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Canadian trends in cancer prevalence

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Abstract

Background
Cancer prevalence trends are rarely reported in the published literature, and until now, have not been reported for Canada.

Data and methods
Based on incidence data from the Canadian Cancer Registry linked with mortality data from the Canadian Vital Statistics Death Database, trends in prevalence proportions over time were calculated by time since diagnosis for a large number of the most common cancers.

Results
Statistically significant increases in prevalence proportions were observed for most individual cancers, and most prevalence durations studied. Aging of the population contributed to these increases. Relatively large increases were observed for liver and thyroid cancer, while decreases occurred for cancers of the larynx and cervix uteri.

Interpretation
Information on how and why trends vary by cancer can inform resource allocation planning.

Key words
Epidemiologic methods, neoplasms, registries, surveillance

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The measure of prevalence, which is used to study the burden of a disease in a population, is a cornerstone of cancer surveillance. Duration-specific prevalence estimates, which incorporate the time elapsed since diagnosis, can be used as a proxy for specific care needs. This is because the length of time since detection of the cancer closely relates to the phase reached along the care continuum. Cases diagnosed in the previous ten years represent the major demand for health care services. In the first two years, services would likely include primary treatment and supportive care for recovery from its effects, followed over the next three years by close clinical assessment for recurrence, and then less intense follow-up over the next five years.[1,2] Cancer-specific estimates are useful in health care planning, as cancer survivors' requirements for services vary according to the particular cancer involved.

Trends in cancer prevalence proportions reveal the dynamics of increase, decrease, or stability of cancers in the population, and thus, can be used in planning the allocation of diagnostic, treatment and care resources.[1,3] Prevalence trends also provide information fundamental to making projections.

In Canada, the rate at which new cancer cases are diagnosed continues to rise,[4] and survival is also increasing.[5-7] A recent study provided a detailed report of cancer prevalence in Canada as of January 1, 2005.[8] However, cancer prevalence trends are rarely published, and until now, have not been reported for Canada.

This report presents trends in two-, five- and ten-year cancer prevalence proportions for all cancers combined, and for more than two dozen of the most frequently occurring individual cancers. Age-adjustment was carried out to assess the contribution of population aging to changes in prevalence proportions. For the most common cancers, the data are examined by age group.

Methods

Data sources

Cancer incidence data are from the January 2011 version of the Canadian Cancer Registry (CCR), a dynamic, person-oriented, population-based database maintained by Statistics Canada. The CCR contains information on cases diagnosed from 1992 onward, compiled from reports from every provincial/territorial cancer registry. Mortality data are from the Canadian Vital Statistics Death Database, also maintained by Statistics Canada. The death data are based on information provided by the vital statistics registrars in each province and territory. Population estimates are from Statistics Canada's Demographic Estimates Compendium 2010.[9]

Analytical techniques

A file containing records of invasive cancer cases and *in situ* bladder cancer cases (the latter are reported for each province/territory except Ontario) was created using the multiple primary coding rules of the International Agency for Research on Cancer.[10] Cancer cases were defined based on the *International Classification of Diseases for Oncology, Third Edition*[11] and classified using Surveillance, Epidemiology, and End Results (SEER) Program grouping definitions, with mesothelioma and Kaposi's sarcoma as separate groups.[12]

Mortality follow-up through December 31, 2007 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. When death was known to have occurred, but the date of death was completely missing (0.02% of deaths), the death was assumed to have occurred after December 31, 2007.

Tumour-based prevalence was determined directly, using the counting method.[13,14] All first or subsequent primary invasive cancers and *in situ* bladder cases that were diagnosed in the time-frame under consideration among persons alive on a given index date were counted. For example, two-year prevalence for 2008 was estimated by counting the number of cancers diagnosed from January 1, 2006 to December 31, 2007 among persons still alive on January 1, 2008. Similarly, five- and ten-year prevalence estimates for 2008 were based on cases diagnosed from 2003 and 1998, respectively.

Because of issues with correctly ascertaining the vital status of cases diagnosed in Quebec, prevalence proportions do not include data from that province.

Crude prevalence proportions (per 100,000) were calculated by dividing prevalence counts by the population on the index date and multiplying by 100,000. Because published population figures represent mid-year estimates, the population estimates for each index date were derived by averaging population estimates for six months before and after the date. Age-standardized proportions were calculated by the direct method using the final post-censal estimates of the July 1, 1991 Canadian population, adjusted for census under-coverage, as the standard.[15]

Trends in prevalence proportions over time were determined using the Joinpoint Regression Program (v 3.4.3) distributed by the SEER program of the National Cancer Institute in the United States.[16] A statistical algorithm finds the optimal number and location of places where a trend changes. The point (in time) where a trend changes is called a joinpoint. The (prevalence) rates are assumed to grow or decay exponentially (that is, to change by a constant percentage each year). Thus, the slope in each segment can be associated with a fixed annual percent change (APC).

In the current study, all Joinpoint default settings were used, except that the maximum number of joinpoints was set at one for two- and five-year analyses, and at zero for ten-year analyses. When the program detected a statistically significant change in trend, the average annual percent change (AAPC) was also reported to provide a summary measure for the entire interval. It is estimated as a weighted average of the joinpoint APCs, with the weights equal to the lengths of each segment over the pre-specified fixed interval. When no change in trend is detected, the APC and AAPC statistics will yield identical values. The software indicates whether an AAPC is significantly different from zero at the level of alpha=0.05 only, but provides p-values for the corresponding test involving the APC.

