Chapter 6

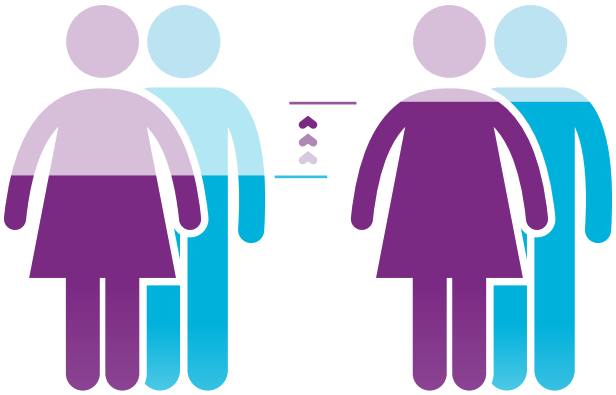
# Cancer survival

Relative survival measures the likelihood of a person who has been diagnosed with cancer surviving for a specified period of time, compared to similar people in the general population. This chapter presents current and historical statistics on cancer survival in Ontario.

## 5-year relative survival ratios

"The greatest improvements in survival have been made in those diagnosed between the ages of 40 and 79 years."

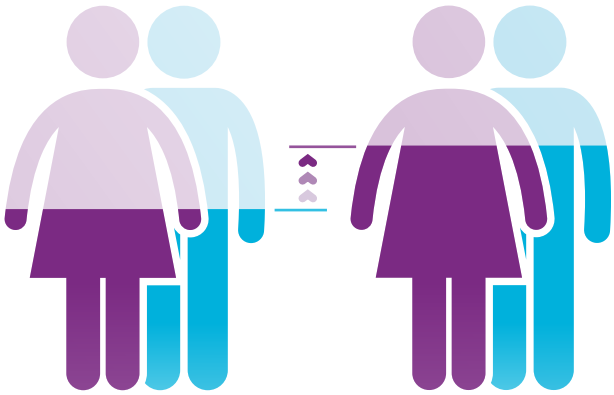
**Age 40–59**



**1984–1988**
55.8%

**2009–2013**
74.9%

**Age 60–79**



**1984–1988**
47.0%

**2009–2013**
63.4%

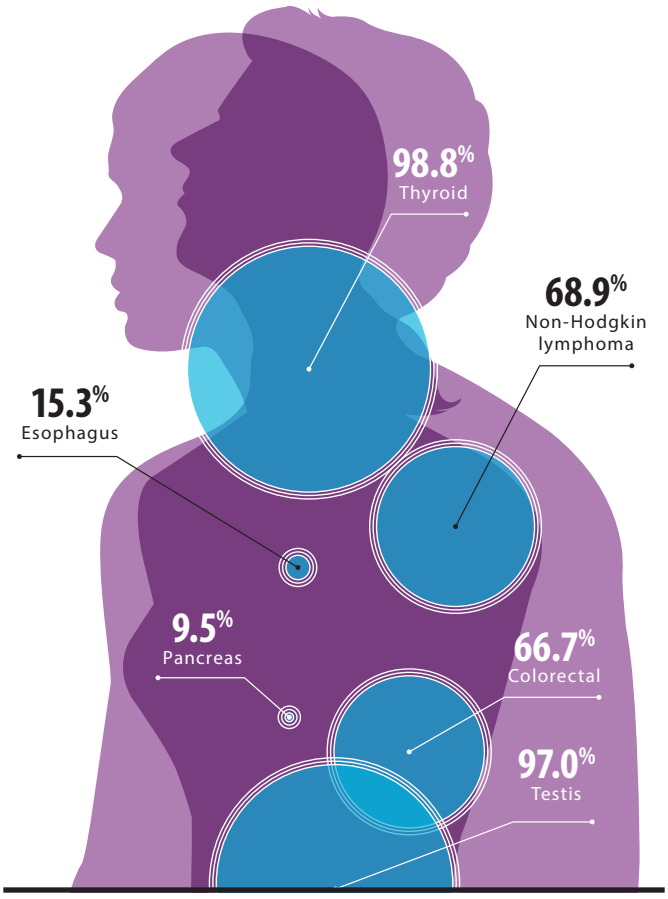
Survival statistics are a key indicator of the effectiveness of cancer treatment and control programs.[1] Relative survival ratios (RSRs) indicate the likelihood of surviving for a certain amount of time (e.g., one, three or five years) after diagnosis compared to similar people (i.e., people of the same age and sex) in the general population.

