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Health Reports

Vol. 14 No. 3

- Prostate cancer
- Social support and mortality among seniors
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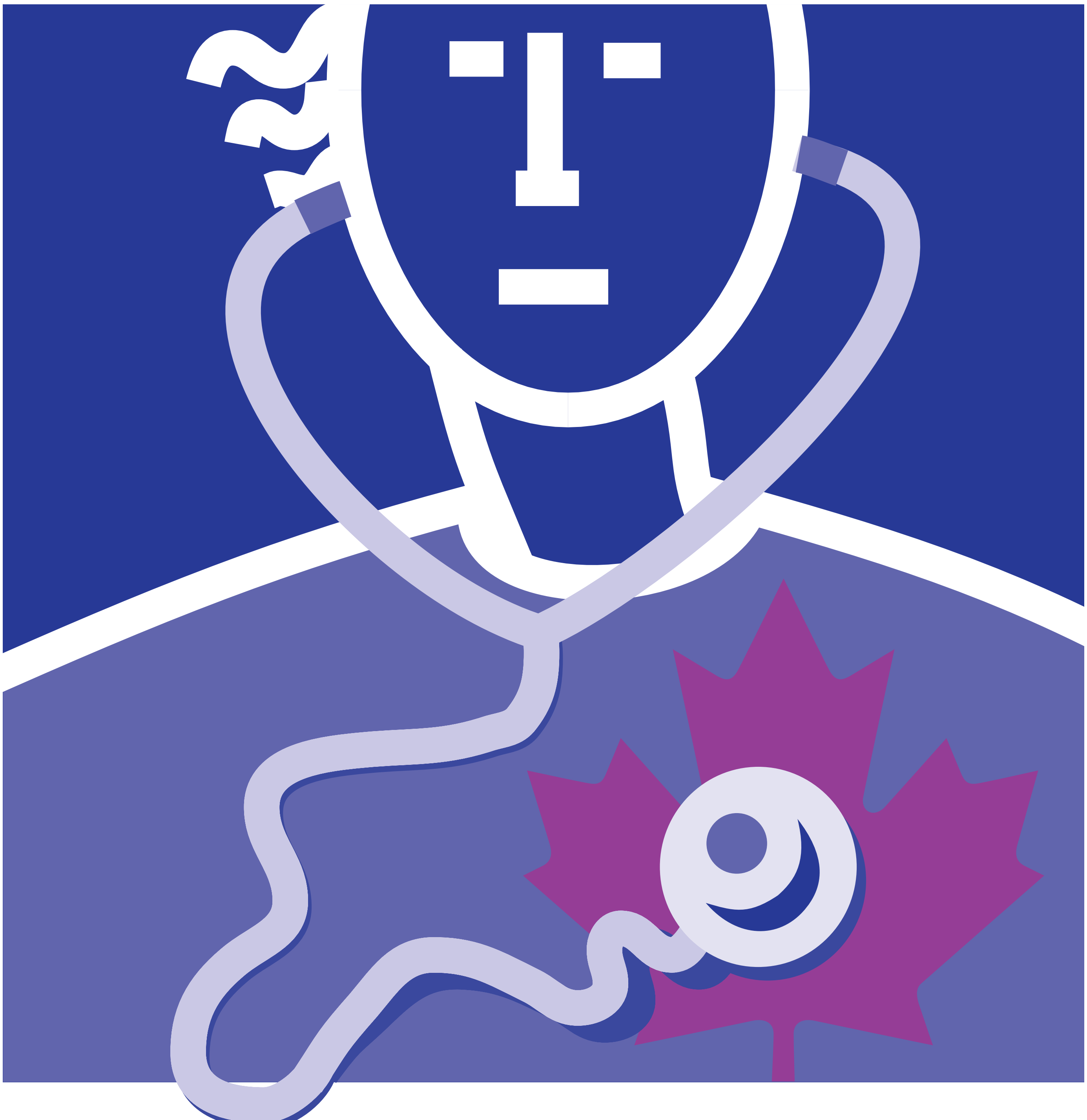

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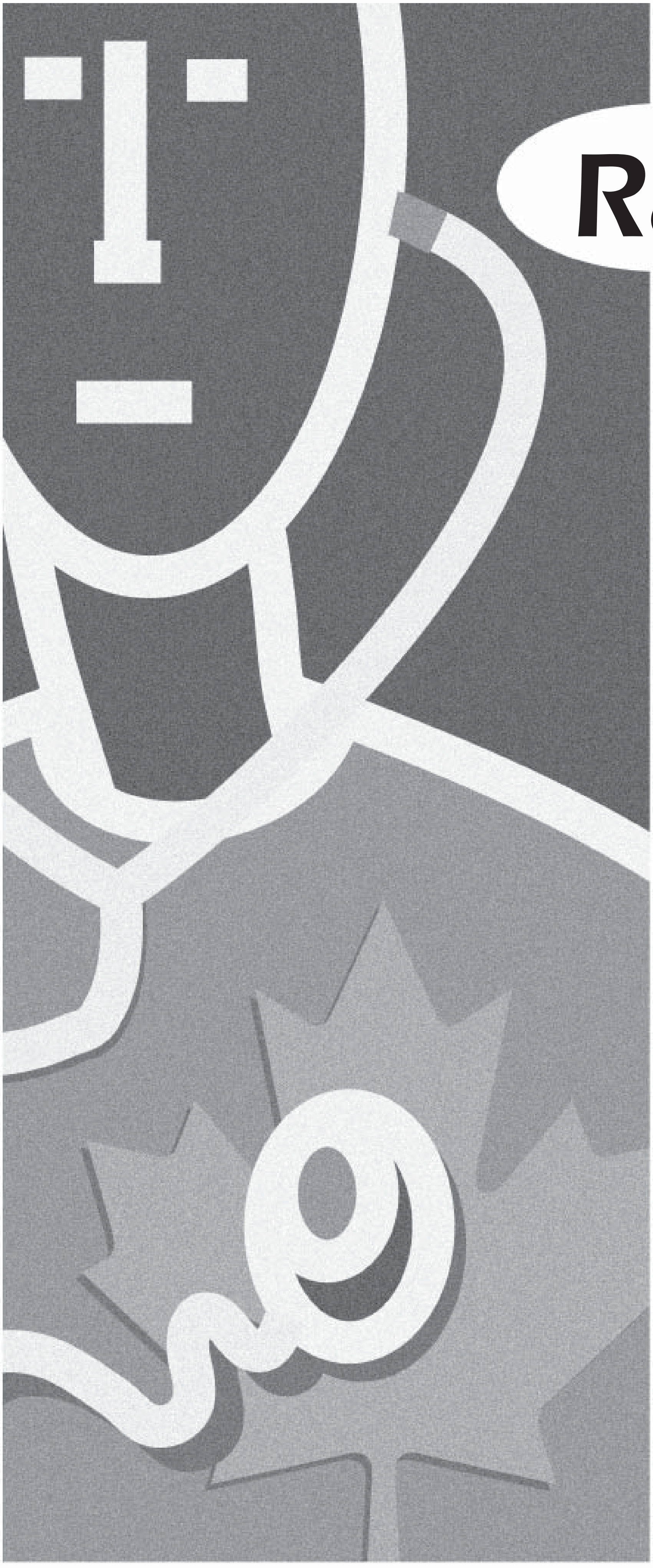

Research Articles

In-depth research and analysis in the fields of health and vital statistics

Prostate cancer—testing, incidence, surgery and mortality

Laurie Gibbons and Chris Waters

Abstract

Objectives

This article examines recent use of the prostate-specific antigen (PSA) test and presents trends in prostate cancer incidence, surgery and mortality.

Data sources

Data are from the 2000/01 Canadian Community Health Survey, the National Cancer Incidence Reporting System and the Canadian Cancer Registry, the Hospital Morbidity Database, and the Canadian Mortality Database.

Analytical techniques

Descriptive data on PSA testing among men aged 40 or older were produced. Age-standardized prostate cancer incidence, surgery and mortality rates were calculated. Significant changes in linear trends were detected with joinpoint analysis. Provincial differences in incidence and mortality rates were tested using a one-way analysis of variance (ANOVA).

Main results

In 2000/01, 43% of Canadian men aged 40 or older reported having had a PSA test. Prostate cancer incidence rates rose in the early 1990s, but have since fallen. Prostate cancer mortality rates have decreased among men aged 60 or older, but show little change among younger men. While interprovincial differences in rates of PSA testing were significant, differences in incidence and mortality rates were not pronounced.

Key words

prostate-specific antigen (PSA), mass screening, radical prostatectomy, bilateral orchiectomy, health surveys

Authors

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Prostate cancer is the second most commonly diagnosed cancer in Canadian men, and it ranks second behind lung cancer in cancer mortality.[1] In 2002, an estimated 18,200 men were diagnosed with the disease, and about 4,300 died from it.[1]

Compared with other forms of cancer, the prognosis for prostate cancer is favourable, with five-year relative survival after diagnosis estimated at 88%.[2] As with most cancers, survival from prostate cancer depends on the extent to which the tumour has spread, or stage at diagnosis.

Advances in the early detection and diagnosis of prostate cancer—most importantly, the prostate-specific antigen (PSA) test—have contributed to sharp fluctuations in incidence rates over the past two decades.[3-5] At the same time, treatments for prostate cancer have changed dramatically, as new options became available.[6,7] A great deal of controversy surrounds the implications of these trends, especially the possible impact of widespread PSA

Methods

Data sources

The information on prostate-specific antigen (PSA) testing in this analysis is from cycle 1.1 of Statistics Canada's 2000/01 Canadian Community Health Survey (CCHS). The CCHS covers the household population aged 12 or older in all provinces and territories, except persons living on Indian reserves, on Canadian Forces bases, and in some remote areas. Data collection for cycle 1.1 began in September 2000 and was conducted over 14 months.

The CCHS uses the area frame designed for Statistics Canada's Labour Force Survey as its primary sampling frame. A multistage stratified cluster design was used to sample dwellings within the area frame. A list of the dwellings was prepared, and a sample of dwellings was selected from the list. The majority (83%) of the sampled households came from the area frame, and face-to-face interviews were held with respondents randomly selected from households in this frame. In some health regions, random digit dialling (RDD) and/or a list frame of telephone numbers was also used. Respondents in the telephone frames (the remaining 17% of the targeted sample) were interviewed by telephone.

In approximately 82% of the households selected from the area frame, one person was randomly selected; two people were randomly chosen in the remaining households. For households selected from the telephone frames, one person was randomly chosen.

The overall response rate for cycle 1.1 was 84.7%; the sample size was 131,535. The sample size for men aged 40 or older was 33,741, weighted to represent an estimated 6.6 million men.

Information on PSA testing is presented for Canada and the provinces. The national figures for PSA tests do not include the territories.

Incidence data for prostate cancer are from the National Cancer Incidence Reporting System (1980 to 1991) and from the Canadian Cancer Registry (1992 to 1998). Each year, provincial and territorial cancer registries report information on all cases of cancer diagnosed in their jurisdictions to the Health Statistics Division at Statistics Canada, which maintains these databases.

The data on radical prostatectomy and bilateral orchiectomy are from the Hospital Morbidity Database, maintained by Statistics Canada between 1981/82 and 1994/95, and by the Canadian Institute for Health Information since 1995/96. The information in this database comes from the admission/separation form completed by hospitals at the end of each stay when a patient is "separated" as a discharge or a death. The file contains data on all inpatient cases separated from general and allied special care hospitals during the fiscal year. Because a patient may be admitted and discharged several times during one year, the statistics are a count of separations, not individual patients.

Mortality data for 1980 to 1998 are from the Canadian Mortality Database, which compiles information provided by the vital statistics registrars in each province and territory. The database is maintained by Statistics Canada and is a virtually complete count of all vital statistics.

Analytical techniques

Information from the 2000/01 CCHS on self-reported use of the PSA test was examined for men aged 40 or older (see *Definitions*) by 10-year age group and by province. Proxy responses were not accepted for questions on PSA testing. Statistically significant differences in use of the PSA test between the overall rate and each age group and/or province were determined using a z-test on the weighted proportions. The critical value was set to account for multiple comparisons.

Age-standardized prostate cancer incidence and mortality rates were calculated for men aged 40 or older using the 1991 male population aged 40 or older as the standard population. Age-specific incidence and mortality rates were calculated by 10-year age group. Age-standardized rates for radical prostatectomies and bilateral orchiectomies among men diagnosed with prostate cancer were calculated for Canada and the provinces and by 10-year age group, based on the male population aged 40 or older.

Joinpoint regression analysis was performed on all incidence, mortality and surgery rates between 1980 and 1998.[8] This analysis fits regression lines to the data. The rates, because of their Poisson distribution, were fitted to the log scale, allowing a minimum of 0 and a maximum of 3 joinpoints. All other modelling options were unchanged from the system defaults. The year in which there was a statistically significant change in the slope of the regression line for each of the age-standardized and age-specific rates is a joinpoint.[9] Average annual percentage changes were computed between those time periods.

To examine provincial differences among the age-standardized rates, three-year cumulative averages of the provincial rates were computed and compared with each other with a one-way analysis of variance (ANOVA) using the Bonferroni t-test.

testing. Recently, data have been reported showing that prostate cancer mortality rates may be declining in Canada and the United States.[10-12]

This article examines PSA testing among men aged 40 or older for Canada and the provinces, based on information from the 2000/01 Canadian Community Health Survey (CCHS). National and provincial trends from 1980 to 1998 in prostate cancer incidence and mortality are presented. Trends in surgery related to prostate cancer are also shown (see *Methods, Definitions* and *Limitations)*.

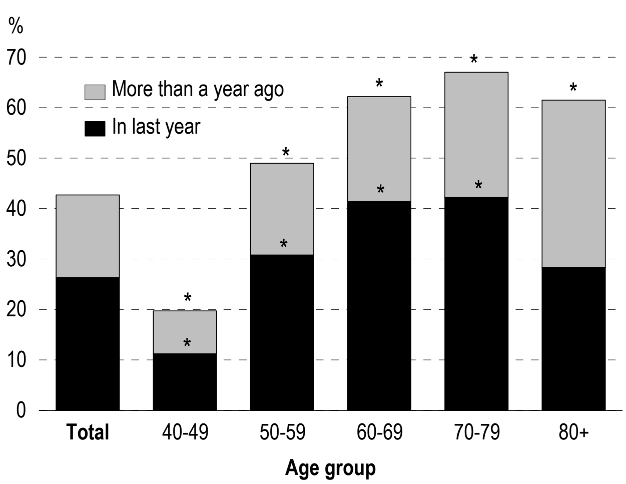
Less than half have had PSA test

Around the mid- to late 1980s, screening for prostate cancer using the PSA test gained widespread acceptance in Canada.[13-15] This test, which measures the level of prostate specific antigen in the blood, was initially developed to monitor the progress of prostate cancer, but its use for screening among asymptomatic men has increased dramatically.[14,16,17]

According to CCHS data, in 2000/01, 43% of Canadian men aged 40 or older reported having had a PSA test at some point (Chart 1). The proportion was highest at older ages, peaking at 67% among 70- to 79-year-olds. Close to half of men in their fifties had been tested; among those in their forties, the figure was just 20%. These rates were higher than in 1995 when, according to a telephone survey, 6% of men aged 40 to 49, 13% aged 50 to 59, and 23% aged 60 to 69 reported having had the test.[18]

Most men who reported to the CCHS that they had had a PSA test said it was fairly recent: three-quarters had had one in the last two years, and about 6 in 10 had been tested in the last year. As a percentage of all men aged 40 or older, however, just over one-quarter (26%) had been tested in the previous year. The figure was highest among men in their sixties and seventies (more than 40%), and lowest among those in their forties (11%).

Chart 1
Percentage of men aged 40 or older who had PSA test, by recency of test and age group, Canada excluding territories, 2000/01



Data source: *2000/01 Canadian Community Health Survey, Cycle 1.1*
** Significantly different from total (p ≤ 0.05)*

Definitions

Use of the PSA test was based on self-reports from men aged 40 or older who were asked the following question in the 2000/01 Canadian Community Health Survey: "Have you ever had a prostate-specific antigen test for prostate cancer, that is, a PSA blood test?" Those who said "yes" were asked when they had had the test. Response options were: less than six months ago, six months to less than one year ago, one year to less than two years ago, two years to less than five years ago, and five or more years ago.

For the incidence and mortality data, prostate cancer was identified by code 185 from the *International Classification of Diseases, Ninth Revision* (ICD-9).[19]

Incidence is the number of new cases of prostate cancer diagnosed each year.

Mortality is the number of deaths during the year attributed to prostate cancer, based on the underlying cause of death.

