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Lead and bisphenol A concentrations in the Canadian population

by Tracey Bushnik, Douglas Haines, Patrick Levallois, Johanne Levesque, Jay Van Oostdam and Claude Viau

Abstract

Background
Lead is a known toxicant that occurs naturally in the environment. Bisphenol A (BPA) is an industrial chemical used primarily in polycarbonate plastic and epoxy resins. It has been 30 years since lead exposure was measured at a national level, and it is the first time for a national assessment of BPA exposure.

Data and methods
Data are from the 2007-2009 Canadian Health Measure Survey. Lead in whole blood (PbB) and urinary BPA were measured in 5,319 and 5,476 respondents aged 6 to 79, respectively. Geometric means (GMs) are presented by age group and sex for PbB (µg/dL), volume-based BPA (µg/L), and creatinine-standardized BPA (µg/g creatinine). Adjusted least squares geometric means (LSGMs) for PbB and BPA are presented by selected covariates.

Results
PbB was detected in 100% of the population, with a GM concentration of 1.34 µg/dL. Adults aged 60 to 79 and males had significantly higher GM PbB concentrations. Lower household income, being born outside Canada, living in a dwelling at least 50 years old, current or former smoking, and drinking alcohol at least once a week were associated with higher PbB concentrations. Urinary BPA was detected in 91% of the population, with a GM concentration of 1.16 µg/L (1.40 µg/g creatinine). Children aged 6 to 11 had significantly higher GM creatinine-standardized BPA concentrations than did other age groups.

Interpretation
Although PbB concentrations have declined dramatically since the 1970s, socio-demographic characteristics, the age of dwellings, and certain lifestyle behaviours are associated with higher levels. Given the short half-life of orally ingested BPA and the high frequency of detection, the CHMS data suggest continual widespread exposure in the Canadian population.

Keywords
biomonitoring, blood lead, detection, environmental exposure

Authors
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Every day, people are exposed to natural and man-made chemicals—in the air, food and water, and consumer products.[1] These chemicals can enter the body through ingestion, inhalation, and/or dermal contact. They may be essential nutrients or toxic compounds.[2] Human biomonitoring is an effective way to provide baseline information about levels of exposure to environmental chemicals, and can help determine usual exposure and changes over time.[1,3,4] It involves the direct measurement of chemicals or their metabolites in blood, urine, other bodily fluids or tissues. From March 2007 through February 2009, the Canadian Health Measures Survey (CHMS) collected biomonitoring data from a nationally representative sample of the population.

The CHMS was conducted by Statistics Canada in partnership with Health Canada and the Public Health Agency of Canada. As part of the physical examination component of the survey,[5] blood and urine samples were collected and analyzed for chronic and infectious diseases, nutritional biomarkers, general health, and a wide range of environmental chemicals and their metabolites.

This study presents estimates of concentrations of two environmental chemicals in the population aged 6 to 79 years: lead and bisphenol A (BPA). Lead is a metal with a relatively long half-life the use of which has declined steadily since the 1970s. BPA is a synthetic organic chemical with a relatively short half-life whose use has increased over the same period.

Canadians' exposure to lead has not been measured at the national level in 30 years.[6] Lead, a known toxicant,[7] occurs naturally in rock and soil, although exposure is often related to human activity. It is no longer added to

automotive gasoline or used as solder in food cans, and lead limits in paint have been reduced. However, it continues to be used in the refining and manufacturing of products such as lead acid car batteries and electronic equipment.[7] It is also found in consumer products such as plastic mini-blinds, toys and jewellery.[8-10]

Lead that has been released into the environment does not degrade to other substances, so its past use continues to contribute to human exposure.[7] Potential sources include ingestion of dust from lead-based paint on older buildings, ingestion of water distributed through lead pipes, and certain occupations or hobbies (soldering, renovation, pottery or ceramics, etc.).[11,12] Lifestyle factors such as smoking and alcohol consumption may also increase exposure.[7,13,14]

The amount of lead that is absorbed depends on its physical and chemical form and on the individual's characteristics including age and sex.[15] Once absorbed, lead circulates in the bloodstream and accumulates in tissues and bone, or is excreted, primarily in urine and feces.[16]

Blood lead (PbB) concentrations, which are commonly used to evaluate human exposure,[15] reflect recent exposure and may also represent past exposure as a result of lead mobilization from bone into blood.[17] The half-life of PbB is approximately one month, but the half-life of lead in bone can be decades long.[18]

High lead levels can increase the risk of brain[19,20] and kidney damage.[21,22] A PbB concentration at or above 10 µg/dL (≥0.48µmol/L) is considered an intervention level.[23] However, recent studies have found health effects among children at lower concentrations,[24-26] suggesting that there may be no obvious threshold.[25-27] Other researchers have suggested that the intervention level be reduced to 5 µg/dL (0.24 µmol/L)[28] or 2 µg/dL (0.10 µmol/L).[29]

The CHMS is the first national survey to measure Canadians' BPA exposure. BPA does not occur naturally in the environment; it is an industrial chemical used primarily in polycarbonate plastic (such as food containers and water bottles) and epoxy resins (protective linings for canned food and beverages, the inner coating on metal lids for glass jars and bottles, and dental sealants[16,30-32]). Exposure is mainly dietary, although BPA is in drinking water, soil, dust, air and consumer products.[16] It can migrate from food packaging, particularly when heated,[33,34] as well as from repeat-use containers.[16]

Orally ingested BPA is quickly absorbed from the gastrointestinal tract and metabolized in the liver to BPA-glucuronide (BPA-G), which is excreted in urine with a half-life of less than six hours.[35,36] Free BPA is considered to be the biologically active form,[37] and together with BPA-G, makes up total BPA.[38] However, because of the effectiveness of initial metabolism, studies suggest low systemic availability of free BPA after oral exposure.[39] Urine is considered the appropriate body fluid to assess exposure to total BPA.[40] Measuring total BPA may provide valuable information for exposure and risk assessment.[41]

BPA is recognized as an endocrine disruptor,[37] although its estrogenic potency is under debate.[42] Reproductive toxicity, including effects on fertility and development, has been identified as a key health effect of exposure to high concentrations.[32] Some studies suggest that repeated maternal exposure could elevate BPA exposure in utero[43] or in the newborn.[44] Although BPA may constitute a health risk,[37] no guidance values are currently available in Canada for urinary BPA.

Methods

Data source

The Canadian Health Measures Survey (CHMS) covers the household population aged 6 to 79 years. Data for this study are from cycle 1, which was conducted from March 2007 through February 2009 at 15 sites across the country. The sample represented 96.3% of the population. Full-time members of the Canadian Forces and residents of Crown lands, Indian reserves, institutions and certain remote regions were excluded.

The CHMS consisted of a face-to-face household interview and a subsequent visit to a mobile examination centre (MEC). The household interview gathered general demographic and socio-economic data and detailed health, nutrition and lifestyle information. Direct measurements were taken at the MEC, including the collection of blood and urine samples.[5] About 92% of respondents who attended the MEC had limited themselves to water for at least two hours before their appointment.

Of the households selected for the CHMS, 69.6% agreed to participate. Of these, 88.3% responded to the household questionnaire. And of those who completed that questionnaire, 84.9% reported to the MEC for the direct measurements, resulting in a total sample size of 5,604 respondents (Appendix Table A).

The overall response rate was 51.7%. Because two people were selected in some households, this overall rate is not the result of multiplying the household and person response rates. The survey weights produced by the CHMS were used to account for the different stages of non-response.[45]

Blood and urine collection

Blood for the lead analysis was taken from 5,319 respondents. A 6.0 mL lavender K2-EDTA vacutainer of whole blood specimen was collected by venipuncture. Urine for the BPA analysis was taken from 5,476 respondents. The spot midstream urine samples were collected at the beginning of each appointment in a 120 ml container. About 59% of respondents provided a urine sample before noon, and 41%, at noon or later.

Standardized procedures were developed for the collection of blood and urine specimens, processing and aliquoting and for shipping biospecimens to the testing laboratory at the Institut national de santé publique du Québec (INSPQ). The INSPQ is accredited under ISO 17025 and followed standardized procedures that were developed for

every assay and technique performed in its laboratory.

Field blanks were performed at all 15 sites to prevent baseline contamination from the collection, handling procedures, site environment or material used. Contamination in the field blanks was found at site 7 (0.08 µg/dL) for PbB. No significant levels of contamination for BPA were found at any site.

PbB analysis

Whole blood samples were diluted in a basic solution containing octylphenol ethoxylate and ammonia. They were analysed for PbB by inductively coupled plasma mass spectrometry (ICP-MS), Perkin Elmer Sciex, Elan DRC II. The accuracy of the analytical testing of PbB was monitored by sending blind reference quality control materials as a form of proficiency testing to the reference laboratory. Three levels of various acceptable ranges (7.45-11.39/ 21.95-32.92/ 39.96-60.04 µg/dL) of PbB controls were sent from each of the 15 sites. All results were within the acceptable ranges.

The limit of detection (LOD) for PbB, as determined by INSPQ, was established at 0.021 µg/dL (0.001 µmol/L).

Urinary BPA analysis

After collection at the MEC, urine samples were frozen at -20°C and shipped on dry ice to the laboratory. One hundred microlitres of urine were fortified with $^{13}C_{12}$-BPA and buffered to a pH 5. Samples were hydrolyzed with β-glucuronidase (Helix Pomatia type HP-2 of Sigma # G-7017 with activity >100000 units/ml and sulfatase activity of 7500 units/ml) for three hours at 37°C, then derivatized with pentafluorobenzyl bromide at 70ºC for 2 hours. The derivatized products were extracted with a mixture of dichloromethane-hexane. Evaporated extracts were re-dissolved and analyzed by gas chromatography (Agilent 6890 or 7890) coupled to tandem mass spectrometry detector (Waters Quattro Micro-GC), operating in MRM mode following negative chemical ionization (NCI). Total BPA was measured by this procedure. Special precautions were taken to minimize BPA contamination throughout the laboratory analysis. Contamination in the laboratory blanks (deionized water, derivatized) was subtracted from each analytical sequence. The LOD for BPA, as determined by INSPQ, was 0.2 µg/L.