The first five years after diagnosis are a critical period for examining survival. This is when someone is most likely to access healthcare services, including primary treatment and close clinical assessment for recurrence. After five years, use of the healthcare system and the chance of recurrence both decrease. Accordingly, this chapter focuses mainly on five-year relative survival for the period of 2009 to 2013.

Cancer survival depends on several factors, including the cancer type (including its morphology), sex, age at diagnosis, stage at diagnosis and the type of treatment received. While RSRs represent the typical survival expectation for the population of people with a certain type of cancer, these statistics may not reflect the prognosis of an individual, whose survival can also depend on their health status, the presence of comorbidities and other personal and tumour-related factors. Survival estimates are based on data from people diagnosed in the past, which means they may not reflect the impact of more recent advances in cancer detection and treatment.

Improvements in survival over time can be attributed to better methods for (and the greater 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.[2] Improvements in survival may also be artefactual: that is, the result of increased incidence through improved early detection.[3] For improvements in survival to be considered signs of progress, they should be accompanied by decreases in incidence and/or mortality.

**Five-year relative survival ratios for selected cancers, 2009–2013**



## Relative survival by cancer type and sex

From 2009 to 2013, the five-year RSR for all cancers combined was 64.7% (Table 6.1). This means those diagnosed with cancer during this period were 64.7% as likely to survive for five years after diagnosis compared to similar people in the general population. Survival has improved over time with the age-standardized five-year RSR increasing from 47.6% in 1983–1987 to 63.9% in 2009–2013.[4]

Male survival for 2009–2013 was significantly lower than female: 63.0% compared to 66.4%. This disparity is likely a result of generally higher survival rates in females compared to males for cancer types that are common in both sexes—particularly lung cancer, which is the leading cause of cancer death in Ontario.

**For cancer types that occur in both sexes:**

- Five-year survival was highest for thyroid cancer (98.8%), Hodgkin lymphoma (86.9%) and melanoma (86.6%).
- Five-year survival was lowest for pancreatic (9.5%), esophageal (15.3%), lung (20.0%) and liver (20.4%) cancers. Low survival rates 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.[5,6]

It should be noted that relative survival estimates for high-mortality cancers (particularly pancreatic cancer) are generally higher in Ontario than in other provinces and may be overestimated. The reason for this overestimation is likely due to survival methodology, which assumes patients lost to follow-up are still alive at the cut-off date (which, in the case of five-year RSRs, is five years after diagnosis).[7] For high-mortality cancers, this is very unlikely. This is particularly a problem for Ontario because there is evidence that Ontario has a higher loss to follow-up rate than other provinces, although the reasons for this are still unclear. Therefore, survival estimates for pancreatic, esophageal, liver and lung cancers should be interpreted with caution, especially when comparing them to other jurisdictions.

**For males, five-year survival was:**

- highest for testicular (97.0%), thyroid (97.0%) and prostate (95.4%) cancers; and
- lowest for pancreas (9.7%), esophageal (15.3%) and lung (17.0%) cancers.

**For females, five-year survival was:**

- highest for thyroid cancer (99.3%), melanoma (90.3%) and breast cancer (88.9%); and
- lowest for pancreas (9.4%), esophageal (15.5%) and liver (18.7%) cancers.

**There were significant differences in five-year survival between males and females for the following cancer types. Specifically:**

- Lung cancer survival was significantly higher in females (23.3%) than males (17.0%). Possible reasons for lower lung cancer 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.[4,8,9]
- Survival for melanoma was significantly higher in females (90.3%) than males (83.5%). Lower survival among males has been attributed to tumour–host interaction that leads to a higher chance of metastasis in males than in females.[10–12] Recent research has also pointed toward the possible role of the expression of the PR70 protein which may act as an X-chromosome linked melanoma tumour suppressor.[13]
- Oral cavity & pharynx cancer survival was significantly higher in females (65.8%) than males (60.2%).
- Bladder cancer was the one cancer for which male survival was significantly higher than female (66.3% in males versus 57.4% in females). 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 affect the progression of cancer.[14, 15]

