Trends in colorectal cancer incidence and mortality

Laurie Gibbons, Chris Waters, Yang Mao and Larry Ellison

Abstract

Objectives

This article examines recent trends in the incidence of and mortality from colorectal cancer among Canadian men and women, then further analyzes trends by three subsites.

Data sources

Incidence data for colorectal cancer were obtained from the National Cancer Incidence Reporting System and from the Canadian Cancer Registry. Mortality data were extracted from the Canadian Vital Statistics Database. Supplementary data on nutrition are from the National Population Health Survey.

Analytical techniques

Age-standardized incidence and mortality rates were calculated for men and women. Age-specific incidence and mortality rates were calculated by 10-year age groups. Joinpoint analysis was applied to detect statistically significant changes in linear trends.

Main results

Since the mid-1980s, colorectal cancer incidence has been declining, with steeper rates of decrease among women. Decreasing rates of colorectal cancer are limited to tumours located in the distal colon and rectum; the incidence of cancers of the proximal colon has not changed over time.

Key words

colon, rectum, proximal, distal

Authors

Laurie Gibbons (613-951-4426; laurie.gibbons@statcan.ca) and Larry Ellison (613-951-5244; larry.ellison@statcan.ca) are with the Health Statistics Division at Statistics Canada, Ottawa, Ontario, K1A 0T6. Chris Waters (613-952-3335) and Yang Mao (613-957-1765) are with the Cancer Bureau of Health Canada, Ottawa, Ontario, K1A 0L2.

Over their lifetime, 1 in 16 Canadian men and 1 in 18 women will develop colorectal cancer.[1] It has been estimated that 17,000 new cases of colorectal cancer would be diagnosed in Canada in 2000, and that 6,500 Canadians would die of this disease.[1] Colorectal cancer ranks third overall in the number of both new cancer cases and cancer deaths, behind prostate and lung cancer among men and behind lung and breast cancer among women. For cancers common to both sexes, colorectal cancer ranks second in incidence and mortality, following lung cancer.

Over the past decade, colorectal cancer rates have been declining in Canada, and differences between men and women have been noted.[1] Colorectal cancer has typically been examined as one entity; however, tumours may occur in different sites throughout the large intestine. Trends over time may differ by subsite, as well as by sex. Preventive strategies, such as early detection and reducing exposure to known risk factors, may have different effects in men and women, and may affect the sites where tumours are found. A detailed examination of the differences between men and

Methods

Data sources

Incidence data for colorectal cancer in Canada were obtained from the National Cancer Incidence Reporting System for 1969 to 1991 and from the Canadian Cancer Registry for 1992 to 1996. Each year provincial and territorial cancer registries report information on all cases of cancer diagnosed among their residents to the Health Statistics Division at Statistics Canada, which maintains these databases. Mortality data for 1969 to 1997 were obtained from the Canadian Vital Statistics Database, which compiles information provided by the vital statistics registrars in each province and territory. Supplementary data on nutrition are from the 1998/99 National Population Health Survey, cross-sectional sample, Health file.

Analytical techniques

Incidence and mortality rates were age-standardized to the 1991 Canadian population to account for changes in the age structure of the population over time. Population estimates were adjusted to account for net census undercoverage from 1971 onward.

A joinpoint regression model and permutation tests for identifying changes in linear trends[2] were applied to each of the sex- and subsite-specific age-standardized incidence rates from 1979 to 1996. This analysis identified the year at which the change in linear trend is significant. For most of the sex- and subsite-specific rates, the year at which the linear trend changes significantly was 1985. The exceptions were: men, total colorectal (1984); men, proximal (1983); and women, proximal (1983).

Age-specific incidence and mortality rates were calculated by 10-year age groups, beginning at 40 through 80 or older. Changes in annual age-standardized and age-specific incidence and mortality rates were examined by computing the average annual percentage change (AAPC) over two periods: 1969 to 1985 and 1986 to 1996 (incidence) or 1997 (mortality). These timespans were chosen based on the results of the joinpoint analysis. Rates were first log-transformed, then a linear model was fitted. Poisson regression was applied to the age-specific rates. For both methods, the AAPC is equal to $100(e^{ß}-1)$, where ß is the slope of the regression line. AAPC is closely approximated by 100ß since $|ß| \leq 0.05$ $e^{ß} = 1 + ß$. The difference between slopes was examined using a t-test and was interpreted as the difference in AAPC.

Information about the location of the tumour within the colon and rectum was obtained by examining the incidence and mortality data by their four-digit *International Classification of Diseases* (ICD) code. If the location of the tumour was not recorded, it was coded as "unspecified" or "other." Incidence data from 1969 to 1978 (*International Classification of Diseases, Eighth Revision*[3]) showed a high proportion (29%) of unspecified colon cancers. From 1979 onward (*International Classification of Diseases, Ninth Revision*[4]), the percentage of unspecified cancers dropped to 13%. For this reason, only ICD-9 information was used when examining incidence by subsite. It was not possible to examine the mortality data by subsite because of the very large proportion (64%) of colorectal cancer deaths coded as unspecified or other between 1979 and 1997.

To compare the incidence of colorectal cancer by age and subsite among both men and women, male-to-female incidence rate ratios were computed. This is a ratio of the male-to-female age-specific incidence rates. A ratio greater than 1 indicates a higher incidence among men; a ratio less than 1 means that the incidence rate is higher among women.

Using data on colorectal cancer cases diagnosed in 1992 from the Canadian Cancer Registry, crude and relative five-year survival rates were calculated using the strel[5] module in STATA.[6] Information on individual death status was not available for cases from Québec; therefore, this province was excluded from the analysis. Those colorectal cancer cases who had previously had cancer were excluded as were those whose colorectal cancer had been determined through autopsy or death certificate only. For the most part, relative survival rates were calculated using 1991 provincial life tables; Canadian life tables were used for Prince Edward Island, the Yukon, and the Northwest Territories.

Limitations

Because data on cancer incidence are provided by provincial cancer registries, variations may exist because of the way in which new cancer cases are registered, as well as in the types of procedures used to define an invasive cancer. Since 1984, however, cancer registration has become relatively consistent across Canada. It has been estimated that cancer incidence data are approximately 95% complete, although this figure may vary by province and cancer site.[7] Nevertheless, reporting procedures do vary from province to province, which limits the interpretation of interprovincial differences somewhat.

Between 1969 to 1991, data on new cancer cases were collected by the National Cancer Incidence Reporting System, an event-oriented system that did not link cases at a national level to identify patients with more than one primary tumour. Patients registered in more than one province were not routinely deleted before 1991.[7] Despite limiting the subsite information to the data coded in ICD-9 only, it is still possible that between 1979 and 1996, changes occurred in the coding of the "other" or "unspecified" categories.

women, particularly within each colorectal subsite, may serve to generate some hypotheses about the etiology of colorectal cancer and the effects of primary and secondary prevention for this disease.