Results

Differences by cancer type

The proportions of prevalent cancer cases in the Canadian population increased significantly over the time periods considered. The two-year prevalence proportion for all cancers combined rose at an annual rate of 2.0% from 1997 to 2008, after holding steady from 1994 to 1997 (Table 1). Similarly, the five-year prevalence proportion rose by 2.1% per year from 1997 to 2008, and the ten-year proportion, by 2.4% per year from 2002 to 2008.

Statistically significant increases in prevalence proportions were observed for most individual cancers and prevalence durations. APC and AAPC values (where joinpoints were deemed appropriate) generally ranged from approximately 0.5% to 4%, though much higher rates were observed for liver and thyroid cancer.

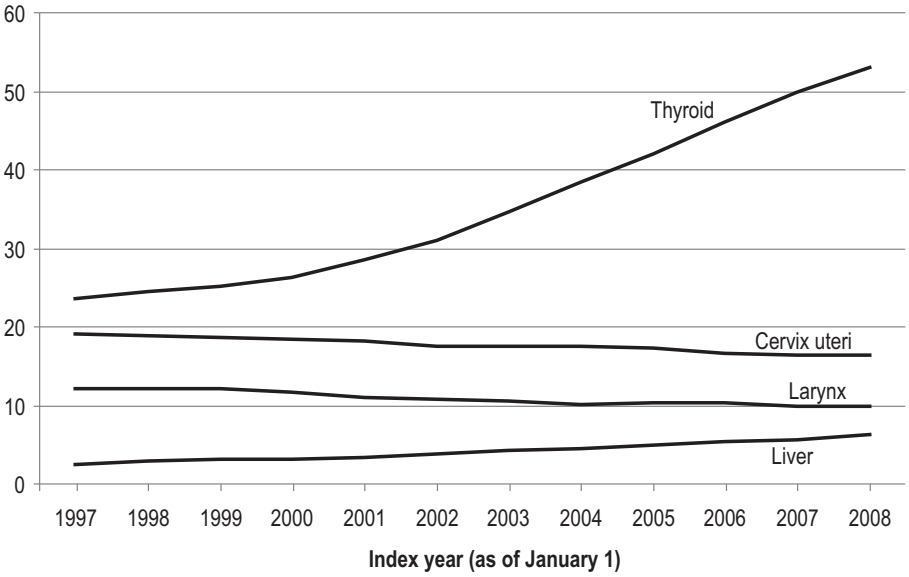
Increases in prevalence proportions for liver and thyroid cancer were more than double those of any other cancer (Table 1, Figure 1). For liver cancer, the increase was greatest (8.5%) for ten-year

Table 1
Two-, five- and ten-year cancer prevalence proportion trends, by sex and cancer type, Canada excluding Quebec, 1994 to 2008