Creatinine was measured using the Jaffé reaction.[46] Specimens with urine creatinine concentrations below 0.05 g/L (0.44 mmol/L) were excluded.[47]

Measures

PbB concentrations were calculated in conventional units (µg/dL) and in Système International (SI) units (µmol/L). Creatinine-standardized BPA concentrations (µg/g creatinine) were calculated by dividing the volume-based BPA measure (µg/L) by the urinary creatinine measure (g/L).[48] This resulted in a valid creatinine-standardized BPA measure for 5,462 respondents. Volume-based and creatinine-standardized BPA data are presented to allow comparisons with a wider range of results in the literature. While BPA may not be excreted through the same renal pathway as creatinine, creatinine standardization may still offer a reasonable biomarker for diuresis/ dilution.[49] Such a standardization procedure likely allows better comparison than volume concentrations in a reasonably homogenous group of individuals. However, comparisons between children and adults, or between men and women should be made with caution.[49]

Individuals whose PbB or urinary BPA concentration fell below the LOD were assigned a value of LOD/2.[50]

Covariates

In addition to age group and sex, household education level, household income and country of birth were examined in association with PbB and BPA concentrations (Appendix Table B). Five age groups were specified: 6 to 11, 12 to 19, 20 to 39, 40 to 59, and 60 to 79 years. The highest level of education for the household was determined based on the highest level attained by each household member and categorized into: less than secondary graduation, secondary graduation, some postsecondary, and postsecondary graduation. Household income quartiles ($25,000 or less, more than $25,000 to $41,000, more than $41,000 to $64,000, more than $64,000) were derived from the reported total household income adjusted for the number of people in the household. Country of birth was categorized as Canada or outside Canada. The association between PbB concentrations and age of the respondent's home, smoking status and alcohol use were examined. Age of dwelling was categorized as less than 20 years, 20 to less than 50 years, and 50 years or more. Smoking status was based on the respondents' reported smoking habits and categorized into never, former or current. Frequency of alcohol consumption was based on respondents' reported consumption in the past 12 months and categorized into: less than once a week, 1 to 3 times a week, 4 to 6 times a week and every day. Children younger than 12 years were not asked about smoking or alcohol consumption and were, therefore, not assigned to a category.

Four categories of PbB concentration were evaluated: 0 to less than 2 µg/dL; 2 to less than 5 µg/dL; 5 to less than 10 µg/dL; and 10 µg/dL or more. These cutpoints correspond to PbB concentrations that recent studies have associated with various health effects.[24-29]

The association between BPA and body mass index (BMI) was examined. At the MEC, each respondent's height and weight were measured. BMI was calculated as weight in kilograms divided by height in metres squared (kg/m^2). Respondents aged 18 years or older were classified as obese (30 kg/m^2 or more), overweight (25 to 29.9 kg/m^2), or neither overweight nor obese (less than 25 kg/m^2).[51] Children aged 6 to 17 years were classified into the same BMI categories based on definitions proposed by the International Obesity Task Force.[52]

Along with creatinine concentration, the time of day of urine collection (before noon; noon or later) was used as a control in the multivariable analysis of BPA.

Analytical techniques

Analyses were weighted using the CHMS survey weights generated by Statistics Canada.[45] The data were analyzed with SAS[53] and SUDAAN[54] software, using DDF=11 in the SUDAAN procedure statements. Proportions, geometric means (GMs), adjusted least squares geometric means (LSGMs) and their confidence intervals were calculated. A separate regression was run for each covariate, controlling for age group and sex, to estimate adjusted LSGM PbB concentrations. A similar approach was used to estimate adjusted LSGM BPA concentrations, with time of day of urine collection and creatinine concentration added as controls. Adjusting for time of urine collection helped address differences in BPA concentrations over the day based on the respondent's last meal or water consumption; controlling for creatinine addressed respondent differences in urine concentration/dilution.[49]

Because the concentrations of PbB, BPA and creatinine were not normally distributed, their log transformations were used in the regression models. Given the 11 degrees of freedom available for variance estimation, Satterwaite-adjusted statistics were used to test the significance of each regression model's coefficients. T-tests were used to compare GMs and LSGMs between categories. Statistical significance was set at $p < 0.05$, but was Bonferroni-adjusted depending on the number of comparisons.[55]

Table 1
Weighted geometric means of blood lead and urinary bisphenol A concentrations, by sex and age group, household population aged 6 to 79 years, Canada, March 2007 to February 2009

Age group (years)		% above limit of detection	Total			Males			Females		
			Geometric mean	95% confidence interval		Geometric mean	95% confidence interval		Geometric mean	95% confidence interval	
				from	to		from	to		from	to
Blood lead											
Total 6 to 79	**µg/dL**	**100.0**	**1.34**	**1.24**	**1.44**	**1.51**	**1.40**	**1.63**	**1.18‡**	**1.08**	**1.30**
	µmol/L	**100.0**	**0.06**	**0.06**	**0.07**	**0.07**	**0.07**	**0.08**	**0.06‡**	**0.05**	**0.06**
6 to 11†	µg/dL	100.0	0.90	0.81	0.99	0.92	0.85	0.99	0.87	0.77	0.99
	µmol/L	100.0	0.04	0.04	0.05	0.04	0.04	0.05	0.04	0.04	0.05
12 to 19	µg/dL	100.0	0.80*	0.74	0.85	0.88	0.82	0.96	0.71‡	0.66	0.77
	µmol/L	100.0	0.04*	0.04	0.04	0.04	0.04	0.05	0.03‡	0.03	0.04
20 to 39	µg/dL	99.9	1.12*	1.04	1.21	1.41	1.28	1.55	0.89‡	0.81	0.98
	µmol/L	99.9	0.05*	0.05	0.06	0.07	0.06	0.07	0.04‡	0.04	0.05
40 to 59	µg/dL	100.0	1.60*	1.46	1.75	1.74	1.57	1.92	1.47‡	1.31	1.65
	µmol/L	100.0	0.08*	0.07	0.08	0.08	0.08	0.09	0.07‡	0.06	0.08
60 to 79	µg/dL	100.0	2.08*	1.90	2.29	2.31	2.08	2.57	1.89‡	1.69	2.12
	µmol/L	100.0	0.10*	0.09	0.11	0.11	0.10	0.12	0.09‡	0.08	0.10
Urinary bisphenol A											
Total 6 to 79	**µg/L**	**90.7**	**1.16**	**1.08**	**1.24**	**1.29**	**1.20**	**1.38**	**1.04‡**	**0.94**	**1.16**
	µg/g creatinine	**90.7**	**1.40**	**1.32**	**1.49**	**1.28**	**1.18**	**1.38**	**1.54‡**	**1.44**	**1.64**
6 to 11†	µg/L	93.2	1.30	1.17	1.45	1.27	1.07	1.52	1.33	1.09	1.61
	µg/g creatinine	93.2	2.00	1.79	2.23	1.93	1.75	2.13	2.08	1.77	2.45
12 to 19	µg/L	93.8	1.50*	1.28	1.77	1.44	1.15	1.81	1.57	1.29	1.92
	µg/g creatinine	93.8	1.31*	1.17	1.46	1.22	1.02	1.45	1.41	1.28	1.56
20 to 39	µg/L	91.2	1.33	1.18	1.49	1.40	1.24	1.58	1.26	1.06	1.49
	µg/g creatinine	91.1	1.49*	1.41	1.57	1.30	1.17	1.45	1.70‡	1.53	1.89
40 to 59	µg/L	87.9	1.04*	0.96	1.12	1.25	1.13	1.39	0.86‡	0.77	0.96
	µg/g creatinine	87.9	1.33*	1.20	1.47	1.23	1.08	1.40	1.43‡	1.27	1.62
60 to 79	µg/L	88.3	0.90*	0.82	0.99	1.08	0.94	1.24	0.76‡	0.65	0.88
	µg/g creatinine	88.3	1.26*	1.14	1.40	1.14	1.02	1.27	1.39‡	1.23	1.56

† reference category
* significantly different from estimate for reference category ($p < 0.05$ adjusted for number of comparisons)
‡ significantly different from estimate for males ($p<0.05$)
Notes: The limit of detection for blood lead was 0.02072 µg/dL or 0.001 µmol/L. The limit of detection for urinary bisphenol A was 0.2 µg/L.
Source: 2007 to 2009 Canadian Health Measures Survey.

Results

Lead exposure

Lead (PbB) was detected in 100% of people aged 6 to 79 years; the geometric mean (GM) concentration was 1.34 µg/dL (Table 1). (Estimates in µmol/L are also presented in Table 1.)

The GM PbB concentration rose through the adult years from 1.12 µg/dL at ages 20 to 39 years to 2.08 µg/dL at ages 60 to 79 years. By contrast, concentrations were 0.9 µg/dL for children aged 6 to 11 years and 0.8 µg/dL at ages 12 to 19 years. The concentration at the 95th percentile ranged from 2.0 µg/dL for children aged 6 to 11 years to 5.2 µg/dL at ages 60 to 79 years (Figure 1).

Males had significantly higher GM PbB concentrations than did females in all age groups except 6 to 11 years.

Within their separate regression models and controlling for age group and sex, household income (p=0.005) and country of birth (p=0.001) were each associated with PbB concentration (Table 2). Residents of households in the lowest income quartile had a significantly higher least squares geometric mean (LSGM) PbB concentration (1.49 µg/dL) than did those in the highest income quartile (1.27 µg/dL). People born outside Canada had a significantly higher concentration (1.54 µg/dL) than did the Canadian-born (1.29 µg/dL). Household education (p=0.077) was not significantly associated with PbB concentration, although residents of households with the lowest level of education had a higher LSGM PbB concentration, compared with their reference group.

Age of dwelling (p=0.006), smoking status (p=0.000) and frequency of alcohol consumption (p=0.000) were each associated with PbB concentration, controlling for age group and sex. Residents of dwellings 50 or more years old had higher LSGM PbB concentrations than did residents of dwellings less than 20 years old. Concentrations were higher among current and former smokers than never smokers (excluding children aged 6 to 11 years). People who drank alcohol at least once a week had higher concentrations than did those who drank less frequently (excluding children aged 6 to 11 years).

Three-quarters (74%) of the population had PbB concentrations below 2 µg/dL, and 23% had concentrations from 2 to less than 5 µg/dL (Table 3). Another 2% had concentrations from 5 to less than 10 µg/dL, and fewer than 1% had concentrations greater than 10 µg/dL.

