Canadian Cancer Statistics

A 2020 special report on lung cancer

Government of Canada Gouvernement du Canada

Canadian Cancer Society

Produced by the Canadian Cancer Society, Statistics Canada, the Public Health Agency of Canada, in collaboration with the provincial and territorial cancer registries
cancer.ca/statistics

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

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About this special report

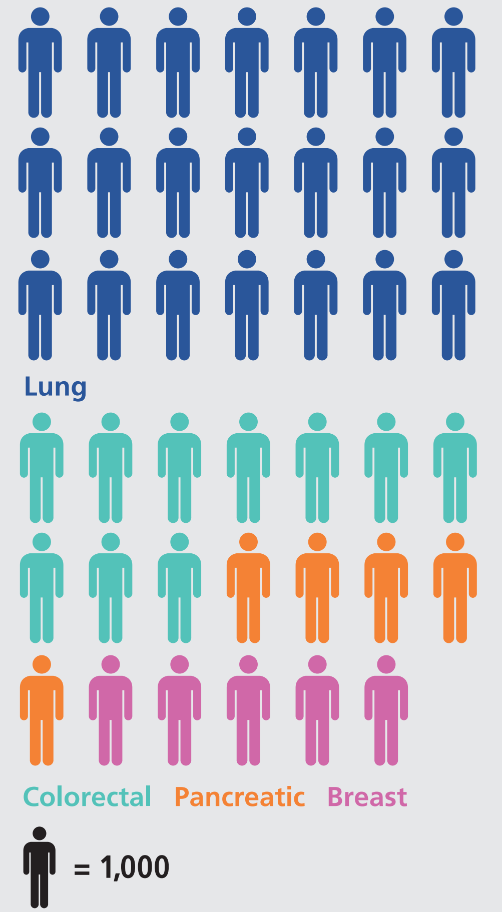
Lung cancer is projected to continue being the most commonly diagnosed cancer and the leading cause of cancer death in Canada in 2020, accounting for 1 in 4 of all cancer deaths. At 19%, the five-year net survival for lung cancer is among the lowest of all types of cancer. Although we have made tremendous progress in lung cancer as a result of tobacco control, there is much more to do.

This special report provides new, detailed estimates of lung cancer incidence, mortality, survival and prevalence in Canada. Where relevant, this information is presented by sex, age group, geographic region, histologic type, stage and time period. It also provides information on important and emerging issues related to lung cancer, such as risk factors, screening, treatment and equity. The findings provide new insight into lung cancer patterns in Canada that can be used to help identify where gaps and opportunities exist.

We hope that our readers think critically about how they can use these numbers in their own work to reduce lung cancer incidence, improve survival and develop better overall care for those dealing with lung cancer in Canada.

This special report sheds important light on the continued high burden of lung cancer, along with the critical importance of enhancing prevention efforts and implementing organized lung cancer screening programs.

In 2020, lung cancer is expected to cause more deaths than colorectal, pancreatic and breast cancers combined.



About Canadian Cancer Statistics

Canadian Cancer Statistics is a partnership between the Canadian Cancer Society, Statistics Canada and the Public Health Agency of Canada aimed at generating and disseminating the latest surveillance statistics on cancer in Canada. To achieve this goal, the partner organizations bring together expertise from across the cancer surveillance and epidemiology community in the form of the Canadian Cancer Statistics Advisory Committee.

The three main Canadian Cancer Statistics products are:

- **Full publication**: Every second year, we release a publication that provides detailed estimates of cancer incidence, mortality and survival by sex, age group, geographic region and time period for more than 20 of the most commonly diagnosed cancers in Canada. The most recent edition was *Canadian Cancer Statistics 2019*, which was published in September of 2019. The next edition is expected in 2021.
- **Snapshot of projected estimates**: In between years with the full publication, we release projected estimates of incidence and mortality by sex and geographic region for the current year. The purpose of this work is to ensure that current-year estimates are available annually. The 2020 projected estimates were published in an article titled Projected estimates of cancer in Canada in 2020 in the Canadian Medical Association Journal in March of 2020. The next snapshot will be released in 2022.
- **Special report**: In the same years as the snapshot publication, we also publish a special report on a topic of particular importance to the cancer control community. The 2020 special report is on lung cancer. The next special report will be published in 2022.

These Canadian Cancer Statistics products are designed to help health professionals, policy-makers and researchers make decisions and identify priorities for action in their respective areas. However, the information contained in these products is relevant to a much broader audience. As such, the media, educators and members of the public with an interest in cancer may also find these products valuable.

All Canadian Cancer Statistics products, along with supporting resources, are accessible through cancer.ca/statistics.

Introduction

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Key findings

- For lung cancer, incidence and mortality rates among males have been declining for over 20 years. The decline in incidence has been especially notable since 2012. Among females, rates began to decline in 2012 for incidence and in 2006 for mortality.
- Lung cancer incidence and mortality rates are higher among males than females, but these rates have been getting closer over time.
- Among Canadians younger than 55 years of age, lung cancer incidence and mortality rates are higher in females than males.
- Excluding Quebec, lung cancer incidence and mortality rates are generally highest in the territories and Atlantic provinces.
- In most provinces and territories, the lung cancer incidence rate has been decreasing for males and decreasing or remaining stable for females. Mortality rates show a similar pattern.
- Almost 1 in 2 of all lung cancer cases with a specified histologic type is classified as adenocarcinoma, the most common histologic type. It is the only histologic type that is diagnosed at a higher rate among females than males.
- About half of all lung cancers are diagnosed at stage 4, at which point survival is extremely low.
- Lung cancer survival and prevalence are typically higher among females than males, regardless of age or province at diagnosis.

1. Please see *Appendix* for a description of the peer-review process.

Background

Lung and bronchus (lung) cancer is the most commonly diagnosed cancer and the leading cause of cancer death in Canada.[1] In 2020 alone, a projected 29,800 Canadians will be diagnosed with lung cancer and 21,200 will die from the disease. More Canadians die of lung cancer than colorectal, pancreatic and breast cancers combined. The high mortality reflects both its high incidence and low survival. Although lung cancer survival in Canada is among the highest in the world,[2] five-year net survival is estimated to be only 19%.[3,4]

Lung cancer is generally considered one of the most costly cancers.[5] It is estimated that lung cancer will cost Canada's publicly funded healthcare system $2 billion in 2020. This represents an average of about $70,000 per lung cancer case.[6] These estimates do not take into account the financial impact on the individual and their family, which can also be substantial.[7]

Risk factors

About 86% of lung cancer cases are attributable to modifiable risk factors, making it one of the most preventable cancers in Canada.[8] Tobacco is by far the leading cause of preventable lung cancer, accounting for about 72% of all cases.[9] Additional factors like radon gas, asbestos, air pollution and certain workplace exposures also increase the risk for lung cancer.[10–13]

Box A The impact of modifiable risk factors on lung cancer incidence and mortality

Contributed by Dr Darren Brenner and Dr Yibing Ruan on behalf of the ComPARe study team

The Canadian Population Attributable Risk of Cancer (ComPARe) study was released in May 2019. The ComPARe study brought together experts from across the country to estimate the number and percentage of new cancer cases in Canada now and in the future due to more than 20 modifiable risk factors.[8,12]

Risk factors are associated with cancer diagnoses, so the subsequent deaths from these diagnoses may also be attributable to the risk factors. The results presented in this section build on the original ComPARe findings by providing updated estimates of the percentage of lung cancer cases attributable to modifiable risk factor and new insight into the percentage of deaths attributable to these risk factors. Table A1 summarizes the percentages of current and future lung cancer cases and deaths that are expected to be attributable to each established risk factor.

TABLE A1 Percentage of lung cancer cases and deaths attributable to established risk factors, 2020 and 2045, Canada

	New cases		Deaths	
	2020	2045	2020	2045
Tobacco	74%	69%	75%	70%
Physical inactivity	11%	10%	12%	10%
Residential radon	7%	7%	7%	7%
Air pollution	6%	5%	6%	5%

The percentages presented in Table A1 cannot be directly added together, but a summary analysis revealed that these risk factors are estimated to account for 80% of all lung cancer cases in 2020 and 75% of all projected lung cancer cases in 2045. The lower percentages of cases expected between 2020 and 2045 assumes current decreases in exposure to tobacco, physical inactivity and air pollution will continue.

When possible risk factors (i.e., second-hand smoke, low fruit consumption and low vegetable consumption) are also considered, the percentage of preventable lung cancer cases rose to 85% in 2020 and 80% in 2045 (data not shown). This amounts to an estimated 25,200 preventable lung cancer cases in 2020 and 19,000 in 2045, for a total of 623,500 potentially preventable lung cancer cases over the 26-year period.

Correspondingly, these four established risk factors are expected to account for about 81% of all lung cancer deaths in 2020 and 76% in 2045.

When possible risk factors are also considered, the percentage of avoidable lung cancer deaths rose to 86% in 2020 and 81% in 2045. This amounts to an estimated 21,000 preventable lung cancer deaths in 2020 and 20,800 in 2045 for a total of 586,900 preventable lung cancer deaths over the 26-year period.

For more information about the ComPARe study, visit prevent.cancer.ca.

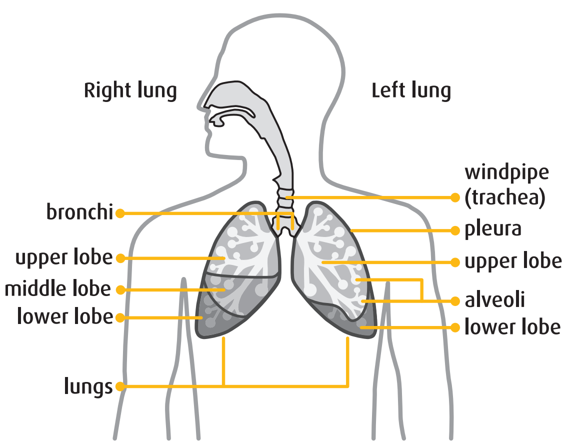
Non-modifiable factors that increase the risk for lung cancer include a personal or family history of lung cancer, a personal history of lung disease and a weakened immune system.

Box A provides new insight into the percentage of lung cancer deaths attributable to modifiable risk factors. Box B provides more information about the impact of workplace-related risk factors on lung cancer.

Types of lung cancer

Lung cancer starts in the cells of the lung or bronchus (Image A). Cancer that starts in another part of the body and spreads to the lung is called lung metastasis. This is not the same disease as primary lung cancer, which is the focus of this report.

Image A The lungs



Box B Some workers have a higher risk for lung cancer

Contributed by Dr Paul Demers on behalf of the Occupational Cancer Research Centre

The Burden of Occupational Cancer in Canada project estimated that about 15% of all lung cancer cases are attributable to well-established workplace carcinogens.[13] The percentage of workplace-related lung cancer cases is higher among males (25%) than females (5%).

The workplace exposures with the most significant impact on lung cancer are asbestos, diesel engine exhaust, crystalline silica, welding fumes, nickel, chromium, radon and second-hand tobacco smoke.[14] The greatest number of excess lung cancer cases was among people who had worked in the construction, transportation and mining industries, as well as some manufacturing sectors.

Cancers caused by workplace exposures are almost all preventable. However, according to CAREX (CARcinogen EXposure) Canada, hundreds of thousands of workers continue to be exposed to well-established lung carcinogens across Canada. Provincial, territorial and federal ministries of labour and workers' compensation agencies are responsible for regulating exposure to carcinogens, but effective prevention efforts require collaboration between these agencies and employers, unions and workers in hazardous industries.

For more information, visit:

- Burden of Occupational Cancer: https://www.occupationalcancer.ca/burden/
- Occupational Disease Surveillance Program: https://odsp-ocrc.ca
- CAREX Canada: https://www.carexcanada.ca/

Lung cancer is defined based on the histology of the cancer cells, which is how they look under a microscope. Lung cancer is divided into two main types: small cell lung cancer (SCLC) and non–small cell lung cancer (NSCLC). SCLC is diagnosed much less frequently than NSCLC, which accounts for about 9 in 10 lung cancer cases.

NSCLC is further classified into three main histologic subtypes: adenocarcinoma, squamous cell carcinoma and large cell carcinoma.

Like most other cancers, lung cancers are also classified as stage 1, stage 2, stage 3 or stage 4 based on the extent of disease in the body at the time of diagnosis. This includes the size of the primary tumour and if it has grown or spread into surrounding tissues or the cancer cells have spread to other parts of the body (Image B).

Sometimes uppercase letters are added to the stage number to divide these categories into substages. Substages are not included in this report.

A case is classified as "stage unknown" when there is not enough stage information to determine a stage.

Histology		
Types	**Non–small cell lung cancer (NSCLC)**	**Small cell lung cancer (SCLC)**
Subtypes	• Adenocarcinoma • Squamous cell carcinoma • Large cell carcinoma	

Image B Description of the stages of cancer

Stage 1	Stage 2	Stage 3	Stage 4
The cancer is relatively small and contained within the organ in which it started.	The cancer has not spread into surrounding tissue but the tumour is larger than in stage 1. Sometimes stage 2 means that cancer cells have spread into lymph nodes close to the tumour.	The cancer is large and may have spread into surrounding tissues and lymph nodes in the area.	The cancer has spread through the blood or lymphatic system from where it started to a distant site in the body (i.e., it has metastasized).

Incidence and mortality

Incidence and mortality by sex, age and geographic region

Table 1 shows the age-standardized incidence rate (ASIR) of lung cancer by sex, age and province or territory. Table 2 shows the same for mortality.

- For lung cancer, the incidence rate is about 20% higher in males than females and the mortality rate is about 31% higher in males than females. However, among Canadians younger than 55 years of age, rates are higher in females than males.
- The lung cancer incidence and mortality rates increase dramatically with age (Figure 1). Incidence rates peak among Canadians aged 75–84 years, while mortality rates peak among Canadians aged 85 years and older.

Among those younger than 55 years of age, lung cancer incidence and mortality rates are higher in females than males.

Incidence

The number of new cancer cases diagnosed in a given population during a specific period of time.

Mortality

The number of cancer deaths in a given population during a specific period of time.

Age-standardized incidence rate (ASIR)

The number of new cases of cancer per 100,000 people in a given population during a specific period of time, standardized to the age structure of the 2011 Canadian standard population. In this report, ASIR is also referred to as "incidence rate."

Age-standardized mortality rate (ASMR)

The number of cancer deaths per 100,000 people in a given population during a specific period of time, standardized to the age structure of the 2011 Canadian standard population. In this report, ASMR is also referred to as "mortality rate" or "death rate."

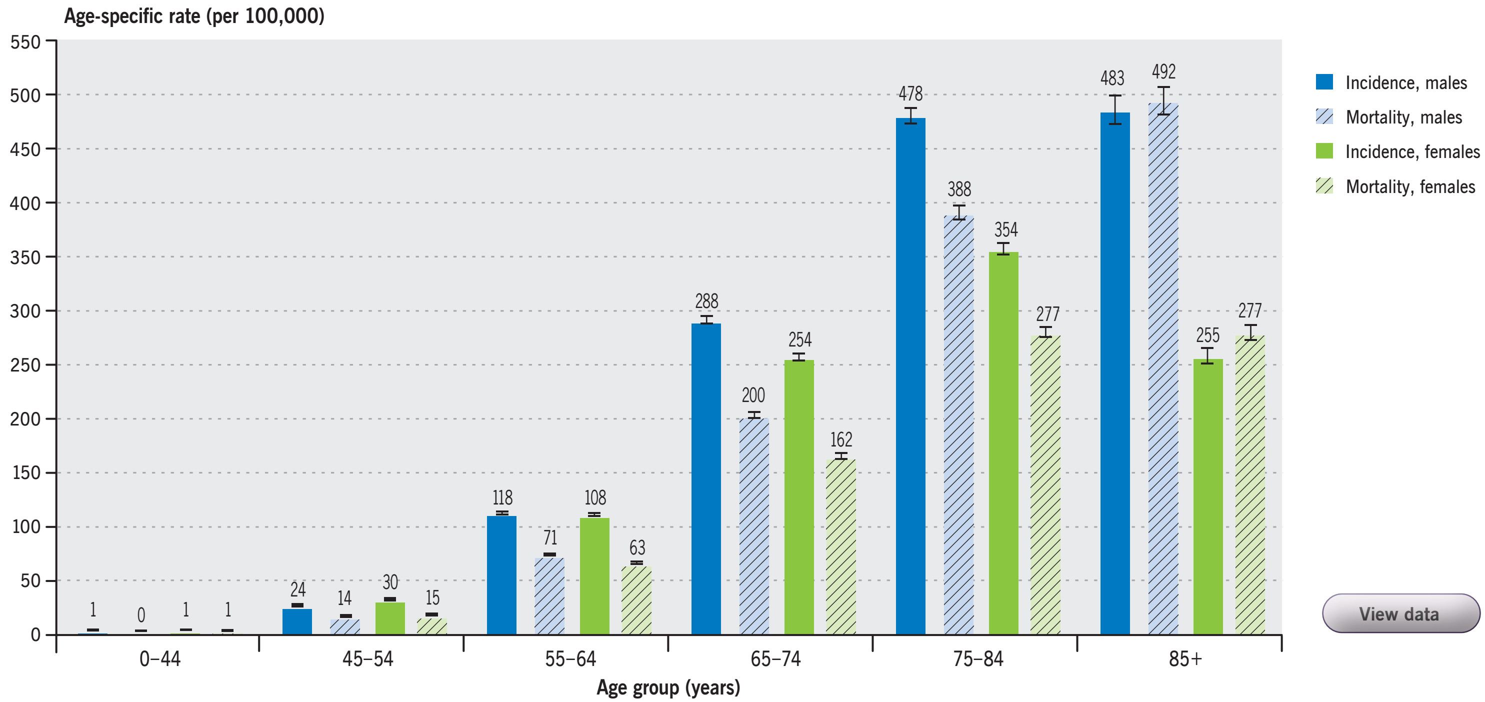
Statistical significance

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

Confidence interval (CI)

A range of values that provides an indication of the precision of an estimate. Confidence intervals are usually 95%. This means that, assuming no other sources of bias, if sample for a study was taken repeated over and over, 95% of the resulting confidence intervals would contain the true value of the statistic being estimated. The highest and lowest values of the interval are called the confidence limits.

