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by Larry F. Ellison

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^{p}	preliminary
^{r}	revised
x	suppressed to meet the confidentiality requirements of the *Statistics Act*
^{E}	use with caution
F	too unreliable to be published
*	significantly different from reference category ($p < 0.05$)

Adjusting relative survival estimates for cancer mortality in the general population

by Larry F. Ellison

Abstract

Background
In theory, expected survival probabilities used in the derivation of relative survival ratios (RSR) are determined from a control group free of the cancer under study. In practice, expected survival is typically estimated from general population life tables—which include people previously diagnosed with cancer—potentially leading to an overestimation of relative survival.

Data and methods
Data are from the Canadian Cancer Registry with mortality follow-up through record linkage to the Canadian Vital Statistics Death database. Period method RSRs for 2006-to-2008 were derived using general population life tables adjusted for cancer mortality and then compared with estimates derived using corresponding unadjusted life tables.

Results
For all cancers combined, the use of general population life tables to derive expected survival probabilities overestimated RSRs by 0.6 (1-year), 2.4 (5-year) and 4.6 (10-year) percentage units. Biases in 5-year survival were highest among males (3.0) and among people aged 75 to 99 at diagnosis (4.1). The bias was negligible for most individual cancers; biases were highest for prostate cancer, followed by colorectal and female breast cancer.

Interpretation
Canadian estimates of relative survival for all cancers combined calculated using general life tables warrant adjustment for cancer mortality. Consideration of adjustment for cancer mortality is recommended for estimates of colorectal, female breast and especially prostate cancer.

Keywords

Bias, epidemiologic methods, life tables, neoplasms, registries, survival

Authors

Larry F. Ellison (larry.ellison@statcan.gc.ca) is with the Health Statistics Division at Statistics Canada, Ottawa, Ontario.

For cancer, relative survival is defined as the ratio of the observed (absolute) survival in a group of people diagnosed with cancer to the expected survival of a comparable group—free of the cancer under study—in the general population.[1] In theory, the relative survival ratio (RSR) provides an estimate of the difference between the all-cause mortality of those diagnosed with cancer and the mortality that would be expected in the absence of cancer (the excess mortality due to cancer).[2] In practical applications, however, expected survival is typically estimated from general population life tables. Because these estimates include people previously diagnosed with cancer, they underestimate expected survival, and hence, overestimate relative survival.

In 1961, based on studies conducted in the Unites States, Ederer et al.[1] concluded that in calculating the relative survival of people diagnosed with a specific cancer, life table adjustment for deaths due to that cancer may not be necessary in estimating expected survival, because deaths due to a specific cancer constitute a negligible proportion of all deaths. Since then, this issue received virtually no further examination until the topic was recently revisited by Talbäck and Dickman.[3] Using computerized population registers in Sweden, these researchers were able to estimate the bias resulting from the use of general population life tables by calculating expected survival, including and excluding people diagnosed with cancer. Their results showed that for older age groups with some common cancers, and especially for all cancers combined, adjustment of expected survival for cancer mortality may be warranted. Otherwise, the bias was sufficiently small that it could be ignored for most applications.

The opportunity to directly determine expected survival excluding people diagnosed with cancer is rarely available. With this in mind, Talbäck and Dickman evaluated a surrogate method of adjusting survival probabilities estimated from general population life tables which required only information about the number and causes of death in a population.[3] The current study applies that method to Canadian data to explore the impact of adjusting expected survival for cancer mortality on relative survival estimates. The proportions of deaths due to all cancers combined and a selected number of commonly diagnosed cancers are also presented for context.

Methods

Data sources

Cancer incidence data are from the October 2011 version of the Canadian Cancer Registry, which includes primary cancer cases diagnosed from 1992 to 2009. The Canadian Cancer Registry is a dynamic, person-oriented, population-based database maintained by Statistics Canada, which contains information on cases compiled from reports from every provincial/territorial cancer registry.

A file containing records of invasive cancer cases and *in situ* bladder cancer cases (the latter are considered invasive for surveillance purposes and are reported for each province/territory except Ontario) was created using the multiple primary coding rules of the International Agency for Research on Cancer.[4] Cancer cases were defined based on the *International Classification of Diseases for Oncology, Third Edition*[5] and classified using Surveillance, Epidemiology, and End Results (SEER) Program grouping definitions.[6]

Mortality follow-up through December 31, 2008, was carried out by record linkage to the Canadian Vital Statistics Death database (excluding deaths registered in the province of Quebec), and from information reported by the provincial/territorial cancer registries. For deaths reported by a provincial registry but not confirmed by the national record linkage, the date of death was assumed to be that submitted by the reporting registry.