	Two-year (1994 to 2008)		Five-year (1997 to 2008)		Ten-year (2002 to 2008)
Sex/Cancer type	APC / Trend change year / APC	AAPC	APC / Trend change year / APC	AAPC	APC
Both sexes					
All cancers	-0.2 / 1997 / 2.0**	1.5*	2.1**	...	2.4**
Oral cavity & pharynx	-2.3** / 1999 / 0.9**	-0.3	-1.9* / 2000 / 0.8**	0.1	0.9**
Esophagus	2.1**	...	2.4**	...	3.3**
Stomach	0.1	...	0.0 / 2004 / 1.8**	0.6*	1.2**
Colorectal	1.7**	...	2.5** / 2003 / 1.9**	2.3*	2.4**
Colon excluding rectum	1.5**	...	1.9**	...	2.0**
Rectum and rectosigmoid	0.1 / 1997 / 2.5**	2.0*	3.2** / 2006 / 1.4	2.8*	3.1**
Anus	6.4** / 2001 / 0.9	3.6*	6.3** / 2002 / 1.8**	3.8*	3.2**
Liver	7.7**	...	8.3**	...	8.5**
Pancreas	2.7** / 2005 / 5.5**	3.3*	3.6**	...	4.0**
Larynx	-1.9**	...	-2.6** / 2004 / -0.8	-1.9*	-1.6**
Lung and bronchus	0.5** / 2004 / 2.5**	1.1*	0.9** / 2005 / 2.6**	1.3*	1.6**
Soft tissue	1.5** / 2003 / 5.7**	3.0*	1.8** / 2004 / 5.2**	3.0*	3.7**
Skin melanoma	2.7**	...	2.7**	...	2.7**
Breast	1.7** / 2000 / 0.6*	1.0*	2.3** / 2001 / 0.7**	1.3*	1.5**
Cervix uteri†	-1.6**	...	-1.5**	...	-1.3**
Corpus uteri†	-1.5 / 1996 / 2.0**	1.5*	1.7** / 2006 / 2.9**	1.9*	2.1**
Ovary†	-0.3 / 1998 / 1.5**	1.0*	0.9* / 2001 / 2.1**	1.7*	1.8**
Prostate†	-3.0 / 1997 / 2.9**	1.6*	3.0**	...	3.4**
Testis†	0.5**	...	0.6**	...	0.5**
Bladder (including in situ)	0.4**	...	0.3**	...	0.5**
Kidney & renal pelvis	2.1** / 2006 / 8.0**	3.0*	2.5** / 2006 / 4.8**	2.9*	3.1**
Brain	1.0**	...	0.6**		0.6**
Thyroid	3.9* / 1999 / 9.3**	7.4*	3.7 / 2000 / 9.5**	7.9*	8.4**
Hodgkin lymphoma	0.0	...	-0.4 / 2002 / 0.5*	0.1	0.2*
Non-Hodgkin lymphoma	2.7**	...	3.2**	...	3.8**
Multiple myeloma	2.6**	...	3.6**	...	4.0**
Leukemias	1.6** / 2002 / 3.9**	2.6*	1.9** / 2002 / 4.1**	3.1*	3.9**
Men					
All cancers	-1.3 / 1997 / 2.2**	1.4*	1.1 / 1999 / 2.5**	2.2*	2.7**
Oral cavity and pharynx	-2.2** / 2000 / 0.8*	-0.5	-1.1** / 2003 / 1.3**	0.0	0.6*
Esophagus	2.8**	...	3.3**	...	4.1**
Stomach	0.3	...	0.9**	...	1.6**
Colorectal	0.2 / 1997 / 2.2**	1.8*	2.5**	...	2.6**
Colon excluding rectum	1.7**	...	2.1**	...	2.2**
Rectum and rectosigmoid	-0.2 / 1997 / 2.8**	2.2*	3.5** / 2005 / 2.2**	3.1*	3.3**
Anus	8.0** / 2001 / -0.8	3.5*	8.6** / 2001 / 1.4**	4.0*	2.9**
Liver	8.4**	...	9.1**	...	9.0**
Pancreas	2.5** / 2005 / 7.2**	3.5*	3.2** / 2006 / 7.8*	4.0*	4.0**
Larynx	-2.0**	...	-2.6** / 2004 / -0.7	-1.9*	-1.6**
Lung and bronchus	-1.1** / 2004 / 1.3*	-0.4*	-0.8** / 2005 / 1.2**	-0.3*	0.0
Soft tissue	1.3** / 2003 / 6.6**	3.2*	1.3** / 2003 / 5.5**	3.2*	4.1**
Skin melanoma	3.0**	...	3.1**	...	3.0**
Breast	4.3** / 2005 / -3.3	2.6*	8.9** / 2000 / 2.2**	4.0*	3.3**
Prostate	-3.0 / 1997 / 2.9**	1.6*	3.0**	...	3.4**
Testis	0.5**	...	0.6**	...	0.6**
Bladder (including in situ)	0.4**	...	0.0 / 2003 / 0.8**	0.4*	0.5**
Kidney and renal pelvis	1.9** / 2005 / 6.6**	2.9*	2.3** / 2005 / 4.4**	2.9*	3.3**
Brain	1.1**	...	0.6**	...	0.7**
Thyroid	7.0**	...	4.1** / 2000 / 7.8**	6.8*	7.3**
Hodgkin lymphoma	-0.2	...	0.1	...	0.0
Non-Hodgkin lymphoma	3.0**	...	3.6**	...	4.4**
Multiple myeloma	2.9**	...	4.1**	...	4.7**
Leukemias	0.1 / 1998 / 3.3**	2.3*	2.1** / 2002 / 4.2**	3.2*	4.0**
Women					
All cancers	1.7**	...	1.9**	...	2.2**
Oral cavity and pharynx	-3.3 / 1997 / 1.2**	0.2	-2.0 / 1999 /1.4**	0.7	1.4**
Esophagus	0.2	...	-1.1* / 2005 / 4.8*	0.5	1.2**
Stomach	-0.2	...	-1.0* / 2004 / 1.8*	0.0	0.6
Colorectal	1.5**	...	2.3** / 2003 / 1.5**	2.0*	2.1**
Colon excluding rectum	1.3**	...	2.2** / 2002 / 1.4**	1.8*	1.9**
Rectum and rectosigmoid	1.9**	...	2.8** / 2006 / 1.0	2.4*	2.7**
Anus	3.6**	...	5.6** / 2002 / 2.5**	3.9*	3.3**
Liver	4.1** / 2004 / 10.7**	5.9*	6.1**	...	7.0**
Pancreas	3.0**	...	3.4**	...	3.9**
Larynx	-1.8**	...	-2.1**	...	-1.7**
Lung and bronchus	2.5** / 2005 / 4.0**	2.8*	2.8** / 2005 / 3.8**	3.0*	3.3**
Soft tissue	1.8** / 2004 / 5.3*	2.8*	1.9** / 2005 / 4.9**	2.7*	3.3**
Skin melanoma	2.5**	...	2.3**	...	2.4**
Breast	1.7** / 2000 / 0.6*	1.0*	2.3** / 2001 / 0.7**	1.2*	1.5**
Cervix uteri	-1.6**	...	-1.5**	...	-1.3**
Corpus uteri	-1.5 / 1996 / 2.0**	1.5*	1.7** / 2006 / 2.9**	1.9*	2.1**
Ovary	-0.3 / 1998 / 1.5**	1.0*	0.9* / 2001 / 2.1**	1.7*	1.8**
Bladder (including in situ)	0.4*	...	1.9 / 1999 / 0.0	0.3	0.2*
Kidney and renal pelvis	2.2** / 2006 / 7.1*	2.9*	2.9**	...	2.9**
Brain	0.8**	...	0.6**	...	0.5
Thyroid	2.5 / 1998 / 9.5**	7.4*	3.6 / 2000 / 10.0**	8.2*	8.7**
Hodgkin lymphoma	0.2	...	-0.7 / 2003 /1.2*	0.2	0.4**
Non-Hodgkin lymphoma	2.4**	...	2.7**	...	3.3**
Multiple myeloma	2.2**	...	2.9**	...	3.1**
Leukemias	1.6** / 2003 / 4.3**	2.6*	2.2** / 2004 / 4.6**	3.1*	3.7**