FIGURE 1 Age-specific incidence (2012–2016) and mortality (2013–2017) rates for lung cancer, by sex, Canada (excluding Quebec)



Note: Quebec is excluded from incidence rates because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry and is excluded from mortality rates for consistency with the incidence data. Age-specific rates were based on counts randomly rounded to a base of five.

Analysis by: Centre for Population Health Data, Statistics Canada

Data source: Statistics Canada, Canadian Cancer Registry database (1992–2016) and Canadian Vital Statistics Death Database

Excluding Quebec, lung cancer incidence and mortality rates are highest in Nunavut, Northwest Territories and the Atlantic provinces. The lowest rates are in British Columbia (Figure 2).

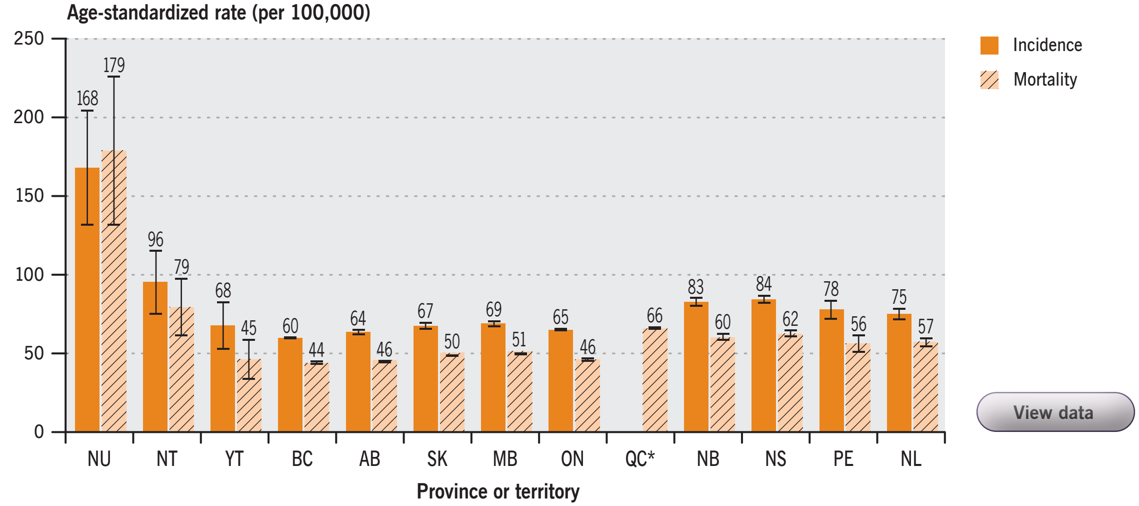
- Lung cancer incidence and mortality rates are higher in males than females in almost all provinces. There are no statistically significant differences in rates between males and females in any of the territories.

Why mortality can be higher than incidence

The mortality rate appears slightly higher than the incidence rate among Canadians aged 85 years and older and people in Nunavut. Incidence and mortality rates are not always expected to align for a few reasons.

For example, there is a latency between incidence and mortality, as mortality often reflects deaths from cases diagnosed one or more years before the current year. This can be amplified in smaller populations, like Nunavut, where year-to-year variation can be particularly high. It is also possible incidence is sometimes underestimated. This is particularly likely in older age groups when investigation of cancer diagnoses can be limited due to poorer health.

FIGURE 2 Age-standardized incidence (2012–2016) and mortality (2013–2017) rates for lung cancer, by geographic region, Canada



* No estimate of Quebec incidence is provided because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry.

Note: Age-standardized rates were calculated using weights from the 2011 Canadian standard population (see *Appendix*).

Analysis by: Centre for Population Health Data, Statistics Canada

Data sources: Statistics Canada, Canadian Cancer Registry database (1992–2016) and Canadian Vital Statistics Death Database

Making comparisons between provinces and territories

Differences in cancer measures, such as incidence and mortality, between provinces and territories could be the result of differences in past risk factors (such as smoking), diagnostic or treatment practices and access to care.

Many of the estimates in this report include confidence intervals. Confidence intervals provide a sense of how much uncertainty there is in the estimate. Typically, there is much less uncertainty for larger populations or samples than smaller ones. This means that extra caution must be taken when interpreting and comparing estimates of smaller provinces and territories.

Quebec estimates

No estimates of Quebec incidence are provided because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry. However, the most recent incidence data for Quebec (2010) indicates it had one of the highest lung cancer rates among provinces and territories. Also, Quebec mortality estimates indicate that the province currently has one of the highest lung cancer mortality rates in the country. Therefore, it is likely that Quebec's current incidence rate is among the highest in the country.

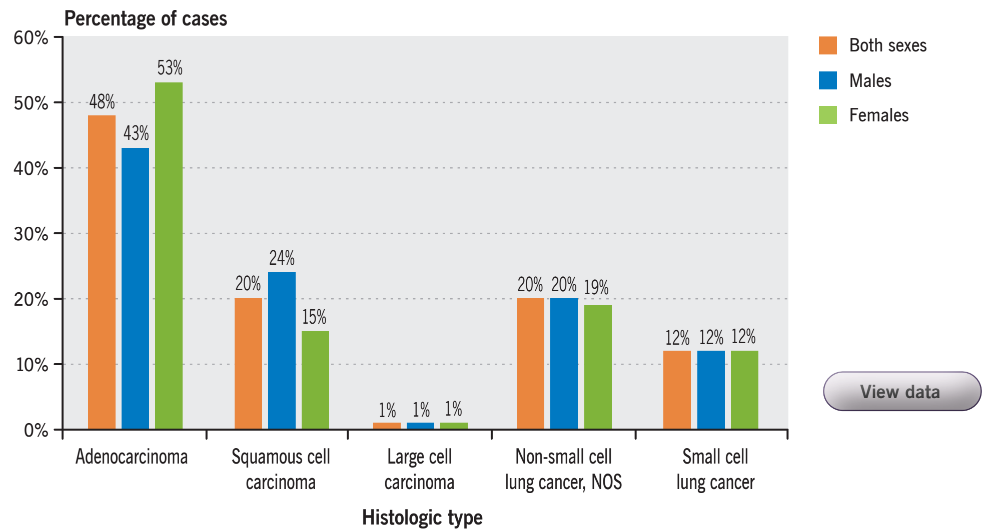
Incidence by histologic type

In Canada (excluding Quebec), about 88% of lung cancer cases with a specified histologic type are NSCLC (Figure 3). Adenocarcinoma is the most common type of lung cancer, accounting for 48% of specified cases, followed by squamous cell carcinoma (20% of specified cases) and non–small cell lung cancer, not otherwise specified (NOS; 20% of specified cases). About 12% of lung cancers with a specified histologic type are small cell lung cancer (SCLC). These percentages do not include cases for which histologic type was unspecified.

The distribution of cases by histologic type is similar between sexes for most types. The exceptions are adenocarcinoma, which is more commonly diagnosed in females than males, and squamous cell carcinoma, which is more commonly diagnosed in males than females (Table 1).

Almost 1 in 2 lung cancer diagnoses with a specified histologic type is adenocarcinoma. It is the only histologic type that is diagnosed more frequently in females than males.

FIGURE 3 Percent distribution of lung cancer cases, by specific* histologic type and sex, Canada (excluding Quebec), 2012–2016



NOS=not otherwise specified

*The histologic type was unspecified for 12% of all lung cancer cases (i.e., including cases with both specified and unspecified histology).

Note: Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry.

Analysis by: Centre for Population Health Data, Statistics Canada

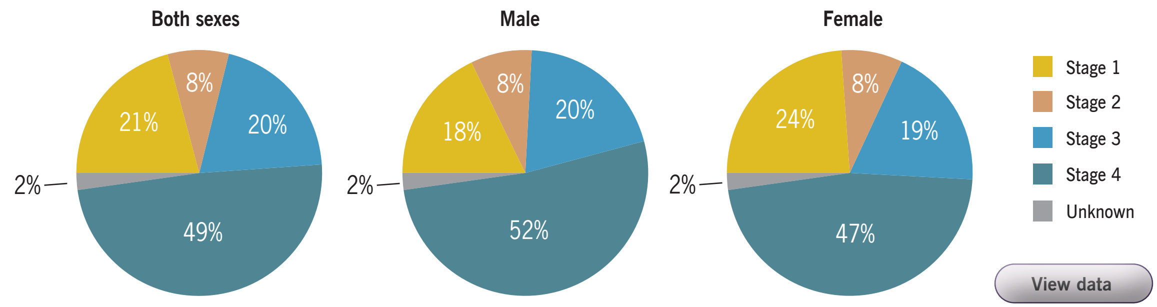
Data source: Statistics Canada, Canadian Cancer Registry database (1992–2016)

Incidence by stage at diagnosis

Approximately half of all lung cancer cases in Canada were stage 4 at diagnosis (Figure 4). An additional 20% of cases were diagnosed at stage 3. A greater percentage of males than females were diagnosed at stage 4, while the reverse was true for stage 1 cases.

> Regardless of sex, age, histologic type or province, lung cancers were most likely to be diagnosed after they have metastasized (stage 4).

FIGURE 4 Percent distribution of lung cancer cases, by stage and sex, Canada (excluding Quebec), 2012–2016



Note: Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry.

Analysis by: Centre for Population Health Data, Statistics Canada

Data source: Statistics Canada, Canadian Cancer Registry database (1992–2016)

About the histologic types

NSCLC accounts for most lung cancer cases. It is further classified into three main subtypes and not otherwise specified category.

- *Adenocarcinoma* is the most commonly diagnosed histologic type. It is also the most commonly diagnosed histologic type in people who have never smoked. Adenocarcinoma tends to develop in smaller airways, such as the alveoli, and grow more slowly than the other types of lung cancer.
- *Squamous cell carcinoma* is more strongly associated with tobacco smoking than any other type of NSCLC. It tends to develop in the middle part of a lung or one of the main airways. These tumours often cause symptoms, such as coughing up blood, trouble breathing and chest pain, earlier than adenocarcinoma.
- *Large cell carcinoma* can appear in any part of the lung. It tends to grow and spread quickly, making it hard to treat. Because of a recent change in the way large cell carcinoma is classified,[15] they now represent a small proportion of all lung cancer cases.
- *Non–small cell lung cancer, not otherwise specified (NOS)* includes tumours that have not undergone pathological examination or the pathological examination has failed to identify the NSCLC subtype. It may also be referred to as "other non–small cell lung cancer."

SCLC is diagnosed much less frequently than NSCLC. It usually starts in the bronchi and is very aggressive. SCLC is almost always diagnosed in people with a smoking history.

Histologic type–specific analyses

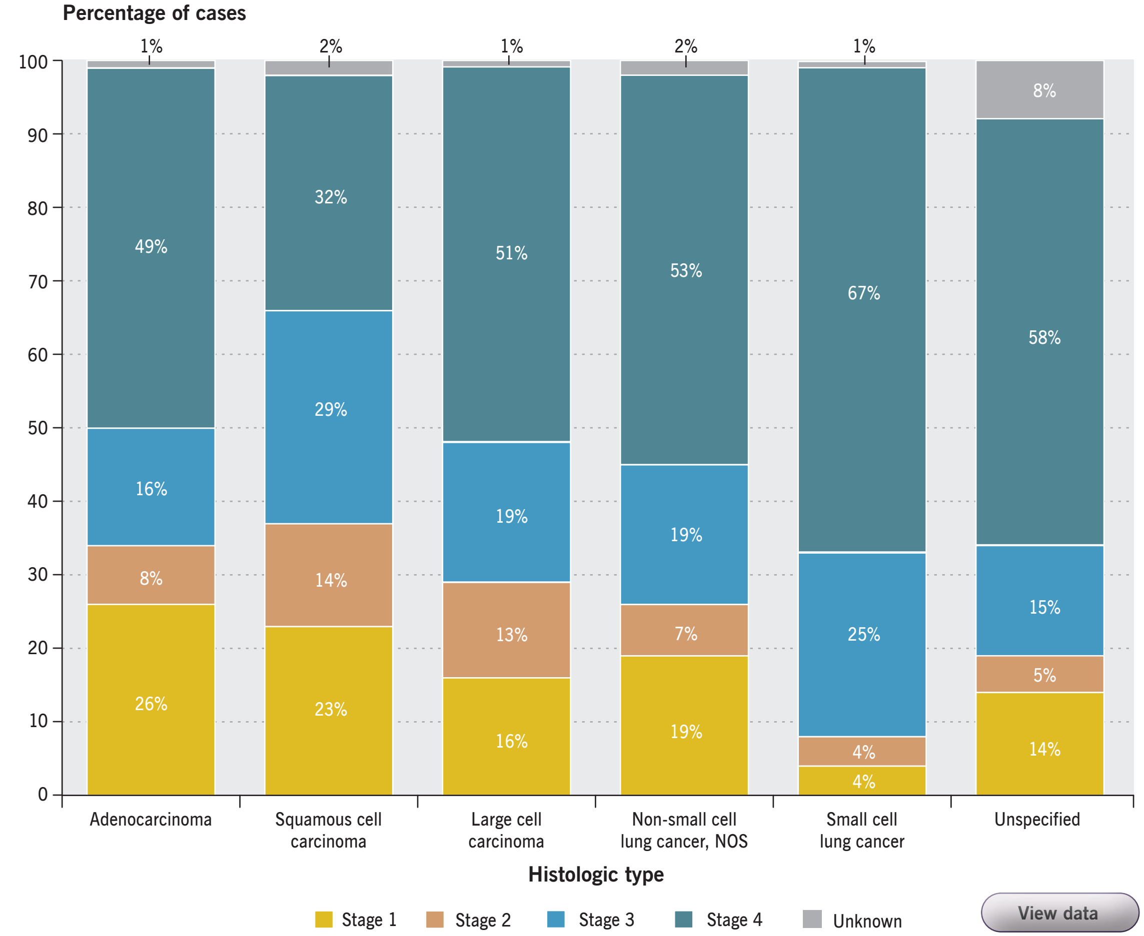
Sarcomas and other specified malignant neoplasms were included in the analyses of all lung cancers combined but were excluded from histologic type–specific analyses. See *Appendix* for how lung histologic types were defined.

Stage at diagnosis varied by histologic type (Figure 5). Sixty seven percent of SCLC are diagnosed at stage 4 compared with 32% of squamous cell carcinoma. SCLC had the lowest percentage of stage 1 or 2 diagnoses at only 8% combined. For other histologic types, the percentage of stage 1 and 2 diagnoses combined varied from 19% (unspecified) to 37% (squamous cell carcinoma).

Table 3 shows that, regardless of sex, age, histologic type or geographic region, lung cancers were most likely to be diagnosed at stage 4 and least likely to be diagnosed at stage 2 (excluding those of unknown stage).

- Regardless of stage at diagnosis, the rate increased with age.
- The highest rate of stage 4 lung cancers was in Nunavut (57 per 100,000), while the lowest was in Ontario (28 per 100,000).
- The highest rate of unknown stage at diagnosis occurs in people aged 85 years or older.

FIGURE 5 Stage-specific percent distribution of lung cancer cases, by histologic type, Canada (excluding Quebec), 2012–2016



NOS=not otherwise specified

Note: Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry. Excluded from the denominator were cancers that were not staged or staged as "Occult." This included cases assigned a stage grouping of "Not Applicable," "CS not run" or "Stage 0." Percent totals may not sum to 100 due to rounding.