This article examines recent trends in the incidence of and mortality from colorectal cancer among men and women aged 40 or older from 1969 to 1996. It further examines colorectal cancer incidence by location of the tumour; specifically, in three subsites (proximal, distal and rectal) from 1979 to 1996 (see *Methods, Definitions* and *Colorectal cancer*).

Overall trends

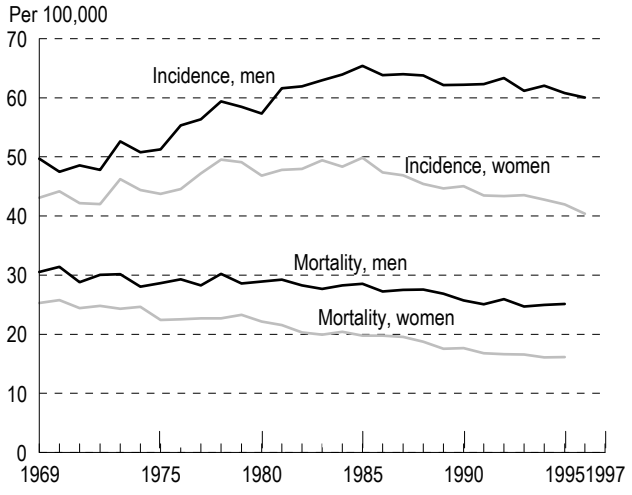
Total colorectal cancer incidence rates for both men and women rose between 1969 and 1985, and then declined, though more precipitously among women (Chart 1). From 1969 to 1985, colorectal cancer incidence rates for men increased annually by 2.08%; from 1986 to 1996 rates declined by 0.55% per year. Among women, incidence rates rose by 0.99% yearly until 1985, after which they declined by 1.37% per year. The rates of increase and decrease differed significantly by sex (Chart 2).

Age-standardized mortality rates for total colorectal cancer have fallen since 1969 (Chart 1). Among men, mortality decreased annually by 0.45% from 1969 to 1985, and then by 1.33%. Declines in mortality rates among women were significantly greater in both periods, with an average annual percentage change of 1.66% between 1969 and 1985, and 2.27% between 1986 and 1997) (Chart 2).

Studies in the United States have found that, since the mid-1980s, colorectal cancer incidence and mortality have been declining in White populations.[8-10] That research, which was able to examine incidence and mortality trends by stage at diagnosis, indicates that much of the decline in mortality is attributable to increased rates of colorectal cancer screening.[8-10] Colorectal cancers are being found earlier in their disease progression, which leads to improved prognosis for many more people. These assumptions cannot be tested in this analysis because complete stage data are not yet available. Canada has no organized screening program for colorectal cancer, but it is likely that rates of informal screening have increased over the past two decades. This may have contributed to the decline in colorectal cancer mortality.

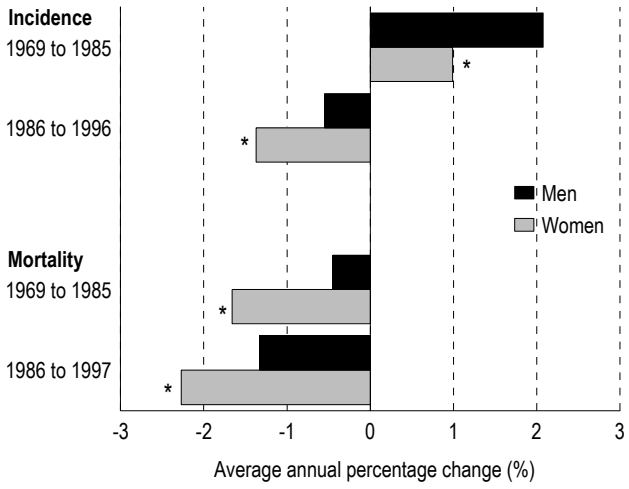
The differential rate of decline in mortality between men and women reflects the steeper

Chart 1
Age-standardized incidence and mortality rates, colorectal cancer, men and women, Canada, 1969 to 1996 (incidence) or 1997 (mortality)



Data sources: *National Cancer Incidence Reporting System (1969 to 1991), Canadian Cancer Registry, (1992 to 1996), Canadian Vital Statistics Database*
Note: *Rates are age-standardized to the 1991 Canadian population adjusted for net census undercoverage.*

Chart 2
Average annual percentage change, colorectal cancer incidence and mortality, men and women, Canada, 1969 to 1985 and 1986 to 1997



Data sources: *National Cancer Incidence Reporting System (1969 to 1991), Canadian Cancer Registry (1992 to 1996), Canadian Vital Statistics Database*
** Difference between sexes is statistically significant ($p \leq 0.05$)*

decrease in colorectal cancer incidence among women since 1985, a phenomenon also noted in the United States.[8-10] The reasons for this trend have not yet been determined, but it has been suggested that differences in exposure to risk factors such as diet and hormones may be protecting women from developing colorectal cancer.[12]

It is thought that women may consume less fat and more vegetables and fibre than men.[12,13] Recent data from the 1998/99 National Population Health Survey (NPHS), which indicate that Canadian women may be more concerned about nutrition than their male counterparts, support this theory. For example, significantly more women (33%) than men (23%) said they either chose or avoided foods because they were worried about developing cancer. Specific food choices described in the NPHS suggest that the diet of Canadian women may protect them from colorectal cancer (Chart 3). In 1998/99, women were significantly more likely than men to choose foods because of lower fat and higher fibre content. And a higher proportion of women than men selected foods based on their vitamin and mineral content.

In addition, it may be that the increased use of oral contraceptives and hormone replacement therapy (exogenous hormones) by women over the past several decades may be conferring a significant protective effect against the development of colorectal cancer.[14-16]

Definitions

From 1969 to 1978, *colorectal cancer* was identified by codes from the *International Classification of Diseases, Eighth Revision*[3] (ICD-8). The codes used to identify relevant colorectal cancer subsites are:

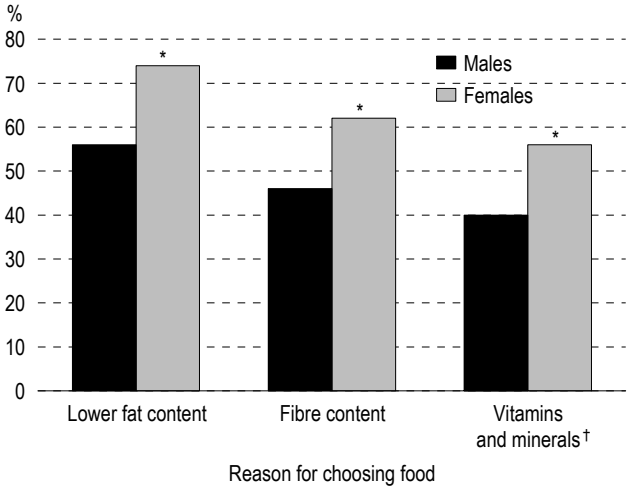
Proximal colon: 153.0, caecum, appendix and ascending colon; 153.1, transverse colon, including hepatic and splenic flexures.
Distal colon: 153.2, descending colon; 153.3, sigmoid colon.
Rectum: 154.0, rectosigmoid junction; 154.1, rectum.
Unspecified: 153.8, large intestine (including colon), part unspecified; 153.9, intestinal tract, part unspecified.