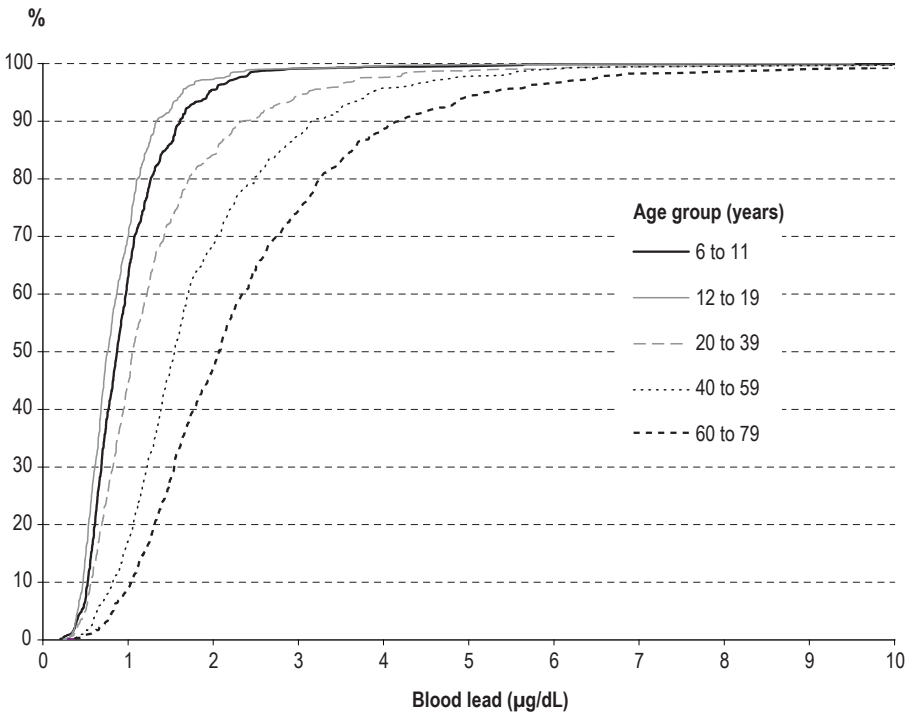
A large majority (at least 95%) of people younger than 20 years had PbB concentrations below 2 µg/dL. This percentage diminished to 47% by ages 60 to 79 years.

Bisphenol A exposure

Bisphenol A (BPA) was detected in 91% of people aged 6 to 79 years, with a volume-based GM concentration of 1.16 µg/L (Table 1). Compared with 6- to 11-year-olds, adolescents and teens (12 to 19) had a higher concentration, while adults aged 40 to 79 years had lower concentrations. Overall, males had a higher concentration (1.29 µg/L) than did females (1.04 µg/L), a difference largely attributable to higher concentrations among men aged 40 to 79. The distribution of BPA varied somewhat by age group: 12- to 19-year-olds generally had higher volume-based values than did people aged 60 to 79 years (Figure 2).

Standardizing BPA with urinary creatinine concentrations resulted in a GM BPA concentration of 1.40 µg/g creatinine for the total population aged 6 to 79 years. At 2.00 µg/g creatinine, 6- to 11-year-olds had a significantly higher concentration than did any other age group. Males generally had lower standardized GM BPA concentrations than did females, a difference that reached statistical significance at ages 20 to 79 years. Men's significantly higher concentrations of creatinine at ages 20 to 79 years (data not shown) helps explain their lower BPA-to-creatinine ratios. Conversely, 6- to-11-year-olds had the

Figure 1
Weighted cumulative distribution of blood lead concentrations, by age group, household population aged 6 to 79 years, Canada, March 2007 to February 2009



Source: 2007 to 2009 Canadian Health Measures Survey.

Table 2
Adjusted least squares geometric means (LSGMs) of blood lead concentrations, by selected characteristics, household population aged 6 to 79 years, Canada, March 2007 to February 2009

Characteristics	LSGM‡ (µg/dL)‡‡	95% confidence interval	
		from	to
Highest level of education in household (p=0.077)			
Less than secondary graduation	1.49*	1.30	1.70
Secondary graduation	1.27	1.17	1.37
Some postsecondary	1.31	1.19	1.43
Postsecondary graduation†	1.32	1.22	1.43
Household income adjusted for household size†† (p=0.005)			
First quartile ($25,000 or less)	1.49*	1.35	1.63
Second quartile (more than $25,000 to $41,000)	1.32	1.17	1.48
Third quartile (more than $41,000 to $64,000)	1.27	1.19	1.35
Fourth quartile (more than $64,000)†	1.27	1.19	1.36
Country of birth (p=0.001)			
Outside Canada	1.54*	1.42	1.68
Canada†	1.29	1.19	1.39
Age of dwelling (p=0.006)			
Less than 20 years†	1.25	1.15	1.37
20 to less than 50 years	1.32	1.23	1.42
50 years or more	1.52*	1.36	1.70
Smoking status§ (p=0.000)			
Never†	1.27	1.16	1.39
Former	1.40*	1.30	1.50
Current	1.66*	1.52	1.80
Frequency of alcohol consumption in past 12 months§ (p=0.000)			
Less than once a week†	1.27	1.17	1.37
1 to 3 times a week	1.39*	1.28	1.52
4 to 6 times a week	1.72*	1.55	1.90
Daily	1.89*	1.75	2.03

† reference category
* significantly different from estimate for reference category (p < 0.05 adjusted for number of comparisons)
‡ adjusted for age group and sex
§ children younger than 12 excluded from model
†† adjusted using 40/30 formula; adjusted household incomes for all respondents ranked and divided into quartiles
‡‡ µg/dL converts to µmol/L by multiplying by 0.0483
Source: 2007 to 2009 Canadian Health Measures Survey.

lowest creatinine levels of all age groups (data not shown), which helps explain their higher creatinine-standardized BPA concentrations.

When the effects of age group, sex, time of day of urine collection and creatinine concentration were controlled, household education (p=0.293), household income (p=0.062), country of birth (p=0.473) and BMI status (p=0.311) were not significantly associated with BPA concentrations (Table 4). However, residents of households with the third highest level of education and those in the third income quartile had higher LSGM BPA concentrations, compared with their respective reference groups.

Discussion

Lead

Although lead was detected in 100% of the population, concentrations have fallen dramatically over the past 30 years. In 1978/1979, the Canada Health Survey estimated a GM PbB concentration of 4.79 µg/dL among people aged 6 to 79 years (excluding the 5% whose PbB concentrations were recorded as 0 µg/dL on the datafile).[56] By 2007-2009, the overall GM PbB concentration was 1.34 µg/dL, about a third of the 1978/1979 concentration. Furthermore, in 1978/1979, about 27% of Canadians aged 6 to 79 years had a PbB concentration at or above the intervention level of 10 µg/dL; in 2007-2009, the figure was less than 1%, reflecting the removal of major lead sources from the environment.

Recent analyses of 2007-2008 National Health and Nutrition Examination Survey (NHANES) data for the United States[57] found similar concentrations of PbB. The American GM PbB concentrations for the 6-to-11 and 12-to-19 age groups were 1.00 and 0.80 µg/dL, respectively, compared with 0.90 and 0.80 µg/dL for the same age groups in Canada. The 2007-2008 Second Korean National Human Exposure and Bio-monitoring Examination reported a GM PbB concentration of 1.72 µg/dL for all respondents aged 18 years or older,[58] again similar to that in Canada.

In this study, people aged 60 to 79 years had the highest PbB concentrations. Seniors have been exposed to higher environmental lead concentrations in the past, and their PbB concentrations might be particularly influenced by bone turnover due to aging.[59,60]

The significantly higher PbB concentrations among males than females are consistent with findings from other studies and may be due to occupational or hobbies' exposure or to a higher hematocrit level in men.[61,62] Although small sample sizes prevented examination of relationships between occupation and PbB concentrations, people (predominantly males) who reported welding or soldering at least once a week as a leisure activity had significantly higher GM PbB concentrations than did those who engaged in such activities less than once a month (data not shown).

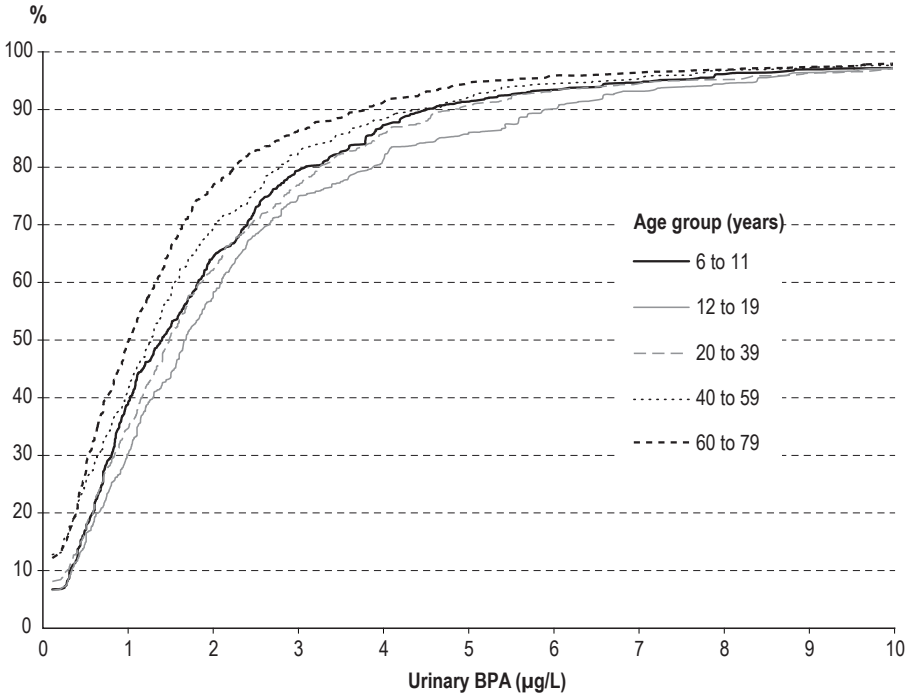
In this study, when age group and sex were taken into account, a higher LSGM PbB concentration was associated with lower household income. The association with socio-economic level has been observed in the United States and other countries,[61,63,64] and could be a consequence of higher exposure to environmental contamination and to greater absorption due to possible nutrition deficiencies.[64,65] The present study also found that people born outside Canada had a higher LSGM PbB concentration than did the Canadian-born.