Analysis by: Centre for Population Health Data, Statistics Canada

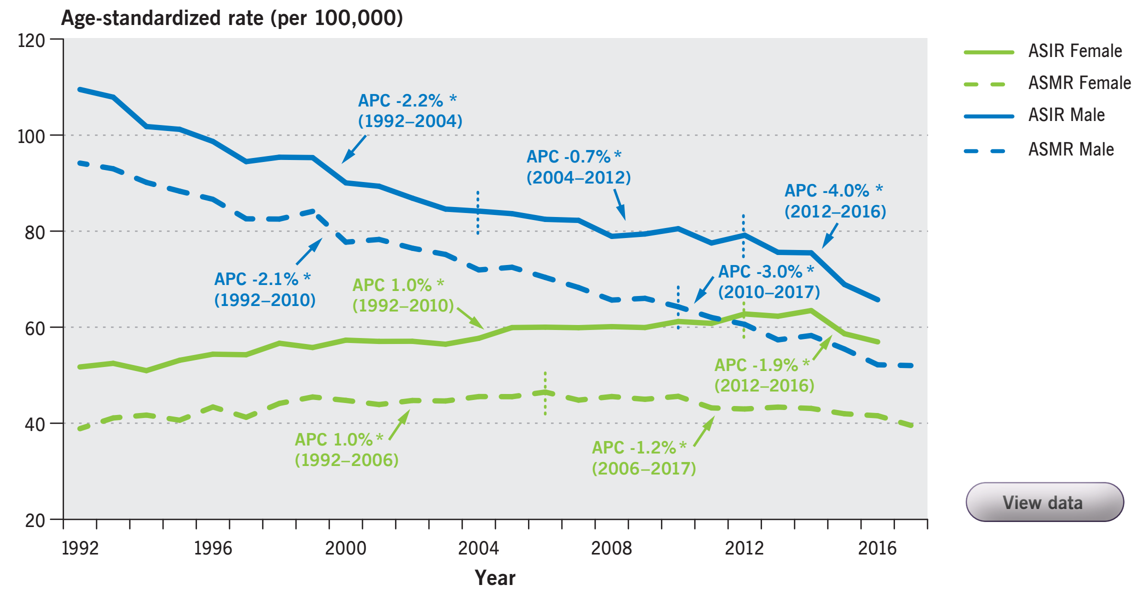
Data sources: Statistics Canada, Canadian Cancer Registry database (1992–2016)

Trends over time

Trends in lung cancer mortality largely follow trends in lung cancer incidence (Figure 6).

- Age-standardized lung cancer incidence and mortality rates have been declining among males for over 20 years. Between 1992 and 2016, the incidence rate decreased 41% (from 110 to 65 cases per 100,000). Between 1992 and 2017, the mortality rate decreased 45% (from 94 to 52 deaths per 100,000).
- The recent decreases among males have been particularly notable, with an annual percent change (APC) of -4.0% for incidence (2012 to 2016) and -3.0% for mortality (2010 to 2017).
- The incidence rate among females increased between 1992 and 2012, but since then it has been decreasing at a rate of about -1.9% per year. The mortality rate among females has been decreasing since 2006 at a rate of about -1.2% per year.
- In Canada, both incidence and mortality rates have been converging between the sexes as a result of changes in the sex-specific patterns in lung cancer over time. For example, the lung cancer incidence rate in males was more than double the rate in females in 1992. By 2016, the incident rate for males was only 15% higher than the rate for females.

FIGURE 6 Trends in age-standardized incidence (1992–2016) and mortality (1992–2017) rates for lung cancer, by sex, Canada (excluding Quebec)



*APC differs significantly from 0, p<0.05

APC=annual percent change; ASIR=age-standardized incidence rate; ASMR=age-standardized mortality rate

Note: Quebec is excluded from incidence rates because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry and is excluded from mortality rates for consistency with the incidence data. Age-standardized rates were calculated using weights from the 2011 Canadian standard population (see *Appendix*).

Analysis by: Centre for Population Health Data, Statistics Canada

Data sources: Statistics Canada, Canadian Cancer Registry database (1992–2016) and Canadian Vital Statistics Death Database

Annual percent change (APC)

The estimated change in a rate per year over a defined period of time in which there is no significant change in trend (i.e., no changepoint). It is reported as a percentage.

The difference in trends in lung cancer rates in males and females largely reflects past differences in tobacco smoking. In males, a decrease in the prevalence of daily smokers began in the mid-1960s in Canada, preceding the decrease in lung cancer incidence by about 20 years. In females, the decrease in smoking did not start until the 1980s.[3,16,17]

The difference in lung cancer incidence between the sexes has diminished considerably since the early 1990s.

Trends in incidence by age

The most recent trends show meaningful declines in lung cancer incidence rates for all age groups younger than 85 years, with APCs ranging from -2.0% to -5.5% (Table 4).

The incidence rate among females for all ages combined started decreasing in 2012. However, Table 4 indicates that lung cancer incidence rates have been declining since at least the early 1990s among females younger than 65 years of age.

Among males, there has been a general decrease in lung cancer incidence rates in all age groups since 1992. The exception is the rate for males aged 85 years and older, which remained stable.

Trends in incidence by geographic region

Trends in incidence rates for both sexes combined are currently decreasing in all provinces except Newfoundland and Labrador, where the rate is stable (Table 5). The current overall trend in Newfoundland and Labrador masks the fact that since 1992 the incidence rate among females increased by 2.8% per year and the rate among males decreased by -1.5% per year. The lung cancer incidence rate has been decreasing among males in all provinces and territories except the Northwest Territories. The biggest decrease in the rate for males was observed in Ontario (APC=-6.3% for 2012–2016). In contrast, while there is an overall decrease in incidence rates for females reported at the national level (-1.9% per year since 2012), the only statistically significant decreases were in Ontario (-3.3% since 2012), Saskatchewan (-3.4% since 2011) and Nunavut (-2.8% since 1992). Incidence rates in females are not changing significantly in most other jurisdictions, except that they are increasing in Newfoundland and Labrador and Nova Scotia.

Trends in incidence by histologic type

Figure 7 shows some important changes in incidence rates over time, by histologic type.

The rates of squamous cell carcinoma and small cell lung cancer (the two types most strongly associated with tobacco smoking) are lower than they were in 1992, while the rate of adenocarcinoma (the type most commonly diagnosed in non-smokers) is higher. It is hypothesized that this pattern, which has been observed elsewhere as well,[18] may be attributable to changes in cigarette composition and design,[19–21] as well as decreases in smoking.

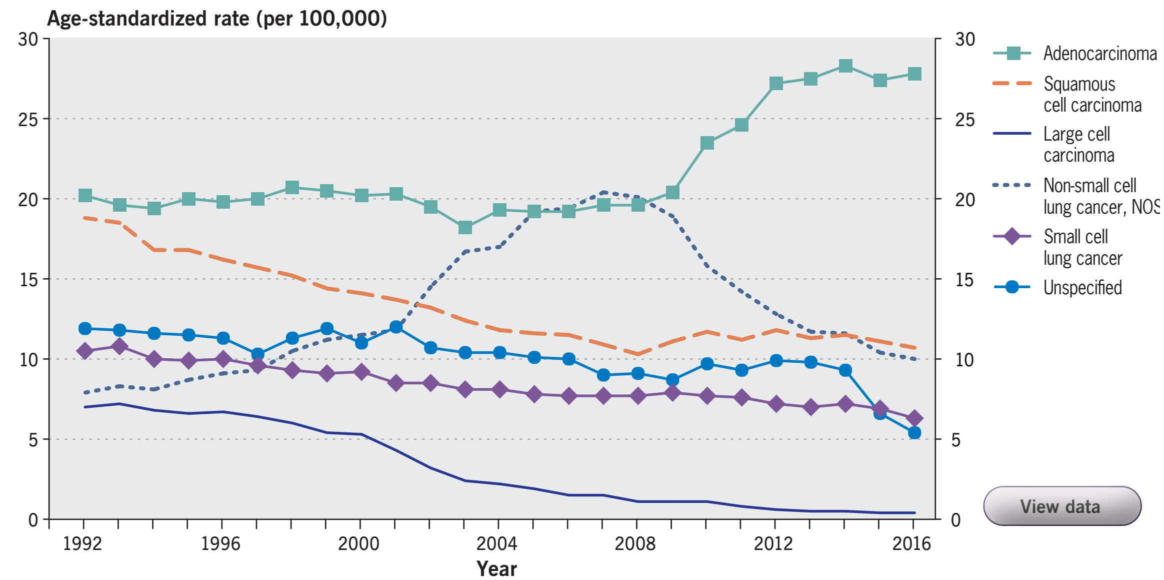
- The rate of non–small cell lung cancer, NOS, has been decreasing since around 2007. This decrease seems to mirror an increase in adenocarcinoma. This shift likely reflects, at least in part, improvements in lung cancer subtyping and an emphasis on adequate tissue sampling that followed emerging evidence on the importance of histologic type in determining treatment. Similar trends have been observed in other countries, including the United States.[18,22,23]
- There were notable decreases in large cell carcinoma beginning around 1999. This likely reflects a change in classification of large cell carcinoma.[15]

The lung cancer incidence rate in females is not decreasing in most provinces and territories.

Figure 8 breaks down these trends by sex and histologic type.

- For each histologic type, the incidence rate in males was higher than the rate in females in 1992. Over time, these rates generally converged, bringing the rate in males closer to the rate in females.
- Rates of adenocarcinoma were similar between sexes from 2005 and 2012, after which the rate in females surpassed the rate in males. Rates of adenocarcinoma have been stable in both sexes since 2012.
- The convergence of rates between males and females seemed to stabilize for squamous cell carcinoma around 2007. The biggest difference in rates by sex continues to exist for this histologic type (Table 1).
- Rates are not currently increasing significantly for any histologic type, though the APC is 1.8% (95% confidence limit -0.3%, 3.9%) for adenocarcinoma in females. For all other histologic types, the APC is below 0, suggesting statistically significant or non-statistically significant decreases in both sexes.
- See online data for the complete results of the trend analyses.

FIGURE 7 Trends in age-standardized incidence rates (ASIR) for lung cancer, by histologic type, Canada (excluding Quebec), 1992–2016



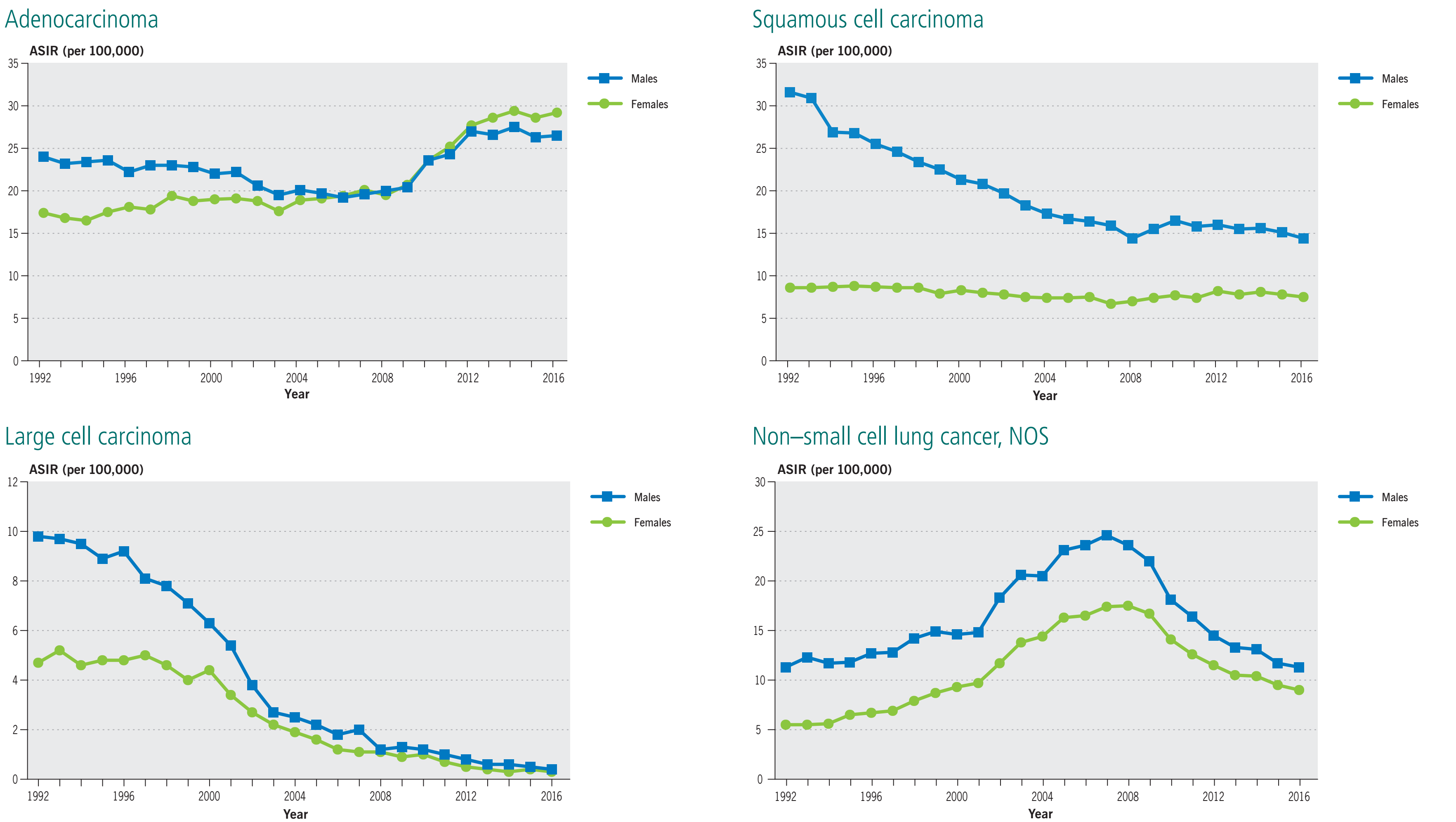
NOS=not otherwise specified

Note: Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry. Age-standardized rates were calculated using weights from the 2011 Canadian standard population (see *Appendix*).

Analysis by: Centre for Population Health Data, Statistics Canada

Data sources: Statistics Canada, Canadian Cancer Registry database (1992–2016)

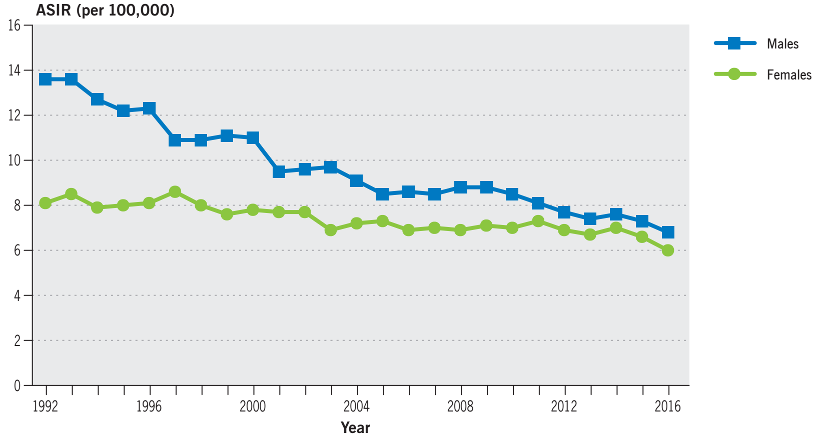
FIGURE 8 Trends in age-standardized incidence rates (ASIR) for lung cancer, by histologic type and sex, Canada (excluding Quebec), 1992–2016



View data

FIGURE 8 Trends in age-standardized incidence rates (ASIR) for lung cancer, by histologic type and sex, Canada (excluding Quebec), 1992–2016 *(continued)*

Small cell lung cancer



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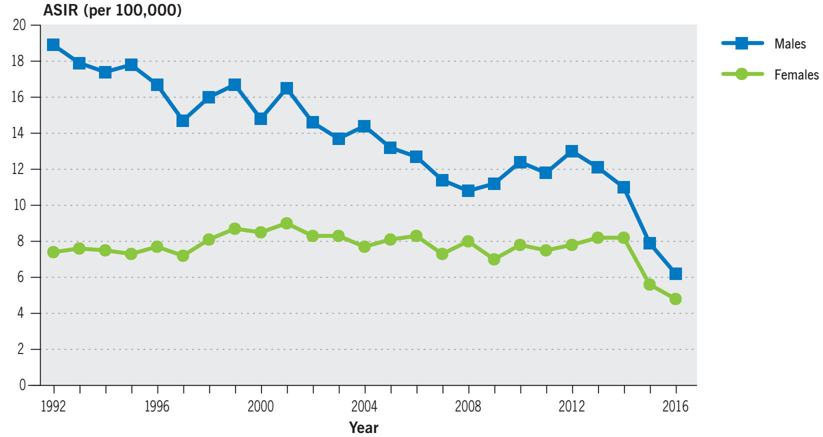

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NOS=not otherwise specified

Note: Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry. Age standardized rates were calculated using weights from the 2011 Canadian standard population (see *Appendix*).

Analysis by: Centre for Population Health Data, Statistics Canada

Data source: Statistics Canada, Canadian Cancer Registry database (1992–2016)

Survival

Survival from lung cancer is poor. A recent study showed that the five-year predicted net survival for the 2012 to 2014 period was 19%. This survival rate is lower than all other cancer types studied except esophageal cancer, pancreatic cancer, liver cancer and mesothelioma.[4] The study also showed the five-year net survival for lung cancer increased 5.4 percentage points since the 1992 to 1994 period, with most of the improvement occurring since the early 2000s. The absolute increase in survival for lung cancer since the 1992 to 1994 period was lower than corresponding increases for other commonly diagnosed cancers, such as female breast (6.8 percentage points), prostate (7.2), colon (9.3) and rectum (11.4). However, it represented a 41% relative increase.[4]

Survival by sex

For lung cancer, one-year and five-year net survival are higher among females than among males (Table 6).

- Five-year net survival for lung cancer is 22% among females and 15% among males. The survival advantage for females was apparent at one year of follow-up (49% versus 40%).
- Survival is higher among females than males across almost all age groups, histologic types, geographic regions and stages of disease. Survival is similar between sexes for the youngest (15 to 44 years) and oldest (85 to 99 years) age groups and for those diagnosed with an unspecified histologic type.

Lung cancer survival is typically higher among females than males, regardless of age, histologic type or province at diagnosis.

