

63%

5-year relative survival for all cancers combined

4

Relative survival

Survival from cancer has increased steadily over the past three decades in Ontario.

Survival statistics are a key indicator of the effectiveness of cancer treatment and control programs. Relative survival ratios (RSRs) indicate the likelihood of people diagnosed with cancer surviving for a certain amount of time (e.g., one, three or five years) compared to similar people (i.e., people of the same age and sex) in the general population. During the first five years following diagnosis, the services offered to people with cancer usually include primary treatment and close clinical assessment for recurrence. After five years, the use of the healthcare system and the chance of recurrence both decrease. Thus, the first five years after diagnosis is a critical period for examining survival.

The survival of a person with cancer depends on several factors, such as the cancer type (including its morphology), sex, age at diagnosis, stage at diagnosis and available treatments. While RSRs give a general expectation of survival at the population level, these statistics may not reflect the prognosis of an individual, whose survival can also depend on their health status, the presence of co-morbidities and other personal and tumour-related factors.

Improvements in survival over time can be attributed to better methods and higher use of early detection, as well as more effective treatments. Even small improvements in survival can reflect a large number of avoided premature deaths at the population level!

Relative survival by cancer type and sex

The overall five-year RSR for all cancers diagnosed between 2008 and 2012 was 63.1% (**Table 4.1**). This means that people diagnosed with cancer between 2008 and 2012 were 63.1% as likely to survive five years after their cancer diagnosis as similar people in the general population. Males had a significantly lower five-year RSR (61.8%) than females (64.5%). The difference in RSRs can be explained by the generally higher survival ratios in females compared to males for cancer types that are common in both sexes.

For both sexes combined:

- The five-year RSRs were highest for thyroid cancer (98.6%), melanoma (85.0%) and Hodgkin lymphoma (84.2%).
- The five-year RSRs were lowest for pancreatic (9.0%), esophageal (14.9%) and lung (18.0%) cancers. Low survival ratios for these cancers are largely attributed to the fact that most cases are diagnosed at an advanced stage, when the cancer has metastasized beyond the primary site.^{2,3}

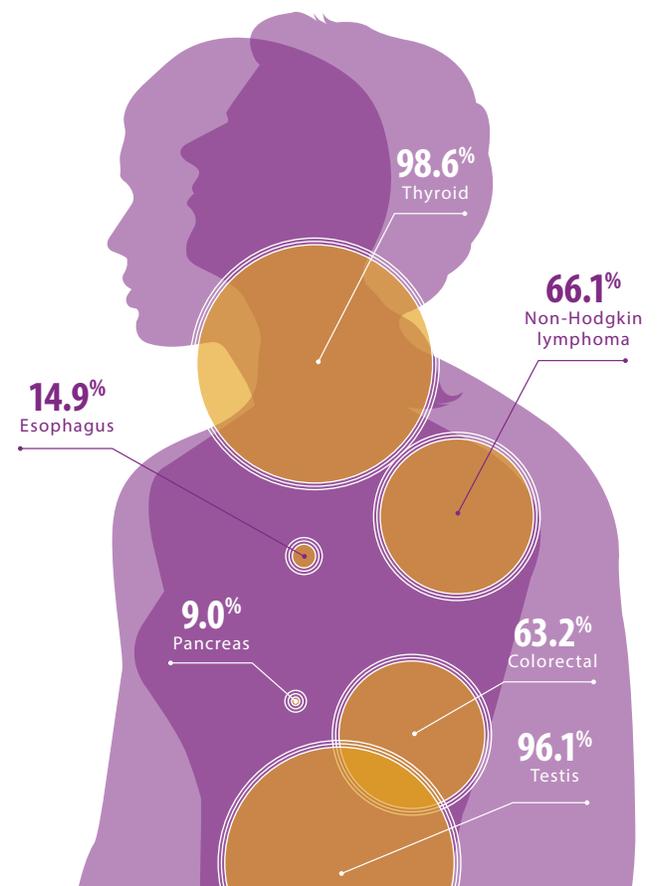
Among males, the five-year RSRs were:

- highest for testicular (96.1%), thyroid (95.6%) and prostate (95.2%) cancers; and
- lowest for pancreatic (9.1%), esophageal (14.7%) and lung (15.1%) cancers.