Table 3
Percentage distribution by selected ranges of blood lead concentrations, by age group, household population aged 6 to 79 years, Canada, March 2007 to February 2009

Age group (years) and sex	0 to less than 2 µg/dL (0<0.10 µmol/L)			2 to less than 5 µg/dL (0.10<0.24 µmol/L)			5 to less than 10 µg/dL (0.24<0.48 µmol/L)			10 µg/dL or higher (≥0.48 µmol/L)		
	%	95% confidence interval from	to	%	95% confidence interval from	to	%	95% confidence interval from	to	%	95% confidence interval from	to
Total 6 to 79	**74.5**	**70.0**	**78.6**	**23.3**	**19.8**	**27.1**	**1.8[E]**	**1.1**	**3.0**	**< 1.0**	**...**	**...**
Age group												
6 to 11	95.5	91.3	97.7	< 8.6	...	...	< 1.4	...	...	< 0.7	...	...
12 to 19	97.2	94.9	98.5	2.5[E]	1.4	4.5	< 1.8	...	...	< 1.0	...	...
20 to 39	84.1*	79.7	87.6	14.7	11.4	18.7	< 3.3	...	...	< 2.9	...	...
40 to 59	68.4*	61.2	74.8	29.4	23.7	35.8	1.9[E]	1.0	3.6	< 1.9	...	...
60 to 79	47.0*	40.1	54.0	47.3	41.6	53.0	4.9[E]	2.8	8.4	< 2.0	...	...
Sex												
Males	69.7	64.2	74.7	27.2	23.0	31.8	2.5[E]	1.5	4.3	< 1.7	...	...
Females	79.4†	73.9	83.9	19.4†	15.1	24.5	1.2[E†]	0.6	2.3	< 0.8	...	...

* significantly different from estimate for 6 to 11 age group ($p < 0.05$ adjusted for number of comparisons)
† significantly different from estimate for males ($p<0.05$)
[E] use with caution (coefficient of variation 16.6% to 33.3%)
... not applicable
Note: If coefficient of variation of estimate exceeds 33%, estimate is indicated as being less than upper limit of 95% confidence interval.
Source: 2007 to 2009 Canadian Health Measures Survey.

Figure 2
Weighted cumulative distribution of urinary bisphenol A concentrations, by age group, household population aged 6 to 79 years, Canada, March 2007 to February 2009



Source: 2007 to 2009 Canadian Health Measures Survey.

The former may have lived in countries where environmental lead levels were higher than in North America.[66]

Residents of older dwellings had higher PbB concentrations, an association that has been well documented in earlier research.[7,67,68] Older buildings are more frequently contaminated by lead paint and might be connected to water main distribution systems with lead pipes.[11,12]

Regardless of age and sex, PbB concentrations among Canadians aged 12 to 79 years were associated with smoking behaviour and alcohol consumption. Daily smokers had higher LSGM PbB concentrations than did former smokers and those who had never smoked. The link with smoking has been found in many studies,[7,13,14,61,62,69] possibly related to the lead content in cigarettes.[70]

People who reported drinking alcohol once a week or more had higher LSGM PbB concentrations than did those who drank less frequently. Alcohol consumption has repeatedly been associated with higher PbB concentrations.[7,13,14,62,64] Lead is present in various types of alcohol, particularly wine.[71,72] Containers in which alcohol is stored and/or served may further increase the lead content.[73-75]

Table 4
Adjusted least squares geometric means (LSGMs) of urinary bisphenol A concentrations, by selected characteristics, household population aged 6 to 79 years, Canada, March 2007 to February 2009

Characteristics	LSGM§ (µg/L)	95% confidence interval	
		from	to
Highest level of education in household (p=0.293)			
Less than secondary graduation	1.14	0.90	1.43
Secondary graduation	1.18	1.03	1.36
Some postsecondary	1.33*	1.20	1.47
Postsecondary graduation†	1.15	1.08	1.22
Household income adjusted for household size‡ (p=0.062)			
First quartile ($25,000 or less)	1.22	1.08	1.39
Second quartile (more than $25,000 to $41,000)	1.16	1.07	1.27
Third quartile (more than $41,000 to $64,000)	1.24*	1.12	1.37
Fourth quartile (more than $64,000)†	1.04	0.97	1.12
Country of birth (p=0.473)			
Outside Canada	1.12	0.99	1.26
Canada†	1.17	1.09	1.26
BMI status (p=0.311)			
Neither overweight nor obese†	1.12	1.00	1.26
Overweight	1.18	1.12	1.25
Obese	1.21	1.14	1.30

† reference category
* significantly different from estimate for reference category (p < 0.05 adjusted for number of comparisons)
‡ adjusted using 40/30 formula; adjusted household incomes for all respondents ranked and divided into quartiles
§ adjusted for age group, sex, time of day of urine collection, and creatinine concentration; age groups 40 to 59 and 60 to 79 combined
Source: 2007 to 2009 Canadian Health Measures Survey.

Bisphenol A

Urinary bisphenol A (BPA), the sum of BPA-G and free BPA, was detected in 91% of Canadians aged 6 to 79. This is similar to NHANES results, where BPA was detected in 93% of the American population aged 6 or older.[76] The German Environmental Survey detected it in 99% of 3- to 14-year-olds.[77] Given the short half-life of orally ingested BPA and the high frequency of detection, these data suggest continual and widespread exposure to BPA.[78]

Because of differences in sample populations, in age groups and in laboratory analytical methods, comparisons with other studies must be made cautiously. Nonetheless, the volume-based GM BPA concentration of 1.16 µg/L for Canadians aged 6 to 79 is consistent with results in other studies of reference populations reporting mean or median concentrations of 1 to 3 µg/L.[40]

In Canada, males had significantly higher volume-based BPA concentrations than did females, but significantly lower creatinine-standardized urinary concentrations of BPA. This reversal in the sex difference from BPA (µg/L) to creatinine-standardized BPA (µg/g creatinine) is attributed to the higher urinary creatinine concentrations in males,[49] which were also observed in this study. Differences between the sexes in urinary BPA concentrations may reflect differences in exposure and in pharmacokinetic factors, the relevance of which is not currently known.[76]

The higher volume-based GM BPA concentrations in 12- to-19-year-olds and the significantly higher creatinine-standardized GM BPA concentrations in children aged 6 to 11 in this analysis are similar to those from NHANES.[76] The higher GM BPA concentrations in children may be due to their greater food consumption in relation to their body weight.[32] They may also reflect differences in absorption, distribution, metabolism, or excretion of BPA,[79] creatinine metabolism and excretion, or the use of products containing BPA.[32]

When the influences of age, sex, time of day of urine collection, and creatinine concentrations were controlled, no associations were found between volume-based BPA concentrations and household education, household income, country of birth, or BMI. However, certain categories of household income and education level did have LSGM BPA values that differed significantly from their respective reference groups. The lack of association between BMI and BPA concentrations in the overall study population corresponds to similar results reported for NHANES.[76]

Limitations

The overall response rate to the CHMS was slightly above 50%. While the survey weights ensured that the sample was representative of the target population, bias might exist if the PbB or BPA concentrations of non-respondents differed systematically from those of respondents.

Logistical and cost constraints in using mobile examination centres restricted the number of collection sites to 15 in the first CHMS cycle.[80] Given this sample design, it was not possible to include all covariates of interest in a single model. As future CHMS cycles become available, exploration of these and other interrelationships might be possible.

Only a small number of covariates was examined in conjunction with PbB. Research suggests that dietary and nutritional factors[81,82] and industry and occupation[7,62] are associated with PbB concentrations. The current analysis did not examine diet, a topic that could be explored in future work with the CHMS, but curent sample sizes limited the exploration of other variables.

BPA concentrations may vary according to food intake, time between urine collection and food consumption, and urine production rate. As well, BPA has a short half-life and urinary excretion is rapid, so the single spot urine collected from CHMS respondents may reflect only very recent exposures and cannot characterize average BPA exposure for any individual.[40] Nonetheless, the large number of single spot samples analyzed in the CHMS likely averages out variations in urinary BPA concentrations

and allows for reasonably accurate population-level exposure estimates.[40]

Conclusion

It has been 30 years since blood lead has been measured in the Canadian population, and until the CHMS, urinary BPA had never been measured in a national survey. Results of this analysis show that exposure to both lead and BPA is widespread.

Lead exposure has declined dramatically in the last decades. Nevertheless, socio-demographic characteristics, the age of dwellings and certain lifestyle behaviours are associated with higher concentrations. Because of the toxicity of lead at even very low concentrations,[25] there is still a place for ongoing monitoring and public health interventions.

Concentrations of urinary BPA tend to be higher in younger age groups. Additional research is needed to better identify factors that contribute to these higher concentrations and to understand factors associated with socio-demographic characteristics that may affect exposure to BPA.

These results can serve as baseline data to track trends as subsequent cycles of the CHMS become available. Future data combined with the first cycle will permit more in-depth examination of factors related to exposure to these two chemicals and the exploration of the association between exposure and health outcomes. ■

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Appendix

Table A
Unweighted sample sizes for respondents with valid blood lead and urinary bisphenol A concentrations, by age group and sex, household population aged 6 to 79 years, Canada, March 2007 to February 2009

	Blood lead		Bisphenol A (µg/L)		Bisphenol A (µg/g creatinine)	
Age group (years)	Males	Females	Males	Females	Males	Females
Total 6 to 79	**2,576**	**2,743**	**2,659**	**2,817**	**2,650**	**2,812**
6 to 11	459	451	524	507	522	506
12 to 19	489	456	504	476	503	475
20 to 39	514	651	513	652	511	650
40 to 59	577	643	577	642	573	641
60 to 79	537	542	541	540	541	540

Source: 2007 to 2009 Canadian Health Measures Survey.