APC = annual percent change; AAPC = average annual percent change; when no change in trend is detected, the APC and AAPC are identical
† sex-specific population data used to derive prevalence proportions underlying trend analysis
* statistically significant ($p < 0.05$)
** statistically significant ($p < 0.01$) (applicable only for APC)
... not applicable
Source: Canadian Cancer Registry—Statistics Canada and provincial/territorial cancer registries.

Figure 1
Five-year prevalence proportions (per 100,000) of selected cancers, Canada excluding Quebec, 1997 to 2008



Source: Canadian Cancer Registry—Statistics Canada and provincial/territorial cancer registries.

duration. For thyroid cancer, increases in the proportions of two- and five-year prevalence exceeded 9% per year from 1999/2000 to 2008. Two- and five-year prevalence proportions for cancer of the anus also rose substantially until the early 2000s (more than 6% per year). Recent rates of increase were also high for the two-year prevalence proportions of pancreatic, and kidney and renal pelvis cancer, as well as for the five-year prevalence proportions of soft tissue, and kidney and renal pelvis cancer.

Among the cancers considered in this study, overall average annual decreases in prevalence proportions occurred only for cancers of the larynx and cervix uteri (Table 1, Figure 1). Annual rates of decrease for laryngeal cancer ranged from 1.6% (ten-year) to 1.9% (two- and five-year); however, the decline in five-year prevalence had been far more pronounced from 1997 to 2004 (2.6% per year) than from 2004 to 2008 (0.8%). Annual rates of decrease in cervical cancer prevalence proportions were fairly uniform across the three durations, at about 1.5%.

No overall statistically significant changes were observed for the two- or five-year prevalence of Hodgkin lymphoma, or for the two-year prevalence of stomach cancer. For the two- and five-year prevalence of oral cavity and pharyngeal cancer, annual decreases of about 2% until 1999/2000, followed by increases of just under 1%, resulted in a nil average change.

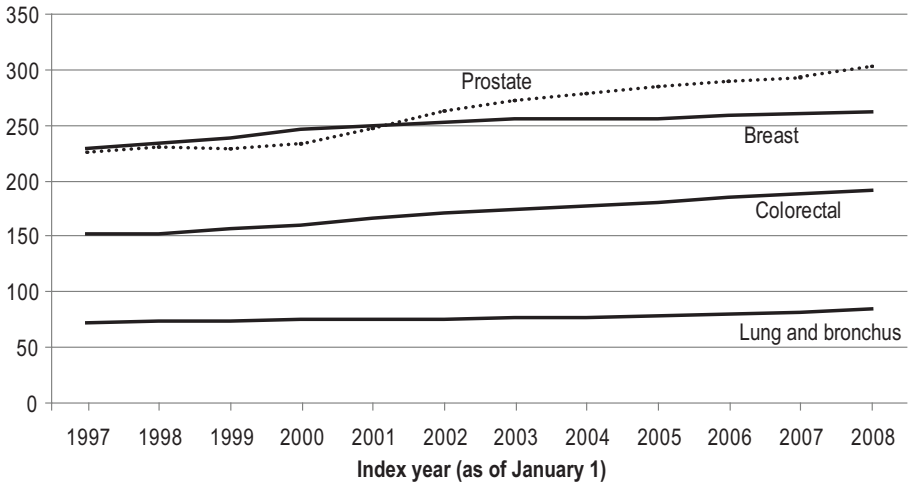
Leading cancers

The prevalence proportions of prostate cancer, the most common cancer in Canada on January 1, 2008 (Appendix Table A), rose substantially (Table 1, Figure 2). The five- and ten-year prevalence proportions increased by 3.0% and 3.4% per year, respectively; the two-year proportion increased more slowly, at an AAPC of 1.6%, tempered by a non-significant 3.0% per year decrease from 1994 to 1997.

Rates of increase in the prevalence proportions of breast cancer, the second most common cancer and the most common in women (Appendix Table A), were more moderate (Table 1, Figure 2). AAPCs ranged from 1.0% (two-year) to 1.5% (ten-year). Annual rates of increase in two- and five-year breast cancer prevalence proportions had been about three times as high before 2000/2001 as afterward.