From 1979 on, colorectal cancer was identified by codes 153 and 154 from the *International Classification of Diseases, Ninth Revision* (ICD-9).[4] The ICD-9 codes used to identify each subsite are:

Proximal colon: 153.0, hepatic flexure; 153.1, transverse colon; 153.4, caecum; 153.5, appendix; 153.6, ascending colon; 153.7, splenic flexure.
Distal colon: 153.2, descending colon; 153.3, sigmoid colon.
Rectum: 154.0, rectosigmoid junction; 154.1, rectum.
Unspecified: 153.8, other; 153.9, colon, unspecified; 159.0, intestinal tract, part unspecified.

Incidence: The number of new cases of colorectal cancer diagnosed each year.
Mortality: The number of deaths during the year attributed to colorectal cancer as the underlying cause of death.
Age-standardized rate: The number of new colorectal cancer cases or deaths per 100,000 that would have occurred in the standard population (1991 Canadian population) if the actual age-specific rates observed in a given population had prevailed in the standard population.
Age-specific rate: The number of new colorectal cancer cases or deaths occurring each year, expressed as a rate per 100,000 in that age group.
Crude survival rate: The estimated probability of survival from all causes of death at the end of some specified period of time. In this analysis, crude survival was computed for the period ending five years after the initial diagnosis of colorectal cancer.
Relative survival rate: The ratio of the observed survival of the group of people under study and the survival experienced by the general population similar to the study group.[11] For this study, the mortality rate of colorectal cancer patients over five years was compared with the five-year mortality rate in the population with the same distribution of sex, age and province of residence.

Chart 3
Percentage of household population aged 15 or older who chose foods for specific reasons, by sex, Canada excluding territories, 1998/99



Data source: *1998/99 National Population Health Survey, cross-sectional sample, Health file*
† Excludes calcium and iron, for which differences between men and women were also significant.
** Difference between sexes is statisticaly significant ($p \leq 0.05$)*

Incidence trends by age

Colorectal cancer incidence rates increase with age for both men and women (Charts 4 and 5). However, the time trends—the increase from 1969 to 1985 and the subsequent decline—prevailed among men and women in most age groups.

Between 1969 and 1985, increases in incidence rates were significantly higher among men compared with women in all age groups, except the youngest. Between 1986 and 1996, incidence rates declined significantly more among women aged 60 to 69 and 70 to 79 than among men of the same ages (Chart 6).

Incidence trends by subsite

Three colorectal cancer subsites were examined. Tumours found in the upper, or ascending, colon were included in the proximal subsite. Cancers below the splenic flexure, in the descending colon, were said to be distal, and tumours below the sigmoid colon were defined as rectal.

Incidence rates for the three subsites and trends over time differ between the sexes (Chart 7). Among men, incidence rates were highest for rectal cancer, followed by proximal colon cancers and then by cancers located in the distal sites. Proximal cancers were the leading site among women, followed by rectal, and then distal colon cancers.

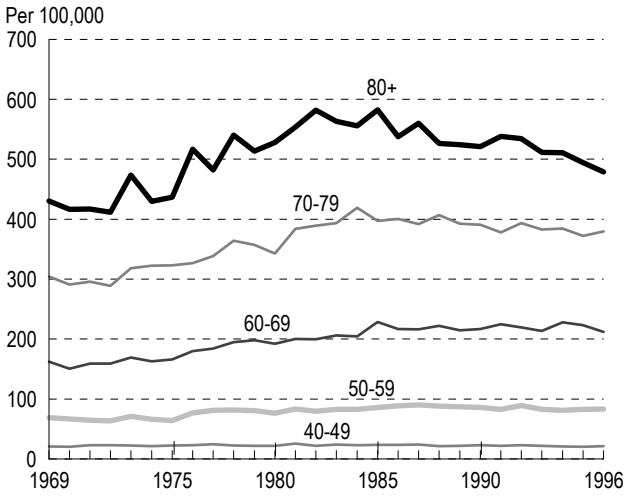
Between 1979 and 1985, rates for all three sites rose among men—most steeply among the proximal cancers (average annual percentage change, 4.56%) (Chart 8). After 1985, there were slight declines for distal and rectal cancers (AAPCs, –0.61% and –0.38%, respectively), while proximal cancers continued to increase very slightly (0.19%).

Among women, proximal cancer rates rose annually by 2.67% between 1979 and 1985, after which they declined slightly (–0.44%). After a small upturn between 1979 and 1985, both distal and rectal cancer incidence rates declined (–2.10% and –1.41%, respectively). Differences between men and women in the annual rates of decrease for distal and rectal cancers were significant in the 1986-to-1996 period.

It is possible that the declines in newly diagnosed distal colon and rectal cancers among men and women since the mid-1980s are partly due to more colorectal cancer screening through the use of the flexible sigmoidoscope.[17] Informal use of this screening tool in Canada may have increased the detection of benign adenomas in the distal colon and rectum, leading to a decreased incidence of these cancers.

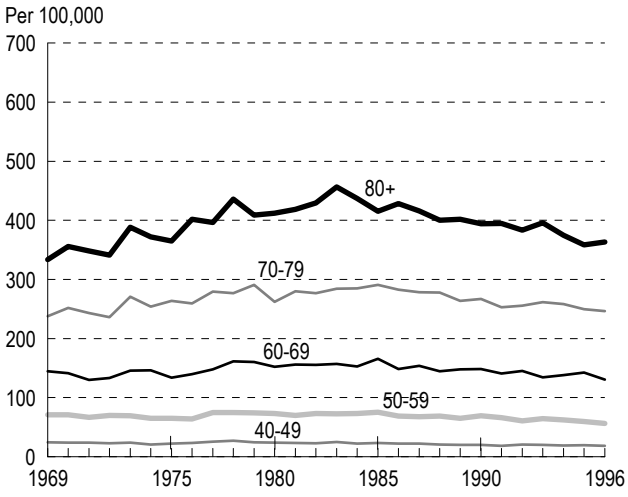
Cancers in the proximal colon are outside the visual range of the flexible sigmoidoscope. Only a colonoscope can visualize the entire colon and detect

Chart 4
Age-specific colorectal cancer incidence rates, men aged 40 or older, Canada, 1969 to 1996



Data sources: *National Cancer Incidence Reporting System (1969 to 1991), Canadian Cancer Registry (1992 to 1996)*

Chart 5
Age-specific colorectal cancer incidence rates, women aged 40 or older, Canada, 1969 to 1996



Data sources: *National Cancer Incidence Reporting System (1969 to 1991), Canadian Cancer Registry (1992 to 1996)*