The *age-standardized rate* is the number of new prostate cancer cases or deaths per 100,000 that would have occurred in the standard population (1991 male population aged 40 or older) if the actual age-specific rates observed in a given population had prevailed in the standard population. For provincial comparisons, age-specific rates used to calculate age-standardized incidence and mortality rates were calculated by aggregating counts of new cases and deaths for three-year periods and dividing by the correspondingly aggregated population for each province.

In accordance with the *Canadian Classification of Diagnostic, Therapeutic, and Surgical Procedures* codes,[20] *radical prostatectomy* was defined as the presence of procedure code 72.4; *bilateral orchiectomy*, 74.3.

Provincial variations in PSA testing

National and provincial public health organizations do not recommend the use of PSA testing for population-based screening for early detection of prostate cancer.[21-26] Provincial health insurance plans do not cover PSA testing to screen for prostate cancer, although they do pay when the test is ordered by a physician for the diagnosis of suspected prostate cancer or for the follow-up of previously diagnosed prostate cancer.[27] It is likely that physician practices with regard to the use of the test vary widely across the country, depending on the insistence of their patients and their own views about the wisdom of using it for the early detection of prostate cancer. This makes it difficult to distinguish between men who received a PSA test for screening and those who had it for diagnostic purposes. And indeed, provincial differences are apparent in the proportions reporting having been tested.

The percentage of men who reported ever having had a PSA test was significantly below the national level (43%) in Alberta (34%) and Saskatchewan (38%), and significantly above it in New Brunswick (49%), British Columbia (46%) and Ontario (45%) (Chart 2). When the percentage who reported being tested in the previous year was considered, just two provinces differed significantly from the national figure: Ontario, which at almost 29% was high, and Alberta, which at 21% was low.

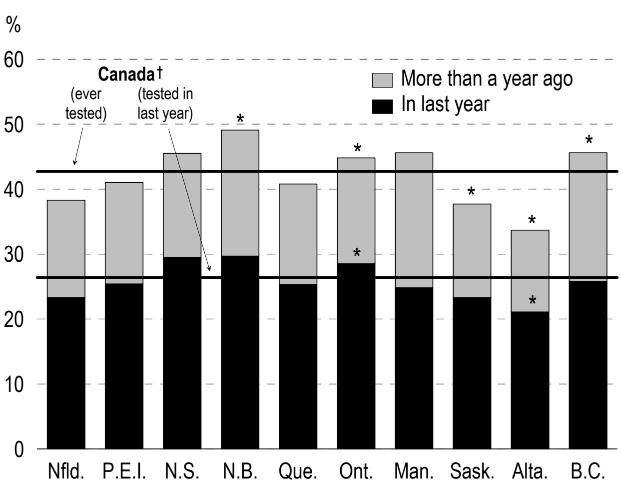
Sharp rise in incidence in early 1990s

In 1998, 16,163 men aged 40 or older were diagnosed with prostate cancer, more than double the 6,079 diagnosed in 1980 (Appendix Table A). Of course, at the same time, the male population in this age range also increased. Yet the annual number of prostate cancers that were newly diagnosed outpaced population growth so that incidence rose from 186 new cases per 100,000 in 1980 to 296 per 100,000 in 1998.

The overall rise in prostate cancer incidence masks considerable fluctuations. From 1980 to 1990, incidence rates increased steadily at an average of 2.8% a year (Chart 3). The annual rate of change jumped to 12.0% between 1991 and 1993. During the next three years (1994 to 1996), incidence rates dropped 8.6% a year, but by 1997 and 1998 were rising again, although at the relatively slow annual pace of 1.9%.

Chart 2

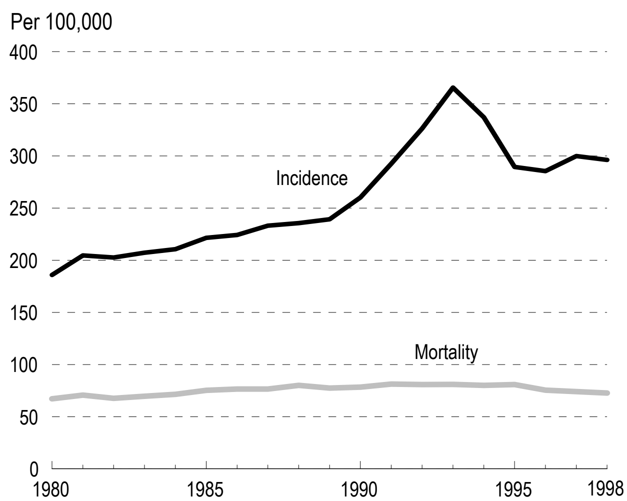
Percentage of men aged 40 or older who had PSA test, by recency of test and province, 2000/01



Data source: *2000/01 Canadian Community Health Survey, Cycle 1.1*
† Excluding territories
** Significantly different from value for Canada ($p \leq 0.05$)*

Chart 3

Age-standardized prostate cancer incidence and mortality rates, men aged 40 or older, Canada, 1980 to 1998



Data sources: *National Cancer Incidence Reporting System (1980 to 1991); Canadian Cancer Registry (1992 to 1998); Canadian Vital Statistics Database*
Note: *Standardized to age distribution of 1991 Canadian male population aged 40 or older, adjusted for net census undercoverage*

Trends were similar in the United States, where prostate cancer incidence rose by 18% a year between 1989 and 1992, but then decreased by almost 13% a year.[28] It is widely thought that much of the steep rise in the early 1990s was attributable to increases in PSA testing.[4,5,29] When the US data are examined by stage at diagnosis, the subsequent decline was most dramatic for late-stage disease.[27] This may indicate a screening effect, whereby increased early detection exhausted the pool of prevalent cancers.[30] However, some of the decrease in incidence may reflect a decline in PSA testing since the early 1990s.[16,31]

Incidence up in most age groups

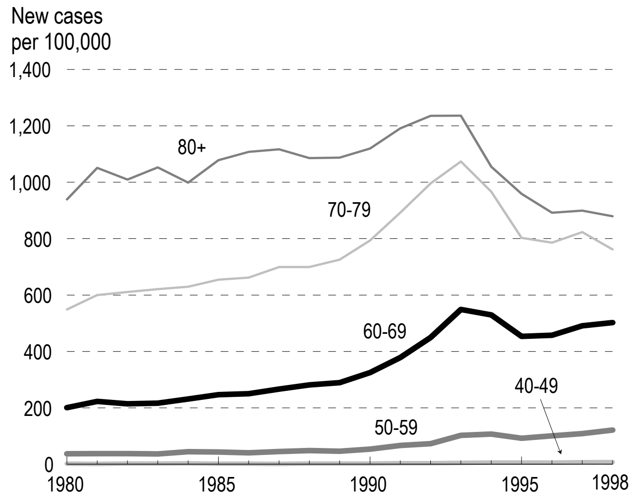
Like most cancers, prostate cancer incidence rates are highest at older ages (Chart 4, Appendix Table A). For example, in 1998, the rate was 879 new cases per 100,000 men aged 80 or older, compared with 121 per 100,000 men in their fifties and just 8 per 100,000 men in their forties.

Trends in prostate cancer incidence, however, differ by age group. The rise in 1990 was not as sharp among men aged 80 or older as among those in their seventies, and since 1994, rates have fallen or levelled off at age 60 or older. By contrast, after a brief downturn between 1994 and 1995, incidence rose among men in their fifties. Although very few men in their forties have prostate cancer, rates in this group rose as well.

These data suggest that the introduction of PSA testing led to more diagnoses among men younger than 80, while rates in older men seemed to have been unaffected. Whether early diagnosis of prostate cancer in younger men improves their prognosis remains to be seen. Some evidence suggests that men diagnosed before age 55 have lower five-year relative survival than do men aged 55 to 85,[2] perhaps because of the more aggressive nature of tumours in younger men. Most of this information, however, was based on cancers diagnosed before the PSA test was widely available.

Provincial differences in prostate cancer incidence rates are not pronounced. Throughout the period, rates in Newfoundland, based on three-year

Chart 4
Age-specific prostate cancer incidence rates, by 10-year age group, men aged 40 or older, Canada, 1980 to 1998



Data sources: *National Cancer Incidence Reporting System (1980 to 1991); Canadian Cancer Registry (1992 to 1998)*

Table 1
Age-standardized prostate cancer incidence rates, men aged 40 or older, Canada and provinces, 1981-1983 to 1996-1998

	Canada†	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.
	New cases per 100,000										
1981-1983	195	125*	158	158	182	212	192	212	254	217	237*
1984-1986	215	152*	174	202*	213	219	206	240*	228	235*	275
1987-1989	237	160*	231	228	255	220	221	254	243	237	323*
1990-1992	296	178*	312	266	308	249	290	368	300	287	406*
1993-1995	351	228*	452	351	412	297	317	419	354	341	338
1996-1998	311	252*	352	324	369*	218*	314	316	300	326	341

Data source: *National Cancer Incidence Reporting System (1981 to 1991); Canadian Cancer Registry (1992 to 1998)*
Note: *Based on three-year averages*
† Includes territories
** Significantly different from value for Canada ($p \leq 0.05$, adjusted for multiple comparisons)*

averages, were significantly below the national level, and until the early 1990s, rates in British Columbia tended to be high. For the 1996-to-1998 period, rates were significantly low in Québec, and significantly high in New Brunswick (Table 1).

Treating prostate cancer

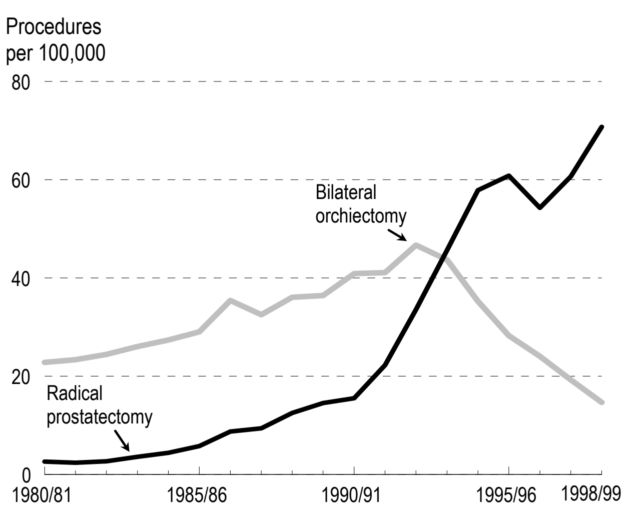
Once prostate cancer has been detected, treatment options depend on the extent of the disease. If the cancer is confined to the prostate, it can often be cured by radical prostatectomy, which is removal of the prostate gland. This is usually indicated for men who are in good health.[32,33] Radiation therapy is also an option for patients with localized disease, as is "watchful waiting" (observation with no treatment) for older men with no prostatic symptoms but other health conditions that may complicate treatment.[34] Advanced metastatic prostate cancer is not curable, but symptoms can be alleviated using treatments to block the hormones and slow the growth of tumours. This may consist of surgical removal of the testicles (bilateral orchiectomy) or the use of various hormonal treatments to decrease the amount of testosterone in the body.[35] Each treatment can have lifestyle implications, as major surgery, radiation and drugs often cause impotence and may cause incontinence.[32-35]

From 1980/81 to 1998/99, the rate of radical prostatectomy increased almost steadily from just 3 to 71 procedures per 100,000 men aged 40 or older diagnosed with prostate cancer (Chart 5, Appendix Table B). Throughout most of the period, rates were highest among men in their sixties, and rose sharply since 1991/92 (Chart 6). Beginning in 1990/91, rates also rose dramatically among men in their seventies, but since 1994/95, have showed signs of levelling off and perhaps decreasing. Among men in their fifties, rates rose almost continuously since 1989/90, and now exceed those for men in their seventies. Few men in their forties or aged 80 or older undergo radical prostactectomy.

The rate of bilateral orchiectomy for men 40 or older rose between 1980/81 and 1992/93, but has since decreased (Chart 5). The 1998/99 rate was 14.6 per 100,000, compared with 22.8 in 1980/81 (Appendix Table C). However, the procedure does not always necessitate an overnight hospital stay, so it is possible that these figures underestimate the

Chart 5

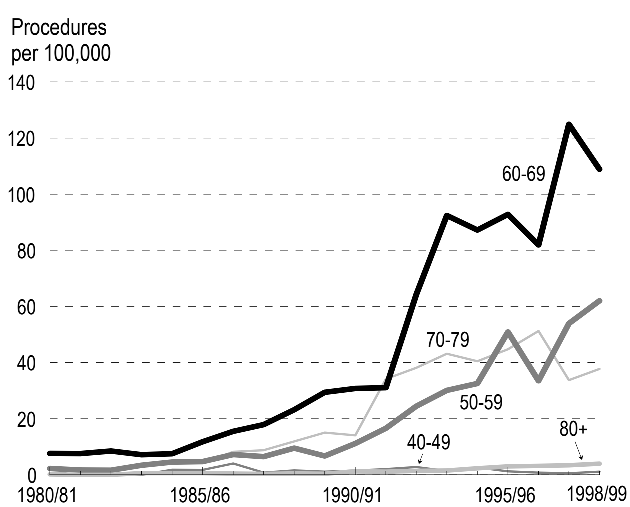
Age-standardized surgery rates, by selected procedures, men aged 40 or older diagnosed with prostate cancer, Canada, 1980/81 to 1998/99



Data sources: *Hospital Morbidity Database, 1980/81 to 1998/99*
Note: *Standardized to age distribution of 1991 Canadian male population aged 40 or older, adjusted for net census undercoverage*

Chart 6

Age-specific radical prostatectomy rates, by 10-year age group, men aged 40 or older diagnosed with prostate cancer, Canada, 1980/81 to 1997/98



Data source: *Hospital Morbidity Database, 1980/81 to 1998/99* number of surgeries, as they do not capture orchiectomies performed on a day-surgery basis. These trends mirror those reported in the United States.[6,7] The decrease in bilateral orchiectomies may be due, in part, to greater use of non-surgical hormonal treatments for late-stage prostate cancer, as well as a decrease in diagnoses of such cancers.[6,29]

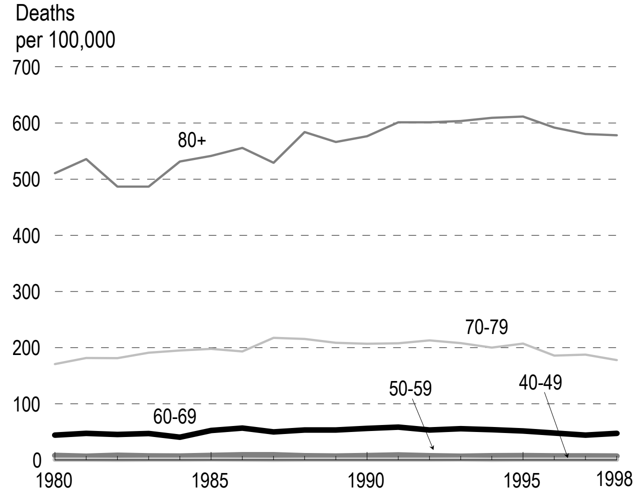
Mortality rate relatively stable

In 1980, prostate cancer claimed the lives of 2,034 Canadian men aged 40 or older; by 1998, the number was 3,664 (Appendix Table D). However, much of this numerical upturn was due to the increase of the adult male population. In fact, prostate cancer mortality rates were fairly stable (Chart 3). Rates rose steadily from 1980 by 1.1% a year, but since 1994 have decreased by 1.7% a year. In 1998, the rate was 73 deaths per 100,000 men aged 40 or older, relatively unchanged from 67 per 100,000 in 1980.

As expected, prostate cancer mortality rates were highest at older ages (Chart 7), although among men older than 60, rates began to decrease in the early to mid-1990s. By contrast, among men in their forties and fifties, prostate cancer mortality rates changed very little throughout the period.

Decreases in prostate cancer mortality rates in Canada and the United States have been noted previously.[10-12] Since the PSA test can detect cancers at earlier stages, this decline in mortality rates has provoked much interest.[28] An important consideration in any discussion of PSA tests and their possible effect on prostate cancer mortality is the amount of time by which diagnosis has been advanced by the test, also known as lead time. Slower-growing tumours will have long lead times, whereas aggressive cancers will have short lead times. A 1999 study concluded that PSA testing may have contributed to some of the recent decline in prostate cancer mortality by detecting cases that otherwise would have been diagnosed at a late stage.[36] It was felt that only patients with aggressive forms of prostate cancer would have short enough lead times for PSA testing to have had an effect. Others contend that most of the downturn happened too soon after the introduction of widespread PSA screening for it to have had an impact, and that the

Chart 7
Age-specific prostate cancer mortality rates, by 10-year age group, men aged 40 or older, Canada 1980 to 1998



Data source: *Canadian Vital Statistics Database*

Table 2
Age-standardized prostate cancer mortality rates, men aged 40 or older, Canada and provinces, 1981-1983 to 1996-1998

	Canada†	Nfld.	P.E.I.	N.S.	N.B.	Que.	Ont.	Man.	Sask.	Alta.	B.C.
	Deaths per 100,000										
1981-1983	68	44*	68	68	76	74	67	72	78	70	68
1984-1986	76	61	85	82	70	80	70*	78	81	76	74
1987-1989	78	65	85	82	68	81	77	86	80	77	77
1990-1992	86	82	114	90	79	82	77*	90	85	82	76
1993-1995	84	80	98	88	82	81	80	82	90	85	75
1996-1998	78	71	78	86	82	70	73	79	94*	81	67

Data source: *Canadian Vital Statistics Database*
Note: *Based on three-year averages*
† Includes territories
** Significantly different from value for Canada ($p \leq 0.05$, adjusted for multiple comparisons)*

Limitations

Although information on the use of PSA tests is from self-reports (proxy reporting was not permitted), the degree to which data are inaccurate due to reporting error is not known.