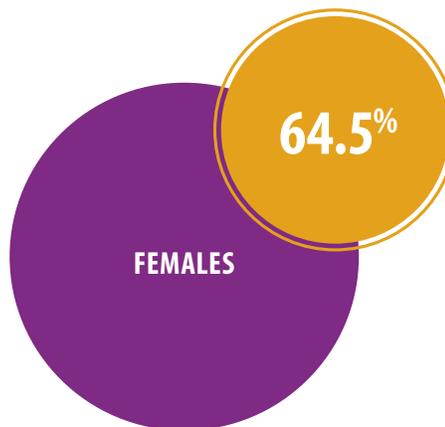
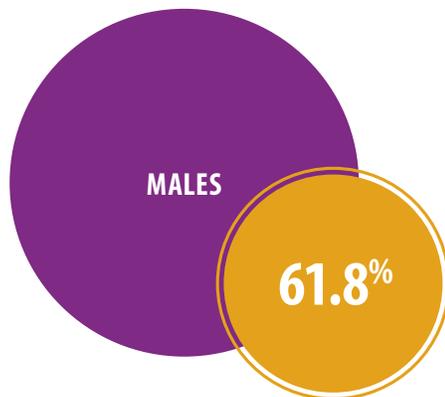
Among females, the five-year RSRs were:

- highest for thyroid cancer (99.4%), melanoma (89.5%) and breast cancer (87.2%); and
- lowest for pancreatic (9.0%), esophageal (15.2%) and lung (21.2%) cancers.

Five-year relative survival ratios for selected cancers, 2008-2012



Five-year RSR for all cancers diagnosed between 2008–2012



For most cancers, there was no statistical difference in the five-year RSR between the sexes, with some exceptions:

- Lung cancer survival was significantly lower for males (15.1%) than for females (21.2%). Possible reasons for lower survival among males include a greater proportion of more aggressive histological lung cancer types in males and a higher propensity for males to be diagnosed at a later stage (see the *In Focus: Lung cancer* section on page 68).^{4,5}
- Melanoma survival was also significantly lower for males (81.2%) than for females (89.5%). This lower survival among males has been attributed to tumour–host interaction that leads to a higher chance of metastasis in males than in females.^{6–8}
- Bladder cancer survival was significantly higher for males (64.9%) than for females (57.0%). Lower survival in females may be the result of their typically more advanced stage at diagnosis compared to males, differences in their ability to metabolize carcinogens and a greater presence of sex steroids in females that could impact the progression of cancer.^{9,10}

The five-year RSRs for both sexes were lowest for pancreatic (9.0%), esophageal (14.9%) and lung (18.0%) cancers.

Relative survival by age group

Survival tends to vary by age at diagnosis and generally decreases with advancing age. During the diagnosis years 2008–2012, the five-year RSR for all cancers combined was 83.8% for people diagnosed between the ages of 15 and 44 years compared to 34.6% for those 85 to 99 years of age at diagnosis (**Table 4.2**).

The higher survival ratio in younger people is likely due to better general health and more favourable responses to treatment. In addition, poor survival in older adults may be influenced by under-representation in clinical trials, an inability to tolerate more aggressive treatments and underlying differences in tumour biology.¹¹⁻¹³

A significant decreasing trend in five-year RSRs across increasing age groups was found for all cancers examined (**Table 4.2**) with the exception of female breast, prostate, testicular, thyroid and uterine cancers:

- While prostate, thyroid and uterine cancer survival decreased with increasing age, the trend was not significant.
- Female breast cancer presented an unusual pattern with the RSR peaking in females 45 to 54 years of age (90.0%) and then declining with advancing age. Females diagnosed

between the ages of 15 and 44 had a lower RSR (87.1%) than those diagnosed between the ages of 45 and 74. Lower survival in the youngest age group may be because younger women are more likely to develop aggressive tumours¹⁴⁻¹⁶ and have a higher risk of being diagnosed at later stages.¹⁷ In addition, improvements in treatment for breast cancer types that are common in middle-aged and older women have not been matched in treatment options available for breast cancer types more common in younger women.¹⁸

- Testicular cancer survival decreased with age, but RSRs could not be produced for the three oldest age groups due to the small number of cases and deaths.

The greatest differences in five-year RSRs between the youngest age group (15 to 44 years) and the oldest age group (85 to 99 years) were in cancers of the cervix (87.8% for the youngest age group, 22.8% for the oldest), ovary (76.4% vs. 12.2%) and kidney (88.7% vs. 25.4%).