Table B
Weighted characteristics of sample with valid blood lead and/or urinary bisphenol A concentrations, household population aged 6 to 79 years, Canada, March 2007 to February 2009

	All respondents		
		95% confidence interval	
Characteristics	%	from	to
Sex			
Males	49.8	49.7	49.9
Females	50.2	50.1	50.3
Age group (years)			
6 to 11	7.3	7.2	7.5
12 to 19	11.4	11.2	11.6
20 to 39	30.9	30.7	31.2
40 to 59	33.5	33.3	33.6
60 to 79	16.9	16.8	17.0
Highest level of education in household			
Less than secondary graduation	5.7	4.3	7.6
Secondary graduation	11.6	8.9	15.0
Some postsecondary	6.6	5.0	8.7
Postsecondary graduation	76.1	69.6	81.5
Household income adjusted for household size†			
First quartile ($25,000 or less)	25.7	21.7	30.1
Second quartile (more than $25,000 to $41,000)	24.1	21.1	27.3
Third quartile (more than $41,000 to $64,000)	25.3	22.3	28.5
Fourth quartile (more than $64,000)	25.0	20.9	29.5
Country of birth			
Outside Canada	21.5[E]	14.1	31.3
Canada	78.5	68.7	85.9
Age of dwelling			
Less than 20 years	33.0	25.4	41.7
20 to less than 50 years	43.5	36.3	51.1
50 years or more	23.4	16.2	32.6
Smoking status‡			
Never	52.6	49.4	55.8
Former	27.0	24.3	30.0
Current	20.3	17.9	23.0
Frequency of alcohol consumption in past 12 months‡			
Less than once a week	54.9	51.0	58.7
1 to 3 times a week	30.2	27.3	33.3
4 to 6 times a week	7.0	5.6	8.6
Daily	7.9	6.2	10.0
BMI status			
Neither overweight nor obese	45.0	40.2	49.9
Overweight	33.6	30.8	36.6
Obese	21.4	18.4	24.6

† adjusted using 40/30 formula; adjusted household incomes for all respondents ranked and divided into quartiles
‡ excludes children younger than 12
[E] use with caution (coefficient of variation 16.6% to 33.3%)
Source: 2007 to 2009 Canadian Health Measures Survey.

14-year diabetes incidence: The role of socio-economic status

by Nancy A. Ross, Heather Gilmour and Kaberi Dasgupta

Abstract

Background
Diabetes prevalence is associated with low socio-economic status (SES), but less is known about the relationship between SES and diabetes incidence.

Data and methods
Data from eight cycles of the National Population Health Survey (1994/1995 through 2008/2009) are used. A sample of 5,547 women and 6,786 men aged 18 or older who did not have diabetes in 1994/1995 was followed to determine if household income and educational attainment were associated with increased risk of diagnosis of or death from diabetes by 2008/2009. Three proportional hazards models were applied for income and for education—for men, for women and for both sexes combined. Independent variables were measured at baseline (1994/1995). Diabetes diagnosis was assessed by self-report of diagnosis by a health professional. Diabetes death was based on ICD-10 codes E10-E14.

Results
Among people aged 18 or older in 1994/1995 who were free of diabetes, 7.2% of men and 6.3% of women had developed or died from the disease by 2008/2009. Lower-income women were more likely to develop type 2 diabetes than were those in high-income households. This association was attenuated, but not eliminated, by ethno-cultural background and obesity/overweight. Associations with lower educational attainment in unadjusted models were almost completely mediated by demographic and behavioural variables.

Interpretation
Social gradients in diabetes incidence cannot be explained entirely by demographic and behavioural variables.

Keywords
education, incidence, income, longitudinal studies, proportional hazards analysis, socio-economic status

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The global prevalence of type 2 diabetes (T2D), estimated at 6.4% in 2010,[1] is expected to be close to 8% by 2030. The increase in prevalence is thought to be due largely to population aging and rising rates of overweight, obesity and physical inactivity.[2,3] The prevalence of T2D has also been shown to be strongly patterned by socio-economic status (SES), particularly among women.[4-8] American data also suggest that the SES gap in diabetes prevalence has widened over time.[9]

Less is known about the role of SES in the incidence of T2D—the onset of new cases. Low SES, as measured by income or education, may influence T2D risk either through higher levels of obesity and physical inactivity or independent of these factors. Associations between SES and incident diabetes were assessed with and without adjustment for obesity and physical activity to clarify this issue. An advantage of studying associations of SES with incident rather than prevalent diabetes is that it clarifies the temporal sequence of any association (that is, low income leading to diabetes versus diabetes reducing labour force participation[10]).

This article reports the results of a 14-year longitudinal analysis of the relationship between T2D incidence and household income and individual educational attainment. It also examines demographic and behavioural factors that may mediate this relationship.

Data and methods

Data source

The data for this analysis are from the first eight cycles (1994/1995 through 2008/2009) of the biennial National Population Health Survey (NPHS). The household component of the survey covers the population living in private dwellings in the 10 provinces in 1994/1995. It excludes people on Indian reserves, in the territories, on Canadian Forces bases, and in some remote areas.

Of 20,095 individuals selected for the longitudinal panel in 1994/1995, 17,276 agreed to participate—a response rate of 83.6%. Based on these 17,276

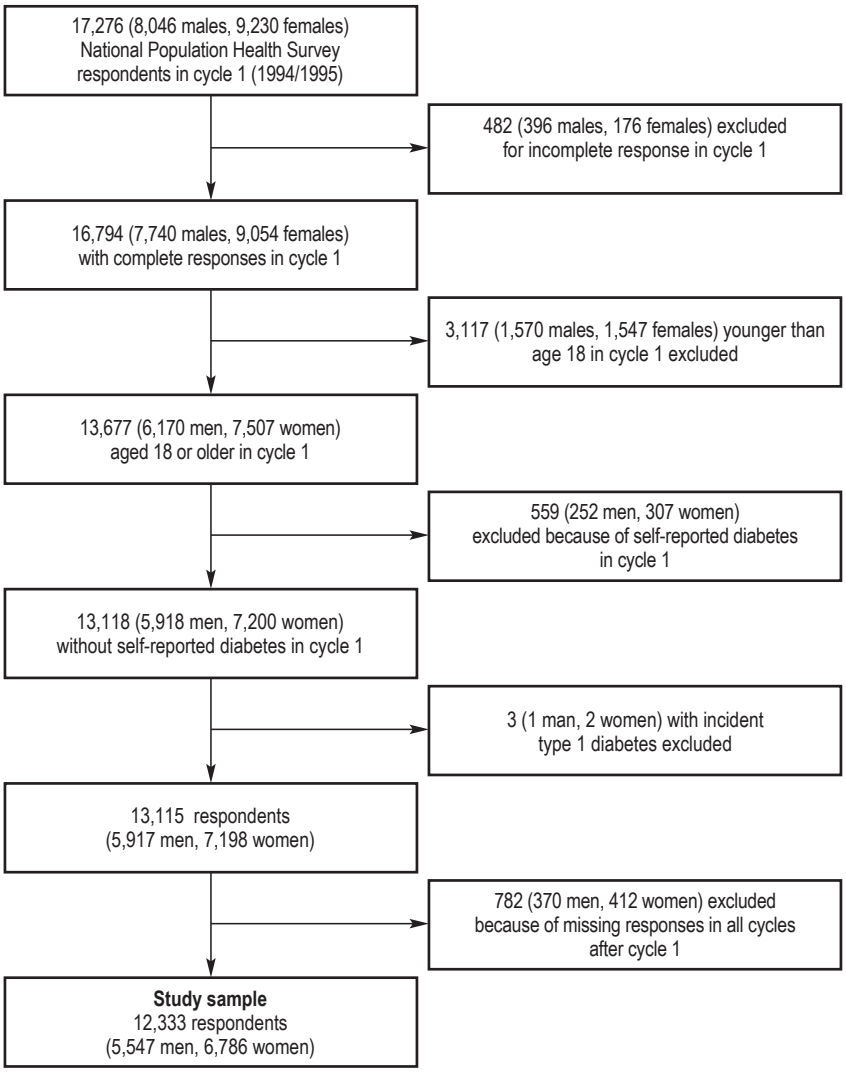
participants, the response rates for subsequent cycles were: 92.8% in 1996/1997; 88.2% in 1998/1999; 84.9% in 2000/2001; 80.8% in 2002/2003; 77.6% 2004/2005; 77.2% in 2006/2007; and 70.7% in 2008/2009.

This analysis uses the cycle 8 (2008/2009) longitudinal "square" file, which contains records for all members of the original panel, regardless of whether information about them was obtained in every subsequent cycle. More detailed descriptions of the design, sample and interview procedures can be found in published reports.[11,12]

Study sample

Of the 17,276 NPHS participants in 1994/1995, 482 who did not have a complete questionnaire response that year, 3,117 who were younger than age 18, and 559 who reported a diagnosis of diabetes were excluded from the study sample (Figure 1). Another 782 were excluded because of missing responses in all cycles after cycle 1. Incident T2D occurring between 1994/1995 and 2000/2001 (identified based on responses to the 2000/2001 interview and application of an algorithm[13]) resulted in the exclusion of three respondents younger than age 30 who reported starting insulin within six months of diagnosis. Four respondents who reported first being diagnosed with diabetes while they were pregnant, but who also reported being diagnosed with diabetes at some other time, were included. The final study sample numbered 12,333 (6,786 women and 5,547 men).

Figure 1
Definition of study sample



Definitions

Diabetes

In the NPHS, the prevalence of chronic conditions, including diabetes, was based on self-reports of diagnosed illness. Respondents were asked about any "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." The NPHS used a checklist of conditions, one of which was diabetes. Death from diabetes was based on ICD-10 codes E10 to E14.

Socio-economic status (SES)

SES was proxied by two measures: household income and individual educational attainment. Each measure was assessed separately, given that the potential for reverse causality is higher for income than for education (that is, because of diabetes onset, income is reduced). As well, although these variables are correlated, their relationship to T2D is likely to differ. Household income may influence risk through its capacity to affect access to material resources for improved health, while education may influence health-related knowledge and behaviour.

Household income was based on total self-reported household income from all sources in the previous 12 months. The ratio between total household income and the low-income cut-off corresponding to the number of people in the household and community size was calculated. The ratios were then divided by the highest ratio for all NPHS respondents.

These adjusted ratios were grouped into deciles, which were collapsed into five categories: low (deciles 1 and 2); low-to-middle (deciles 3 and 4); middle (deciles 5 and 6); high-to-middle (deciles 7 and 8); and high (deciles 9 and 10). More information about the income variable can be found in the NPHS derived variable documentation at www.statcan.gc.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SDDS=3225&lang=en&db=imdb&adm=8&dis=2#4.

Education refers to the highest level acquired by the respondent throughout the entire study period: postsecondary graduation; some postsecondary; secondary graduation; or less than secondary graduation.

Covariates

Age in 1994/1995 was measured as a continuous variable and contained values of 18 years or more.

Ethno-cultural background was based on the question, "How would you best describe your race or colour?" Respondents were grouped into three categories: White, Aboriginal or South/Southeast Asian, and other (includes multiple-race category).

Body mass index (BMI) in 1994/1995 was calculated by dividing self-reported weight in kilograms by the square of self-reported height in metres. The BMI groups were: underweight/acceptable (BMI less than 25.0 kg/m^2) and overweight/obese (25.0 kg/m^2 or more).