Colorectal cancer

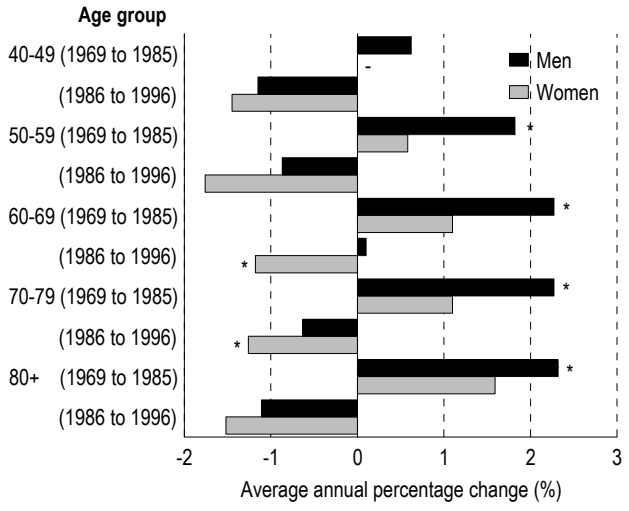
Tumours that grow in the colon and rectum begin as polyps, or adenomas, which arise through a series of genetic mutations caused by several hereditary and/or environmental factors. If left undetected over a period of 10 to 15 years, these benign polyps may become cancerous tumours.[18] Two genetic syndromes increase the risk of developing colorectal cancer: familial adenomatous polyposis and hereditary nonpolyposis colorectal cancer. These syndromes account for less than 1% and approximately 2% of all colorectal cancers, respectively.[18]

In the absence of these syndromes, family history also predisposes individuals to colorectal cancer. People with a first-degree relative who has been diagnosed with colorectal cancer are twice as likely to develop it as those who do not have a family history of this disease.[18] Individuals with inflammatory bowel disease such as Crohn's disease or colitis are also at increased risk.[18]

Epidemiological studies have found associations between a number of modifiable risk factors and the development of colorectal adenomas and their subsequent transformation into colorectal carcinoma. There appears to be a direct relationship between consumption of red meat and developing colorectal cancer, while eating vegetables and fruit and foods high in fibre appears to have a protective effect.[19-21] Physical activity has been shown to reduce the risk of colorectal cancer,[19,22] as has the use of acetylsalicylic acid and other non-steroidal anti-inflammatories.[23,24] The use of exogenous hormones in the form of oral contraceptives or hormone replacement therapy among women has been shown to be protective.[14-16] Alcohol use and long-term cigarette smoking have also been implicated in the development of colorectal cancer.[19,25,26]

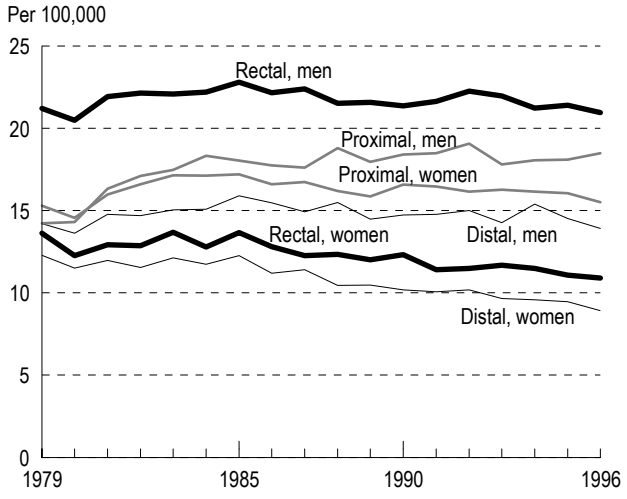
Colorectal cancer can be detected in several ways, including faecal occult blood testing (FOBT), double contrast barium enema, flexible sigmoidoscopy, and colonoscopy. When colorectal cancer is detected at early stages, patients survive longer than those whose cancer is found after the tumour has spread.[18] Data from US studies show that the five-year survival rate for localized disease approaches 90% for cancer of the colon and 80% for cancer of the rectum; the five-year case fatality rate for advanced disease is 50%.[27] Screening for colorectal cancer may result in the detection of benign polyps before they become cancerous. Surgical removal of the tumour is the primary form of treatment for colorectal cancer. Patients with more advanced disease may also receive chemotherapy and radiation treatment.

Chart 6
Average annual percentage change, age-specific colorectal cancer incidence rates, men and women, Canada, 1969 to 1985 and 1986 to 1996



Data sources: *National Cancer Incidence Reporting System (1969 to 1991), Canadian Cancer Registry (1992 to 1996)*
- Nil
** Difference between sexes is statistically significant ($p \leq 0.05$)*

Chart 7
Age-standardized incidence rates, colorectal cancer, men and women, by subsite, Canada, 1979 to 1996



Data sources: *National Cancer Incidence Reporting System (1969 to 1991), Canadian Cancer Registry (1992 to 1996)*
Note: *Rates are age-standardized to the 1991 Canadian population adjusted for net census undercoverage.*

tumours or benign polyps located in the proximal colon. Two recently published studies found that screening asymptomatic men with colonoscopy was effective in detecting advanced proximal colon cancer.[28,29] Although the presence of distal polyps predicted proximal neoplasia, in both studies approximately half the sample with proximal tumours had no distal polyps, so their cancers would not have been detected with sigmoidoscopy screening alone. Investigators have been studying a screening test based on faecal occult blood testing (FOBT), which, if positive, is followed by investigation by colonoscopy.[30-32] Perhaps the use of these techniques in Canada has not yet become routine and/or sufficient time has not yet elapsed to see the expected decrease in the incidence of all subsites of colorectal cancer, including those tumours located in the proximal colon.

Incidence rate ratios

Incidence rate ratios by sex, age and subsite indicate whether the incidence of a specific form of colorectal cancer is higher among men or women in a particular age group. A ratio greater than 1.00 indicates a higher incidence among men; less than 1.00, a higher incidence among women. For example, in 1996, when the total colorectal cancer rates were 60.04 new cases per 100,000 men and 40.41 new cases per 100,000 women, the male-to-female incidence rate ratio was 1.49 (60.04 divided by 40.41).

Among all age groups, the incidence rate ratios for proximal cancers were close to 1.00 throughout the period (Appendix Table A). As well, there was little difference in ratios by age group.

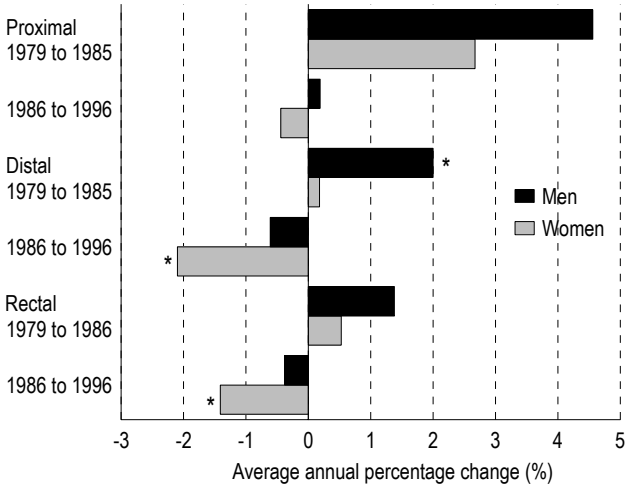
By 1996, the rate ratios for distal cancers indicated a higher incidence among men than among women at older ages. However, in the early years of the period, among people in their forties and fifties, the incidence of distal cancer had actually been higher among women.