Colorectal, and lung and bronchial cancer were the third and fourth most common cancers at the start of 2008. AAPCs in colorectal cancer prevalence proportions ranged from 1.7% (two-year) to 2.4% (ten-year) (Table 1, Figure 2). For lung and bronchial cancer, two- and five-year prevalence increased at a much higher annual rate (about 2.5%)

Figure 2
Five-year prevalence proportions (per 100,000) of most commonly diagnosed cancers, Canada excluding Quebec, 1997 to 2008



Source: Canadian Cancer Registry—Statistics Canada and provincial/territorial cancer registries.

beginning in 2004/2005 than previously (less than 1% per year); the ten-year prevalence proportion increased by 1.6% per year from 2002 to 2008 (Table 1, Figure 2).

Differences by sex

Trends in prevalence proportions differed between men and women for a number of cancers (Table 1). The greatest disparity was for cancer of the lung and bronchus; for example, the five-year prevalence proportion increased by an annual average of 3.0% in women, but decreased by 0.3% in men. Trends also differed between the sexes for esophageal cancer, although the discrepancies were smaller (slightly less than three percentage points). However, for esophageal cancer, rates of increase were higher in men than in women. For liver cancer, the annual rate of increase was relatively high in women (6.1%, five-year duration), but even greater in men (9.1%, five-year duration). By contrast, increases in thyroid cancer prevalence proportions were higher for women than for men (8.2% versus 6.8%, five-year duration).

Differences by age

For all cancers combined, average annual age-specific rates of increase in prevalence proportions were generally about 1% per year among people younger than 80 (Table 2). There was little or no change in prevalence proportions among those aged 80 or older.

Table 2
Two-, five- and ten-year age-specific cancer prevalence proportion trends, all cancers combined and four leading cancers, Canada excluding Quebec, 1994 to 2008

	Two-year (1994 to 2008)		Five-year (1997 to 2008)		Ten-year (2002 to 2008)
Cancer type/Age group	APC / Trend change year / APC	AAPC	APC / Trend change year / APC	AAPC	APC
All cancers					
20 to 39	0.5** / 2002 / 1.4**	0.9*	0.3* / 2002 / 1.5**	0.9*	1.2**
40 to 49	-0.4 / 1998 / 1.3**	0.8*	1.0** / 2004 / 2.1**	1.4*	1.6**
50 to 59	1.0**	...	1.6** / 2004 / 1.1**	1.4*	1.3**
60 to 69	0.7**	...	1.7** / 2003 / 0.6**	1.2*	1.3**
70 to 79	-2.9 / 1996 / 0.5**	0.0	0.7**	...	1.2**
80 or older	-3.8 / 1996 / -0.1	-0.6	-0.2*	...	-0.1
Prostate					
20 to 39	3.4	...	7.3**	...	6.3
40 to 49	14.6** / 2003 / 7.0**	11.8*	18.3** / 2003 / 8.4**	13.7*	9.4**
50 to 59	8.3** / 2002 / 4.1**	6.5*	10.1** / 2003 / 4.5**	7.5*	6.2**
60 to 69	2.2**	...	4.7** / 2003 / 1.4*	3.2*	3.1**
70 to 79	-5.4 / 1997 / 0.3	-0.9	0.7**	...	1.7**
80 or older	-13.0* /1996 / -2.4**	-4.0*	-2.2**	...	-1.4**
Breast					
20 to 39	-0.2	...	-0.5*	...	-0.1
40 to 49	0.1	...	0.1 / 2005 / 1.6*	0.5*	1.1**
50 to 59	1.9** / 2000 / -1.6**	-0.1	1.9** / 2001 / -1.4**	-0.2*	-0.6**
60 to 69	0.8* / 2003 / -1.2	0.1	1.6** / 2003 / -0.9**	0.5*	0.7*
70 to 79	-1.0**	...	-0.9**	...	-0.1
80 or older	-1.1**	...	0.2 / 2001 / -1.8**	-1.1*	-1.3**
Colorectal					
20 to 39	1.7** / 2005 / 6.6**	2.7*	1.3* / 2003 / 3.8**	2.4*	2.6**
40 to 49	-1.4 / 1998 / 1.4**	0.6	1.5**	...	1.8**
50 to 59	-4.3 / 1996 / 1.0**	0.2	1.2**	...	1.4**
60 to 69	0.1	...	1.1** / 2004 / -0.3	0.6*	0.5**
70 to 79	0.6**	...	1.4** / 2002 / 0.8**	1.1*	1.1**
80 or older	0.6 / 2002 / -0.9*	0.0	1.1** / 2003 / -0.7**	0.3*	0.2**
Lung and bronchus					
20 to 39	-2.4**	...	-2.2**	...	-2.3
40 to 49	-4.3* / 1998 / -0.7	-1.7*	-0.8**	...	-0.9*
50 to 59	-2.8** / 2005 / 0.8	-2.0*	-2.9** / 2005 / 0.1	-2.1*	-1.9**
60 to 69	-1.0**	...	-0.9**	...	-0.6
70 to 79	0.9**	...	1.0**	...	1.0**
80 or older	0.5 / 2000 / 2.4**	1.6*	2.1**	...	1.8**

APC = annual percent change; AAPC = average annual percent change; when no change in trend is detected, the APC and AAPC are identical
* statistically significant ($p < 0.05$)
** statistically significant ($p < 0.01$) (applicable only for APC)
... not applicable
Source: Canadian Cancer Registry—Statistics Canada and provincial/territorial cancer registries.

