. 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 among other factors.[28]

What do these statistics mean?

While the overall incidence rate of cancer has been relatively stable in Canada in recent years, 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.

Other resources

Publications

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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 102-4313. 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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TABLE 3.1 Lifetime probability of dying from cancer overall and at selected ages, Canada, 2010

	Lifetime probability of dying from cancer overall		Probability (%) of dying from cancer in next 10 years at selected ages					
	%	One in:	30	40	50	60	70	80
Males								
All cancers	**28.6**	**3.5**	**0.1**	**0.4**	**1.8**	**5.3**	**11.2**	**16.5**
Lung and bronchus	7.7	13	—	0.1	0.5	1.8	3.5	3.9
Prostate	3.7	27	—	—	—	0.3	1.1	2.9
Colorectal	3.5	29	—	0.1	0.2	0.6	1.4	2.1
Pancreas	1.4	72	—	—	0.1	0.3	0.6	0.7
Bladder	1.2	82	—	—	—	0.1	0.4	0.8
Leukemia	1.0	96	—	—	—	0.2	0.4	0.7
Non-Hodgkin lymphoma	1.0	99	—	—	0.1	0.2	0.4	0.6
Esophagus	0.9	106	—	—	0.1	0.2	0.4	0.4
Stomach	0.8	118	—	—	0.1	0.2	0.3	0.5
Kidney and renal pelvis	0.7	139	—	—	0.1	0.1	0.3	0.4
Brain/CNS	0.7	153	—	—	0.1	0.2	0.3	0.2
Multiple myeloma	0.5	195	—	—	—	0.1	0.2	0.3
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
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 and bronchus	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
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 and uterus NOS	0.6	156	—	—	0.1	0.1	0.2	0.3
Stomach	0.5	182	—	—	—	0.1	0.2	0.3
Brain/CNS	0.5	197	—	—	0.1	0.1	0.1	0.2
Bladder	0.5	210	—	—	—	—	0.1	0.3
Kidney and renal pelvis	0.4	234	—	—	—	0.1	0.1	0.2
Multiple myeloma	0.4	239	—	—	—	0.1	0.2	0.2
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
Cervix	0.2	475	—	—	—	—	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

— Value less than 0.05; CNS=central nervous system; NOS=not otherwise specified

* Liver cancer deaths are underestimated; see *Appendix II: Data and methods issues.*

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 A8.

TABLE 3.2 Estimated deaths and age-standardized mortality rates (ASMR) for cancers by sex, Canada, 2016

	Deaths			Deaths per 100,000		
	Total*	Males	Females	Total*	Males	Females
All cancers	**78,800**	**41,700**	**37,100**	**198.7**	**235.9**	**171.2**
Lung and bronchus	20,800	10,900	9,800	52.1	60.5	45.8
Colorectal	9,300	5,000	4,300	23.4	28.4	19.2
Breast	5,000	55	4,900	12.8	0.3	23.4
Pancreas	4,700	2,400	2,400	11.9	13.1	10.8
Prostate	4,000	4,000	—	—	24.2	—
Leukemia	2,900	1,650	1,200	7.2	9.4	5.6
Non-Hodgkin lymphoma	2,700	1,500	1,200	6.8	8.5	5.4
Bladder	2,300	1,650	670	5.8	9.6	2.9
Brain/CNS	2,300	1,300	1,000	6.0	7.1	5.0
Esophagus	2,100	1,600	460	5.3	8.9	2.1
Stomach	2,000	1,250	780	5.1	7.0	3.6
Kidney and renal pelvis	1,850	1,200	660	4.7	6.6	3.0
Ovary	1,750	—	1,750	—	—	8.3
Multiple myeloma	1,450	800	640	3.6	4.5	2.9
Oral	1,250	840	390	3.1	4.6	1.8
Melanoma	1,200	770	440	3.1	4.3	2.1
Liver†	1,200	910	270	3.0	4.9	1.3
Body of uterus and uterus NOS	1,100	—	1,100	—	—	5.2
Larynx	400	320	75	1.0	1.8	0.3
Cervix	400	—	400	—	—	2.0
Thyroid	210	90	120	0.5	0.5	0.5
Hodgkin lymphoma	130	80	45	0.3	0.4	0.2
Testis	40	40	—	—	0.2	—
All other cancers	9,800	5,300	4,500	24.7	30.9	19.8

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; NOS=not otherwise specified

— Not applicable

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

† Liver cancer deaths are underestimated; see *Appendix II: Data and methods issues*.

Note: Rates are age-standardized to the 2011 Canadian population. The complete definition of the specific cancers listed here can be found in Table A8.

TABLE 3.3 Age-standardized mortality rates (ASMR) for selected* cancers, males, Canada, 1987–2016

Year	Deaths per 100,000								
	All cancers	Lung and bronchus	Colorectal	Prostate	Pancreas	Non-Hodgkin lymphoma	Stomach	Liver†	Larynx
1987	335.5	104.6	44.0	41.7	16.9	9.3	17.5	3.0	4.9
1988	345.4	108.5	44.3	44.1	16.0	10.2	17.7	3.4	5.1
1989	338.4	107.9	43.9	42.4	15.6	10.1	16.8	3.2	4.3
1990	333.4	105.8	42.1	42.8	15.3	10.6	15.4	2.5	4.9
1991	336.3	105.1	41.6	44.8	14.9	10.8	14.2	2.4	4.7
1992	332.9	103.6	42.9	44.7	15.3	10.7	14.7	2.8	4.5
1993	329.9	103.9	40.7	44.7	15.0	10.2	13.3	2.9	4.3
1994	329.0	100.5	41.6	44.5	14.9	11.2	13.5	3.2	4.3
1995	325.1	97.7	41.1	44.9	14.5	11.1	13.3	2.7	4.3
1996	321.6	97.3	40.4	42.2	14.8	11.2	12.9	2.8	3.8
1997	316.2	94.4	39.7	41.8	13.7	11.5	12.4	3.2	3.8
1998	313.9	93.8	39.7	40.8	14.1	11.8	11.8	3.5	3.6
1999	312.8	94.2	39.1	39.4	14.4	12.3	11.5	3.4	3.6
2000	308.3	86.1	39.3	39.2	13.7	12.1	11.2	3.1	3.7
2001	307.1	86.7	37.4	39.2	14.1	12.2	10.5	3.4	3.7
2002	302.5	86.8	38.2	37.1	13.5	11.5	10.0	3.4	3.5
2003	295.9	84.4	36.8	35.8	14.1	11.4	10.1	3.6	3.1
2004	291.4	81.3	37.1	35.1	14.1	11.2	9.6	3.5	2.9
2005	286.0	80.5	36.6	32.9	13.3	10.7	9.5	4.0	2.8
2006	278.5	77.9	34.6	31.4	13.5	10.2	9.6	4.0	2.7
2007	276.2	77.1	33.9	31.0	14.0	10.5	9.0	4.1	2.5
2008	272.5	74.2	34.2	30.4	13.6	10.0	8.5	4.0	2.7
2009	266.7	73.7	32.7	29.6	13.8	10.0	8.2	4.3	2.6
2010	259.4	71.1	31.5	29.3	13.0	9.4	7.9	4.5	2.3
2011	255.3	69.2	31.7	27.4	13.5	9.5	7.6	4.5	2.0
2012	252.7	67.8	30.6	26.3	13.1	9.3	7.3	5.0	2.1
2013‡	247.3	65.4	30.1	26.1	13.2	9.0	7.4	4.8	2.0
2014‡	243.4	63.7	29.5	25.3	13.2	8.9	7.2	4.8	1.9
2015‡	239.6	62.1	28.9	24.7	13.1	8.7	7.1	4.9	1.9
2016‡	235.9	60.5	28.4	24.2	13.1	8.5	7.0	4.9	1.8

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).

† Liver cancer deaths are underestimated; see *Appendix II: Data and methods issues*.

‡ Rates were estimated based on long-term historic data and may not always reflect recent changes in trends. Actual mortality data were available to 2012. For further details, see *Appendix II: Data sources and methods*.

Note: Rates are age-standardized to the 2011 Canadian population. The complete definition of the specific cancers listed here can be found in Table A8.

TABLE 3.4 Age-standardized mortality rates (ASMR) for selected* cancers, females, Canada, 1987–2016

Year	Deaths per 100,000										
	All cancers	Lung and bronchus	Breast	Colorectal	Pancreas	Non-Hodgkin lymphoma	Body of uterus and uterus NOS	Stomach	Oral	Liver†	Larynx
1987	207.2	33.7	41.7	31.6	11.9	6.9	5.4	7.9	2.6	1.2	0.8
1988	208.5	35.5	41.7	31.3	11.1	6.5	4.8	7.1	2.3	1.2	0.8
1989	205.4	35.8	41.7	29.4	10.6	7.3	5.1	7.5	2.4	1.3	0.7
1990	205.3	36.4	41.6	29.4	11.0	7.3	5.2	6.9	2.4	1.1	0.7
1991	206.3	39.0	40.1	28.7	10.9	7.7	4.7	6.6	2.4	0.9	0.9
1992	205.6	39.2	40.6	28.1	10.8	7.4	4.7	6.6	2.6	1.0	0.5
1993	207.4	41.8	39.1	28.0	11.2	7.3	4.5	6.2	2.2	0.9	0.7
1994	208.6	42.2	40.2	27.6	11.4	7.5	4.3	6.3	2.2	0.8	0.7
1995	204.5	41.3	38.6	27.3	10.7	7.8	4.8	6.3	2.4	0.9	0.8
1996	208.2	44.4	38.8	27.1	11.3	7.8	4.6	6.0	2.0	0.9	0.6
1997	202.4	43.2	37.4	26.2	10.9	7.7	4.6	5.4	2.4	0.8	0.6
1998	203.8	45.6	35.8	26.8	11.0	8.0	4.5	5.2	2.5	0.9	0.5
1999	202.4	46.2	34.1	25.9	10.7	7.7	4.6	5.5	2.2	1.1	0.7
2000	202.7	45.7	34.0	25.4	10.8	8.1	4.4	5.4	2.1	1.0	0.6
2001	200.6	45.5	33.9	24.9	10.6	7.7	4.5	4.6	2.0	0.9	0.5
2002	202.1	46.9	33.1	24.6	10.7	7.7	4.5	4.9	2.2	1.0	0.6
2003	201.1	46.9	33.0	23.8	11.1	7.4	4.8	4.8	2.1	1.0	0.6
2004	199.4	48.0	31.5	24.1	11.3	7.8	4.6	4.7	2.3	0.9	0.6
2005	194.8	47.5	30.8	23.5	10.7	6.8	4.2	4.8	2.1	1.0	0.5
2006	191.7	48.8	29.2	22.0	10.9	6.7	4.3	4.3	1.9	1.1	0.4
2007	191.7	48.2	29.7	22.9	10.8	7.0	4.7	3.9	2.0	1.1	0.5
2008	189.7	48.4	28.4	22.1	10.7	6.5	4.5	4.4	2.0	1.1	0.5
2009	185.9	48.1	27.6	21.2	10.9	6.4	4.8	4.0	1.9	1.1	0.4
2010	184.7	48.2	27.1	20.9	10.4	6.0	5.0	3.9	2.1	1.1	0.4
2011	181.7	46.7	26.4	21.0	10.6	5.9	4.8	4.0	1.8	1.2	0.4
2012	180.4	46.7	25.9	19.9	11.1	6.0	5.1	3.7	1.7	1.2	0.4
2013‡	177.5	46.8	25.0	20.1	10.8	5.7	5.0	3.8	1.9	1.2	0.4
2014‡	175.4	46.5	24.4	19.8	10.8	5.6	5.1	3.7	1.8	1.2	0.4
2015‡	173.4	46.3	23.8	19.5	10.8	5.5	5.1	3.6	1.8	1.3	0.4
2016‡	171.2	45.8	23.4	19.2	10.8	5.4	5.2	3.6	1.8	1.3	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).

† Liver cancer deaths are underestimated; see *Appendix II: Data and methods issues*.

‡ Rates were estimated based on long-term historic data and may not always reflect recent changes in trends. Actual mortality data were available to 2012. For further details, see *Appendix II: Data sources and methods*.

Note: Rates are age-standardized to the 2011 Canadian population. The complete definition of the specific cancers listed here can be found in Table A8.

TABLE 3.5 Annual percent change (APC) in age-standardized mortality rates (ASMR) for selected cancers, by sex, Canada, 2003–2012

	Males		Females	
	APC†	Changepoint‡	APC†	Changepoint‡
All cancers	**–1.8****		**–1.2****	
Lung and bronchus	–2.3**		–0.8	2006
Colorectal	–2.3**	2004	–2.0**	
Breast	–1.6		–2.6**	
Pancreas	–0.6*		–0.4	
Prostate	–3.1**		—	
Leukemia	–1.4**		–0.8	
Non-Hodgkin lymphoma	–2.2**		–2.8**	
Bladder	–1.5	2008	–0.4	
Stomach	–3.6**		–2.7**	
Esophagus	0.0		–0.6	
Brain/CNS	–1.1	2008	0.8	
Kidney and renal pelvis	–1.4*		–1.4	
Ovary	—		–2.0**	2004
Multiple myeloma	–0.9		–1.8**	
Oral	–1.2*		–2.2*	
Liver§	3.6**		2.8**	
Melanoma	1.1		0.8	
Body of uterus and uterus NOS	—		2.2*	2006
Larynx	–4.3**		–4.3**	
Cervix	—		1.8	2008

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; NOS=not otherwise specified

— Not applicable

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

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

† APC is calculated by fitting a piecewise log linear model to the rates in 1992–2012. When there is no changepoint in the most recent 10 years, the APC is obtained by running a separate joinpoint analysis on the most recent 10 years. If there is a changepoint, the APC is taken from the last segment and the related changepoint is reported. "All cancers" includes cancers not found in the table. For further details, see *Appendix II: Data sources and methods*. The complete definition of the specific cancers listed here can be found in Table A8.

‡ Changepoint indicates the baseline year for the APC shown, if the slope of the trend changed after 2003.

§ Liver cancer deaths are underestimated; see *Appendix II: Data and methods issues*.

Note: Rates are age-standardized to the 2011 Canadian population.

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

Highlights

- In 2016, it is estimated that 53% of all cancer deaths will occur among males and 47% among females.
- Overall, mortality rates for all cancers have been decreasing since 1988 for both sexes.
- The mortality rate has been decreasing to varying degrees in males in all age groups and females under 70 years.
- In 2016, almost all cancer deaths in Canada (96%) will occur in people age 50 years and older. 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 cancer deaths 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 2016, 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 and the higher number of deaths among females at younger ages for lung and bronchus (lung) cancer.

Trends over time by sex

Figure C (*Introduction)* shows the trend in cancer mortality rates by sex from 1987 to 2016.

- The overall cancer mortality rate for males has been declining since 1988, primarily due to the decline in lung cancer mortality rates (Table 3.3), which is closely linked to decreases in smoking prevalence.
- Among females, the overall cancer mortality rate has been decreasing since 1988 (Table 3.4). The decrease in mortality rate 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]

For more detailed information on trends in specific cancer mortality rates by sex, see the trends sections in *Chapter 3*.

Mortality by age

In 2016, 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 2016 it is estimated that:

- Canadians aged 70 years or older will account for 49,000 cancer deaths (or 62% of all cancer deaths).
- Canadians aged 60–69 years will account for an additional 17,900 deaths (or 23% of all cancer deaths).
- Canadians aged 50–59 years will account for 8,600 deaths (or 11% of all cancer deaths).

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

- While the majority of new breast cancer cases (68% 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 age group compared to women 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 have been linked to aggressive tumour 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.
- 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*).

Trends over time by age

Cancer mortality rates have decreased to varying degrees over time for all age groups in males and for females aged 0–69 years (Figure 4.1).

- The age-standardized mortality rate for males aged 60–69, for example, has dropped by 39% from 764 per 100,000 in 1987 to 467 per 100,000 in 2016.
- By comparison, the mortality rate for females of the same age group (60–69) dropped by 25% over the same time period (from 481 to 362 per 100,000).

Deaths

The number of deaths due to cancer in a given period of time, often a year.

Age-standardized mortality rate (ASMR)

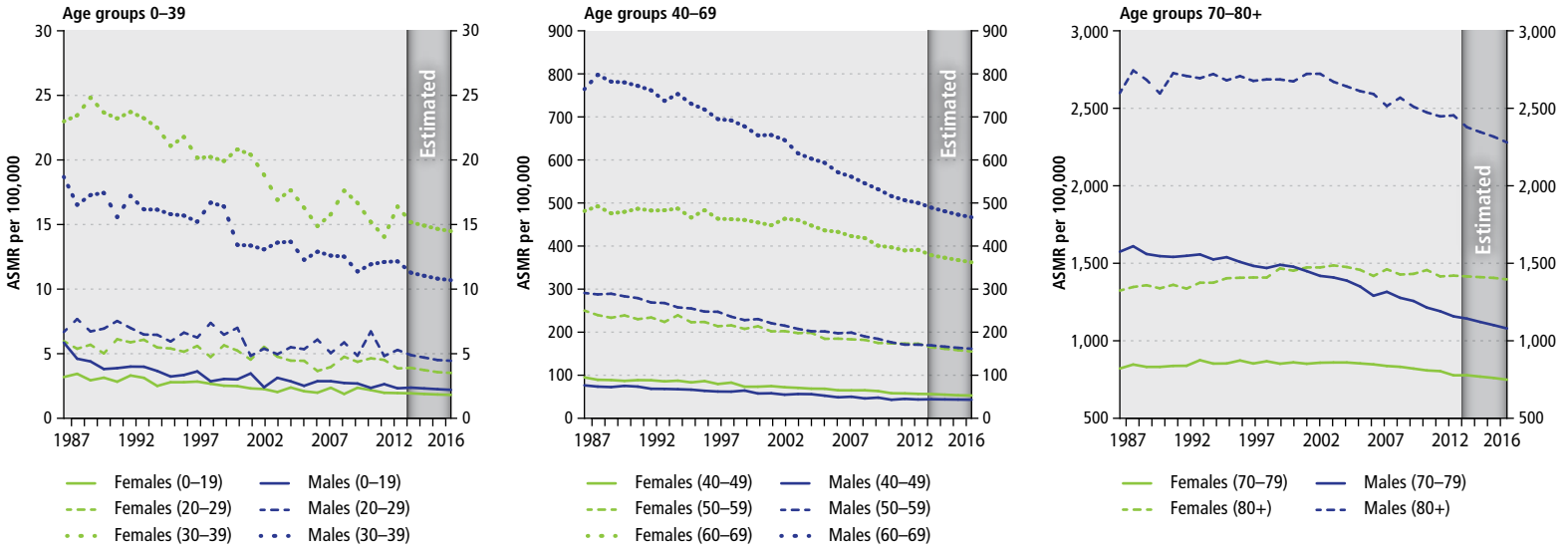
The number of cancer deaths per 100,000 people, standardized to the age structure of the 2011 Canadian population.

Age standardization is used to adjust for differences in age distributions over time and across provinces and territories, thereby allowing for more accurate comparisons. In this report, ASMR is also referred to as "mortality rate".

Province or territory

Refers to the province or territory of a person's permanent residence at the time of their death. The most recent actual data available for all provinces and territories are to 2012 (see Tables A5 and A6 in *Appendix I: Actual data for new cases and deaths*).

FIGURE 4.1 Age-standardized mortality rates (ASMR) for all cancers, by age group, Canada, 1987–2016



Note: The range of rate scales differs widely between the age groups. Rates are age-standardized to the 2011 Canadian population. Actual mortality data were available up to 2012.

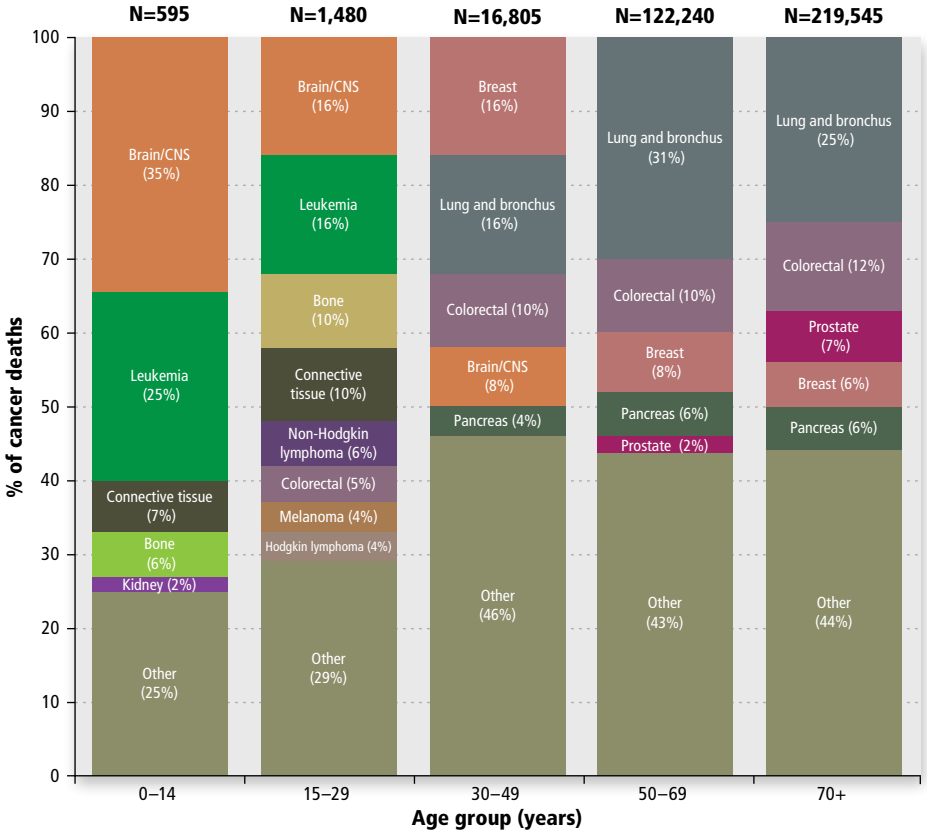
View data

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

Cancer deaths among children, adolescents and young adults

- Cancer deaths among children (aged 0–14 years) accounted for less than 0.2% of all cancer deaths in Canada (Figure 4.2). Males are more likely to die of cancer than females of that age group.[6]
- 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 295 people in Canada between the ages of 15 and 29 die from cancer each year. Adolescent and young adult males are more likely to die of cancer than females of that age group. The male mortality rates tend to be higher than females for every major cancer, except cancers of the genital organs.
- The leading causes of cancer deaths among children, adolescents and young adults were cancers of the brain and central nervous system (CNS) and leukemia. These two types of cancer accounted for 60% of all childhood cancer deaths (ages 0–14) and 32% of all adolescent and young adult cancer deaths (ages 15–29) (Figure 4.2).

FIGURE 4.2 Distribution of cancer deaths for selected cancers by age group, Canada, 2008–2012



N is the total number of cases over 5 years (2008–2012) for each age group; CNS=Central nervous system.

Note: The complete definition of the specific cancers listed here can be found in Table A8.

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

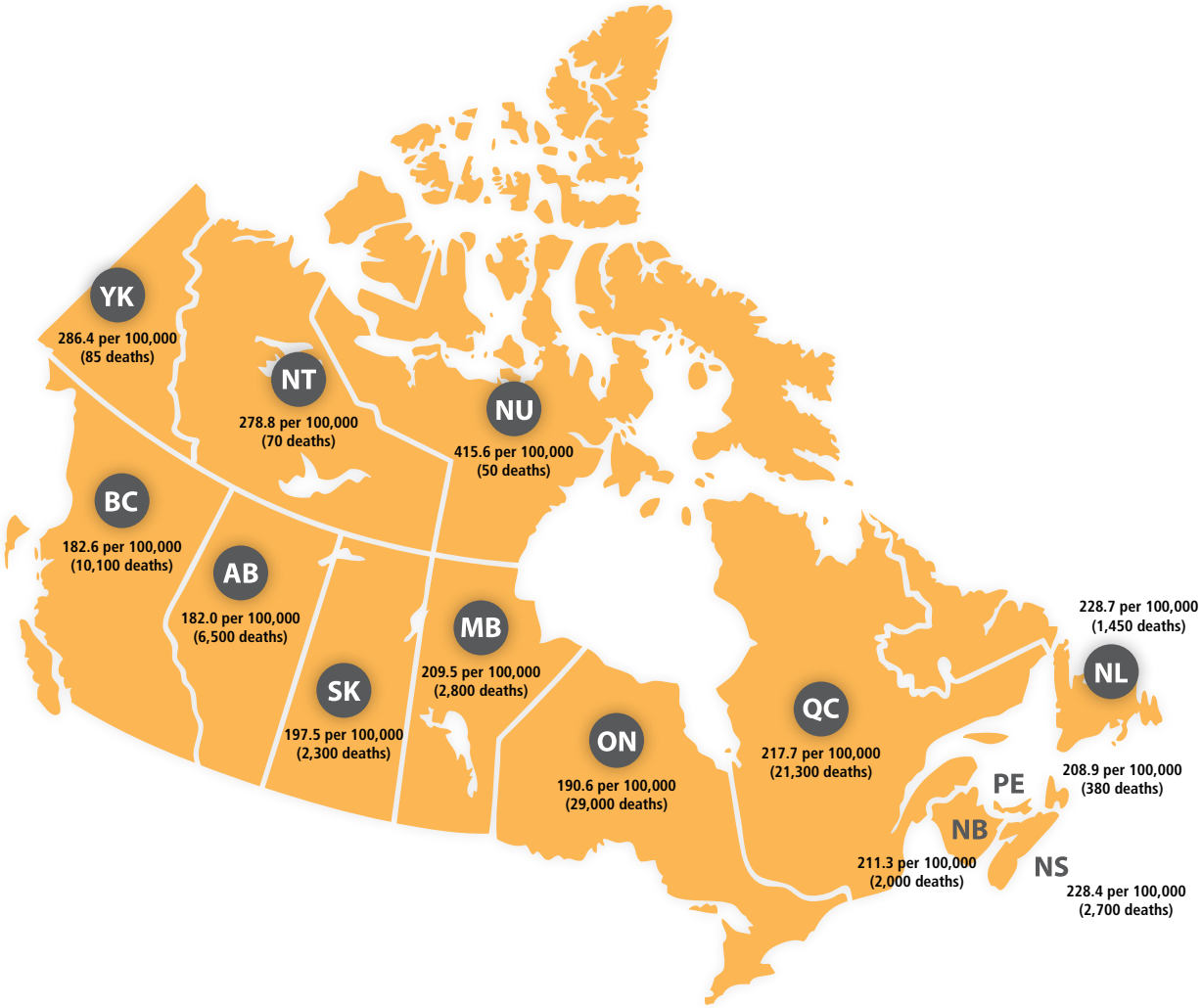
Mortality by geographic region

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 4.3. Similar to the pattern for incidence rates, the mortality rate for all cancers combined generally was lowest in the west and highest in the east. These patterns most likely reflect differences in incidence (due to regional variations in risk factors, including socio-economic factors) 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 generally highest in Quebec and the Atlantic provinces. The mortality rates for this cancer are lowest in British Columbia and Alberta for males and British Columbia, Alberta and Ontario 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 males and in Newfoundland and Labrador and Prince Edward Island for females. Newfoundland and Labrador also has the highest incidence rate of colorectal cancer for males and females.
- Prostate cancer mortality rates are higher in Prince Edward Island, Saskatchewan, Manitoba and Newfoundland and Labrador. Mortality rates for prostate cancer are lowest in Quebec and British Columbia.