Rectal cancer, too, was more common among men than women in all age groups in 1996. The disproportion was most pronounced among people in their sixties and seventies. Moreover, with only minor exceptions in the early 1980s, the higher incidence among men had prevailed in all age groups since 1979.

It is not clear why the incidence of distal colon and rectal cancer is lower among women than men. Differing susceptibilities to carcinogens may exist within various sites in the colon because of biological differences in the intestine.[33] For instance, genetic factors may play an important role in the development of proximal tumours whereas external risk factors such as diet, physical activity and hormone use are associated more with distal tumours.[33] Thus, higher rectal and distal cancer rates among men may be due to greater exposure to specific risk factors that cause cancers at these subsites. Lower male-to-female rate ratios for distal cancer in those under 60 (until the mid-1980s) may indicate either different risk factors affecting each subsite by sex, or the same risk factor with different latent periods for each subsite.

Distal cancer rates among women aged 60 to 69 began to drop in the mid-1980s, as did rectal cancer rates among women older than 50. This suggests either an increase in exposure to some protective effect, or a decrease in exposure to one or more risk factors. One hypothesis is that endogenous

Chart 8
Average annual percentage change, colorectal cancer incidence, men and women, by subsite, Canada, 1979 to 1985 and 1986 to 1996



Data sources: *National Cancer Incidence Reporting System (1969 to 1991), Canadian Cancer Registry (1992 to 1996)*
** Difference between sexes is statistically significant ($p \leq 0.05$)*

Survival rates

Estimated crude five-year survival from colorectal cancer decreases with age. Among people diagnosed with colorectal cancer at ages 40 to 49, 57% of men and 64% of women will survive five years. These figures fall to 24% among men and 30% among women diagnosed at ages 80 to 99. Because crude survival reflects mortality from all causes, not just cancer, this is as expected.

Relative survival compares the mortality rate of cancer patients to the overall mortality rate of a population with the same distribution of age, sex, and province of residence. In Canada, a man aged 60 to 69 diagnosed with colorectal cancer has a 56% chance of surviving five years, compared with a 60- to 69-year-old man without colorectal cancer in the same province. Relative survival in women the same age is 62%. By ages 80 to 99, relative survival drops to 50% for men and to 51% for women.

Five-year crude and relative survival rates, men and women aged 40 or older, by sex and age at diagnosis, colorectal cancer cases diagnosed in 1992†

	Crude survival rate	95% confidence interval	Relative survival rate	95% confidence interval
	%		%	
Men				
40-49	57	51-62	58	52-63
50-59	56	53-60	59	56-63
60-69	50	47-52	56	54-59
70-79	42	39-44	56	53-60
80-99	24	21-27	50	44-56
40-99	45	43-46	56	54-58
Women				
40-49	64	58-70	65	59-71
50-59	62	58-66	64	59-68
60-69	58	55-60	62	59-65
70-79	49	47-52	59	56-62
80-99	30	27-33	51	47-56
40-99	49	48-51	59	57-61

***Data source**: 1992 Canadian Cancer Registry*
† Excluding Québec

hormones may have been protecting some women from developing colorectal cancer at the distal and rectal sites and that increases in the use of exogenous hormones, through use of hormone replacement therapy or oral contraceptives, may have resulted in further decreases in these cancers since the mid-1980s. This putative protective effect has not extended to cancers of the proximal colon, supporting the idea that the carcinogenic process differs by subsite.

Provincial incidence and mortality

Compared with national rates from 1986 to 1996, colorectal cancer incidence rates increased significantly among men in Newfoundland. Among women in Prince Edward Island, both incidence and mortality rates increased significantly during the same period, though these rates are based on small numbers and may be imprecise.

The reasons for provincial differences in colorectal cancer incidience and mortality are not known. Exposure to risk factors may vary by province, as might rates of screening. (See Appendix Tables B through E for provincial incidence and mortality rates, by sex.)

Concluding remarks

Colorectal cancer incidence and mortality rates have been declining in recent years. Mortality has been decreasing since 1969, but incidence rates only began to decline in the mid-1980s.

Screening for colorectal cancer may have contributed to some of the decrease in mortality by detecting early cancers that are more easily treated. Detection and treatment of pre-cancerous polyps may also have contributed to declines in incidence. Healthier diets and lifestyle habits may be factors as well. The rate of decline in both mortality and incidence was significantly steeper in women, though not for cancers of the proximal colon.

Women may be inherently more protected against cancers of the distal colon and rectum because of naturally occurring hormones. As well, differential rates of exposure to external risk factors such as diet, exercise and therapeutic hormones may have contributed to steeper rates of decline among women for these two subsites.

Cancer of the proximal colon seems to have a different etiology than those of the other subsites. It has been relatively unaffected by whatever changes have produced declines over time in cancers of the distal colon and rectum, and it does not seem to be as influenced by sex-related differences.

Table 1
Average annual percentage change, colorectal cancer incidence and mortality, men and women, Canada and the provinces, 1969 to 1985 and 1986 to 1996 (incidence) or 1997 (mortality)

	Canada	Newfoundland	Prince Edward Island	Nova Scotia	New Brunswick	Québec	Ontario	Manitoba	Saskatchewan	Alberta	British Columbia
	Average annual percentage change (%)										
Incidence, 1969 to 1985											
Men	**2.08**	2.36	2.42	1.03	2.10	3.94*	1.36	1.76	2.48	2.34	1.26
Women	**0.99**	2.94*	0.84	–0.76*	0.95	2.69*	0.35	0.68	1.29	1.24	0.34
Mortality, 1969 to 1985											
Men	**–0.45**	0.11	–1.39	–1.44	–0.06	–0.31	–0.55	0.84	0.62	–0.66	–1.08
Women	**–1.60**	0.74*	–4.43*	–2.70	–2.54	–1.72	–1.54	–1.14	0.43*	–1.77	–2.14
Incidence, 1986 to 1996											
Men	**–0.55**	1.33*	–1.27	–0.84	–0.16	–0.36	–0.76	–0.31	–0.54	–0.01	–0.81
Women	**–1.37**	–1.00	4.62*	–1.25	–1.99	–1.43	–1.36	–1.39	–1.28	–1.08	–1.51
Mortality, 1986 to 1997											
Men	**–1.33**	–0.86	0.48	–1.56	–2.67	–0.17	–2.05	–1.70	–0.02	–1.35	–1.89
Women	**–2.27**	–2.72	1.11*	–1.01	–1.59	–1.31	–2.81	–2.11	–3.48	–3.90	–2.70

Data source: *National Cancer Incidence Reporting System (1969 to 1991), Canadian Cancer Registry, (1992 to 1996), Canadian Vital Statistics Database*
** Slope of regression line is significantly different from that for Canada ($p \leq 0.05$).*

Certain public health implications stem from these findings. Primary prevention strategies for colorectal cancer (increasing or decreasing exposure to specific risk factors) may have different effects on men and women.