Mortality data are from the Canadian Vital Statistics Death database. Deaths due to cancer were classified using the World Health Organization's *International Statistical Classification of Diseases and Related Health Problems—10th Revision (ICD-10)*[7] for deaths from year 2000 onward, and *9th Revision (ICD-9)*[8] for deaths from previous years.

Analytical techniques

The proportion of deaths among Canadian residents recorded as being due to cancer as a whole (ICD-10: C00-C97) and due specifically to colorectal (C18-C20, C26.0), lung and bronchus (C34), skin melanoma (C43), breast (C50), prostate (C61), bladder (C67), kidney and renal pelvis (C64-C65), thyroid (C73), non-Hodgkin lymphoma (C82-C85, C96.3) and leukemia (C90.1, C91-C95) was determined by sex, age group (younger than 1 year, 1 to 4, 5 to 9, 10 to 14, 15 to 19, . . . , 85 to 89, 90 to 94, and 95 or older), and year of death. The cancers chosen represent a variety of the most commonly diagnosed cancers in Canada. Based on this information, adjustments to general population life tables were made as per Talbäck and Dickman,[3] according to the following general formula:

$$P_{adj} = P_{gp}^{(1-\alpha)}$$

where P_{gp} is the expected survival probability estimated from general population life tables, and α is the proportion of deaths due to cancer in the population.

One-, 5- and 10-year predicted cumulative RSRs were calculated for the 2006-to-2008 period for all cancers combined and for selected individual cancers using expected probabilities of survival derived from general population life tables with no adjustment for cancer mortality. Analyses were repeated adjusting the expected probabilities to account for the fact that deaths due to the cancer of interest are included in the general population life tables. Percentage unit differences were determined for corresponding estimates.

Analyses were also conducted separately using adjustments based on provincial-specific mortality data for the 5-year period from 2005 to 2009 rather than individual-year Canadian data. A 5-year period was chosen to help stabilize provincial estimates of the adjustment proportion—particularly for less populous provinces. Adjustments of expected survival probabilities for the three sparsely populated territories were performed using α values corresponding to the territories as a whole.

RSRs were calculated using the period method.[9] Analyses were based on a publicly available algorithm[10]—incorporating the Ederer II method[11]—with minor adaptations to increase precision. Expected survival was derived from sex-specific complete annual provincial life tables.[12] Complete life tables were not available for Prince Edward Island and the three territories because of their small populations; expected survival proportions for these areas were derived—up to age 99—from abridged life tables for Canada and the affected jurisdictions and complete Canadian life tables using a method suggested by Dickman et al.[13] Expected survival probabilities for age 100 or older for these areas were drawn from Canadian life tables.

Analyses were based on all primary cancers.[14-16] Data from the province of Quebec were excluded because the method of determining the date of diagnosis in this province differed from that of the other provinces, and because of issues in correctly ascertaining the vital status of cases. Records were also excluded if: age at diagnosis was younger than 15 or older than 99; diagnosis was established through autopsy only or death certificate only; or the year of birth or death was unknown.

A similar analysis was conducted for cancer cases diagnosed from 1992 to 1994 (the first three years of the Canadian Cancer Registry) to determine the sensitivity of the results to the time period studied. This analysis was restricted to all cancers combined (for life table adjustment purposes ICD-9: 140.0-208.9), prostate (185), female breast (174) and colorectal cancers (153, 154.0, 154.1, 159.0). The cohort method of survival was used.

Results

About 3 in 10 deaths of Canadian residents from 2006 to 2008 were attributed to cancer (Table 1). The overall proportion (expressed as a percentage) was higher in males (30.8%) than in females (28.4%), although proportions were higher among females for all age groups from 15 to 19 through 70 to 74. The proportion of deaths attributable to cancer increased with age, peaking at 43.7% in the 60-to-64 and 65-to-69 age groups among men, and at 56.7% in the 55-to-59 age group among women.

Lung and bronchus (lung) cancer accounted for approximately 8% of all deaths from 2006 to 2008. Colorectal, female breast and prostate cancer were the only other cancers to account for more than 1.1% of all deaths in this period. The proportion of female deaths attributed to breast cancer peaked at ages 45 to 49 (13.2%). The proportion of male deaths attributed to prostate cancer was highest in the 80-to-84 and 85-to-89 age groups (4.6%).