FIGURE 4.3 Geographic distribution of estimated cancer deaths and age-standardized mortality rates (ASMR) by province and territory, both sexes, Canada, 2016



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

Note: Rates are age-standardized to the 2011 Canadian population.

Interprovincial differences in mortality rates could reflect variations in the prevalence of risk factors, including socio-economic 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. For example, prostate cancer deaths typically occur in older males, whereas breast cancer deaths 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 both incidence and mortality rates. Lung cancer mortality in men has dropped substantially over the last 20 years because of the sharp decline in smoking rates.[7] Lung cancer mortality in females is no longer increasing, mirroring lung cancer incidence trends among women.

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 groups. There are likely also age and sex differences in response to cancer treatment,[8] which may contribute to variations in the mortality rate.

Other resources

Publications

- Ellison LF. "Prostate cancer trends in Canada, 1995 to 2012." Health at a Glance. 2016. Statistics Canada Catalogue no. 82-624-X. Available at: http://www.statcan.gc.ca/pub/82-624-x/2016001/article/14548-eng.pdf (accessed May 2016).
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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 102-4313. 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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TABLE 4.1 Estimated population and deaths for all cancers by age group and sex, Canada, 2016

Age	Population (in thousands)			Deaths		
	Total*	Males	Females	Total*	Males	Females
All ages	**36,229**	**17,968**	**18,261**	**78,800**	**41,700**	**37,100**
0–19	7,893	4,050	3,842	160	90	70
20–29	4,949	2,513	2,436	200	110	85
30–39	4,959	2,469	2,489	620	260	360
40–49	4,782	2,389	2,392	2,300	1,000	1,250
50–59	5,372	2,691	2,681	8,600	4,400	4,200
60–69	4,273	2,100	2,173	17,900	9,900	8,000
70–79	2,468	1,158	1,310	22,100	12,300	9,800
80+	1,534	597	937	26,900	13,500	13,400

* 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, 2016

Age	Lung and bronchus			Colorectal			Prostate	Breast
	Total*	Males	Females	Total*	Males	Females	Males	Females
All ages	**20,800**	**10,900**	**9,800**	**9,300**	**5,000**	**4,300**	**4,000**	**4,900**
0–19	—	—	—	—	—	—	—	—
20–29	5	5	5	15	10	5	—	10
30–39	35	15	20	60	35	25	—	110
40–49	330	160	170	250	140	120	10	340
50–59	2,300	1,150	1,200	920	530	390	130	810
60–69	5,600	3,000	2,600	1,850	1,150	720	530	1,100
70–79	6,800	3,600	3,100	2,500	1,450	1,000	1,100	1,050
80+	5,600	2,900	2,700	3,700	1,700	2,000	2,300	1,550

— 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 A8.

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, 2016

	Population (in thousands)			Deaths		
	Total*	Males	Females	Total*	Males	Females
CANADA	**36,229**	**17,968**	**18,261**	**78,800**	**41,700**	**37,100**
British Columbia (BC)	4,750	2,358	2,392	10,100	5,400	4,700
Alberta (AB)	4,272	2,172	2,100	6,500	3,600	3,000
Saskatchewan (SK)	1,135	572	563	2,300	1,250	1,100
Manitoba (MB)	1,306	650	656	2,800	1,450	1,350
Ontario (ON)	13,929	6,839	7,090	29,000	15,400	13,600
Quebec (QC)	8,342	4,148	4,194	21,300	11,100	10,200
New Brunswick (NB)	760	376	384	2,000	1,100	920
Nova Scotia (NS)	946	463	482	2,700	1,400	1,300
Prince Edward Island (PE)	150	73	77	380	190	190
Newfoundland and Labrador (NL)	521	256	265	1,450	780	670
Yukon (YT)	38	19	19	85	45	35
Northwest Territories (NT)	44	23	21	70	40	30
Nunavut (NU)	37	19	18	50	25	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, 2016

	Canada*	BC	AB	SK	MB	ON	QC	NB	NS	PE	NL
Males											
All cancers	**41,700**	**5,400**	**3,600**	**1,250**	**1,450**	**15,400**	**11,100**	**1,100**	**1,400**	**190**	**780**
Lung and bronchus	10,900	1,250	810	290	330	3,700	3,500	340	370	60	220
Colorectal	5,000	670	450	150	190	1,700	1,350	120	200	25	130
Prostate	4,000	560	410	160	170	1,550	860	95	120	20	75
Pancreas	2,400	340	190	70	75	910	580	60	75	10	40
Bladder	1,650	250	140	55	55	610	410	40	55	10	25
Leukemia	1,650	210	140	55	60	650	400	40	55	5	25
Esophagus	1,600	250	170	55	70	650	290	40	60	10	25
Non-Hodgkin lymphoma	1,500	190	120	45	55	550	400	45	55	5	25
Brain/CNS	1,300	160	120	30	35	540	320	30	45	5	20
Stomach	1,250	130	110	35	50	460	330	35	40	5	40
Kidney and renal pelvis	1,200	170	100	40	55	410	290	35	45	5	25
Liver†	910	160	85	15	20	380	210	10	20	—	10
Oral	840	130	75	20	25	330	190	20	25	5	15
Multiple myeloma	800	100	70	25	30	310	200	15	30	5	10
Melanoma	770	90	65	20	25	320	190	20	30	—	10
Larynx	320	40	25	10	10	120	110	10	10	—	10
Thyroid	90	15	5	5	5	35	20	5	5	—	—
Hodgkin lymphoma	80	10	5	5	—	30	25	—	5	—	—
Testis	40	5	5	—	—	15	10	—	—	—	—
Females											
All cancers	**37,100**	**4,700**	**3,000**	**1,100**	**1,350**	**13,600**	**10,200**	**920**	**1,300**	**190**	**670**
Lung and bronchus	9,800	1,200	790	290	350	3,400	3,000	250	350	50	140
Breast	4,900	610	410	160	190	1,850	1,300	120	160	25	100
Colorectal	4,300	610	320	130	160	1,500	1,200	95	170	25	90
Pancreas	2,400	290	210	65	80	910	620	70	75	10	30
Ovary	1,750	250	150	55	65	680	420	45	55	10	30
Non-Hodgkin lymphoma	1,200	160	90	35	50	460	270	35	50	5	20
Leukemia	1,200	160	110	40	40	490	290	30	40	10	15
Body of uterus and uterus NOS	1,100	130	85	25	35	450	300	25	40	5	20
Brain/CNS	1,000	130	75	25	25	440	240	20	30	—	15
Stomach	780	90	60	20	25	300	210	20	20	—	20
Bladder	670	95	45	20	25	260	180	15	20	5	10
Kidney and renal pelvis	660	70	55	15	25	250	170	20	25	5	20
Multiple myeloma	640	80	55	20	25	240	170	20	15	5	15
Esophagus	460	75	40	15	15	190	85	10	20	—	10
Melanoma	440	50	35	10	10	190	110	10	15	5	5
Cervix	400	50	40	20	20	150	80	10	15	5	10
Oral	390	55	35	10	15	150	110	10	15	—	5
Liver†	270	35	20	5	10	120	60	5	5	—	5
Thyroid	120	20	10	—	5	45	25	5	5	—	5
Larynx	75	10	5	—	—	30	40	—	5	—	—
Hodgkin lymphoma	45	5	5	—	—	25	15	—	—	—	—

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; NOS=not otherwise specified

— 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.

† Liver cancer deaths are underestimated; see *Appendix II: Data and methods issues*.

Note: The complete definition of the specific cancers listed here can be found in Table A8.

TABLE 4.5 Estimated age-standardized mortality rates (ASMR) for selected cancers by sex and province, Canada, 2016

	Deaths per 100,000										
	Canada*	BC	AB	SK	MB	ON	QC	NB	NS	PE	NL
Males											
All cancers	**235.9**	**211.5**	**219.1**	**231.9**	**244.6**	**228.6**	**258.1**	**258.4**	**272.4**	**238.5**	**272.4**
Lung and bronchus	60.5	48.6	49.2	55.1	55.4	53.9	79.4	78.1	69.1	71.9	73.7
Colorectal	28.4	26.4	27.5	28.6	32.1	25.7	31.2	28.8	38.9	32.3	46.1
Prostate	24.2	22.9	28.0	31.1	30.0	24.2	21.4	24.8	24.9	31.2	29.2
Pancreas	13.1	13.3	11.5	12.8	12.7	13.3	13.3	13.9	13.8	14.9	13.8
Bladder	9.6	9.9	8.9	10.5	9.3	9.3	10.0	10.2	11.1	10.2	9.5
Leukemia	9.4	8.2	8.8	10.0	10.6	9.8	9.2	9.1	10.7	8.9	8.3
Esophagus	8.9	9.5	9.8	10.3	11.3	9.4	6.6	9.6	11.1	11.3	8.9
Non-Hodgkin lymphoma	8.5	7.7	7.3	8.9	9.4	8.1	9.4	10.0	10.7	9.2	9.0
Brain/CNS	7.1	6.1	6.4	5.6	5.4	7.7	7.2	6.5	8.5	7.1	6.5
Stomach	7.0	5.0	6.6	6.5	8.4	6.8	7.8	8.0	7.3	7.6	14.8
Kidney and renal pelvis	6.6	6.8	6.2	7.9	9.1	6.0	6.6	7.8	9.0	8.3	8.9
Liver†	4.9	5.9	4.6	2.3	3.6	5.5	4.8	2.2	3.9	—	3.4
Oral	4.6	5.2	4.1	3.3	3.9	4.8	4.4	4.5	5.0	6.0	4.7
Multiple myeloma	4.5	3.9	4.4	4.6	5.5	4.5	4.7	4.1	5.4	5.6	3.8
Melanoma	4.3	3.7	3.6	3.6	3.8	4.7	4.5	4.1	5.5	—	3.4
Larynx	1.8	1.5	1.6	1.8	1.3	1.8	2.5	2.5	2.3	—	3.7
Thyroid	0.5	0.6	0.4	0.5	0.5	0.5	0.4	0.8	0.7	—	—
Hodgkin lymphoma	0.4	0.3	0.4	0.5	—	0.5	0.6	—	0.7	—	—
Testis	0.2	0.3	0.2	—	—	0.2	0.2	—	—	—	—
Females											
All cancers	**171.2**	**159.5**	**153.7**	**172.3**	**185.8**	**162.4**	**190.0**	**176.3**	**196.4**	**187.8**	**196.0**
Lung and bronchus	45.8	40.9	41.7	46.3	48.5	40.3	57.5	47.2	52.9	52.4	39.9
Breast	23.4	21.3	21.0	25.9	26.3	23.0	24.8	22.3	24.6	25.5	29.7
Colorectal	19.2	20.4	16.5	19.2	21.0	17.2	21.1	17.7	24.8	26.4	26.4
Pancreas	10.8	9.8	10.8	10.2	10.9	10.7	11.3	12.8	11.4	11.9	9.4
Ovary	8.3	8.7	7.9	8.7	9.3	8.3	8.0	8.8	8.9	8.9	8.7
Leukemia	5.6	5.2	5.4	5.8	5.5	5.8	5.4	6.0	6.0	7.4	5.0
Non-Hodgkin lymphoma	5.4	5.4	4.8	5.7	6.7	5.4	5.0	6.4	7.3	6.1	5.6
Body of uterus and uterus NOS	5.2	4.4	4.4	3.8	4.8	5.5	5.7	4.7	6.0	4.3	5.1
Brain/CNS	5.0	4.9	3.8	4.1	3.4	5.6	4.9	4.6	5.1	—	5.0
Stomach	3.6	3.0	3.0	3.0	3.4	3.6	3.9	4.1	3.4	—	6.5
Bladder	2.9	3.0	2.3	3.0	3.0	2.9	3.1	2.6	3.1	5.1	3.0
Kidney and renal pelvis	3.0	2.3	2.9	2.6	3.4	3.0	3.0	4.0	3.7	4.5	5.9
Multiple myeloma	2.9	2.8	2.9	3.3	3.1	2.7	3.1	3.3	2.6	3.4	3.8
Esophagus	2.1	2.5	2.1	2.1	2.0	2.2	1.6	2.1	3.2	—	2.5
Melanoma	2.1	1.8	1.8	1.9	1.5	2.3	2.1	2.0	2.7	3.8	1.9
Cervix	2.0	1.8	2.1	4.0	2.6	2.0	1.7	2.6	2.6	3.0	2.8
Oral	1.8	1.9	1.7	1.7	2.1	1.7	1.9	2	1.9	—	0.9
Liver†	1.3	1.3	1.1	0.6	1.1	1.4	1.1	0.7	0.7	—	0.8
Thyroid	0.5	0.6	0.5	—	0.6	0.5	0.5	0.5	0.5	—	1.3
Larynx	0.3	0.3	0.2	—	—	0.4	0.7	—	0.4	—	—
Hodgkin lymphoma	0.2	0.2	0.2	—	—	0.3	0.3	—	—	—	—

— ASMR based on fewer than 3 deaths.

CNS=central nervous system; NOS=not otherwise specified

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

† Liver cancer deaths are underestimated; see *Appendix II: Data and methods issues*.

Note: Rates are age-standardized to the 2011 Canadian population. The complete definition of the specific cancers listed here can be found in Table A8.

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

CHAPTER 5
Net survival: What is the probability of surviving cancer?

Net versus relative survival

This edition of the publication reports estimates of net survival where previous editions reported relative survival. Until recently, it was commonly believed that relative and net survival referred to the same measure, and relative survival (defined as the ratio of all-cause observed survival to expected survival) was generally implicitly used to estimate net survival. However, traditional methods of estimating relative survival have recently been shown to produce biased estimates of net survival under certain circumstances. This edition of the publication incorporates a refinement to the traditional relative survival methods to mitigate this bias. An additional refinement has also been made to more fully satisfy an assumption regarding the calculation of expected survival. As a result of these refinements, some survival estimates reported in this edition differ from last year's publication even though the same data were used.

Survival estimates reported in this edition are now explicitly referred to as net survival and interpreted as such. For further details on the survival methodology used, see *Appendix II: Data sources and methods*.

Net survival

The survival probability that would be observed in the hypothetical situation where the cancer of interest is the only possible cause of death (i.e., the survival as far as the cancer of interest is concerned). Net survival is the preferred method for comparing cancer survival in population-based cancer studies because it adjusts for the fact that different populations may have different levels of background risk of death. It 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.

Age-standardized net survival

The net survival that would have occurred if the age distribution at diagnosis of the group of people with the cancer under study had been the same as that of the standard population. For each cancer, the standard population was based on persons diagnosed with that cancer in Canada from 2004 to 2008. While every estimate of net survival has been age-standardized except the age-specific ones, this terminology is applied in the text only where results concern comparisons over time, sex or geography.

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, assuming no other sources of bias, one can be 95% confident the range contains the true value for the estimate of interest.

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.

Conditional net survival

A measure that reflects the probability of surviving an additional number of years (e.g., five years), given that a fixed number of years have already been survived. This is measured in the hypothetical situation where the cancer of interest is the only possible cause of death.

Highlights

- For 2006 to 2008, the five-year age-standardized net survival for people diagnosed with cancer was 60%, an increase of 7 percentage points from 1992 to 1994.
- Five-year net survival is highest for thyroid (98%), testicular (96%) and prostate (95%) cancers. It is lowest for pancreatic (8%), esophageal (14%) and lung and bronchus (lung) (17%) cancers.
- A significant survival advantage for females compared to males was observed for most of the cancers studied.
- Five-year net survival generally decreases with age.
- Between 2006 and 2008, the five-year net survival for all cancers combined increased from 60% when measured from the date of diagnosis, to 76% when measured among those who had survived the first year after a cancer diagnosis.

Introduction

Five-year net survival provides a measure of disease severity and prognosis. Net survival estimates, when examined across cancer types and geographic regions, can be used to establish priorities for improving prognosis. Examining net survival 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 probability 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.

Population-based estimates of survival provide useful "average" indicators of survival[2] and do not reflect any individual's prognosis. They are 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.

It is also important to remember that survival estimates 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 net survival estimates 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 55% (Table 5.1).

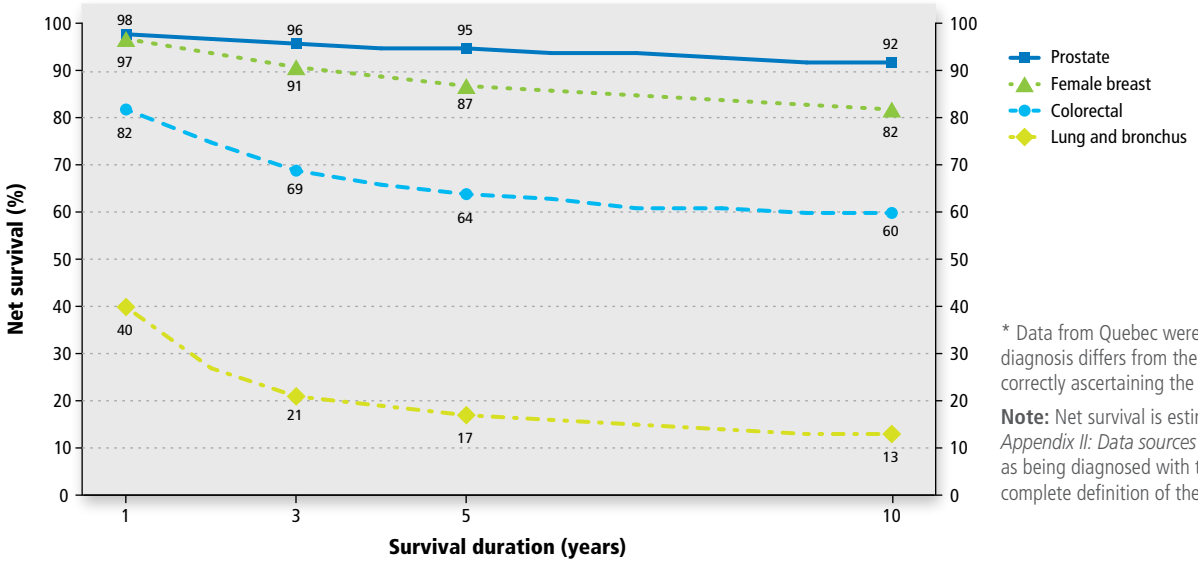
Five-year net survival

Table 5.1 shows five-year net survival estimates for people diagnosed with selected cancers in Canada between 2006 and 2008.

- For all cancers combined, five-year survival is 60%. This figure was overestimated in previous editions as 63% (see *Appendix II: Data sources and methods*).
- Five-year survival estimates are highest for thyroid (98%), testicular (96%) and prostate (95%) cancers.
- Five-year survival estimates are lowest for pancreatic (8%), esophageal (14%) and lung (17%) cancers.
- For most of the cancers examined, five-year survival tends to be higher among females.

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

FIGURE 5.1 Age-standardized net survival for the most common cancers by survival duration, ages 15–99, 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: Net survival is estimated using age-standardized relative survival ratios. For further details, see *Appendix II: Data sources and methods*. For each cancer in turn, the age distribution of persons recorded as being diagnosed with the given cancer in Canada from 2004–2008 was used as the standard. The complete definition of the specific cancers listed here can be found in Table A8.

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

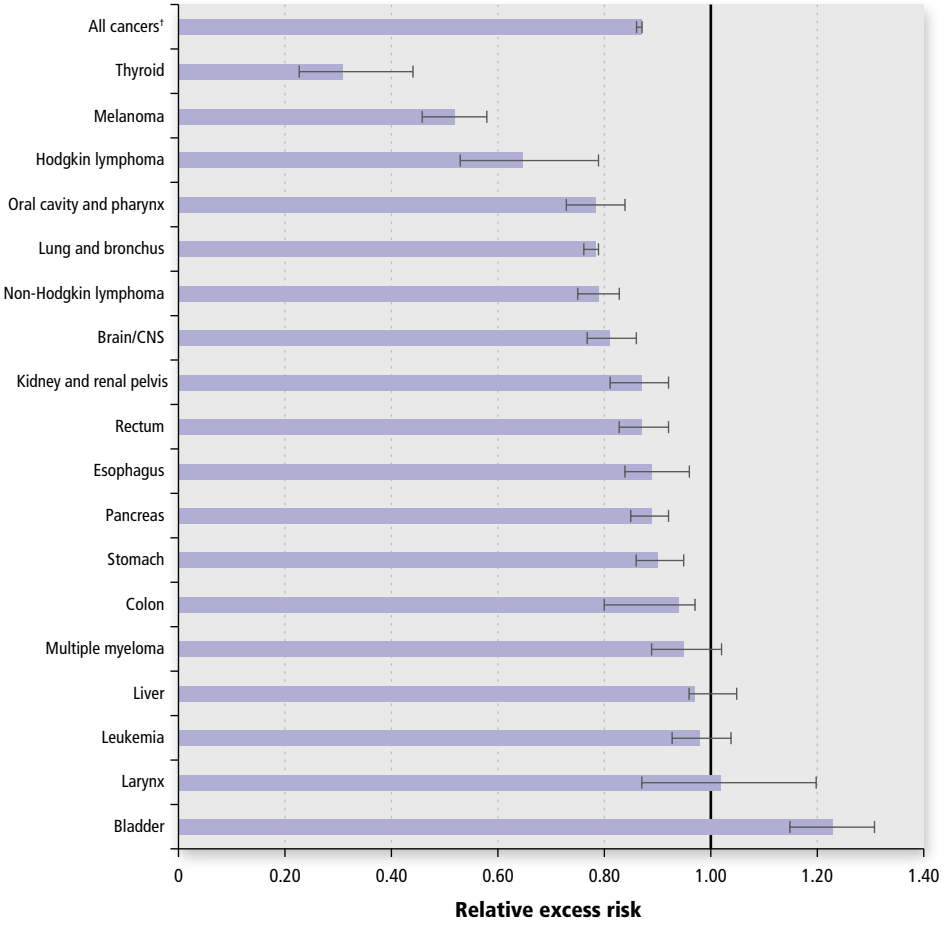
Survival by sex

For cancers common to both sexes, the cancers for which five-year age-standardized net survival is highest and lowest is similar between females and males (Table 5.1).

- For both females and males, five-year survival was highest for thyroid cancer (females 98%, males 95%) followed by melanoma (92%, 85%) and Hodgkin lymphoma (87%, 83%). For females, breast cancer five-year survival was also 87%.
- For both females and males, five-year survival was lowest for pancreatic cancer (females 8%, males 7%), followed by esophageal (17%, 13%) and lung cancer (20%, 14%). For females, liver cancer five-year survival was also 20%.

Figure 5.2 provides data excerpted from a study published earlier this year that examined survival differences between the sexes in Canada in detail.[3] The study considered all of the non-sex-specific cancers listed in Table 5.1 with the exception of breast cancer. The primary outcome measure was the five-year relative excess risk (RER) of death—the ratio of the excess risk of death experienced by females after a cancer diagnosis compared (relative) to that of males.

FIGURE 5.2 Five-year relative excess risks (RERs) of death for women compared to men, by cancer, ages 15–99, Canada (excluding Quebec*), 2004–2008



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 genital system cancers and breast cancer.

Note: All results adjusted for age group; all cancers' result also adjusted for case mix.

Source: Adapted from Table 4 in Ellison LF. Differences in cancer survival in Canada by sex. *Health Reports* 2016;27(4):19–27.

- A significant survival advantage for females compared to males was observed for most of the cancers studied. The advantage was greatest for thyroid cancer (RER = 0.31), skin melanoma (0.52) and Hodgkin lymphoma (0.65).
- For all cancers combined, females had a 13% lower excess risk of death (RER = 0.87), which increased to 23% lower (RER = 0.77) when the analysis was restricted to those diagnosed before the age of 55.
- In the study, cancer-specific point estimates of RER were "almost uniformly lower" among those diagnosed between the ages of 15 and 54 (data not shown)[3] lending indirect support for a hypothesized hormonal influence.[4]
- Bladder cancer was the only cancer for which females had a significant disadvantage (RER = 1.23).
- The underlying reasons behind differences in cancer survival between the sexes are not well understood and are best examined on a cancer-specific level.

Survival by province

Table 5.2 shows age-standardized five-year net survival estimates 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 underreporting 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.
- Survival estimates for Prince Edward Island are less precise than for other provinces because of the relatively small number of cancer cases in this province.
- Despite these constraints, several patterns are worth mentioning:
  - The highest survival for prostate cancer is in Ontario (96%); the lowest are in Manitoba (89%), Saskatchewan (90%) and Prince Edward Island (90%).
  - There is little provincial variation in survival for female breast cancer.
  - Survival for colorectal cancer ranges from 60% to 62% in all provinces except Ontario (67%).
  - Survival for lung cancer ranges 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.

Survival by age at diagnosis

Net 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.[5]

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

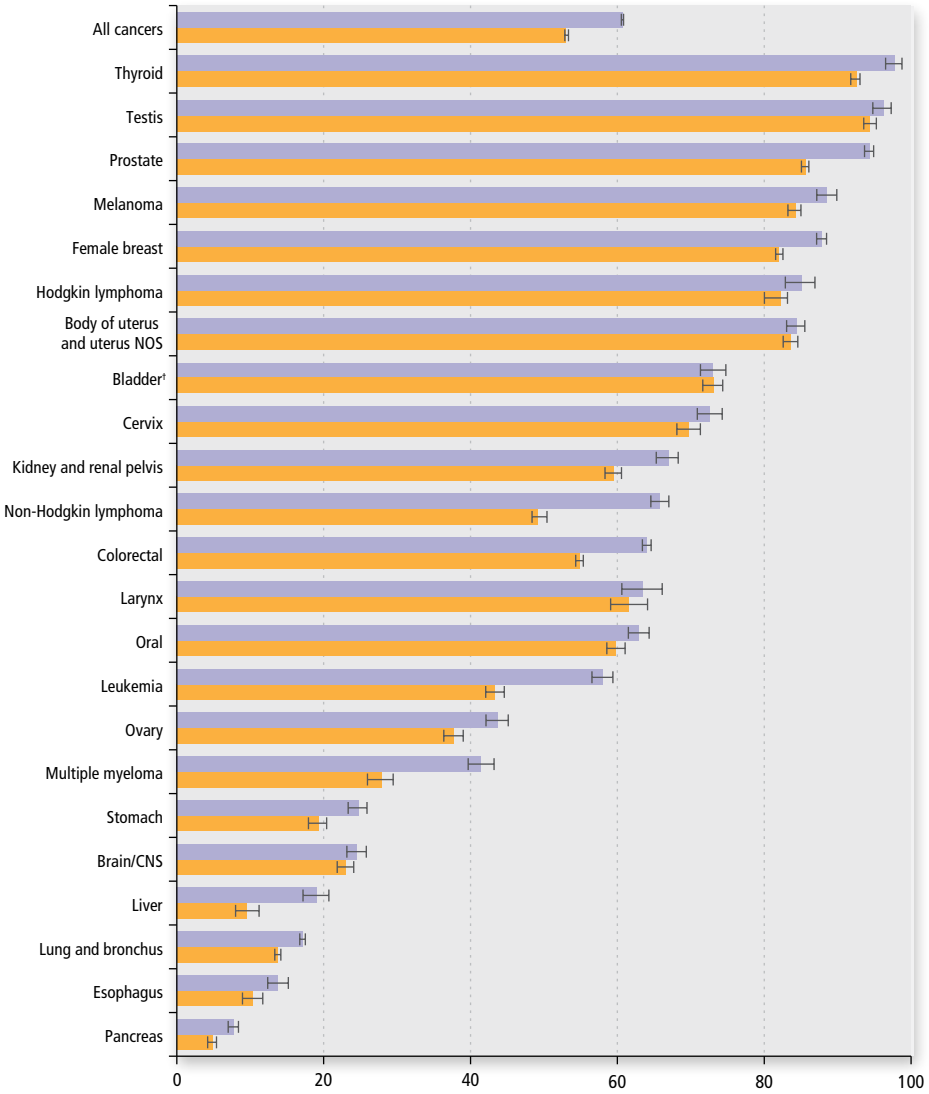
- Survival for prostate cancer is consistently high (≥95%) among males diagnosed between the ages of 40 and 79 years; at older ages, survival is significantly lower.
- Survival is highest for female breast cancer among women diagnosed between the ages of 40 and 69 years (89%–90%). Lower survival is particularly evident among women 80–99 years (78%).
- Survival estimates for colorectal cancer are consistent at 68% among people diagnosed between the ages of 15 and 69 years, then decrease with advancing age.
- For lung cancer, survival decreases with advancing age. People aged 15–39 years at diagnosis have the highest survival at 45%, while people aged 80–99 years have the lowest at 10%.