The distribution of colorectal subsites by sex and age, and their different behaviour over time, seem to reveal that colorectal cancer may be two or even more distinct diseases that may have different etiologies. This has ramifications for primary, as well as secondary, prevention of colorectal cancer. If proximal colon cancer does, indeed, have a different etiology that is less susceptible to known modifiable risk factors, then research could focus on such tumours to determine how they can best be detected and prevented. ●

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Appendix

Table A

Male-to-female age-specific colorectal cancer incidence rate ratios, by age and subsite, Canada, 1979 to 1996

	Age group				
	40-49	50-59	60-69	70-79	80+
Proximal					
1979	0.93	1.06	0.89	0.89	0.90
1980	1.13	0.81	0.98	0.91	1.09
1981	1.18	0.97	1.08	0.96	1.06
1982	1.19	1.00	1.01	1.01	1.04
1983	1.17	0.99	1.08	1.05	0.86
1984	1.16	0.86	1.07	1.19	0.96
1985	0.85	0.89	1.09	1.01	1.17
1986	1.00	1.02	1.10	1.07	1.05
1987	1.00	1.04	1.09	1.01	1.06
1988	1.12	1.12	1.25	1.13	1.12
1989	1.02	1.17	1.05	1.19	1.15
1990	1.00	1.10	1.14	1.12	1.07
1991	1.21	1.10	1.16	1.09	1.08
1992	0.97	1.28	1.24	1.17	1.10
1993	0.75	1.11	1.18	1.08	1.09
1994	1.12	1.04	1.19	1.06	1.13
1995	1.06	1.17	1.16	1.09	1.12
1996	1.26	1.17	1.20	1.18	1.14
Distal					
1979	0.73	0.87	1.14	1.16	1.76
1980	0.65	0.82	1.20	1.46	1.40
1981	0.61	1.02	1.14	1.55	1.49
1982	0.85	0.89	1.12	1.52	1.77
1983	0.78	0.89	1.25	1.41	1.52
1984	0.70	1.07	1.20	1.49	1.54
1985	0.82	1.03	1.32	1.54	1.45
1986	0.80	1.27	1.36	1.65	1.50
1987	0.86	1.13	1.19	1.47	1.65

	Age group				
	40-49	50-59	60-69	70-79	80+
Distal - Concluded					
1988	0.91	1.15	1.56	1.64	1.60
1989	1.11	1.05	1.39	1.60	1.41
1990	1.07	0.99	1.41	1.57	1.94
1991	0.85	1.02	1.59	1.70	1.65
1992	0.98	1.23	1.48	1.67	1.70
1993	1.07	1.22	1.53	1.70	1.49
1994	1.04	1.41	1.79	1.72	1.65
1995	1.04	1.39	1.58	1.58	1.79
1996	0.90	1.35	1.61	1.85	1.43
Rectal					
1979	1.08	1.38	1.65	1.63	1.74
1980	1.00	1.44	1.69	1.92	1.93
1981	1.47	1.48	1.64	1.88	1.77
1982	0.96	1.39	1.93	1.96	1.68
1983	0.93	1.47	1.72	1.76	1.59
1984	1.42	1.50	1.73	1.93	1.74
1985	1.38	1.43	1.82	1.74	1.72
1986	1.33	1.57	2.02	1.86	1.47
1987	1.20	1.83	1.95	1.98	1.69
1988	1.29	1.73	1.86	1.88	1.56
1989	1.37	1.78	2.07	1.82	1.62
1990	1.40	1.59	1.90	1.91	1.48
1991	1.44	1.68	2.10	2.02	1.88
1992	1.52	1.95	1.92	2.16	1.82
1993	1.33	1.70	2.22	1.96	1.71
1994	1.21	1.53	2.19	1.96	1.81
1995	1.05	1.68	2.16	2.17	1.77
1996	1.40	1.81	2.18	2.03	1.63

Data source: *National Cancer Incidence Reporting System (1969 to 1991), Canadian Cancer Registry, (1992 to 1996), Canadian Vital Statistics Database*

Table B
Age-standardized incidence rates, colorectal cancer, men, Canada and provinces, 1969 to 1996

	Canada	New-foundland	Prince Edward Island	Nova Scotia	New Brunswick	Québec	Ontario	Manitoba	Saskat-chewan	Alberta	British Columbia
					New cases per 100,000 men						
1969	49.72	45.16	47.87	57.24	53.40	41.53	56.01	53.67	41.59	41.89	50.80
1970	47.45	54.16	37.00	59.45	49.34	37.72	54.20	52.50	39.73	37.00	49.41
1971	48.53	47.46	40.55	49.93	43.75	42.96	51.32	51.07	48.55	40.50	55.01
1972	47.80	57.28	36.06	55.62	44.59	40.93	53.30	48.45	43.27	39.77	49.68
1973	52.59	38.04	59.04	56.74	45.62	45.00	60.98	56.57	46.76	48.74	47.34
1974	50.77	42.57	59.43	47.71	52.02	40.98	58.26	55.59	43.67	45.47	54.23
1975	51.25	48.06	38.85	59.36	49.14	43.51	55.86	54.65	44.29	43.67	56.29
1976	55.33	58.19	38.06	65.95	40.55	45.73	64.05	60.66	47.34	46.46	55.13
1977	56.37	62.56	42.56	51.43	60.99	58.64	58.58	55.63	53.56	45.13	53.97
1978	59.36	57.54	46.77	53.76	61.21	60.72	62.36	66.15	55.22	48.05	56.42
1979	58.45	47.04	61.44	64.16	52.47	58.45	63.25	55.85	56.01	47.27	54.66
1980	57.31	60.12	63.16	55.74	67.02	47.21	62.97	67.32	54.05	50.79	57.60
1981	61.60	59.69	58.20	59.28	55.49	66.75	62.33	63.33	58.15	52.29	58.88
1982	61.91	64.72	49.87	63.25	56.68	66.86	62.82	64.53	54.10	53.76	59.44
1983	62.96	70.39	56.73	55.64	60.44	69.95	64.13	60.56	60.38	56.61	55.83
1984	63.95	63.61	50.68	64.37	59.88	65.93	67.72	65.09	55.37	55.38	60.05
1985	65.41	63.62	67.89	71.43	68.55	67.72	65.76	69.54	62.41	56.49	63.45
1986	63.82	67.82	72.45	73.94	63.01	67.95	63.01	70.88	58.37	54.87	60.50
1987	64.00	66.48	79.01	75.38	63.05	66.47	65.14	59.43	60.31	53.76	61.62
1988	63.75	64.91	66.67	66.65	72.04	66.45	67.02	59.62	62.94	58.97	51.29
1989	62.13	61.98	41.35	64.83	62.08	62.53	65.82	66.65	48.86	60.58	55.69
1990	62.22	62.10	58.49	75.27	60.76	63.22	66.83	63.00	61.21	49.52	50.86
1991	62.32	73.05	48.59	74.01	57.73	65.76	63.62	66.15	51.96	52.09	57.21
1992	63.33	69.21	75.36	68.52	67.83	67.23	64.07	63.10	55.55	57.56	57.33
1993	61.16	80.10	65.74	64.94	65.72	64.95	61.58	66.24	57.63	49.78	55.63
1994	62.02	69.12	53.52	66.93	69.18	64.10	62.76	65.18	57.20	55.91	57.67
1995	60.78	79.10	68.00	70.79	62.62	64.54	60.34	60.97	56.13	59.72	52.39
1996	60.04	67.20	55.72	65.72	59.95	63.96	61.11	61.68	55.44	54.50	52.45
Average annual percentage change											
1969-1985	2.08%	2.36%	2.42%	1.03%	2.10%	3.94%*	1.36%	1.76%	2.48%	2.34%	1.26%
1986-1996	–0.55%	1.33%*	–1.27%	–0.84%	–0.16%	–0.36%	–0.76%	–0.31%	–0.54%	–0.01%	–0.81%