Substantial increases in prostate cancer prevalence proportions occurred among men in all age groups younger than 70. Average annual rate increases were highest at ages 40 to 49—ranging from 9.4% (ten-year) to 13.7% (five-year); the magnitude of the increase fell in each successively older age group. Among 70- to 79-year-old men, relatively small increases in prostate cancer occurred for durations of five and ten years, and no significant trend was observed for two-year duration. At age 80 or older, declining trends were significant.

For other leading cancers, no consistent age pattern emerged in the rate of change. Average annual rates of increase in prevalence proportions for colorectal cancer were highest (about 2.5%) in the 20-to-39 age group for each of the three durations. Within this age range, rates of increase were even higher in more recent years in two-year (6.6%) and five-year (3.8%) prevalence proportions. For lung and bronchial cancer, prevalence proportions decreased in age groups younger than 70, but rose in older age groups. Annual rates of decrease were highest in the 20-to-39 age group, at just over 2%. The highest rates of increase (about 2% per year) occurred among people aged 80 or older.

For breast cancer, age-specific changes over time in prevalence proportions were modest. Among women aged 50 to 59, however, the two- and five-year prevalence proportions rose at a rate of almost 2% per year until the early 2000s, and then fell about 1.5% annually until 2008. A similar, though slightly attenuated, pattern was observed in the 60-to-69 age group, with 2003 as the pivotal year.

Age-structure effects

For all cancers combined, average annual rates of increase in prevalence proportions were more than halved when the effects of aging of the population over the study period were taken into account. For example, when adjusted for age, the rate of increase in the five-year prevalence proportion changed from 2.1% to 1.0% per year (Table 1, Table 3).

For all but one of the individual cancers considered, increases in prevalence proportions were smaller (or decreases

Table 3
Two-, five- and ten-year age-standardized cancer prevalence proportion trends, by cancer type, Canada excluding Quebec, 1994 to 2008

	Two-year (1994 to 2008)		Five-year (1997 to 2008)		Ten-year (2002 to 2008)
Cancer type	APC / Trend change year / APC	AAPC	APC / Trend change year / APC	AAPC	APC
All cancers	**-0.9 / 1997 / 0.8****	**0.4***	**1.0****	**...**	**1.2****
Oral cavity and pharynx	-3.3** / 1999 / -0.6*	-1.5*	-3.0** / 2000 / -0.6**	-1.3*	-0.6*
Esophagus	0.7**	...	1.0**	...	1.7**
Stomach	-1.1**	...	-1.2** / 2004 / 0.4	-0.7*	-0.2
Colorectal	0.4**	...	1.2** / 2003 / 0.4*	0.9*	0.9**
Colon excluding rectum	0.2	...	1.0** / 2002 / 0.2	0.6*	0.5**
Rectum and rectosigmoid	0.9**	...	1.9** / 2005 / 0.4	1.5*	1.5**
Anus	5.1** / 2001 / -0.7	2.2*	4.9** / 2002 / 0.2	2.3*	1.6**
Liver	6.2**	...	6.7**	...	6.7**
Pancreas	1.8**	...	2.2**	...	2.5**
Larynx	-3.2**	...	-3.3**	...	-3.2**
Lung and bronchus	-0.6** / 2004 / 0.9	-0.2	-0.4** / 2005 / 1.0**	0.0	0.2
Soft tissue	1.0** / 2004 / 5.7**	2.3*	1.3** / 2005 / 5.1**	2.3*	2.9**
Skin melanoma	1.6**	...	2.1** / 2000 / 1.5**	1.6*	1.5**
Breast	0.4 / 2000 / -0.8**	-0.3	0.9** / 2001 / -0.7**	-0.1	0.0
Cervix uteri†	-1.9**	...	-1.8**	...	-1.6**
Corpus uteri†	-1.7 / 1996 / 0.7**	0.4	0.5** / 2006 / 1.3*	0.7*	0.7**
Ovary†	-1.4* / 1998 / 0.4**	-0.1	-0.3 / 2001 / 1.1**	0.6*	0.7**
Prostate†	0.5	...	1.3**	...	1.5**
Testis†	1.1**	...	1.2**	...	1.2**
Bladder (including in situ)	-0.9**	...	-1.1**	...	-1.1**
Kidney and renal pelvis	0.9** / 2006 / 6.3*	1.7*	1.3** / 2006 / 3.1*	1.6*	1.7**
Brain	0.4**	...	0.2	...	0.2*
Thyroid	3.4* / 1999 / 8.7**	6.7*	3.1 / 2000 / 8.8**	7.2*	7.7**
Hodgkin lymphoma	0.0	...	0.0	...	0.1
Non-Hodgkin lymphoma	1.6**	...	2.0**	...	2.5**
Multiple myeloma	1.3**	...	2.1**	...	2.4**
Leukemias	0.9* / 2002 / 2.7**	1.7*	1.1** / 2002 / 3.0**	2.2*	2.9**

APC = annual percent change; AAPC = average annual percent change; when no change in trend is detected, the APC and AAPC are identical
† sex-specific population data used to derive prevalence proportions underlying trend analysis
* statistically significant ($p < 0.05$)
** statistically significant ($p < 0.01$) (applicable only for APC)
... not applicable
Source: Canadian Cancer Registry—Statistics Canada and provincial/territorial cancer registries.

were larger) based on age-standardized than on crude rates. The exception was testicular cancer—the annual rate of increase in the crude five-year prevalence proportion was 0.6%, but 1.2% when age-standardization was applied.