Trends over time

Figure 5.3 shows that there was substantial improvement in five-year age-standardized net survival between 1992 to 1994 and 2006 to 2008 for many of the most commonly diagnosed cancers of today.

- Survival for all cancers combined has risen by 7.3 percentage points to 60.3% in 2006 to 2008 from 53.0% 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), leukemia (15 percentage points) and multiple myeloma (14 percentage points).
- A few factors have contributed to the increased 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.[6]
- Improvements in survival among adolescents and adults diagnosed with leukemia in Canada were examined in a 2016 study.[7] The study reported that adjusting for case-mix in addition to age reduced the overall increase from 14.6% to 12.8%. Additionally, increases in five-year survival, ranging from 9 (acute myeloid) to 25 percentage points (chronic myeloid), were found to be significant for all four main subtypes of leukemia.

FIGURE 5.3 Five-year age-standardized net survival for selected cancers by time period, ages 15–99, Canada (excluding Quebec*), 2006–2008 versus 1992–1994



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

View data

CNS=central nervous system; NOS=not otherwise specified

* 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 did not report *in situ* bladder cancers for the time period considered.

Note: Age-standardized net survival is estimated using age-standardized relative survival ratios. For further details, see *Appendix II: Data sources and methods*. For each cancer in turn, the age distribution of persons recorded as being diagnosed with the given cancer in Canada from 2004–2008 was used as the standard. "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 A8.

- Reasons for improvements in survival for leukemia vary somewhat depending on the subtype considered.[7] Increases for chronic myeloid leukemia have been attributed to advances in treatment – particularly imatinib, the first targeted treatment for this cancer.[8]
- Survival for colorectal, prostate and liver cancers each increased by nine percentage points. The improvement in colorectal cancer survival is mainly due to the 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 net survival

The five-year conditional net survival 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 net survival 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. For these people, the five-year net survival measured at diagnosis no longer applies.[9,10]

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

- The five-year survival for all cancers combined increased from 60% when measured from the date of diagnosis to 76% when measured among those who survived the first year after a cancer diagnosis.
- Each additional year survived resulted in further, although less dramatic, increases in the five-year conditional survival.
- The impact of time survived on the five-year conditional RSR varied by type of cancer. Cancers with low initial five-year survival (e.g., stomach, brain, liver, lung, esophagus and pancreas) showed the most dramatic increases in five-year conditional survival.
- Conversely, since the potential for improvement is limited for cancers that have an excellent prognosis at diagnosis, cancers with high initial five-year survival (e.g., thyroid, testis and prostate) showed little improvement in five-year conditional survival.

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,[11] diagnosed with cancer in Canada between 2004 and 2008. 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 hepatic tumours at (68%), malignant bone tumours (70%), soft tissue (72%) and central nervous system (74%) cancers. The estimate for hepatic tumours, however, is less precise than the others in Table 5.5 as it is based on a small number of cases.

What do these statistics mean?

Despite improvements in survival from 1992 to 1994 and 2006 to 2008, some cancers continue to have lower net survival 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 five-year net survival across provinces for prostate, lung and colorectal cancers, while there is little provincial variation for breast cancer. These differences in five-year net survival 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.

Other resources

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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 age-standardized net and observed survival for selected cancers by sex, ages 15–99, Canada (excluding Quebec*), 2006–2008

	Net survival (%) (95% confidence interval)			Observed survival proportion (%) (95% confidence interval)		
	Both sexes	Males	Females	Both sexes	Males	Females
All cancers	**60 (60–61)**	**60 (59–60)**	**61 (60–61)**	**55 (55–56)**	**54 (54–54)**	**56 (56–57)**
Thyroid	98 (97–98)	95 (94–97)	98 (98–99)	95 (94–95)	92 (91–93)	96 (95–96)
Testis	—	96 (95–97)	—	—	95 (94–96)	—
Prostate	—	95 (94–95)	—	—	81 (81–82)	—
Melanoma	88 (87–89)	85 (83–86)	92 (90–93)	79 (78–80)	75 (74–76)	84 (83–85)
Breast	87 (87–88)	79 (72–84)	87 (87–88)	80 (80–81)	71 (65–75)	80 (80–81)
Hodgkin lymphoma	85 (83–86)	83 (80–85)	87 (85–89)	83 (81–84)	80 (78–82)	86 (83–87)
Body of uterus and uterus NOS	—	—	84 (83–85)	—	—	78 (77–79)
Bladder†	73 (72–74)	74 (72–75)	71 (69–74)	60 (59–61)	59 (58–61)	61 (59–63)
Cervix	—	—	73 (71–74)	—	—	70 (69–72)
Kidney and renal pelvis	67 (66–68)	66 (64–67)	69 (68–71)	60 (59–61)	58 (56–59)	64 (62–65)
Non-Hodgkin lymphoma	66 (65–67)	63 (62–65)	69 (68–70)	59 (58–59)	55 (54–56)	63 (61–64)
Colorectal	64 (63–65)	63 (62–64)	65 (64–66)	54 (54–55)	52 (52–53)	56 (56–57)
Larynx	63 (61–66)	64 (61–66)	63 (57–68)	55 (53–57)	54 (52–57)	57 (52–62)
Oral	63 (62–64)	60 (59–62)	68 (65–70)	56 (55–57)	53 (52–55)	62 (60–63)
Leukemia	58 (57–59)	58 (56–59)	59 (57–60)	51 (50–52)	50 (48–51)	52 (51–54)
Ovary	—	—	44 (42–45)	—	—	41 (40–42)
Multiple myeloma	42 (40–43)	42 (40–45)	41 (38–43)	36 (35–38)	36 (34–38)	36 (34–39)
Stomach	25 (23–26)	23 (21–24)	28 (26–30)	21 (20–22)	19 (18–20)	25 (23–27)
Brain/CNS	24 (23–26)	22 (21–24)	28 (26–29)	24 (23–25)	21 (20–23)	27 (25–29)
Liver	19 (17–21)	19 (17–21)	20 (17–24)	17 (16–19)	17 (15–19)	19 (16–22)
Lung and bronchus	17 (17–17)	14 (14–15)	20 (19–20)	15 (15–15)	12 (12–13)	18 (17–18)
Esophagus	14 (12–15)	13 (12–15)	17 (14–20)	12 (11–13)	11 (10–13)	16 (13–19)
Pancreas	8 (7–8)	7 (6–8)	8 (7–9)	7 (6–7)	6 (5–7)	7 (6–8)

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

CNS=central nervous system; NOS=not otherwise specified; — 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 and territories and because of issues in correctly ascertaining the vital status of cases.

† Excludes data from Ontario, which did not report *in situ* bladder cancers for the time period considered.

Note: Net survival is estimated using age-standardized relative survival ratios. For further details, see *Appendix II: Data sources and methods*. For each cancer in turn, the age distribution of persons recorded as being diagnosed with the given cancer in Canada from 2004–2008 was used as the standard. "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 A8.

TABLE 5.2 Five-year age-standardized net survival for the most common cancers by province, ages 15–99, Canada (excluding Quebec*), 2006–2008

Province	Net survival (%) (95% confidence interval)			
	Prostate	Female breast	Colorectal	Lung and bronchus
Canada*	**95 (94–95)**	**87 (87–88)**	**64 (63–65)**	**17 (17–17)**
British Columbia (BC)	93 (92–94)	88 (87–89)	61 (60–62)	15 (15–16)
Alberta (AB)	92 (90–93)	86 (85–87)	61 (60–63)	14 (13–15)
Saskatchewan (SK)	90 (88–92)	86 (84–88)	61 (58–63)	16 (14–18)
Manitoba (MB)	89 (87–91)	85 (83–87)	60 (57–62)	20 (19–22)
Ontario (ON)	96 (96–97)	88 (87–89)	67 (66–67)	19 (18–19)
New Brunswick (NB)	93 (90–95)	88 (86–91)	62 (59–65)	15 (14–17)
Nova Scotia (NS)	93 (91–95)	87 (85–89)	60 (58–63)	14 (12–15)
Prince Edward Island (PE)	90 (84–93)	84 (78–89)	60 (53–67)	—

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

— 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: Age-standardized net survival is estimated using age-standardized relative survival ratios. For further details, see *Appendix II: Data sources and methods*. For each cancer in turn, the age distribution of persons recorded as being diagnosed with the given cancer in Canada from 2004–2008 was used as the standard. Estimates 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 A8.

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

Age	Net survival (%) (95% confidence interval)			
	Prostate	Female breast	Colorectal	Lung and bronchus
15–39	*94 (63–99)*	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 (88–89)	68 (67–69)	21 (20–22)
60–69	98 (98–99)	90 (89–91)	68 (67–69)	19 (18–20)
70–79	95 (94–96)	87 (86–88)	64 (63–65)	16 (15–17)
80–99	79 (77–82)	78 (76–80)	56 (54–57)	10 (9–11)

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

* 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: Net survival is estimated using relative survival ratios. For further details, see *Appendix II: Data sources and methods*. Estimates associated with a standard error > 0.05 and ≤ 0.10 are italicized. The complete definition of the specific cancers listed here can be found in Table A8.

TABLE 5.4 Five-year age-standardized net survival for selected cancers conditional on having survived the specified number of years, ages 15–99, Canada (excluding Quebec*), 2006–2008

	Conditional net survival (%) (95% confidence interval)					
	0	1	2	3	4	5
All cancers	**60 (60–61)**	**76 (76–77)**	**82 (82–82)**	**85 (85–85)**	**87 (87–87)**	**88 (88–89)**
Thyroid	98 (97–98)	99 (98–100)	100 (98–100)	99 (98–100)	99 (98–100)	99 (97–99)
Testis	96 (95–97)	98 (97–98)	99 (98–99)	99 (98–99)	99 (98–100)	99 (98–100)
Prostate	95 (94–95)	96 (95–96)	97 (96–97)	97 (96–97)	97 (96–97)	96 (95–97)
Melanoma	88 (87–89)	91 (90–92)	93 (92–94)	95 (93–96)	95 (94–97)	97 (95–98)
Female breast	87 (87–88)	89 (88–89)	90 (90–91)	91 (91–92)	93 (92–93)	94 (93–94)
Hodgkin lymphoma	85 (83–86)	91 (89–93)	92 (90–94)	92 (89–94)	93 (90–94)	93 (90–95)
Body of uterus & uterus NOS	84 (83–85)	90 (89–91)	94 (93–95)	96 (95–97)	98 (96–99)	99 (97–99)
Bladder†	73 (72–74)	81 (79–82)	84 (82–86)	86 (84–88)	88 (86–90)	88 (85–90)
Cervix	73 (71–74)	80 (78–82)	87 (85–88)	90 (89–92)	93 (91–95)	96 (94–97)
Kidney and renal pelvis	67 (66–68)	81 (79–82)	86 (84–87)	89 (87–90)	91 (89–93)	93 (91–95)
Non-Hodgkin lymphoma	66 (65–67)	81 (79–82)	84 (82–85)	85 (84–87)	87 (85–89)	89 (86–90)
Colorectal	64 (63–65)	76 (76–77)	83 (82–83)	88 (87–89)	91 (90–92)	94 (93–95)
Larynx	63 (61–66)	71 (68–74)	77 (74–80)	80 (76–83)	82 (78–85)	82 (78–86)
Oral	63 (62–64)	74 (73–76)	82 (80–84)	86 (84–87)	87 (85–89)	89 (86–91)
Leukemia	58 (57–59)	78 (77–80)	81 (79–83)	83 (81–85)	84 (81–86)	83 (80–86)
Ovary	44 (42–45)	53 (51–55)	62 (60–65)	70 (67–73)	78 (75–81)	84 (80–87)
Multiple myeloma	42 (40–43)	49 (47–51)	51 (48–54)	52 (48–55)	56 (52–61)	60 (55–65)
Stomach	25 (23–26)	51 (49–54)	72 (69–75)	85 (81–88)	92 (87–95)	95 (88–98)
Brain/CNS	24 (23–26)	45 (41–48)	63 (58–67)	72 (67–76)	74 (68–80)	80 (73–85)
Liver	19 (17–21)	39 (35–42)	51 (46–56)	63 (56–69)	74 (65–81)	82 (73–89)
Lung	17 (17–17)	38 (37–39)	54 (53–56)	64 (63–66)	70 (68–72)	75 (72–77)
Esophagus	14 (12–15)	33 (29–36)	53 (48–58)	67 (60–73)	75 (66–81)	80 (71–86)
Pancreas	8 (7– 8)	30 (26–33)	53 (47–59)	68 (60–75)	78 (68–85)	81 (70–89)

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

CNS=central nervous system; NOS=not otherwise specified

* 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.

† Excludes data from Ontario, which did not report *in situ* bladder cancers for the time period considered.

Note: Net survival is estimated using age-standardized relative survival ratios. For further details, see *Appendix II: Data sources and methods*. For each cancer in turn, the age distribution of persons recorded as being diagnosed with the given cancer in Canada from 2004–2008 was used as the standard. "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 A8.

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	*68 (53–78)*
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

* 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.

† International classification of childhood cancer (ICCC) Recode ICD-O-3/WHO 2008. Surveillance, Epidemiology, and End Results Program (SEER). Only selected subgroups within each diagnostic group are listed.

Note: Estimates associated with a standard error > 0.05 and ≤ 0.10 are italicized.

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 (*Canadian Cancer Statistics 2014* and *2015*). 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 cancers 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

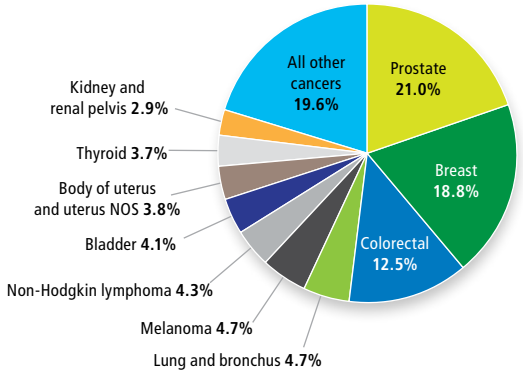
Figure 6.1 shows that prostate and breast cancers together accounted for 40% of all 10-year prevalent cancers. Other common cancers included colorectal cancer (13% of all 10-year prevalent cases), lung cancer (5%), melanoma (5%), non-Hodgkin lymphoma (4%) and bladder cancer (4%).

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 A8.

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:

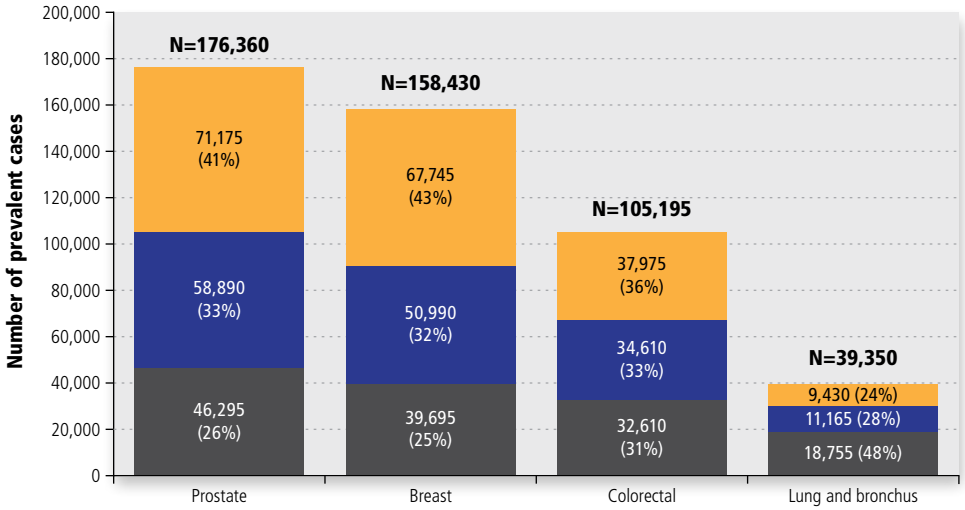
- The prevalence of breast cancer and prostate cancer rises with longer duration compared to other common cancers, such as colorectal and lung cancers.
- The poor prognosis for lung cancer cases means that proportionately fewer individuals with this cancer are alive beyond two years after diagnosis compared 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 A8.

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

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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 Reports.* 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 and bronchus†	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 and uterus NOS	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 and renal pelvis	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; NOS=not otherwise specified

— 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 A8.

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 and bronchus†			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 A8.

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 and bronchus†	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 and uterus NOS	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 and renal pelvis	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; NOS=not otherwise specified

— 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 A8.

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 and bronchus†	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 the 2013 edition. 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 A8.

CHAPTER 7
Special topic: HPV-associated cancers

Led by members of the Canadian Cancer Statistics Advisory Committee:

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Highlights

- In 2012, 3,760 Canadians were diagnosed with an HPV-associated cancer. This number is expected to rise to 4,375 in 2016.
- The most common types of HPV-associated cancer in 2012 were oropharyngeal cancer (OPC; 1,335 cases) and cervical cancer (1,300 cases), followed by anal cancer (475 cases).
- About two-thirds of HPV-associated cancers were diagnosed in females.
- The incidence rate of HPV-associated OPC was more than 4.5 times higher in males than females in 2012.
- The incidence rate of OPC increased in both sexes, but at a much faster rate among males.
- Cervical cancer incidence rates decreased dramatically following the introduction of widespread cervical cancer screening, but this rate has remained relatively stable in Canada since 2005.
- About 1,200 Canadians died from an HPV-associated cancer in Canada in 2012.
- Almost 40% of HPV-associated deaths in 2012 were attributed to cervical cancer and more than 30% to HPV-associated OPC.
- Across HPV-associated cancers, five-year net survival was lowest for vaginal cancer (57%) and highest for vulvar cancer (75%). Five-year age-standardized net survival for OPC increased by 15.6 percentage points from 1992–1996 to 2004–2008.

Projections to 2016 (all HPV-associated cancers combined*)

Incidence	Males	Females
Number of new cases	1,700	2,675†
Age-standardized rate (per 100,000)‡	9.3	14.3†
% of all new cancers	1.7	2.7
Mortality		
Number of deaths	395	780§
Age-standardized rate (per 100,000)‡	2.2	3.8§
% of all cancer deaths	0.9	2.1

HPV=human papillomavirus

* The definitions of HPV-associated cancers can be found in Tables A12 and A13.

† When cervical cancer is excluded, the number of new cases is estimated to be 1,258 and the age-standardized incidence rate is 6.5 per 100,000 females.

‡ Rates were standardized to the 2011 Canadian population.

§ When cervical cancer is excluded, the number of deaths is estimated to be 402 and the age-standardized mortality rate is 1.8 per 100,000 females.

Introduction

Human papillomavirus (HPV) is a group of more than 100 different types of related viruses, so named because they can cause warts, or papillomas, in various parts of the body. More than 40 types of HPV can infect the anogenital tract, including the skin of the penis, vulva and anus, and the lining of the vagina, cervix and rectum. These types can also infect the lining of the mouth and throat, notably the oropharynx, base of tongue and tonsil.

HPV is transmitted through skin-to-skin or skin-to-mucosa contact. Most sexually active individuals will have an HPV infection at some point during their lifetime, making it the most common sexually transmitted infection in Canada and around the world.[1] The majority of these infections will clear within 1–2 years and cause no physical symptoms,[2] but others can have clinical consequences, including the development of anogenital warts or cancer. The types of HPV that cause warts are referred to as "low-risk" types and those that can lead to the development of cancer (i.e., carcinogens) are referred to as "high-risk" types.

In 2009, the International Agency for Research on Cancer (IARC) classified 12 types of HPV (HPV 16, 18, 31, 33, 35, 39, 45, 51, 52, 56, 58, 59) as known carcinogens, one type (HPV68) as a probable carcinogen and another 12 as possible carcinogens.[3] HPV16 is the most common type of high-risk HPV and is responsible for more than half of all cervical cancers worldwide.[4] The IARC review also indicated there is sufficient evidence to conclude that HPV16 causes cancer of the cervix, vulva, vagina, penis, anus, oral cavity and oropharynx and tonsil, and limited evidence that it can cause cancer of the larynx.

Virtually all cases of cervical cancer are caused, at least in part, by a persistent HPV infection with a high-risk type. HPV is also associated with about 80%–90% of anal cancers, 40% of vaginal and vulvar cancers and 40%–50% of penile cancers. While the majority of mouth and throat cancers are primarily associated with tobacco and alcohol use, about 25%–35% of oral cavity and oropharyngeal cancers are attributed to high-risk HPV types.[5]

HPV is a necessary cause of cervical cancer, but the vast majority of females with an HPV infection do not develop cancer. A number of cofactors influence whether an HPV infection progresses to cervical cancer, including smoking, multiple full-term pregnancies, long-term use of oral contraceptives and a weakened immune system.[6] Within the mouth and throat, smoking and alcohol are the major causes of cancer, particularly in regions that are not associated with HPV. Although smoking does not appear to be an independent risk factor for HPV-associated oral cancers, it may increase the risk among those exposed to HPV by promoting the infection.[7] Smoking is also associated with anal, penile, vaginal and vulvar cancers.

In 2006, the first prophylactic HPV vaccine became available in Canada. Since then, there has been increased attention on HPV-associated cancers and their prevention. However, with the exception of cervical cancer, there is little epidemiologic data on HPV-associated cancers in Canada. Baseline measures of the population burden of HPV-associated cancers are important for a number of reasons, including prevention planning and evaluation.

This chapter provides up-to-date epidemiologic data on HPV-associated cancers in Canada. Detailed information on the methodology is provided in *Appendix II: Data sources and methods*, but several points are worth noting as they relate to the outcome definitions.

- As it was not possible to test for the presence of HPV in the tumour, HPV status for incident cases was defined based on cancer site and morphology.
- For cancers of the vagina, vulva, penis, anus, oropharynx and oral cavity, HPV is associated primarily with squamous cell carcinomas (SCC).[8] For each of these cancers, all SCCs were classified as "HPV-associated".
- Since it is well established that HPV is a necessary cause of cervical carcinomas,[9] all cervical carcinomas (including SCCs, adenocarcinomas and other specified and unspecified carcinomas) were classified as HPV-associated.
- For simplicity, references to cervical, vaginal, vulvar, penile and anal cancers in this report are generally used synonymously with the HPV-associated definitions of these cancers.

- Head and neck cancers at sites known to be related to HPV (mainly the base of the tongue, tonsils and other oropharynx) are referred to as oropharyngeal cancers (OPC). Cancers of oral sites that show a stronger association with tobacco and alcohol are referred to as oral cavity cancers (OCC). The latter were included to compare trends in HPV-associated versus smoking/alcohol-associated head and neck cancers.
- Since morphology data were not available for mortality, cancers for these analyses were defined based on site only, meaning mortality estimates include HPV-associated and non–HPV-associated cancer deaths. As a result, caution should be taken when comparing HPV-associated incidence rates with mortality rates, as the latter will appear artificially high.
- The definitions used for incidence are provided in Table A12 and are consistent with the literature.[10,11] The definitions used for mortality are provided in Table A13.

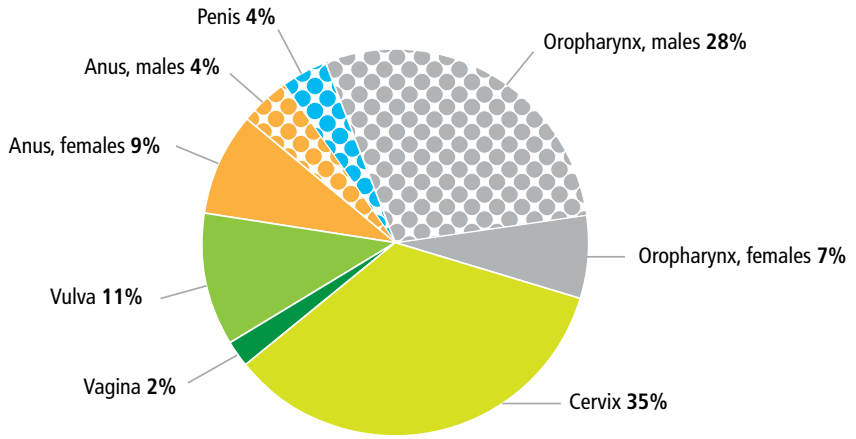
Epidemiology of HPV-associated cancers in Canada

Incidence

In 2012, 3,760 HPV-associated cancers were diagnosed in Canada, 64% of which were diagnosed in females and 36% in males (Table 7.1). Among women, cancer of the cervix was the most common HPV-associated cancer, while cancer of the oropharynx was the most common among men.

Oropharyngeal and cervical cancers were the most commonly diagnosed HPV-associated cancers in Canada, each accounting for approximately 35% of all HPV-associated cancers in Canada (Figure 7.1). Anal (13%) and vulvar (11%) cancers are the next most commonly diagnosed HPV-associated cancers, followed by cancers of the penis (4%) and vagina (2%).

FIGURE 7.1 Proportion (%) of new cases for selected HPV-associated cancers*, Canada, 2012†



* Includes selected topographies and morphologies. Refer to Table A12 for definitions.

† Quebec data are from 2010.