On the other hand, esophageal cancer (18.0% in the youngest age group, 7.6% in the oldest), melanoma (91.4% vs. 74.6%) and female breast cancer (87.1% vs. 66.6%) had the smallest differences.

Cervical cancer 5-year RSR



Relative survival by survival duration

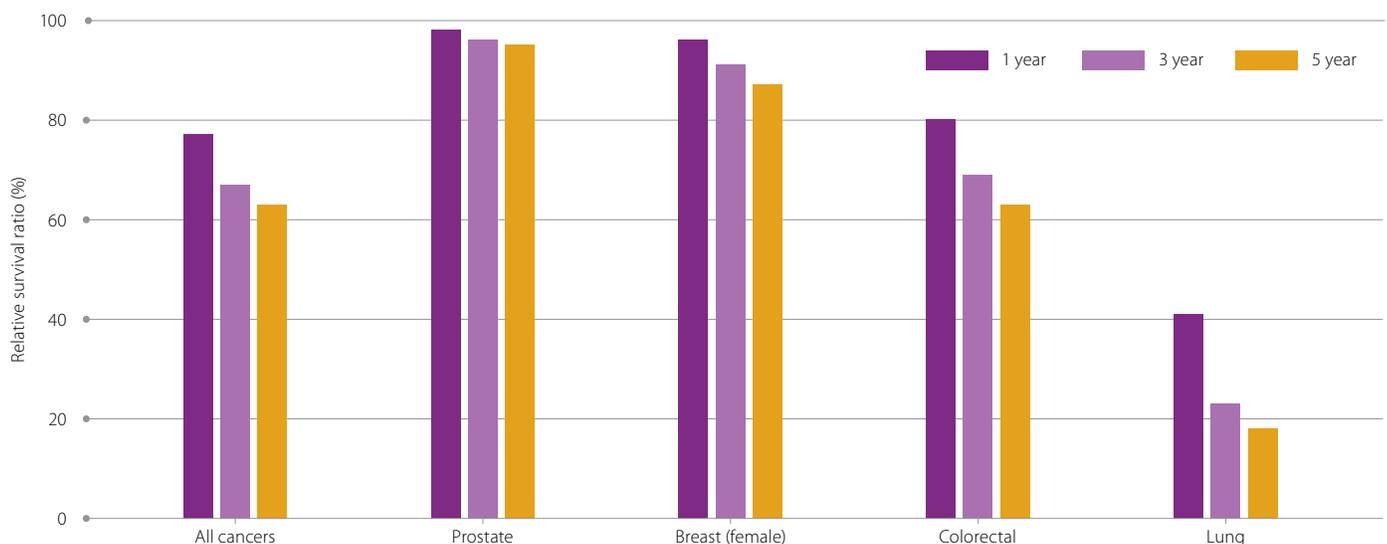
The RSR for all cancers combined between 2008 and 2012 was 76.8% after one year, 67.0% after three years and 63.1% after five years (**Figure 4.1**). As with most individual cancers, overall cancer survival declined most during the first year after diagnosis, followed by progressively smaller decreases in survival as the time from diagnosis increased.

Between 2008 and 2012, the following was observed for the four most common cancers:

- Prostate cancer had the highest RSR over all three survival durations. The one-year RSR was 97.5%, and there was no significant difference between the three-year RSR (95.8%) and the five-year RSR (95.2%).
- While prostate cancer survival remained fairly stable across the survival durations, female breast cancer survival declined from 96.0% at one-year to 91.1% after three years, and then to 87.2% after five years.
- Colorectal cancer survival declined even more as time from diagnosis increased, with a one-year RSR of 80.5%, a three-year RSR of 68.8% and a five-year RSR of 63.2%.
- Lung cancer had the lowest relative survival of the four most common cancers. The one-year RSR was 40.8%, the three-year RSR was 22.7% and the five-year RSR was 18.0%. Not only did lung cancer have the lowest survival ratios across all three survival periods, it also had the greatest decrease in survival between one and three years after diagnosis, with an absolute survival difference of almost 20%.