**Table 6.1** Five-year relative survival ratios by cancer type and sex, Ontario, 2009–2013

| Cancer type | Both Sexes | | Males | | Females | |
|---|---|---|---|---|---|---|
| | RSR (%) | 95% CI | RSR (%) | 95% CI | RSR (%) | 95% CI |
| **All cancers** | **64.7** | **64.4–64.9** | **63.0** | **62.6–63.4** | **66.4** | **66.1–66.8** |
| High survival (80%–100%) | | | | | | |
| Thyroid | 98.8† | 98.3–99.2 | 97.0† | 95.2–98.1 | 99.3† | 98.7–99.6 |
| Testis | — | — | 97.0† | 95.5–98.1 | — | — |
| Prostate | — | — | 95.4† | 94.8–95.9 | — | — |
| Breast (female) | — | — | — | — | 88.9 | 88.3–89.4 |
| Hodgkin lymphoma | 86.9† | 84.4–89.1 | 85.9† | 82.2–88.9 | 86.8† | 82.9–89.9 |
| Melanoma | 86.6 | 85.4–87.7 | 83.5 | 81.7–85.2 | 90.3 | 88.7–91.7 |
| Uterus | — | — | — | — | 83.2 | 82.0–84.4 |
| Average survival (40%–79%) | | | | | | |
| Kidney | 74.3 | 72.8–75.8 | 73.6 | 71.7–75.5 | 75.4† | 73.0–77.7 |
| Cervix | — | — | — | — | 73.2 | 70.7–75.5 |
| Non-Hodgkin lymphoma | 68.9 | 67.7–70.1 | 67.6 | 65.9–69.2 | 70.5† | 68.7–72.2 |
| Colorectal | 66.7 | 65.9–67.5 | 66.5 | 65.3–67.6 | 66.8 | 65.6–68.0 |
| Bladder | 64.2 | 62.5–65.8 | 66.3 | 64.3–68.2 | 57.4† | 54.0–60.6 |
| Oral cavity & pharynx | 62.0 | 60.3–63.7 | 60.2 | 58.1–62.2 | 65.8 | 62.8–68.6 |
| Larynx | 59.9 | 56.2–63.3 | 60.6 | 56.6–64.3 | 56.2 | 47.1–64.3 |
| Leukemia | 58.1 | 56.5–59.6 | 58 | 56.0–60.0 | 58.1 | 55.8–60.4 |
| Ovary | — | — | — | — | 46.9 | 44.9–48.8 |
| Myeloma | 44.0 | 41.7–46.3 | 43.2 | 40.0–46.3 | 45 | 41.5–48.4 |
| Low survival (<40%) | | | | | | |
| Stomach | 31.4 | 29.6–33.2 | 31.6 | 29.3–34.0 | 30.9 | 28.1–33.7 |
| Brain | 29.9† | 27.1–30.7 | 27.0† | 24.7–29.4 | 31.2† | 28.5–33.9 |
| Liver | 20.4 | 18.8–22.1 | 21.1 | 19.1–23.2 | 18.7 | 15.8–21.8 |
| Lung | 20.0 | 19.5–20.6 | 17.0 | 16.2–17.8 | 23.3 | 22.4–24.2 |
| Esophagus | 15.3 | 13.6–17.1 | 15.3 | 13.3–17.4 | 15.5† | 12.1–19.1 |
| Pancreas | 9.5 | 8.6–10.5 | 9.7 | 8.3–11.1 | 9.4 | 8.1–10.8 |

CI=Confidence interval
RSR=Relative survival ratio
†The RSR has increased over a prior interval and has been adjusted
**Note:** Analysis was restricted to people ages 15 to 99.
**Analysis by:** Surveillance, Analytics and Informatics, CCO
**Data source:** Ontario Cancer Registry (November 2016), CCO

## Survival by age group

The five-year RSR for all cancers combined decreased with age. For 2009–2013, the five-year RSR was 87.1% for people diagnosed between the ages of 15 and 39 but just 44.7% for those diagnosed between 80 and 99 years of age (Figure 6.1).