Data on cancer incidence are provided by provincial cancer registries. While cancer registration is relatively consistent across the country, variations may exist in the way that new cases are registered. Some recent work in Québec has found that approximately one-third of prostate cancer cases are not registered because they have not been admitted to a hospital.[37] When incidence rates for Canada excluding Quebec were examined, there was little change in the overall or age-specific national trend (data not shown); nevertheless, interpretation of interprovincial differences should be made with caution.

The survey data on PSA testing were collected after that of prostate cancer incidence and mortality, and information on stage of disease at diagnosis is not available in the Canadian Cancer Registry. These two limitations make it difficult to draw any inferences about the possible influence of PSA on prostate cancer trends.

The surgical procedures reported in this article were limited to those performed in hospital, because outpatient procedures are not included in the Hospital Morbidity Database. This may result in underestimates, particularly of orchiectomies, which may not require an overnight hospital stay. As well, the use of non-surgical means of treating prostate cancer, namely radiation and hormonal therapy, could not be examined.

The numbers from the territories for prostate cancer incidence, mortality and surgery were very small, causing the rates for these regions to be unstable over time. Therefore, while territorial data are included in national estimates, they are not shown separately.

decline in mortality is due primarily to more aggressive treatment of later-stage disease.[38]

Three-year averages of prostate cancer mortality rates show few statistically significant differences between the provinces (Table 2). In the early 1980s, Newfoundland's rate was significantly below the national level, as was Ontario's in the mid-1980s and early 1990s. However, over the 1996-to-1998 period, the prostate cancer mortality rate differed from the national rate only in Saskatchewan, where it was significantly high.

Concluding remarks

An effective screening test is one that can detect a cancer early enough for the patient to be successfully treated, thereby leading to decreased mortality.[30,39] In 2000/01, about 4 in 10 men aged 40 or older reported having had a recent prostate-specific antigen test. While evidence suggests that PSA testing contributed to an increase in the diagnosis of prostate cancer in its early stages,[40-42] no data indicate that this resulted in decreased mortality.

It is likely that the decline in prostate cancer mortality rates occurred too soon after the initiation of population-based PSA testing for it to have been an effect of screening. The decrease is more apt to be due to improved treatments for later-stage cancer. Because of this, Canadian public health organizations do not currently advocate PSA testing for population-based screening. Other organizations, such as the Canadian Cancer Society, encourage men over 50 to discuss the possible risks and benefits of PSA and digital rectal exam (DRE) screening with their doctor.[27] Randomized trials of prostate cancer screening with PSA and DRE are underway, [43,44] but it will be some time before there will be definitive results about the effectiveness of these methods.

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Appendix

Table A
New cases of prostate cancer and age-specific incidence rates, by 10-year age group, men aged 40 or older, Canada, 1980 to 1998

	Age group											
	Total 40+		40-49		50-59		60-69		70-79		80+	
	Number	Rate per 100,000†	Number	Rate per 100,000	Number	Rate per 100,000	Number	Rate per 100,000	Number	Rate per 100,000	Number	Rate per 100,000
1980	6,079	185.9	26	2.0	440	37.1	1,679	200.7	2,470	548.5	1,464	938.7
1981	6,855	204.6	19	1.4	454	37.9	1,915	223.0	2,788	599.8	1,679	1,050.5
1982	6,966	202.6	36	2.7	454	37.5	1,890	214.2	2,923	610.3	1,663	1,008.8
1983	7,284	207.2	32	2.3	446	36.6	1,947	216.3	3,070	621.1	1,789	1,052.3
1984	7,684	210.6	41	2.9	546	44.6	2,122	231.2	3,214	629.0	1,761	998.3
1985	8,281	221.5	31	2.1	531	43.3	2,306	246.6	3,452	654.4	1,961	1,077.6
1986	8,569	224.1	33	2.2	499	40.6	2,390	249.9	3,574	661.5	2,073	1,107.4
1987	9,246	233.1	24	1.5	553	44.8	2,619	266.3	3,870	699.4	2,180	1,116.2
1988	9,633	235.5	42	2.5	604	48.6	2,844	281.0	3,943	699.0	2,200	1,085.5
1989	10,106	239.2	44	2.5	579	46.0	3,004	289.0	4,182	725.1	2,297	1,087.0
1990	11,386	260.1	47	2.6	682	53.7	3,447	325.1	4,743	793.3	2,467	1,119.4
1991	13,290	292.5	67	3.5	863	66.8	4,081	378.3	5,538	892.0	2,741	1,190.8
1992	15,274	326.3	71	3.6	960	73.1	4,904	449.1	6,388	995.2	2,951	1,235.4
1993	17,666	365.5	96	4.7	1,380	102.4	6,057	548.8	7,069	1,073.3	3,064	1,235.6
1994	16,731	336.9	126	6.0	1,485	106.8	5,887	529.5	6,518	966.0	2,715	1,054.4
1995	14,621	289.4	131	6.0	1,318	91.9	5,074	453.3	5,543	802.3	2,555	958.6
1996	14,790	285.4	137	6.1	1,497	100.8	5,154	457.4	5,564	785.2	2,438	891.6
1997	15,946	299.8	155	6.7	1,700	108.5	5,566	490.6	6,002	822.9	2,523	898.7
1998	16,163	296.2	155	7.7	1,989	121.0	5,735	502.1	5,725	761.4	2,534	879.2

Data source: *National Cancer Incidence Reporting System (1980 to 1991); Canadian Cancer Registry (1992 to 1998)*
† Standardized to age distribution of 1991 Canadian male population aged 40 or older, adjusted for net census undercoverage

Table B
Radical prostatectomies and age-specific rates, by 10-year age group, men aged 40 or older, Canada, 1980/81 to 1998/99

	Age group											
	Total 40+		40-49		50-59		60-69		70-79		80+	
	Number	Rate per 100,000†	Number	Rate per 100,000	Number	Rate per 100,000	Number	Rate per 100,000	Number	Rate per 100,000	Number	Rate per 100,000
1980/81	111	2.6	1	0.2	41	2.3	64	7.7	5	1.8	0	0
1981/82	100	2.4	0	0.0	30	1.7	65	7.6	4	1.4	1	2.3
1982/83	115	2.7	0	0.0	30	1.7	75	8.5	10	1.3	0	0
1983/84	156	3.6	4	0.6	42	3.4	93	7.2	17	3.4	0	0
1984/85	196	4.4	4	0.6	56	4.6	108	7.5	26	5.1	2	1.8
1985/86	258	5.8	4	0.6	58	4.7	158	11.8	36	4.2	2	1.8
1986/87	396	8.7	3	0.5	89	7.2	231	15.5	71	8.2	2	4.1
1987/88	437	9.4	5	0.3	80	6.5	273	17.9	78	8.8	1	0.8
1988/89	594	12.5	4	0.5	118	9.5	363	23.2	107	11.9	2	1.6
1989/90	705	14.5	7	0.4	126	6.7	446	29.4	123	15.1	3	1.2
1990/91	765	15.5	10	1.2	142	11.2	477	30.8	133	14.1	3	1.5
1991/92	1,125	22.3	22	1.2	214	16.6	670	31.1	212	34.2	7	2.0
1992/93	1,724	33.6	28	1.4	321	24.4	1,025	64.2	344	38.2	6	2.8
1993/94	2,388	45.6	31	1.5	406	30.1	1,492	92.4	456	43.2	3	1.4
1994/95	3,092	57.9	49	2.3	658	32.6	1,939	87.2	440	40.5	6	2.6
1995/96	3,307	60.8	66	3.0	730	50.9	2,078	92.8	430	44.7	3	1.3
1996/97	3,002	54.3	72	3.2	719	33.5	1,846	81.9	363	51.2	2	0.8
1997/98	3,412	60.7	79	3.4	845	53.9	2,095	124.9	392	33.8	1	0.6
1998/99	4,045	70.8	94	4.0	1,020	62.0	2,478	108.9	450	37.8	3	1.2

Data source: *Hospital Morbidity Database, 1980/81 to 1998/99*
† Standardized to age distribution of 1991 Canadian male population aged 40 or older, adjusted for net census undercoverage

Table C
Bilateral orchiectomies and age-specific rates, by 10-year age group, men aged 40 or older, Canada, 1980/81 to 1998/99

	Total 40+		40-49		50-59		60-69		70-79		80+	
	Number	Rate per 100,000†	Number	Rate per 100,000	Number	Rate per 100,000	Number	Rate per 100,000	Number	Rate per 100,000	Number	Rate per 100,000
1980/81	729	22.8	4	0.3	65	3.7	190	11.4	331	36.8	139	60.8
1981/82	781	23.4	4	0.6	67	3.7	239	13.9	318	34.2	153	54.6
1982/83	837	24.4	1	0.2	72	6.0	246	13.9	371	38.7	147	50.8
1983/84	926	26.0	7	0.5	63	5.2	251	13.9	472	47.7	133	44.4
1984/85	968	27.4	4	0.3	58	3.2	256	17.8	450	44.0	200	64.2
1985/86	1,050	29.0	5	0.8	64	5.2	267	28.6	502	47.6	212	65.8
1986/87	1,318	35.4	4	0.6	79	3.2	355	18.6	605	56.0	275	82.7
1987/88	1,232	32.5	4	0.6	73	5.9	327	16.6	562	50.8	266	76.5
1988/89	1,433	36.0	6	0.4	60	4.8	349	17.2	705	88.8	313	86.5
1989/90	1,459	36.4	7	0.4	67	3.5	376	18.1	664	57.6	345	91.4
1990/91	1,710	40.9	5	0.3	77	4.0	443	20.9	792	66.2	393	99.9
1991/92	1,762	41.1	7	0.4	75	5.8	416	19.3	807	65.0	457	111.6
1992/93	2,042	46.7	4	0.4	71	5.4	454	27.0	960	74.8	553	130.2
1993/94	1,944	43.7	8	0.4	62	2.3	423	38.3	928	70.5	523	118.6
1994/95	1,634	35.2	5	0.5	50	2.5	334	20.5	844	62.5	401	102.9
1995/96	1,342	28.2	4	0.2	48	3.4	298	17.4	650	67.6	342	71.9
1996/97	1,155	24.0	2	0.2	28	1.9	219	13.2	577	40.7	329	67.2
1997/98	944	19.2	2	0.1	27	1.7	170	7.5	474	32.5	271	53.9
1998/99	732	14.6	3	0.1	19	1.2	114	6.8	367	24.4	229	67.6

Data source: *Hospital Morbidity Database, 1980/81 to 1998/99*
† Standardized to age distribution of 1991 Canadian male population aged 40 or older, adjusted for net census undercoverage

Table D
Deaths from prostate cancer and age-specific rates, by 10-year age group, men aged 40 or older, Canada, 1980 to 1998

	Total 40+		40-49		50-59		60-69		70-79		80+	
	Number	Rate per 100,000†	Number	Rate per 100,000	Number	Rate per 100,000	Number	Rate per 100,000	Number	Rate per 100,000	Number	Rate per 100,000
1980	2,034	67.1	7	0.5	93	7.9	369	44.1	769	170.8	796	510.4
1981	2,192	70.7	6	0.5	80	6.7	407	47.4	843	181.4	856	535.6
1982	2,172	67.6	3	0.2	99	8.2	400	45.3	868	181.2	802	486.5
1983	2,287	69.5	6	0.4	88	7.2	423	47.0	943	190.8	827	486.5
1984	2,393	71.4	7	0.5	82	6.7	371	40.4	996	194.9	937	531.2
1985	2,627	75.2	11	0.8	98	8.0	490	52.4	1,043	197.7	985	541.3
1986	2,745	76.5	6	0.4	114	9.3	541	56.6	1,044	193.2	1,040	555.6
1987	2,842	76.5	5	0.3	112	9.1	490	49.8	1,202	217.2	1,033	528.9
1988	3,035	80.0	9	0.5	90	7.2	538	53.2	1,215	215.4	1,183	583.7
1989	3,045	77.4	7	0.4	86	6.8	553	53.2	1,203	208.6	1,196	566.0
1990	3,210	78.3	10	0.5	99	7.8	594	56.0	1,237	206.9	1,270	576.2
1991	3,426	81.2	11	0.6	113	8.8	630	58.4	1,289	207.6	1,383	600.8
1992	3,491	80.8	11	0.6	98	7.5	581	53.2	1,365	212.7	1,436	601.1
1993	3,581	80.9	15	0.7	88	6.5	612	55.5	1,370	208.0	1,496	603.3
1994	3,623	80.0	5	0.2	101	7.3	599	53.9	1,350	200.1	1,568	609.0
1995	3,758	80.8	11	0.5	111	7.7	577	51.6	1,430	207.0	1,629	611.2
1996	3,588	75.4	12	0.5	104	7.0	539	47.8	1,315	185.6	1,618	591.7
1997	3,620	74.0	10	0.4	111	7.1	502	44.3	1,368	187.6	1,629	580.3
1998	3,664	72.6	12	0.5	110	6.7	539	47.2	1,337	177.8	1,666	578.0

Data source: *Canadian Vital Statistics Database*
† Standardized to age distribution of 1991 Canadian male population aged 40 or older, adjusted for net census undercoverage

Social support and mortality in seniors

Kathryn Wilkins

Abstract

Objectives

This article investigates the effect of social support on mortality among Canadian seniors.

Data source

The analysis is based on longitudinal household data from the National Population Health Survey (NPHS) for 2,422 people aged 65 or older in 1994/95. Vital status and date of death were established using data collected in 2000/01.

Analytical techniques

Multivariate proportional hazards models were used to study associations between four indicators of social support (marital status; social contacts; participation in organizations; and perceived emotional support) in 1994/95 and death by 2000/01. Separate analyses were performed for men and women.

Main results

When the influence of age, socio-economic status, stress, health-related behaviours and physical/mental health status was taken into account, no association between social support and mortality emerged for women, but such a relationship was evident for men. Married men had a 40% lower hazard of death, compared with their non-married counterparts. Participation in organizations also conferred a reduced likelihood of dying for men.

Key words

marital status, death, longitudinal studies, health surveys

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As baby boomers approach retirement, the proportion of seniors in the Canadian population is about to increase dramatically. Projections indicate that by 2016, one in six people will be aged 65 or older; in 2001, the ratio was one in eight.[1] Substantial gains in seniors' life expectancy are contributing to this growth. Men aged 65 in 1996 could expect to live another 16 years, and women, nearly 20 more.[2]

Aside from physical health and socio-economic status, other factors influence how long seniors will survive into old age. Over the past two decades, evidence has accumulated indicating that people with weak social ties are at greater risk of death, even when age, physical limitation and illness, and socio-economic status are taken into account.[3-16]

The consistency of the relationship between social support and mortality by sex is less clear.[17] Although more evidence supports such a relationship for men than for women, most studies have not examined the sexes separately.

This article, based on longitudinal data from the National Population Health Survey (NPHS), investigates the association between social support and mortality in the Canadian senior population (see *Data source, Analytical techniques*, *Definitions* and *Limitations*). Specifically, the analysis tests the hypothesis that social support is predictive of survival in people aged 65 or older who live in private households. Because of differences in men's and women's social relationships, each sex is analyzed separately (see *Gender differences in social support*).

The analysis is based on Sugisawa's theoretical framework,[20] which consolidates the work of other researchers. The framework, which proposes that social relationships influence the risk of dying through physical health and health behaviour, comprises three sets of variables: socio-demographic characteristics and social relationships; physical health and health-related behaviours (mediating variables); and death, the dependent variable. This analysis focuses on the social support aspects—marital status, contacts with family, friends and neighbours, participation in organizations and

Data source

This article focuses on men and women aged 65 or older who were residents of private households in the ten provinces in 1994/95. The data are from the longitudinal component of the National Population Health Survey (NPHS). The NPHS, which began in 1994/95, collects information about the health of the Canadian population every two years. It covers household and institutional residents in all provinces and territories, except persons on Indian reserves, on Canadian Forces bases, and in some remote areas. The NPHS has both longitudinal and cross-sectional components.