Figure 4.1

Relative survival ratios (RSR), by survival duration and cancer type, Ontario, 2008-2012



Note: Analysis restricted to ages 15-99

Analysis by: Surveillance, Analytics and Informatics, CCO

Data source: Ontario Cancer Registry (November 2015), CCO

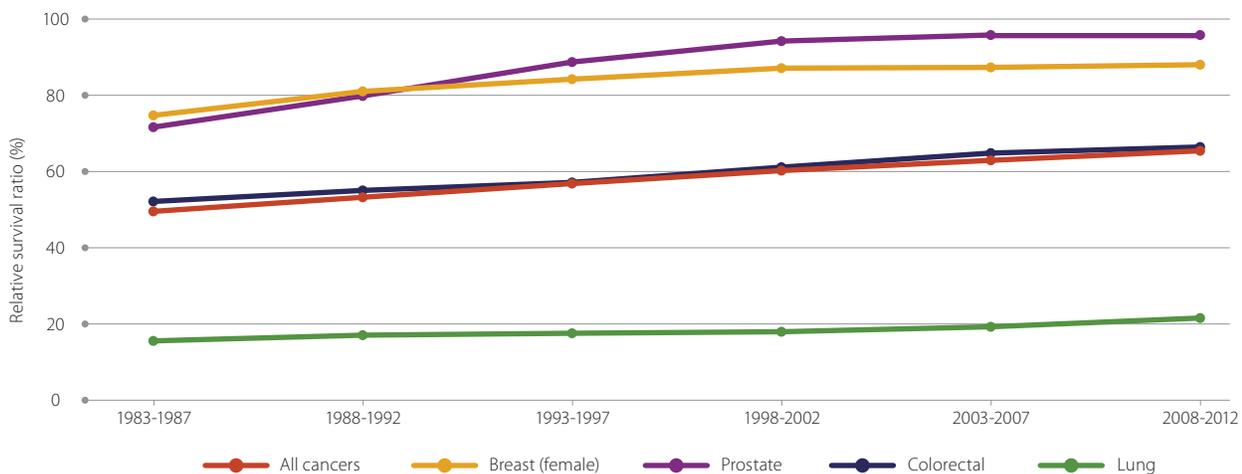
Relative survival over time

To account for changes in the age structure of the population over time, RSRs are age-standardized when comparing ratios between two time periods. The age-standardized five-year RSR for all cancers combined increased over time, from 47.6% for cases diagnosed between 1983 and 1987 to 62.5% for the years 2008 to 2012. In addition, survival for people diagnosed with the four most common cancers also increased over the same time period (**Figure 4.2**):

- Prostate cancer had the greatest RSR increase (24.2 percentage points). It rose from 69.7% for the period 1983–1987 to 93.9% for 2008–2012. While female breast cancer survival was higher than prostate cancer between 1983 and 1987, a decade later (1993 to 1997) the prostate cancer RSR was higher than the breast cancer RSR. Between 2008 and 2012 the RSR for prostate cancer was almost eight percentage points higher than for breast cancer. This increase in survival may be a result of greater use of PSA testing and more frequent identification of early-stage, slow-growing cancers. Lead-time bias for prostate cancer is estimated to be between five and 12 years.¹⁹
- The RSR for female breast cancer also increased over time, but not to the same extent as the RSR for prostate cancer. Between 1983 and 1987, the RSR for female breast cancer was 72.8%. It rose 13.3 percentage points to 86.1% for the period 2008–2012. Similar to prostate cancer, the rate of increase for female breast cancer slowed from the diagnosis years 1998–2002 onward. The increase in breast cancer survival is likely due to a combination of screening and improved treatments (e.g., adjuvant systemic therapy), especially since the implementation of a provincially coordinated organized screening program in the late 1980s.²⁰
- Between the periods 1983–1987 and 2008–2012, colorectal cancer survival increased by 14.3 percentage points and lung cancer survival increased by 6.0 percentage points. The absolute increase in survival for lung cancer was the smallest among the most common cancers, but this increase was still substantial because survival was so low for lung cancer. Lung cancer consistently had the lowest RSR of the top four cancers for all periods examined.