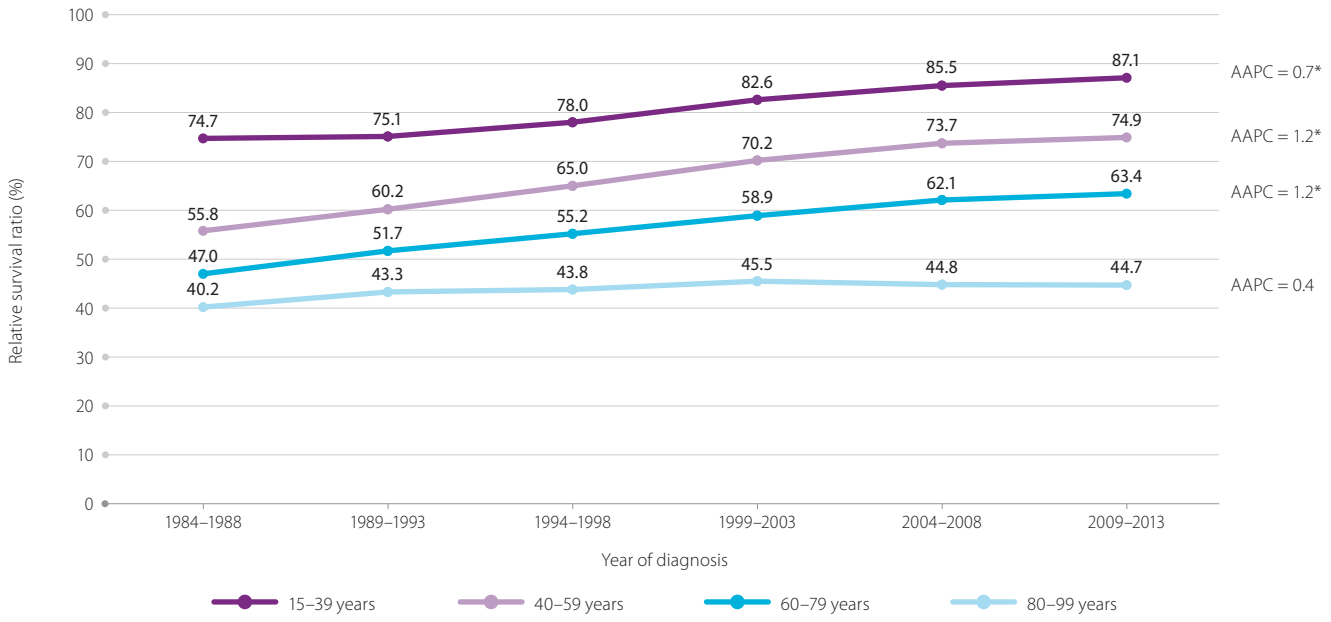
Since the 1984–1988 period, people ages 15 to 79 have seen significant increases in five-year survival, with the greatest increase occurring in the 40 to 59 age group (with an average annual percent change [AAPC] of 1.2%) and the 60 to 79 age group (with an AAPC of 1.2%).

People diagnosed between the ages of 15 and 39 also had a significant increase in survival; however, the increase was approximately half that of the two older age groups (an AAPC of 0.7%). The smaller improvement in survival among people ages 15 to 39 likely reflects the fact that the most common cancers in this age group (e.g., testicular, thyroid) already have high survival, meaning there is less room for improvement.

The increase in survival that did occur in this age group may be partially an artifact of increased early detection. This is evidenced by the increase in incidence that occurred in this age group—especially after 2001 (Figure 4.2).

People diagnosed between the ages of 80 to 99 have seen no significant improvement in five-year survival since the 1984–1988 period. As a result, the gap in survival between this age group and the younger age groups has widened over time. During the 1984–1988 period, those diagnosed between the ages of 60 and 79 had a five-year RSR that was seven percentage points greater than those diagnosed at age 80 or older. By the 2009–2013 period, this disparity had increased to almost 20 percentage points. The greater improvements in survival among people ages 40 to 79 may be the result of greater participation in screening programs (e.g., mammography) by this age group and improved treatments.[16]

**Figure 6.1** **Five-year relative survival ratios by age group and time period for all cancers combined, Ontario, 1984–2013**




AAPC=Average annual percent change
*Statistically significant AAPC
**Notes:** 1. Analysis was restricted to ages 15 to 99.
2. Cohort method was used for time periods 1984–1988 to 2004–2008. Period method was used for the 2009–2013 time period.
**Analysis by:** Surveillance, Analytics and Informatics, CCO
**Data source:** Ontario Cancer Registry (November 2016), CCO

## Survival by duration

For 2009–2013, the RSR for all cancers combined was 78.3% after one year, 64.7% after five years, 60.7% after 10 years and 58.4% after 15 years (Figure 6.2). 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.

For the four most common cancers, the following was observed for relative survival by duration:

- For breast cancer, the RSR one year after diagnosis was very high at 97.1%. After five years, the RSR fell by almost 10 percentage points to 88.9%. It then fell by approximately five percentage points between five and 10 years post-diagnosis and by another five percentage points between 10 and 15 years post-diagnosis.
- For colorectal cancer, the RSR one year after diagnosis was 82.5% but fell to 66.8% after five years—a greater decrease than for breast cancer. There was no significant difference between the 10 and 15-year RSR for colorectal cancer.
- The greatest decrease in survival between one and five years post-diagnosis was for lung cancer, which fell from 43.9% to 20.0%. Survival decreased significantly at 10 years (14.9%) and 15 years (12.1%).
- Prostate cancer survival decreased by a small, but significant, amount between one year and five years post-diagnosis, but there was no significant difference between five-year, 10-year and 15-year survival. In fact, the five-year and 10-year RSRs were exactly the same (95.4%). Survival for prostate cancer was so high that the 15-year RSR was higher than the five-year RSR for all major cancer types except testis and thyroid.