The use of expected survival probabilities derived from general population life tables overestimated (biased) RSRs for all cancers combined by 0.6 (1-year), 2.4 (5-year) and 4.6 (10-year) percentage units, compared with RSRs calculated with expected survival probabilities adjusted for cancer mortality (Table 2). These differences were considerably larger than for any individual cancer studied. Biases in RSRs were highest for prostate (0.1, 0.6 and 1.4 percentage units), followed by colorectal (0.1, 0.4 and 0.8) and female breast (0.1, 0.3 and 0.6) cancer. For all other cancers studied, the bias associated with 10-year relative survival did not exceed 0.3 percentage units; for skin melanoma, kidney and renal pelvis, and thyroid cancer it did not exceed 0.1 percentage units, and results for these cancers were omitted from Table 2. The bias increased monotonically with increasing survival duration for each cancer studied.

For all cancers combined, the overestimation of RSRs resulting from the use of general population life tables unadjusted for cancer mortality increased with advancing age at diagnosis. Biases were highest among people aged 75 to 99 at diagnosis at 1.0 (1-year), 4.1 (5-year) and 8.1 (10-year) percentage units, followed by those aged 65 to 74 (0.6, 2.9 and 6.2) and 55 to 64 (0.3, 1.4 and 3.2). Among individual cancers, this trend was most pronounced for prostate cancer where, for example, the bias in the 10-year RSR rose from 0.1 (aged 15 to 54 at diagnosis) to 3.5 (75 to 99) percentage units. For colorectal cancer, the bias in 10-year relative survival rose from 0.1 (aged 15 to 54 at diagnosis) to 1.6 (75 to 99) percentage units; the corresponding rise among females diagnosed with breast cancer was from 0.2 to 1.4 percentage units.

Table 1
Percentage of deaths due to cancer, by age group, sex,† and selected cancers, Canada, 2006 to 2008

Age group (years)	All cancers		Colorectal		Lung and bronchus		Skin melanoma	Female breast‡	Prostate‡	Bladder	Kidney and renal pelvis	Thyroid	Non-Hodgkin lymphoma	Leukemia
	Male	Female	Male	Female	Male	Female								
	percentage													
All ages	30.8	28.4	3.8	3.4	8.7	7.0	0.4	4.3	3.1	0.8	0.7	0.1	1.1	1.0
Less than 1	0.5	0.5	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1
1 to 4	13.6	16.6	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.9	0.0	0.5	3.9
5 to 9	22.7	18.6	0.3	0.0	0.3	0.0	0.0	0.0	0.0	0.0	0.8	0.0	1.0	4.1
10 to 14	15.2	14.4	0.0	0.0	0.2	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.3	4.2
15 to 19	5.9	7.9	0.2	0.0	0.1	0.0	0.1	0.0	0.0	0.0	0.0	0.0	0.4	1.3
20 to 24	6.1	11.0	0.2	0.7	0.1	0.1	0.3	0.0	0.0	0.0	0.2	0.0	0.5	1.3
25 to 29	7.9	14.6	0.8	1.2	0.2	0.4	0.6	1.1	0.0	0.0	0.0	0.0	0.6	1.2
30 to 34	10.8	25.6	1.0	2.3	0.3	0.9	1.0	6.2	0.0	0.0	0.1	0.1	0.9	1.4
35 to 39	14.2	33.2	1.4	2.6	1.2	1.9	1.1	10.3	0.0	0.1	0.3	0.0	0.9	1.5
40 to 44	17.5	40.9	2.2	3.4	2.8	5.7	0.9	12.5	0.0	0.2	0.5	0.1	1.2	1.1
45 to 49	25.5	49.3	2.9	3.6	6.2	11.6	1.0	13.2	0.3	0.4	0.8	0.1	1.1	1.0
50 to 54	34.0	53.8	4.3	4.6	8.9	13.9	0.9	12.1	0.6	0.5	1.0	0.1	1.4	1.0
55 to 59	39.5	56.7	4.9	5.2	12.0	15.6	0.8	11.2	1.0	0.7	1.2	0.1	1.6	1.0
60 to 64	43.7	55.5	5.3	4.9	14.2	17.7	0.7	9.5	1.9	0.8	1.2	0.1	1.6	1.2
65 to 69	43.7	52.1	5.3	5.0	14.8	16.7	0.5	7.1	2.6	0.9	1.0	0.1	1.7	1.5
70 to 74	41.4	44.1	5.0	4.6	13.6	13.6	0.4	5.3	3.3	1.0	0.9	0.1	1.6	1.4
75 to 79	35.5	35.3	4.4	4.3	10.7	9.6	0.4	3.9	3.9	1.0	0.8	0.1	1.4	1.2
80 to 84	28.8	25.3	3.6	3.5	7.6	5.6	0.3	3.1	4.6	1.0	0.6	0.1	1.1	1.0
85 to 89	22.1	17.3	2.9	3.0	4.7	3.0	0.2	2.2	4.6	0.8	0.4	0.1	0.8	0.7
90 to 94	16.3	10.9	2.1	2.1	2.7	1.4	0.1	1.6	4.1	0.6	0.3	0.0	0.4	0.5
95 or older	11.8	6.7	1.3	1.4	1.2	0.6	0.1	1.3	4.0	0.4	0.2	0.0	0.2	0.3