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

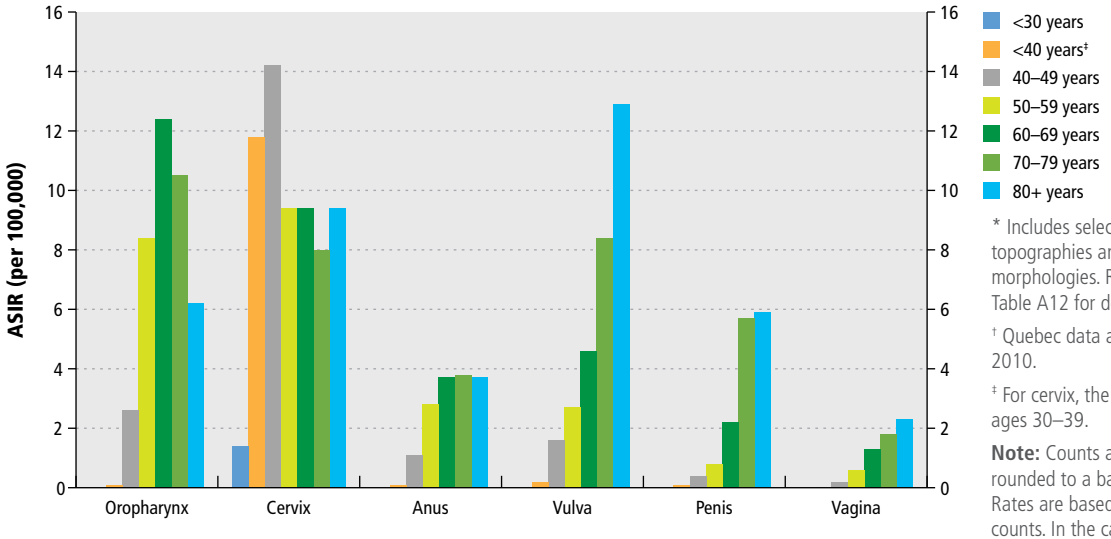
Incidence by age

Like most cancers, the incidence of HPV-associated cancers of the anus, vulva, penis and vagina generally increases with age (Figure 7.2). In contrast, more than half of cervical cancers were diagnosed in females under the age of 50 years, with the highest risk among females aged 40–49 years (14.2 per 100,000 females). Rates of HPV-associated oropharyngeal cancers peaked among Canadians aged 60–69 years (12.4 per 100,000 Canadians) and decreased thereafter.

Incidence by region

Rates of HPV-associated cancers of the oropharynx, cervix, vulva and penis were higher in the Atlantic region than other regions, but these are not statistically different from Canadian rates (Table 7.2). Differences in cancer rates between regions can reflect differences in data collection and coding, clinical practice and differences in the prevalence of risk factors.

FIGURE 7.2 Age-standardized incidence rates (ASIR) for HPV-associated cancers*, by age, Canada, 2012†



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

View data

* Includes selected topographies and morphologies. Refer to Table A12 for definitions.

† Quebec data are from 2010.

‡ For cervix, the data refer to ages 30–39.

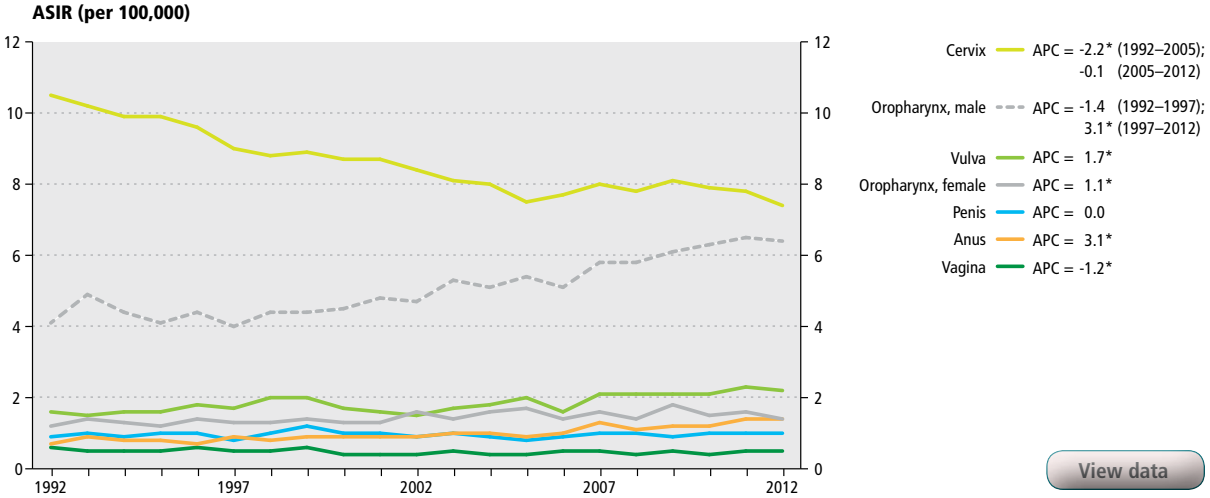
Note: Counts are randomly rounded to a base of five. Rates are based on rounded counts. In the calculation of rates, female population data were used for cancers of the cervix, vagina and vulva; male population data were used for cancer of the penis.

Incidence over time

Figure 7.3 displays trends in HPV-associated cancers between 1992 and 2012.

- The rate of cervical cancer decreased by an average of 2.2% per year between 1992 and 2005 and remained relatively stable thereafter.
- There was also an average decrease in HPV-associated vaginal cancers of 1.2% per year (1992–2012).
- The incidence of HPV-associated penile cancer remained stable during the 20-year period at a rate of approximately 1 per 100,000 males.
- In contrast, the rate of HPV-associated anal cancer increased by an average of 3.1% per year, particularly among females (3.7% compared with 2.2% among males, data not shown). Over that time, there was also a significant increase in the rate of vulvar cancer (1.7% per year).

FIGURE 7.3 Trends in age-standardized incidence rates (ASIR) and annual percent change (APC)[†] for HPV-associated cancers[‡], Canada, 1992–2012[§]



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

[†] APCs refer to 1992–2012 calendar years, unless there was a changepoint, in which case the applicable years are indicated.

[‡] Includes selected topographies and morphologies. Refer to Table A12 for definitions.

[§] Actual incidence data were available to 2012 for all provinces and territories except Quebec, for which data were available to 2010 and carried forward thereafter.

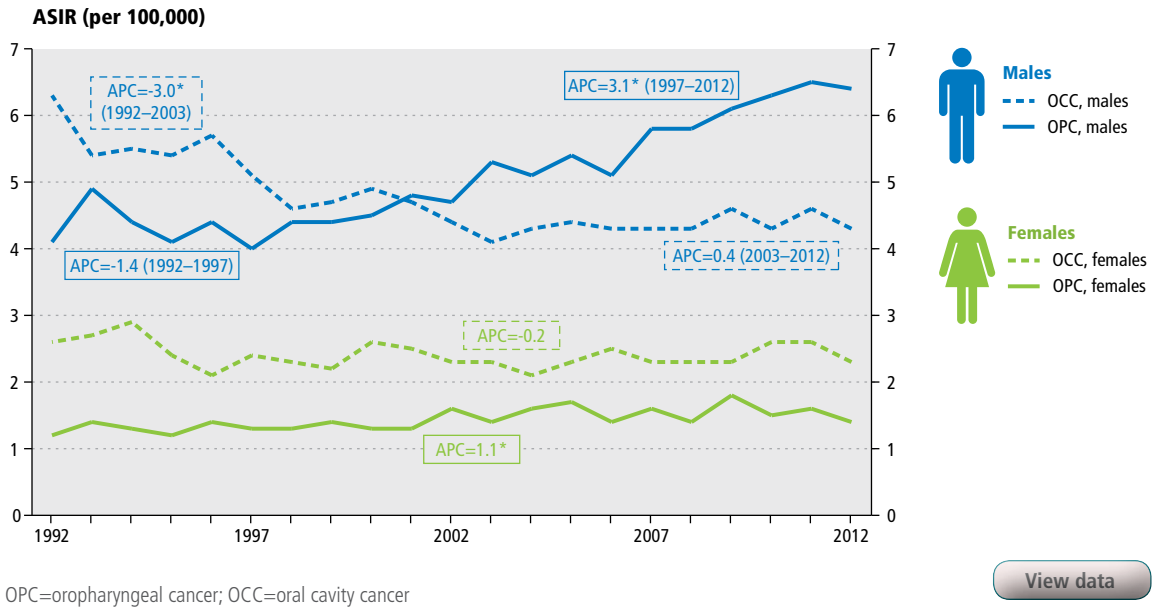
Note: Rates are age-standardized to the 2011 Canadian population.

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

Figure 7.4 displays trends in HPV-associated oropharyngeal cancers (OPC) and non-HPV-associated oral cavity cancers (OCC) between 1992 and 2012, by sex.

- The risk of OPC is considerably higher in males compared to females. Over the 20-year period, males were 2.9 to 4.5 times more likely to be diagnosed with OPCs than females.
- The incidence rate of OPC has increased significantly in both males and females since the mid-1990s. The rate of increase was particularly notable in males, increasing by an average of 3.1% per year from 4.1 per 100,000 in 1997 to 6.4 per 100,000 in 2012.
- If recent trends continue, the rate of OPC in males may surpass the rate of cervical cancer in females in the near future (Figure 7.3).

FIGURE 7.4 Trends in age-standardized incidence rates (ASIR) and annual percent change (APC)† for HPV-associated (OPC) and non-HPV-associated (OCC) head and neck cancers‡, by sex, Canada, 1992–2012§



OPC=oropharyngeal cancer; OCC=oral cavity cancer

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

† APCs refer to 1992–2012 calendar years, unless there was a changepoint, in which case the applicable years are indicated.

‡ Includes selected topographies and morphologies. Refer to Table A12 for definitions.

§ Actual incidence data were available to 2012 for all provinces and territories except Quebec, for which data were available to 2010 and carried forward thereafter.

Note: Rates are age-standardized to the 2011 Canadian population.

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

Incidence

The number of new cases of cancer in a given period of time, often a year.

Age-standardized incidence rate (ASIR)

The number of new cases of cancer per 100,000 people, standardized to the age structure of the 2011 Canadian population. Age standardization is used to adjust for differences in age distributions over time and across provinces and territories, thereby allowing for more accurate comparisons between populations. In this report, ASIR is also referred to as "incidence rate".

Province or territory

Refers to the province or territory of a person's permanent residence at the time of their cancer diagnosis or death.

Annual percent change (APC)

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

Changepoint

The year corresponding to a significant change in trend of age-standardized rates. The changepoint year is determined by an algorithm and may not correspond identically to patterns in the data in Figures 7.3 and 7.4.

- In females, OPC incidence rates increased more slowly at an average annual rate of 1.1%, from 1.2 to 1.4 per 100,000 females between 1992 and 2012. Since HPV is transmitted through orosexual practices,[7] increases in HPV-associated oropharyngeal cancers have been attributed to changes in sexual behavior, including increased oral sex.[12]
- Rates of OCC were 1.8 to 2.6 higher in males than females across the 20-year period, which likely reflects a history of higher tobacco consumption among males.
- Between 1992 and 2003, there was a significant decrease in the incidence of OCC in males, and rates were relatively stable thereafter. Rates among females did not change significantly between 1992 and 2012. The decline in OCC among men likely reflects the latent effect of decreased tobacco consumption that began in 1965.[13] Since decreased tobacco consumption among females did not begin until the 1990s, we might expect a similar decline in OCC among females in the near future.
- In males, the incidence of OPC surpassed the incidence of OCC in 2001. In females, the incidence of OCC is relatively stable and continues to be higher than the incidence of HPV-associated OPC.

Cervical cancer: How does Canada compare?

- Cervical cancer is the third most commonly diagnosed cancer and the fourth leading cause of cancer death in females worldwide. This burden disproportionately affects developing countries and other medically underserved populations where screening is not widespread.[14] In Canada, it is the thirteenth most commonly diagnosed cancer (Table 2.4) and the sixteenth leading cause of cancer death (Table 4.4) in females.
- Cervical cancer incidence rates are slightly lower in Canada than the United States, and mortality rates are considerably lower in Canada.[15] Nevertheless, North America boasts some of the lowest cervical cancer incidence and mortality rates in the world, rivaled only by Western Asia and Australia/New Zealand. Rates are highest in Eastern, Western and Southern Africa, with incidence and mortality rates 6 and 10 times higher (respectively) in East Africa than North America.[14]

HPV-associated oropharyngeal cancer: How does Canada compare?

- Increasing rates of HPV-associated OPC, and the fact that the burden disproportionately affects males, have also been observed in the United States and some countries in Europe.[12]
- For example, a recent study from the United States showed that HPV prevalence in OPC increased from 16% in 1984 to 1989 to 72% in 2000 to 2004.[16]
- The US study also showed that if recent incidence trends continue, the annual number of HPV-positive OPC should surpass the annual number of cervical cancers by the year 2020. In Canada, the annual number of OPC (for both sexes combined) is already rivaling cervical cancer.
- Figure 7.3 suggests that the age-standardized incidence rate of OPC in males may surpass that of cervical cancer in females in the near future.

Mortality

There were over 1,100 deaths from HPV-associated cancers in Canada in 2012, 38% of which were attributed to cervical cancer and 32% to OPC (Table 7.3). More than two-thirds of deaths were among females and less than one-third was among males. The mortality rate was highest for cervical cancer at 2.4 per 100,000 females, followed by OPC in males (1.7 per 100,000). Mortality rates were lowest for cancers of the vagina, penis and anus, ranging from 0.2–0.3 per 100,000.

Cervical cancer mortality rates decreased by an average of 2.8% per year between 1992 and 2008; there was no significant change in rates thereafter (Figure 7.5). Mortality rates for oropharyngeal cancers decreased for both males and females by an average of 1.8% per year between 1992 and 2012 – from 2.8 to 1.7 per 100,000 males and from 0.8 to 0.5 per 100,000 females. Mortality rates for vaginal cancer in females and penile in males did not change significantly between 1992 and 2012. In females, mortality rates for vulvar cancer increased significantly by an annual average of 1.9%. The significant increase in anal cancer mortality rates observed between 1992 and 2012 (3% per year) was driven by the high rate of increase among females (4.7% per year), as anal cancer mortality rates in males remained relatively unchanged during that period (data not shown).

Deaths

The number of deaths due to cancer in a given period of time, often a year.

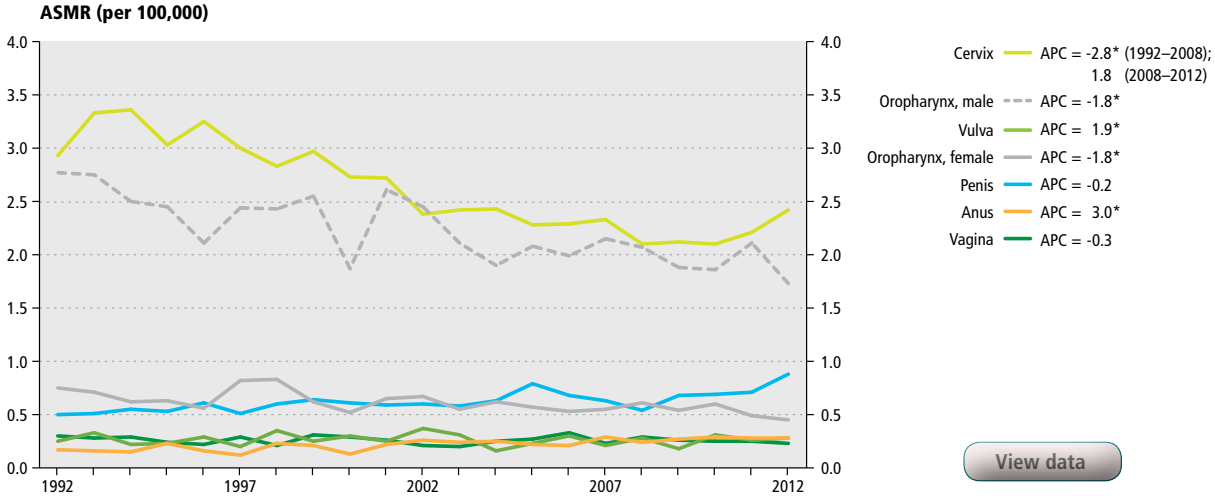
Age-standardized mortality rate (ASMR)

The number of cancer deaths per 100,000 people, standardized to the age structure of the 2011 Canadian population. Age standardization is used to adjust for differences in age distributions over time and across provinces and territories, thereby allowing for more accurate comparisons. In this report, ASMR is also referred to as "mortality rate".

Net survival

Note: This section presents age-standardized net survival using two different types of standards. Estimates derived using the cancer-specific standard provide information that is relevant to the study of each cancer individually. Conversely, because the age distributions of HPV-associated cancers vary considerably, comparisons across cancers for all ages combined are best made by examining estimates that have been standardized to a common age distribution.

FIGURE 7.5 Age-standardized mortality rates (ASMR) and annual percent change (APC)† for HPV-associated cancer types‡, Canada, 1992–2012



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

† APCs refer to 1992–2012 calendar years, unless there was a changepoint, in which case the applicable years are indicated.

‡ Refer to Table A13 for definitions. As morphology data were not available for deaths, these include both HPV-associated and non–HPV-associated cancers of each cancer type.

Note: Rates are age-standardized to the 2011 Canadian population.

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

Net survival

The survival probability that would be observed in the hypothetical situation where the cancer of interest is the only possible cause of death (i.e., the survival as far as the cancer of interest is concerned). Net survival is the preferred method for comparing cancer survival in population-based cancer studies because it adjusts for the fact that different populations may have different levels of background risk of death. It 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.

Age-standardized net survival

The net survival that would have occurred if the age distribution at diagnosis of the group of people with the cancer under study had been the same as that of the standard population. For each cancer, the standard population was typically based on persons diagnosed with that cancer in Canada from 2004 to 2008. However, a common standard based on all persons diagnosed with an HPV-associated cancer was also employed (Table 7.4). While every estimate of net survival has been age-standardized except the age-specific ones, this terminology is only applied in the text where results concern comparisons over time, sex, or HPV-associated cancers.

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, assuming no other sources of bias, one can be 95% confident the range contains the true value for the estimate of interest. Confidence limits (CL) report the upper and lower bound of the interval.

Table 7.4 provides predicted age-standardized net survival estimates for each HPV-associated cancer by time since diagnosis. Five- and 10-year age-standardized survival was highest for cancer of the vulva at 75% and 68% respectively and was lowest for cancers of the vagina (57%, 46%) and oropharynx (60%, 52%). One-year age-standardized survival was highest for cancers of the anus (91%), vulva (89%) and penis (89%) and lowest, once again, for cancers of the oropharynx (81%) and vagina (82%).

There was a considerable decline in net survival for vaginal cancer following the first year of diagnosis, from 76% at one year to 37% at 10 years. Indeed, the five-year conditional net survival for vaginal cancer (73%, data not shown) was poor relative to many other cancers (Table 5.4). However, estimates of net survival for HPV-associated vaginal cancer were higher than corresponding estimates of non-HPV-associated cancers of the vagina. For example, the five-year net survival was 51% for the former versus 37% (data not shown) for the latter. For cervical cancer there was little excess mortality beyond five years, as evidenced by the decrease in survival from 73% to 70% at 10 years.

Among people diagnosed with HPV-associated anal cancer, five-year net survival was higher among women than among men (Table 7.5). In contrast, the prognosis for HPV-associated oropharyngeal cancer was similar between the sexes. In general, five-year net survival decreased with age for HPV-associated cancers. From the youngest to the oldest age groups, declines in survival ranged from 42 percentage points among those diagnosed with cancers of the cervix (85% to 43%) and oropharynx (76% to 34%), to just over 20 percentage points for cancer of the anus (75% to 54%).

Changes in survival from 1992–1996 to 2004–2008 varied considerably by type of HPV-associated cancer (Table 7.6). Age-standardized five-year net survival for oropharyngeal cancer increased 15.6 percentage points from 1992–1996 (43%) to 2004–2008 (58%). This increase was most pronounced among people diagnosed between the ages of 55 and 64 (21.9 percentage points, data not shown). Similar improvements in survival for HPV-associated OPCs have been reported in the US[16] and may be attributable to reductions in tobacco use, an important predictor of survival.[17] A modest, yet statistically significant, increase in five-year net survival was also observed for cervical cancer. Non-statistically significant decreases of between four and eight percentage points were observed for cancers of the penis, anus and vulva, while the prognosis for women diagnosed with vaginal cancer remained virtually unchanged over this period.

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 these individuals. Tumour-based estimates refer to the number of cancers diagnosed among individuals living with or beyond cancer on a specified date (referred to as the index date). Person-based estimates refer to the number of individuals living with or beyond cancer on an index date.

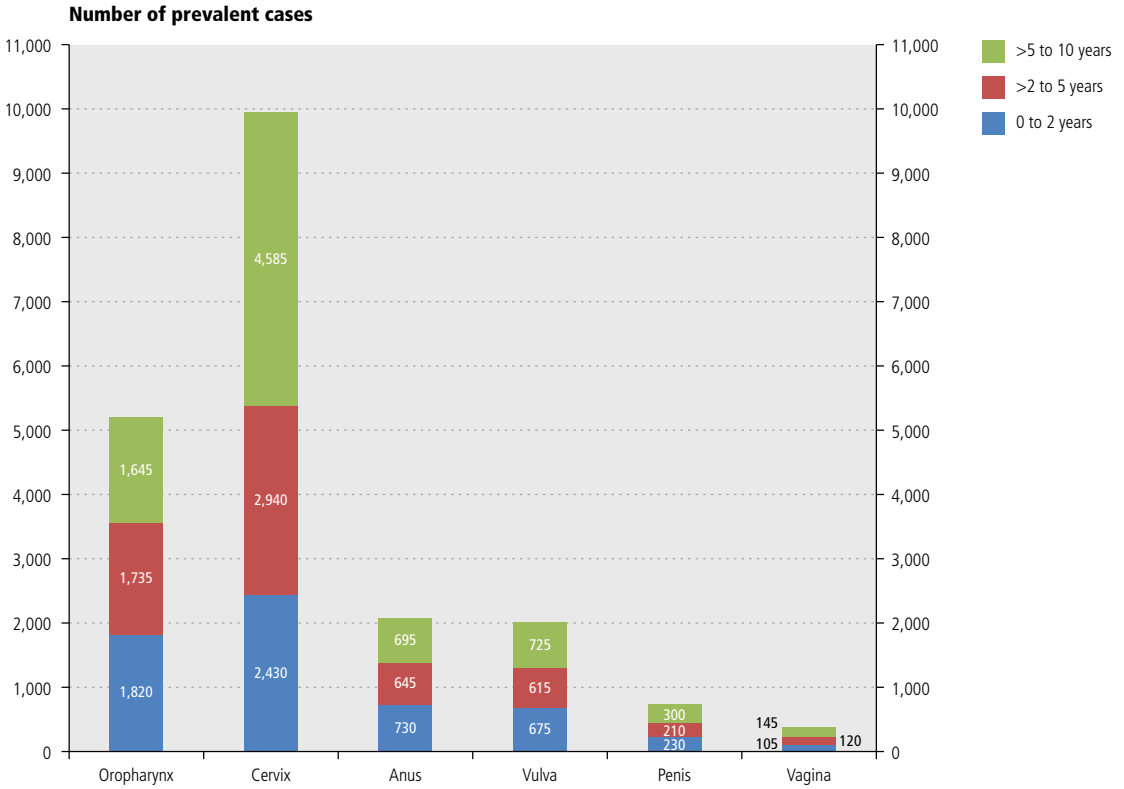
Prevalence

It is estimated that on January 1, 2009, more than 20,000 Canadians (5,395 males and 14,895 females) had been diagnosed with an HPV-associated cancer in the previous 10 years and were still alive on that date (data not shown). Among these, a total of 20,345 HPV-associated cancers were recorded (Table 7.7), meaning some individuals had been diagnosed with more than one HPV-associated cancer. To compare the prevalence of HPV-associated cancers with other cancers, see Table 6.1.

Two-thirds of the 10-year prevalent tumours in women were cervical cancers, while almost three-quarters of HPV-associated tumours in men were oropharyngeal cancers. The greater prevalence of oropharyngeal cancer among men reflects greater incidence of these cancers relative to women. The greater prevalence of anal cancers among women reflects both greater incidence (Table 7.1) and survival (Table 7.5) relative to men.

Figure 7.6 shows the distribution of prevalent HPV-associated tumours according to when they were diagnosed relative to 2009.

FIGURE 7.6 Tumour-based prevalence for HPV-associated cancers* by duration, Canada,† January 1, 2009



* Includes selected topographies and morphologies. Refer to Table A12 for definitions.

† 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. For further details, see *Appendix II, Data sources and methods*.

Note: 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.

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

- Approximately 29% of all HPV-associated cancers were diagnosed within the previous two years, 31% were diagnosed >2 to 5 years prior, and 40% were diagnosed >5 to 10 years prior.
- Almost half of cervical cancers were diagnosed >5 to 10 years prior. This likely reflects the relatively good long-term survival associated with cervical cancer, as well as its declining incidence rate.
- The distribution of HPV-associated OPCs by duration was relatively uniform, but the highest percentage (35%) corresponded with tumours diagnosed within the previous two years. This likely reflects the increasing incidence of the disease.

Prevention and early detection

HPV vaccines

There are currently three HPV vaccines available in Canada to prevent HPV infection and its associated diseases. The quadrivalent (4-valent) vaccine, Gardasil®, protects against four types of HPV, the bivalent (2-valent), Cervarix™, protects against two and the nonavalent (9-valent), Gardasil 9®, protects against nine.

All three vaccines protect against HPV types 16 and 18, which are the types most commonly associated with cancer – they cause 70% of cervical cancers and are also causally associated with cancers of the vagina, vulva, penis, anus, oral cavity and oropharynx. The 9-valent protects against five additional high-risk HPV types (31, 33, 45, 52, 58), which are associated with an additional 20% of cervical cancers. Both the 4-valent and 9-valent HPV vaccines protect against HPV6 and HPV11, which cause at least 90% of anogenital warts.

The first HPV vaccine available in Canada was the 4-valent. It was approved for females aged 9–26 in 2006 and males aged 9–26 in 2012. The indications for HPV vaccines have continued to expand since their initial approval.

Effectiveness

All three vaccines are highly efficacious in preventing infection with the types of HPV they target and are most effective when administered prior to the onset of sexual activity, when the probability of prior infection is low.[18,19]

HPV vaccines are currently indicated as a three-dose vaccination series administered at 0, 2 and 6 months. Alternatively, the 4-valent and 2-valent HPV vaccines may be administered as a two-dose series at 0 and 6–12 months in males and females ages 9–14 years.[20]

Given the long latency between HPV infection and cancer, it may be years before the impact of HPV vaccination on cancer rates can be assessed. However, studies have shown that HPV vaccination programs have led to reductions in precancerous cervical lesions in females.[21-23] In addition, there is strong evidence that female vaccination helps prevent infection in males through herd immunity.[24]

The duration of protection provided by HPV vaccines is not fully known, but evidence shows that immunity can last at least 9 years with the 4-valent vaccine [25] and at least 9.4 years with the 2-valent vaccine [26] in females. Studies are ongoing to determine the duration of protection and whether a booster dose is necessary.