Net survival

The percentage of people diagnosed with a cancer who survive a given period of time past their diagnosis assuming that the cancer of interest is the only possible cause of death. 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 different timeframes but, as is standard in other reports, five years has been chosen as the primary duration of analysis for this publication. However, three-year net survival is used for survival by stage due to data availability.

Predicted survival

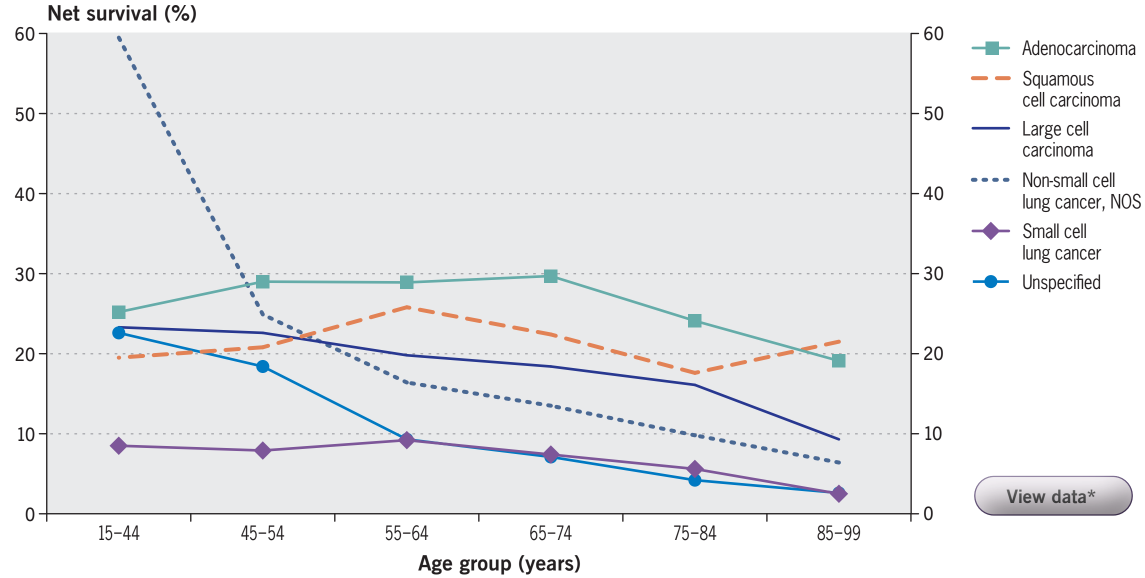
Predicted (period) survival provides a more up-to-date estimate of survival by exclusively using the survival experienced by cancer cases during a recent period (e.g., 2012 to 2014). When there is an increasing trend in survival, predicted estimates provide a more up-to-date, though conservative, measure of recent survival.[24,25]

Survival by age

Net survival for lung cancer generally decreases with advancing age (Table 6).

- Five-year net survival declined from 35% among those between 15 and 44 years of age at diagnosis to 9% among those 85 to 99 years of age.
- Among males, the decline was larger in the younger age groups. The reverse was true among females.
- For those diagnosed with non–small cell lung cancer, NOS, five-year net survival decreased from 60% (95% confidence interval [CI] 52%–67%) among those aged 15 to 44 years at diagnosis to 25% (95% CI 22%–28%) among those aged 45 to 54 years. Survival continued to consistently decline with the older age groups, but to a lesser extent (Figure 9).
- In contrast, there was considerably less variation in age-specific net survival among those diagnosed with either squamous cell carcinoma or small cell lung cancer (Figure 9).

FIGURE 9 Five-year predicted net survival for lung cancer, by age group and histologic type, Canada (excluding Quebec), 2012–2014



NOS=not otherwise specified

*Includes confidence intervals for estimates

Note: Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry.

Analysis by: Centre for Population Health Data, Statistics Canada

Data sources: Statistics Canada, Canadian Cancer Registry death linked file (1992–2014) and life tables

Survival by geographic region

Across the provinces, little variation was observed in net survival for lung cancer (Table 6).

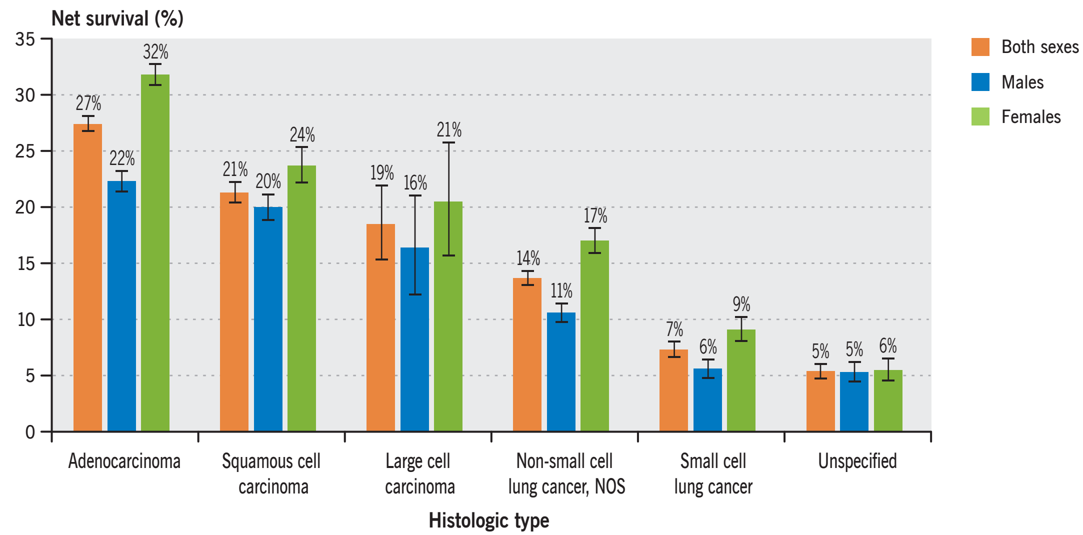
- Five-year age-standardized net survival for lung cancer was highest in Manitoba (21%), Ontario (20%) and New Brunswick (20%). It ranged from 16% to 18% elsewhere.
- While an age-standardized five-year survival estimate for Prince Edward Island could not be calculated, the corresponding unstandardized estimate was 12% (95% CI 9%–16%). In this instance, the unstandardized estimate very likely is an appropriate proxy measure (see limitations outlined in *Appendix*). The results suggest that lung cancer survival may have been lower in Prince Edward Island than in many other provinces.
- Geographic differences in survival may be due to many factors, including differences in stage and histologic type distributions.

Survival by histologic type

Net survival for lung cancer varied by histologic type.

- Five-year net survival was highest for adenocarcinoma (27%), but it was much lower among those diagnosed with small cell lung cancer (7%) and an unspecified histology (5%) (Figure 10). This pattern generally held true regardless of age at diagnosis (Figure 9).

FIGURE 10 Five-year predicted net survival estimates for lung cancer, by histologic type and sex, Canada (excluding Quebec), 2012–2014



NOS=not otherwise specified

Note: Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry.

Analysis by: Centre for Population Health Data, Statistics Canada

Data sources: Statistics Canada, Canadian Cancer Registry death linked file (1992–2014) and life tables

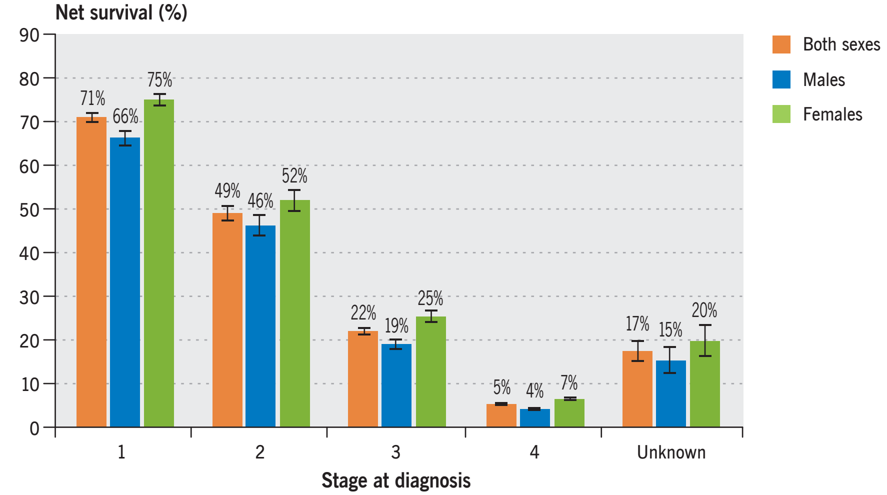
Survival by stage at diagnosis

Due to the availability of stage data, three-year net survival was used instead of five-year net survival to estimate survival by stage. Three-year net survival decreased significantly with later stage at diagnosis (Figure 11).

- Three-year net survival for lung cancer decreased from 71% among those diagnosed at stage 1 to 5% among those diagnosed at stage 4. Similar results were observed for both sexes with consistently higher survival among females.

Three-year net survival for lung cancer diagnosed at stage 4 was 5%, but it rose to 71% for lung cancer diagnosed at stage 1.

FIGURE 11 Three-year predicted net survival estimates for lung cancer, by stage and sex, Canada (excluding Quebec), 2012–2014



Note: Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry.

Analysis by: Centre for Population Health Data, Statistics Canada

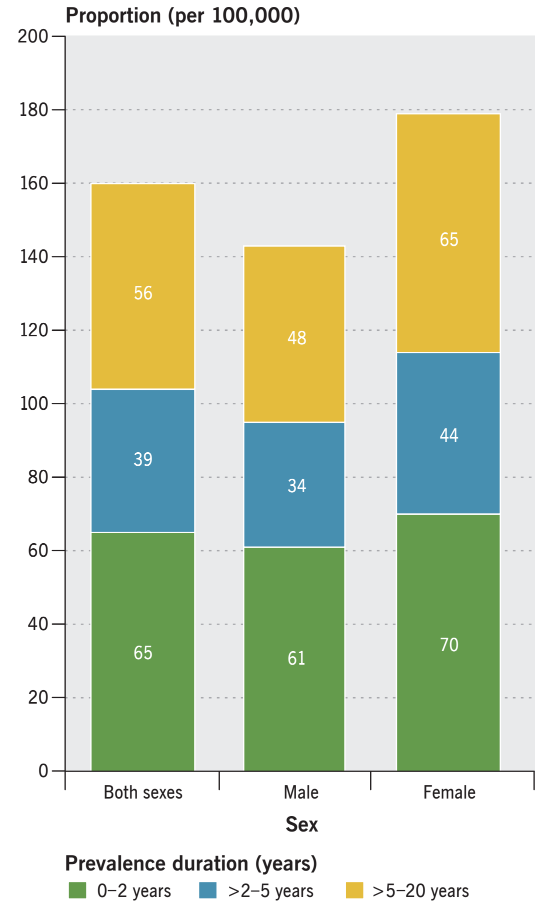
Data sources: Statistics Canada, Canadian Cancer Registry death linked file (1992–2014) and life tables

Prevalence

Despite being one of the leading cancers in terms of incidence, the poor long-term survival for lung cancer results in a much lower prevalence than that of breast, colorectal or prostate cancer.[26] Table 7 shows the lung cancer prevalence in 2015 by sex and age group.

- Among people in Canada (excluding Quebec) alive on January 1, 2015, an estimated 44,140 lung cancer cases had been diagnosed in the previous 20 years. Based on the size of Quebec and its historic lung cancer prevalence relative to the rest of Canada, the 20-year prevalence of lung cancer is estimated to rise to approximately 61,800 in Canada as a whole (see *Appendix* for details).
- Lung cancer prevalence proportions were higher among females than males, which is likely because of the higher survival rates among females. The higher prevalence held for two-, five- and 20-year durations (Figure 12).
- The prevalence proportion of lung cancer increased with increasing age, peaking in those aged 75 to 84 years, before declining among the oldest age group (Table 7).
- At the beginning of 2015, 41% of prevalent lung cancer cases diagnosed in the previous 20 years had been diagnosed in the two most recent years (i.e., 2013 or 2014). For all other cancers combined, this number is only 19%.[26] The relatively small lung cancer survivor population underscores the poor long-term prognosis for people diagnosed with this cancer.
- Table 8 shows the lung cancer prevalence by geographic region.[26]

FIGURE 12 Tumour-based prevalence proportions for lung cancer, by duration and sex, Canada (excluding Quebec), January 1, 2015



Prevalence

The number of cancers diagnosed within a specified time frame (previous two, five or 20 years) among individuals living on a certain date. In this case, that date is January 1, 2015.

Prevalence proportion

The number of cancers diagnosed within a specified time frame (previous two, five or 20 years) among individuals living on a certain date per 100,000 individuals in the population on that date.

Note: Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry. In the legend, 0–2 years refers to those diagnosed in 2013 and 2014; >2–5 years refers to those diagnosed between 2010 and 2012; >5–20 years refers to those diagnosed between 1995 and 2009. An entire bar corresponds to a 20-year proportion.

Analysis by: Centre for Population Health Data, Statistics Canada

Data sources: Statistics Canada, Canadian Cancer Registry database (1992–2016)

Related issues

Tobacco

Tobacco smoking is by far the leading cause of preventable lung cancer, accounting for an estimated 72% of all lung cancer cases diagnosed in 2015.[12] The latency period between tobacco smoking exposure and lung cancer diagnosis is estimated to be between 7 and 33 years,[27] meaning current tobacco consumption patterns are important for providing insight into future potential lung cancer patterns.

According to the Canadian Community Health Survey,[28] in 2018:

- An estimated 16% of Canadians were current (daily or occasional) smokers.
- A higher percentage of males (19%) were current smokers than females (13%).
- The prevalence of smoking was highest between the ages of 18 and 64 years (18% to 19%) and lowest among those older than 65 years of age (10%) and between the ages of 12 and 17 years (3.2%).
- There was some variation in smoking prevalence across provinces. Compared with the Canadian average, smoking prevalence is significantly higher in Saskatchewan (20%) and Quebec (18%) and lower in British Columbia (12%).

Although smoking data for the territories is from a different source, in 2017 to 2018, the percentage of people 12 years of age and older who smoked daily or occasionally was an estimated 63% in Nunavut, 35% in Northwest Territories and 20% in Yukon.[29]

The prevalence of tobacco smoking has decreased dramatically over the past 50 years. In 1965, about 50% of Canadians smoked,[16] compared to about 16% in 2018.[28] In males, this decrease started in the 1960s, but the decline in females did not begin until about 20 years later.[17] This pattern mirrors the pattern in lung cancer incidence rates, as lung cancer rates in females have only recently started to decline, 20 years after smoking in females started to decrease (Figure 6).

Smoking prevalence is much higher in Nunavut than any other province or territory.

E-cigarettes

E-cigarettes, also known as vapes, are battery-powered devices that try to create the same feeling as smoking cigarettes but without tobacco. The ingredients commonly include propylene glycol, glycerol, flavouring and nicotine.

It is generally believed that using e-cigarettes is less harmful than smoking, provided there is not dual use of both products. However e-cigarettes are not harmless. There is mixed evidence on the effectiveness of e-cigarettes as a tool to help smokers reduce or stop smoking tobacco.[30] E-cigarettes may not be more effective than already existing harm reduction tools, such as nicotine replacement therapy, pharmacotherapy and financial incentives.[31] However, it is difficult to make conclusions about their effectiveness in smoking cessation based on the limited research available. Therefore, the recent report from the Surgeon General of the United States on smoking cessation stated there currently is not adequate evidence to conclude that using e-cigarettes increases smoking cessation.[32]

The long-term effects of e-cigarettes are not yet known, including their association with lung cancer. However, evidence on the acute effects of e-cigarette use is emerging.[33] Also, there are important concerns that e-cigarette use is undermining tobacco control efforts and smoking, especially among youth.

- Notably, a 2017 survey suggested that most Canadians who have ever used e-cigarettes are under the age of 34, with the highest percentage reported among those in their early 20s.[34] Less than 10% of Canadians 45 years of age and older report ever using an e-cigarette.
- Additionally, a recent study showed a 74% increase between 2017 and 2018 in the

percentage of youth aged 16 to 19 years in Canada who had used an e-cigarette in the past 30 days.[35] This high and increasing use among youth is not surprising to those who think the e-cigarette industry is targeting their marketing to young people.[36] The study also showed a 45% increase in recent tobacco smoking in the same population.[35] This finding reinforces the idea that e-cigarette use may lead to increased tobacco use.

- Current advocacy efforts are primarily focused on restricting marketing and access to non-smokers, especially youth.

Cannabis

In October 2018, cannabis became legal in Canada. Since then, there have been increased efforts to collect data on cannabis consumption. This will contribute to our understanding of the effects of cannabis in the future. Some studies suggest that smoking cannabis over a long period of time may increase the risk for certain cancer types. The strongest evidence of an association is for testicular cancer, while evidence for lung, oral and other cancers remains unclear.[37] The link between cannabis and lung cancer may be because cannabis smoke contains many of the same carcinogens as tobacco smoke. Also, people who smoke cannabis tend to inhale more smoke per puff and hold it in their lungs for longer than people who smoke tobacco cigarettes. However, the evidence is inconsistent. More research is needed to determine if cannabis is a risk factor for lung cancer.

E-cigarette use is increasing among Canadian youth.

As with e-cigarette use, another concern with smoking cannabis is the potential of smoking more generally, especially since it is now legal to smoke and vape cannabis in many public places across Canada.