For household residents, individual data are organized into two files: General and Health. Socio-demographic and some health information was obtained for each member of participating households. These data are found in the General file. Additional, in-depth health information was collected for one randomly selected household member. The in-depth health information, as well as the information in the General file pertaining to that individual, is found in the Health file.

Among individuals in the longitudinal component of the NPHS, the person providing in-depth health information about himself or herself for the Health file was the randomly selected person for the household in cycle 1 and was usually the person who provided information about all household members for the General file in subsequent cycles.

In 1994/95, the NPHS collected information from a sample of 20,725 households. In 18,342 of these households, the selected person was aged 12 or older. Their response rate to the in-depth health questions was 96.1%, or 17,626 respondents. Beginning with cycle 4 in 2000/01, the NPHS became strictly longitudinal. Of the original panel of 17,276 respondents, 957 had died and 135 had been institutionalized; 13,559 were interviewed, for a response rate of 84.8% in cycle 4. More detailed descriptions of the NPHS design, sample and interview procedures can be found in published reports.[18,19]

In this analysis, frequencies and bivariate tabulations were carried out using the sample of people who in 1994/95 resided in households and were aged 65 or older, and for whom data for the cycles 1 and 4 surveys were available: 954 men and 1,468 women (Appendix Tables A and B). Multivariate analysis was based on data from the respondents for whom no responses were missing on the variables used in any of the multivariate models: 804 men and 1,303 women.

Gender differences in social support

In 1994/95, among the household population aged 65 or older, men were much more likely than women to be married. However, the level of perceived emotional support did not differ by sex, possibly because women participated in social organizations and pursued social contacts outside the home more often than did men. Previous research suggests that social support increases for women after the death of their spouse,[21] and that women generally have a wider range of sources of emotional support than do men, who tend to rely on their spouse for most of their social support.[22,23]

Social support, by sex, household population aged 65 or older, Canada excluding territories, 1994/95

	Men	Women
Married (%)	76*	45
Participation in organizations (mean)	3.0*	3.7
Social contacts (mean)	4.1*	4.3
Emotional support (mean)	3.6	3.7

Data source: *1994/95 National Population Health Survey, cross-sectional sample, Health file*
** Significantly different from estimate for women (p < 0.05)*

perceived emotional support among Canadian seniors (see *Measures of social support*). The influence of mastery (a psychological resource) is also considered, as it is thought to affect social participation and perceived social support, and has been reported to have a protective effect against death.[4,24]

Men die sooner

Among people who were aged 65 or older in 1994/95 when they were interviewed for the NPHS, the likelihood of death before 2000/01 was substantially higher for men than for women (Table 1). Even though the average age of elderly respondents in 1994/95 did not differ by sex (data not shown), women survived an average of about 3 months (96 days) longer in the follow-up period.

Table 1
Percentage who died by 2000/01 and mean survival time, by sex, household population aged 65 or older in 1994/95, Canada excluding territories

	Men	Women
Died (%)	32*	21
Mean number of days survived	1,906*	2,003

***Data source**: 1994/95 and 2000/01 National Population Health Survey, longitudinal sample, Health file*
** Significantly different from estimate for women ($p < 0.05$)*

Measures of social support

Two categories were established for *marital status*. People who reported that they were now married, living common-law or living with a partner were classified as married; reports of single (never married), widowed, separated or divorced were grouped as not married.

To determine *participation in organizations*, respondents were asked:

- How often did you participate in meetings or activities sponsored by these groups (voluntary organizations or associations such as school groups, church social groups, community centres, ethnic associations or social, civic or fraternal clubs) in the past 12 months?
- Other than on special occasions (such as weddings, funerals or baptisms), how often did you attend religious services or religious meetings in the past 12 months?

The response range was 0 to 8, with a higher score indicating greater participation. In bivariate analysis, a score of 0 was defined as a low participation; 25% of respondents in the weighted distribution fell into this category. Scores of 1 through 8 were considered to reflect high participation. In multivariate analysis, the score was used as a continuous variable.

Social contacts was based on responses to the following item: The next few questions are about your contact in the past 12 months with persons who do not live with you—in person, by phone or by mail. If you have more than one person in a category, for example, several sisters, think of the one with whom you have the most contact. How often did you have contact with: your parents or parents-in-law; your grandparents; your daughters or daughters-in-law; your sons or sons-in-law; your brothers or sisters; other relatives (including in-laws); your close friends; your neighbours? Response categories were: don't have any; every day; at least once a week; 2 or 3 times a month; once a month; a few times a year; once a year; never. The number of contacts were summed and then divided by the number of existing network sectors (for example, grandparents and siblings would each be counted as a sector) who could be counted, up to a maximum of 8. The response range was 0 to 6, with a higher number indicating more contacts. In bivariate analysis, infrequent contact was defined by scores of 0 through 3, which accounted for 20% of respondents in the weighted distribution. Frequent contact was defined as a score of 4 through 8. In multivariate analysis, the score was used as a continuous variable.

Perceived emotional support was measured by summing the responses to four questions: Do you have someone:

- you can confide in, or talk to about your private feelings or concerns?
- you can really count on to help you out in a crisis situation?
- you can really count on to give you advice when you are making important personal decisions?
- who makes you feel loved and cared for?

Each "no" response was scored 0; each "yes," 1. The scores were summed and had a response range of 0 to 4, with a higher score indicating greater emotional support. For bivariate analysis, emotional support was categorized as low or high, with scores of 0 through 3 defined as low (23% of the weighted distribution), and a score of 4, high. In multivariate analysis, the score was used as a continuous variable.

Analytical techniques

A total of 2,740 household residents interviewed in 1994/95 for the National Population Health Survey (NPHS) were aged 65 or older. Of these respondents, 318 were excluded from this analysis: 55 because of an incomplete cycle 1 interview, and the remaining 263 because of incomplete information or non-response to the cycle 4 interview in 2000/01. Of the remaining sample of 2,422 respondents, 1,745 were still alive and living in households or institutions by the time of the cycle 4 interview; 677 (334 men and 343 women) were reported to be deceased in cycle 4 and had resided in households or institutions at the time of their death.

Date of death was not available for 118 of the 677 respondents reported deceased because linkage to Statistics Canada's Canadian Mortality Database, routinely attempted on the records of all NPHS respondents who are reported to have died, could not be successfully completed. For most (90) of them, contact with an NPHS interviewer had occurred in cycle 3 (1998/99), and death had been reported in cycle 4 (2000/01). In these cases, linkage was not possible because the death records were not yet included in the Mortality Database. For the remaining 28 respondents whose deaths had occurred earlier, failure to link with the Mortality Database resulted from discrepancies in data, missing information on maiden name, and/or delays in receiving the death record at Statistics Canada.

For the 118 respondents reported deceased but with no date of death, a date was generated so that they could be included in the analysis. The year of death was calculated as the most recent year in which the respondent's "alive" vital status had been reported by an NPHS interviewer, plus one. For example, a person last interviewed in 1998/99 who was reported deceased in the cycle 4 interview was assigned 1999 as the year of death. January 1 was used for month and day of death.

Bivariate tabulations were used to examine the distribution of independent variables for men and women in cycle 1, and for people who died and those who survived. Differences in proportions of the independent variables were assessed between survivors and decedents; significance was designated as $p < 0.05$.

Multivariate proportional hazards analysis was used to assess the association between social support and time to death. The proportional hazards coefficient estimates the effect on survival time of each covariate entered in the model. For respondents who died during the follow-up period, the duration of survival was measured as the number of days from the date of the cycle 1 interview until the date of death at some time before the cycle 4 interview. For people who completed the cycle 4 interview, the duration of survival was defined as the difference in days between the cycles 1 and 4 interviews; after the cycle 4 interview, the survival time was considered censored.

This analysis used a series of proportional hazards models into which the independent variables reflecting social support together with age, and then groups of other control variables, were cumulatively entered. Change that occurs in the hazards ratios for control variables known to be linked to mortality (for example, level of education) can be observed as additional variables are added to the model. Separate analyses were conducted for men and women. Selection of variables was based on the literature, which delineates distinct components of social relationships (social networks, social involvement, and emotional support),[25,26] as well as on availability in the NPHS. Because all the control variables included in this analysis have been shown to be predictive of mortality, most were retained in successive models regardless of whether they were significant. The exception was household income, which was first included in a model with level of education, but dropped from successive models because of the possibility of multicollinearity.

Preliminary proportional hazards analyses were carried out to test for interaction effects between psychological distress and each social support variable (marital status, social contacts, participation in organizations, and perceived emotional support). The continuous variables included in the interaction terms (psychological distress, social contacts, participation in organizations, and perceived emotional support) were first centered by calculating the weighted mean of each variable and subtracting it from the value of the variable. Each interaction term was included separately in the full multivariate model; none was significantly associated with mortality, suggesting that social support did not buffer the effect of psychological distress (data not shown).

Preliminary proportional hazards models were also produced to examine the relationship between age and survival, using a term for age-squared. With the age-squared term in the model, the association between time of death and age-squared was not significant, suggesting that the relationship was not exponential (data not shown).

Model 1 includes age and the four factors reflecting social support; for Model 2, variables indicating socio-economic status (education and household income) were added. A variable measuring mastery, which indicates a sense of control over one's life, was incorporated in Model 3. For Model 4, health-related behaviours—smoking status and leisure-time physical activity level—were added. Model 5 includes a variable reflecting psychological distress. Model 6, the full model, was constructed by adding variables reflecting physical health: selected chronic conditions, functional impairment (need for help with the activities of daily living), and health status as measured by the Health Utilities Index.

The data were weighted to reflect the age and sex distribution of the household population aged 65 or older in 1994. To account for survey design effects, standard errors and coefficients of variation were estimated with the bootstrap technique.[27-29]

Table 2
Percentage who died by 2000/01, by sex and selected characteristics, household population aged 65 or older in 1994/95, Canada excluding territories

	Men	Women
	%	
Total	32.3†	21.3
Age group		
65-74	22.6*	10.7*
75-84	45.1*	34.9*
85+‡	64.2	48.0
Social support		
Marital status		
Married	27.1*	17.6*
Not married‡	48.3	24.4
Participation in organizations		
Infrequent	33.1	32.6*
Frequent‡	28.5	17.0
Social contacts		
Infrequent	27.5	24.1
Frequent‡	30.5	19.7
Emotional support		
Low	30.6	21.5
High‡	29.6	20.1
Socio-economic status		
Household income		
Lower	48.5*	25.5*
Higher‡	29.7	19.7
Education		
Less than secondary graduation	38.5*	24.1*
Secondary graduation or more‡	24.3	18.1
Mastery		
Low	37.7*	29.4*
High‡	26.4	17.4
Health-related behaviour		
Leisure time		
Moderately active/Active‡	22.6	13.6
Inactive	34.6*	22.8*
Smoking		
Daily/Occasional	34.9	25.4
Former smoker	32.2	23.3
Never smoked‡	30.2	19.4
Health status		
Psychological distress		
High	33.6*	23.7*
Low‡	24.6	11.5
Cancer		
Yes	66.2*	39.0*
No‡	30.3	20.3
Diabetes		
Yes	41.1	41.4*
No‡	31.0	19.3
Heart disease		
Yes	53.6*	32.8*
No‡	27.4	19.2
Respiratory disease		
Yes	54.0*	41.3*
No‡	30.3	20.1
Effects of stroke		
Yes	67.9*	43.7*
No‡	30.6	20.5
Functional dependency		
Yes	81.3*	58.1*
No‡	29.3	19.0
Health Utility Index 3		
High	50.6*	36.4*
Low‡	26.4	15.5

***Data source**: 1994/95 and 2000/01 National Population Health Survey, longitudinal sample, Health file*
† Significantly different from estimate for women ($p < 0.05$)
‡ Reference category
** Significantly different from sex-specific estimate for reference category ($p < 0.05$)*

Social support related to survival for men

The percentage of seniors who died differed significantly by marital status. For both sexes, the proportion who died was higher among those who were not married than among those who were married (Table 2). As well, women with infrequent participation in organizations were more likely to die sooner than women who participated more often.

With adjustment for age and other potential influences (socio-economic status, mastery, health-related behaviours, and mental and physical health status), the protective effect of being married remained for men, but not women (Tables 3 and 4). Married men had a 40% lower hazard of death, compared with men who were not married. As well, for men, even when the other factors were taken into account, participation in organizations remained positively associated with survival (Table 3, Model 6). For women, the association between participation in organizations and survival was attenuated slightly and lost statistical significance ($p = 0.06$) when smoking, level of leisure-time physical activity and psychological distress were considered (Table 4, Models 4 and 5), and disappeared with the addition of variables for physical health (Table 4, Model 6).

The finding that being married confers a protective effect against mortality for men, but not women, is consistent with results of an earlier report based on Canadian mortality data, as well as studies elsewhere that have controlled for other influences.[5,30-33] Other reports have also noted a benefit only to men when social support was more broadly defined to include social networks, social ties, frequency of contacts and involvement in associations.[5,34]

Education a factor for men

Seniors who died tended to have lower socio-economic status than their counterparts who survived. The likelihood of dying was significantly higher among people who had not finished high school and among those who lived in lower income households, compared with more highly educated and more affluent individuals (Table 2). This difference did not reflect generally lower education among the oldest seniors, who would, of course, be the most likely to die. At age 80 or older, the proportion who had not graduated from high school was not statistically greater than that for 65- to 79-year-olds (data not shown), suggesting that factors apart from age accounted for the association between death and lower educational attainment.

When other potential influences were taken into account, education was linked with mortality in men, although its level of significance changed as control variables were added to the models (Table 3). No similar finding emerged for women (Table 4).

As expected, differences in some health-related behaviours distinguished seniors who had died by

Table 3
Adjusted proportional hazard ratios for death by 2000/01, by selected characteristics, male household population aged 65 or older in 1994/95, Canada excluding territories

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Proportional hazard ratio	95% confidence interval	Proportional hazard ratio	95% confidence interval	Proportional hazard ratio	95% confidence interval	Proportional hazard ratio	95% confidence interval	Proportional hazard ratio	95% confidence interval	Proportional hazard ratio	95% confidence interval
Age†	1.1*	1.1, 1.1	1.1*	1.0, 1.1	1.1*	1.1, 1.1	1.1*	1.0, 1.1	1.1*	1.1, 1.1	1.1*	1.0, 1.1
Social support												
Marital status												
Married	0.6*	0.4, 0.8	0.6*	0.5, 0.9	0.6*	0.4, 0.8	0.6*	0.4, 0.9	0.6*	0.4, 0.9	0.6*	0.4, 0.8
Not married‡	1.0	...	1.0	...	1.0	...	1.0	...	1.0	...	1.0	...
Participation in organizations†	0.9*	0.8, 1.0	0.9*	0.9, 1.0	0.9*	0.9, 1.0	0.9*	0.9, 1.0	0.9*	0.9, 1.0	0.9*	0.9, 1.0
Social contacts†	1.1	0.9, 1.3	1.0	0.9, 1.2	1.1	0.9, 1.2	1.1	0.9, 1.3	1.1	0.9, 1.3	1.1	0.9, 1.4
Emotional support†	1.1	0.9, 1.3	1.1	0.9, 1.3	1.1	0.9, 1.3	1.1	0.9, 1.3	1.1	0.9, 1.3	1.0	0.9. 1.3
Socio-economic status												
Household income												
Lower			1.4	0.9, 2.0								
Higher‡			1.0	...								
Education												
Less than secondary graduation‡			1.0	...	1.0	...	1.0	...	1.0	...	1.0	...
Secondary graduation or more			0.7*	0.5, 1.0	0.7*	0.5, 1.0	0.7	0.5, 1.1	0.8	0.5, 1.1	0.7*	0.5, 1.0
Mastery†					1.0	0.9, 1.0	1.0	0.9, 1.0	1.0	0.9, 1.0	1.0	1.0, 1.0
Health-related behaviour												
Leisure time												
Moderately active/Active							0.7	0.5, 1.1	0.8	0.5, 1.1	0.8	0.5, 1.2
Inactive‡							1.0	...	1.0	...	1.0	...
Smoking												
Daily/Occasional‡							1.0	...	1.0	...	1.0	...
Former smoker							1.1	0.7, 1.6	1.2	0.8, 1.8	1.2	0.7, 2.0
Never smoked							0.8	0.5, 1.4	0.9	0.5, 1.6	1.2	0.6, 2.2
Health status												
Psychological distress†									1.1*	1.0, 1.1	1.0	1.0, 1.1
Cancer§											2.9*	1.5, 5.7
Diabetes§											1.2	0.7, 2.3
Heart disease§											1.7*	1.1, 2.6
Respiratory disease§											2.1*	1.3, 3.5
Effects of stroke§											1.3	0.5, 3.3
Functional dependency§											1.2	0.4, 3.1
Health Utility Index 3†											0.7	0.4, 1.6