People diagnosed with cancer were 64.7% as likely to survive for five years after diagnosis compared to similar people in the general population.

For 2009–2013, the relative survival ratio for all cancers combined was

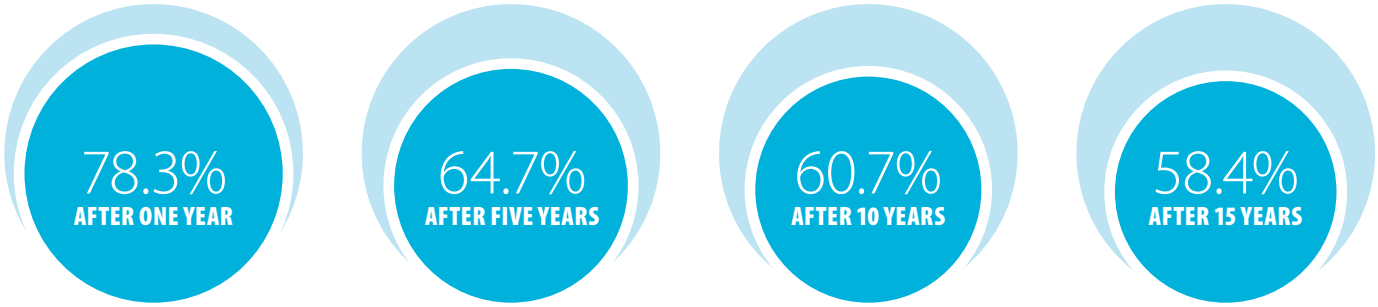
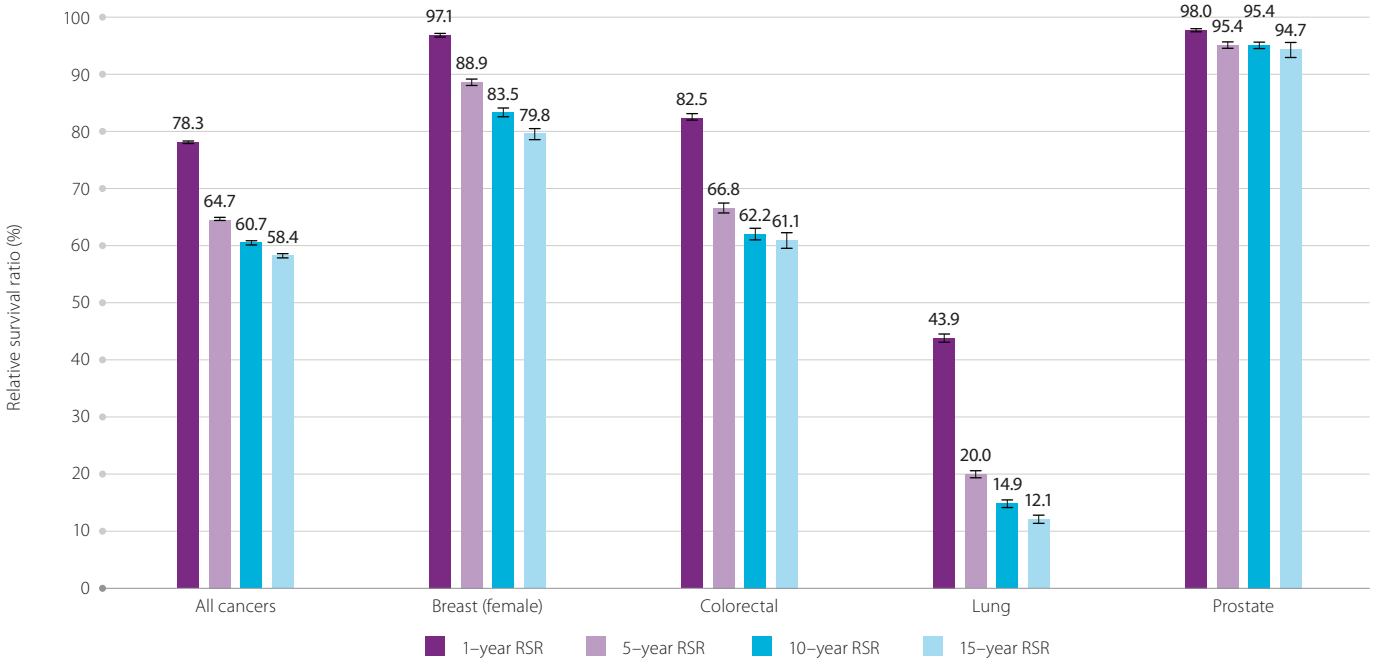



**Figure 6.2** **Relative survival ratios by cancer type and survival duration for selected cancers, Ontario, 2009–2013**




RSR=Relative survival ratio
**Note:** Analysis was restricted to ages 15 to 99.
**Analysis by:** Surveillance, Analytics and Informatics, CCO
**Data source:** Ontario Cancer Registry (November 2016), CCO

## Survival by stage

Stage at diagnosis is one of the most important predictors of cancer survival. Population-level stage data in Ontario is available from 2010 onward for the most common cancers (breast, colorectal, lung and prostate) and cervical cancer, and for a limited number of years for thyroid cancer and melanoma. This section focuses on the most common cancers.