Screening

This report shows that about 50% of lung cancers are diagnosed at stage 4, at which point the three-year net survival is only about 5%. Meanwhile, only about 21% of lung cancers are diagnosed at stage 1, when the three-year net survival is over 70%. A major reason why lung cancers are diagnosed at a late stage is that symptoms are often unnoticeable at early stages.

Currently in Canada, there are no organized screening programs for lung cancer. However, opportunistic screening is occurring in at least six provinces[38] and implementation of organized programs is expected in the coming years. This is based on emerging evidence about lung cancer screening. Notably, two large randomized controlled trials have shown a significant (20% to 24%) reduction in mortality in current heavy smokers or former smokers who were screened using low-dose computed tomography (LDCT).

- The National Lung Screening Trial in the United States compared LDCT with standard chest x-ray in just under 53,500 individuals aged between 55 and 74 years who smoked 30 pack-years or more and smoked within the past 15 years.[39] 30 pack-years is defined as 1 pack per day for at least 30 years or 2 packs per day for 15 years. The study found a 20% reduction in lung cancer deaths among people screened annually for three years with LDCT compared with the standard chest x-ray.
- The Dutch-Belgian Randomized Lung Cancer Screening Trial (also called the NELSON study) compared LDCT with no screening in 15,822 people aged between 50 and 74 years who smoked an average of at least 15 cigarettes per day for 25 years or at least 10 cigarettes per day for 30 years or more and have smoked within 10 years. The study found that screening with LDCT resulted in a 24% reduction in lung cancer deaths in men. It also appeared to reduce lung cancer mortality risk even more in women.[40]

Organized screening programs follow guidelines to ensure a large proportion of the target group is screened and receives the appropriate follow-up care.

Opportunistic screening refers to the screening of individuals that occurs outside of an organized screening program.

The Canadian Task Force on Preventive Health Care (CTFPHC) currently recommends screening for lung cancer with LDCT in adults aged 55 to 74 years who currently smoke or who quit within the last 15 years and have smoked 30 pack-years.[41,42] The recommendations emphasize that LDCT screening only be carried out in settings with expertise in early diagnosis and treatment of lung cancer. They also note the importance of incorporating smoking cessation into any screening program aimed at reducing lung cancer morbidity and mortality.

As with any screening, there are risks associated with lung cancer screening. Examples include complications related to biopsy procedures or resection of benign lung nodules. When lung cancer screening is conducted among high-risk individuals, the benefits of LDCT screening are found to outweigh the potential harms.[43] Therefore, shared information for decision-making between the individual and their healthcare provider is also important.[44]

Opportunistic screening also presents a series of risks because it does not follow a set of regulations and is not monitored. For example, a potential risk is inappropriate screening of people who do not have a high risk of developing lung cancer. Another potential risk is that screening may be done by physicians who lack the necessary expertise or resources to appropriately interpret the scan, provide follow-up of abnormal results, diagnose lung cancer or offer treatment for early lung cancer. Opportunistic screening is also less likely to be connected to appropriate, evidence-based smoking cessation supports for current smokers. The CTFPHC guidelines recommend lung cancer screening only within organized programs.

Implementation of organized screening programs has been identified as an action in the 2019 to 2029 Canadian Strategy for Cancer Control.[45] There is a publicly funded lung cancer screening pilot trial in Ontario aimed at determining how best to implement organized screening in the province. In addition, British Columbia and Alberta have ongoing research studies aimed at determining how best to screen for lung cancer.[46–50]

All three efforts use a lung cancer risk prediction tool called the PLCOm2012 model.[51] The move to the PLCOm2012 model to determine eligibility for screening is based on studies that showed using this risk prediction tool has several benefits over using age and pack-years as criteria.[51,52] For example, the model (1) led to fewer people being screened, (2) identified a higher percentage of lung cancer cases and (3) resulted in a lower percentage of false positives.

While about 10% to 20% of screening-aged adults in the general population smoke,[28] about half of individuals who meet lung cancer screening eligibility criteria are active smokers.[48] This reinforces the importance of integrating smoking cessation into lung cancer screening programs and explains why it is a crucial part of the CTFPHC's recommendation. For former smokers, screening is one of the best options to reduce their risk of dying from lung cancer.

Efforts are underway to support implementation of organized lung cancer screening programs in Canada.

Box C provides additional information on the potential impact of lung cancer screening on outcomes in Canada. Box D sheds light on socio-economic disparities in lung cancer outcomes that reinforce the important need to ensure universal and equitable access to proven interventions, like lung cancer screening.

Treatment

Lung cancer and its associated care has a tremendous impact on Canadians, their loved ones and the Canadian healthcare system. The main types of lung cancer treatment are surgery, radiation, chemotherapy and palliative care (i.e., symptom management). The most appropriate treatment depends upon the stage and histologic type of the cancer, as well as the health of the individual.

Surgery typically offers the best chance for successful treatment or disease management, but only a small percentage of people diagnosed with lung cancer are eligible for surgery with curative intent. Radiation therapy, especially with new advances in how it is delivered, offers a potentially curative treatment option for individuals who are not well enough to have surgery. Radiation also plays an important part in symptom control for people diagnosed with more advanced stage disease. Chemotherapy can increase the chance of successful treatment for some people with lung cancer when it is given after surgery. It is also used for lung cancers that have spread, with the aim of extending survival and improving quality of life. Targeted therapy (usually pill-based) and, increasingly, immunotherapy may work better than chemotherapy in lung cancers that have spread or may be added to chemotherapy, depending on extra tests of the cancer cells.

The most overlooked treatment option is palliative care.[53] While often associated with end-of-life care, in reality palliative care focuses on the comfort and wellness of people with cancer regardless of their prognosis.[54] Palliative care can extend survival and enhance quality of life.[55] It should be a fundamental part of the treatment plan for all people with lung cancer.

Box C The projected impact of lung cancer screening

Contributed by Canadian Partnership Against Cancer

Setting

Using the Canadian Partnership Against Cancer's microsimulation model, OncoSim,[6] an analysis was conducted to project the lifetime impact of lung cancer screening with LDCT in Canada for a cohort of individuals eligible for screening in the next 20 years (2020 to 2039). This work was conducted by the Canadian Partnership Against Cancer to help provinces and territories develop business plans for implementing programs that optimize the quality and impact of lung cancer screening.

The analysis included three scenarios that are commonly considered by provinces and territories:

1. continue with no screening
2. offer annual screening up to three times to high-risk individuals aged 55 to 74 years (referred to here as "Annual x3")
3. offer screening every two years until the person is ineligible due to their age (up to 10 times) to high-risk individuals aged 55 to 74 years (referred to here as "Biennial x10")

In each scenario, it was assumed that lung cancer screening would start in 2020, reach a 40% participation rate in the subsequent 10 years and participants would have a rescreening rate of 70%. Also, smoking cessation would be offered to current smokers at each screening visit. An earlier analysis showed that integrating smoking cessation with lung cancer screening would prevent more lung cancer cases and save more life-years.[56]

Additional details on the methods are provided in the *Appendix*.

Impact of lung cancer screening

Screening could detect lung cancer earlier in a cohort of high-risk individuals eligible for lung cancer screening in the next 20 years in Canada. This could lead to 5,000 to 11,000 fewer lung cancer deaths in Canada over the lifetime of the cohort.

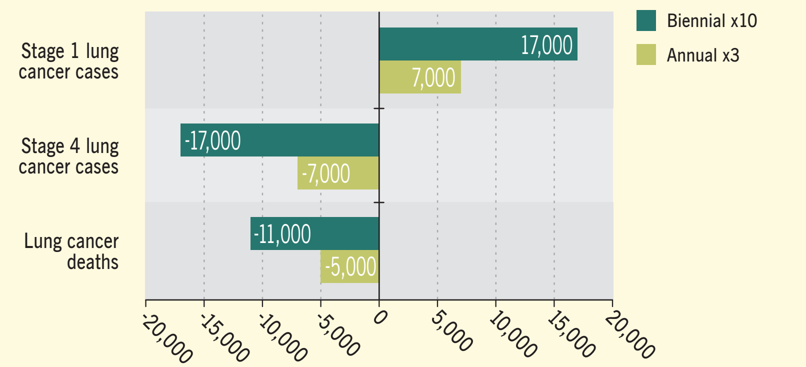
Cost-effectiveness of lung cancer screening

Over the lifetime of the cohort, lung cancer screening in high-risk individuals would be more clinically effective than no screening, but it would also cost more. Compared to no screening, the two lung cancer screening strategies cost less than $25,000 per quality-adjusted life-year (QALY) gained. This is considered highly cost-effective given the frequently used cost-effectiveness threshold in Canada is $50,000 per QALY gained.[57]

Conclusion

Lung cancer screening in a cohort of high-risk individuals could prevent 5,000 to 11,000 lung cancer deaths over the cohort's lifetime. The two commonly considered screening strategies (every year up to three times and every two years until the person is ineligible because of their age) are expected to be highly cost-effective.

Figure C1 Clinical impact of LDCT screening in Canada



Box D Equity and lung cancer

Contributed by Canadian Partnership Against Cancer

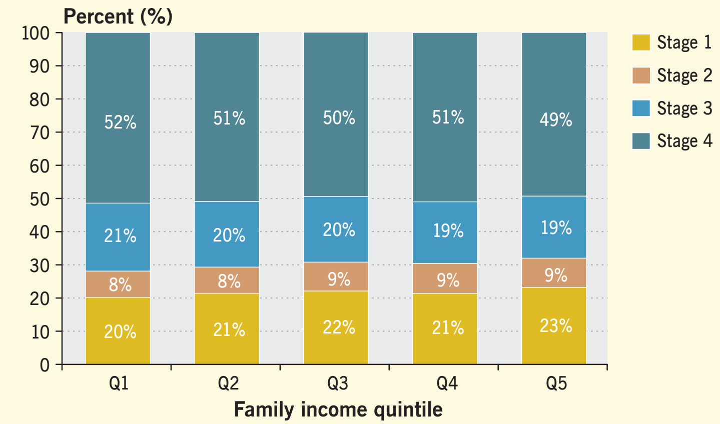
Canada has a publicly funded healthcare system intended to support equitable care for all.

Analysis of newly available data on income and other socio-economic factors indicate that there are disparities between access to care and outcomes for people with cancer who have high or low incomes. A full report on findings from this analysis will be featured in an upcoming report by the Canadian Partnership Against Cancer. Below is a preview of select findings.

Preview of findings from the Partnership's upcoming report

- People of low income are more likely to be diagnosed with lung cancer than people of high income.
- People of low income who are diagnosed with lung cancer are more likely to be diagnosed at a late stage than people of high income. Specifically, Figure D1 shows the percentage of people diagnosed with lung cancer at stage 3 or 4 was 4% higher for people in the lowest family income quintile compared with the highest. While 4% may seem small, it means that in 2020, a projected 300 lower-income Canadians would be diagnosed at a late stage (stage 3 or 4) rather than early stage (stage 1 or 2), when the probability of surviving is substantially better.
- Even when diagnosed early, when the chance of complete removal of the tumor is high, people of low income are less likely to receive curative surgery than people of high income.
- Figure D2 indicates lower survival among individuals of lower income than higher income, even when diagnosed at the same stage. The substantial decreases in three-year observed survival by stage emphasize the importance of early diagnosis on survival.

Figure D1 Distribution of lung cancer cases by stage at diagnosis and family income quintile, Canada (excluding Quebec), 2013–2015



Q=quintile

Note: Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry. Quintiles are shown from lowest (Q1) to highest (Q5).

Analysis by: Performance, Canadian Partnership Against Cancer

Data sources: Statistics Canada, Canadian Cancer Registry database (1992–2016) and T1 Family File (2017)

These and other results in the report reinforce the important need to ensure universal and equitable access to proven interventions to reduce lung cancer risk and improve survival outcomes. Additional investigation is also needed to better understand the factors underlying these inequities. This is further discussed in the Canadian Partnership Against Cancer's upcoming report.

In alignment with priorities of the 2019–2029 Canadian Strategy for Cancer Control, implementing lung cancer screening programs and increasing access to smoking cessation supports are two examples of interventions that will advance our efforts to reduce the inequities faced by people with lung cancer in Canada. As steward of the Canadian Strategy for Cancer Control, the Canadian Partnership Against Cancer is leading this work with policy makers and cancer programs across the country.

Box D Equity and lung cancer *(continued)*

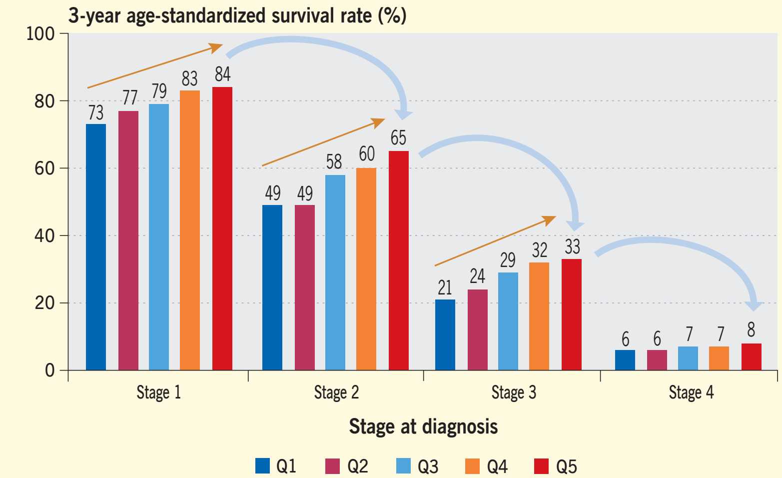
Linking cancer data to advance research and action on equity

The findings above are made possible through analysis of data linked as part of a collaborative effort of the Canadian Partnership Against Cancer and Statistics Canada to link the Canadian Cancer Registry to datasets containing socio-economic, treatment and mortality information at the individual level. This allows researchers to investigate disparities in cancer in Canada in ways not previously possible.

The upcoming report mentioned above will explore in more detail inequities among groups of people as they move through the lung cancer journey, including First Nations, Inuit and Métis; lower-income Canadians; immigrants; and people living in rural and remote regions of Canada.

The contents of this box were received after the peer-review process was complete so have not been peer reviewed (see *Appendix*).

Figure D2 Age-standardized, three-year stage-specific observed survival rates for lung cancer, by income quintile, Canada (excluding Quebec), 2010–2011



Q=quintile

Note: Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry. This figure shows estimates of three-year observed survival, which is different from the three-year predicted net survival shown elsewhere in the report. See *Appendix* for details. Quintiles are shown from lowest (Q1) to highest (Q5).

Analysis by: Performance, Canadian Partnership Against Cancer

Data sources: Statistics Canada, Canadian Cancer Registry database (1992–2015), T1 Family File (1992–2015) and Canadian Vital Statistics Death Database (1992–2014)

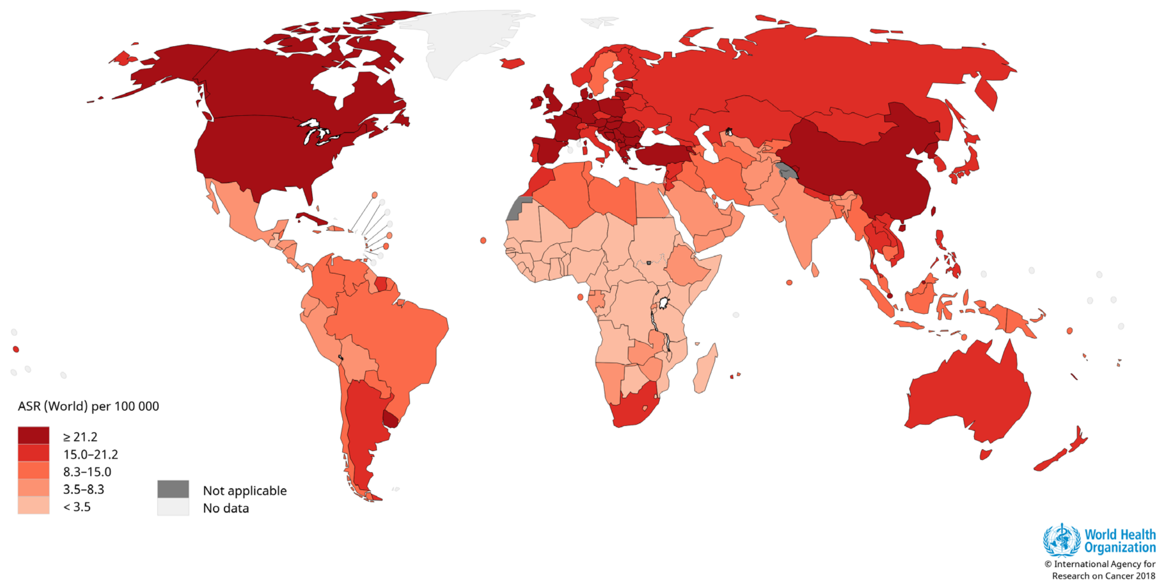
International comparison

Lung cancer is the leading cause of cancer incidence and death in the world, accounting for an estimated 2.1 million diagnoses and 1.8 million deaths in 2018.[58] Canada has among the highest rates of lung cancer incidence and mortality in the world.[58] Image C shows rates are indeed generally higher in many high-income countries (including many European countries, Canada and the United States) and are low in many African countries. Some of this pattern may be attributed to differences in the quality of reporting of lung cancer deaths around the world, as well as differences in life expectancy and exposure to lung cancer risk factors.