Data source*: 1994/95 and 2000/01 National Population Health Survey, longitudinal sample, Health file*
Notes*: All models are based on sample of 804 men for whom there were no missing values on any variable included. Because of rounding, some confidence intervals with 1.0 as lower/upper limit are significant.*
† Treated as continuous variable
‡ Reference category
§ Reference category is absence of condition.
** $p < 0.05$*

2000/01 from those who survived. For example, among those who were inactive in their leisure time, a higher proportion died, compared with those who were more active (Table 2). This is consistent with previous reports showing a protective association between physical activity and mortality.[3,35,36]

Psychological distress

The likelihood of death was significantly higher among people reporting high psychological distress in 1994/95 (Table 2). When age, mastery and health-related behaviours were controlled, a positive association between psychological distress and

Table 4
Adjusted proportional hazard ratios for death by 2000/01, by selected characteristics, female household population aged 65 or older in 1994/95, Canada excluding territories

	Model 1		Model 2		Model 3		Model 4		Model 5		Model 6	
	Propor-tional hazard ratio	95% confi-dence inter-val	Propor-tional hazard ratio	95% confi-dence inter-val	Propor-tional hazard ratio	95% confi-dence inter-val	Propor-tional hazard ratio	95% confi-dence inter-val	Propor-tional hazard ratio	95% confi-dence inter-val	Propor-tional hazard ratio	95% confi-dence inter-val
Age†	1.1*	1.1, 1.1	1.1*	1.1, 1.1	1.1*	1.1, 1.1	1.1*	1.1, 1.1	1.1*	1.1, 1.1	1.1*	1.1, 1.1
Social support												
Marital status												
Married	1.2	0.8, 1.8	1.3	0.8, 1.9	1.2	0.8, 1.8	1.2	0.8, 1.8	1.2	0.8, 1.8	1.2	0.8, 1.8
Not married‡	1.0	...	1.0	...	1.0	...	1.0	...	1.0	...	1.0	...
Participation in organizations†	0.9*	0.9, 1.0	0.9*	0.9, 1.0	0.9*	0.9, 1.0	0.9	0.9, 1.0	0.9	0.9, 1.0	1.0	0.9, 1.0
Social contacts†	1.1	0.9, 1.3	1.1	0.9, 1.3	1.1	0.9, 1.3	1.1	0.9, 1.3	1.1	0.9, 1.3	1.1	0.9, 1.3
Emotional support†	0.9	0.7, 1.1	0.9	0.7, 1.1	0.9	0.7, 1.1	0.9	0.7, 1.1	1.0	0.8, 1.3	1.0	0.8, 1.3
Socio-economic status												
Household income												
Lower			1.1	0.8, 1.6								
Higher‡			1.0	...								
Education												
Less than secondary graduation‡			1.0	...	1.0	...	1.0	...	1.0	...	1.0	...
Secondary graduation or higher			0.9	0.6, 1.2	0.9	0.7, 1.2	0.9	0.7, 1.2	0.9	0.7, 1.3	0.9	0.6, 1.3
Mastery†					0.9*	0.9, 1.0	0.9*	0.9, 1.0	1.0	0.9, 1.0	1.0	0.9, 1.0
Health-related behaviour												
Leisure time												
Moderately active/Active							0.7	0.5, 1.2	0.7	0.4, 1.2	0.8	0.5, 1.3
Inactive‡							1.0	...	1.0	...	1.0	...
Smoking												
Daily/Occasional‡							1.0	...	1.0	...	1.0	...
Former smoker							1.0	0.6, 1.7	1.2	0.7, 2.2	1.1	0.6, 2.1
Never smoked							0.6	0.4, 1.0	0.7	0.4, 1.3	0.7	0.4, 1.3
Health status												
Psychological distress†									1.1*	1.0, 1.1	1.1*	1.0, 1.1
Cancer§											2.2*	1.2, 4.0
Diabetes§											1.5	0.9, 2.4
Heart disease§											1.4	0.9, 2.1
Respiratory disease§											1.5	0.8, 2.8
Effects of stroke§											1.4	0.7, 2.9
Functional dependency§											1.2	0.6, 2.4
Health Utility Index 3†											0.6	0.3, 1.2

Data source: *1994/95 and 2000/01 National Population Health Survey, longitudinal sample, Health file*
Notes: *All models are based on a sample of 1,303 women for whom there were no missing values on any variable included. Because of rounding, some confidence intervals with 1.0 as upper/lower limit are significant.*
† Treated as continuous variable
‡ Reference category
§ Reference category is absence of condition.
... Not applicable
** $p < 0.05$*

Definitions

Vital status (dead or alive at the time of the 2000/01 interview) defines the dependent variable in bivariate analysis. It was also used with duration of survival in proportional hazards modelling.

Duration of survival is calculated from the date of the National Population Health Survey (NPHS) cycle 1 interview in 1994/95. A date of death was generated for those for whom the date was unavailable (see *Analytical techniques*). Duration of survival ranged from 4 days to 2,590 days.

In bivariate analysis, *age* was defined categorically: 65 to 74, 75 to 84, and 85 or older. In multivariate analysis, age was used as a continuous variable, based on years of age as reported in cycle 1. A multiplicative term for age (age-squared) was also defined.

Two *household income* groups, based on household size and total household income from all sources in the 12 months before the 1994/95 interview, were derived:

Household income group	People in household	Total household income
Lower	1 or 2	Less than $15,000
	3 or 4	Less than $20,000
	5 or more	Less than $30,000
Higher	1 or 2	$15,000 or more
	3 or 4	$20,000 or more
	5 or more	$30,000 or more

Education was categorized as less than high school graduation, or high school graduation or more.

Mastery measures the extent to which individuals believe that their life chances are under their control. Respondents were asked to react to seven items, which were ranked on a five-point scale ranging from "strongly agree" (score 0) to "strongly disagree" (score 4):

- You have little control over the things that happen to you.
- There is really no way you can solve some of the problems you have.
- There is little you can do to change many of the important things in your life.
- You often feel helpless in dealing with problems of life.
- Sometimes you feel that you are being pushed around in life.
- What happens to you in the future mostly depends on you (reverse scored).
- You can do just about anything you really set your mind to (reverse scored).

The responses were summed; possible scores ranged from 0 to 28, with a higher score indicating a higher sense of mastery. For bivariate analysis, the total score was categorized into two groups: low (scores 0 through 16, which fell in the lower quartile of the weighted distribution), and high (over 16). In multivariate analysis, mastery was treated as a continuous variable. Cronbach's alpha for this scale was 0.76.[37]

Level of *leisure-time physical activity* was based on total accumulated energy expenditure, or EE. EE was calculated from the reported frequency and duration of a respondent's leisure-time physical activities in the three months before the cycle 1 interview and the metabolic energy demand of each activity.[38,39] Leisure time was classified as being moderately active/active (1.5 or more kilocalories per kilogram per day) or inactive (less than 1.5). An example of moderately active leisure time would be walking for an hour four times a week. Leisure-time physical activity that consisted only of gardening or yardwork for an hour a week would be categorized as inactive.

Smoking status was determined by asking respondents if they smoked cigarettes daily, occasionally, or not at all. Three groups were established: daily/occasional smoker, former smoker and never smoked.

The measure of *psychological distress* was based on responses to the following questions: During the past month, about how often did you feel:

- so sad that nothing could cheer you up?
- nervous?
- restless or fidgety?
- hopeless?
- worthless?
- that everything was an effort?

Each question was answered on a five-point scale, ranging from "none of the time" (score 0) to "all of the time" (4). Responses were scored and summed. Total scores could range from 0 to 24, with a higher score indicating greater distress. In bivariate analysis, the score was categorized in two groups, with 0, which covered 32% of responses in the weighted distribution, indicating low distress, and 1 through 24, high distress. In multivariate analysis, the score was used as a continuous variable. Cronbach's alpha for this scale was 0.77.[40]

Respondents were asked if they had any of a number of "long-term health conditions that have lasted or are expected to last six months or more and that have been diagnosed by a health professional." Interviewers read a list of *chronic conditions*, the following of which were considered in this analysis: cancer, diabetes, heart disease, chronic bronchitis or emphysema (respiratory disease), and effects of stroke. Conditions reported in 1994/95 were considered to be present (see *Limitations*).

Functional dependency was based on need for assistance with activities of daily living. Respondents were asked if, because of any condition or health problem, they needed help with personal care (such as washing, dressing or eating) or moving about inside the house. A "yes" response to either was considered to indicate functional dependency.

The *Health Utilities Index* (HUI3) is a summary measure that incorporates functional health and societal preferences of health states.[41,42] Based on responses to 30 questions about eight aspects of functional health (vision, hearing, speech, mobility, dexterity, emotions, cognition, and pain and discomfort) together with a valuation component, an overall score, or index, is produced for each individual. Perfect health is rated 1.000, and death, 0.000; negative scores reflect health states considered worse than death. Possible response values of the HUI3 range from -0.360 to 1.000. For bivariate analysis, HUI3 scores in the lower quartile of the weighted distribution (from -0.324 to 0.664) were categorized as a high level of limitation, and scores above 0.664, a low level. In multivariate analysis, the HUI3 score was used as a continuous variable.

mortality emerged for men (Table 3, Model 5), but it disappeared with the addition of chronic diseases (Table 3, Model 6). For women, the relationship between distress and mortality persisted, even when controlling for chronic diseases (Table 4, Model 6). These findings suggest that the origins and impact of psychological distress differ by sex. For men, psychological distress may simply reflect the difficulties and suffering caused by ill health, factors that affect mortality. By contrast, for women, psychological distress is apparently independent of other indicators of poor physical health, and its effect on mortality is as important.

Limitations

This analysis focuses on quantitative rather than qualitative measures of social support. Social interactions or marriages that are discordant or stressful may give rise to adverse health effects,[25,43,44] which would likely dilute any positive association between social support and survival. Although a few National Population Health Survey (NPHS) questions address negative stressors that may stem from a marital or common-law relationship, the low frequency with which such problems were reported precluded using the data in this analysis.

Information is not available from the NPHS on some of the "upstream" factors that are thought to influence how or if people form social networks—culture, the larger economic context, and political and social change, for example.[3,45]

Although this analysis focuses on the influence of social support on mortality, physical health may, in turn, affect social support. For example, illness may reduce participation in organizations, but increase social contacts. Because the measures of social support were taken only from information provided in cycle 1, it was not possible to study reciprocal effects that may have occurred between social support and illness.

The data file used for the analysis contains full responses on all variables in cycle 1 and vital status for the same respondents in cycle 4. Use of this file maximizes the number of records, but also limits the predictive value of the independent variables, which are based only on data collected in cycle 1. For example, a person who reported being married in cycle 1 may have subsequently lost his or her spouse, but in order to include all deaths that occurred after the cycle 1 interview, changes in marital status or the other social support factors were not considered. Similarly, people diagnosed with chronic conditions after the cycle 1 interview were categorized as not having the conditions. As a result, the observed associations with death may be weaker than they would have been had changes in the independent variables been considered.

Of the initial sample of 2,740 people aged 65 or older in cycle 1, 318 (12%) were excluded from the bivariate analysis because of incomplete information for either cycle 1 or cycle 4. An additional 315 were dropped from multivariate analysis because of missing values on variables included in the models. Selection bias may have affected the results if those who were dropped differed from the remaining sample in mortality, level of social support, or both. For example, if the respondents lost to follow-up generally had less social support and also experienced a higher rate of death than those who continued, the association between these factors would have been stronger if the analysis had included these people.

Missing information necessitated generating a date of death for 17% of records, which reduced the accuracy of the calculation of days of survival. To address the issue of missing date of death, the data were also analyzed using logistic regression. This analysis was based on the proportion of people surviving the interval between surveys, rather than the duration of survival—the basis of the proportional hazards regression analysis. The results of the logistic regression analysis were highly consistent with those of the proportional hazards regressions; that is, using either approach, the same variables were significantly predictive of death (data not shown).

Small cell sizes for the education and household income variables precluded defining more than two categories. A finer breakdown of these variables might have revealed gradients in their association with death.

Information was not available for objective measures of heath (for example, blood pressure, blood chemistry, severity of disease, or diet) that may influence survival, or for many other factors (for example, personal and genetic) that affect the way people perceive and/or receive social support or resist disease and death.[46]

NPHS data are self- or proxy-reported, and the degree to which they are biased because of reporting error is unknown. Reports of chronic or other conditions were not validated against clinical records.

Physical health: relationships differ by sex

As expected, the likelihood of death was greater for seniors with chronic diseases, functional dependency or impaired physical function (as measured by the Health Utilities Index), compared with those without these conditions (Table 2). Previous research, indicating that decreased self-care capacity is a precursor of death,[36,47] is consistent with the finding that dependency on others for activities of daily living was also much more common among people who died.

Even when the effects of other influences were controlled, men who reported in 1994/95 that they had been diagnosed with cancer, heart disease or respiratory disease had higher hazard ratios for death by 2000/01 than did men without these diagnoses (Table 3). For women, when the other factors were taken into account, cancer was the only physical health variable linked to mortality (Table 4). The lack of relationships between mortality and other chronic conditions (diabetes, effects of stroke, and functional dependency, for example) was likely caused by insufficient statistical power resulting from the relatively low prevalence of such conditions.

Concluding remarks

The findings of this analysis, based on data from a panel of senior household residents who were followed over approximately six years, partly support the hypothesis that individual components of social support are linked to survival. The results extend previous observations of the role of social support in relation to death. Among men aged 65 or older, but not among their female counterparts, being married and participating in organizations were each independently predictive of survival.

One of the strengths of this analysis of the National Population Health Survey data is that the number of deaths of men and women during the follow-up period was roughly the same. Therefore, the disparity in the results by sex is not caused by insufficient statistical power, an explanation that has been offered for similar findings.[13] The basis for the difference may be more fundamental: for example, psychological research suggests that the neuroendocrine response to social interaction differs between men and women, with men registering a strong response and women none at all.[48] Women, it is suggested, may be more vulnerable than men to negative aspects of social interactions and may also be more likely to assume the caring tasks in a relationship.[49] Consequently, social interaction may subject women more than men to harmful health effects.[13] The contrasting results emphasize the importance of performing separate analyses by sex, and suggest that the role of social support in relation to mortality is distinct in each gender.

This analysis provides important information about the impact of social support on the risk of dying among seniors. Although the physiological mechanisms of the relationship between social support and death are not well understood, the findings suggest that older men living in households may benefit from interventions that promote social contact.