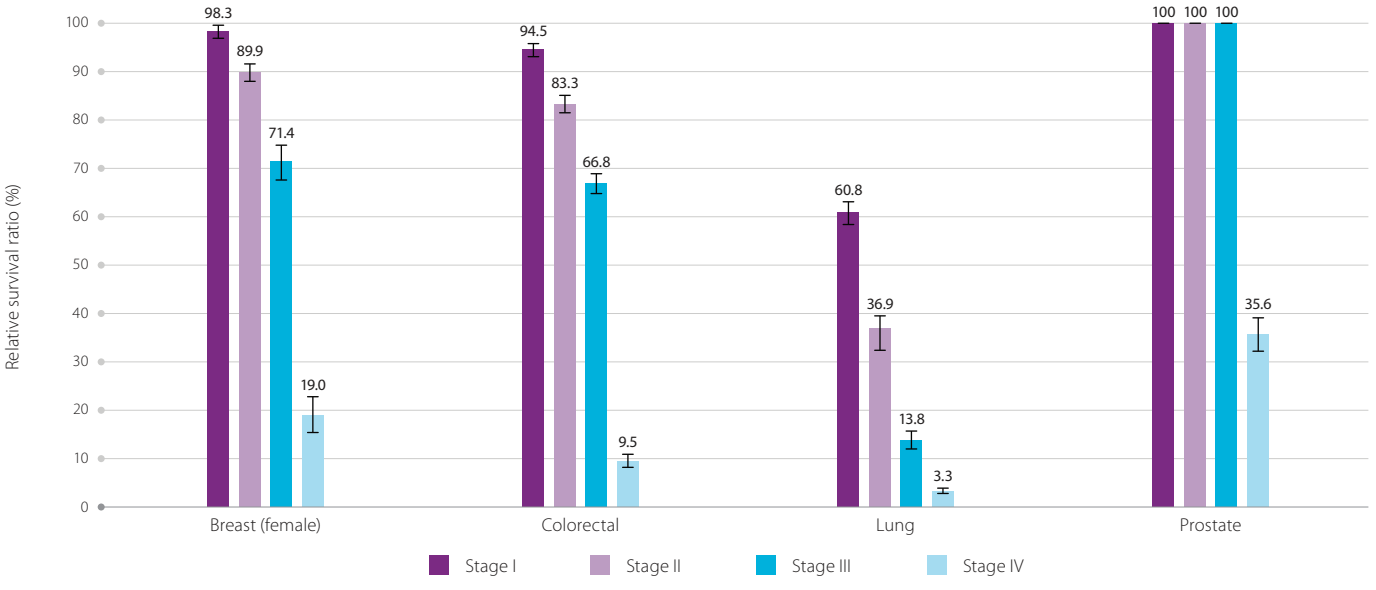
Five year relative survival for 2010–2013 tended to decrease as stage at diagnosis increased; however the level of decrease varied by cancer type (Figure 6.3). Specifically:

- While breast cancer cases diagnosed at stage I had a five-year RSR of 98.3%, the RSR decreased to just 19.0% for cases diagnosed at stage IV. Breast cancer was most commonly diagnosed at stage I in 2013 while only 5.3% of cases were diagnosed at stage IV (see *Chapter 4: Cancer incidence rates and trends*).
- Colorectal cancer cases diagnosed at stage I had a five-year RSR of 94.5%, which declined to 83.3% for cases diagnosed at stage II, 66.8% at stage III and just 9.5% at stage IV. A considerable amount of colorectal cases were stage IV cancers, with 19.1% of cases diagnosed at this stage.

Five year relative survival for 2010–2013 tended to decrease as stage at diagnosis increased; however the level of decrease varied by cancer type.

- Of the four most common cancers, lung cancer had the lowest survival at every stage. Even at stage I, five-year survival was just 60.8%, declining to 3.3% at stage IV. This low RSR is particularly concerning because 51.6% of lung cases were diagnosed at stage IV in 2013.
- Stage at diagnosis had the least effect on prostate cancer. Five-year survival for stages I to III was 100%; however, survival dipped to 35.6% for cases diagnosed at stage IV—which accounted for 10.8% of prostate cases in 2013.