Figure 4.2

Age-standardized five-year relative survival ratios (RSR), by cancer type, Ontario, 1983–1987 to 2008–2012



Note: Analysis restricted to ages 15-99

Analysis by: Surveillance, Analytics and Informatics, CCO

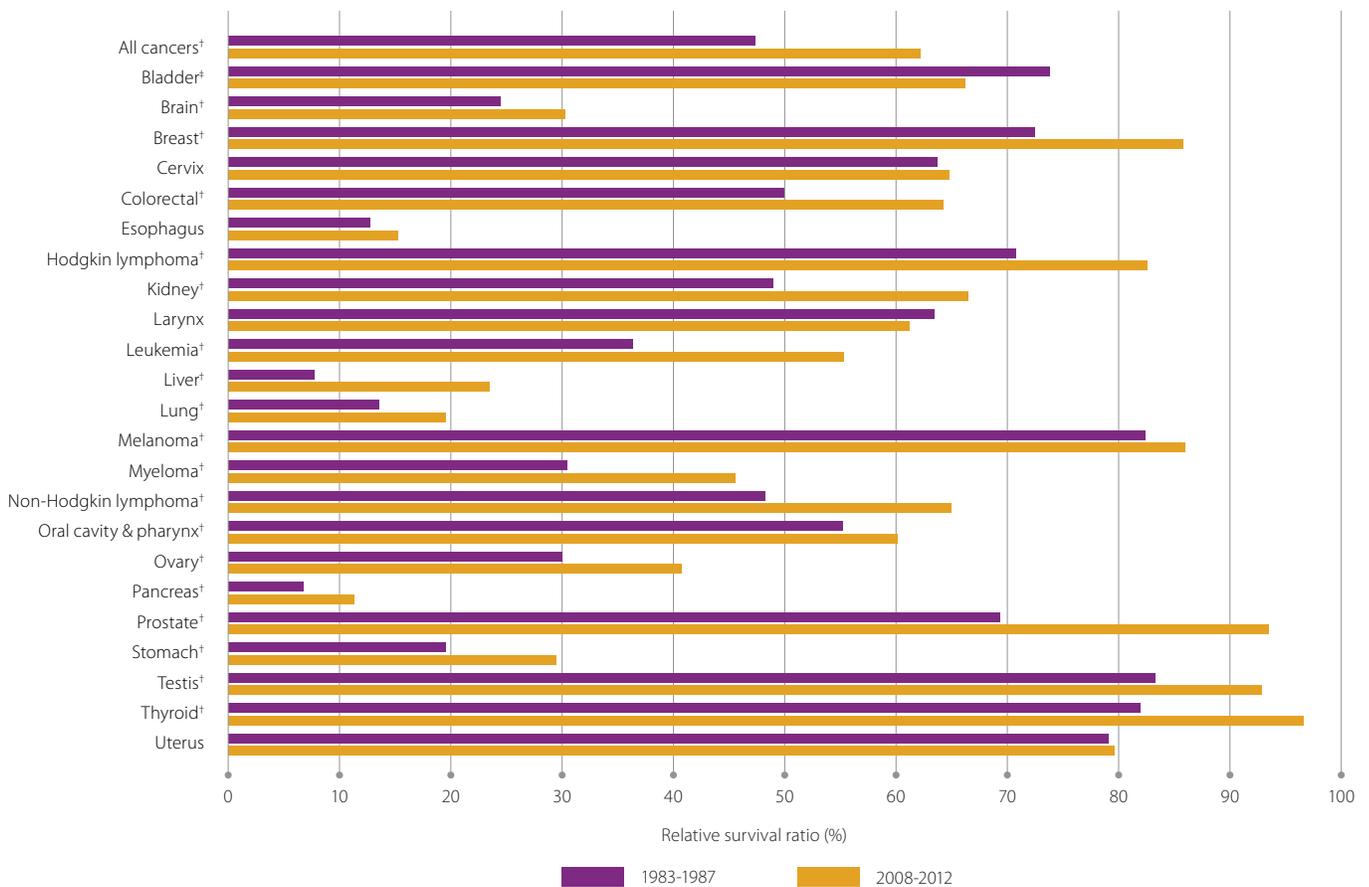
Data source: Ontario Cancer Registry (November 2015), CCO

The five-year RSR improved, to varying degrees, for all other cancer types during the periods 1983–1987 and 2008–2012 (Figure 4.3) with the following exceptions:

- There was no significant change in survival for cervical, esophageal, uterine and laryngeal cancers between the two time periods.
- The RSR for bladder cancer experienced a significant decrease, declining from 74.2% for the period 1983–1987 to 66.5% for the period 2008–2012. Decreasing or stabilizing trends in bladder cancer survival have also been observed in other jurisdictions²¹⁻²² and are probably the result of changes to classification and coding practices that have coded more cancers as *in situ* or “uncertain” in recent years.^{23,24}

Figure 4.3

Age-standardized five-year relative survival ratios (RSR), by cancer type and time period, Ontario, 1983–1987 and 2008–2012



†Significantly higher five-year RSR in 2008-2012 compared to 1983-1987

‡Significantly lower five-year RSR in 2008-2012 compared to 1983-1987

Note: Analysis restricted to ages 15-99

Analysis by: Surveillance, Analytics and Informatics, CCO

Data source: Ontario Cancer Registry (November 2015), CCO

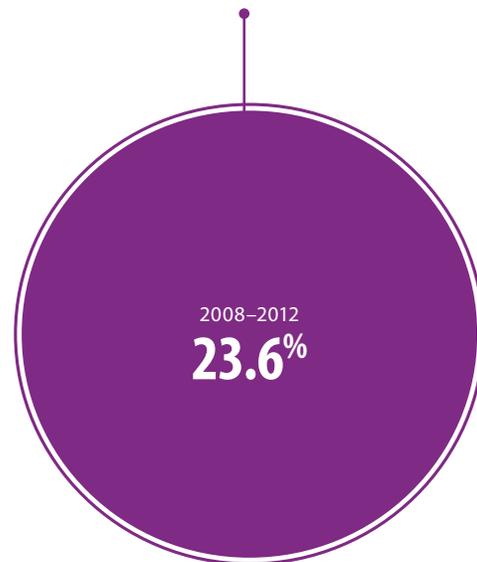
Five-year relative survival increased by 15 percentage points between 1983–1987 and 2008–2012.

Although all other cancers had significant increases in survival, some increases were particularly notable. Between the periods 1983–1987 and 2008–2012:

- The RSR for liver cancer tripled from 7.8% to 23.6%. A similar increase in the United States has been attributed to more awareness of the disease and its risk factors, more frequent screening for hepatitis infection and earlier diagnosis of people with a high-risk of developing the disease.²⁵ Diagnostic improvements may have also been achieved through the use of ultrasound and measurement of alpha-fetoprotein beginning in the 1980s.^{26,27}
- The RSR for pancreatic cancer almost doubled from 6.8% to 11.4%. Despite this increase, survival ratios for pancreatic cancer remain among the lowest of all cancer types. An increase in pancreatic cancer survival has also been reported in the United States, where the five-year RSR doubled over a similar time period, albeit from a lower baseline value.²⁸ In contrast, in the United Kingdom the five-year relative survival for pancreatic cancer has remained stable since the 1970s.²⁹
- The RSR for stomach cancer increased by about half from 19.6% to 29.6%.
- The RSR for leukemia increased by almost half from 36.5% to 55.6%.
- The RSR for myeloma increased by about half from 30.6% to 45.8%.



5-year relative survival for liver cancer tripled over a 25-year period



Relative survival by stage at diagnosis

Stage at diagnosis is one of the most important predictors of cancer survival. Survival generally tends to decrease as stage at diagnosis increases. Because of limited availability of stage data at the time of this analysis, this section examines three-year RSRs for cancers diagnosed between 2010 and 2012.