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Appendix

Table A

Distribution of selected characteristics, male household population aged 65 or older in 1994/95, Canada excluding territories

	Sample size	Estimated population	
		'000	%
Total	**954**	**1,381**	**100.0**
Age group			
65-74	587	880	63.8
75-84	307	392	28.4
85+	60	109	7.9
Vital status, 2000/01			
Alive	620	936	67.8
Dead	334	445	32.3
Marital status			
Married	626	1,046	75.7
Not married	328	335	24.3
Participation in organizations			
Infrequent	275	350	25.3
Frequent	692	867	62.8
Missing	107	164	11.9
Social contacts			
Infrequent	198	273	19.8
Frequent	770	944	68.4
Missing	106	164	11.9
Emotional support			
Low	269	322	23.3
High	696	892	64.6
Missing	109	167	12.1
Household income			
Lower	231	237	17.2
Higher	681	1,708	78.1
Missing	42	66[E1]	4.8[E1]
Education			
Less than secondary graduation	559	729	52.8
Secondary graduation or more	390	638	46.2
Missing	5	F	F
Mastery			
Low	245	295	21.4
High	707	903	65.4
Missing	122	183	13.3
Leisure time			
Inactive	553	722	52.3
Moderately active/Active	326	507	36.7
Missing	75	151	11.0
Smoking			
Daily/Occasional	171	238	17.3
Former smoker	597	854	61.8
Never smoked	186	289	20.9
Missing	0	0	0
Psychological distress			
Low	383	492	35.6
High	577	714	51.7
Missing	114	174	12.6
Cancer			
Yes	52	75[E1]	5.4[E1]
No	901	1,306	94.6
Missing	1	F	F
Diabetes			
Yes	114	170	12.3
No	839	1,211	87.7
Missing	1	F	F
Heart disease			
Yes	181	258	18.7
No	772	1,123	81.3
Missing	1	F	F
Respiratory disease			
Yes	78	113	8.2
No	875	1,268	91.8
Missing	1	F	F
Effects of stroke			
Yes	38	62[E1]	4.5[E1]
No	915	1,319	95.5
Missing	1	F	F
Functional dependency			
Yes	52	79[E1]	5.7[E1]
No	902	1,302	94.3
Health Utility Index 3			
Low	788	1046	75.8
High	254	316	22.9
Missing	32	F	F

Data source: *1994/95 and 2000/01 National Population Health Survey, longitudinal sample, Health file*
Note: *Because of rounding, detail may not add to totals.*
E1 Coefficient of variation between 16.6% and 25.0%
F Coefficient of variation greater than 33.3%
··· Not applicable

Table B
Distribution of selected characteristics, female household population aged 65 or older in 1994/95, Canada excluding territories

	Sample size	Estimated population	
		'000	%
Total	**1,468**	**1,824**	**100.0**
Age group			
65-74	805	1,102	60.4
75-84	522	580	31.8
85+	141	143	7.8
Vital status, 2000/01			
Alive	1,125	1,435	78.7
Dead	343	389	21.3
Marital status			
Married	481	819	44.9
Not married	987	1,005	55.1
Participation in organizations			
Infrequent	324	385	21.1
Frequent	1,246	1,334	73.1
Missing	96	106E1	5.8E1
Social contacts			
Infrequent	220	303	16.6
Frequent	1,347	1,412	77.4
Missing	99	109E1	6.0E1
Emotional support			
Low	298	357	19.6
High	1,269	1,361	74.6
Missing	99	105E1	5.8E1
Household income			
Lower	576	539	29.6
Higher	815	1,177	64.5
Missing	77	107	5.9
Education			
Less than secondary graduation	814	986	54.1
Secondary graduation or more	652	835	45.8
Missing	2	F	F
Mastery			
Low	422	446	24.4
High	1,125	1,248	68.4
Missing	119	130	7.1
Leisure time			
Inactive	1,037	1,222	67.0
Moderately active/Active	389	506	27.8
Missing	42	96	5.3
Smoking			
Daily/Occasional	193	236	12.9
Former smoker	455	581	31.8
Never smoked	818	999	54.8
Missing		F	F
Psychological distress			
Low	439	439	24.0
High	1,126	1,272	69.7
Missing	101	113E1	6.2E1
Cancer			
Yes	84	97	5.3
No	1,380	1,723	94.5
Missing	4	F	F
Diabetes			
Yes	137	169	9.2
No	1,327	1,651	90.5
Missing	4	F	F
Heart disease			
Yes	242	287	15.7
No	1,222	1,533	84.0
Missing	4	F	F
Respiratory disease			
Yes	85	105	5.8
No	1,379	1,715	94.0
Missing	4	F	F
Effects of stroke			
Yes	55	66E1	3.6E1
No	1,409	1,755	96.2
Missing	4	F	F
Functional dependency			
Yes	85	107	5.9
No	1,383	1,717	94.1
Health Utility Index 3			
Low	1,157	1,314	72.0
High	446	475	26.0
Missing	63	35E2	1.9E2

***Data source**: 1994/95 and 2000/01 National Population Health Survey, longitudinal sample, Health file*
***Note:** Because of rounding, detail may not add to totals.*
E1 Coefficient of variation between 16.6% and 25.0%
E2 Coefficient of variation between 25.1% and 33.3%
F Coefficient of variation greater than 33.3%
... Not applicable

Tracking diabetes: Prevalence, incidence and risk factors

Wayne J. Millar and T. Kue Young

Abstract

Objectives

This article examines the prevalence and incidence of diabetes among Canadians aged 18 or older and risk factors associated with developing the condition.

Data sources

The data are from the 1994/95, 1996/97, 1998/99 and 2000/01 National Population Health Survey and the 2000/01 Canadian Community Health Survey, both conducted by Statistics Canada.

Analytical techniques

Descriptive statistics on the prevalence and incidence of self-reported diabetes were computed. Multiple logistic regression was used to identify predictors of incident diabetes. Age-adjusted rates were used to compare diabetic and non-diabetic respondents on a variety of health measures.

Main results

In 2000/01, 4.5% of Canadians aged 18 or older, an estimated 1.1 million, reported having diabetes. The incidence from 1994/95 to 2000/01 was 4.9 new cases per 1,000 person-years at risk. When the possible confounding effects of a number of factors were taken into account, advancing age, family history, sedentary leisure time and excess weight were associated with developing diabetes.

Key words

body mass index, physical activity, longitudinal studies, health surveys

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Diabetes, already one of the most prevalent chronic diseases, is affecting increasing numbers worldwide.[1,2] This increase cannot be attributed to a single cause, but rather, to a combination of demographic, lifestyle and clinical factors. A decline in diabetes mortality over the past two decades has resulted in a large number of people surviving with the disease. Reductions in physical activity and greater caloric intake have contributed to a substantial rise in the prevalence of overweight, a risk factor for diabetes.[3-5] Changes in diagnosis criteria could also influence the number of cases that are identified. In 1998, the cut-point for a diagnosis of diabetes mellitus was lowered from a fasting plasma glucose (FPG) level of 7.8 to 7.0 mmol/L[6] (see *What is diabetes?*). Finally, growing public and physician awareness could increase testing, and result in detection of more cases.[7]

Studies of diabetes in Canada have generally been based on cross-sectional prevalence data. While useful for public administration purposes, such statistics do not indicate the incidence of new cases over time. With longitudinal data from the National Population Health Survey (NPHS), however, it is possible to estimate the incidence of diabetes since the mid-1990s.

Data sources

National Population Health Survey

This analysis is based on Statistics Canada's National Population Health Survey (NPHS), weighted to represent the population of the 10 provinces. The NPHS, which began in 1994/95, collects information about the health of the Canadian population every two years. It covers household and institutional residents in all provinces and territories, except people on Indian reserves, on Canadian Forces bases, and in some remote areas. The NPHS has a longitudinal and a cross-sectional component.

Cross-sectional sample: The 1994/95 and 1996/97 (cycles 1 and 2) cross-sectional samples are made up of longitudinal respondents and other members of their households, as well as individuals selected as part of supplemental samples, or buy-ins, in some provinces. The 1998/99 (cycle 3) cross-sectional sample is made up mostly of longitudinal respondents and their cohabitants. Although no buy-ins were added to the cycle 3 sample, infants born after 1994 and immigrants who entered Canada after 1994 were randomly selected and added to keep the sample representative. To replace sample lost to attrition, individuals in households that were part of the original sampling frame but whose members did not respond in 1994/95 were contacted and asked to participate.

NPHS data are stored in two files. The General file contains socio-demographic and some health information for each member of participating households. The Health file contains in-depth health information for one randomly selected household member, as well as the information in the General file pertaining to that individual.

In 1994/95, in all selected households, one knowledgeable person provided the socio-demographic and health information about all household members for the General file. As well, one household member, not necessarily the same person, was randomly selected to provide in-depth health information about him- or herself for the Health file.

Among individuals in the longitudinal component in 1996/97 and 1998/99, the person providing in-depth health information about himself or herself for the Health file was the randomly selected person for the household in cycle 1 (1994/95), and was usually the person who provided information on all household members for the General file in cycles 2 and 3. In households added to the 1998/99 cross-sectional sample, the randomly selected respondent was also the person who provided information for the General file.

The 1994/95 provincial, non-institutional sample consisted of 27,263 households, of which 88.7% agreed to participate. After application of a screening rule to keep the sample representative, 20,725 households remained in scope. In 18,342 of these households, the selected person was aged 12 or older. Their response rate to the in-depth health questions was 96.1%, or 17,626 respondents. The response rate at the household level was 82.6% in 1996/97 and 88.2% in 1998/99.

The cross-sectional NPHS data used in this analysis pertain to 16,291, 68,282 and 14,150 respondents aged 18 or older in cycles 1, 2 and 3. Beginning with cycle 4 in 2000/01, the NPHS became strictly longitudinal; the cross-sectional component was taken over by the Canadian Community Health Survey (CCHS).

Longitudinal sample: Of the 17,626 randomly selected respondents in 1994/95, 14,786 were eligible members of the longitudinal panel, along with 468 persons for whom only general information was collected. An additional 2,022 of the 2,383 randomly selected respondents under age 12 were also eligible. Thus, the longitudinal sample is composed of the 17,276 respondents who were selected in cycle 1 and had completed at least the General component of the questionnaire. The longitudinal sample size remained the same (17,276) for all cycles. The response rate for the Health component was 83.6% in cycle 1, 92.8% in cycle 2, 88.9% in cycle 3, and 84.8% in cycle 4.

The 2000/01 cycle 4 longitudinal square master file was used for this analysis. This file contains records for all longitudinal respondents, regardless of whether they provided information for all four cycles (that is, individuals selected for the longitudinal sample for whom information is available on the General file of cycle 1).

The sample used in this analysis pertains to 14,117 respondents aged 18 or older in 1994/95. The diabetes status of 54 respondents could not be determined; they were deleted, leaving 14,063.

More detailed descriptions of the NPHS design, sample and interview procedures can be found in published reports.[8-10]

Canadian Community Health Survey

Data about the prevalence of diabetes in 2000/01 and the association with selected health conditions and health care use are from cycle 1.1 of Statistics Canada's Canadian Community Health Survey (CCHS). The CCHS covers the household population aged 12 or older in all provinces and territories, except persons on Indian reserves, on Canadian Forces bases, and in some remote areas.

The responding sample size for cycle 1.1 was 131,535, and the response rate was 84.7%. The sample used for this article consists of 116,171 respondents aged 18 or older in the 10 provinces. More detail about the design, sample and interview procedures of the CCHS is available in a previously published report.[11]

Using the results of successive waves of the NPHS, this analysis tracks changes from 1994/95 to 2000/01 in the prevalence and incidence of diabetes among Canadian adults and identifies potential risk factors (see *Data sources, Analytical techniques, Definitions* and *Limitations*). A comparison of the diabetic and non-diabetic populations is based on the 2000/01 Canadian Community Health Survey (CCHS).

Prevalence increasing

In 2000/01, an estimated 1.1 million Canadians aged 18 or older reported that they were diabetic (see *Compromised health*). They accounted for 4.5% of the population in that age range, up from 3.4% in 1994/95 (Table 1).

In 1994/95, there had been no difference between men and women in the prevalence of diabetes, but by 2000/01, the rate was significantly higher among men. The proportion of men who had been diagnosed rose from 3.4% to 4.8%, while among women, the increase was from 3.3% to 4.2%. The increase among men was significant at ages 18 to 44 and 45 to 64, but among women, only at ages 45 to 64.

Table 1
Prevalence of diabetes, by sex and age group, household population aged 18 or older, Canada excluding territories, 1994/95 to 2000/01

	1994/95	1996/97	1998/99	2000/01
		%		
Both sexes	**3.4**	**3.5**	**3.8**	**4.5***
18-44	0.9	0.9	1.1	1.3*
45-64	4.1	4.9	4.8	6.0*
65-74	11.0	9.9	10.9	12.9
75+	11.4	11.4	12.3	12.5
Men	**3.4**	**3.8**	**4.3**	**4.8***
18-44	0.8E1	0.8	1.4E1	1.2*
45-64	4.5	5.8	5.4	6.7*
65-74	12.5	11.2	12.3	14.7
75+	13.0E1	14.6	15.9	14.8
Women	**3.3**	**3.2**	**3.3**	**4.2***
18-44	1.1E1	1.0	0.7E1	1.3
45-64	3.7	4.1	4.3	5.3*
65-74	9.8	8.8	9.7	11.3
75+	10.4	9.2	9.7	10.9

Data sources: *1994/95, 1996/97 and 1998/99 National Population Health Survey, cross-sectional sample, Health file; 2000/01 Canadian Community Health Survey*
E1 Coefficent of variation between 16.6% and 25.0%
** Significantly different from 1994/95 (p < 0.05)*

What is diabetes?

Diabetes is a chronic disease that has no cure, but can be controlled.[12] There are two major types. Type 1 diabetes occurs most often in children and young adults and is relatively uncommon, accounting for 10% to 15% of cases.[13] It is an autoimmune disease in which the body produces little or no insulin, a hormone needed to convert food into energy. The resulting insulin deficiency is severe, and to survive, a person with type 1 diabetes must regularly inject insulin.

Type 2, which results when the pancreas does not produce enough insulin or when the body does not use the insulin that is produced effectively, accounts for 85% to 90% of cases. It may affect children and adolescents, but usually begins after age 30 and becomes more common with advancing age.

Another form of the disease—gestational diabetes—is a temporary condition that occurs in up to 4% of pregnancies and increases the risk of eventually developing diabetes.

The first symptoms of diabetes are related to high blood sugar levels. As the blood-glucose level rises, glucose passes into the urine. The kidneys excrete additional water to dilute the large amounts of glucose that are being lost. This leads to excessive urination, which in turn, creates abnormal thirst. Because of the severity of insulin deficiency, people with type 1 diabetes almost always lose weight. Most people with type 2 do not lose weight and may not have symptoms for years or decades. Early symptoms of type 2 include recurring skin, gum or bladder infections, slow-to-heal cuts and bruises, itchy skin, vaginal yeast infections, fatigue, blurred vision, frequent urination, and tingling in the hands or feet. Over time, elevated blood sugar levels damage blood vessels, nerves and other internal structures, resulting in serious long-term complications, such as heart attack and stroke. Damage to the blood vessels of the eye can cause vision loss. The kidneys can malfunction, resulting in kidney failure that requires dialysis.

Type 2 diabetes can be detected in blood tests before it has fully developed. The fasting plasma glucose (FPG) test measures blood-glucose levels, usually first thing in the morning after an overnight fast. The oral glucose tolerance test (OGTT) measures blood-glucose levels twice: once after fasting, and again two hours after a sugar-rich drink.

Diabetes is treated by control of blood sugar levels, combined with control of blood pressure and blood lipids. Insulin replacement therapy or an oral hypoglycemic medication is often needed, although many people with type 2 would not need medication if they lost weight and exercised regularly.

Despite the notable upturn at younger ages, diabetes remains a disease of the elderly. In 2000/01, over 12% of seniors were diabetic, compared with 6% of 45- to 64-year-olds and just over 1% of people aged 18 to 44.

A family history is a major risk factor. In 1998/99, 8.5% of people with a diabetic parent and/or sibling reported that they, too, had the disease; the rate among people who did not report first-degree relatives as having diabetes was 2.0% (Table 2).

Diabetes tended to be associated with lifestyle. In 2000/01, rates were high among people who were obese or sedentary. The prevalence was also high among former drinkers and smokers, perhaps reflecting a modification of lifestyle triggered by the diagnosis. There also seems to be some association

Analytical techniques

The unadjusted prevalence of diabetes was computed for 1994/95, 1996/97 and 1998/99 based on the National Population Health Survey (NPHS) and for 2000/01 based on the Canadian Community Health Survey (CCHS).

The diabetes incidence rate is the number of new cases diagnosed in a given period, divided by the total person-time under observation.[14-16] Respondents who were free of "diagnosed diabetes" at the start of each NPHS cycle constitute the population among whom incidence rates were calculated.

Since four cycles of longitudinal NPHS data are available, there are three two-year intervals (1994/95 to 1996/97, 1996/97 to 1998/99, and 1998/99 to 2000/01). Three records were created for each individual on the master file, one record for each two-year interval. The number of respondents free of diabetes at the beginning of each interval constituted the population "at risk" of being diagnosed over the next two years. The sum of respondents at risk at the beginning of each of the three intervals was the population at risk during the entire six years: 33,599.

A respondent was considered to be an incident case if (s)he did not report diabetes in one cycle, but did report having been diagnosed in the next. Interviews for each cycle were conducted approximately two years apart, so the time-at-risk between two adjacent cycles was assumed to be two years for respondents not reporting a diagnosis at either cycle. For respondents who did not report diabetes when they were interviewed at the beginning of one cycle, but did report it at the next interview, the time-at-risk between the two interviews was taken to be one year, based on the assumption that new diagnoses were evenly distributed throughout the interval. The maximum time-at-risk for respondents not diagnosed throughout the survey cycles was six years. Any interval between the cycles for which the existence or non-existence of diabetes was unknown was not used to calculate time-at-risk.

The numerator for the incidence of diabetes was the number of new cases that accumulated over the period; the denominator was the number of person-years contributed by the population at risk (that is, who did not have diabetes) over the follow-up period. Rates were expressed as cases per 1,000 person-years at risk for each two-year interval and for the entire six years.

The selection of independent variables was based on a review of the literature and their availability in the NPHS: sex, age, family history of diabetes, body mass index, physical activity, alcohol use, smoking and education (see *Definitions*). For all independent variables except family history, data from each survey cycle were used. Information on family history was collected only in 1998/99 (see *Limitations*). If respondents stated that they had a family history of diabetes in 1998/99, a family history variable was assigned to their responses for 1994/95 and 1996/97.

Individuals were considered to have a particular characteristic for the full two years between each cycle, even if the value of the characteristic changed from one interview to the next. For example, respondents' answers to the leisure-time physical activity questions in one interview might place them in the "sedentary" category, but answers in the subsequent interview might qualify as "moderately active." Nonetheless, such respondents would be considered "sedentary" for the entire two years between interviews. For each characteristic, an "unknown" category was created so that respondents for whom diabetes information was available could be included in the analysis even if they had not provided data about other characteristics.