† sex-specific percentages provided for selected cancers constituting 2% or more of deaths for all ages combined in given period
‡ sex-specific denominators used to determine percentages for female breast and prostate cancer
Source: Canadian Vital Statistics Death database.

For all cancers combined, biases in RSRs were higher for males at 0.7 percentage units (1-year), 3.0 (5-year) and 5.9 (10-year) than for females (0.4, 1.7 and 3.4 percentage units, respectively). However, sex-specific biases in 1- and 5-year relative survival were very similar (less than or equal to 0.1 percentage units) for the individual cancers studied, and the maximum between-sex difference for 10-year survival was 0.3 percentage units (bladder cancer). Where observed, bias was greater among males.

Virtually identical RSRs were obtained when adjustments to expected survival probabilities for cancer mortality were performed using province-specific mortality data for the 5-year period from 2005 to 2009 rather than individual-year Canadian data (data not shown). The largest difference in observed bias between the two approaches (0.2 percentage units) occurred in the 10-year RSR estimate among people aged 75 to 99 at diagnosis for all cancers combined.

The proportion of deaths due to cancer in 2006-to-2008 exceeded the proportion in 1992-to-1994 by at least 3 percentage units for each 5-year age group between ages 60 and 89, and by at least 6 percentage units for each age group between 65 and 79 (Figure 1). For all ages, the proportion increased by 2.0 percentage units—2.7 for males and 1.3 for females—between these periods (data not shown).

The consequences of using expected survival probabilities unadjusted for cancer mortality when calculating 1- and 5-year relative survival estimates for cases diagnosed in 1992-to-1994 were virtually the same as for the 2006-to-2008 period (Table 3). For all cancers combined, the bias in 10-year RSRs was slightly higher in the more recent period—about one-half of a percentage unit higher among those aged 65 to 99 at diagnosis.

Discussion

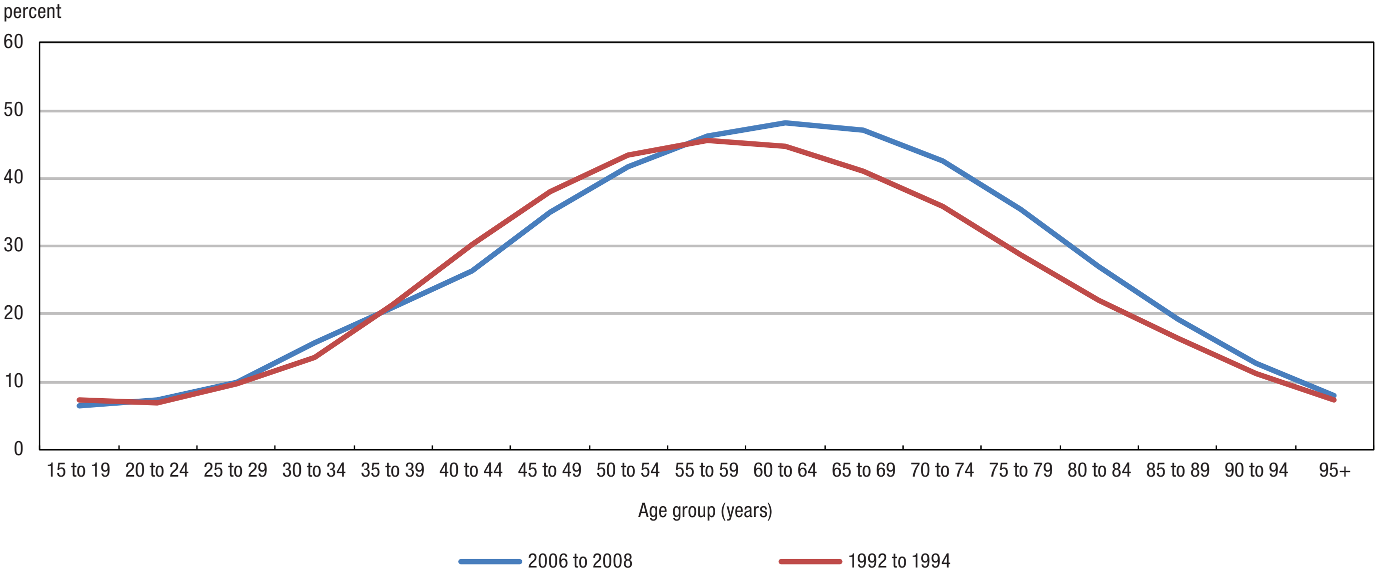
This study provides empirical data on the bias introduced into RSRs in Canada by using general population life tables—unadjusted for cancer mortality—to derive expected survival probabilities. Cancer-type-specific biases