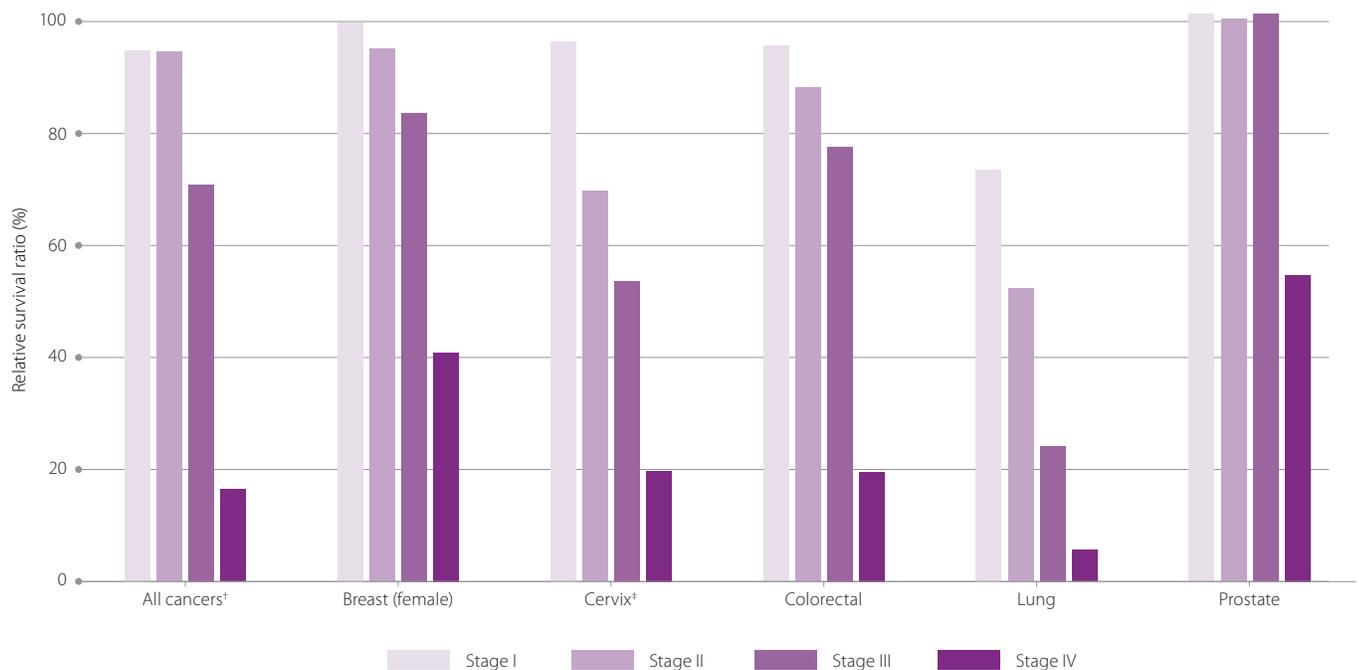
For all cancers for which stage data was available (prostate, female breast, colorectal, lung and cervix), the three-year RSR was 94.9% for cases diagnosed at stage I. Survival declined non-significantly to 94.7% for cases diagnosed at stage II, and significantly to 70.9% for stage III and 16.5% for stage IV (Figure 4.4). In other words, while individuals diagnosed at stage I or II had less than a 6% reduction in the probability of

surviving another three years compared to their counterparts in the general population, those diagnosed at stage IV had a reduction of almost 85%.

While stage at diagnosis is an important prognostic factor for most cancers, the impact was less pronounced for prostate cancer. The three-year RSR for prostate cancer was over 100% for stages I, II and III. This means that men diagnosed with prostate cancer at these stages were just as likely (or more likely) to survive three years after their diagnosis compared to similar men in the general population. However, the three-year survival for stage IV prostate cancer was only 54.7%.

Figure 4.4

Three-year relative survival ratios (RSR), by stage and cancer type, Ontario, 2010–2012



†For this figure, all cancers refers to cancers for which stage data was available (prostate, breast (female), colorectal, lung and cervix)

‡Due to stage data availability, the cervical cancer RSRs use data from the diagnosis years 2011 and 2012

Note: Analysis restricted to ages 15-99; Case counts: prostate n=24,965 (excludes unknown stage=3,080), breast n=26,717 (excludes unknown stage=3,976), colorectal n=20,718 (excludes unknown stage=7,463), lung n=22,684 (excludes unknown stage=5,904), cervix n=1,458 (excludes unknown stage=487)

Analysis by: Surveillance, Analytics and Informatics, CCO

Data source: Ontario Cancer Registry (November 2015), CCO

The three-year RSRs for the other cancers for which data are available are as follows:

- The RSR for breast cancer was high for those diagnosed in stage I (99.8%) and stage II (95.3%) but fell to 83.7% for stage III and 40.9% for stage IV.
- The colorectal cancer RSR declined substantially from a high of 95.7% at stage I to 19.6% at stage IV.
- The RSR for lung cancer declined significantly at every stage: 73.6% at stage I, 52.4% at stage II, 24.2% at stage III and 5.6% at stage IV.
- The RSR for cervical cancer was high for those diagnosed in stage I (96.4%) but declined by almost 30 percentage points to 69.8% for stage II. The RSRs were even lower for diagnoses at stage III (53.6%) and stage IV (19.8%).