Age-standardization flattened the trends for some cancers with significantly increasing crude prevalence proportions (for example, breast, and lung and bronchus), and led to significantly declining trends for others (bladder and stomach).

Discussion

This analysis shows significant increases in prevalence proportions for most individual cancers and most prevalence durations studied. Increases were relatively large for liver and thyroid cancer, while prevalence proportions decreased for cancers of the larynx and cervix uteri. The greatest sex-specific disparity was for cancer of the lung and bronchus, which had begun to decline among men, but continued to increase among women. Increases in prostate cancer prevalence proportions were inversely related to age.

Cancer prevalence is a function of the incidence of and survival from the disease. One of the most important factors contributing to growth in the proportion of incident cancer cases in Canada is simply aging of the population, because the occurrence of most cancers increases with age. For all cancers combined, roughly half the reported average annual rate of increase for five- and ten-year prevalence, and almost three-quarters for two-year prevalence, were attributable to aging of the population during the study period. However, for individual cancers, the role of population aging in shaping prevalence trends varied considerably.

For liver cancer, both incidence and observed survival rose markedly over the study period[5,17]; only about 20% of the increase in prevalence was due to aging of the population. Various explanations of rising liver cancer incidence in Canada have been suggested. These include increases in immigrants from countries where hepatitis B and C virus infections and exposure to aflatoxins are more common[18]; rising incidence of hepatitis C infection linked to intravenous drug use and needle-sharing; and growing rates of obesity and diabetes.[19] Five-year survival from liver cancer in Canada has nearly doubled since the early 1990s, but remains under 20%.[5,6] In the United States, screening of at-risk groups and treatment of localized-stage tumours may have contributed to increasing survival.[20]

Increases in thyroid cancer incidence rates, especially among young and middle-aged women, have been reported in countries around the world, and have been attributed to advancements in diagnostic techniques.[21,22] A recent study from the United States, however, suggests that more detection cannot completely explain the increases noted in that country.[23]

Rising prevalence proportions of anal cancer could be attributed to higher incidence, as survival did not improve over the study period. Only about 20% of the substantial increases in two- and five-year prevalence noted until the early 2000s were due to aging of the population, whereas virtually all of the smaller increase thereafter can be attributed to this factor. People infected with the human immunodeficiency virus (HIV) are much more susceptible to anal cancer.[24] Increases in incidence concomitant with the use of highly active antiretroviral treatment for HIV—leading to longer survival, and thus, greater potential for exposure of people at particular risk—have been observed in both Canada and the United States.[17,25]

Some cancers for which the prevalence proportions increased most quickly are relatively uncommon, and therefore, even a sharp annual rate of increase does not make a great difference in their absolute prevalence. Liver cancer, for instance, was the least prevalent cancer studied, with a five-year prevalence proportion of 6.2 cases per 100,000 persons on January 1, 2008. For perspective, the corresponding figure for prostate cancer was nearly 100-fold higher (Appendix Table A).

What is already known on this subject?

- In Canada, the rate at which new cancer cases are diagnosed continues to rise.
- Survival from cancer is also increasing.
- Cancer prevalence trends are rarely published, and until now, have not been reported for Canada.

What does this study add?

- Statistically significant increases in prevalence proportions were observed for most individual cancers and most prevalence durations.
- Increases were relatively large for liver and thyroid cancer.
- Decreases occurred for cancers of the larynx and cervix uteri.
- The greatest sex-specific disparity was for cancer of the lung and bronchus, which had begun to decline in men, but continued to increase in women.
- Increases in prostate cancer prevalence proportions were inversely related to age.

For the most commonly diagnosed cancers, the impact of population aging varied. The strong relationship of population aging to prostate cancer prevalence is evidenced by the marked attenuation of the increase in prevalence proportions when the analysis was conducted using age-adjusted values. Nonetheless, rising trends for the age-standardized five- and ten-year prevalence proportions remained significant. These increases reflect rising incidence rates over the past decade, coupled with greatly improved observed survival proportions.[5,17] Factors other than population aging that likely

contribute to rising incidence include lowering of the prostate-specific antigen threshold for biopsy, more extensive screening, and improved sensitivity of prostate biopsy.[26,27]

For colorectal cancer, population aging accounted for roughly two-thirds of the rise in prevalence proportions. Longer survival[5]—attributed to earlier detection as a result of screening and improved treatment[28]—likely accounts for the rest, as age-standardized colorectal cancer incidence rates declined slightly during the relevant period.[17]

Increases in breast cancer prevalence proportions were virtually all due to population aging; trends in age-standardized proportions for all durations studied were not significant.

Between the sexes, changes in the prevalence rate of lung cancer diverged. This discrepancy was due to sharper decreases in smoking prevalence in men since the mid-1960s.[29]

Significant declines in the prevalence proportions of cancer of the larynx likely reflect declining incidence rates of this cancer,[17] due to decreasing smoking rates.[29] Similarly, for cervical cancer, falling incidence rates of squamous cell carcinoma—the predominant type of cervical cancer—as a result of detection and treatment of pre-malignant lesions through Pap screening programs may account for decreases in prevalence.[30] Further declines in cervical cancer incidence may occur with the introduction of a preventive vaccine against certain types of the human papilloma virus—the most important risk factor.