Data source: *National Cancer Incidence Reporting System (1969 to 1991), Canadian Cancer Registry, (1992 to 1996)*
** Provincial average annual percentage change is significantly different from that for Canada ($p \leq 0.05$).*

Table C
Age-standardized incidence rates, colorectal cancer, women, Canada and provinces, 1969 to 1996

	Canada	New-foundland	Prince Edward Island	Nova Scotia	New Brunswick	Québec	Ontario	Manitoba	Saskat-chewan	Alberta	British Columbia
					New cases per 100,000 women						
1969	43.11	32.24	38.98	55.95	39.99	36.36	47.91	44.86	37.75	40.32	41.58
1970	44.18	43.50	46.61	61.38	50.11	36.47	48.63	46.33	37.02	36.39	45.07
1971	42.15	39.55	43.65	58.98	42.32	34.97	44.92	46.35	33.42	36.13	46.88
1972	41.99	40.27	73.11	49.20	44.99	37.42	45.21	43.63	42.57	33.12	39.98
1973	46.20	38.94	45.48	52.45	49.03	39.55	51.79	45.46	37.77	39.74	47.38
1974	44.39	35.85	45.32	50.67	54.61	38.00	49.48	42.39	37.36	37.16	44.18
1975	43.73	47.54	46.83	50.32	44.81	35.15	46.74	55.43	41.23	38.54	46.55
1976	44.57	30.71	43.97	54.63	43.82	37.40	49.93	46.66	38.65	37.72	46.50
1977	47.19	49.13	56.97	55.98	46.43	45.51	49.57	51.37	38.87	40.40	44.57
1978	49.54	54.04	49.88	52.28	48.79	50.00	51.42	48.78	40.21	38.91	49.18
1979	49.10	48.14	48.64	58.37	49.83	48.40	50.95	52.11	45.44	45.21	43.47
1980	46.81	50.92	46.98	61.18	54.78	38.70	50.34	52.39	47.30	40.88	45.64
1981	47.80	51.98	53.41	47.14	47.86	52.04	47.36	48.04	44.54	40.08	44.52
1982	47.95	49.97	47.14	43.55	50.12	51.04	49.24	50.26	39.23	41.70	44.20
1983	49.44	67.11	50.54	46.70	45.72	54.31	49.71	44.85	44.56	44.68	44.41
1984	48.34	48.11	59.34	50.26	53.38	48.81	50.24	47.34	42.81	41.21	46.34
1985	49.83	54.82	50.61	55.45	52.61	50.76	49.47	52.99	44.60	46.24	48.50
1986	47.39	56.11	32.31	53.97	48.53	51.51	46.87	45.56	41.72	40.93	43.96
1987	46.86	55.38	44.62	52.58	48.19	50.64	47.50	45.69	41.87	37.54	41.60
1988	45.42	45.77	50.72	51.96	49.09	45.35	47.09	50.28	41.55	35.61	42.50
1989	44.68	51.36	39.14	52.85	46.92	45.38	45.32	47.18	41.48	39.89	41.30
1990	45.05	50.00	51.03	54.72	47.57	47.52	45.41	41.89	40.62	38.43	40.97
1991	43.46	57.26	43.13	49.35	42.57	43.75	45.67	46.45	41.88	35.76	36.85
1992	43.36	56.81	70.68	50.93	46.71	47.40	42.45	47.90	33.92	35.61	38.95
1993	43.52	49.90	56.40	49.97	42.19	46.67	43.56	43.47	40.13	36.00	39.54
1994	42.76	49.48	58.30	49.82	41.92	45.97	43.77	39.29	36.84	36.76	37.01
1995	41.96	55.75	50.43	46.00	40.02	43.99	42.88	41.90	35.75	35.04	38.14
1996	40.41	42.14	60.23	48.54	41.88	41.34	40.58	41.99	40.33	35.39	37.77
Average annual percentage change											
1969-1985	0.99%	2.94%*	0.84%	–0.76%*	0.95%	2.69%*	0.35%	0.68%	1.29%	1.24%	0.34%
1986-1996	–1.37%	–1.00%	4.62%*	–1.25%	–1.99%	–1.43%	–1.36%	–1.39%	–1.28%	–1.08%	–1.51%

Data source: *National Cancer Incidence Reporting System (1969 to 1991), Canadian Cancer Registry, (1992 to 1996)*
** Provincial average annual percentage change is significantly different from that for Canada ($p \leq 0.05$).*

Table D
Age-standardized mortality rates, colorectal cancer, men, Canada and provinces, 1969 to 1997