The number of *secondary behavioural risk factors* in 1994/1995 was based on whether respondents reported heavy drinking (15 or more drinks in the past week for men; 10 or more for women); were current daily smokers; or were physically inactive during leisure time (based on average daily energy expenditure from leisure activities in the three months before the interview).

Statistical analysis

Cox proportional hazards modeling was used to identify variables associated with an increased or decreased risk of being diagnosed with or dying from diabetes during follow-up. This technique allows for the study of relationships between individual characteristics and an outcome when that outcome can take place over a period of time. The method accounts for the possibility that respondents do not develop or die from diabetes during the study period, and minimizes the bias associated with attrition.

The analysis was restricted to respondents aged 18 or older at cycle 1 (1994/1995). Since the prevalence of and characteristics associated with diabetes can differ between men and women,[4,5,8,14-18] combined and sex-specific analyses were conducted.

If a respondent reported a diagnosis of diabetes or died of diabetes after 1994/1995, this was considered an event. Given that the development of diabetes, which is a continuous process, was measured only at discrete two-year intervals, many transitions to a diabetes event were recorded at the same time—after 2, 4, 6, 8, 10, 12 or 14 years—even though they could have occurred at any time between the interviews. Thus, the complementary log-log model was used.[19]

If self-reported diabetes information was missing for one or more survey cycles, but values for subsequent cycles were available, the cases were retained. This creates intervals of varying lengths between observations. To control for the fact that the longer the interval, the more likely a respondent was to develop diabetes, values for interval length and interval length squared were entered as independent variables in the model.

An imputed value of "No" to the diabetes question was used if a missing response was bounded by "No's" in the previous and subsequent cycles. Of the 12,333 respondents, 1,928 (15.6%) contain imputed "No" response(s) in one or more cycles.

For both sexes combined, for men and for women, three models were applied separately for household income and for education. The first model was adjusted for income or education and the varying lengths of time between observations. The second adjusted for these variables and age. The final model adjusted for these variables and for ethno-cultural background, BMI, and the number of secondary behavioural risk factors.

All the analyses were weighted using the longitudinal weights constructed to represent the total population in 1994. The bootstrap method was used to account for the complex survey design in the calculation of confidence intervals and in the assessment of statistical significance.[20-22] The significance level was set at $p<0.05$.

Results

Characteristics of respondents

A total of 12,333 respondents aged 18 or older were followed from 1994/1995 to 2008/2009. During this period, 877 of them (an estimated 1.2 million) were diagnosed with or died from diabetes (Table 1). The overall 14-year incidence rate of T2D was slightly higher for men (7.2%) than for women (6.3%), a difference that was not statistically meaningful.

Few respondents died from diabetes—23 overall (12 men, 11 women). Half of these 23 respondents reported a diabetes diagnosis before they died, so the incident cases that were deaths were 6 men (1.5% of 407 events) and 6 women (1.3% of 469 events) (data not shown).

The men in the sample were more likely than the women to live in the highest income households and to be postsecondary graduates (Appendix Table A). They were also more likely to be overweight/obese and to report two or three of the secondary behavioural risk factors considered in this study (heavy drinking, smoking, physical inactivity).

Household income

An elevated risk of T2D incidence remained in the models for both sexes combined among people in the lowest income households (proportional hazards ratio 1.6; CI: 1.1 to 2.3), compared with those in the most affluent, and a modest association for those in low-to-middle-income households (proportional hazards ratio 1.4; CI: 1.0 to1.9) (Table 2).

Table 1
New diagnosis of or death from diabetes between 1996/1997 and 2008/2009, by sex, household population aged 18 or older with no diagnosis of diabetes in 1994/1995, Canada excluding territories

	Both sexes			Men			Women		
	Sample size	Estimated population '000	%	Sample size	Estimated population '000	%	Sample size	Estimated population '000	%
Total	**12,333**	**18,385**	**100.0**	**5,547**	**8,917**	**100.0**	**6,786**	**9,468**	**100.0**
No diagnosis of or death from diabetes	11,456	17,151	93.3	5,140	8,277	92.8	6,316	8,874	93.7
Diagnosis of or death from diabetes	877	1,234	6.7	407	640	7.2	470	594	6.3

Note: Deaths attributed to diabetes are based on records for which cause of death was available.
Source: 1994/1995 to 2008/2009 National Population Health Survey, longitudinal square file.

The magnitude of associations changed little with adjustment. Other important associations with diabetes were ethno-cultural background (Aboriginal or South/Southeast Asian), overweight/obesity, and the number of secondary behavioural risk factors (Appendix Table B).

Among men, there were consistent increases in hazards ratios with decreasing household income in all models, and associations between household income and T2D were similar in adjusted and unadjusted models. Other associations with T2D in men included overweight/obesity (proportional hazards ratio 3.2; CI: 2.3 to 4.7) and the number of secondary behavioural factors they reported.

Among women, associations between income and incident diabetes were evident in both unadjusted and adjusted models, but in contrast to men, the unadjusted hazard ratios were not notably larger than the adjusted ones. For example, the unadjusted hazard ratio comparing incident diabetes between the lowest and highest income women was 2.4, falling to 1.9 with age adjustment and to 1.7 with full adjustment.

Individual educational attainment

For both sexes combined, no important association between T2D incidence and level of education persisted when adjusting for demographic and behavioural factors (Table 2). Sex-specific analyses showed that among men, the association between lower educational attainment and incident T2D was entirely accounted for by age, overweight/obesity (proportional hazards ratio 3.2; CI: 2.1 to 4.8) and behavioural factors (proportional hazards ratios of 1.7 and 1.5 for reporting one or two to three secondary behavioural factors, respectively) (Appendix Table C). Among women, a modest association with secondary versus postsecondary graduation persisted, although it was strongly attenuated by Aboriginal or South/Southeast Asian ethno-cultural background (proportional hazards ratio 3.3; CI: 1.8 to 5.9) and overweight/obesity (proportional hazards ratio 4.1; CI: 2.9 to 5.7).

Discussion

Compared with the highest income individuals, overall there was a persistent association between low income and incident diabetes in fully adjusted models. The magnitude of associations between income and incident diabetes was similar for men and women in the fully adjusted models, but greater for women in the unadjusted models, suggesting that age and other variables partly explained associations between incident diabetes and low income in women.

While T2D incidence was inversely associated with educational attainment in unadjusted analyses, in multivariate analyses, the relationship was sustained only among women with secondary graduation versus postsecondary graduation. The risk associated with low educational attainment was mediated by overweight/obesity and Aboriginal or South/Southeast Asian ethno-cultural background.

The results of this analysis differ somewhat from comparable American research. In a study of the relationship between SES and the 34-year incidence of T2D among a sample of more than 6,000 residents of Alameda County, California, Maty et al.[23] found that the excess risk associated with income and educational status was largely accounted for by other factors, especially obesity. Robbins et al.[4] looked at the relationship

What is already known on this subject?

- Cross-sectional studies have found an association between socio-economic status (SES) and diabetes prevalence.
- Results of the few longitudinal population-based studies that have examined the association between SES and diabetes incidence have been inconsistent.

What does this study add?

- There is a clear association between low income and incident diabetes.
- Among women, the SES-T2D incidence relationship is partially mediated by overweight/obesity and Aboriginal or South/South East Asian ethno-cultural background.

Table 2
Adjusted proportional hazards ratios relating household income and education in 1994/1995 to diagnosis of or death from diabetes between 1996/1997 and 2008/2009, household population aged 18 or older and free of diabetes in 1994/1995, Canada excluding territories

	Unadjusted	95% confidence interval		Age-adjusted	95% confidence interval		Fully adjusted	95% confidence interval	
		from	to		from	to		from	to
Household income									
Both sexes									
Highest†	1.0	…	…	1.0	…	…	1.0	…	…
Middle-to-high	1.2	0.9	1.6	1.2	0.9	1.6	1.2	0.8	1.7
Middle	1.3	1.0	1.8	1.3	0.9	1.7	1.3	0.8	1.9
Low-to-middle	1.7**	1.3	2.3	1.4*	1.1	1.9	1.4*	1.0	1.9
Lowest	1.7**	1.3	2.3	1.6**	1.2	2.1	1.6**	1.1	2.3
Men									
Highest†	1.0	…	…	1.0	…	…	1.0	…	…
Middle-to-high	1.0	0.7	1.6	1.1	0.7	1.6	1.1	0.7	1.7
Middle	1.3	0.8	1.9	1.2	0.8	1.8	1.3	0.9	2.0
Low-to-middle	1.5	1.0	2.2	1.3	0.9	2.0	1.4	0.9	2.1
Lowest	1.4	0.9	2.1	1.4	0.9	2.2	1.5	1.0	2.4
Women									
Highest†	1.0	…	…	1.0	…	…	1.0	…	…
Middle-to-high	1.4	0.9	2.4	1.4	0.9	2.3	1.3	0.8	2.3
Middle	1.5	0.9	2.5	1.4	0.8	2.4	1.2	0.7	2.2
Low-to-middle	2.2**	1.4	3.4	1.7*	1.1	2.6	1.5	0.9	2.3
Lowest	2.4**	1.5	3.7	1.9**	1.2	3.1	1.7*	1.1	2.8
Education									
Both sexes									
Postsecondary graduation†	1.0	…	…	1.0	…	…	1.0	…	…
Some postsecondary	1.1	0.9	1.4	1.2	0.9	1.5	1.1	0.8	1.6
Secondary graduation	1.3*	1.0	1.8	1.3*	1.0	1.8	1.3	1.0	1.7
Less than secondary graduation	1.9**	1.5	2.4	1.2	1.0	1.6	1.2	0.9	1.5
Men									
Postsecondary graduation†	1.0	…	…	1.0	…	…	1.0	…	…
Some postsecondary	1.2	0.9	1.8	1.4	0.9	2.0	1.4	0.9	2.0
Secondary graduation	1.1	0.8	1.7	1.2	0.8	1.8	1.2	0.8	1.8
Less than secondary graduation	1.5*	1.1	2.2	1.1	0.8	1.6	1.1	0.8	1.6
Women									
Postsecondary graduation†	1.0	…	…	1.0	…	…	1.0	…	…
Some postsecondary	1.0	0.7	1.4	1.0	0.7	1.4	0.9	0.6	1.4
Secondary graduation	1.6*	1.1	2.4	1.5*	1.0	2.3	1.5*	1.0	2.2
Less than secondary graduation	2.4**	1.7	3.3	1.4*	1.0	1.9	1.2	0.9	1.7

* significantly different from estimate for reference category ($p < 0.05$)
** significantly different from estimate for reference category ($p < 0.01$)
... not applicable
Note: Because of rounding, some hazards ratios with 1.0 as lower confidence limit are statistically significant. A variable was included in all models to control for varying lengths of time between observations, but hazards ratios are not shown. Fully adjusted models also control for age, ethno-cultural background, overweight/obese, and number of secondary behavioural risk factors (heavy drinker, current smoker, inactive). To maximixe sample size, "missing" categories were included for several variables, but hazards ratios are not shown.
Source: 1994/1995 to 2008/2009 National Population Health Survey, longitudinal square file.

between three measures of SES (income, education, occupation) and diabetes risk for more than 11,000 respondents to the NHANES1 National Epidemiologic follow-up study. They found that mediating factors virtually eliminated the risk associated with income and education for women (although a strong risk remained for occupational status), while for men, the risks associated with income and education were not substantially attenuated by mediating factors. In the Whitehall II Study of British civil servants, SES measures were related to T2D incidence only for men. However, the sample contained twice as many men as women, and so was likely under-powered for detecting the relationship between SES and women's T2D risk.[24]

The findings of this study support the conclusion that the inverse association between diabetes *prevalence* and SES, more consistent among women than among men in Canada,[8] is unlikely to be driven by reverse causation (diabetes affecting income through the inability to work) or by longer survival of more affluent or more highly educated diabetes patients.