Limitations

Trends in prevalence proportions presented in this study were derived without data from the province of Quebec (see *Analytical techniques*)—where almost one-quarter of the Canadian population resides. The extent to which the results reflect trends in Canada as a whole is influenced by how similar prevalence trends in Quebec are to the rest of the country—a question that is difficult to answer. While accurate survival estimates for Quebec are not currently calculable using CCR data, crude incidence trends provide at least some insight. Over the study period, the rates of increase in the incidence of some of the most commonly diagnosed cancers (colorectal, breast, and lung and bronchus) were greater in Quebec than in Canada as a whole.[4] Trends in prostate cancer incidence cannot be compared because case completeness for this cancer is problematic in the province of Quebec.[31]

The possibility that some persons counted as prevalent cancer cases may have been cured was not considered in this study. To estimate the number of prevalent cases that have not been cured, statistical approaches have been applied to model "cure prevalence,"[32,33] but such analyses were beyond the scope of this study. Nonetheless, even among people who have been cured, cancer treatment can lead to long-term or permanent physical and psychological after-effects.

Conclusion

This study presents the first Canadian cancer prevalence trend estimates to be reported. Trends in prevalence for an extensive list of cancers by time since diagnosis, sex and age group signal changes in the extent of disease in the Canadian population. Rising cancer prevalence proportions are due to increases in incidence, which partly result from the aging of the population, and to improvements in survival. Information about the degree to which changes in prevalence are occurring, and for which cancers in particular, is valuable for resource planning. ■

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Appendix

Table A
Prevalence proportion (per 100,000), by prevalence-duration, cancer type and sex, Canada excluding Quebec, January 1, 2008

	Two-year			Five-year			Ten-year		
Cancer type	**Both sexes**	**Men**	**Women**	**Both sexes**	**Men**	**Women**	**Both sexes**	**Men**	**Women**
All cancers	**720.7**	**754.0**	**687.9**	**1,489.5**	**1,537.5**	**1,442.2**	**2,405.9**	**2,441.6**	**2,370.8**
Oral cavity and pharynx	17.1	23.0	11.2	34.7	46.6	23.1	56.1	74.3	38.1
Esophagus	4.3	6.5	2.1	6.2	9.2	3.2	7.9	11.7	4.2
Stomach	8.8	11.3	6.4	15.0	19.1	10.9	21.3	26.8	16.0
Colorectal	93.3	104.5	82.2	191.4	211.2	171.9	300.1	325.6	275.0
Colon excluding rectum	61.8	64.9	58.8	126.9	131.3	122.7	200.1	203.3	196.9
Rectum and rectosigmoid	31.4	39.6	23.4	64.4	79.9	49.2	100.1	122.4	78.1
Anus	3.0	2.4	3.6	6.3	5.3	7.4	9.9	8.2	11.6
Liver	4.0	6.1	2.0	6.2	9.4	3.0	8.0	12.2	3.9
Pancreas	6.4	6.7	6.2	8.6	8.7	8.5	10.4	10.4	10.4
Larynx	4.7	7.9	1.5	10.0	16.6	3.4	16.5	27.4	5.7
Lung and bronchus	54.0	53.4	54.6	84.3	81.1	87.4	111.7	106.7	116.5
Soft tissue	5.4	6.2	4.7	10.9	12.2	9.6	17.2	18.9	15.5
Skin melanoma	30.6	32.2	29.1	66.5	69.1	64.0	112.3	113.7	110.9
Breast	116.3	1.8	229.0	262.5	4.1	516.9	458.6	6.3	903.7
Cervix uteri	…	…	14.6	…	…	32.5	…	…	60.3
Corpus uteri	…	…	47.0	…	…	103.0	…	…	176.2
Ovary	…	…	20.9	…	…	41.0	…	…	61.2
Prostate	…	280.4	…	…	610.0	…	…	1,016.2	…
Testis	…	10.2	…	…	24.7	…	…	46.8	…
Bladder (including in situ)	28.9	43.9	14.1	61.8	93.9	30.3	99.9	150.4	50.2
Kidney and renal pelvis	21.4	26.2	16.7	42.7	51.9	33.7	68.4	82.2	54.7
Brain	7.2	8.2	6.2	12.4	13.9	10.9	19.0	21.2	16.9
Thyroid	24.0	10.8	37.0	53.1	22.3	83.3	84.3	35.7	132.2
Hodgkin lymphoma	4.8	5.1	4.6	11.4	12.3	10.5	21.0	23.0	19.1
Non-Hodgkin lymphoma	31.6	34.4	28.8	65.9	71.4	60.5	103.0	109.6	96.5
Multiple myeloma	8.5	9.3	7.7	15.6	17.4	13.8	20.4	22.5	18.3
Leukemias	20.7	24.3	17.1	41.8	49.3	34.3	63.6	74.6	52.9
Other, unknown	39.9	39.3	40.5	78.5	77.7	79.3	119.0	117.1	120.9

... not applicable
Source: Canadian Cancer Registry—Statistics Canada and provincial/territorial cancer registries.