Table 2
Period-based cumulative relative survival ratios (RSR) derived using expected survival probabilities adjusted for cancer mortality, and differences from RSRs derived using unadjusted probabilities, by age group and sex, selected cancers, Canada excluding Quebec, 2006 to 2008

	RSR using adjusted life tables (%)			Overestimate of RSR using unadjusted life tables (% units)		
	Survival duration			Survival duration		
Cancer, age group, sex	1-year	5-year	10-year	1-year	5-year	10-year
All cancers						
15 to 99	76.3	60.9	54.3	0.6	2.4	4.6
15 to 44	92.9	82.8	78.1	0.0	0.1	0.4
45 to 54	86.3	72.2	66.2	0.1	0.5	1.3
55 to 64	82.3	67.1	60.2	0.3	1.4	3.2
65 to 74	76.1	59.9	51.8	0.6	2.9	6.2
75 to 99	62.6	45.1	38.8	1.0	4.1	8.1
Male	75.2	59.5	52.4	0.7	3.0	5.9
Female	77.7	62.4	56.3	0.4	1.7	3.4
Colorectal						
15 to 99	82.2	64.0	59.7	0.1	0.4	0.8
15 to 54	89.8	67.4	61.2	0.0	0.0	0.1
55 to 64	88.3	68.6	62.8	0.0	0.2	0.4
65 to 74	84.7	66.9	61.3	0.1	0.4	0.8
75 to 99	73.9	58.2	58.0	0.2	0.7	1.6
Male	82.9	63.5	58.4	0.1	0.4	0.9
Female	81.3	64.7	61.2	0.1	0.3	0.7
Lung and bronchus						
15 to 99	40.3	16.9	12.4	0.1	0.2	0.3
15 to 54	49.5	23.4	19.1	0.0	0.0	0.1
55 to 64	45.2	19.9	15.0	0.1	0.1	0.3
65 to 74	41.9	17.5	11.9	0.1	0.3	0.4
75 to 99	32.9	12.2	9.1	0.1	0.2	0.4
Male	36.4	14.2	10.5	0.1	0.2	0.4
Female	44.6	19.9	14.6	0.1	0.2	0.3
Female breast						
15 to 99	96.8	87.5	81.6	0.1	0.3	0.6
15 to 54	98.3	88.9	81.9	0.0	0.1	0.2
55 to 64	97.7	89.2	83.4	0.1	0.3	0.5
65 to 74	97.2	89.0	83.8	0.1	0.4	0.9
75 to 99	92.8	81.6	77.3	0.1	0.7	1.4
Prostate						
15 to 99	98.1	95.1	92.1	0.1	0.6	1.4
15 to 54	99.6	96.9	95.2	0.0	0.0	0.1
55 to 64	99.6	97.8	95.8	0.0	0.1	0.3
65 to 74	99.6	98.0	95.9	0.1	0.4	1.3
75 to 99	93.7	86.7	79.6	0.3	1.5	3.5
Bladder						
15 to 99	85.3	71.1	64.8	0.0	0.2	0.3
15 to 54	92.5	82.9	79.5	0.0	0.0	0.0
55 to 64	91.6	80.6	74.6	0.0	0.0	0.1
65 to 74	87.9	73.8	66.3	0.0	0.1	0.3
75 to 99	79.3	61.9	54.6	0.1	0.3	0.6
Male	86.6	72.4	65.4	0.0	0.2	0.4
Female	81.3	67.4	62.7	0.0	0.1	0.1
Non-Hodgkin lymphoma						
15 to 99	79.0	66.3	58.9	0.0	0.1	0.2
15 to 54	90.7	81.2	74.6	0.0	0.0	0.0
55 to 64	86.8	74.4	65.1	0.0	0.1	0.1
65 to 74	80.1	64.7	54.2	0.0	0.1	0.2
75 to 99	63.1	48.3	44.3	0.0	0.2	0.3
Male	78.4	64.5	56.3	0.0	0.1	0.2
Female	79.7	68.3	61.8	0.0	0.1	0.1
Leukemia						
15 to 99	72.1	59.2	50.0	0.0	0.1	0.1
15 to 54	85.9	72.7	66.1	0.0	0.0	0.0
55 to 64	83.7	70.0	60.6	0.0	0.0	0.1
65 to 74	71.7	60.2	45.0	0.0	0.1	0.2
75 to 99	56.3	42.4	35.2	0.0	0.1	0.3
Male	73.7	59.5	49.9	0.0	0.1	0.2
Female	69.8	58.7	50.2	0.0	0.1	0.1