Limitations

NPHS respondents were asked if they had "diabetes," but no information was collected about the specific type of diabetes. This is not, however, a major limitation, as an estimated 95% of diabetes cases are type 2.[13]

The degree to which self-reported diagnoses of chronic conditions, including diabetes, are inaccurate because of reporting error is unknown. If individuals with lower income or education were less likely to report having been diagnosed with diabetes by a health professional, the strength of the association between these SES variables and T2D incidence is underestimated. However, adjusting the models for "having a regular family doctor" at baseline did not change the relationship (data not shown).

If some respondents who did not report diabetes actually had it, the incidence would be underestimated. The presence of respondents with undiagnosed diabetes in the "no diabetes" reference group would weaken associations in the models between risk factors and incidence. But while undiagnosed diabetes remains an important public health issue in North America,[25,26] it is less common now than it was several decades ago.[9]

Not all factors known to be associated with incident diabetes could be examined in this study. For example, the NPHS does not collect data on diet or biological measures such as blood glucose. Family history of diabetes was not used, because it was collected only in cycle 3 (1998/1999).

BMI was based on self-reported weight and height, which tend to yield lower estimates of obesity than measured data.[27] Thus, this study could underestimate the association between obesity and T2D incidence.

Conclusion

There is a clear association between low income and incident diabetes. Low household income was associated with the onset of T2D in Canadian women, although the relationship was attenuated by overweight/obesity and by Aboriginal or South/South east Asian ethno-cultural background.

The inverse association between educational attainment and T2D incidence in unadjusted analyses was sustained in multivariate analyses only for women. However, again, the relationship was weakened by adjustment for ethno-cultural background and overweight/obesity.

The attenuation of the association between T2D onset and overweight/obesity and membership in two ethnic groups (Aboriginal and South/Southeast Asian) among women is suggestive of more highly targeted prevention strategies. ■

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Appendix

Table A
Baseline (1994/1995) characteristics of study sample, by sex, Canada excluding territories

	Men			Women		
		Estimated population			Estimated population	
Characteristics	Sample size	'000	%	Sample size	'000	%
Total	**5,547**	**8,917.4**	**100.0**	**6,786**	**9,468.0**	**100.0**
Age group						
18 to 44	3,179	5,447.7	61.1*	3,637	5,419.7	57.2
45 to 64	1,562	2,428.2	27.2	1,811	2,633.3	27.8
65 to 74	523	694.7	7.8*	766	896.1	9.5
75 or older	283	346.9	3.9*	572	519.0	5.5
Household income						
Highest	1,217	2,008.9	22.5*	1,100	1,756.7	18.6
Middle-to-high	1,057	1,772.4	19.9	1,205	1,716.1	18.1
Middle	1,056	1,699.2	19.1	1,166	1,698.1	17.9
Low-to-middle	985	1,455.2	16.3*	1,363	1,827.4	19.3
Lowest	884	1,321.0	14.8*	1,528	1,822.7	19.3
Missing	348	660.8	7.4	424	647.1	6.8
Education						
Postsecondary graduation	1,730	3,057.9	34.3*	2,051	2,940.7	31.1
Some postsecondary	1,373	2,290.4	25.7	1,788	2,547.5	26.9
Secondary graduation	834	1,354.4	15.2*	1,061	1,640.2	17.3
Less than secondary graduation	1,601	2,201.0	24.7	1,880	2,331.9	24.6
Missing	9	F	F	6	F	F
Ethno-cultural background						
White	5,170	8,022.2	90.0	6,360	8,562.2	90.4
South/Southeast Asian or Aboriginal	135	303.8	3.4	175	332.3	3.5
Other	216	530.9	6.0	228	510.1	5.4
Missing	26	60.5E	0.7E	23	63.4E	0.7E
Body mass index						
Underweight/Acceptable (less than 25 kg/m^2)	2,303	3,899.8	43.7*	3,810	5,481.7	57.9
Overweight/Obese (25 kg/m^2 or more)	3,212	4,959.8	55.6*	2,718	3,593.3	38.0
Missing	32	57.8E	0.7E*	258	393.0	4.2
Secondary behavioural risk factors						
0	1,614	2,701.6	30.3*	1,783	2,527.0	26.7
1	2,557	4,185.0	46.9*	3,534	4,952.6	52.3
2 or 3	1,375	2,026.1	22.7*	1,453	1,965.3	20.8
Missing	F	F	F	16	23.0E	0.2E

* significantly different from estimate for women ($p<0.05$)
E use with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be published (coefficient of variation greater than 33.3%)
Source: 1994/1995 to 2008/2009 National Population Health Survey, longitudinal square file.

Table B
Adjusted proportional hazards ratios relating household income and selected characteristics to diagnosis of or death from diabetes between 1996/1997 and 2008/2009, by sex, household population aged 18 or older and free of diabetes in 1994/1995, Canada excluding territories

	Both sexes			Men			Women		
	Proportional hazards ratio	95% confidence interval		Proportional hazards ratio	95% confidence interval		Proportional hazards ratio	95% confidence interval	
Characteristics		from	to		from	to		from	to
Age (continuous)	1.04**	1.03	1.05	1.04**	1.03	1.04	1.04**	1.03	1.05
Household income									
High†	1.0	…	…	1.0	…	…	1.0	…	…
Middle-to-high	1.2	0.8	1.7	1.1	0.7	1.7	1.3	0.8	2.3
Middle	1.3	0.8	1.9	1.3	0.9	2.0	1.2	0.7	2.2
Low-to-middle	1.4*	1.0	1.9	1.4	0.9	2.1	1.5	0.9	2.3
Low	1.6**	1.1	2.3	1.5	1.0	2.4	1.7*	1.1	2.8
Ethno-cultural background									
White†	1.0	…	…	1.0	…	…	1.0	…	…
South/Southeast Asian or Aboriginal	2.4**	1.4	4.0	1.7	0.7	3.9	3.1**	1.7	5.7
Other	1.2	0.7	2.0	1.4	0.8	2.5	1.0	0.4	2.4
Body mass index									
Underweight/Acceptable (less than 25 kg/m^2)†	1.0	…	…	1.0	…	…	1.0	…	…
Overweight/Obese (25 kg/m^2 or more)	3.8**	2.7	5.3	3.2**	2.3	4.7	4.1**	3.0	5.7
Secondary behavioural risk factors									
0†	1.0	…	…	1.0	…	…	1.0	…	…
1	1.3*	1.1	1.7	1.7**	1.3	2.3	1.0	0.8	1.4
2 or 3	1.2	0.9	1.7	1.5*	1.0	2.2	1.0	0.7	1.5

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
** significantly different from estimate for reference category ($p < 0.01$)
... not applicable
Note: Because of rounding, some hazard ratios with 1.0 as lower confidence limit are statistically significant. To maximize sample size, "missing" categories were included for several variables, but hazards ratios are not shown. A variable was included to control for varying lengths of time between observations, but hazards ratios are not shown.
Source: 1994/1995 to 2008/2009 National Population Health Survey, longitudinal square file.

Table C
Adjusted proportional hazards ratios relating education and selected characteristics to diagnosis of or death from diabetes between 1996/1997 and 2008/2009, by sex, household population aged 18 or older and free of diabetes in 1994/1995, Canada excluding territories

	Both sexes			Men			Women		
	Proportional hazards ratio	95% confidence interval		Proportional hazards ratio	95% confidence interval		Proportional hazards ratio	95% confidence interval	
Characteristics (1994/1995)		from	to		from	to		from	to
Age (continuous)	1.04**	1.03	1.05	1.04**	1.03	1.05	1.04**	1.03	1.05
Household education									
Postsecondary graduation†	1.0	…	…	1.0	…	…	1.0	…	…
Some postsecondary	1.1	0.8	1.6	1.4	0.9	2.0	0.9	0.6	1.4
Secondary graduation	1.3	1.0	1.7	1.2	0.8	1.8	1.5*	1.0	2.2
Less than secondary graduation	1.2	0.9	1.5	1.1	0.8	1.6	1.2	0.9	1.7
Ethno-cultural background									
White†	1.0	…	…	1.0	…	…	1.0	…	…
South/Southeast Asian or Aboriginal	2.5**	1.5	4.1	1.8	0.8	4.1	3.3**	1.8	5.9
Other	1.3	0.8	2.2	1.5	0.8	2.7	1.0	0.4	2.5
Body mass index									
Underweight/Acceptable (less than 25 kg/m^2)†	1.0	…	…	1.0	…	…	1.0	…	…
Overweight/Obese (25 kg/m^2 or more)	3.7**	2.7	5.1	3.2**	2.1	4.8	4.1**	2.9	5.7
Secondary behavioural risk factors									
0†	1.0	…	…	1.0	…	…	1.0	…	…
1	1.3*	1.1	1.7	1.7**	1.2	2.4	1.0	0.8	1.4
2 or 3	1.2	0.9	1.7	1.5*	1.0	2.3	1.0	0.6	1.5

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
** significantly different from estimate for reference category ($p < 0.01$)
... not applicable
Note: Because of rounding, some hazards ratios with 1.0 as the lower confidence limit are statistically significant. To maximize sample size, "missing" categories were included for several variables, but hazards ratios are not shown. A variable was included to control for varying lengths of time between observations, but hazards ratios are not shown.
Source: 1994/1995 to 2008/2009 National Population Health Survey, longitudinal square file.