Despite the high incidence and mortality of lung cancer in this country, a recent study showed that Canada has among the highest lung cancer survival in the world.[2] The high incidence of lung cancer and poor survival around the world underscore the importance of improving lung cancer prevention, detection and treatment globally.

> Canada has among the highest lung cancer incidence and mortality rates in the world, but its survival is also among the highest.

Image C Estimated age-standardized mortality rates (ASMR) for lung cancer, both sexes, all ages, World, 2018



(http://gco.iarc.fr/today) World Health Organization

Graph production: IARC

Data source: GLOBOCAN 2018

Conclusion

Tremendous progress has been made in many aspects of lung cancer. Incidence and mortality rates for the disease are decreasing in both sexes, in most provinces and territories, in most age groups and for most histologic types. This progress is largely the result of success in prevention and cessation of tobacco use.

Still, there is a lot left to do. Lung cancer remains the most commonly diagnosed cancer and the leading cause of cancer death in Canada, accounting for 1 in 4 of all cancer deaths. Fortunately, important opportunities to reduce incidence and mortality exist, including enhancing lung cancer prevention and supporting organized screening programs. Also, better understanding the trends reported here will help move this issue forward.

Addressing stigma

Despite some improvement in lung cancer survival over time, it continues to have one of the lowest cancer survivals of all cancer types.[2] As a result, there is a not a big survivor population to advocate for the needs of people with lung cancer.

The fact that lung cancer currently receives only about 6% of research funding,[59] despite causing 1 in 4 cancer deaths,[1] may help explain the limited progress. Donations toward lung cancer are also estimated to be low.[60] Lung cancer is largely considered under-funded relative to the immense impact it has on people in Canada and the Canadian healthcare system.

Stigma may be a reason why the attention lung cancer receives does not align with its burden. Many members of the public continue to view smoking as a bad habit rather than a serious addiction. When people who smoke are diagnosed with lung cancer, they often feel ashamed and blamed by others.[61] It is also generally assumed that lung cancer is always caused by smoking. In reality, the percentage of lung cancer cases due to smoking is decreasing. Currently about 28% of lung cancer diagnoses are not attributed to smoking.[12]

Lung cancer stigma, whether real or perceived, can be a barrier to high-quality care and support.[62] Efforts to reduce stigma may be fundamental to improving clinical care and quality of life for people diagnosed with the disease.

Enhancing prevention

About 86% of lung cancer cases are attributable to modifiable risk factors, making it one of the most preventable cancers in Canada.[8] Tobacco awareness and tobacco control polices have had a dramatic effect on lung cancer in Canada. If Canada reaches its target of decreasing smoking prevalence to less than 5% by 2035, an estimated 50,225 lung cancer cases will be prevented by 2042.[9]

Unfortunately, the high and increasing use of e-cigarettes among youth[35] may compromise cancer control efforts by possibly re-normalizing tobacco smoking. Efforts to increase the legal age of use, restrict product flavours and decrease access may help mitigate these risks.

In the coming years, we may also see reductions in lung cancer incidence due to the ban on asbestos and radon mitigation strategies. Additional strategies to target the exposures in high-risk workplaces and support smoking cessation are needed to further reduce the impact of lung cancer in Canada.

Implementing organized screening programs

Earlier detection of lung cancer is key to improving survival and mortality. Half of all lung cancer cases are diagnosed at stage 4, at which point treatment with curative intent is rarely administered and survival is extremely low. In contrast, three-year net survival rises to 71% when lung cancers are diagnosed at stage 1.

Opportunistic lung cancer screening is currently occurring in at least six provinces,[38] but the Canadian Task Force on Preventive Health Care (CTFPHC) guidelines recommend lung cancer screening only within organized programs.[41,42] Lung cancer is the only cancer where organized screening is recommended by the CTFPHC but programs do not yet exist. This report shows organized lung cancer screening in Canada over the next 20 years is a cost-effective strategy that can lead to between 7,000 and 17,000 fewer stage 4 diagnoses and 5,000 to 11,000 fewer deaths.

Better understanding the patterns in lung cancer

Some of the patterns discussed in this report are relatively well understood, such as the decreases in incidence and mortality over time and the convergence of rates between sexes for most histologic types. Other trends are less clear.

Notably, it is not fully understood why adenocarcinoma is the only histologic type where the rate is higher in females than males, though the pattern has been reported elsewhere as well.[18] Interestingly, adenocarcinoma is the histologic type most commonly diagnosed among non-smokers. Information on smoking status by lung cancer type is limited in Canada, but data outside Canada suggests differences between females and males.[63] For example, in the United States and Europe an estimated 20% of females with lung cancer have never smoked compared with 2% to 6% of males.[64] This pattern is even more pronounced in Asian populations.[65] The higher percentage of lung cancers diagnosed in never-smoking females compared with never-smoking males suggests lung cancer may develop differently in females than in males.

Similarly, it has been proposed that non–small cell lung cancer (NSCLC) is a different entity in people who never smoked than in people who used to smoke or currently smoke. Greater understanding of the interplay between smoking and lung cancer in Canada may help us better interpret the patterns reported here, such as the finding that the lung cancer incidence rate is higher in females than males among Canadians younger than 55 years of age.

Patterns were not explored by ethnicity or immigration status. Given Canada's high ethnic diversity, the previously noted sex differences in lung cancer among never-smokers by country of origin and differences in exposure to risk factors around the world, it would be interesting to explore the impact of ethnicity and immigration status on lung cancer patterns in Canada. For example, it might help explain some of the geographic variation and changes over time reported here.

Additional research is needed to understand the patterns observed in this report. This information will be important for developing more appropriate lung cancer control strategies.

> Next steps should include enhancing prevention efforts, implementing organized screening, improving treatment, reducing lung cancer stigma and better understanding the trends reported here.

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Tables

TABLE 1 Age-standardized incidence rates for lung cancer, by sex, age group, histologic type and geographic region, Canada (excluding Quebec), 2012–2016

	Cases per 100,000 (95% CI)					
	Both sexes		Males		Females	
All lung cancer	**65.7**	**(65.3–66.2)**	**72.7**	**(72.1–73.4)**	**60.7**	**(60.2–61.3)**
Age group (years)						
0–44	1.1	(1.1–1.2)	1.0	(0.9–1.1)	1.2	(1.1–1.4)
45–54	26.7	(26.0–27.5)	23.9	(22.9–24.8)	29.6	(28.5–30.6)
55–64	108.8	(107.3–110.4)	109.6	(107.5–111.8)	108.1	(105.9–110.2)
65–74	270.7	(267.7–273.7)	288.5	(284.0–292.9)	254.2	(250.2–258.3)
75–84	409.8	(404.8–414.8)	477.7	(469.7–485.8)	354.5	(348.3–360.8)
85+	334.1	(327.1–340.8)	483.3	(469.4–497.5)	255.3	(248.0–262.8)
Histologic type						
Adenocarcinoma	27.6	(27.3–27.9)	26.8	(26.4–27.2)	28.7	(28.4–29.1)
Squamous cell carcinoma	11.3	(11.1–11.4)	15.3	(15.0–15.6)	7.9	(7.7–8.1)
Large cell carcinoma	0.5	(4.4–4.6)	0.6	(0.5–0.6)	0.4	(0.3–0.4)
Non–small cell lung cancer, NOS	11.2	(7.2–7.4)	12.8	(12.5–13.0)	10.2	(9.9–10.4)
Small cell lung cancer	6.9	(6.8–7.1)	7.3	(7.1–7.6)	6.6	(6.4–6.8)
Unspecified	8.1	(8.0–8.3)	9.9	(9.7–10.2)	6.9	(6.7–7.1)
Geographic region						
Nunavut Territory	168.0	(131.1–204.8)	161.7	(116.1–242.7)	174.3	(123.8–261.6)
Northwest Territories	95.5	(75.7–115.3)	103.4	(73.8–133.0)	88.1	(63.1–120.9)
Yukon Territory	67.8	(53.1–82.5)	78.0	(55.9–100.2)	56.9	(39.3–81.1)
British Columbia	59.9	(59.0–60.9)	63.6	(62.2–65.0)	57.4	(56.1–58.6)
Alberta	63.6	(62.4–64.8)	68.7	(66.8–70.6)	60.0	(58.4–61.7)
Saskatchewan	67.5	(65.3–69.7)	73.1	(69.8–76.4)	63.6	(60.7–66.6)
Manitoba	69.0	(67.0–71.1)	73.2	(70.0–76.3)	66.6	(63.8–69.4)
Ontario	64.8	(64.2–65.4)	72.5	(71.6–73.5)	59.3	(58.6–60.1)
New Brunswick	82.7	(80.0–85.3)	99.5	(95.2–103.9)	70.6	(67.2–73.9)
Nova Scotia	84.2	(81.8–86.6)	95.4	(91.6–99.2)	76.4	(73.3–79.5)
Prince Edward Island	78.0	(72.0–83.9)	87.0	(77.6–96.5)	72.0	(64.2–79.7)
Newfoundland and Labrador	75.1	(72.0–78.1)	90.3	(85.4–95.3)	62.5	(58.7–66.4)

CI=confidence interval; NOS=not otherwise specified

Note: Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry. Age-standardized incidence rates were calculated using weights from the 2011 Canadian standard population (see *Appendix*). Age-specific rates were based on counts randomly rounded to a base of five and were not age-standardized.

Analysis by: Centre for Population Health Data, Statistics Canada

Data source: Statistics Canada, Canadian Cancer Registry database (1992–2016)

TABLE 2 Age-standardized mortality rates for lung cancer, by sex, age group and geographic region, Canada (excluding Quebec), 2013–2017

	Cases per 100,000 (95% CI)					
	Both sexes		Males		Females	
All lung cancer	**47.5**	**(47.1–47.8)**	**55.0**	**(54.4–55.5)**	**41.9**	**(41.4–42.3)**
Age group (years)						
0–44	0.5	(0.5–0.6)	0.4	0.4–0.5)	0.6	(0.5–0.7)
45–54	14.7	(14.2–15.2)	14.0	(13.3–14.7)	15.4	(14.6–16.2)
55–64	67.2	(66.0–68.4)	71.2	(69.5–73.0)	63.2	(61.6–64.9)
65–74	180.7	(178.3–183.1)	200.5	(196.9–204.1)	162.3	(159.2–165.5)
75–84	327.1	(322.7–331.5)	387.9	(380.8–395.1)	277.4	(272.0–282.9)
85+	352.1	(345.2–359.1)	491.7	(478.0–505.7)	276.9	(269.4–284.6)
Geographic region						
Nunavut Territory	178.9	(131.5–226.3)	172.0	(116.3–263.9)	188.6	(122.0–295.3)
Northwest Territories	79.4	(61.1–97.6)	79.0	(55.6–111.8)	79.6	(55.2–112.3)
Yukon Territory	46.2	(33.9–58.6)	51.2	(34.2–77.3)	42.0	(27.1–63.4)
British Columbia	43.9	(43.1–44.7)	47.8	(46.5–49.0)	41.0	(39.9–42.0)
Alberta	45.8	(44.8–46.8)	52.0	(50.4–53.6)	41.1	(39.8–42.4)
Saskatchewan	50.3	(48.4–52.1)	55.0	(52.1–57.8)	46.9	(44.4–49.4)
Manitoba	51.4	(49.6–53.1)	57.9	(55.1–60.7)	46.8	(44.5–49.0)
Ontario	46.0	(45.6–46.5)	54.2	(53.4–55.0)	40.0	(39.3–40.6)
New Brunswick	60.1	(57.9–62.3)	76.5	(72.7–80.3)	48.3	(45.5–51.0)
Nova Scotia	62.5	(60.4–64.5)	73.8	(70.5–77.1)	54.2	(51.7–56.8)
Prince Edward Island	56.3	(51.3–61.3)	70.2	(61.7–78.6)	46.0	(39.9–52.1)
Newfoundland and Labrador	57.4	(54.8–60.1)	72.7	(68.2–77.3)	45.2	(42.0–48.5)

CI=confidence interval

Note: Quebec is excluded from incidence rates because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry and is excluded from mortality rates for consistency with the incidence data. Age-standardized incidence rates were calculated using weights from the 2011 Canadian standard population (see *Appendix*). Age-specific rates were based on counts randomly rounded to a base of five and were not age-standardized.

Analysis by: Centre for Population Health Data, Statistics Canada

Data source: Statistics Canada, Canadian Vital Statistics Death Database

TABLE 3 Age-standardized incidence rates for lung cancer, by stage, sex, age group, histologic type and geographic region, Canada (excluding Quebec), 2012–2016

	Cases per 100,000 (95% CI)									
	Stage 1		Stage 2		Stage 3		Stage 4		Unknown	
All	**12.8**	**(12.6–13.0)**	**5.0**	**(4.9–5.2)**	**12.0**	**(11.8–12.2)**	**30.5**	**(30.2–30.8)**	**1.2**	**(1.2–1.3)**
Sex										
Males	12.3	(12.0–12.6)	5.6	(5.4–5.8)	13.4	(13.2–13.7)	35.1	(34.7–35.6)	1.5	(1.4–1.6)
Females	13.5	(13.2–13.8)	4.6	(4.4–4.8)	11.0	(10.7–11.2)	26.9	(26.5–27.3)	1.0	(1.0–1.1)
Age group (years)										
0–44	0.2	(0.2–0.3)	0.1	(0.1–0.1)	0.2	(0.1–0.2)	0.5	(0.5–0.6)	0.0	(0.0–0.0)
45–54	4.3	(4.0–4.6)	1.6	(1.5–1.8)	4.7	(4.4–5.0)	14.3	(13.8–14.8)	0.2	(0.1–0.3)
55–64	20.2	(19.6–20.9)	8.0	(7.5–8.4)	21.0	(20.4–21.7)	53.2	(52.1–54.3)	1.1	(0.9–1.3)
65–74	57.3	(55.9–58.7)	22.5	(21.6–23.3)	51.5	(50.2–52.8)	122.1	(120.1–124.1)	3.6	(3.3–4.0)
75–84	84.2	(82.0–86.5)	32.6	(31.2–34.0)	74.5	(72.4–76.7)	181.9	(178.6–185.2)	9.6	(8.8–10.4)
85+	49.2	(46.6–51.9)	21.5	(19.8–23.3)	48.1	(45.6–50.8)	154.6	(149.9–159.3)	17.1	(15.6–18.8)
Histologic type										
Adenocarcinoma	7.0	(6.9–7.1)	2.2	(2.1–2.2)	4.1	(4.0–4.2)	13.0	(12.8–13.2)	0.3	(0.2–0.3)
Squamous cell carcinoma	2.6	(2.5–2.6)	1.5	(1.4–1.6)	3.2	(3.1–3.3)	3.5	(3.4–3.6)	0.2	(0.2–0.2)
Large cell carcinoma	0.1	(0.1–0.1)	0.1	(0.0–0.1)	0.1	(0.1–0.1)	0.2	(0.2–0.2)	0.0	(0.0–0.0)
Non–small cell lung cancer, NOS	2.1	(2.0–2.1)	0.7	(0.7–0.8)	2.0	(1.9–2.1)	5.7	(5.6–5.8)	0.2	(0.2–0.3)
Small cell lung cancer	0.3	(0.2–0.3)	0.2	(0.2–0.3)	1.7	(1.6–1.7)	4.5	(4.4–4.6)	0.1	(0.1–0.1)
Unspecified	0.9	(0.8–0.9)	0.3	(0.3–0.3)	0.9	(0.9–1.0)	3.5	(3.4–3.6)	0.5	(0.5–0.5)
Geographic region										
Nunavut Territory	33.0	(18.0–68.5)	15.6	(7.0–47.0)	35.2	(21.5–68.8)	57.0	(37.2–95.7)	2.7	(0.1–33.9)
Northwest Territories	12.8	(6.7–23.6)	10.9	(4.9–22.0)	25.2	(16.2–38.7)	39.7	(28.2–55.4)	5.7	(1.6–15.3)
Yukon Territory	7.1	(3.1–15.0)	5.3	(2.1–12.5)	21.7	(14.1–33.0)	30.9	(21.9–43.3)	2.8	(0.7–9.2)
British Columbia	10.1	(9.7–10.5)	4.5	(4.3–4.8)	12.3	(11.9–12.7)	29.5	(28.9–30.2)	3.2	(3.0–3.4)
Alberta	13.0	(12.4–13.6)	5.3	(4.9–5.6)	11.3	(10.8–11.8)	33.1	(32.2–33.9)	0.8	(0.6–0.9)
Saskatchewan	10.8	(9.9–11.6)	4.6	(4.0–5.2)	12.8	(11.9–13.8)	37.7	(36.1–39.4)	1.2	(0.9–1.4)
Manitoba	14.8	(13.8–15.7)	5.7	(5.1–6.3)	13.7	(12.8–14.7)	33.7	(32.2–35.1)	1.0	(0.8–1.2)
Ontario	12.5	(12.3–12.8)	4.8	(4.6–4.9)	11.1	(10.9–11.3)	27.9	(27.5–28.3)	0.6	(0.5–0.7)
New Brunswick	20.9	(19.5–22.2)	7.7	(6.9–8.5)	17.1	(15.9–18.3)	36.1	(34.4–37.9)	0.4	(0.2–0.6)
Nova Scotia	18.7	(17.6–19.9)	7.0	(6.3–7.6)	14.5	(13.5–15.4)	41.8	(40.1–43.5)	1.9	(1.6–2.3)
Prince Edward Island	14.4	(11.9–17.0)	5.4	(4.0–7.3)	17.5	(14.7–20.3)	39.1	(34.9–43.3)	1.1	(0.5–2.1)
Newfoundland and Labrador	17.9	(16.4–19.4)	5.9	(5.0–6.7)	14.7	(13.3–16.0)	33.9	(31.9–36.0)	2.1	(1.6–2.7)

CI=confidence interval; NOS=not otherwise specified

Note: Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry. Age-standardized incidence rates were calculated using weights from the 2011 Canadian standard population (see *Appendix*). Age-specific rates were based on counts randomly rounded to a base of five and were not age-standardized.