Safety

The safety of 4-valent and 2-valent HPV vaccines has been reviewed extensively, and the research shows they are generally safe, well tolerated and have side effects similar to those experienced with other vaccines. The most common side effects of the vaccines are soreness (pain), swelling, itching and redness at the injection site, as well as syncope (fainting).[27,28]

A comprehensive review of the safety evidence of the 4-valent HPV vaccine published in 2015 examined post-licensure evidence collected over nine years in more than one million individuals from various countries. The authors did not find evidence of an increase in the incidence of serious adverse events, including Guillain-Barré Syndrome, anaphylaxis and venous thromboembolism.[29]

The safety of all HPV vaccines is being followed in Canada and around the world on an ongoing basis.

HPV vaccination programs

The first provincial publicly funded HPV vaccination programs were implemented in 2007, and by the end of 2010, all provinces and territories had school-based HPV vaccination programs for girls. The programs differ slightly by province and territory in terms of the school grade(s) targeted for vaccination, but all offer HPV vaccination free to a population of young girls through school-based programs.

In 2013, Prince Edward Island became the first province to expand its publicly funded HPV vaccination program to include males. Nova Scotia, Alberta, Manitoba, Quebec and Ontario have since also transitioned to gender-neutral HPV vaccination programs. British Columbia offers free HPV vaccination to certain populations at high risk of HPV, including men who have sex with men and street youth, but does not offer comprehensive school-based HPV vaccination for males. Quebec is the only province that offers a comprehensive, gender-neutral, school-based program along with a program for men who have sex with men.

HPV vaccination rates vary considerably across the country. Recent estimates of receipt of the first dose range from 47% in the Northwest Territories to 93% in Newfoundland and Labrador.[30]

Males and females not eligible for publicly funded HPV vaccination may pay for the vaccine and receive it from their public health provider. Many private health insurance plans now provide coverage for HPV vaccination.

Early detection

The goal of cancer screening is to detect the disease at an early stage for those people with no symptoms. Early detection offers the best chance of effective treatment and therefore reduces the likelihood of death. Cervical cancer is the only HPV-associated cancer type for which organized screening programs are available in Canada.

Papanicolaou (Pap) test: For more than 60 years, the Pap test (also known as the Pap smear or cervical cytology) has been the backbone of cervical cancer screening in Canada. A Pap test involves collecting cells from the cervix to identify changes that may be precancerous or cancerous. Further inspection by colposcopy may be required to determine if treatment is required. Early detection and treatment of cervical dysplasia is highly effective and has led to significant reductions in cervical cancer incidence and mortality in countries where cervical screening is commonplace.[31,32]

In 2013, the Canadian Task Force on Preventive Health Care updated their guidelines on cervical cancer screening to recommend women 25–69 years of age be screened at 3-year intervals.[31] The previous guidelines, published in 1994, recommended annual screening following initiation of sexual activity, or at age 18 years. For females aged 20–69 years, screening was recommended

Summary of HPV vaccine programs in Canada*

P/T	Females		Males		Number of doses
	Start year	Grade(s)	Start year	Grade	
BC	2008	6	2015	—†	2
AB	2008	5	2014	5	3
SK	2008	6	—	—	3
MB	2008	6	2016	6	3
ON§	2007	7	2016	7	2
QC	2008	4 and 9	2016	4‡	2
NB	2008	7	—	—	3
NS	2007	7	2015	7	3
PE	2007	6	2013	6	3
NL	2007	6	—	—	3
NT	2009	5	—	—	3
YT	2009	6	—	—	3
NU	2010	6 (or ≥9 years old)	—	—	3

P/T: province or territory

* Up to date as of April 25, 2016

† As of January 2016, British Columbia has offered publicly funded HPV vaccination to males at higher risk of HPV. This includes males aged 9–26 years who (1) have sex with men (or are questioning their sexual orientation), (2) are street involved or (3) are infected with the human immunodeficiency virus (HIV); males aged 9–18 years in the care of Ministry of Children and Family Development; and males aged 12–17 years in youth custody services centres.

‡ As of January 2016, Quebec has also offered publicly funded HPV vaccination to men 26 years of age and under who have sex with men.

§ On April 21, 2016, the Ontario government announced its girls-only Grade 8 HPV vaccination program will move to a gender-neutral Grade 7 program as of September 2016. At that time, the program will move from 3 doses to 2 doses for most students.

every 3 years after 2 normal Pap tests, but much of the profession continued annual screening.[33]

The HPV vaccine does not eliminate the need for cervical cancer screening. Vaccinated females are still susceptible to infection from other high-risk HPV types not covered by the vaccines, and women who were sexually active prior to receiving the vaccine may have been previously infected with a high-risk type. As a result, current screening guidelines are the same for vaccinated and unvaccinated females. Screening strategies will likely continue to evolve in the era of HPV vaccination.[34]

HPV test: Screening programs use Pap tests to find cell abnormalities, but testing for HPV can be used to detect the presence of high-risk HPV types even before there are visible changes to cells in the cervix. HPV testing is generally not recommended before the age of 30 since most HPV infections among females in their 20s are transient infections that will clear within 1–2 years.[35]

HPV tests are available in Canada and are sometimes used as follow-up to a positive Pap test. There is growing evidence and consensus that HPV testing should replace Pap tests as the primary technology in cervical cancer screening in Canada.[36] In part, this is because HPV tests are more sensitive (though less specific) than Pap tests, a measure that will become increasingly important as more individuals receive the vaccine and the prevalence of HPV16 and HPV18 decreases in the population.

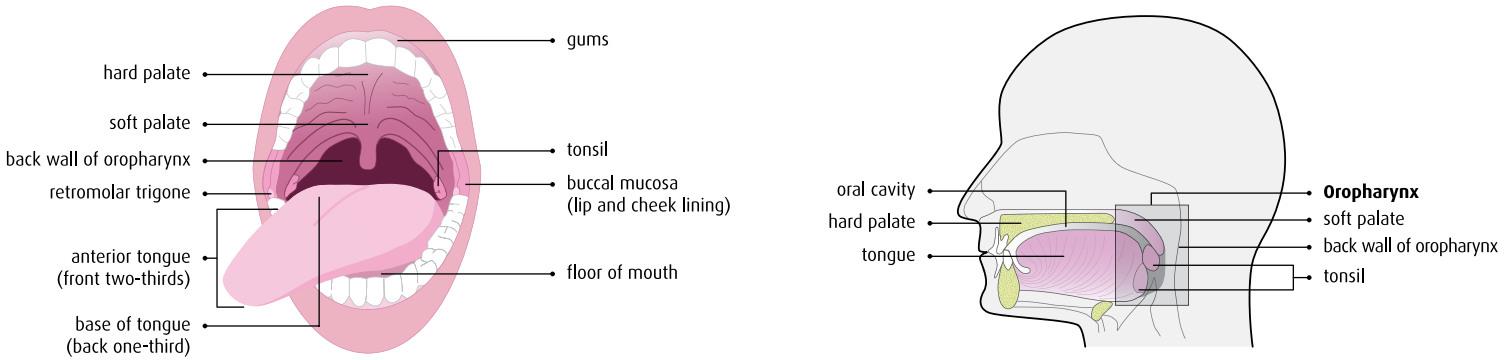
Although there are no organized screening programs for non-cervical HPV-associated cancers, tests are sometimes available. For example, anal Pap tests are sometimes used to detect early signs of anal cancer, particularly among high-risk populations, such as men who have sex with men. The HPV test may be used on sites other than the cervix, such as the anus or oral cavity. Also, some dental professionals perform physical examinations of the mouth to detect early signs of oral cancers. The Canadian Task Force on Preventive Health Care has not recommended population-based screening for any of the non-cervical HPV-associated cancer types, and more research is needed to demonstrate the effectiveness and harms of such screening.

Clinical perspective – oropharyngeal and oral cavity cancers

Anatomically, the oropharynx and oral cavity are key components of the upper aerodigestive tract. The oropharynx comprises the base of tongue, soft palate, tonsils and the middle part of the pharynx. The oral cavity comprises the front two-thirds of the tongue, the floor of the mouth, the lining inside the cheek and lips, the gums and the hard palate (Figure 7.7).

The increasing incidence of HPV-associated oropharyngeal cancers in the population, especially among males, may have a significant impact on the healthcare system and resources. Of course, each diagnosis also has important implications for the patient.

FIGURE 7.7 Selected anatomical sites of the oropharynx and oral cavity



Note: See Table A12 to relate these sites to the definitions of HPV-associated and non–HPV-associated cancers.

Created by: Canadian Cancer Society

Prevention

HPV16 is present in approximately 90% of HPV-associated OPCs.[37] Although HPV vaccines are not currently indicated for the prevention of OPC, a recent randomized controlled trial found the bivalent HPV vaccine was 93% efficacious in preventing oral infections of HPV16 and 18.[38] This provides strong evidence that HPV vaccines may prevent most oral HPV infections and in turn may be an important tool for addressing the increasing burden of these cancers in Canada.

Diagnosis

Head and neck cancers is a term used to describe a collective group of cancers that usually begin in the squamous cells of the moist, mucosal surfaces that line the head and neck. The diagnosis and management of squamous cell carcinoma of the head and neck (SCCHN), which includes both OPC and OCC, requires a multidisciplinary approach. Patients may present with local signs or symptoms, such as detection of a neck lump, hoarseness, discomfort in swallowing, pain in the throat or ear, or weight loss. Diagnostic investigations broadly consist of a medical history, physical and endoscopic examinations, diagnostic imaging (which may include computed tomography, magnetic resonance imaging and positron emission tomography), examination under anesthesia, and biopsy and histopathological confirmation of diagnosis.[39]

For head and neck cancers where HPV might be implicated, such as OPC, it is now routine to test the tumour for the presence of HPV. For patients with non-HPV-associated SCCHN, such as OCC, HPV testing is not considered part of routine care.[40]

Risk stratification based on HPV status

HPV-associated OPC is now recognized as a biologically distinct disease entity from non-HPV-associated SCCHN. HPV-positive OPCs have a more favourable prognosis than HPV-negative OPCs, regardless of treatment,[41-43] and efforts have been made to further classify HPV-associated OPC into different prognostic risk groups.[41,44] Clinical trials (e.g., NCT02254278) are ongoing to investigate the feasibility and efficacy of strategies aimed at reducing the intensity of radiotherapy and chemotherapy in patients with favorable risk HPV-associated OPC (e.g., non-smokers with early stage disease). Proposals have been made to refine the existing tumour staging system specifically for this patient population.[45]

Treatment: Early stage or locoregionally advanced disease

Preserving organ function is an important goal in treating non-metastatic OPC and OCC. Typically, localized OPC is managed by radiotherapy alone, while surgical resection is recommended for localized OCC. Patients with locoregionally advanced OPC or OCC are usually also treated with chemoradiotherapy, and salvage surgery is reserved for residual disease. The five-year absolute overall survival benefits from the addition of concurrent chemotherapy to locoregional treatment is 8.1% in OPC and 8.9% in OCC.[46] In recent years, transoral robotic surgery (TORS) has been used in selected cases of OPC to preserve functional and esthetic outcomes and to reduce the intensity of additional treatments, such as postoperative radiotherapy or chemoradiotherapy.[47]

Treatment: Recurrent or metastatic disease

For recurrent or metastatic OPC or OCC that is not suitable to curative options, systemic regimens that incorporate palliative chemotherapy and molecularly targeted agents, such as anti-epidermal growth factor receptor inhibitors (i.e., cetuximab), may be given to certain patients.[48] Immune checkpoint inhibitors can use the patient's own immune system to fight the cancer, with promising results seen in the treatment of recurrent or metastatic SCCHN.[49] Regardless of the therapeutic approach used, supportive care (e.g., pain management) is critical because of the substantial disease-related impact of this disease on the quality of life of patients.

The future burden of cervical cancer

Setting

Since HPV vaccination became available in Canada only about 10 years ago, its impact on preventing cervical cancer has yet to be fully realized. Even in the era of HPV vaccination, it is still important that alternative strategies for primary cervical cancer screening are considered. To this end, the OncoSim model (formerly the Cancer Risk Management Model or CRMM) version 2.3.0.1 was used to project the impact of different prevention scenarios on the burden of cervical cancer in Canada from 2016 to 2036.

The health and economic impact of six different cervical cancer prevention strategies were assessed. This included two types of primary screening strategies:

1) Pap tests only, every three years from ages 21 to 65 (referred to as "Pap only")
2) Sequential, age-based screening, with Pap tests every three years from ages 21 to 29 then switching to HPV DNA tests every 5 years from ages 30 to 65 (referred to here as "sequential testing" or "Pap then HPV test")

For each screening strategy, vaccination coverage rates for 12-year-old girls were varied at 0%, 60% and 85%.

Impact of HPV Vaccination

- In the absence of HPV vaccination, it is projected that age-standardized cervical cancer incidence rates would increase over the next 20 years, whereas they are expected to decrease with moderate to high vaccination coverage (Table A). For example, with the current primary screening strategy (i.e., Pap only), with no HPV vaccination, it is estimated that cervical cancer incidence rates would increase 6% between 2016 and 2036. Age-standardized incidence rates are projected to decrease 17% and 24% with vaccination coverage rates of 60% and 85%, respectively.
- Mortality was also projected to decrease over the next two decades in the presence of HPV vaccination. For example, it is projected that a scenario of Pap only and no HPV vaccination would lead to an average of 490 cervical cancer related deaths per year from 2016 to 2036, whereas an estimated 20 fewer women would die of cervical cancer in Canada per year with the same screening strategy but with 85% HPV vaccination coverage.
- Overall, moderate to high HPV vaccination rates were projected to reduce cervical cancer incidence and mortality by 2036, regardless of screening strategy. These results highlight the important impact HPV vaccination can have on the burden of disease, even in the near future.

Table A – Incidence and mortality, cases and age-standardized rates*

Prevention scenario	Incidence			Mortality		
	ASIR 2016	ASIR 2036	Average annual cases† (2016–2036)	ASMR 2016	ASMR 2036	Average annual deaths† (2016–2036)
Pap only; 0% vaccination	8.0	8.5	1,640	2.0	2.4	490
Pap only; 60% vaccination	8.1	6.7	1,520	2.0	2.1	470
Pap only; 85% vaccination	8.0	6.1	1,500	2.1	2.0	470
Pap then HPV test; 0% vaccination	8.0	8.6	1,630	2.1	2.3	490
Pap then HPV test; 60% vaccination	8.2	7.0	1,510	2.1	1.9	470
Pap then HPV test; 85% vaccination	8.1	6.4	1,490	2.1	1.9	460

ASIR=Age-standardized incidence rate; ASMR=Age-standardized mortality rate

* Rates were age-sex-standardized to a standard 2011 Canadian female population and are per 100,000

† Incident cases and deaths were not age-standardized and rounded to the nearest 10.

Impact of cervical cancer screening modality

Incidence and mortality

With a 60% HPV vaccination rate, the average annual number of cervical cancer cases diagnosed over 2016 to 2036 would be comparable between a Pap-only scenario (1,520 cases per year) and sequential testing scenario (1,510 cases per year) (Table A). The average annual number of deaths would also be comparable between Pap-only testing and a sequential testing (470 deaths per year). On an age-standardized per 100,000 females basis, however, the Pap-only scenarios are projected to have less impact on reducing mortality rates in 2036 compared to the sequential testing scenarios. For example, with a 60% vaccination rate, the age-standardized mortality rate is expected to be 2.1 per 100,000 females in a Pap-only scenario compared with 1.9 per 100,000 with the sequential testing scenario.

Costs

The Pap-only scenarios would be more costly than the sequential screening scenarios. For example, at 60% vaccination coverage, the average annual costs for Pap only would be almost $35 million more than the average annual cost of sequential testing (Table B). This was primarily driven by differences in the direct costs of the screening modality ($281 million vs. $253 million) because of the higher frequency of Pap tests. Secondarily, the difference in total cost was driven by the higher cost of pre-cervical cancer treatment (excluding warts) incurred by the Pap only testing ($54 million) compared with the sequential testing ($47 million). Also of note, the proportion of total costs attributed to pre-cervical cancer treatment (excluding warts) decreases more with sequential testing (from 13% in 2016 to 9% in 2036) compared to Pap only testing (from 14% in 2016 to 11% in 2036) (data not shown, but available upon request from riskmgmt@partnershipagainstcancer.ca).

Conclusions

- Overall, moderate to high HPV vaccination rates of girls were projected to reduce cervical cancer incidence and mortality by 2036, regardless of screening strategy, highlighting the important impact HPV vaccination can have on the burden of disease, even in the near future.
- An age-based, sequential screening strategy of Pap followed by HPV testing is projected to cost less than the current Pap only strategy. This, coupled with projected decreases in mortality, provided strong support for this screening strategy.

Table B – Average annual costs* (2016–2036), by cost category

Prevention scenario	HPV vaccination	Cervical cancer screening	Cervical cancer treatment	Wart treatment	Pre-cervical cancer treatment†	Average annual total cost
Pap only; 60% vaccination	$62,133,000	$280,938,000	$27,862,000	$11,848,000	$54,107,000	$436,888,000
PAP then HPV test; 60% vaccination	$62,133,000	$253,277,000	$27,575,000	$11,868,000	$47,403,000	$402,255,000

* All costs in CAD 2016. Rounded to the nearest $1,000.

† Pre-cervical cancer treatment includes cold knife, loop electrosurgical excision procedure, cryotherapy, laser, pre-cervical cancer-related hysterectomy, and excludes warts.

Conclusion – What do these statistics mean?

It has long been known that HPV causes cervical cancer, but it is only in recent years that HPV has also been causally linked with cancers of the vagina, vulva, anus, penis and oropharynx. This report provides up-to-date information on the burden of these cancers in Canada.

Incidence rates for cervical cancer have declined considerably since 1992, reflecting the continued success of cervical cancer screening programs. However, these rates have been stagnant since 2005. Over the same period of time, incidence rates of HPV-associated anal, vulvar and oropharyngeal cancers increased. In fact, if recent incidence trends continue, the rate of HPV-associated oropharyngeal cancer in males will soon surpass the rate of cervical cancer in females.

With two-thirds of HPV-associated cancers occurring in areas other than the cervix, and one-third occurring in males, cervical cancer screening alone is not sufficient to reduce the burden of HPV-associated cancer in Canada. HPV vaccines, which prevent infection from the most common types of HPV associated with cancers, offer a powerful tool to reduce the burden of cervical and non-cervical HPV-associated cancers. With all provinces and territories offering school-based programs, and many also including boys, public health efforts should focus on increasing HPV vaccine availability and coverage across the country, and on promoting the link between HPV and non-cervical cancers in both males and females. In addition, there is a need for standardized collection and reporting of vaccination rates and HPV prevalence in Canada to monitor the impact of these programs both at the population level, as well as among high-risk groups.

Increased understanding of the link between HPV and cancer is not only changing how these cancers are prevented, it is also changing the way they are detected, diagnosed and treated. The HPV test can be used to detect the presence of high-risk HPV types before there are visible changes to cells in the cervix, and there is growing evidence and consensus that this test should replace Pap tests as the primary technology in cervical cancer screening in Canada. There is a need for additional research into whether these tests could also be used to screen for other cancer types. For oropharyngeal cancers, HPV-positive cancers are now recognized as biologically distinct from HPV negative cancers. It has become routine to test for the presence of HPV to assist with staging and determining the appropriate course of treatment.

By preventing HPV infections, finding HPV-associated cancers earlier and modifying treatment strategies by HPV status, there is great potential to reduce the burden of HPV-associated cancer in Canada. Continued monitoring and evaluation of these programs and policies will be crucial to optimizing their success.

Guest Editorial: Outlook on the prevention and control of HPV-associated cancers in Canada

Eduardo L. Franco (McGill University, Montreal)

This year's edition of the *Canadian Cancer Statistics* offers a special topic on cancers caused by an infectious agent that has become well known to Canadians in the last decade: human papillomavirus (HPV). With the possible exception of tobacco control and new advances of genomics in precision medicine, few areas in cancer prevention and control have advanced as rapidly into population-based cancer prevention strategies as the discovery of HPV as a human carcinogen.[50]

The discovery of HPV in cervical and other anogenital tumours in the early 1980s led to large molecular epidemiologic studies that unveiled the causal link between HPV and cervical cancer in the early 1990s. By 1995, the World Health Organization's International Agency for Research on Cancer (IARC) had declared HPV types 16 and 18 as human carcinogens and several other HPV types as probable or possible carcinogens.[51] IARC's validation of the carcinogenic effect of HPV immediately gave the private sector the motivation to develop preventive strategies. On the primary prevention front, two large pharmaceutical companies, Merck and SmithKline Beecham (later incorporated into GlaxoSmithKline), began massive clinical trials to evaluate their candidate HPV vaccines. These trials, involving Canadian patients, were proven successful 10 years later.[52,53] As indicated in this edition of the *Canadian Cancer Statistics*, efficacious HPV vaccines have been a reality for Canadians since 2007. On the secondary prevention front (i.e., early detection, screening and diagnosis), biotechnology companies brought us new ways to detect HPV infections in clinical specimens. This elicited a change in cervical cancer screening and management by bringing the old Papanicolaou (Pap) cytology test into the era of molecular technology with HPV tests.[54,55] By 2008, the state of the science on HPV-associated cancers was impressive enough that Harald zur Hausen – the scientist whose discoveries in the early 1980s prompted many medical and public health advances based on HPV technologies – was awarded the Nobel Prize in Physiology or Medicine.[56]

Conservatively speaking, about 5% of all human cancers[57] are caused by 25 possible, probable or certainly carcinogenic HPV genotypes[58] that belong to the Alphapapillomavirus genus, which includes about 70 mucosotropic genotypes grouped into 13 species.[59] The alpha HPVs tend to infect the mucosal areas and moist skin parts of our bodies. Carcinogenic alpha HPVs are a necessary cause of cervical cancer and represent the first cause of a human cancer that was classified as "necessary".[60,61] Alpha HPVs, especially HPV 16, are a major cause of anal cancer in men and women and a significant cause of genital cancers of women (vulva and vagina) and of men (penile). It is also gradually becoming the dominant causal agent in oropharyngeal cancer. The increases in the incidence of anal and oropharyngeal cancers reported in this chapter underscore the importance of proper surveillance coupled with HPV-based preventive strategies.

This chapter provides detailed incidence, mortality, survival and prevalence statistics on these cancers, all unequivocally HPV-associated. But is it possible that other types of cancer could also be caused by HPV? The scientific evidence is compelling for a carcinogenic role for HPV in some oral cavity and laryngeal cancers. Beyond anogenital and head and neck cancers, the science is still uncertain. Although the medical literature has many reports of HPV DNA found in cancers of the lung, breast, colorectum, ovary, bladder and prostate, the findings are inconsistent and the evidence inadequate. Other HPV genera, such as the Beta- and Gammapapillomaviruses, include HPV genotypes that infect dry skin and are thus called cutaneous HPVs. What do we know about these other HPVs? Can they cause cancer? There is currently limited evidence that the cutaneous HPV types cause non-melanoma skin cancers, at least on the basis of carcinogenic mechanisms that are known for the alpha HPVs.[62] However, the fact that organ transplant recipients who undergo immunosuppressive therapy experience a high risk of genital and skin warts, as well as squamous cell cancers, represents strong circumstantial evidence[63], which is bolstered by seroepidemiological studies.[64] In sum, depending on how the science evolves in this rapidly growing field it, is possible that the range of cancers for which HPV infection plays a causal role may be extended in the future.

As indicated in this report, Canada has been a success story in implementing publicly funded, school-based HPV vaccination for young girls. As of today, more than 5.7 million doses of the quadrivalent HPV vaccine have been given in Canada, mostly to preadolescent Canadian girls (Rodier C, Merck Canada, 2016, oral communication, 9th July). The provincial programs are now gradually expanding to boys. With the recently approved nonavalent HPV vaccine, we expect further gains in the prevention of HPV-associated diseases – primarily, cervical cancer, a disease in which many other carcinogenic types besides

HPV types 16 and 18 play a causal role. With sustained high coverage of HPV vaccination, further enhanced by herd immunity, sexual transmission of HPV will continue to decrease in the population. However, optimizing this success will require effective epidemiologic surveillance and adjustments in public health policy. As successive birth cohorts of vaccinated women reach screening age, we must be prepared to change the way cervical cancer screening is done.[65] The traditional strategy of screening (too often and over a lifetime) will have to be replaced by improved molecular HPV testing (done less often). Based on the past 10 years of post-HPV vaccination experience and the outlook with the new nonavalent vaccine, cervical cancer may become a very rare disease a few decades from now. In fact, the time may come when we have to reconsider the balance of benefits and harms, as well as the cost-effectiveness of maintaining cervical cancer screening as a public health activity.[66]

The combination of primary (present and future generations of HPV vaccines) and secondary (molecular HPV testing) preventive strategies should lead us to a future in which the public health burden of HPV-associated cancers will be very low or hopefully completely eliminated. The verb "eradicate" has never been used in the context of a cancer before. Will future historians write about cervical cancer as a disease that affected only previous generations of Canadians? We certainly hope so. However, the road to get there may be challenging. The negative influence of anti-vaccine activism has already affected some countries, reversing earlier gains in HPV vaccination, as seen recently in Denmark and Japan.[67] It is imperative that Canadians resist such influences and embrace these new public health technologies that are significantly improving cancer control and prevention.

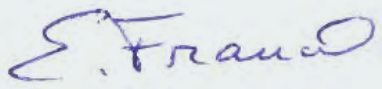


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TABLE 7.1 Incidence counts and age-standardized incidence rates (ASIR) for HPV-associated cancer*, by sex, Canada, 2012†

Cancer	Both sexes		Males		Females	
	Cases‡	ASIR (95% CI)	Cases	ASIR (95% CI)	Cases	ASIR (95% CI)
Oropharynx	1,335	3.8 (3.6–4.0)	1,070	6.4 (6.0–6.7)	260	1.4 (1.2–1.6)
Cervix	—	—	—	—	1,300	7.4 (7.0–7.8)
Anus	475	1.4 (1.2–1.5)	150	0.9 (0.8–1.0)	325	1.8 (1.6–2.0)
Vulva	—	—	—	—	415	2.2 (2.0–2.4)
Penis	—	—	150	1.0 (0.8–1.1)	—	—
Vagina	—	—	—	—	85	0.5 (0.4–0.6)

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

CI=confidence interval

— Not applicable

* Includes selected topographies and morphologies. Refer to Table A12 for definitions.

† Quebec data are from 2010.

‡ Total counts may not sum to row totals due to rounding.

Note: Counts are randomly rounded to a base of five. Rates are calculated before rounding and are age-standardized to the 2011 Canadian population.