	Canada	New-foundland	Prince Edward Island	Nova Scotia	New Brunswick	Québec	Ontario	Manitoba	Saskat-chewan	Alberta	British Columbia
					Deaths per 100,000 men						
1969	30.53	22.90	29.93	25.10	32.21	32.83	33.26	26.08	19.06	24.43	32.90
1970	31.42	40.68	15.57	36.84	28.80	31.89	33.05	28.66	27.15	27.19	28.91
1971	28.82	26.18	19.40	29.76	26.55	33.19	30.61	24.85	20.15	21.68	26.90
1972	30.07	30.25	31.74	36.76	28.61	32.95	32.62	22.92	22.76	24.58	26.02
1973	30.16	19.22	36.43	26.12	23.56	34.28	30.62	28.37	28.39	26.36	29.87
1974	28.02	33.67	32.34	25.34	35.46	29.19	29.52	27.42	15.79	26.95	25.53
1975	28.66	30.74	11.68	34.58	33.66	29.81	30.55	27.18	26.06	23.49	23.87
1976	29.27	26.50	18.66	32.72	28.57	31.95	31.01	28.84	21.13	25.20	25.45
1977	28.24	23.22	13.33	29.42	23.32	27.57	30.82	33.58	21.97	25.33	26.21
1978	30.19	33.86	21.78	26.06	30.11	33.42	31.33	30.15	23.03	24.45	30.02
1979	28.60	28.23	23.77	32.52	31.09	30.44	30.31	27.94	25.33	19.52	25.78
1980	28.90	27.48	17.19	31.39	42.13	29.68	30.66	28.59	20.63	23.07	26.21
1981	29.23	28.64	27.63	27.09	30.28	30.94	31.65	30.54	26.16	21.72	25.05
1982	28.24	26.89	30.75	26.84	32.99	30.41	29.03	29.06	24.31	26.56	24.13
1983	27.66	26.18	8.09	24.32	26.14	29.55	29.57	27.76	23.92	23.57	25.20
1984	28.26	37.11	17.06	25.09	27.86	31.41	29.25	28.89	21.86	22.02	26.64
1985	28.55	24.72	31.91	22.61	24.98	33.65	29.97	29.51	24.99	23.04	23.24
1986	27.20	27.95	16.78	26.00	24.63	30.83	29.76	24.39	20.54	23.12	21.17
1987	27.50	28.90	25.68	23.28	26.27	31.73	28.15	30.89	22.81	22.53	23.41
1988	27.55	17.11	9.78	27.24	27.87	33.50	29.14	27.04	23.49	23.53	19.46
1989	26.84	26.86	21.12	22.64	23.36	31.68	28.63	23.48	22.43	23.30	21.11
1990	25.71	24.80	17.21	21.02	23.34	31.83	26.20	28.45	21.40	20.11	19.44
1991	25.09	23.61	25.56	24.02	18.75	30.20	25.40	24.74	24.82	21.21	19.71
1992	25.93	32.23	19.92	23.39	18.55	33.91	25.48	23.98	19.69	23.04	19.44
1993	24.71	26.30	13.51	20.73	17.93	30.21	24.48	27.01	22.89	22.66	19.67
1994	24.96	26.09	16.96	22.13	20.12	31.71	24.74	26.88	23.22	18.98	19.80
1995	25.13	23.01	21.12	22.46	21.67	30.27	26.03	24.44	22.59	21.73	18.75
1996	24.34	24.89	19.01	23.93	21.71	32.37	23.88	22.20	19.94	20.99	17.21
1997	23.49	20.26	18.01	19.48	19.44	31.02	23.36	20.97	23.33	19.13	17.51
Average annual percentage change											
1969-1985	–0.45%	0.11%	–1.39%	–1.44%	–0.06%	–0.31%	–0.55%	0.84%	0.62%	–0.66%	–1.08%
1986-1997	–1.33%	–0.86%	0.48%	–1.56%	–2.67%	–0.17%	–2.05%	–1.70%	–0.02%	–1.35%	–1.89%

Data source: *Canadian Vital Statistics Database*

Table E
Age-standardized mortality rates, colorectal cancer, women, Canada and provinces, 1969 to 1997

	Canada	New-foundland	Prince Edward Island	Nova Scotia	New Brunswick	Québec	Ontario	Manitoba	Saskat-chewan	Alberta	British Columbia
1969	25.27	15.12	36.53	29.41	29.55	27.70	25.28	21.89	16.55	21.29	26.37
1970	25.75	26.11	25.17	31.24	25.85	28.32	26.82	24.66	17.41	20.06	23.05
1971	24.39	24.83	37.54	31.27	28.97	25.43	25.43	23.72	16.85	18.44	22.20
1972	24.81	19.96	25.50	28.79	30.82	28.01	24.75	24.55	21.37	21.15	20.89
1973	24.32	16.37	32.79	27.74	30.67	25.45	25.08	20.48	20.90	19.21	24.41
1974	24.65	23.46	24.81	29.41	28.21	27.75	24.54	22.43	20.09	22.53	21.07
1975	22.43	29.20	29.27	25.14	20.88	25.40	22.50	23.16	13.25	20.63	18.83
1976	22.52	20.16	12.17	23.98	25.84	23.37	23.47	24.00	18.46	20.37	19.80
1977	22.66	20.43	18.83	23.02	24.10	23.81	23.78	20.65	17.56	22.70	20.09
1978	22.66	23.78	19.39	25.40	27.68	24.07	22.69	19.82	16.95	21.56	22.03
1979	23.27	29.08	21.09	28.71	32.18	22.96	23.36	21.47	22.92	20.90	21.36
1980	22.15	27.10	15.84	28.15	25.87	22.73	22.97	21.96	21.62	16.63	18.60
1981	21.56	19.93	19.19	21.54	26.11	21.88	22.50	21.20	18.75	16.86	21.36
1982	20.28	24.49	14.93	20.70	23.13	21.34	21.42	24.15	17.00	16.07	15.39
1983	19.94	20.85	21.17	19.87	20.03	21.84	20.06	22.41	18.41	16.07	17.62
1984	20.39	27.09	19.42	18.25	15.59	23.61	20.93	16.87	16.80	17.33	17.78
1985	19.75	18.07	16.27	22.69	19.74	21.30	20.21	18.61	20.72	15.28	17.12
1986	19.74	23.56	13.98	17.03	17.47	23.29	19.64	18.52	16.94	18.66	16.11
1987	19.56	20.62	12.75	14.77	15.74	23.59	19.23	19.10	16.59	17.51	17.18
1988	18.75	21.72	15.87	16.77	13.92	22.56	19.01	19.81	16.12	15.40	14.37
1989	17.56	18.50	11.06	19.49	12.74	20.82	17.74	15.43	15.35	13.95	14.97
1990	17.67	20.81	12.04	16.04	14.37	21.57	17.19	15.23	15.36	14.77	15.54
1991	16.76	17.57	19.55	14.64	17.15	20.49	16.56	16.24	13.64	13.52	13.64
1992	16.62	14.52	16.23	12.89	14.03	21.78	16.15	19.54	14.05	13.16	11.76
1993	16.56	16.75	15.42	16.06	16.28	22.07	15.39	15.71	13.62	13.94	12.17
1994	16.07	19.07	11.45	18.27	14.24	20.63	15.14	14.80	13.04	10.82	13.80
1995	16.16	15.57	20.16	13.05	10.92	20.68	16.27	16.44	10.74	11.62	13.34
1996	15.74	14.78	14.04	16.44	14.15	20.83	15.08	15.98	10.76	13.29	11.17
1997	15.23	20.10	13.84	14.64	13.78	19.26	14.15	13.85	14.02	11.60	13.38
Average annual percentage change											
1969-1985	–1.60%	0.74%*	–4.43%*	–2.70%	–2.54%	–1.72%	–1.54%	–1.14%	0.43%*	–1.77%	–2.14%
1986-1997	–2.27%	–2.72%	1.11%*	–1.01%	–1.59%	–1.31%	–2.81%	–2.11%	–3.48%	–3.90%	–2.70%

Data source: *National Cancer Incidence Reporting System (1969 to 1991), Canadian Cancer Registry, (1992 to 1998), Canadian Vital Statistics Database*
** Provincial average annual percentage change is significantly different from that for Canada ($p \leq 0.05$).*