Analysis by: Centre for Population Health Data, Statistics Canada

Data source: Statistics Canada, Canadian Cancer Registry database (1992–2016)

TABLE 4 Age-specific trends in incidence rates for lung cancer, by sex, Canada (excluding Quebec), 1992–2016

Age group (years)	Both sexes				Males				Females			
	Period	APC	95% CL	p-value	Period	APC	95% CL	p-value	Period	APC	95% CL	p-value
0–44	1992–2001	-2.0	(-3.1, -0.8)	0.003	1992–2016	-4.0	(-4.4, -3.7)	<0.001	1992–2001	-0.7	(-2.6, 1.2)	0.421
	2001–2016	-4.7	(-5.4, -4.1)	<0.001					2001–2016	-5.0	(-6.1, -3.9)	<0.001
45–54	1992–2012	-2.2	(-2.6, -1.9)	<0.001	1992–2016	-3.5	(-3.7,-3.2)	<0.001	1992–2016	-1.5	(-1.8, -1.1)	<0.001
	2012–2016	-5.5	(-10.1, -0.7)	0.028								
55–64	1992–2016	-2.0	(-2.2, -1.9)	<0.001	1992–2004	-3.6	(-4.0, -3.2)	<0.001	1992–2016	-0.7	(-0.9, -0.5)	<0.001
					2004–2016	-2.3	(-2.9, -1.7)	<0.001				
65–74	1992–2012	-0.4	(-0.6, -0.3)	<0.001	1992–2002	-2.1	(-2.5, -1.8)	<0.001	1992–2006	1.7	(1.4, 2.0)	<0.001
	2012–2016	-2.9	(-4.5, -1.3)	0.001	2002–2012	-1.4	(-1.9, -0.9)	<0.001	2006–2016	0.0	(-0.5, 0.5)	0.972
					2012–2016	-4.3	(-6.4, -2.2)	<0.001				
75–84	1992–2003	0.6	(0.2, 1.0)	0.006	1992–2000	-1.6	(-2.1, -1.1)	<0.001	1992–2012	3.0	(2.7, 3.3)	<0.001
	2003–2012	1.7	(1.0, 2.4)	<0.001	2000–2012	0.1	(-0.3, 0.5)	0.543	2012–2016	-1.4	(-4.4, 1.7)	0.359
	2012–2016	-2.6	(-4.6, -0.6)	0.013	2012–2016	-3.7	(-5.7, -1.6)	0.002				
85+	1992–2016	1.4	(1.1, 1.7)	<0.001	1992–2016	-0.2	(-0.6, 0.1)	0.169	1992–2012	3.5	(3.1, 3.9)	<0.001
									2012–2016	-3.3	(-8.4, 2.0)	0.200

APC=annual percent change; CL=confidence limits

Note: Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry.

Analysis by: Centre for Population Health Data, Statistics Canada

Data source: Statistics Canada, Canadian Cancer Registry database (1992–2016)

TABLE 5 Geographic region-specific trends in age-standardized incidence rates for lung cancer, by sex, Canada (excluding Quebec), 1992–2016

	Both sexes				Males				Females			
	Period	APC	95% CL	p-value	Period	APC	95% CL	p-value	Period	APC	95% CL	p-value
Canada (excluding Quebec)	1992–2003	-0.9	(-1.2, -0.5)	<0.001	1992–2004	-2.2	(-2.5, -1.9)	<0.001	1992–2012	1.0	(0.8, 1.1)	<0.001
	2003–2012	0.1	(-0.4, 0.5)	0.829	2004–2012	-0.7	(-1.4, -0.1)	0.035	2012–2016	-1.9	(-3.4, -0.5)	0.011
	2012–2016	-2.9	(-4.2, -1.6)	<0.001	2012–2016	-4.0	(-5.5, -2.6)	<0.001				
Nunavut Territory	1992–2016	-2.9	(-4.8, -1.0)	0.005	—	—	—	—	1992–2016	-2.8	(-5.1, -0.4)	0.024
Northwest Territories	1992–2016	-0.2	(-1.6, 1.1)	0.705	1992–2016	-0.2	(-1.9, 1.5)	0.823	1992–2016	-0.3	(-2.6, 1.9)	0.755
Yukon Territory	1992–2016	-0.7	(-2.4, 1.1)	0.439	—	—	—	—	1992–2016	1.0	(1.9, 4.1)	0.479
British Columbia	1992–2016	-1.0	(-1.2, -0.9)	<0.001	1992–2016	-2.0	(-2.2, -1.8)	<0.001	1992–2016	-0.1	(-0.3, 0.2)	0.573
Alberta	1992–2016	-0.4	(-0.6, -0.2)	<0.001	1992–2016	-1.6	(-1.8, -1.3)	<0.001	1992–2004	1.9	(1.1, 2.7)	0.00
									2004–2016	-0.1	(-0.7, 0.5)	0.824
Saskatchewan	1992–2012	0.5	(0.3, 0.7)	<0.001	1992–2016	-1.2	(-1.4, -0.9)	<0.001	1992–2011	2.5	(2.0, 3.0)	<0.001
	2012–2016	-3.7	(-6.0, -1.2)	0.005					2011–2016	-3.4	(-6.3, -0.4)	0.028
Manitoba	1992–2005	0.0	(-0.5, 0.6)	0.987	1992–2016	-2.0	(-2.2, -1.7)	<0.001	1992–2002	2.7	(1.4, 4.1)	<0.001
	2005–2016	-1.5	(-2.2, -0.9)	<0.001					2002–2016	-0.5	(-1.1, 0.2)	0.171
Ontario	1992–2007	-1.1	(-1.4, -0.7)	<0.001	1992–2007	-2.4	(-2.7, -2.0)	<0.001	1992–2007	0.6	(0.3, 0.9)	0.002
	2007–2012	2.0	(-0.1, 4.2)	0.056	2007–2012	1.6	(-0.8, 4.2)	0.183	2007–2012	2.3	(0.2, 4.5)	0.034
	2012–2016	-4.8	(-6.7, -2.9)	<0.001	2012–2016	-6.3	(-8.5, -4.1)	<0.001	2012–2016	-3.3	(-5.2, -1.4)	0.002
New Brunswick	1992–2006	0.3	(-0.3, 0.9)	0.317	1992–2016	-1.5	(-1.8, -1.3)	<0.001	1992–2006	2.6	(1.6, 3.7)	<0.001
	2006–2016	-1.4	(-2.3, -0.5)	0.005					2006–2016	-0.5	(-1.8, 0.8)	0.413
Nova Scotia	1992–2016	-0.5	(-0.8, -0.2)	0.001	1992–2016	-1.7	(-2.1, -1.4)	<0.001	1992–2016	1.0	(0.7, 1.4)	<0.001
Prince Edward Island	1992–2016	-0.6	(-1.2, 0.0)	0.036	1992–2016	-1.4	(-2.2, -0.7)	<0.001	1992–2016	0.3	(-0.7, 1.3)	0.505
Newfoundland and Labrador	1992–2016	0.0	(-0.5, 0.6)	0.895	1992–2016	-1.5	(-2.1, -0.9)	<0.001	1992–2016	2.8	(2.0, 3.6)	<0.001

—not available for reference period

APC=annual percent change; CL=confidence limits

Note: Trend analyses were conducted using the standard Joinpoint model for all geographic regions except Newfoundland and Labrador, for which the jump model was used (see *Appendix*). Trends were not available for males for Nunavut Territory and Yukon Territory because the population estimate was zero for at least one of the age groups for one or more years. Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry.

Analysis by: Centre for Population Health Data, Statistics Canada

Data source: Statistics Canada, Canadian Cancer Registry database (1992–2016)

TABLE 6 One- and five-year predicted net survival estimates for lung cancer, by sex, age group, histologic type and geographic region, Canada (excluding Quebec), 2012–2014

	1-year net survival (%) (95% CI)						5-year net survival (%) (95% CI)					
	Both sexes		Males		Females		Both sexes		Males		Females	
All lung cancer	**44**	**(44–45)**	**40**	**(39–41)**	**49**	**(48–50)**	**19**	**(18–19)**	**15**	**(15–16)**	**22**	**(22–23)**
Age group (years)												
15–44	65	(61–69)	60	(53–66)	69	(64–74)	35	(31–39)	36	(31–42)	33	(28–39)
45–54	51	(49–52)	43	(41–46)	57	(54–59)	24	(22–25)	20	(18–22)	27	(25–29)
55–64	49	(49–50)	44	(42–45)	55	(54–57)	22	(21–23)	18	(17–19)	27	(26–28)
65–74	47	(47–48)	43	(42–44)	52	(51–53)	21	(20–21)	17	(16–18)	25	(24–26)
75–84	40	(39–41)	37	(35–38)	44	(42–45)	15	(14–16)	12	(12–13)	18	(17–19)
85-99	30	(29–32)	28	(27–30)	32	(30–34)	9	(7–10)	8	(6–11)	9	(7–11)
Histologic type												
Adenocarcinoma	56	(55–57)	49	(48–50)	62	(61–62)	27	(27–28)	22	(21–23)	32	(31–33)
Squamous cell carcinoma	52	(51–53)	50	(49–52)	54	(52–56)	21	(20–22)	20	(19–21)	24	(22–25)
Large cell carcinoma	41	(36–45)	41	(35–47)	40	(33–47)	19	(15–22)	16	(12–21)	20	(16–26)
Non–small cell lung cancer, NOS	37	(36–38)	33	(31–34)	41	(40–43)	14	(13–14)	11	(10–12)	17	(16–18)
Small cell lung cancer	32	(31–33)	27	(26–29)	36	(34–38)	7	(7–8)	6	(5– 7)	9	(8–10)
Unspecified	20	(19–21)	19	(18–20)	21	(19–22)	5	(5–6)	5	(4–6)	5	(5–7)
Geographic region												
British Columbia	43	(42–44)	39	(38–41)	47	(46–49)	17	(16–18)	15	(14–16)	20	(19–21)
Alberta	44	(43–45)	39	(38–41)	48	(47–50)	17	(16–18)	14	(13–16)	19	(18–21)
Saskatchewan	42	(40–44)	38	(35–41)	46	(43–49)	16	(15–18)	13	(10–15)	20	(18–23)
Manitoba	44	(42–46)	40	(37–43)	48	(45–51)	21	(19–23)	18	(15–20)	24	(21–27)
Ontario	45	(45–46)	41	(40–42)	50	(49–51)	20	(19–20)	16	(16–17)	23	(23–24)
New Brunswick	47	(45–49)	43	(40–45)	52	(49–55)	20	(18–22)	17	(14–19)	23	(20–26)
Nova Scotia	41	(39–43)	38	(36–41)	44	(42–47)	16	(15–18)	13	(11–15)	20	(18–22)
Prince Edward Island	38	(33–43)	31	(25–38)	—	—	—	—	—	—	—	—
Newfoundland and Labrador	46	(43–48)	41	(38–45)	52	(48–57)	18	(16–21)	15	(12–18)	22	(17–26)

— estimate can not be calculated as one or more of the age-specific estimates are undefined; CI=confidence interval; NOS=not otherwise specified

Note: Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry. Geographic-specific results have been age-standardized using the Canadian cancer survival standard weights for lung cancer.[4] Crude (unstandardized) estimates by province are available in the online data. All estimates are associated with a standard error less than or equal to 0.05.

Analysis by: Centre for Population Health Data, Statistics Canada

Data sources: Canadian Cancer Registry death linked file (1992–2014) and life tables at Statistics Canada

TABLE 7 Two-, five- and 20-year tumour-based prevalence case counts and proportions for lung cancer, by sex and age group, Canada (excluding Quebec), January 1, 2015

	2-year (diagnosed since 2013)			5-year (diagnosed since 2010)			20-year (diagnosed since 1995)		
	Number of cases	Proportion (per 100,000)	95% CI	Number of cases	Proportion (per 100,000)	95% CI	Number of cases	Proportion (per 100,000)	95% CI
All lung cancer	17,915	65.4	(64.4–66.3)	28,685	104.7	(103.5–105.9)	44,140	161.1	(159.6–162.6)
Sex									
Males	8,280	60.9	(59.6–62.3)	12,950	95.3	(93.7–97.0)	19,455	143.2	(141.2–145.2)
Females	9,630	69.7	(68.3–71.1)	15,735	113.8	(112.1–115.6)	24,690	178.6	(176.4–180.9)
Age group (years)									
0–44	195	1.3	(1.1–1.4)	330	2.1	(1.9–2.4)	565	3.6	(3.4–4.0)
45–54	1,060	26.1	(24.6–27.7)	1,645	40.5	(38.5–42.5)	2,280	56.2	(53.9 -58.5)
55–64	3,905	107.6	(104.3–111.1)	6,030	166.2	(162.1–170.5)	8,550	235.7	(230.7–240.7)
65–74	6,550	274.6	(268.0–281.3)	10,475	439.2	(430.9–447.8)	15,650	656.1	(645.9–666.5)
75–84	4,900	382.3	(371.7–393.1)	8,060	628.8	(615.2–642.7)	12,995	1,013.8	(996.5–1,031.4)
85+	1,305	234.7	(222.1–247.8)	2,140	384.9	(368.7–401.5)	4,095	736.5	(714.1–759.4)

CI= confidence interval

Note: Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry. All counts were randomly rounded to a base of five to protect confidentiality. Proportions were calculated using rounded counts. Row or column counts may not sum to total counts due to rounding.

Analysis by: Centre for Population Health Data, Statistics Canada

Data source: Statistics Canada, Canadian Cancer Registry death linked file (1992–2014)

TABLE 8 20-year tumour-based lung cancer prevalence case counts and proportions, by geographic region, Canada (excluding Quebec), January 1, 2015

Geographic region	Count	Proportion (per 100,000) (95% CI)	
Nunavut Territory	40	110.4	(78.9–150.3)
Northwest Territories	30	68.1	(45.9–97.2)
Yukon Territory	45	120.3	(87.7–160.9)
British Columbia	7,020	148.0	(144.6–151.6)
Alberta	4,740	115.2	(112.0–118.5)
Saskatchewan	1,630	145.9	(138.9–153.2)
Manitoba	2,380	185.1	(177.8–192.7)
Ontario	22,875	167.4	(165.3–169.6)
New Brunswick	1,875	247.1	(236.0–258.5)
Nova Scotia	2,165	230.9	(221.3–240.9)
Prince Edward Island	265	183.5	(162.1–207.0)
Newfoundland and Labrador	1,070	202.6	(190.6–215.1)

CI=confidence interval

Note: Quebec is excluded because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry. Counts have been randomly rounded to a base of five to protect confidentiality. Proportions are based on rounded counts.

Data sources: Statistics Canada, Table 13-10-0751-01 Number of prevalent cases and prevalence proportions of primary cancer, by prevalence duration, cancer type, attained age group and sex. https://www150.statcan.gc.ca/t1/tbl1/en/tv.action?pid=1310075101. Accessed February 19, 2020.

Appendix

Data sources and methods

Data sources and definitions

Incidence

Cancer incidence data (1992 to 2016) are from the November 2018 Canadian Cancer Registry (CCR) tabulation file released January 29, 2019. The CCR is a population-based database comprised of cases diagnosed among Canadian residents since 1992.[1] Each provincial and territorial cancer registry provides demographic and cancer-specific information to Statistics Canada in a standard format. Annual submissions by jurisdiction include additions and revisions to data submitted in previous years. For this study, the International Agency for Research on Cancer multiple primary coding rules were used.[2]

Cancer cases were defined based on the *International Classification of Diseases for Oncology, Third Edition* (ICD-O-3).[3] Cases were classified as lung and bronchus cancer (lung cancer) if the topography (site) code was C34, the behaviour was coded as malignant and the histology was not 9050–9055, 9140 or 9590–9992. Lung cancer cases were divided into seven histologic types (see table on the right) following the groupings outlined in Volume XI of *Cancer Incidence in Five Continents*.[4] One exception was that cases assigned histology code 8010, carcinoma not otherwise specified (NOS), were classified as non–small cell lung cancer, NOS, rather than large cell carcinoma.[5,6] This adjustment addresses the fact that, up to the 2000 diagnosis year, practitioners tended not to report non–small cell lung cancers with specificity, which resulted in a sizeable number of non–small cell lung cancers being coded to 8010. Cases classified as sarcomas and other specified malignant neoplasms were excluded from histologic type–specific analyses but included in analyses of all lung cancer combined.