**Figure 6.3** **Five-year relative survival ratios by cancer type and stage at diagnosis for selected cancers, Ontario, 2010–2013**




**Notes:** 1. Analysis was restricted to ages 15 to 99.
2. Case counts are as follows: breast n = 27,310 (excludes unknown stage = 206); colorectal n = 24,614 (excludes unknown stage = 824); lung n = 28,173 (excludes unknown stage = 232); prostate n = 26,078 (excludes unknown stage = 162). Cases that were not staged were excluded from this analysis.
**Analysis by:** Surveillance, Analytics and Informatics, CCO
**Data source:** Ontario Cancer Registry (November 2016), CCO

## Conditional survival

Relative survival ratios represent the likelihood of surviving a specific number of years after diagnosis. However, sometimes it may be useful to measure survival starting at a point in time other than the date of diagnosis. Because most mortality occurs in the first year following diagnosis, survival after the first year may be very different from survival measured at diagnosis. Table 6.2 presents five-year RSRs conditional on surviving zero (the equivalent of non-conditional survival), one, two, three and four years after diagnosis.

The following was observed:

- While the five-year RSR measured from diagnosis for all cancers combined for 2009–2013 was 64.7%, the RSR increased to 82.7% for those who survived the first year after diagnosis. The five-year RSR increased for each year survived until four years after diagnosis, when the RSR was 97.7%.
- Because most mortality occurs in the first year following diagnosis, the one-year conditional RSR showed the greatest increases over the non-conditional RSR (zero survived years) for all cancers. The lower survival cancers (e.g., pancreas, esophagus, lung) showed the greatest increases in one-year conditional survival over non-conditional survival. While the five-year RSR for pancreatic cancer was only 9.5% at diagnosis, it increased to 34.7% for those who survived one year.
- The high survival cancers (e.g., thyroid, testis, prostate) showed the smallest improvements in one year conditional RSRs because there was less room for improvement. For these high-survival cancers, the one-year conditional RSR tended to not be significantly higher than the non-conditional RSR.