TABLE 7.2 Incidence counts and age-standardized incidence rates (ASIR) for HPV-associated cancers*, by region, Canada, 2012†

Cancer	Region‡									
	British Columbia		Prairies§		Ontario		Quebec		Atlantic**	
	Cases	ASIR (95% CI)	Cases	ASIR (95% CI)	Cases	ASIR (95% CI)	Cases	ASIR (95% CI)	Cases	ASIR (95% CI)
Oropharynx	185	3.8 (3.3–4.4)	200	3.5 (3.1–4.0)	495	3.7 (3.4–4.0)	330	4.0 (3.6–4.4)	115	4.4 (3.6–5.1)
Cervix	160	6.7 (5.6–7.7)	230	7.8 (6.8–8.8)	515	7.5 (6.9–8.2)	290	7.1 (6.3–8.0)	100	7.9 (6.3–9.4)
Anus	90	1.9 (1.5–2.3)	60	1.1 (0.8–1.4)	220	1.5 (1.3–1.7)	85	1.0 (0.8–1.2)	35	1.3 (0.9–1.8)
Vulva	50	2.0 (1.4–2.5)	75	2.5 (2.0–3.1)	170	2.3 (2.0–2.7)	75	1.7 (1.3–2.1)	40	2.9 (2.1–4.0)
Penis	15	0.6 (0.3–1.1)	20	0.8 (0.5–1.3)	60	1.0 (0.8–1.3)	35	0.9 (0.6–1.3)	20	1.7 (1.1–2.7)
Vagina	15	0.5 (0.3–0.9)	15	0.6 (0.3–0.9)	30	0.4 (0.3–0.6)	15	0.4 (0.2–0.6)	5	0.4 (0.2–1.0)

CI=confidence interval

* Includes selected topographies and morphologies. Refer to Table A12 for definitions.

† Quebec data are from 2010.

‡ The Territories were not included as there were fewer than five cases for each cancer. The overall number of HPV-associated cancers in the Territories was 10, and the corresponding ASIR was 14.5 (95% CI 6.6–32.9).

§ Includes Alberta, Saskatchewan and Manitoba

** Includes New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland and Labrador

Note: Counts are randomly rounded to a base of five. Rates are calculated before rounding and are age-standardized to the 2011 Canadian population. In the calculation of ASIRs, female population data were used for cancers of the cervix, vagina and vulva; male population data were used for cancer of the penis.

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

TABLE 7.3 Deaths and age-standardized mortality rates (ASMR) for HPV-associated cancer types*, by sex, Canada, 2012

Cancer	Both sexes		Males		Females	
	Deaths	ASMR (95% CI)	Deaths	ASMR (95% CI)	Deaths	ASMR (95% CI)
Oropharynx	372	1.05 (0.95–1.16)	286	1.73 (1.53–1.94)	86	0.45 (0.36–0.55)
Cervix	—	—	—	—	443	2.42 (2.19–2.65)
Anus	99	0.28 (0.23–0.34)	36	0.22 (0.15–0.30)	63	0.33 (0.25–0.42)
Vulva	—	—	—	—	175	0.88 (0.74–1.01)
Penis	—	—	43	0.28 (0.20–0.38)	—	—
Vagina	—	—	—	—	47	0.23 (0.17–0.30)

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

CI=confidence interval

— Not applicable

* Refer to Table A13 for definitions. As morphology data were not available for deaths, these include both HPV-associated and non-HPV-associated cancers for a given cancer type.

Note: Rates are age-standardized to the 2011 Canadian population.

TABLE 7.4 Age-standardized net survival (95% CI) for HPV-associated cancers*, by survival duration and standard used†, ages 15–99 at diagnosis, Canada (excluding Quebec‡), 2004–2008

Cancer	Cancer-specific standard			Common standard		
	1-year	5-year	10-year	1-year	5-year	10-year
Oropharynx	81 (80–82)	58 (56–60)	49 (47–51)	81 (80–83)	60 (58–62)	52 (49–54)
Cervix	89 (88–90)	73 (72–75)	70 (68–71)	85 (84–87)	68 (66–69)	63 (61–65)
Anus	90 (88–92)	67 (64–70)	59 (55–62)	91 (89–92)	68 (65–71)	60 (56–64)
Vulva	85 (83–87)	68 (65–71)	60 (56–64)	89 (87–91)	75 (73–78)	68 (64–71)
Penis	86 (82–89)	62 (57–68)	50 (44–56)	89 (86–92)	67 (61–72)	58 (52–64)
Vagina	76 (70–80)	51 (44–58)	37 (30–44)	82 (76–86)	57 (50–63)	46 (39–53)

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

CI=confidence interval

* Includes selected topographies and morphologies. Refer to Table A12 for definitions.

† The cancer-specific standard uses, for each cancer in turn, the age distribution of cases diagnosed with the given cancer from 2004 to 2008 as the standard. The common standard uses the age distribution of all cases diagnosed with the selected cancers combined from 2004 to 2008. The former provide information that is relevant to the study of each cancer individually, while the latter – though more artificial in nature – are useful for comparing survival across HPV-associated cancers. For further details, see *Appendix II, Data sources and methods*.

‡ 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: Net survival is estimated using age-standardized relative survival ratios.

TABLE 7.5 Five-year net survival for HPV-associated cancers*, by sex and age group, Canada (excluding Quebec†), 2004–2008

HPV-associated cancer	Net survival (%) (95% confidence interval)						
	Sex		Age group (years)				
	Males	Females	15–44	45–54	55–64	65–74	75–99
Oropharynx	58 (56–60)	58 (54–61)	76 (70–81)	71 (67–74)	61 (58–65)	47 (43–51)	34 (28–40)
Cervix	—	73 (72–75)	85 (84–87)	72 (69–74)	69 (65–72)	60 (54–64)	43 (37–49)
Anus	58 (52–63)	71 (67–75)	75 (66–82)	69 (63–74)	72 (66–77)	66 (58–73)	54 (45–63)
Vulva	—	68 (65–71)	87 (80–92)	86 (80–90)	76 (69–82)	67 (59–74)	53 (46–59)
Penis	62 (57–68)	—	*80 (61–91)*	*62 (48–73)*	69 (59–78)	*68 (58–78)*	*49 (37–61)*
Vagina	—	51 (44–58)	*67 (44–82)*	*67 (51–79)*	*56 (41–69)*	*40 (28–52)*	*45 (32–59)*

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

— Not applicable

* Includes selected topographies and morphologies. Refer to Table A12 for definitions.

† 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: Age-specific net survival is estimated using relative survival ratios. Sex-specific net survival is estimated using age-standardized relative survival ratios. For each cancer in turn, the age distribution of cases diagnosed with the given cancer from 2004 to 2008 was used as the standard. See Table 7.6 to compare survival across cancers for ages 15–99 combined. Estimates associated with standard errors ≥ 0.05 but < 0.1 are italicized. For further details, see *Appendix II, Data sources and methods*.

TABLE 7.6 Age-standardized five-year net survival for HPV-associated cancers*, ages 15–99 at diagnosis, Canada (excluding Quebec†), 1992–1996 versus 2004–2008

Cancer	Net survival (%) (95% CI)		Changes in 5-year net survival	
	Time period		1992–1996 to 2004–2008	
	1992–1996	2004–2008	% unit (95% CL)	p-value
Oropharynx	43 (40–45)	58 (56–60)	15.6 (12.7, 18.4)	< 0.0005
Cervix	71 (70–72)	73 (72–75)	2.3 (0.5, 4.1)	0.011
Anus	72 (67–75)	67 (64–70)	-4.4 (-9.4, 0.7)	0.090
Vulva	72 (68–76)	68 (65–71)	-4.2 (-9.4, 0.9)	0.107
Penis	70 (63–76)	62 (57–68)	-8.0 (-16.5, 0.5)	0.064
Vagina	51 (43–57)	51 (44–58)	0.4 (-9.6, 10.3)	0.943

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

CI=confidence interval; CL=confidence limits

* Includes selected topographies and morphologies. Refer to Table A12 for definitions.

† 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: Net survival is estimated using age-standardized relative survival ratios. For each cancer in turn, the age distribution of cases diagnosed with the given cancer from 2004 to 2008 was used as the standard. See Table 7.4 to compare survival across cancers. For further details, see *Appendix II, Data sources and methods*.

TABLE 7.7 Sex distribution for 10-year tumour-based prevalence for HPV-associated cancers*, Canada†, January 1, 2009

Cancer	Sex	
	Males	Females
Oropharynx	4,020	1,180
Cervix	—	9,955
Anus	645	1,420
Vulva	—	2,015
Penis	740	—
Vagina	—	370

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

* Includes selected topographies and morphologies. Refer to Table A12 for definitions.

† 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.

APPENDIX I: Actual data for new cases and deaths

TABLE A1 Actual data for new cases of cancer, Canada, 2010 (based on May 2015 Canadian Cancer Registry file; see Statistics Canada CANSIM Table 103-0554 for availability of later data releases)

Cancer	ICD-O-3 Site/Type*	Total	Males	Females
All cancers	**All invasive sites**	**174,225**	**89,110**	**85,110**
Oral (buccal cavity and pharynx)	**C00–C14**	**3,945**	**2,690**	**1,260**
Lip	C00	290	205	80
Tongue	C01–C02	1,055	705	350
Salivary gland	C07–C08	460	260	195
Mouth	C03–C06	765	440	320
Nasopharynx	C11	250	175	75
Oropharynx	C10	210	175	40
Other and unspecified	C09,C12–C14	915	725	195
Digestive organs	**C15–C26,C48**	**35,855**	**19,880**	**15,975**
Esophagus	C15	1,820	1,390	435
Stomach	C16	3,035	1,920	1,115
Small intestine	C17	750	415	335
Large intestine	C18,C26.0	14,385	7,200	7,185
Rectum	C19–C20	7,055	4,340	2,715
Anus	C21	580	200	380
Liver	C22.0	1,740	1,310	430
Gallbladder	C23	510	170	340
Pancreas	C25	4,035	2,005	2,035
Other and unspecified	C22.1,C24,C26.8–.9,C48	1,940	940	1,005
Respiratory system	**C30–C34,C38.1–.9,C39**	**25,740**	**14,100**	**11,640**
Larynx	C32	1,155	980	175
Lung and bronchus	C34	24,230	12,915	11,315
Other and unspecified	C30–31,C33,C38.1–.9,C39	355	205	145
Bone	**C40–C41**	**345**	**195**	**150**
Soft tissue (including heart)	**C38.0,C47,C49**	**1,165**	**655**	**510**
Skin (melanoma)	**C44 Type 8720–8790**	**5,495**	**2,965**	**2,525**
Breast	**C50**	**23,100**	**210**	**22,890**
Genital organs	**C51–C63**	**33,790**	**23,620**	**10,170**
Cervix	C53	1,420	—	1,420
Body of uterus	C54	5,090	—	5,090
Uterus, part unspecified	C55	175	—	175
Ovary	C56	2,560	—	2,560
Prostate	C61	22,440	22,440	—
Testis	C62	965	965	—
Other and unspecified	C51–52,C57,C58,C60,C63	1,145	215	925
Urinary organs	**C64–C68**	**12,955**	**9,055**	**3,895**
Bladder	C67	7,370	5,570	1,795
Kidney and renal pelvis	C64–C65	5,080	3,165	1,920
Other urinary	C66,C68	505	320	180
Eye	**C69**	**370**	**185**	**185**
Brain and central nervous system	**C70–C72**	**2,640**	**1,480**	**1,165**
Endocrine glands	**C37,C73–C75**	**5,335**	**1,275**	**4,060**
Thyroid	C73	5,020	1,120	3,905
Other endocrine	C37,C74–C75	315	160	155
Hodgkin lymphoma†	**Type 9650–9667**	**910**	**495**	**415**
Non-Hodgkin lymphoma†	**See Table A8**	**6,965**	**3,755**	**3,210**
Multiple myeloma†	**Type 9731,9732,9734**	**2,350**	**1,300**	**1,055**
Leukemia†	**See Table A8**	**5,250**	**3,040**	**2,215**
Mesothelioma†	**Type 9050–9055**	**520**	**425**	**95**
All other and unspecified cancers	**See Table A8**	**7,495**	**3,795**	**3,700**

Analysis by: Health Statistics Division, Statistics Canada

Data source: Canadian Cancer Registry database at Statistics Canada

— Not applicable.

* Fritz A, Percy C, Jack A, Shanmugaratnam K, Sobin L, Parkin D et al. Editors. *International Classification of Disease 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 (basal and squamous).

TABLE A2 Actual data for cancer deaths, Canada, 2012 (see Statistics Canada CANSIM Table 102-0522 for availability of later data releases)

	ICD-10*	Total	Males	Females
All cancers	**C00–C97**	**74,361**	**39,080**	**35,281**
Oral (buccal cavity and pharynx)	**C00–C14**	**1,122**	**787**	**335**
Lip	C00	13	12	1
Tongue	C01–C02	300	201	99
Salivary gland	C07–C08	102	69	33
Mouth	C03–C06	199	117	82
Nasopharynx	C11	100	72	28
Oropharynx	C10	113	89	24
Other and unspecified	C09,C12–C14	295	227	68
Digestive organs	**C15–C25,C26.0,C26.8–.9,C48**	**20,443**	**11,516**	**8,927**
Esophagus	C15	1,824	1,394	430
Stomach	C16	1,863	1,137	726
Small intestine	C17	231	135	96
Large intestine	C18,C26.0	6,670	3,487	3,183
Rectum	C19–C20	2,052	1,225	827
Anus	C21	99	36	63
Liver†	C22.0,C22.2–.7	1,059	825	234
Gallbladder	C23	252	98	154
Pancreas	C25	4,268	2,078	2,190
Other and unspecified	C22.1,C22.9,C24,C26.8–.9,C48	2,125	1,101	1,024
Respiratory system	**C30–C34,C38.1–.9,C39**	**20,222**	**11,103**	**9,119**
Larynx	C32	410	325	85
Lung and bronchus	C34	19,688	10,706	8,982
Other and unspecified	C30–31,C33,C38.1–.9,C39	124	72	52
Bone	**C40–C41**	**152**	**92**	**60**
Soft tissue (including heart)	**C38.0,C47,C49**	**528**	**293**	**235**
Skin (melanoma)	**C43**	**1,047**	**652**	**395**
Breast	**C50**	**5,019**	**42**	**4,977**
Genital organs	**C51–C63**	**7,128**	**3,809**	**3,319**
Cervix	C53	443	—	443
Body of uterus	C54	595	—	595
Uterus, part unspecified	C55	397	—	397
Ovary	C56	1,593	—	1,593
Prostate	C61	3,708	3,708	—
Testis	C62	52	52	—
Other and unspecified	C51–52,C57,C58,C60,C63	340	49	291
Urinary organs	**C64–C68**	**3,899**	**2,611**	**1,288**
Bladder	C67	2,010	1,431	579
Kidney and renal pelvis	C64–C65	1,676	1,051	625
Other urinary	C66,C68	213	129	84
Eye	**C69**	**54**	**30**	**24**
Brain and central nervous system	**C70–C72**	**1,978**	**1,122**	**856**
Endocrine glands	**C37,C73–C75**	**319**	**165**	**154**
Thyroid	C73	184	101	83
Other endocrine	C37,C74–C75	135	64	71
Hodgkin lymphoma	**C81**	**127**	**77**	**50**
Non-Hodgkin lymphoma	**C82–C85,C96.3**	**2,647**	**1,442**	**1,205**
Multiple myeloma	**C90.0, C90.2**	**1,372**	**777**	**595**
Leukemia	**C91–C95, C90.1**	**2,659**	**1,505**	**1,154**
Mesothelioma	**C45**	**467**	**395**	**72**
All other and unspecified cancers	**See Table A8**	**4,758**	**2,392**	**2,366**

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.

† Liver cancer deaths are underestimated; see Appendix II: Data and methods issues.

TABLE A3 Actual data for new cases for the most common cancers by sex and geographic region, Canada, most recent year* (based on May 2015 CCR file; see Statistics Canada CANSIM Table 103-0554 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	**89,115**	**11,955**	**8,435**	**2,815**	**3,085**	**33,035**	**22,810**	**2,415**	**3,100**	**475**	**1,660**	**60**	**65**	**30**
Prostate	22,435	3,165	2,365	740	630	7,855	4,490	560	730	135	405	15	10	5
Lung and bronchus	12,915	1,475	940	360	395	4,510	4,185	385	490	75	260	10	10	5
Colorectal	11,540	1,605	1,065	450	470	4,030	3,130	310	460	55	315	10	15	5
Bladder§	5,570	865	560	180	190	1,535	1,780	190	215	30	95	5	0	0
Non-Hodgkin lymphoma	3,755	535	370	105	155	1,560	870	105	135	15	60	0	0	5
Kidney and renal pelvis	3,160	395	340	115	160	1,190	855	100	135	10	70	0	5	5
Leukemia	3,040	380	330	120	125	1,090	670	95	85	10	30	0	0	0
Melanoma	2,965	495	305	75	80	1,380	470	85	125	20	40	0	0	0
Oral	2,685	335	270	75	115	1,155	665	60	85	15	45	5	0	0
Pancreas	2,005	300	175	75	85	870	565	65	70	15	25	0	0	0
Stomach	1,920	230	160	70	70	750	505	55	65	10	55	5	0	0
Brain/CNS	1,480	190	125	40	50	600	400	30	40	5	35	0	0	0
Esophagus	1,390	210	150	45	50	600	310	35	50	5	20	0	0	0
Liver	1,310	240	135	35	50	575	330	30	45	5	25	0	0	0
Multiple myeloma	1,300	165	125	35	55	555	315	35	30	10	20	0	0	0
Thyroid	1,115	115	130	25	30	685	290	35	40	5	35	0	0	0
Testis	965	120	115	40	35	395	215	20	25	10	5	5	5	0
Females														
All cancers	**85,105**	**10,895**	**7,600**	**2,535**	**3,110**	**33,935**	**22,495**	**2,085**	**2,875**	**405**	**1,560**	**55**	**65**	**30**
Breast	22,890	2,960	2,160	675	810	8,955	5,765	510	730	115	375	15	20	5
Lung and bronchus	11,315	1,440	965	355	445	4,225	3,420	300	470	55	170	10	10	10
Colorectal	9,900	1,310	795	345	320	3,630	2,690	230	385	60	245	10	10	5
Body of uterus and uterus NOS	5,265	740	530	155	220	2,390	1,245	120	170	20	125	0	5	0
Thyroid	3,905	335	360	85	125	2,380	950	95	80	5	105	0	0	0
Non-Hodgkin lymphoma	3,210	430	290	110	115	1,225	740	90	95	20	60	5	0	0
Ovary	2,555	315	195	60	85	1,060	655	50	75	10	40	0	0	0
Melanoma	2,525	430	250	50	70	1,145	400	85	135	25	55	0	0	0
Leukemia	2,215	260	200	65	75	795	510	55	50	10	25	0	0	0
Pancreas	2,035	280	215	60	90	885	540	55	75	5	30	0	5	0
Kidney and renal pelvis	1,915	200	175	65	95	760	550	80	100	5	55	5	0	5
Bladder§	1,800	280	170	70	70	545	610	60	75	10	20	5	0	0
Cervix	1,420	160	135	45	60	555	310	30	45	5	15	5	0	0
Oral	1,255	145	95	30	60	525	335	30	30	5	20	0	0	0
Brain/CNS	1,165	135	100	35	35	475	335	25	25	5	20	5	0	0
Stomach	1,115	145	95	40	40	475	305	30	20	5	35	0	0	0
Multiple myeloma	1,050	140	80	30	35	430	255	20	35	5	20	5	0	0
Esophagus	435	90	35	15	10	170	100	10	20	5	10	0	0	0
Liver	430	75	45	15	25	180	130	10	10	0	10	0	0	0

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

CNS=central nervous system; NOS=not otherwise specified

* 2010 for Canada and Quebec; 2012 for British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland and Labrador; 2008–2012 average for Yukon, Northwest Territories and Nunavut. The numbers of cases from death certificate only for Ontario in 2012 and Quebec in 2010 are estimated.

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

‡ The number of cases for some cancers for this province are underestimated.

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

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 A8.

TABLE A4 Actual age-standardized incidence rates (ASIR) for the most common cancers by sex and geographic region, Canada, most recent year*
(based on May 2015 CCR file; see Statistics Canada CANSIM Table 103-0554 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	**584.4**	**520.7**	**558.9**	**566.2**	**554.4**	**534.8**	**622.5**	**606.3**	**629.4**	**637.3**	**589.0**	**423.7**	**543.5**	**454.9**
Prostate	146.1	135.4	156.0	149.8	112.5	125.9	122.8	136.6	143.4	176.5	136.6	111.1	101.5	47.6
Lung and bronchus	85.8	64.3	66.4	73.5	71.9	73.8	114.0	98.8	101.1	99.7	92.3	68.6	93.9	178.3
Colorectal	76.2	70.1	71.6	90.8	84.4	65.6	85.2	77.8	94.2	74.0	116.4	52.0	100.9	70.5
Bladder§	37.9	38.1	40.3	36.2	34.9	25.7	49.5	49.0	44.9	41.7	34.3	34.0	—	—
Non-Hodgkin lymphoma	24.4	23.4	24.3	21.4	27.9	25.1	23.5	27.7	28.5	24.0	22.0	—	—	9.1
Kidney and renal pelvis	20.2	17.2	21.4	22.4	28.7	18.9	22.4	23.9	26.4	18.0	24.0	—	24.5	15.4
Leukemia	20.0	16.7	21.6	23.7	22.5	17.8	18.5	25.7	17.2	13.3	10.6	—	—	—
Melanoma	19.2	21.8	19.6	15.2	14.7	22.3	12.5	20.9	25.5	26.1	13.9	—	—	—
Oral	17.0	14.6	16.2	14.7	20.7	18.3	17.3	13.4	16.8	19.8	16.3	22.0	—	—
Pancreas	13.3	13.1	12.2	14.7	15.8	14.3	15.5	16.4	14.1	17.9	9.4	—	—	—
Stomach	12.7	10.3	11.2	14.0	12.8	12.3	14.1	13.3	13.3	9.3	20.1	16.7	—	—
Brain/CNS	9.2	8.3	7.1	7.0	8.1	9.4	10.6	7.3	8.3	13.2	12.2	—	—	—
Esophagus	9.2	9.1	10.1	8.9	8.6	9.8	8.5	8.2	10.7	7.8	7.4	—	—	—
Liver	8.5	10.4	8.4	7.1	8.8	9.1	8.9	7.8	8.7	6.8	7.6	—	—	—
Multiple myeloma	8.6	7.2	8.5	7.5	9.3	9.1	8.8	9.5	6.7	16.8	7.0	—	—	—
Thyroid	6.8	4.9	7.1	4.7	5.0	10.5	7.3	9.0	8.1	5.5	12.8	—	—	—
Testis	5.7	5.4	5.2	6.8	6.3	6.0	5.4	5.4	5.1	9.0	1.7	5.3	8.2	—
Females														
All cancers	**475.9**	**433.8**	**448.4**	**456.4**	**485.4**	**472.7**	**505.5**	**465.2**	**506.8**	**474.5**	**514.5**	**406.2**	**517**	**461.9**
Breast	130.2	120	127.1	125.2	130.1	126.8	133.2	115.7	131.4	136.7	122.7	126.2	132.6	72.7
Lung and bronchus	62.9	56.2	59.2	62.8	68.7	57.9	76.4	65.6	80.7	59.3	55.9	66	77.3	186
Colorectal	53.9	50.4	47.5	60.8	48.3	49.1	58.4	49.5	65.7	62.4	79.1	60.5	115.4	88.4
Body of uterus and uterus NOS	30.2	30.1	31.5	29.6	35.4	34	28.5	27	30.1	22.4	41.8	—	25.3	—
Thyroid	22.7	14.3	19.6	16	21	34.9	23.1	23.5	16	9.4	35.3	—	—	—
Non-Hodgkin lymphoma	17.8	16.9	17.3	18.8	17.2	16.9	16.5	20.5	16.6	25.3	19.4	11.8	—	—
Ovary	14.4	12.7	11.6	10.9	14.1	15	14.8	12.3	13.6	11.7	14.3	—	—	—
Melanoma	14.4	17.5	14.4	9.1	11.9	16.1	9.4	20.6	24.4	34.5	19.2	—	—	—
Leukemia	12.2	10.5	11.9	11.8	11.2	10.8	11.1	12.1	9.4	7	7.4	—	—	—
Pancreas	11	10.6	12.8	10.4	13.1	11.9	11.6	11	13.3	7.1	9.2	—	27	—
Kidney and renal pelvis	10.7	8	10.3	12.4	15.2	10.7	12.3	17	18.2	2.4	17.8	6.2	—	23.9
Bladder§	9.8	10.8	10.2	11.6	10.2	7.1	13.2	12.6	12.2	12.6	6.9	15.6	—	—
Cervix	8.2	6.7	7.3	8.8	10	8.1	7.6	7.4	8.9	6.5	6.9	8.5	—	—
Oral	7	5.9	5.7	5.7	8.7	7.2	7.6	6.7	4.7	5.8	5.6	—	—	—
Brain/CNS	6.6	5.7	5.8	6.1	5.5	6.7	7.6	5	5.2	3.5	6.8	3.1	—	—
Stomach	6	5.5	5.6	7	5.4	6.4	6.5	5.9	3.1	4.4	10.3	—	—	—
Multiple myeloma	5.7	5.4	4.9	5.3	5.1	5.8	5.6	4.6	5.9	7.9	5	9.3	—	—
Esophagus	2.4	3.4	2	2.3	1.4	2.3	2.2	1.3	4	3.4	2.4	—	—	—
Liver	2.4	2.9	2.9	2.5	2.9	2.5	2.8	1.8	1.4	—	2.5	—	—	—

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

CNS=central nervous system; NOS=not otherwise specified

— When the rounded number of cases is zero, the age-standardized rate is suppressed to maintain confidentiality.

* 2010 for Canada and Quebec; 2012 for British Columbia, Alberta, Saskatchewan, Manitoba, Ontario, New Brunswick, Nova Scotia, Prince Edward Island and Newfoundland and Labrador; 2008–2012 average for Yukon, Northwest Territories and Nunavut. The numbers of cases from death certificate only for Ontario in 2012 and Quebec in 2010 are estimated.

† Canada totals include provincial and territorial estimates.

‡ The number of cases for some cancers for this province are underestimated.

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

Note: Rates for "All cancers" exclude non-melanoma skin cancer (neoplasms, NOS; epithelial neoplasms, NOS; and basal and squamous). Rates are age-standardized to the 2011 Canadian population. The complete definition of the specific cancers listed here can be found in Table A8.