Information on stage at diagnosis was available on the CCR file for cancer cases diagnosed from 2010 to 2016. Cases were staged using the Collaborative Stage (CS) Data Collection System and coding Instructions,[7] which is available from the Collaborative Staging Task Force of the American Joint Committee on Cancer (AJCC) (http://www.cancerstaging.org/cstage/Pages/default.aspx). The CS system regulates the quality and completeness of stage data by standardizing various aspects of cancer data collection, such as timing, clinical and pathological assessments and cancer type descriptions. The most recent version of the CS system is based on the seventh edition of the AJCC Cancer Staging Manual. This framework is used for stage-specific analysis. Cancer cases that are not covered under this framework are considered “unstageable” and were excluded from the stage-specific analysis. Cases staged as occult (n=317 for Canada excluding Quebec for 2010 to 2016) were excluded as were those that have not been staged and assigned to CS not run. Additionally, one stage 0 case was excluded from stage-specific analyses because this code is commonly reserved for *in situ* cases.

Histologic type	Histology codes
Squamous cell carcinoma	8050–8078, 8083–8084
Adenocarcinoma	8140, 8211, 8230–8231, 8250–8260, 8323, 8480–8490, 8550–8552, 8570–8574, 8576
Small cell carcinoma	8040–8045
Large cell carcinoma	8011–8012, 8014–8031, 8035, 8310
Non–small cell lung cancer, not otherwise specified (NOS)	all other carcinomas (8010–8576) not described above
Sarcomas and other specified malignant neoplasms	8800–8811, 8830, 8840–8921, 8990–8991, 9040–9044, 9120–9133, 9150, 9540–9581 and all other specified malignant neoplasms not already described above
Unspecified	8000–8005

At the time of reporting to the CCR, death certificate only (DCO) cases had not been submitted to the CCR from Ontario for 2015 and 2016, from Manitoba for 2013 to 2016 and from Newfoundland and Labrador prior to 2006. DCO cases were imputed for Ontario for 2015 and 2016 by randomly assigning DCO cases diagnosed in this province in 2013 to 2014 to these years. Likewise, DCO cases were imputed for Manitoba for 2013 to 2016 using the DCO cases diagnosed from 2009 to 2012. DCO cases were not imputed for Newfoundland and Labrador due to the relatively large period of time for which they were not available.

Mortality

Mortality data (1992 to 2017) are from the May 30, 2019, release of the Canadian Vital Statistics—Death Database.[8] This database includes demographic and cause of death information for all deaths in Canada. Lung cancer deaths were identified using the World Health Organization's ICD-10[9] code C34 for deaths occurring from 2000 onward and ICD9[10] codes 162.2 to 162.5, 162.8 and 162.9 for deaths occurring from 1992 to 1999.

Population

Population data were obtained from Canada's population estimates released on September 30, 2019.[11]

Survival and prevalence

Survival and prevalence analyses were performed on a pre-existing death-linked analytic file. This file had previously been created by linking the November 2017 CCR tabulation file of incident cases from 1992 to 2014 to mortality information until December 31, 2014.[12] Information on deaths had been obtained from the Canadian Vital Statistics—Death Database and T1 personal master files (as reported on tax returns). Annual expected survival probabilities that are needed to calculate net survival were obtained from provincial and territorial life tables, available for three-year overlapping time periods. For example, expected survival data for 2014 were obtained from life tables for 2013 to 2015. More detail has been provided elsewhere.[13]

Statistical analysis

Incidence and mortality

Sex-specific lung cancer incidence rates by age group, histologic type, stage and geographic region were calculated by dividing the number of new primary cases by the corresponding population counts. Similarly, sex-specific lung cancer mortality rates by age group and geographic region were calculated by dividing the number of new deaths by the corresponding population counts. Age-standardized rates were calculated using the direct method, which involved weighting the age-specific rates according to the age distribution of the 2011 Canadian standard population.[14] Rates are expressed per 100,000 people. Incidence data from Quebec were entirely omitted because cases diagnosed in this province from 2011 onward had not yet been submitted to the CCR. Although mortality data were available for Quebec, they were also omitted from national analyses for consistency.

Annual percent changes (APCs) in rates were estimated using Joinpoint regression software.[15,16] Rates and their corresponding standard errors used as input to Joinpoint analysis were initially calculated to 10 decimal places using the SAS system software version 9.3. P-values associated with APCs correspond to two-sided tests of the null hypothesis that the underlying APC value is zero (i.e., stable) with a significance level of 0.05. Years in which the APC changed significantly are referred to as changepoints. Default parameters were used with the exception that the minimum number of observations from a changepoint to either end of the data was set at four (i.e., 2012 to 2016 was the most recent time period for which an APC could be detected). Likewise, the minimum number of observations between two changepoints was also set at four.

While the default estimation model used for trend analysis was the standard Joinpoint model, the jump model was used to estimate the trend in age-standardized incidence rates for Newfoundland and Labrador. This alternate method was selected because of the known issue of case under-reporting from the province to the CCR prior to the 2006 diagnosis year. As a result of the improvements in case ascertainment by the Newfoundland and Labrador Cancer Registry starting in the 2006 diagnosis year, the total number of cancer cases reported to the CCR by the province in 2006 was 21% greater than in 2005, and the number of lung cancer cases was 30% higher. The jump model is well suited to such situations as it is designed to provide a direct estimation of trends where there is a systematic scale change that causes a "jump" in the rates but is assumed not to affect the underlying trend.[15]

Net survival

Records from the analytic file for survival were excluded *a priori* if the diagnosis had been established through autopsy only or death certificate only, or if the year of birth or death was unknown. Both of the latter circumstances were extremely rare. Survival analyses were then restricted to first primary lung cancer cases[17,18] diagnosed from 1992 to 2014 among people aged 15 to 99 years. Finally, data from Quebec were excluded because cases diagnosed in this province from 2011 onward had not been submitted to the CCR.

Unstandardized (crude) survival analysis estimates were derived using an algorithm[19] that Ron Dewar of the Nova Scotia Cancer Care Program augmented to include the Pohar Perme estimator of net survival (Dewar R, email communication, April 19, 2018).[20] The updated program uses the hazard transformation approach. Age-standardized net survival estimates were calculated using the direct method and the Canadian cancer survival standard (CCSS) weights.[13] These weights, which are based on recent Canadian incidence data, were chosen to enhance the interpretability of the findings in the Canadian context. The CCSS weights for lung cancer are as follows: 0.010 (ages 15–44), 0.067 (ages 45–54), 0.212 (ages 55–64), 0.331 (ages 65–74) and 0.380 (ages 75–99). Standard errors for age-standardized net survival estimates were estimated by taking the square root of the sum of the squared, weighted, age-specific net survival standard errors.

Net survival estimates for 2012 to 2014 were predicted using the period method.[21] Follow-up information used in the period method necessarily does not relate to a fixed cohort of people. Instead, period survival estimates are based on the assumption that people diagnosed in the period of interest will experience the most recently observed conditional probabilities of net survival. Estimates were suppressed if the corresponding standard error was greater than 0.10, and caution was indicated if the standard error was greater than 0.05 but less than or equal to 0.10.

Prevalence

Tumour-based limited-duration prevalence counts were determined directly using the counting method.[22,23] Specifically, all primary invasive lung cancer cases diagnosed among persons in the relevant time period, and alive at the start of January 1, 2015 (index date), were counted. Prevalent cases diagnosed in the province of Quebec were excluded because incident cases diagnosed in this province from 2011 onward had not been submitted to the CCR. Sex- and age-specific population estimates for January 1, 2015, were derived by averaging the 2014 and 2015 mid-year population estimates for all of Canada, excluding Quebec. Sex-specific lung cancer prevalence proportions by age group were calculated by dividing the number of prevalent cases by the estimated population counts for the index date.

An approximate estimation of the 20-year tumour-based lung cancer prevalence count on the index date for Canada including Quebec was derived as follows. The January 1, 2011 lung cancer count for Canada excluding Quebec was applied to the current 20-year lung cancer prevalence count for Canada excluding Quebec. The 2011 date represents the most recent index date for which an estimate that includes Quebec could be derived. Ten-year prevalence was used because there was insufficient historic data from which to calculate 20-year prevalence for January 1, 2011. The effect on the derived ratio (1.4) of this substitution is very likely quite minimal. While the ratio was observed to slightly increase with increasing prevalence duration, it was also observed to be slightly declining with time (data not shown).

Limitations

Analyzing and interpreting survival for cases diagnosed in the relatively lightly populated province of Prince Edward Island was challenging due to the small number of cases diagnosed annually there. In the current analysis, lung cancer age-standardized five-year net survival estimates for Prince Edward Island could not be calculated because estimates for the 15–44 age group could not be calculated. This in turn was due to the limited number of cases diagnosed in this age group in this province. Unstandardized province-specific estimates of one- and five-year net survival by sex and for both sexes combined for people aged 15–99 years are available in online data. For both sexes combined, these estimates are virtually the same on a province-by-province basis as the corresponding age-standardized estimates because the weights used in the age-standardization process were derived from recent cancer incidence data. As such, the unstandardized five-year net survival for Prince Edward Island is very likely an excellent proxy for the corresponding age-standardized estimate.

External contributions

Boxes A—D were contributed by external groups. The interpretations expressed therein do not necessarily reflect those of the special report's working group members or their host organizations.

Canadian Population Attributable Risk of Cancer (ComPARe)

Box A provides statistics estimated by the ComPARe study team. The methods used to identify established and possible risk factors and to estimate the population attributable risks are the same used for the ComPARe study. These are described in detail elsewhere.[24,25] Of specific note for the analyses used in this report: the current trends in screening and diagnosis, and therefore incidence and stage at diagnosis, were assumed to continue. The impact of risk factors on death is assumed to be constant by stage and histology. Furthermore, the factors and trends impacting survival and competing causes of death are assumed to be fixed.

OncoSim model

Box C provides statistics estimated using the OncoSim model. OncoSim is a free, web-based simulation tool that evaluates cancer control strategies.[26] Combining data from the real world, expert opinion and the published literature, OncoSim projects health and economic outcomes and attributes them to 27 risk factors, such as smoking and inadequate physical activity. It currently models four cancer types (breast, colorectal, lung and cervical) and related screening programs in detail, and it provides high-level projections for 28 other cancer types. This analysis was conducted using OncoSim-Lung version 3.2.8.

OncoSim-Lung

OncoSim-Lung is a mathematical microsimulation model of lung cancer. It simulates the smoking behaviour of the Canadian population and the lifetime impact of smoking and exposure to radon on lung cancer incidence, healthcare costs and all-cause deaths. It has a screening module for evaluating lung cancer screening strategies.

- It simulates smoking behaviour to mimic smoking prevalence by age, sex, province and year reported in several large Canadian health surveys.
- It models the change in smoking rates and intensity across time periods for each age group, by sex and province. For instance, age group 15–19 in 1979 corresponds to age group 30–34 in the 1994 survey (15 years later) and age group 40–44 in 2004 (25 years later). Survey data from the 1970s is essential because most individuals eligible for lung cancer screening in 2020 (aged 55–74 years) would have started smoking in the 1970s. In addition to the three surveys, the smoking initiation rates were calibrated to match the smoking prevalence by five year age group, sex and province reported in the 2009 Canadian Community Health Survey.
- OncoSim-Lung models the impact of smoking history and radon exposure on lung cancer using published risk equations and the model is calibrated to match the lung cancer incidence data from the Canadian Cancer Registry.[27,28]
- OncoSim-Lung simulates large, representative samples of the Canadian population, one individual at a time, from birth to death, using Statistics Canada's official demographic projections.
- The model aggregates the projected outcomes at the provincial, territorial and national level. Examples of outcomes include the number of individuals eligible for lung cancer screening, the number of computed tomography scans, lung cancer incidence by stage, life expectancy, quality-adjusted life years and healthcare costs.
- OncoSim-Lung underwent extensive validation testing to ensure that the assumptions in the model were acceptable to Canadian lung cancer experts and that its projected cause-specific mortality reproduced the observed data in the Canadian Cancer Registry. When projecting the effects of lung cancer screening, OncoSim-Lung reproduces the results of the National Lung Screening Trial (NLST), as well as other comparable lung cancer microsimulation models.[29]

Scenarios

The analysis included three scenarios (no screening and two commonly considered screening strategies):

1. no screening
2. offer annual screening up to three times to high-risk individuals aged 55–74 years
3. offer biennial screening until the person is ineligible due to their age (up to 10 times) to high-risk individuals aged 55–74 years

"High risk" was defined based on the Canadian Task Force on Preventive Health Care recommendation for lung cancer screening (i.e., for individuals aged 55–74 years with a smoking history of 30 pack-years and current smokers or individuals who quit less than 15 years ago). Pack-years is a way to measure the amount a person has smoked over a long period of time. To calculate pack-years, the number of packs of cigarettes smoked per day is multiplied by the number of years the person has smoked. For example, 1 pack year is equal to smoking 1 pack per day for 1 year or 2 packs per day for half a year.

The screening scenarios assumed screening starts in 2020, with a 10-year phase-in, a 40% participation rate and a 70% adherence rate. It was assumed that smoking cessation was offered at each screening interval for current smokers and that 85% of participants that are current smokers would receive a smoking cessation intervention.

Analysis

The analysis included lifetime outcomes capturing the number of lung cancer cases, stage distribution, lung cancer deaths and health system costs, discounted at 1.5% per year. It was conducted from a healthcare payer's perspective and included costs of low-dose computed tomography (LDCT) plus reading, follow-up diagnostics, incidental findings and smoking cessation. The analysis also accounted for cost-savings from avoiding advanced stage treatments, such as immunotherapy.

Equity and lung cancer

Box D provides statistics estimated by the Canadian Partnership Against Cancer. To support the analyses around disparity, the CCR was linked to several administrative databases containing socioeconomic, treatment and mortality information. The analyses presented in this section are based on linking the CCR with the T1 Family File (T1FF) and the Canadian Vital Statistics—Death Database.

For each tax year, Statistics Canada derived an income decile variable by ranking the individual's total family after-tax income, adjusted for geographic region and family size. Income decile was assigned within three age groups (<25, 25–64 and 65+) using the full T1FF file. The income quintile variable was then created by collapsing the decile variable. Lung cancer cases that were not linked or were missing relevant information from the T1FF within the two years prior to diagnosis were excluded from analyses. Cases that were under the age of 30 years, missing staging information or where diagnosis was established through death certificate only were also excluded. Quebec was excluded from the analysis because cases diagnosed in Quebec from 2011 onward had not been submitted to the Canadian Cancer Registry. AJCC-7 was used for staging information. When AJCC-7 was missing or unknown, AJCC-6 was used.

Cause-specific observed survival was calculated using the cohort method where a cohort of individuals diagnosed with lung cancer were followed to estimate the probability of survival in 2010 and 2011 in Canada (excluding Quebec). After the exclusion criteria were applied, approximately 85% of lung cancer cases diagnosed in 2010 and 2011 were included in the survival analysis. The last follow-up date was December 31, 2014. Individuals with lung cancer who died from other causes before December 31, 2014, were censored. Age-specific survivals were estimated based on the following age groups: 30–44, 45–54, 55–64, 65–74 and 75+. Age-standardized estimates were calculated using the direct method and the International Cancer Survival Standards type 1 weights.[30]

Peer review

The peer-review process was overseen by the Canadian Cancer Statistics Advisory Committee's Working Group (WG) on Lung Cancer. The WG recruited three peer reviewers based on their clinical and epidemiologic expertise. A full draft of this chapter (including text, tables, figures and the description of data sources and methods but excluding Box D) was sent to those who agreed to participate. Peer reviewers were provided with two weeks to review the materials, and they provided written feedback on the materials directly to the WG. The WG reviewed and discussed the feedback as a group and decided what changes would be made as a result.

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Partner organizations

Public Health Agency of Canada (PHAC)

For information on chronic diseases including cancer, their determinants, and their risk and protective factors in Canada, please refer to https://www.canada.ca/en/public-health.html (select "Chronic Diseases") Email: phac.chronic.publications-chronique.aspc@canada.ca.

Statistics Canada

statcan.gc.ca (search "cancer")

More detailed information on the methodology used in this publication is available from the Centre for Population Health Data at Statistics Canada, National Enquiries Line (1-800-263-1136) or through Client Services at the Centre for Population Health Data (statcan.hd-ds.statcan@canada.ca or 613-951-1746).

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 Helpline at 1-888-939-3333 or visit cancer.ca. For questions about this publication, email: stats@cancer.ca.

Canadian Council of Cancer Registries

Cancer incidence data are supplied to Statistics Canada by provincial and territorial cancer registries to form the Canadian Cancer Registry (CCR). The CCR is governed by the Canadian Council of Cancer Registries (CCCR), a collaboration between the 13 provincial and territorial cancer registries and the Centre for Population Health Data Statistics Canada. Information about the CCR and CCCR can be found on Statistics Canada's Canadian Cancer Registry (CCR) website. Detailed information regarding the statistics for each province or territory is available from the relevant registry:

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Statistics Canada

Vital Statistics Council for Canada

Mortality data are supplied to Statistics Canada by the provincial and territorial Vital Statistics Registrars to form the Canadian Vital Statistics—Death Database (CVSD). The Canadian Vital Statistics System is governed by the Vital Statistics Council for Canada (VSCC) since 1945. The VSCC is a collaboration between the 13 provincial and territorial Vital Statistics Registrars and the federal government represented by the Centre for Population Health Data of Statistics Canada. Detailed information on the VSCC and the CVSD can be found on Statistics Canada's Vital Statistics—Death Database (CVSD).

Questions about cancer?

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