Five-year conditional relative survival ratios for all cancers combined

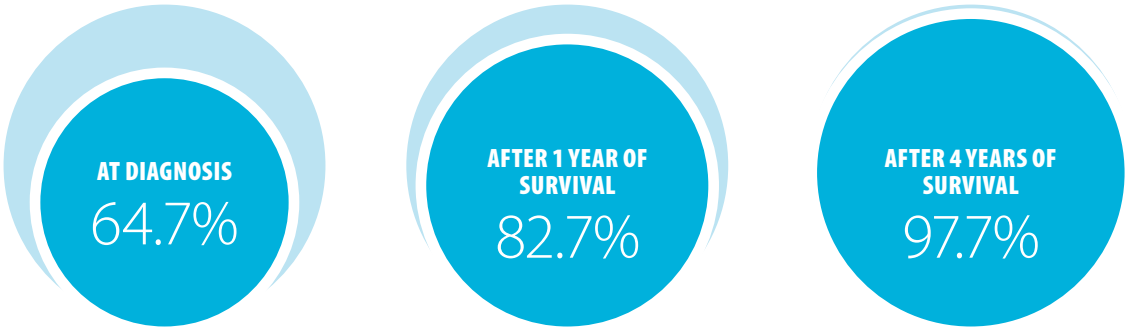


**Table 6.2** Conditional five-year relative survival ratios by cancer type and years survived, Ontario, 2009–2013

| Cancer type | Survived years | | | | |
|---|---|---|---|---|---|
| | 0† RSR % (95% CI) | 1 RSR % (95% CI) | 2 RSR % (95% CI) | 3 RSR % (95% CI) | 4 RSR % (95% CI) |
| **All cancers** | **64.7 (64.4–64.9)** | **82.7 (82.5–83.0)** | **90.2 (89.9–90.4)** | **94.5 (94.3–94.7)** | **97.7 (97.6–97.8)** |
| Bladder | 64.2 (62.5–65.8) | 78.1 (76.3–79.8) | 87.1 (85.5–88.6) | 92.4 (90.9–93.6) | 96.5 (95.3–97.4) |
| Brain | 29.9 (27.1–30.7) | 54.6 (51.9–57.2) | 76.9 (74.0–79.4) | 87.3 (84.9–89.4) | 95.5 (93.8–96.8) |
| Breast (female) | 88.9 (88.3–89.4) | 91.5 (91.0–92.0) | 93.6 (93.1–94.1) | 95.8 (95.3–96.1) | 98.2 (97.9–98.5) |
| Cervix | 73.2 (70.7–75.5) | 84.1 (81.8–86.1) | 90.2 (88.2–91.9) | 94.4 (92.6–95.7) | 97.2 (95.8–98.2) |
| Colorectal | 66.7 (65.9–67.5) | 80.6 (79.8–81.4) | 87.6 (86.8–88.3) | 93.2 (92.6–93.8) | 97.0 (96.5–97.4) |
| Esophagus | 15.3 (13.6–17.1) | 36.1 (32.4–39.8) | 59.3 (54.1–64.2) | 77.6 (72.0–82.2) | 92.0 (87.0–95.2) |
| Hodgkin lymphoma | 86.9 (84.4–89.1) | 92.3 (90.0–94.1) | 94.0 (92.9–96.4) | 96.3 (94.5–97.6) | 98.3 (98.8–99.1) |
| Kidney | 74.3 (72.8–75.8) | 87.3 (85.8–88.6) | 92.4 (91.1–93.5) | 95.2 (94.0–96.1) | 97.7 (96.8–98.3) |
| Larynx | 59.9 (56.2–63.3) | 72.5 (68.8–75.9) | 82.1 (78.3–85.2) | 89.0 (85.6–91.6) | 95.4 (92.7–97.1) |
| Leukemia | 58.1 (56.5–59.6) | 80.5 (78.9–82.0) | 88.3 (86.8–89.6) | 92.5 (91.2–93.7) | 95.9 (94.8–96.7) |
| Liver | 20.4 (18.8–22.1) | 48.5 (45.0–51.8) | 66.1 (62.1–69.8) | 80.0 (76.0–83.4) | 90.3 (86.9–92.8) |
| Lung | 20.0 (19.5–20.6) | 45.6 (44.5–46.8) | 64.7 (63.2–66.0) | 79.8 (78.4–81.2) | 90.3 (89.1–91.3) |
| Melanoma | 86.6 (85.4–87.7) | 90.9 (89.8–91.9) | 93.9 (92.9–94.8) | 96.3 (95.5–97.1) | 98.9 (98.1–99.2) |
| Myeloma | 44.0 (41.7–46.3) | 58.8 (55.9–61.5) | 68.0 (64.9–70.8) | 76.7 (73.6–79.4) | 88.0 (85.4–90.2) |
| Non-Hodgkin lymphoma | 68.9 (67.7–70.1) | 85.0 (83.8–86.2) | 90.3 (89.2–91.3) | 93.3 (92.3–94.2) | 97.0 (96.2–97.6) |
| Oral cavity & pharynx | 62.0 (60.3–63.7) | 75.5 (73.9–77.3) | 85.8 (84.2–87.3) | 92.7 (91.2–93.9) | 96.7 (95.6–97.5) |
| Ovary | 46.9 (44.9–48.8) | 62.6 (60.4–64.8) | 74.7 (72.4–76.8) | 85.5 (83.4–87.3) | 94.2 (92.7–95.5) |
| Pancreas | 9.5 (8.6–10.5) | 34.7 (31.6–37.8) | 62.9 (58.3–67.1) | 79.1 (74.4–83.0) | 92.2 (88.3–94.9) |
| Prostate | 95.4 (94.8–95.9) | 97.3 (96.8–97.8) | 98.8 (98.3–99.1) | 99.4 (99.0–99.6) | 99.8 (99.5–99.9) |
| Stomach | 31.4 (29.6–33.2) | 58.8 (56.0–61.5) | 77.4 (74.3–80.1) | 87.9 (85.0–90.3) | 94.7 (92.3–96.3) |
| Testis | 97.0 (95.5–98.1) | 98.6 (97.2–99.3) | 99.5 (98.0–99.9) | 99.7 (98.1–100.0) | 99.9 (98.2–100.0) |
| Thyroid | 98.8 (98.3–99.2) | 99.6 (99.0–99.8) | 99.8 (99.2–99.9) | 99.8 (99.4–100.0) | 100 |
| Uterus | 83.2 (82.0–84.4) | 89.4 (88.3–90.5) | 94.4 (93.4–95.2) | 97.0 (96.1–97.7) | 98.7 (98.0–99.2) |

CI=Confidence interval
RSR=Relative survival ratio
†Zero years survived is the equivalent of non-conditional survival
**Note:** Analysis was restricted to ages 15 to 99.
**Analysis by:** Surveillance, Analytics and Informatics, CCO
**Data source:** Ontario Cancer Registry (November 2016), CCO

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