Multivariate pooled logistic regression was used to study the association between incident diabetes and the selected risk factors. To ensure an adequate sample size, data for men and women were combined. For the same reason, "missing value" categories were included for some independent variables, but their odds ratios are not shown.

To account for survey design effects, standard errors and coefficients of variation were estimated with the bootstrap re-sampling technique.[17-20] Results at the 0.05 level were considered significant. In instances where multiple means or proportions were tested, the significance levels were adjusted via the Exacted Alpha/L Method.

with socio-economic status, as a relatively large proportion of people with less than secondary graduation were diabetic.

Table 2
Unadjusted prevalence of diabetes, by selected characteristics, household population aged 18 or older, Canada excluding territories, 2000/01

	Sample size	Estimated population	Prevalence of diabetes	
		'000	'000	%
Total	**116,171**	**23,300**	**1,054**	**4.5**
Sex				
Men	53,110	11,430	552	4.8*
Women†	63,061	11,870	502	4.2
Age group				
18-44†	55,279	12,387	155	1.3
45-64	36,758	7,269	436	6.0*
65-74	13,148	2,154	277	12.9*
75+	10,986	1,490	186	12.5*
Family history of diabetes‡				
Yes	...	...	...	8.5*
No†	...	...	...	2.0
Missing	...	...	...	4.2*
Body mass index (BMI)§				
Not overweight (< 25)†	55,768	11,895	295	2.5
Overweight (25.0-29.9)	38,393	7,457	387	5.2*
Obese (≥ 30)	18,447	3,333	352	10.6*
Missing	3,563	615	20	3.2
Leisure time				
Active†	23,181	4,430	140	3.2
Moderately active	26,146	5,044	202	4.0
Sedentary	60,232	12,022	625	5.2*
Missing	6,612	1,799	86	4.8*
Alcohol consumption				
Current drinker	91,252	18,586	635	3.4*
Former drinker	16,638	2,803	272	9.7*
Abstainer†	7,583	1,768	142	8.0*
Missing	698	138	5	3.7
Smoking				
Daily/Occasional	32,886	6,312	204	3.2*
Former smoker	48,094	9,136	535	5.9*
Never smoked†	34,928	7,792	314	4.0
Missing	263	58	1	2.4
Education				
Less than secondary graduation	31,234	5,218	445	8.5*
Secondary graduation/Some postsecondary	31,874	6,757	234	3.5
Postsecondary graduation†	51,830	11,111	361	3.3
Missing	1,233	214	14	6.3*

Data source: *2000/2001 Canadian Community Health Survey; 1998/99 National Population Health Survey, cross-sectional sample, Health file*
Note: *Because of rounding, detail may not add to totals.*
† Reference group
‡ 1998/99 National Population Health Survey
§ Excludes pregnant women.
** Significantly different from reference group (p < 0.05)*
... Not applicable

Compromised health

According to the results of the 2000/01 Canadian Community Health Survey, people with diabetes tended to have other medical problems, and not surprisingly, made frequent use of health care services, even when the older age profile of the diabetic population was accounted for.

Those who reported that they had been diagnosed with diabetes were more likely than non-diabetics to have high blood pressure, heart disease, urinary incontinence and stroke. Vision problems, too, were more common. Given these high percentages, it is not surprising that over a third of diabetics (37%) rated their health as poor or fair, whereas this was true of 11% of non-diabetics.

As might be expected, diabetics made relatively frequent use of health care services. For instance, 29% reported 10 or more general practitioner contacts in the previous year, compared with 12% of non-diabetics. Diabetics were also more likely to have had at least three contacts with eye doctors and with other specialists in that time. Fully 18% of diabetics had been hospitalized in the past year, compared with 8% of non-diabetics, and a significantly higher proportion had spent more than two weeks in hospital.

Age-adjusted† prevalence of selected health indicators, by diabetes status, household population aged 18 or older, Canada excluding territories, 2000/01

	Diabetic	Non-diabetic
	%	
Chronic conditions		
Heart disease	12*	5
High blood pressure	34*	13
Urinary incontinence	5*	2
Stroke	3*	1
Vision problems		
None	38*	44
Corrected	58*	54
Uncorrected	4*	2
Glaucoma	3*	1
Cataracts	7*	4
Fair/Poor self-perceived health	37*	11
Health care use in past year		
10+ physician contacts	29*	12
3+ eye doctor contacts	13*	6
3+ other medical specialist contacts	21*	9
Hospitalized	18*	8
Hospitalized more than 14 days	3*	1

Data source: *2000/01 Canadian Community Health Survey*
† Adjusted to 2000/01 population, both sexes
** Significantly different from non-diabetic (p < 0.05)*

However, many of these characteristics are interrelated. For example, advancing age is associated with increased weight, decreased physical activity, and decreased use of alcohol and tobacco. As well, levels of education tend to be relatively low among elderly people. The potential effects of such confounding relationships should be taken into account to determine associations between diabetes and various risk factors, particularly with regard to new diagnoses.

Definitions

Both the National Population Health Survey (NPHS) and the Canadian Community Health Survey (CCHS) contain questions about chronic conditions. NPHS respondents were asked if they had any "long-term health conditions that have been diagnosed by a health professional." CCHS respondents were asked if they had any "long-term health problems." In addition to diabetes from both surveys, this analysis considers heart disease, high blood pressure, stroke, urinary incontinence, glaucoma and cataracts from the CCHS.

For descriptive analysis, *age* was grouped into four categories: 18 to 44, 45 to 64, 65 to 74, and 75 or older. Age was used as a continuous variable in the adjusted analysis.

In 1998/99, NPHS respondents were asked about the medical history of their immediate family. A *family history of diabetes* was considered to exist if a respondent reported that at least one first-degree relative (biological parent and/or sibling) had the disease. A substantial number (4,005) of respondents did not know their family history. These respondents, who tended to have a higher incidence of diabetes than those without a positive family history (Appendix Table A), were initially excluded. However, additional analysis showed that the independent associations of family history and body mass index with incident diabetes persisted even when these respondents were included and classified as having no family history. Consequently, estimates are shown for this group.

In the NPHS and CCHS, respondents were asked their weight and height. *Body mass index* (BMI) was calculated by dividing weight in kilograms by the square of height in metres. Three categories were defined: not overweight (BMI less than 25), overweight (25 to 29.9) and obese (30 or more). Pregnant women were excluded from the calculations.

Leisure-time physical activity was based on total energy expenditure during leisure time. Information about physical activity at work was not available from either survey. Energy expenditure was based on the frequency and duration of respondents' reported leisure-time activities in the previous three months and the metabolic energy demand of each activity. Activities lasting less than 15 minutes were not counted. Three activity levels were defined: active (3.0 or more kilocalories per kilogram of body weight per day) moderate (1.5 to less than 3.0) and sedentary (less than 1.5).

Respondents to both surveys were asked: "During the past 12 months, how often did you drink alcoholic beverages?" For this analysis, three categories of *alcohol consumption* were established: current (regular and occasional) drinker, former drinker and abstainer.

Respondents to both surveys were asked about their past and current cigarette consumption. Three categories of *smoking* were identified: daily/occasional, former smoker and never smoked.

Education was categorized as less than secondary graduation, secondary graduation/some postsecondary and postsecondary graduation.

As well as the inclusion of cataracts and glaucoma among chronic conditions, the CCHS asked about *vision problems*. This analysis uses three categories of vision problems: none, corrected and uncorrected (including no sight).

CCHS respondents were asked: "In general would you say your health is: excellent, very good, good, fair, poor?" For this analysis, three categories of *self-perceived health* were defined: excellent/very good, good, and fair/poor.

In the CCHS, the use of family doctors or general practitioners was determined by asking: "In the past 12 months how many times have you seen or talked on the telephone about your physical, emotional or mental health with a family doctor or general practitioner?" ... an eye specialist (such as an ophthalmologist or optometrist)?" The same general question also related to consultations with other medical specialists (such as surgeon, allergist, orthopedist, gynecologist or psychiatrist). Frequent use of general practitioner services was defined as 10 or more times in the past year. Frequent use of eye or other medical specialists was defined as three or more times in the past year.

CCHS respondents were asked if they had been an overnight patient in a hospital, nursing home or convalescent home in the past 12 months and for how many nights. In this analysis, heavy users of hospital services were those who had spent more than 14 days in hospital.

Rising incidence

The rate at which new cases of diabetes were diagnosed increased in recent years. Between 1994/95 and 1996/97, the two-year incidence rate was 4.0 cases per 1,000 person-years at risk; between 1998/99 and 2000/01, the rate was 6.7 cases (Table 3). The increase among men from 3.5 to 6.8 cases per 1,000 person-years at risk was statistically significant, but the apparent rise in rates among women from 4.5 to 6.5 cases was not.

From 1994/95 to 2000/01, 353 new cases of diabetes were reported by NPHS respondents, representing about 497,000 new diagnoses. The overall incidence rate for this six-year period was 4.9 cases per 1,000 person-years at risk.

Incidence rose with age from 1.8 new cases per 1,000 person-years at risk for 18- to 44-year-olds to 14.2 cases at age 75 or older (Table 4). Even when adjustments were made for the effects of factors such as family history, weight, physical activity, drinking, smoking and education, the odds of developing diabetes were significantly higher at older ages (Table 5).

Table 3
Two-year incidence of diabetes, by sex, household population aged 18 or older, Canada excluding territories, 1994/95 to 2000/01

	New cases per 1,000 person-years at risk	95% confidence interval
Both sexes		
1994/95 to 1996/97	4.0	3.1, 4.9
1996/97 to 1998/99	4.4	3.3, 5.5
1998/99 to 2000/01	6.7†	5.1, 8.2
Men		
1994/95 to 1996/97	3.5	2.3, 4.7
1996/97 to 1998/99	4.5	2.6, 6.4
1998/99 to 2000/01	6.8†	4.6, 9.0
Women		
1994/95 to 1996/97	4.5	3.1, 5.9
1996/97 to 1998/99	4.3	2.9, 5.7
1998/99 to 2000/01	6.5	4.4, 8.7

Data source: *1994/95, 1996/97, 1998/99, 2000/01 National Population Health Survey, longitudinal sample, Health file*
Note: *Critical ratio adjusted for multiple comparisons and non-independent samples*
† Significantly higher than 1994/95 to 1996/97 ($p < 0.05$)

Family history

A family history of a disease may indicate a genetic predisposition. It might also increase awareness, which could instigate testing and detection. Among people who had a biological parent and/or sibling with diabetes, the six-year incidence rate was 9.7 new cases per 1,000 person-years at risk, compared with 3.0 cases among people without such a background. A family history, however, may also signal a shared

Table 4
Unadjusted six-year incidence of diabetes, by selected characteristics, household population aged 18 or older, Canada excluding territories, 1994/95 to 2000/01

	New cases per 1,000 person-years at risk	95% confidence interval
Total	**4.9**	**4.3, 5.6**
Sex		
Men†	4.8	3.8, 5.8
Women	5.0	4.1, 6.0
Age group		
18-44‡	1.8	1.1, 2.4
45-64	7.0*	5.7, 8.4
65-74	11.6*	8.4, 14.9
75+	14.2*	8.8, 19.7
Family history of diabetes		
Yes	9.7*	7.5, 11.9
No†	3.0*	2.3, 3.6
Missing	5.8*	4.1, 7.4
Body mass index (BMI)§		
Not overweight (< 25)‡	1.9	1.3, 2.5
Overweight (25.0-29.9)	6.1*	4.8, 7.5
Obese (≥ 30)	13.5*	10.6, 16.4
Leisure time		
Active‡	2.7	1.6, 3.9
Moderately active	4.5	3.1, 5.9
Sedentary	5.8*	4.8, 6.8
Alcohol consumption		
Current drinker‡	3.7	3.0, 4.3
Former drinker	10.7*	7.7, 13.8
Abstainer	8.7*	5.2, 12.2
Smoking		
Daily/Occasional	3.4	2.4, 4.4
Former smoker	6.6	5.2, 8.0
Never smoked‡	4.6	3.5, 5.8
Education		
Less than secondary graduation	8.8*	7.0, 10.7
Secondary graduation/Some postsecondary	3.9	3.0, 4.9
Postsecondary graduation‡	3.6	2.5, 4.6

Data source: *1994/95, 1996/97, 1998/99, 2000/01 National Population Health Survey, longitudinal sample, Health file*
† Reference group
‡ Reference group at beginning of each two-year interval
§ Excludes pregnant women.
** Significantly different from reference group ($p < 0.05$)*

home environment that increases the risk of developing a disease. In the case of diabetes, shared behaviour in nutrition, physical activity, smoking and alcohol use could contribute to higher incidence rates.[21-23] Yet even when these factors along with age, sex and education were taken into account, the odds that a person with a diabetic parent or sibling would be diagnosed with the disease were almost three times those of a person without such a family history.

Table 5
Adjusted odds ratios relating selected characteristics to incidence of diabetes between 1994/95 and 2000/01, household population aged 18 or older, Canada excluding territories

	Adjusted odds ratio	95% confidence interval
Sex		
Men	1.11	0.78, 1.56
Women†	1.00	...
Age (in years)‡	1.13*	1.06, 1.21
Family history of diabetes		
Yes	2.75*	1.94, 3.90
No†	1.00	...
Missing	1.56*	1.06, 2.30
Body mass index (BMI)§		
Not overweight (< 25)†	1.00	...
Overweight (25.0-29.9)	1.59*	1.30, 1.94
Obese (≥ 30)	1.77*	1.56, 2.02
Leisure time		
Active†	1.00	...
Moderately active	1.51	0.91, 2.51
Sedentary	1.65*	1.03, 2.64
Alcohol consumption		
Current drinker†	1.00	...
Former drinker	1.97*	1.38, 2.82
Abstainer	1.76*	1.10, 2.81
Smoking		
Daily/Occasional	1.02	0.65, 1.61
Former smoker	1.24	0.85, 1.80
Never smoked†	1.00	...
Education		
Less than secondary graduation	1.14	0.79, 1.65
Secondary graduation/Some postsecondary	1.04	0.71, 1.53
Postsecondary graduation†	1.00	...

Data source: *1994/95, 1996/97, 1998/99, 2000/01 National Population Health Survey, longitudinal sample, Health file*
† Reference group
‡ Age-squared was used in model, but data are not shown.
§ Excludes pregnant women.
** Significantly different from reference group ($p < 0.05$)*
... Not applicable

Weight and exercise

Excess weight is an important risk factor for the development of type 2 diabetes,[24-27] and the risk tends to rise as weight increases.[28] The six-year incidence rate among people who were obese was 13.5 new cases per 1,000 person-years at risk, and among those who were overweight, 6.1 cases. This compared with 1.9 cases among people who were not overweight. The association remained significant when factors such as age, family history and physical activity were considered. The odds that an obese or overweight person would be diagnosed with diabetes were one and a half times those of someone who was not overweight.

Physical activity has been shown to reduce the risk of developing diabetes.[29-39] Over the six years covered by the NPHS, the incidence of the disease was 2.7 new cases per 1,000 person-years at risk for people who were physically active in their leisure time, compared with 5.8 new cases for those with sedentary pursuits. Even though active people are less likely to have excess weight,[40,41] when BMI and the other factors were taken into account, the odds of incident diabetes were significantly higher among people who were sedentary.

Drinking and smoking

The six-year incidence rates of diabetes were highest among former drinkers at 10.7 new cases per 1,000 person-years at risk and abstainers at 8.7 new cases. The rate among current drinkers was just 3.7 cases. People with a family history of diabetes may abstain from alcohol, thus accounting for the higher incidence rate in that group. As well, the high incidence rates among former drinkers and abstainers might be attributable to the age structure of the two groups, since drinking tends to decline at older ages.[42] Yet even when family history, age, and the other factors were considered, the odds of incident diabetes were significantly higher among former drinkers and abstainers than among current drinkers.

Prospective studies have suggested that smoking may be a risk factor for diabetes,[27,43-47] but according to the analysis of the NPHS data, the odds of developing diabetes over the six years did not differ significantly by smoking status. This is in line with a 1996 report that attempted to control for a wide range of variables and suggested that a causal relationship between smoking and insulin resistance is unlikely.[48]

Education

From 1994/95 to 2000/01, the incidence rate of diabetes for people with less than secondary graduation was 8.8 new cases per 1,000 person-years at risk, considerably above the rate for postsecondary graduates (3.6 cases). But when age, sex, family history, and lifestyle factors were taken into account, the odds of developing diabetes over the period did not differ significantly by education.