Sources: Canadian Cancer Registry database, life tables and Canadian Vital Statistics Death database.

Figure 1
Percentage deaths due to cancer, by age group and period, Canada, 1992 to 1994 and 2006 to 2008



Source: Canadian Vital Statistics Death database.

were highest—though considerably smaller than for all cancers combined—for prostate, followed by colorectal and female breast cancer. Biases increased with advancing age at diagnosis and survival duration.

The current analysis corroborates two related studies,[3,17] in that adjustment for cancer mortality is warranted when RSRs for all cancers combined are calculated using general population life tables. The proportion of deaths due to cancer in Canada was higher than in either Sweden[3] or Finland,[17] leading to generally larger biases in RSRs in the current study. Nonetheless, as in the Scandinavian studies, the magnitude of the bias was negligible for most individual cancers in Canada.

A sensitivity analysis concluded that in older age groups α would need to reach at least 2% in common cancers before important differences would be realized.[17] In addition to the proportion of deaths due to the cancer(s) under study, other factors that affect the extent of the bias in RSR estimates that results from using general population life tables to derive expected survival probabilities include the probability of living from one age to the next in the general population, and the prognosis for the cancer(s) in question.

Table 3
Comparison of biases in relative survival estimates over time introduced through use of general population life tables to derive expected survival probabilities, by age group, sex and selected cancers, Canada excluding Quebec, 2006 to 2008 versus 1992 to 1994

	Difference in bias† between RSR estimates for 2006 to 2008 and 1992 to 1994 (% units)		
	Survival duration		
Cancer, age group, sex	1-year	5-year	10-year
All cancers			
15 to 99	0.0	0.0	0.3
15 to 44	0.0	0.0	0.0
45 to 54	0.0	0.0	0.0
55 to 64	-0.1	0.0	0.2
65 to 74	-0.1	0.1	0.6
75 to 99	0.0	0.0	0.5
Male	-0.1	0.0	0.4
Female	0.0	0.1	0.3
Colorectal			
15 to 99	0.0	0.0	0.1
15 to 54	0.0	0.0	0.0
55 to 64	0.0	0.0	0.0
65 to 74	0.0	0.0	0.1
75 to 99	0.0	0.0	0.2
Male	0.0	0.0	0.1
Female	0.0	0.0	0.0
Female breast			
15 to 99	0.0	-0.1	-0.1
15 to 54	0.0	0.0	0.0
55 to 64	0.0	-0.1	-0.1
65 to 74	0.0	-0.1	-0.1
75 to 99	0.0	-0.1	0.0
Prostate			
15 to 99	-0.1	-0.3	-0.4
15 to 54	0.0	0.0	0.0
55 to 64	0.0	-0.1	-0.1
65 to 74	-0.1	-0.2	-0.3
75 to 99	-0.1	-0.2	-0.1

† positive differences indicate that when RSRs were derived using expected survival probabilities unadjusted, rather than adjusted, for cancer mortality, the bias in relative survival was greater in 2006 to 2008 than 1992 to 1994
Sources: Canadian Cancer Registry database, life tables and Canadian Vital Statistics Death database.