TABLE A5 Actual data for cancer deaths for the most common cancers by sex and geographic region, Canada, 2012*
(see Statistics Canada CANSIM Table 102-0552 and CANSIM Table 102-0522 for availability of later data releases)

	Deaths													
	Canada†	BC	AB	SK	MB	ON	QC	NB	NS	PE	NL	YT	NT	NU
Males														
All cancers	**39,080**	**4,900**	**3,185**	**1,215**	**1,395**	**14,320**	**10,665**	**1,015**	**1,335**	**200**	**760**	**35**	**30**	**20**
Lung and bronchus	10,710	1,235	720	295	290	3,625	3,490	310	395	75	225	10	10	10
Colorectal	4,710	575	390	140	170	1,690	1,310	120	175	30	110	5	5	5
Prostate	3,710	525	360	180	165	1,415	770	80	130	15	70	5	0	0
Pancreas	2,080	285	170	65	85	790	520	50	65	10	30	0	0	0
Leukemia	1,505	180	120	45	70	600	370	35	50	10	20	0	0	0
Non-Hodgkin lymphoma	1,440	185	120	40	60	555	350	40	55	10	35	0	5	0
Bladder	1,430	205	120	50	40	535	365	35	45	5	20	0	0	0
Esophagus	1,395	185	145	55	45	585	270	40	40	5	25	5	0	0
Stomach	1,140	135	80	25	40	410	335	35	25	5	30	0	0	0
Brain/CNS	1,120	140	105	20	30	430	315	25	35	5	20	0	0	0
Kidney and renal pelvis	1,050	155	95	40	55	355	260	25	40	10	20	0	5	0
Liver‡	825	130	75	20	20	325	200	20	20	5	15	0	0	0
Oral	785	110	75	15	20	305	205	15	15	5	10	5	5	5
Multiple myeloma	780	100	60	30	40	295	205	20	15	0	10	0	0	0
Melanoma	650	80	55	20	25	285	140	15	25	5	10	0	0	0
Females														
All cancers	**35,285**	**4,505**	**2,775**	**1,070**	**1,295**	**13,050**	**9,705**	**830**	**1,220**	**165**	**605**	**25**	**25**	**20**
Lung and bronchus	8,985	1,095	685	250	330	3,120	2,785	195	335	40	130	10	5	5
Breast	4,975	665	395	160	175	1,905	1,265	105	175	20	95	5	5	5
Colorectal	4,010	560	300	140	150	1,410	1,115	80	145	25	75	5	0	5
Pancreas	2,190	275	180	65	85	845	580	55	70	10	25	0	0	5
Ovary	1,595	220	125	45	55	630	400	40	50	5	25	5	0	5
Non-Hodgkin lymphoma	1,205	150	95	45	55	455	300	30	50	0	20	0	0	0
Leukemia	1,155	160	90	25	45	450	280	30	40	10	20	0	0	0
Body of uterus and uterus NOS	990	105	80	25	35	405	245	30	40	10	20	0	0	0
Brain/CNS	855	105	65	25	20	335	240	25	25	0	15	5	0	0
Stomach	725	105	55	15	20	275	200	15	20	0	15	0	5	0
Kidney and renal pelvis	625	75	50	10	20	205	185	20	25	5	20	0	5	0
Multiple myeloma	595	70	55	15	25	235	160	10	15	5	10	0	0	0
Bladder	575	80	40	20	20	215	155	10	20	5	5	0	0	0
Cervix	445	50	35	20	15	185	90	15	10	5	10	5	0	0
Esophagus	430	65	25	15	15	175	100	10	20	0	5	0	0	0
Melanoma	395	45	30	15	15	170	75	10	20	0	5	0	0	0
Oral	335	45	20	10	15	130	90	10	5	0	5	0	0	0
Liver‡	235	30	25	5	10	90	65	0	5	0	5	0	0	0

CNS=central nervous system; NOS=not otherwise specified

* 2008–2012 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.

‡ Liver cancer deaths are underestimated; see *Appendix II: Data and methods issues*.

Note: The complete definition of the specific cancers listed here can be found in Table A8.

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, 2012*
(see Statistics Canada CANSIM Table 102-0522 and CANSIM Table 102-0552 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	**253.5**	**221.2**	**233.0**	**248.8**	**261.5**	**244.0**	**284.9**	**271.9**	**288.4**	**285.5**	**295.6**	**319.8**	**313.1**	**448.1**
Lung and bronchus	67.8	54.8	52.5	60.2	54.4	60.4	90.4	80.7	83.5	99.0	82.2	90.8	89.7	213.0
Colorectal	30.8	25.9	28.3	29.2	31.2	29.1	35.4	31.8	37.9	37.3	43.5	35.9	52.9	59.9
Prostate	26.7	25.5	29.5	37.3	32.3	26.4	23.9	24.7	31.9	24.3	33.3	30.7	—	—
Pancreas	13.1	12.6	12.3	12.6	15.5	13.2	13.2	13.9	14.0	16.4	12.3	—	—	—
Leukemia	9.8	8.4	8.9	9.2	13.3	10.2	9.9	9.4	11.5	8.7	8.8	—	—	—
Non-Hodgkin lymphoma	9.4	8.4	9.0	8.1	10.6	9.5	9.4	10.3	11.5	12.4	12.5	—	14.6	—
Bladder	9.8	9.5	9.5	11.1	8.1	9.6	10.5	10.1	10.4	9.3	9.7	—	—	—
Esophagus	8.7	8.1	10.0	10.7	8.0	9.6	6.9	10.0	8.2	11.4	9.2	18.7	—	—
Stomach	7.3	6.2	6.1	5.5	7.6	6.9	8.9	8.5	5.7	11.9	11.5	—	—	—
Brain/CNS	6.7	6.0	6.2	4.2	5.1	6.8	7.7	6.2	7.0	8.7	7.5	—	—	—
Kidney and renal pelvis	6.7	6.9	6.6	7.5	10.0	6.0	6.8	6.5	8.1	10.6	6.9	—	8.4	—
Liver‡	5.0	5.6	4.8	3.7	4.0	5.2	5.0	4.1	4.2	4.3	5.6	—	—	—
Oral	4.9	5.0	4.9	3.2	4.1	5.0	5.2	4.1	2.8	2.6	4.5	6.5	16.2	30.0
Multiple myeloma	5.0	4.5	4.5	6.0	7.3	4.9	5.6	4.8	3.8	—	3.3	—	—	—
Melanoma	4.1	3.6	3.6	4.1	4.5	4.7	3.5	3.7	5.5	2.5	2.0	—	—	—
Females														
All cancers	**180.1**	**170.3**	**165.4**	**177.2**	**186.3**	**172.9**	**198.3**	**173.9**	**203.6**	**183.5**	**194.1**	**256.7**	**245.8**	**369.3**
Lung and bronchus	46.8	42.0	41.8	43.4	48.2	41.9	58.5	41.3	56.6	46.9	41.6	78.8	65.4	183.7
Breast	25.8	25.8	23.5	26.1	25.6	25.6	26.4	22.5	29.8	17.1	31.2	34.9	27.0	11.3
Colorectal	19.8	20.6	17.7	23.0	19.8	18.1	21.9	16.2	23.2	27.2	24.5	35.1	—	39.8
Pancreas	11.1	10.2	10.8	11.0	11.9	11.1	11.6	11.6	11.8	10.4	7.6	—	—	21.6
Ovary	8.3	8.4	7.3	7.8	8.6	8.6	8.2	9.1	8.6	8.1	6.8	6.6	—	4.2
Non-Hodgkin lymphoma	6.0	5.4	5.7	6.6	7.2	6.0	6.1	6.8	7.7	—	5.9	—	—	—
Leukemia	5.8	6.0	5.2	4.2	6.7	5.9	5.6	6.4	6.6	11.4	6.2	—	—	—
Body of uterus and uterus NOS	5.1	4.0	4.6	4.4	5.2	5.5	5.0	6.0	6.3	6.8	5.6	—	—	—
Brain/CNS	4.6	4.3	3.8	4.4	3.5	4.7	5.2	5.8	4.4	—	4.4	2.4	—	—
Stomach	3.7	3.9	3.2	2.2	3.2	3.6	3.9	3.9	2.8	—	6.0	—	4.6	—
Kidney and renal pelvis	3.1	2.8	2.9	2.3	3.0	2.7	3.7	4.5	4.0	4.4	6.4	—	13.2	—
Multiple myeloma	3.0	2.6	3.3	3.0	3.4	3.0	3.1	2.3	2.5	4.6	2.6	—	—	—
Bladder	2.8	2.9	2.3	3.3	3.0	2.7	2.9	1.5	3.0	5.9	2.1	—	—	—
Cervix	2.4	2.0	2.0	4.0	2.6	2.6	2.1	2.7	1.8	5.9	4.5	1.0	—	—
Esophagus	2.2	2.5	1.5	2.3	1.5	2.3	2.0	2.0	3.1	—	2.1	—	—	—
Melanoma	2.1	1.8	1.5	2.2	2.1	2.3	1.7	2.4	3.7	—	2.4	—	—	—
Oral	1.7	1.8	1.3	1.9	2.2	1.7	1.9	2.1	0.8	—	0.6	—	—	—
Liver‡	1.2	1.2	1.6	1.0	1.2	1.2	1.3	—	0.4	—	1.3	—	—	—

CNS=central nervous system; NOS=not otherwise specified

— When the rounded number of deaths is zero, the age-standardized rate is suppressed to maintain confidentiality.

* 2008–2012 average for Yukon, Northwest Territories and Nunavut.

† Canada totals include provincial and territorial estimates.

‡ Liver cancer deaths are underestimated; see *Appendix II: Data and methods issues*.

Note: Rates are age-standardized to the 2011 Canadian population. The complete definition of the specific cancers listed here can be found in Table A8.

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)†	**4,540**	**163.3**
Average per year	**910**	
I. Leukemia	**1,460**	**53.0**
a. Lymphoid	1,140	41.6
b. Acute myeloid	200	7.2
III. Central nervous system	**875**	**31.3**
a. Ependymoma	100	3.6
b. Astrocytoma	375	13.4
c. Intracranial & intraspinal embryonal	195	7.1
II. Lymphoma	**505**	**17.6**
a. Hodgkin lymphoma	190	6.4
b. Non-Hodgkin lymphoma	160	5.6
c. Burkitt lymphoma	45	1.6
IV. Neuroblastoma & other PNC	**355**	**13.1**
a. Neuroblastoma	350	13.0
IX. Soft tissue	**295**	**10.6**
a. Rhabdomyosarcoma	140	5.1
VI. Renal tumours	**235**	**8.7**
a. Nephroblastoma	225	8.3
XI. Other malignant epithelial	**205**	**7.1**
b. Thyroid	90	3.1
d. Malignant melanoma	50	1.7
VIII. Malignant bone	**195**	**6.8**
a. Osteosarcoma	100	3.5
c. Ewing sarcoma	75	2.7
X. Germ cell and other gonadal	**145**	**5.0**
c. Gonadal germ cell tumours	55	2.0
V. Retinoblastoma	**120**	**4.5**
XII. Other and unspecified cancers	**70**	**2.5**
VII. Hepatic tumours	**75**	**2.7**

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

PNC= peripheral nervous cell tumours

* International classification of childhood cancer (ICCC) Recode ICD-O-3/WHO 2008. Surveillance, Epidemiology, and End Results Program (SEER). Diagnostic groups are listed in descending order of disease incidence. Only selected subgroups within each diagnostic group are listed.

† Total included 10 malignant cases that were unclassifiable.

Note: Rates are age-standardized to the under age 15 years component of the 2011 Canadian population using the following age groups: < 1, 1–4, 5–9 and 10–14. Rates are expressed per million due to disease rarity.

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 1987 to 2012 (except for Quebec, for which data from 1986 to 2010 were used). Data for 1992 to 2012 were obtained from the CCR[1] May 2015 CCR Tabulation Master File, released October 2015. 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 diagnosed with new cases of 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, First Revision* (ICD-O-3.1) from 1992 onward.[2] Cancer diagnoses in the NCIRS (i.e., prior to 1992) were classified according to the *International Statistical Classification of Diseases and Related Health Problems, Ninth Revision* (ICD-9).[3]
- International Agency for Research on Cancer (IARC) rules[4] for multiple primaries were used for cases from the CCR (see *Data and methods issues*), 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.
- *Chapter 7:* Due to concerns with quality of the histology data in the NCIRS, incidence data for this chapter were obtained only from the CCR. As such, actual incidence data for Chapter 7 were from 1992 to 2012, except for Quebec, for which actual incidence data were to 2010. For completeness, Quebec 2011 and 2012 data, both incidence and population, were assumed to be the same as 2010.

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

The actual cancer mortality data cover the period of 1987 to 2012 and were obtained from the Canadian Vital Statistics – Death Database (CVS: D).[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 2012. 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 (ICD): ICD-9 from 1979 to 1999 and ICD-10 from 2000 onward.[6]
- Cancer deaths are those for which some form of cancer, as certified by a physician, is the underlying cause of death.
- *Chapter 7*: To correspond with the period covered by the incidence data, actual cancer mortality data were from 1992 to 2012.

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 2015.[7]

- Projected population estimates are used for 2016, as prepared by Statistics Canada under assumptions of medium growth (scenario M1).[8] The scenario M1 incorporates medium-growth and historical trends (1991/1992 to 2010/2011) 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 expected survival used in the calculation of relative (net) survival.
- 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 1991–1993 to 2004–2006.[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

- Cancer cases are defined according to ICD-9 prior to 1992 and ICD-O-3[2] thereafter. Cancer deaths are defined according to ICD-9 prior to 2000 and ICD-10[6] thereafter (Table A8).
- The grouping for mortality follows Surveillance, Epidemiology, and End Results Program (SEER) adapted classification, with the exception of liver cancer. In the present publication, C22.9 (liver, not otherwise specified) is put with "other and unspecified" digestive organs. We grouped all mesothelioma with "All other and unspecified cancers" instead of grouping them with the organs where they originated; this is an option of the SEER classification.
- Some definitions have changed slightly over time. Changes occurring since the 2004 edition of this publication are outlined in Tables A9-1 and A9-2.
- For children aged 0–14 years, new cancers were classified and reported according to the SEER update[15] of the International Classification of Childhood Cancer, Third Edition (ICCC-3).[16] The update is in response to new morphology codes introduced by the World Health Organization.[17] The classification 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.
- Bladder cancer included bladder *in situ* carcinomas, which are considered invasive for the purpose of incidence reporting, for all provinces and territories except Ontario. *In situ* bladder cancer cases were not reported in Ontario until 2013 and were therefore not available in the data used in this publication.
- *Chapter 7*: The operational definitions of HPV-associated cancer incidence and mortality are provided in Tables A12 and A13, respectively. See *Data and methods issues* for additional information on these definitions.

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 (e.g., 0–4, 5–9,…, 85–89 and 90+ 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 incidence and mortality by sex, age and geography, age-standardized rates were computed for other age groupings (e.g. 0–19, 20–29,…, 70–79 and 80+ years).
- Age-standardized incidence rates 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 2011 Canadian population. In order to use the Nordpred projection package, all tables and figures that include projected rates were based on 18 age groups instead of 19, whereby the last two categories were collapsed to 85+ and assigned a weight of 0.018725 (see *Estimation of incidence and mortality for 2016* below).
- Age-specific rates were also age-standardized by age categories (e.g., 0–19, 20–29,…, 70–79 and 80+) using appropriately adjusted weights. Specifically, the weights assigned to each age group in the category were divided by the sum of the weights in the age category.

Age standardization

A notable change in the statistical methodology for this year's edition is that incidence and mortality rates were standardized to the age distribution of the 2011 Canadian population, whereas rates were standardized to the 1991 Canadian population in previous editions (1995 to 2015). The table to the right demonstrates the impact of this methodological change on the cancer-specific age-standardized incidence rates. Due to the fact that the 2011 Canadian population has a higher proportion of people in older age groups, in which cancer is often more common, than the 1991 population, rates standardized to the 2011 Canadian population are generally higher than those standardized to the 1991 population. For example, 2016 incidence rates for all cancers combined are 31.4% and 28.5% higher in men and women, respectively, when age-standardized to the 2011 Canadian population compared with the 1991 Canadian population. Conversely, cancers occurring primarily in younger age groups, such as testicular cancer and Hodgkin lymphoma, show decreases or little change. It is crucial to recognize that these differences are methodological artefacts and do not represent actual differences in risk.

The change in standard population was made this year to more accurately reflect the current age structure of the Canadian population and to align with the efforts of other health organizations, including Statistics Canada. For additional information on age-standardization, see the following resources: "Age standardized rate" (http://www.statcan.gc.ca/eng/dai/btd/asr), "Updating the standard population and its effect on cancer incidence and mortality rates" (in press; http://www5.statcan.gc.ca/olc-cel/olc.action?ObjId=82-624-X&ObjType=2&lang=en&limit=0).

Estimated new cases and age-standardized incidence rates (ASIR*) for cancers by sex and standard population, Canada 2016

Cancer	Males				Females			
	Cases	ASIR (1991 STD)	ASIR (2011 STD)	Percent difference†	Cases	ASIR (1991 STD)	ASIR (2011 STD)	Percent difference
All cancers‡	102,900	428.0	562.4	31.4	99,500	379.8	488.2	28.5
Lung and bronchus	14,400	59.0	78.9	33.6	14,000	49.9	66.2	32.6
Colorectal	14,500	59.6	79.5	33.3	11,600	40.6	54.5	34.0
Breast	230	0.9	1.3	34.3	25,700	101.1	130.1	28.6
Prostate	21,600	86.0	114.7	33.5	—	—	—	—
Bladder	6,600	27.3	36.9	35.4	2,100	7.3	9.8	34.9
Non-Hodgkin lymphoma	4,400	18.8	24.2	29.1	3,600	13.6	17.5	28.8
Thyroid	1,550	7.1	8.4	18.3	5,300	25.2	28.6	13.8
Melanoma	3,700	15.9	20.5	29.0	3,100	13.0	15.8	21.3
Body of uterus and uterus NOS	—	—	—	—	6,600	24.6	32.7	32.8
Kidney and renal pelvis	4,100	16.9	22.1	30.9	2,300	8.8	11.4	29.3
Leukemia	3,500	15.3	19.5	27.5	2,400	9.4	11.8	24.6
Pancreas	2,600	10.6	14.3	34.4	2,600	8.9	12.0	34.9
Oral	3,200	13.0	17.2	32.3	1,450	5.5	7.1	29.5
Stomach	2,200	8.9	11.9	33.8	1,300	4.6	6.0	32.9
Brain/CNS	1,750	8.0	9.5	17.9	1,300	5.8	6.7	15.6
Ovary	—	—	—	—	2,800	10.7	13.8	28.5
Multiple myeloma	1,600	6.5	8.7	34.4	1,150	4.0	5.4	34.4
Liver	1,800	7.4	9.7	32.4	590	2.1	2.8	31.8
Esophagus	1,800	7.3	9.8	34.5	530	1.8	2.4	36.5
Cervix	—	—	—	—	1,500	7.4	8.0	8.3
Testis	1,100	6.8	6.1	–10.7	—	—	—	—
Larynx	890	3.6	4.8	33.8	170	0.6	0.8	30.6
Hodgkin lymphoma	550	3.0	3.1	1.0	460	2.5	2.5	-0.7
All other cancers	11,000	46.3	61.5	33.0	8,900	32.4	42.3	30.7

— Not applicable.

STD=standard population; NOS=not otherwise specified; CNS=central nervous system.

* Per 100,000 persons.

† Percent difference=[(ASIR using 2011 STD) – (ASIR using 1991 STD)]/(ASIR using 1991 STD) ×100.

‡ Columns may not sum to total due to rounding.

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

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

2011 Canadian standard population

Age group	Population	Standard weight
0–4	1,899,064	0.055297
5–9	1,810,433	0.052717
10–14	1,918,164	0.055853
15–19	2,238,952	0.065194
20–24	2,354,354	0.068555
25–29	2,369,841	0.069006
30–34	2,327,955	0.067786
35–39	2,273,087	0.066188
40–44	2,385,918	0.069474
45–49	2,719,909	0.079199
50–54	2,691,260	0.078365
55–59	2,353,090	0.068518
60–64	2,050,443	0.059705
65–69	1,532,940	0.044636
70–74	1,153,822	0.033597
75–79	919,338	0.026769
80–84	701,140	0.020416
85–89*	426,739	0.012426
90+*	216,331	0.006299
Total	**34,342,780**	**1.000000**

Note: The Canadian population distribution is based on the final postcensal estimates of the July 1, 2011, Canadian population, adjusted for census undercoverage.

*Age-standardized incidence and mortality rates in Chapters 1–4 and the projected age-standardized incidence and mortality rates in Chapter 7 were based on 18 age groups, whereby the last two categories were collapsed to 85+, with a population size of 643,070 and a standard weight of 0.018725. All other age-standardized incidence and mortality rates used 19 age groups.

Data source: Census and Demographics Branch, Statistics Canada

Figure D (*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 (the baseline year) for males and females in each five-year age group were applied to the age-specific populations for each of the subsequent calendar years (1989 to 2012) to obtain the expected number of deaths for each of those years if the 1988 mortality 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 analyses were done for lung cancer for 1989 to 2012 (with 1988 as the baseline year) and breast cancer in women for 1987 to 2012 (with 1986 as the baseline year).

Figure E (*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 1987. 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 1987. 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 E 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 1987 population distribution for males or females as the standard weights
- Next-to-baseline series: the 1987 total population multiplied by the annual age-standardized rate, using the 1987 population distribution for males or females as the standard weights
- Baseline (dotted line): the observed number of Canadian cancer cases or deaths during 1987, for males or females

Estimation of incidence (new cases) and mortality (deaths) for 2016

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 2016 for each cancer type by sex (except new cases of prostate cancer; see *Prostate 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.[18] Nordpred was developed into a software package[19] and is now one of the most frequently used methods for cancer projections worldwide.[20-24] The Nordpred Power5 regression model was used when the average annual number of cases or deaths 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 1988 to 2012 for both incidence (1986 to 2010 for Quebec) 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. 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.[25] P_p is the nonlinear period component of period p, and C_c is the nonlinear cohort component of cohort c.
- The 18 age groups used are as described above for the standard population with the 85–89 and 90+ age groups collapsed to form an 85+ category. The last two age groups were collapsed to use the Nordpred projection package.
- 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 2016. The predicted numbers of cancer cases in 2016 were calculated by multiplying these extrapolated incidence rates by the sex-, age- and province-specific population projections for the same year.
- Provincial cancer registries could request modifications of Nordpred "recent" and "cut-trend" options to produce estimates that were more consistent with the most recent data available to the provincial cancer registries.

Five-year averaging

New cases and deaths in 2016 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 or territory. The predicted numbers were then obtained by multiplying these rates by the corresponding projected population sizes.

For a few provincial cancer registries, a correction factor was applied to the five-year average rate to address case completeness issues in the CCR or more recent substantial declines in cancer incidence.

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 counts.
- 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 A10 and A11 indicate the cancer types that were reported according to the five-year average method for 2016. In these situations, the age-standardized rates for 2016 reported in this publication were calculated using the most recent five years of actual data.

Chapter 7

- Incidence was projected to 2016 for all HPV-associated cancers combined using actual incidence data from 1993 to 2012, except Quebec, for which 2010 incidence data were copied forward to 2011 and 2012.
- Mortality was projected to 2016 for all HPV-associated cancers combined using actual mortality data from 1988 to 2012.
- Incidence projections were obtained using the Nordpred Power5 regression model with four 5-year periods (1993 to 1997, 1998 to 2002, 2003 to 2007, 2008 to 2012) instead of five 5-year periods.

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.

Prostate cancer incidence

The results of the Nordpred Power5 regression model are not satisfactory for prostate cancer because of the impact of prostate specific antigen (PSA) screening initiated in the early 1990s. 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 2016 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 rate for the most recent year of data was calculated for each five-year age group and province or territory. The predicted numbers were then obtained by multiplying these rates by the corresponding projected population sizes. For one provincial cancer registry, a correction factor was applied to the rates to address a sudden change in prostate cancer screening practices.

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.
- 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.

Throughout the publication, actual incidence and mortality frequencies are randomly rounded up or down to a multiple of 5.

Precision of 2016 estimates

Estimates of precision (standard errors, coefficients of variation and confidence intervals) for 2016 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 age-standardized rates in each segment. The models incorporated estimated standard errors of the age-standardized rates. 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 (1992 to 2010 for incidence and 1992 to 2012 for mortality) to determine years in which the APC changed significantly. Such years are referred to as changepoints. In previous years, the start year for analysis was 1986. Since sensitivity analyses indicated moving to a more recent year did not impact results in a practically important manner, the committee decided to limit analyses to more current and higher quality data.
- 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 for incidence and 2008 to 2012 for mortality.
- If no changepoint was detected within the most recent 10 years, data were truncated to the most recent 10 years and APC were estimated by fitting a model in the same way as described above.
- If a changepoint was detected within the most recent 10 years, both the changepoint year and the APC for the years beyond the changepoint are reported in Tables 1.5 and 3.5.
- *Chapter 7*: Joinpoint analysis was applied to annual age-standardized incidence rates from 1992 to 2012. For Quebec, 2010 data, both incidence and population, were carried forward to 2011 and 2012. A joinpoint analysis was not conducted for mortality rates.

Probability of developing or dying from cancer

Probabilities of developing or dying from cancer were calculated using age- and sex-specific cancer incidence and mortality rates for Canada in 2010 and abridged life tables. Life tables were based on all-cause mortality rates for 2008 to 2010, which were calculated for quinquennial age categories (0–4 to 90+) and a hypothetical cohort of 100,000 live births. The methodology used was that of Zdeb[26] and Seidman et al.[27]

At the time of this publication, national mortality data were available to 2012. However, cancer incidence data for all provinces and territories were available only to 2010. To maintain consistency in the time periods used to calculate the probability of developing or dying from cancer, estimates were not updated from the 2015 edition, which used incidence data from the September 2012 CCR Tabulation Master File and summary data from the Quebec Cancer Registry (2008 to 2010).

Probability of developing cancer

- The method used for the probability of developing cancer assumes that current sex- and age-specific incidence rates and all-cause mortality rates prevail throughout the lifetime of the hypothetical cohort of 100,000 live births. Since this assumption may not be true, the probabilities should be regarded only as approximations.
- For any defined time period (e.g., age 0–90+ or 30–40), the probability of developing cancer is the number of new cancers occurring over the time period divided by the number of persons never diagnosed with cancer at the start of the time period. Thus, the lifetime probability of developing cancer is the total number of cancers occurring over the complete lifetable (age 0–90+) divided by the hypothetical cohort of 100,000 live births. This calculation does not assume that an individual lives to any particular age. Similarly, the probability of developing cancer between the age of 30 and 40 is the total number of cancers diagnosed between the two ages divided by the number of persons alive at age 30 who have never been diagnosed with cancer.
- Probabilities can be calculated for all cancers combined or by cancer type.

Probability of dying from cancer

- The method used for the probability of dying of cancer assumes that current sex- and age-specific cancer mortality rates and all-cause mortality rates prevail throughout the lifetime of the hypothetical cohort of 100,000 live births. Since this assumption may not be true, the probabilities should be regarded only as approximations.
- For any defined time period (e.g., age 0–90+ or 30–40), the probability of dying of cancer is the number of cancer deaths occurring over the time period divided by the number of persons alive at the start of the time period. Thus, the lifetime probability of dying of cancer is the total number of cancer deaths occurring over the complete lifetable (age 0–90+) the hypothetical cohort of 100,000 live births. This calculation does not assume that an individual lives to any particular age. Similarly, the probability of dying of cancer between the ages of 30 and 40 is the total number of cancer deaths occurring between the two ages divided by the total number of all deaths occurring between the two ages divided by the number of persons alive at age 30.
- Probabilities can be calculated for all cancers combined or by cancer type.