Nonetheless, the association between education and diabetes is complex. Similar incidence rates may conceal great differences between education groups in factors that contribute to a diagnosis of diabetes, but that could not be accounted for in this analysis. For example, less-educated people are generally more likely to report chronic diseases,[59] not just diabetes, which could contribute to higher incidence rates. On the other hand, they may not be aware of the means of preventing diabetes and the symptoms associated with it, which could mean fewer diagnoses. Better-educated people, by contrast, tend to be more aware of risk factors and symptoms, which could increase their demand for screening and result in elevated incidence rates. But at the same

Limitations

Diabetes tends to be underdiagnosed,[49,50] as the onset of the disease may occur several years before clinical diagnosis.[13] It has been estimated that as many as one-third of adults with the condition have not been diagnosed.[51] Consequently, some National Population Health Survey (NPHS) and Canadian Community Health Survey (CCHS) respondents who did not report diabetes may actually have had it, so its incidence and prevalence may be underestimated.

On the other hand, no independent source was available to confirm if respondents who reported diabetes (or other chronic conditions) had actually been diagnosed by a health professional. However, a study that compared self-reports of diabetes with hospital and physician claims data suggests that self-reports were fairly accurate.[52]

Reliance on self-reports entails other problems. For instance, self-reported weight and height (used to calculate BMI) may underestimate the prevalence of overweight, particularly among seniors.[53-55] With age, loss of bone mass and height is common, but people tend to report their height as measured in younger years. Similarly, self-reported leisure-time physical activity may bias results toward underestimation of the effect of physical activity on chronic disease incidence and prevalence.[56-58]

In NPHS and CCHS data, type 1 and type 2 diabetes cannot be differentiated. Since the risk factors are not the same, the strength of the relationship between the independent variables and the incidence of diabetes (that is, type 2) may have been diluted.

Although the prevalence of diabetes is high among Aboriginal people,[60-63] the NPHS longitudinal file sample was not large enough to yield precise estimates for this population.

Family history was defined as the presence of diabetes in a biological parent and/or sibling. The number of first-degree relatives with the disease would have been useful,[64-66] but this information is not available. In addition, the question about family history was not asked until the third NPHS cycle, and the responses were applied to individuals who participated in the first cycle. No family history information was available for respondents who had died or moved into residential care by the time of the cycle 3 interview.

The analysis of the association between the independent variables and the incidence of diabetes assumed that the respondent's status in each independent variable category remained stable during each two-year interval. But factors like physical activity or weight might have changed markedly during the interval, so the lack of such information could affect inferences about the importance of some independent variables on the incidence of diabetes.

The cycle 4 NPHS Longitudinal Master File contains records for all longitudinal respondents for whom there was some information in 1994/95. If individuals became non-respondents after the first cycle, they could still contribute to the estimates. In cases where the survey lacks full information on these individuals, there is a potential for bias if those without full responses behave differently from those with full responses for the characteristic being studied.

time, they might be more likely to take preventive measures and make lifestyle changes that would lower the incidence of the disease.

Concluding remarks

In 2000/01, 4.5% of Canadians aged 18 or older—an estimated 1.1 million—had diabetes, and the pace at which new cases were diagnosed seems to have increased.

The analysis of data from the Canadian Community Health Survey reinforces other studies that have shown that that diabetes not only takes a personal toll on those with the disease, but also imposes a substantial burden on physician and hospital services.[67-74]

The analysis of longitudinal data from the National Population Health Survey shows that age, family history, weight and physical activity were the most important predictors of incident diabetes. Age and family history, of course, cannot be modified. However, weight and physical activity can be changed.

The results underscore the importance of public health initiatives aimed at reducing diabetes risk by attaining and maintaining a healthy weight.[6,75] People who gain weight and accumulate fat around the waist, abdomen and upper body tend to have relatively high odds of developing the disease.[76] A recent cohort study found that during a 13-year period, overweight men and women who reported intentional weight loss had about a 25% reduction in the rate of developing diabetes, compared with their counterparts who did not report intentional weight loss.[77]

Higher levels of physical activity may help to prevent type 2 diabetes by increasing sensitivity to insulin and inhibiting progression of the disease in its early stages. And through its influence on weight control, physical activity is important in preventing diabetes.[78,79] Even when weight was accounted for in the NPHS analysis, physical activity was independently associated with a lower risk of developing the disease.

Current patterns of overweight and physical activity suggest that the prevalence of diabetes will rise in the next decade. Despite the benefits of exercise, the majority of Canadians, with and without diabetes, are not active in their leisure time and the proportion of the population who are overweight is rising. Moreover, the number of seniors will increase, so even if incidence rates remain stable, demographic changes may lead to a considerable upturn in the overall prevalence of the disease.

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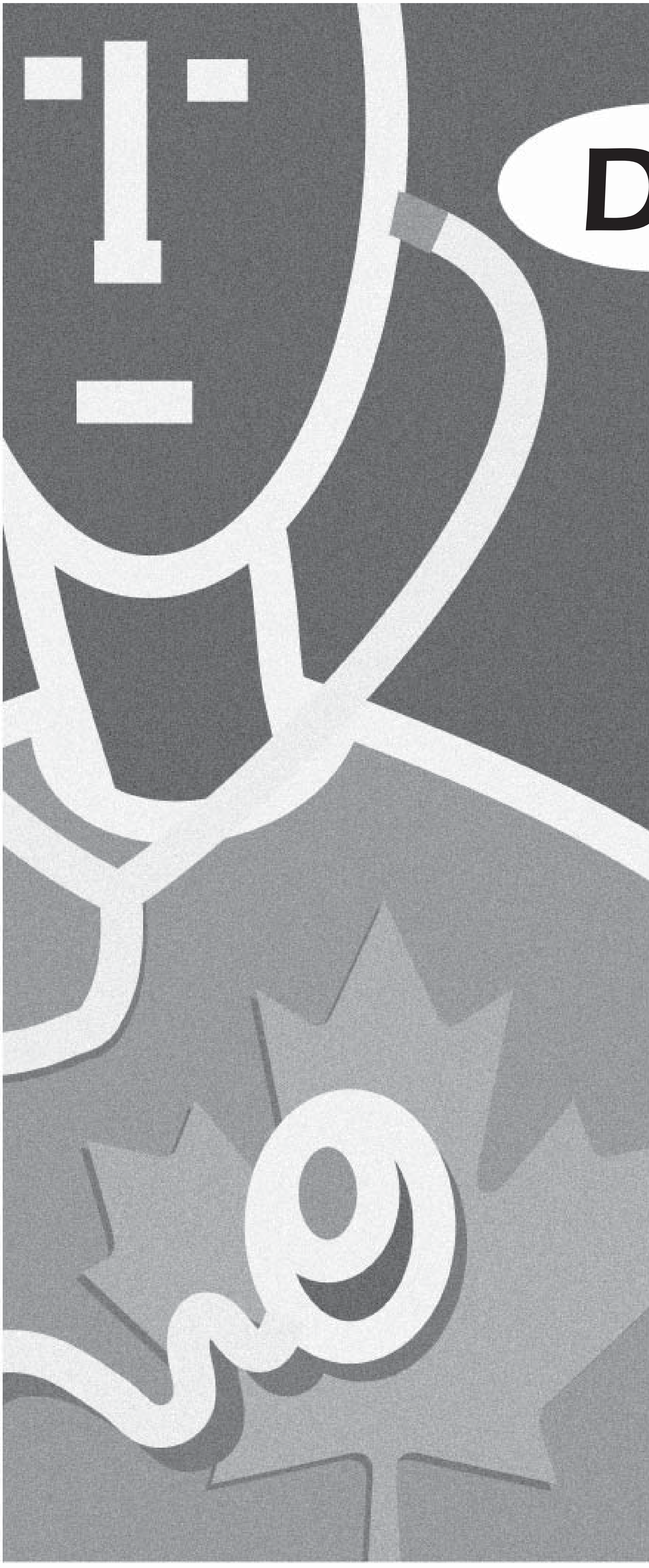
Appendix

Table A
Characteristics of household population aged 18 or older with no diagnosis of diabetes, Canada excluding territories, 1994/95

	Sample size	Estimated population	
		'000	%
Total	**13,565**	**20,398**	**100.0**
Sex			
Men	6,210	10,012	49.1
Women	7,355	10,386	50.9
Age group			
18-44	7,405	11,878	58.2
45-64	3,711	5,679	27.8
65-74	1,434	1,784	8.8
75+	1,015	1,056	5.2
Family history of diabetes			
Yes	2,609	3,791	18.6
No	6,951	10,432	51.1
Missing	4,005	6,175	30.3
Body mass index (BMI)†			
Not overweight (< 25)	6,835	10,432	51.1
Overweight (25.0-29.9)	4,319	6,375	31.3
Obese (≥ 30)	2,260	3,375	16.6
Missing	151	216	1.1
Leisure time			
Active	2,165	3,240	15.9
Moderately active	2,737	4,064	19.9
Sedentary	7,728	11,301	55.4
Missing	935	1,793	8.8
Alcohol consumption			
Current drinker	10,267	15,634	76.6
Former drinker	1,784	2,314	11.3
Abstainer	1,082	1,612	7.9
Missing	432	837	4.1
Smoking			
Daily/Occasional	4,265	6,134	30.1
Former smoker	4,077	5,947	29.2
Never smoked	4,800	7,492	36.7
Missing	423	824	4.0
Education			
Less than secondary graduation	3,888	5,131	25.2
Secondary graduation/Some postsecondary	5,521	8,581	42.1
Postsecondary graduation	4,127	6,639	32.5
Missing	29	46	0.2

Data source: *1994/95, 1996/97, 1998/99, 2000/01 National Population Health Survey, longitudinal sample, Health file*
Note: *Because of rounding, detail may not add to totals.*
† Excludes pregnant women.
F Coefficient of variation greater than 33.3%



Data Releases

Synopses of recent health information produced by Statistics Canada

Marriages, 1999

The number of couples who got married increased for the first time in three years in 1999, although the total fell short of the most recent high. In 1999, 155,742 couples married, up 1.9% over 1998. The annual number had been declining since 1995, when it had reached 160,251.

In 1999, marriages increased in every province except British Columbia (-0.6%) and Quebec (-0.1%), where drops were marginal. The number also fell in the territories. The largest increases were in Newfoundland and Labrador (+7.9%), Nova Scotia (+6.8%) and Prince Edward Island (+5.7%). The growth rate in the remaining provinces was more than 2%.

The crude marriage rate in 1999 was unchanged at 5.1 for every 1,000 inhabitants. This was well below the rate of 7.0 in both 1988 and 1989, attributable to a surge in remarriages after changes to the Divorce Act.

The average age of brides was 31.3 years in 1999, an increase of 2.5 years from 1989 and 5.5 years from 1979. Women marrying for the first time tended to be youngest, with a mean age of 27.8 years in 1999, compared with 40.5 years for women who had been divorced, and 55.7 years for those who had been widowed.

The average age of grooms was 33.8 years in 1999. This was an increase of 2.4 years from 1989, and 5.4 years from 1979. First-time grooms' average age was 29.8 years in 1999. The average for grooms who had been divorced was 44.0 years, and for those who had been widowed, 62.6 years.

Since 1979, people who have been divorced have made up a growing proportion of people getting married. In 1999, they accounted for 21.6% of brides and 22.1% of grooms, compared with 14.1% and 15.6%, respectively, two decades earlier.

The overall increase in the average age of brides and grooms since 1979 was largely due to a rise in the age of those marrying for the first time.

Information on methods and data quality is available in the Integrated Meta Data Base: survey number 3232.

To order *Marriages, 1999* (84F0212XPB, $20) or custom tabulations, contact Client Custom Services (613-951-1746; hd-ds@statcan.ca). For more information, or to enquire about the concepts, methods or data quality of this release, contact Patricia Tully (613-951-1759; patricia.tully@statcan.ca) or Leslie Geran (613-951-5243; leslie.geran@statcan.ca), Health Statistics Division.

Report on smoking, 1985 to 2001

The *Report on smoking in Canada, 1985 to 2001* analyzes the comparability of survey data on smoking prevalence and daily cigarette consumption between 1985 and 2001. During these years, Statistics Canada conducted 15 surveys that asked questions about smoking. Most of these surveys had similar questions, although not all are directly comparable.

Each province experienced some decline in smoking during the period. From 1985 to 1991, the prevalence of daily and occasional smoking fell overall, for both sexes, and among all age groups except 15 to 24. Larger declines occurred between 1991 and 2001. Although smoking prevalence among youths did not change between 1985 and 1994/95, there was a 6 percentage-point decrease between 1994/95 and 2001.

The *Report on smoking in Canada*, *1985 to 2001* (82F0077XIE) is available free on Statistics Canada's web site (www.statcan.ca). From the "Products and services" page, see "Browse our Internet publications," choose "Free," then "Health." Information on methods and data quality is available in the integrated Meta Data Base: survey number 4440.

For more information, or to enquire about concepts, methods or data quality, contact Jason Gilmore (613-951-7118; jason.gilmore@statcan.ca), Health Statistics Division.

Errata

Health Reports, How healthy are Canadians? 2002 Annual Report, Supplement to Volume 13

Table of Contents

On page 5 of the English version of this report, the title of the second article, authored by Stéphane Tremblay, Nancy A. Ross and Jean-Marie Berthelot, should read "Regional socio-economic context and health" instead of "Regional differences in self-reported unmet health care needs."

Maps

In the enlarged Inset B of the third map, "Self-perceived Health by Health Region 2000-01: Proportion of the population aged 18 and over with fair to poor health," health regions 3535, 3537, 3541, 3545, 3554, 3555 and 3560 are coloured incorrectly. The full-scale map displays the correct colour codes for these health regions.

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Title		Catalogue number	Format	Price (CAN$)†‡
Health Reports	· subscription · single issue	82-003-XPE	Paper	$58 $20
	· subscription · single issue	82-003-XIE	Internet	$44 $15
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Health Indicators, electronic publication		82-221-XIE	Internet	Free
Comparable health indicators - Canada, provinces and territories		82-401-XIE	Internet	Free
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Guide to Health Statistics *(This provides quick and easy access to health information on Statistics Canada's web site. It can only be used online in html format and cannot be downloaded.)*		82-573-GIE	Internet	Free
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Report on Smoking in Canada, 1985 to 2001		82F0077-XIE	Internet	Free
Health Care in Canada 2000 – A First Annual Report		82-222-XIE (and http://www.cihi.ca)	Internet	Free
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Divorces	84F0213XPB	Paper	$20
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Other Information

POPULATION HEALTH SURVEYS

Canadian Community Health Survey (CCHS)

Cycle 1.1: CCHS was conducted by Statistics Canada to provide cross-sectional estimates of health determinants, health status and health system utilization for 133 health regions across Canada, plus the territories.

Cycle 1.2: CCHS-Mental Health and Well-being is being conducted by Statistics Canada to provide provincial cross-sectional estimates of mental health determinants, mental health status and mental health system utilization.

Cycle 2.1: CCHS will be conducted by Statistics Canada to provide cross-sectional estimates of health determinants, health status and health system utilization for 134 health regions across Canada.

National Population Health Survey (NPHS)

Household - The household component includes household residents in all provinces, with the principal exclusion of populations on Indian Reserves, Canadian Forces Bases and some remote areas in Québec and Ontario.

Institutions - The institutional component includes long-term residents (expected to stay longer than six months) in health care facilities with four or more beds in all provinces with the principal exclusion of the Yukon and the Northwest Territories.

North - The northern component includes household residents in both the Yukon and the Northwest Territories with the principal exclusion of populations on Indian Reserves, Canadian Forces Bases and some of the most northerly remote areas of the Territories.

Joint Canada - United States Health Survey (JCUHS)

The Joint Canada - United States Health Survey (JCUHS) will collect information from both Canadian and U.S. residents, about their health, their use of health care and their functional limitations.

For more information about these surveys, visit our web site at
http://www.statcan.ca/english/concepts/hs/index.htm

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Statistics Canada, in collaboration with the Social Sciences and Humanities Research Council (SSHRC), has launched an initiative that will help strengthen the country’s social research capacity, support policy-relevant research, and provide insights on important issues to the Canadian public. The initiative involves the creation of nine research data centres at McMaster University in Hamilton, the Université de Montréal, Dalhousie University, and the Universities of Toronto, Waterloo, Calgary, Alberta, New Brunswick (Fredericton), and British Columbia. Prospective researchers who wish to work with data from the surveys must submit project proposals to an adjudicating committee operating under the auspices of the SSHRC and Statistics Canada. Approval of proposals will be based on the merit of the research project and on the need to access detailed data. The centres and research projects will be evaluated periodically to assess security standards and the success of analysis resulting from the projects. Researchers will conduct the work under the terms of the *Statistics Act*, as would any other Statistics Canada employee. This means that the centres are protected by a secure access system; that computers containing data will not be linked to external networks; that researchers must swear a legally binding oath to keep all identifiable information confidential; and that the results of their research will be published by Statistics Canada. For more information, contact Garnett Picot (613-951-8214), Business and Labour Market Analysis Division.