What is already known on this subject?

- Expected survival probabilities used to derive relative survival ratios (RSRs) are typically estimated from general population life tables rather than from the theoretically preferred control group free of the cancer under study.
- The use of general population life tables—which include people previously diagnosed with cancer—leads to biased estimates of expected survival, and potentially, of relative survival.
- Researchers in Sweden who had the unique opportunity to calculate expected survival including and excluding individuals with cancer, and thereby, to evaluate the size of this bias, recently reported that adjustment for cancer mortality is recommended in some circumstances.
- These researchers also demonstrated that cause-of-death statistics can be used to adjust expected survival probabilities from general life tables for cancer mortality.

What does this study add?

- The magnitude of the bias introduced into RSR estimates through the use of general population life tables to derive expected survival is negligible for most individual cancers in Canada.
- Consideration of adjustment for cancer mortality is recommended for Canadian long-term relative survival estimates of colorectal, female breast, and especially, prostate cancer, calculated using general life tables.
- Canadian estimates of long-term relative survival for all cancers combined calculated using general life tables warrant adjustment for cancer mortality.

For younger ages at diagnosis (for example, less than 55) the bias in expected survival will be negligible, even if α is large, because the probability of dying at these ages is already low.[3,17] However, at older ages, particularly age 75 and beyond, the probability of dying is higher, and expected survival is susceptible to non-trivial bias. Moreover, a relatively large α in older age groups will bias expected survival, but this may not translate into a biased RSR if the prognosis for the cancer is poor.[12,18]

Prostate cancer appears to be a good candidate for adjustment of expected survival, given its excellent prognosis and relatively high α in older age groups. Indeed, Talbäck and Dickman[3] recommended adjustment in the calculation of RSRs for this cancer based, in part, on a detected bias in the 10-year RSR for men in the oldest age category that was about 1 percentage unit lower than currently observed.

The case for adjustment of expected survival probabilities used to derive RSRs for colorectal and female breast cancer is also apparent, though weaker. For both diseases, the bias in the 10-year RSR for the 75-to-99-age-at-diagnosis group was approximately 1.5 percentage units. The proportion of deaths due to colorectal cancer exceeded the 2% benchmark proposed by Hinchliffe et al.[17] for all but the 95-or-older age group. The proportion for female breast cancer exceeded 2% through to ages 85 to 89, and the proportion for prostate cancer ranged from 2.6% to 4.6% after age 64. Given that there is no statistical disadvantage in adjusting expected survival probabilities, a more, rather than less, liberal use of adjustment may be preferable with these cancers.

Although lung cancer had the highest proportion of deaths due a specific cancer, the bias in its RSRs peaked at 0.4 percentage units (10-year RSR for ages 75 to 99). This is a prime example of the prognosis of the specific cancer playing an important role in determining the extent of the bias in RSR estimates.

Between 1992-to-1994 and 2006-to-2008, the proportion of all deaths attributable to cancer rose in Canada, particularly in older age groups. Nonetheless, adjusting for cancer mortality did not materially affect estimated changes in RSRs since the early 1990s.

The biases in RSRs reported in this study are estimates of actual biases that result from deriving expected survival probabilities from general population life tables rather than from the theoretically preferred cancer-free population. The surrogate method adjusts the expected survival generated from population life tables for cancer mortality, and thus, relies on cause-of-death statistics to provide accurate estimates of the proportion of deaths in the population due to cancer. This method has been shown to perform well in detecting/reducing the bias under consideration.[3]

Talbäck and Dickman[3] caution that their study "addresses only the potential bias associated with assuming the general population is 'free from the cancer under study' and the proposed adjustment corrects only for this one specific potential bias." The same caveat applies to the present study—other assumptions must be assessed separately.

Conclusion

Canadian estimates of relative survival for all cancers combined calculated using general life tables warrant adjustment for cancer mortality. While the magnitude of the bias is negligible for most individual cancers, consideration of adjustment is recommended for estimates of colorectal, female breast, and especially, prostate cancer. ■

Acknowledgement

Each provincial and territorial cancer registry supplies data on cancer patients and tumours in a standard format and has the ability to add, update and delete records. Statistics Canada uses a series of core edits and an internal record linkage process to identify duplicate records to build and maintain the Canadian Cancer Registry.

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