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Table 4.1**Five-year relative survival ratios (RSR), by cancer type and sex, Ontario, 2008–2012**

Cancer type	Both sexes	Males	Females
All cancers	63.1%	61.8%	64.5%
Bladder	62.9%	64.9%	57.0%
Brain	25.9%	24.8%	27.2%
Breast (female)	—	—	87.2%
Cervix	—	—	71.4%
Colorectal	63.2%	63.2%	63.1%
Esophagus	14.9%	14.7%	15.2%
Hodgkin lymphoma	84.2%	83.0%	85.6%
Kidney	69.0%	68.8%	69.4%
Larynx	61.0%	61.6%	57.6%
Leukemia	54.3%	54.8%	53.5%
Liver	24.1%	24.5%	22.7%
Lung	18.0%	15.1%	21.2%
Melanoma	85.0%	81.2%	89.5%
Myeloma	42.6%	43.4%	41.5%
Non-Hodgkin lymphoma	66.1%	64.6%	67.9%
Oral cavity and pharynx	63.1%	61.9%	65.3%
Ovary	—	—	45.8%
Pancreas	9.0%	9.1%	9.0%
Prostate	—	95.2%	—
Stomach	28.4%	27.7%	29.6%
Testis	—	96.1%	—
Thyroid	98.6%	95.6%	99.4%
Uterus	—	—	82.6%

Note: Analysis restricted to ages 15-99**Analysis by:** Surveillance, Analytics and Informatics, CCO**Data source:** Ontario Cancer Registry (November 2015), CCO

Table 4.2 Five-year relative survival ratio (RSR), by cancer type and age group, Ontario, 2008–2012

Cancer type	Age group (years)					
	15–44	45–54	55–64	65–74	75–84	85–99
All cancers [†]	83.8%	74.8%	69.9%	63.3%	49.4%	34.6%
Bladder [†]	78.3%	74.2%	72.9%	69.8%	57.3%	38.5%
Breast (female)	87.1%	90.0%	89.7%	89.7%	82.3%	66.6%
Cervix [†]	87.8%	70.2%	64.7%	53.5%	33.8%	22.8%
Colorectal [†]	70.9%	70.1%	69.1%	67.6%	57.8%	45.3%
Esophagus [†]	18.0%	21.3%	18.0%	15.3%	10.6%	7.6%
Hodgkin lymphoma [†]	93.5%	87.7%	77.3%	61.7%	52.0%	—
Kidney [†]	88.7%	78.6%	73.6%	68.8%	56.5%	25.4%
Larynx [†]	89.6%	67.4%	64.1%	61.9%	54.7%	38.5%
Leukemia [†]	71.3%	70.6%	67.4%	56.2%	39.9%	25.4%
Liver [†]	43.1%	33.6%	32.3%	22.0%	11.1%	4.6%
Lung [†]	36.7%	23.5%	22.0%	19.4%	13.8%	6.4%
Melanoma [†]	91.4%	88.3%	85.6%	84.6%	79.1%	74.6%
Myeloma [†]	73.2%	62.5%	54.4%	45.7%	27.6%	19.5%
Non-Hodgkin lymphoma [†]	83.7%	78.1%	74.8%	66.0%	50.9%	36.5%
Oral cavity & pharynx [†]	82.6%	73.8%	66.4%	58.6%	50.0%	36.8%
Ovary [†]	76.4%	62.0%	49.1%	37.3%	25.2%	12.2%
Pancreas [†]	40.5%	17.6%	13.7%	7.3%	5.3%	1.3%
Prostate	94.0%	98.0%	98.4%	98.6%	89.4%	58.4%
Stomach [†]	38.6%	35.9%	34.3%	30.5%	23.7%	11.9%
Testis	96.8%	96.0%	91.8%	—	—	—
Thyroid	99.9%	99.8%	98.7%	96.3%	88.9%	—
Uterus	90.1%	87.6%	87.5%	79.6%	74.5%	50.4%

[†]Statistically significant decreasing trend in RSR across age groups

Note: Analysis restricted to ages 15–99

For some age group and cancer combinations there were too few cases and/or deaths to produce reliable estimates

Analysis by: Surveillance, Analytics and Informatics, CCO

Data source: Ontario Cancer Registry (November 2015), CCO