Potential Years of Life Lost (PYLL)

The indicator was calculated by taking the exact age of each person dying before the age of 75 years and subtracting that from 75 to calculate individual years lost. The sum of all these values represents the total PYLL. Figure B presents the total PYLL for people aged 0–74 in 2010 to 2012, inclusively. The following ICD-10 codes were used to create the categories presented in Figure B.

Category	ICD-10 cause of death terminology	ICD -10 Codes
Cancer	All malignant neoplasms	C00-C97
Accidents	Unintentional injuries	V01-X59, Y85-Y86
Heart disease	Ischemic heart disease	I20-I25
Suicide	Suicides and self-inflicted injuries	X60-X84, Y87.0
Respiratory disease	Respiratory diseases (excluding infectious and parasitic diseases)	J00-J99
Cerebrovascular disease	Cerebrovascular diseases	I60-I69
HIV	Human immunodeficiency virus (HIV) disease	B20-B24

Survival

No new data were available to produce more recent survival estimates for this year's publication. However, several updates to the methodology have been incorporated, and conceptual changes to the interpretation of the results have been made. The following are of particular note:

- Whereas previous editions of this publication reported relative survival, estimates are now explicitly referred to as net survival[28] and interpreted as such.
- Traditional methods of estimating relative survival have recently been shown to produce biased estimates of net survival under certain circumstances.[29] In particular, estimates of net survival for "all ages" combined are prone to a potential bias that can arise because people diagnosed at older ages are more likely to die from causes other than the cancer of interest than those diagnosed at younger ages. Age-standardization has been shown to be a useful tool to mitigate this potential bias.[30,31] Where appropriate, survival estimates in this report were age-standardized.
- Estimating net survival in a relative survival framework requires that the non-cancer mortality rate in a group of people diagnosed with cancer is the same as that in the population-based life table.[30] Previous editions of this publication made the common assumption that the bias introduced by the use of population-based life tables, which include people previously diagnosed with cancer, was negligible. This has been shown to be true for most, but not all, individual cancers and to not be true for all cancers combined.[32-34] To account for this bias, in this edition, expected survival data were adjusted for cancer-specific mortality in the general population, where appropriate.[32]

The following is a complete description of the survival methodology used:

- Analyses were based on individuals aged 15–99 years at diagnosis, excluding adolescent (15–19 years) bone cancers, which are dissimilar to bone cancers diagnosed in older adults. A second exception related to the analysis of childhood cancers, which was based on children under the age of 15 years at diagnosis.
- Observed survival proportions were reported for the analysis of childhood cancers.
- Age-specific net survival was estimated directly from age-specific relative survival ratios (RSRs).
- Net survival for ages 15–99 combined was estimated using age-standardized (RSRs).[35] As previously mentioned, age-standardization is used here to mitigate the bias that can arise because people diagnosed at older ages are more likely to die from causes other than the cancer of interest than those diagnosed at younger ages.
- Age-standardization was performed using the direct method, which involved weighting age-specific estimates for a given cancer to the age distribution of persons recorded as being diagnosed with that cancer in Canada from 2004 to 2008.
- *Chapter 7:* HPV-associated cancers were also standardized to the age distribution of all such cancers combined diagnosed from 2004 to 2008. See Table 7.4.
- 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. As previously mentioned, earlier editions of this publication made the assumption that the bias introduced by the use of population-based life tables, which include people previously diagnosed with cancer, was negligible. This has been shown to be true for most, but not all, individual cancers and to not be true for all cancers combined.[32-34,36]
- To account for the aforementioned bias, expected survival data used in the calculation of RSRs for prostate, female breast, and colorectal cancer, as well as for all cancers combined, were adjusted for cancer-specific mortality in the general population.[32-34,36] In each case, the proportion of deaths among Canadian residents due to the cancer(s), by sex, five-year age group and year of death, was used for the adjustment.
- Analyses were based on a publicly available algorithm,[37] with some minor adaptations to increase precision. Expected survival proportions were derived using the Ederer II approach,[38] from sex-specific provincial life tables produced by Statistics Canada.
- Analyses were based on all primary cancers. The effect of including multiple cancers in survival analyses has been studied both internationally[37,39] and in Canada.[40]
- 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.
- Survival time was measured in days. Cases with the same date of diagnosis and death (not including those previously excluded because they were diagnosed through autopsy only or death certificate only) were assigned one day of survival because the program automatically excludes cases with zero days survival. Exclusion of these cases would have biased the RSRs upward.
- For five-year survival, 3-month subintervals were used for the first year of follow-up, then 6-month subintervals for the remaining 4 years, for a total of 12 subintervals. Where the analysis was extended to 10 years, 1-year subintervals were used for the 6th through 10th years.
- In practice, estimates of RSRs may exceed 100%. However, as these estimates were used to estimate net survival probability, a maximum of 100% was permitted for interval-specific RSRs.

- Survival analyses were conducted using both period and cohort analysis methods.[41] The period approach to survival analysis provides up-to-date predictions of cancer survival.[42] 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 was calculated as per five-year RSRs using only the data of people who have already survived specified amounts of time since diagnosis.[43,44]
- Confidence intervals are provided as an indication of the level of statistical uncertainty in the survival estimates. For age-standardized RSRs, standard errors were estimated by taking the square root of the sum of the squared weighted age-specific RSR standard errors. Standard errors of RSRs were estimated by dividing the standard error of the observed survival (determined by Greenwood's method[45]) by expected survival.[46]
- Net survival probabilities were expressed as percentages.
- Survival estimates associated with standard errors greater than 0.10 were omitted. Estimates associated with standard errors greater than 0.05 but less than or equal to 0.10 were italicized.

Prevalence

This section of the publication has been reproduced, as is, from the corresponding section in the 2014 publication. 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.[47,48] 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 and Management 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 and borderline tumours, and carcinomas *in situ* are not routinely captured or reported except for *in situ* carcinomas of the bladder. For the period included in this report, all provinces and territories except Ontario reported *in situ* bladder cancers to the CCR. Ontario began reporting *in situ* bladder in 2013.
- In previous editions of this publication, it was noted that data from Newfoundland and Labrador (NL) were potentially affected by under-reporting of cases due to incomplete linkage of cancer and vital statistics information. The NL Cancer Registry has implemented death clearance processes to improve case ascertainment and have also improved the reporting of cases from subprovincial regions that previously under-reported cases. As a result of the enhancements to the NL Cancer Registry, case ascertainment is improved in the 2006 data onward, and references to the potential for case under-reporting in NL have been removed in this publication. These changes may have impacted the case counts and rates reported within this report, resulting in apparent increases for NL compared to previous editions of this publication.
- Because the Quebec registry relied primarily on hospital data for the period included in the present report, the number 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.[49] The 2016 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 death certificate only (DCO) cases for 2010 in Quebec was estimated by randomly assigning DCO cases diagnosed in 2005 to 2009 to the time period 2010 to 2014 and retaining the 2010 DCOs. The number of DCO cases for 2008, 2009, 2010, 2011 and 2012 in Ontario were estimated by randomly assigning DCO cases diagnosed in 2003 to 2007 to the time period 2008 to 2012.
- Non-melanoma skin cancers (neoplasms, NOS, epithelial neoplasms NOS, basal and squamous) are not included since most provincial and territorial cancer registries (PTCRs) do not collect incidence data on this type of cancer. These cancers are difficult to register because they may be diagnosed and/or treated in a variety of settings that do not report to the PTCRs, including dermatologist offices.

Multiple primaries

- There are two common systems of rules used to determine when a second or subsequent cancer should be considered a new primary cancer, as opposed to a relapse or duplicate of a previously registered cancer: one from the International Agency for Cancer Research (referred to as the "IARC rules") and one from the Surveillance, Epidemiology, and End Results Program (referred to as "SEER rules"). IARC rules tend to yield lower total case counts than the SEER rules because IARC rules generally do not permit multiple cancers to be diagnosed at the same site within a single individual.
- Although all provinces and territories now register cancers according to the SEER rules for multiple primaries, historically, some did not. Since this report uses historical data, data were collapsed into the IARC rules for all regions. Consequently, cancer counts for some provinces may appear lower in this publication than cancer counts in provincial cancer reports. The magnitude of difference between the two systems varies by province, cancer, sex and diagnosis year. For example, unpublished analyses performed by the Public Health Agency of Canada on the CCR file showed British Columbia would report approximately 6% more female breast cancer cases under the SEER rules compared to the IARC rules for diagnosis year 2010. For male melanoma in British Columbia, the number of new cases in 2010 under the SEER rules would be about 8% higher than under the IARC rules. A recent paper from the United States based on data from the SEER program reported similar differences between statistics based on SEER and IARC rules[50] and also examined the impact of the rules on reported trends.

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 A9-1 and A9-2), there are a few 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)[3] 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.
- The liver cancer mortality definition currently used differs from that used by some other North American publications (http://www.naaccr.org/dataandpublications/cinapubs.aspx; http://seer.cancer.gov/csr/1975_2012/). SEER Cancer Statistics Review presents estimates for liver and intrahepatic bile duct (C22.0 to C22.9) while Cancer in North America (CINA) presents estimates for liver (C22.0, C22.2 to C22.9). Consistent with CINA, the Canadian Cancer Statistics publication presents estimates for liver but excludes liver, unspecified (C22.9) because of concerns it may contain metastatic cancers. Consequently, estimates of liver cancer mortality presented in this publication are underestimates. The impact of adding liver, unspecified (C22.9) to the current liver cancer mortality definition would be substantial; the number of liver cancer deaths in Canada in 2012 would increase by about 45.9%. Therefore, the method of defining liver cancer mortality should be acknowledged when comparing estimates across publications. The Canadian Cancer Statistics Advisory Committee will be examining this issue in greater detail to determine the best definition to adopt for future publications.

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[51] 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

No information on the presence or absence of HPV DNA in tumours was available in the Canadian Cancer Registry database. Therefore, consistent with previous studies,[52] HPV-associated cancers were identified based on site and morphology for incidence.

- For cancers of the vagina, vulva, penis, anus, oropharynx and oral cavity, HPV is associated primarily with squamous cell carcinomas (SCC).[53] For each of these cancers, all SCCs were classified as "HPV-associated" and other morphologies were classified as "non-HPV-associated".
- All cervical carcinomas (including SCCs, adenocarcinomas, and other specified and unspecified carcinomas) were classified as HPV-associated. Others (namely sarcomas and other specified and unspecified malignant neoplasms) were classified as non-HPV-associated.
- The definitions used for cancers of the cervix, vagina, vulva, anus, penis and oropharynx were consistent with those used by Watson et al.[52]
- For head and neck cancers, subsites were used to further define whether a cancer was HPV-associated. For example, the base of tongue, tonsil and other regions of the oropharynx are known to be related to HPV; these were referred to in the text as "oropharyngeal cancers". In contrast, subsites of the gum and cheek, floor of mouth, other mouth and anterior tongue are known to have a stronger association with smoking and alcohol consumption and were therefore used to identify non-HPV-associated cancers. These were referred to as "oral cavity cancers (OCC)" in the text. The definitions for non-HPV-associated oral cancers (OCC) were consistent with those used by Auluck et al.[54]
- The operational outcome definitions for incidence are provided in Table A12.
- Since morphology data were not available for mortality, cancers for these analyses were defined based on site only, meaning mortality estimates include HPV-associated and non-HPV-associated cancer deaths. As a result, caution should be taken when comparing HPV-associated incidence rates with mortality rates, as the latter will appear artificially high. The operational outcome definitions for mortality are provided in Table A13.

Canadian Partnership Against Cancer modelling

The OncoSim model (formerly the Cancer Risk Management Model, or CRMM), developed by the Canadian Partnership Against Cancer and Statistics Canada through funding from Health Canada, was designed to evaluate the impact of cancer care policy changes in the Canadian system. OncoSim incorporates 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. OncoSim includes sub-models for lung, colorectal, cervical and breast cancers. Cervical cancer was evaluated in this report.

OncoSim is a discrete event microsimulation 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 OncoSim simulation results in this report were based on version 2.3.0.1 and based on 32 million simulated cases (scaled to the size of the Canadian population).

Data

OncoSim simulates and projects a representative sample of the Canadian population using Statistics Canada's official demographic projections. OncoSim 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 cancers. 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 2016 Canadian dollars. Sources for economic data included Census and other simulation models at Statistics Canada. Additional parameter values 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

The OncoSim HPV/Cervical cancer model consists of two complementary components: Human Papillomavirus Microsimulation Model (OncoSim-HPVMM) and Cervix Model (OncoSim-Cerivx). The OncoSim-HPVMM component is a fully developed pre-model that simulates HPV transmission through sexual contact networks and feeds OncoSim-Cervix with HPV incidence rates under various vaccinations strategies. The OncoSim-Cervix sub-model simulates the natural history from HPV infection to cervical intraepithelial neoplasia to cancer, as well as infection to anogenital warts in men and women. It also simulates screening, treatment, progression and case-fatality.

OncoSim-HPVMM

OncoSim-HPVMM is an interacting-agent model that simulates lifetimes of hypothetical persons to model sexual network, virus transmission and vaccination strategies. OncoSim-HPVMM was developed based on a published model by Van de Velde et al (2010).[55] The interacting nature of the model allows men and women 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.

OncoSim-HPVMM assumes that the population being simulated is stationary (i.e., the population does not grow nor shrink over time) and that the characteristics ruling individuals' sexual behaviours (e.g., sexual debut, partnership formation/separation, sexual acts) and virus transmission rate (e.g., virus infection, clearance) are constant over time. Under these assumptions, OncoSim-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. OncoSim-HPVMM allows 100 years of projection to assess the effect of various vaccination strategies on HPV prevalence and incidence.

OncoSim-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),[55] literature, clinical trials and Statistics Canada surveys. Input parameters, particularly those associated with sexual behaviour and virus transmissions are subject to high degree of uncertainty due to limited information available. Therefore, extensive parameter estimation was performed to find feasible parameter 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 OncoSim-HPVMM, therefore, can be presented as a range of outputs (i.e., confidence bands) that account for the possible variations in outputs resulting from uncertain input parameter values.

OncoSim-HPVMM was run with 250,000 interacting agents with 100-year burn-in to obtain equilibrium sexual network and HPV prevalence levels. All OncoSim-HPVMM simulation results are based on version 1.8.0.0, and results are scaled to reflect the population size of Canadians aged 10 years and older in 2011.

OncoSim-Cervix

OncoSim-Cervix 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 OncoSim-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 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 optional 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 survivals are based on Canadian Cancer Registry data 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 calibrated 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 screenings are consistent with published data. Conceptual model specification and face-validity of inputs and results were ensured through an expert working group consisting of oncologists, epidemiologists and other cancer specialists.

Scenarios

Vaccination

The vaccination program has the following common assumptions:

- Vaccination of 12-year-old girls annually with three doses of a quadrivalent HPV vaccine
- Vaccination program begins in 2008 without a ramp-up in vaccination rates
- Vaccines are perfect (i.e., 100% efficacious with no waning over time)

Cervical screening:

The screening recruitment rate is 80% and follow-up protocols are based on current practice. Cervical screening outcomes reflect a combination of historical patterns (1955 to 2015) based on primary cytology testing (both standard and liquid-based) and future patterns (2016 and after) based on alternative primary modalities. Two alternative modalities were examined for this report: 1) cytology (Pap) only for women aged 21-65 years, with triennial testing; and 2) two modalities in sequence, cytology from 21-29 years of age, triennially, followed by HPV DNA testing 30-65 of age, every 5 years.

Vaccination and screening:

For each of the two primary screening modalities, vaccination rates are varied by 0%, 60% and 85%. A total of six scenarios were consequently examined.

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TABLE A8 Cancer definitions

Cancer	ICD-O-3 Site/Type (incidence)	ICD-10 (mortality)
Oral	C00–C14	C00–C14
Esophagus	C15	C15
Stomach	C16	C16
Colorectal	C18–C20, C26.0	C18–C20, C26.0
Liver	C22.0	C22.0, C22.2–C22.7
Pancreas	C25	C25
Larynx	C32	C32
Lung and bronchus	C34	C34
Melanoma	C44 (Type 8720–8790)	C43
Breast	C50	C50
Cervix	C53	C53
Body of uterus and uterus NOS	C54–C55	C54–C55
Ovary	C56.9	C56
Prostate	C61.9	C61
Testis	C62	C62
Bladder (including *in situ* for incidence)	C67	C67
Kidney and renal pelvis	C64.9, C65.9	C64–C65
Brain/CNS	C70–C72	C70–C72
Thyroid	C73.9	C73
Hodgkin lymphoma*	Type 9650–9667	C81
Non-Hodgkin lymphoma*	Type 9590–9597, 9670–9719, 9724–9729, 9735, 9737, 9738	C82–C85, C96.3
	Type 9811-9818, 9823, 9827, 9837 all sites except C42.0,.1,.4	
Multiple myeloma*	Type 9731, 9732, 9734	C90.0, C90.2
Leukemia*	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	C91–C95, C90.1
	Type 9811-9818, 9823, 9827, 9837 sites C42.0,.1,.4	
All other cancers	All sites C00–C80, C97 not listed above	All sites C00–C80, C97 not listed above
All other and unspecified cancers (grouping used only in Tables A1 and A2)	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	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; NOS=not otherwise specified

* 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 A9-1 Recent cancer definition changes in incidence

	New definition	Year changed	Old definition
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 and renal pelvis	ICD-O-3 C64–C65	2008	ICD-O-3 C64–C66, C68
Lung and bronchus	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: Bladder, colorectal, kidney, lung and ovary cancers exclude 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 A9-2 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 and renal pelvis	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 and bronchus	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 A10 Use of five-year average method* for incidence projection by cancer type, sex and province, 2016

	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 and bronchus									■	●							■	●		●
Colorectal									■	●										
Breast	■		■		■		■				■		■		■		■		■	●
Prostate†																	■			
Bladder																	■	●		●
Non-Hodgkin lymphoma																	■	●		
Thyroid				●	■	●	■						■	●	■		■	●	■	
Melanoma																	■	●	■	●
Body of uterus and uterus NOS		●																●		●
Kidney and renal pelvis					■												■	●		●
Leukemia																	■	●	■	●
Pancreas																	■	●	■	●
Oral			■			●								●		●	■	●	■	●
Stomach						●		●					■	●		●	■	●		●
Brain/CNS					■	●	■	●					■	●	■	●	■	●	■	●
Ovary																		●		●
Multiple myeloma					■	●	■	●					■	●	■	●	■	●	■	●
Liver				●	■	●	■	●					■	●	■	●	■	●	■	●
Esophagus				●	■	●	■	●					■	●		●	■	●	■	●
Cervix				●		●		●						●		●		●		●
Testis					■		■						■		■		■		■	
Larynx		●		●	■	●	■	●					■	●	■	●	■	●	■	●
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 & Labrador.

CNS=central nervous system; NOS=not otherwise specified

* 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.

† 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 A11 Use of five-year average method* for mortality projection by cancer type, sex and province, 2016

	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 and bronchus																		●		
Colorectal																	■	●		
Breast	■		■		■		■		■		■		■		■		■	●	■	
Pancreas																	■	●	■	●
Prostate																	■			
Leukemia					■	●		●					■	●	■	●	■	●	■	●
Non-Hodgkin lymphoma					■	●	■	●					■	●	■	●	■	●	■	●
Bladder				●	■	●	■	●					■	●	■	●	■	●	■	●
Brain/CNS			■	●	■	●	■	●					■	●	■	●	■	●	■	●
Esophagus				●	■	●		●					■	●		●	■	●	■	●
Stomach			■		■	●	■	●					■	●	■	●	■	●	■	●
Kidney and renal pelvis				●	■	●	■	●					■	●	■	●	■	●	■	●
Ovary						●								●				●		●
Multiple myeloma				●	■	●	■	●					■	●	■	●	■	●	■	●
Oral		●		●	■	●	■	●					■	●	■	●	■	●	■	●
Melanoma		●		●	■	●	■	●					■	●	■	●	■	●	■	●
Liver		●		●	■	●	■	●					■	●	■	●	■	●	■	●
Body of uterus and uterus NOS						●		●						●		●		●		●
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 & Labrador.

CNS=central nervous system; NOS=not otherwise specified

* 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.

TABLE A12 Cancer definitions for incidence in Chapter 7

Cancer	ICD-O-3 Topography	ICD-O-3 Morphology*
HPV-associated cancers		
Cervix uteri	**C53**	All carcinomas (8010-8671, 8940-8941)
Endocervix	C53.0	
Exocervix	C53.1	
Overlapping lesion of cervix uteri	C53.8	
Cervix uteri	C53.9	
Vagina	**C52**	Squamous cell carcinoma (8050-8084, 8120-8131; exclude 8077/2†)
Vagina, NOS	C52.9	
Vulva	**C51**	Squamous cell carcinoma (8050-8084, 8120-8131; exclude 8077/2†)
Labuim majus	C51.0	
Labuim minus	C51.1	
Clitoris	C51.2	
Overlapping lesion of vulva	C51.8	
Vulva, NOS	C51.9	
Anus	**C21**	Squamous cell carcinoma (8050-8084, 8120-8131; exclude 8077/2†)
Anus, NOS	C21.0	
Anal canal	C21.1	
Cloacogenic zone	C21.2	
Overlapping lesion of rectum, anus, anal canal	C21.8	
Penis	**C60**	Squamous cell carcinoma (8050-8084, 8120-8131)
Prepuce (foreskin)	C60.0	
Glans penis	C60.1	
Body of penis	C60.2	
Overlapping lesion of penis	C60.8	
Penis, NOS	C60.9	
Oropharynx‡		Squamous cell carcinoma (8050-8084, 8120-8131)
Base of tongue, lingual tonsil		
Base of tongue, NOS	C01.9	
Lingual tonsil	C02.4	
Tonsil (including Waldeyer ring)		
Tonsillar fossa	C09.0	
Tonsillar pillar	C09.1	
Overlapping lesion of tonsil	C09.8	
Tonsil, NOS	C09.9	
Waldeyer ring	C14.2	
Others, potentially associated with HPV		
Overlapping lesion of tongue	C02.8	
Lateral wall of oropharynx	C10.2	
Overlapping lesion of oropharynx	C10.8	
Oropharynx, NOS	C10.9	
Pharynx, NOS	C14.0	
Overlapping lesion of lip, oral cavity, pharynx	C14.8	

Cancer	ICD-O-3 Topography	ICD-O-3 Morphology*
Non-HPV-associated cancers		
Oral cavity§		Squamous cell carcinoma (8050-8084/8120-8131)
Tongue		
Dorsal surface of tongue, NOS	C02.0	
Border of tongue	C02.1	
Ventral surface of tongue, NOS	C02.2	
Anterior 2/3 of tongue, NOS	C02.3	
Tongue, NOS	C02.9	
Gum and Cheek		
Upper gum	C03.0	
Lower gum	C03.1	
Gum, NOS	C03.9	
Cheek mucosa	C06.0	
Vestibule of mouth	C06.1	
Retromolar area	C06.2	
Floor of mouth		
Anterior floor of mouth	C04.0	
Lateral floor of mouth	C04.1	
Overlapping lesion of floor of mouth	C04.8	
Floor of mouth, NOS	C04.9	
Other mouth		
Mucosa of upper lip	C00.3	
Mucosa of lower lip	C00.4	
Mucosa of lip	C00.5	
Hard palate	C05.0	
Soft palate, NOS	C05.1	
Uvula	C05.2	
Overlapping lesion of palate	C05.8	
Palate, NOS	C05.9	
Overlapping lesion of other and unspecified parts of mouth	C06.8	
Mouth, NOS	C06.9	

NOS=not otherwise specified

* The following morphologies were also excluded, as they do not represent invasive cancers: 9140, 9050-9055, 9590-9992.

† In keeping with previous publications, morphology 8077/2 (intraepithelial neoplasia 2) were excluded for vaginal, vulvar and anal cancers.

‡ Although this includes some oral cavity cancer sites, since most HPV-associated head and neck cancers originate in the oropharynx, they are referred to as oropharyngeal cancers (OPC) in this report.

§ Although this includes some sites of the oropharynx (e.g., soft palate), since most non-HPV-associated head and neck cancers originate in the oral cavity, they are referred to as oral cavity cancers (OCC) in this report.

Note: ICD-O-3 refers to the *International Classification of Diseases for Oncology, Third Edition*.[2]

TABLE A13 Cancer definitions for mortality in Chapter 7

Cancer	ICD-10
Cervix uteri	**C53**
Endocervix	C53.0
Exocervix	C53.1
Overlapping lesion of cervix uteri	C53.8
Cervix uteri, unspecified	C53.9
Vagina	**C52**
Vulva	**C51**
Labuim majus	C51.0
Labuim minus	C51.1
Clitoris	C51.2
Overlapping lesion of vulva	C51.8
Vulva, unspecified	C51.9
Anus	**C20, C21**
Anus, unspecified	C21.0
Anal canal	C21.1
Cloacogenic zone	C21.2
Overlapping lesion of rectum, anus, anal canal	C21.8
Penis	**C60**
Prepuce (foreskin)	C60.0
Glans penis	C60.1
Body of penis	C60.2
Overlapping lesion of penis	C60.8
Penis, unspecified	C60.9
Oropharynx	
Base of tongue, lingual tonsil	
Base of tongue, NOS	C01
Lingual tonsil	C02.4
Tonsil (including Waldeyer ring)	
Tonsillar fossa	C09.0
Tonsillar pillar	C09.1
Overlapping lesion of tonsil	C09.8
Tonsil, NOS	C09.9
Waldeyer ring	C14.2
Other (potentially associated with HPV)	
Overlapping lesion of tongue	C02.8
Lateral wall of oropharynx	C10.2
Overlapping lesion of oropharynx	C10.8
Oropharynx, unspecified	C10.9
Pharynx, NOS	C14.0
Overlapping lesion of lip, oral cavity, pharynx	C14.8

NOS=not otherwise specified

Note: ICD-10 refers to the *International Statistical Classification of Diseases and Related Health Problems, Tenth Revision*.[4]

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:

2015 Predictions of the future burden of cancer in Canada

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

APC	Annual percent change
ASIR	Age-standardized incidence rate
ASMR	Age-standardized mortality rate
CCR	Canadian Cancer Registry
CI	Confidence interval
CL	Confidence limits
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
HPV	Human papillomavirus
IARC	International Agency for Research on Cancer
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
NCIRS	National Cancer Incidence Reporting System
NMSC	Non-melanoma skin cancer
NOS	Not otherwise specified
OCC	Oral cavity cancer
OPC	Oropharyngeal cancer
OSP	Observed survival proportion
PSA	Prostate-specific antigen
PTCR	Provincial and territorial cancer registries
PYLL	Potential years of life lost
RSR	Relative survival ratio
SCC	Squamous cell carcinoma
SCCHN	Squamous cell carcinoma of the head and neck
SEER	Surveillance, Epidemiology, and End Results Program

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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, charts 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.

Canadian Council of Cancer Registries

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gnb.ca/0051/cancer/index-e.asp

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STATISTICS CANADA

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Canadian Cancer Society offices

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Fax: 403-205-3979
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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