Hospitalization risk in a type 2 diabetes cohort

by Edward Ng, Kimberlyn M. McGrail and Jeffrey A. Johnson

Abstract

Background
Using a health outcome research framework, the hospitalization risk for a type 2 diabetes (T2DM) cohort is evaluated. Diabetes is "ambulatory care sensitive"— a condition largely manageable with appropriate care in the community. Thus, hospitalization may represent a negative care outcome.

Data and methods
Analyses were conducted by linking data from the Canadian Community Health Survey (CCHS) cycle 1.1 to the Canadian Hospital Morbidity Database for respondents identified as having T2DM. Logistic regression was used to examine the association between the likelihood of all-cause hospitalization within two years of the survey date and patients' characteristics, care path, and health system characteristics.

Results
When the effects of demographic, socio-economic and health status characteristics were taken into account, physical inactivity and former or current smoking were significantly associated with an increased likelihood of hospitalization for those with type 2 diabetes. Specialist visits were positively related to hospitalization (OR=1.4), whereas the relationship with general practitioner visits was negative (OR=0.7). Regional hospital use patterns were significantly associated with hospitalization (OR=2.6).

Interpretation
Regional patterns of hospital use are important for hospitalization: T2DM residents of health regions with generally higher hospitalization rates were more likely to be hospitalized than were those living elsewhere. In terms of care path, GP consultations were associated with a lower risk of hospitalization. Specialist consultations, likely a marker of disease severity, had the reverse effect.

Keywords
databases, health services research, health surveys, hospital records, inpatient, outcome assessment, probabilistic linkage

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In recent years, diabetes-related mortality has increased, an increase that has been linked to an upturn in the prevalence of obesity.[1,2] Diabetes is currently the sixth leading cause of death in Canada.[3] In 2005, approximately 1.3 million Canadians aged 12 or older (5% of the population in that age range) reported that they had been diagnosed with the disease.[4] The complications of diabetes can attack every major organ. Because of its wide-ranging impact on the health of individuals and the economic burden it places on the health care system,[5,6] diabetes is recognized as a major public health problem.

Yet, to some extent, diabetes is also "ambulatory care sensitive." That is, it can be managed with appropriate care in the community.[7] But if not well controlled, diabetes can result in multiple co-morbidities that may require extensive care,[8] including hospitalization.[8-10]

With the rise of health expenditures,[11] emphasis is being placed on the effectiveness of services. A conceptual framework, developed jointly by Statistics Canada and the Canadian Institute for Health Information,[12,13] highlights the relationship between patient outcomes and three sets of possible determinants—health care system, care path and patient characteristics—in the context of place and environment. Through a linkage of survey and hospitalization data, the current study applies this framework to diabetes.

Specifically, this analysis examines risk factors for acute care hospitalization in a cohort with type 2 diabetes (T2DM), the predominant form of the disease, accounting for 95% of cases. Acute care hospitalization (for any reason) is used as a proxy for negative outcome. Associations between hospitalization and patients' characteristics, care path factors, and health system characteristics are analysed.

With regard to care path, relatively little is known about the roles of general practitioners (GPs) and specialists in the risk of hospitalization of people with

diabetes. Previous research suggests that the more aggressive care offered by specialists[14-18] may simply reflect more advanced disease.

With regard to characteristics of the health care system, the use of services has been shown to vary by region.[19-22] It is possible, then, that the likelihood of hospital admission may, in part, reflect where an individual lives; all else being equal, residents of "high-use" areas may be more likely to be hospitalized.

Of course, the role of risk factors like smoking, drinking, physical activity and diet must also be taken into account.[23,24]

This article assesses a range of factors associated with hospitalization of individuals with type 2 diabetes, using linked survey and administrative data.

Methods

The dataset used in this analysis links the 2000/2001 Canadian Community Health Survey (CCHS) to the Hospital Morbidity Data Base (HMDB). The CCHS collects information about the health and well-being of the household population. For cycle 1.1 (2000/2001), about 130,000 Canadians aged 12 or older were interviewed.[25] In addition to questions about socio-demographic characteristics, risk factors, and health care services use, they were asked about diabetes and related treatment. The HMDB is a national administrative database of acute inpatient hospital stays from 1992/1993 to 2003/2004. It can be used to analyse trends in causes of hospitalization,[26-28] but it lacks detailed patient information such as socio-economic background and risk factors. However, linkage of the CCHS and the HMDB yields a dataset with information about hospital patients' socio-economic status and risk factors.[29]

The linked dataset used in this analysis consisted of a preliminary cohort of 6,361 CCHS 1.1 respondents who self-reported diabetes. Of these, 1,003 Quebec residents were excluded because Statistics Canada did not have health insurance numbers with which to link them to the HMDB. An additional 467 non-Quebec respondents who refused permission to link their survey results to health services administrative data were excluded, along with 37 who reported only gestational diabetes. An algorithm[30] was used to exclude another 243 respondents identified as having type 1 diabetes.[31] The final T2DM cohort consisted of 4,611 CCHS respondents. Statistics Canada's Policy Committee approved the data linkage .

A hospital episode is defined as any record of acute hospital discharge obtained from the HMDB. Hospital episodes that occurred within one year before and two years after the survey date were included in the analyses. The primary outcome of interest was hospitalization during the two years after the CCHS interview, excluding hospital stays related to pregnancy/birth. All other acute hospitalizations, defined as all-cause hospitalization, were included in the study,

Univariate and bivariate statistics were calculated to describe the data. With bootstrap methods[32,33] and special linked weights, the descriptive statistics were

Table 1
Canadian Community Health Survey (CCHS) and Hospital Morbidity Database (HMDB) variables used in analyses of hospitalization of CCHS respondents with type 2 diabetes

Variable	Source	Explanation
Socio-demographic		
Age group	CCHS	12 to 44, 45 to 64, 65 or older
Sex	CCHS	Male/Female
Household income adjusted for household size	CCHS	Quintiles; missing kept as category
Residence	CCHS	Urban/Rural
Health status		
Health utility index (HUI3)	CCHS	Continuous measure
Other chronic conditions	CCHS	Binary variable; "yes" to at least one of : emphysema/chronic obstructive pulmonary disease, heart disease, asthma, arthritis/rheumatism (excluding fibromyalgia), high blood pressure, cancer, stroke
Prior hospitalization	HMDB	Hospitalization for any reason (except pregnancy/delivery) in year before CCHS interview
Impact of health problems	CCHS	Impact of long-term physical and mental conditions on home, work/school, other activities: often, sometimes, never
Risk factors		
Body mass index (BMI)	CCHS	Underweight, normal, overweight, obese
Physical activity index	CCHS	Active, moderate, inactive
Smoking	CCHS	Current smoker, former smoker, never smoked
Alcohol consumption	CCHS	Regular, occasional, former/never drinker
Daily fruit/vegetable consumption	CCHS	Fewer than than 5 times/5 or more times
Care path		
Current insulin use	CCHS	Yes/No
GP consultation (past 12 months)	CCHS	Yes/No
Specialist consultation (past 12 months)	CCHS	Yes/No
Unmet health care needs	CCHS	Yes/No
System response		
Regional hospitalization patterns	HMDB/CCHS	Likelihood of hospital admission in each health region

adjusted for the complex survey design and to account for non-response when permission to link survey data to hospital records had been denied. Predictors of hospitalization were identified through multivariate logistic regression. Normalized weights were used to ensure proportional representation of the provincial, age and gender distributions in the sample with diabetes, and to report the 95% confidence intervals and significance levels (0.01 and 0.05).

Most variables were derived directly from the CCHS or the HMDB (Table 1). For example, among the CCHS derived variables, "impact of health problem" is a measure of the effect of long-term physical and mental conditions on home, work or school, and other activities: often, sometimes or never. GP and specialist consultations were based on separate questions about the number of contacts with doctors in the past 12 months.

Two additional variables were derived from the linked CCHS/HMDB file. The first attempts to capture regional hospital utilization patterns as an indicator of regional variations in the use of health care services. This variable, based on the full CCHS sample linked to all acute hospitalizations (excluding pregnancy/delivery) in the two years after the survey is the ratio of the observed number of hospitalizations to the expected number in each health region, controlling for characteristics of the region's population that represent need: age, sex, functional health status as measured by the Health Utility Index Mark 3 (HUI3), self-reported health compared with a year earlier, prior hospitalization, co-morbidities, smoking status, alcohol use and physical activity. The second derived variable—prior hospitalization—is a marker for disease severity indicating if the respondent had been admitted to hospital in the year before the CCHS interview.

The role of risk factors, care path and health system characteristics on all-cause hospitalization of the T2DM cohort was examined while controlling for age, sex and household income.[34,35]

Table 2
Selected characteristics of type 2 diabetes cohort compared with other Canadians, household population aged 12 or older, Canada excluding Quebec and territories, 2000/2001

	Type 2 diabetes cohort				Other			
	Percent (weighted)				Percent (weighted)			
		95% confidence interval		Number (unweighted)		95% confidence interval		Number (unweighted)
	%	from	to		%	from	to	
Total	**100.0**	...	...	**4,611**	**100.0**	...	...	**103,566**
Socio-demographic								
Age group								
12 to 44	10.8	9.5	12.6	433	57.5	57.3	57.7	53,783
45 to 64	43.9	41.8	46.0	1,789	27.0	26.8	27.2	28,233
65 or older	45.3	43.3	47.2	2,389	15.6	15.3	15.8	21,550
Sex								
Male	52.8	50.7	54.9	2,285	49.0	48.8	49.2	47,583
Female	47.2	45.1	49.3	2,326	51.0	50.8	51.3	55,983
Household income quintile								
Lower	4.1	3.4	4.9	261	3.3	3.1	3.6	4,442
Lower-middle	10.4	9.2	11.7	702	6.5	6.3	6.8	9,967
Middle	28.4	26.4	30.5	1,390	19.0	18.5	19.4	23,036
Upper-middle	27.4	25.4	29.5	1,193	30.8	30.3	31.3	32,193
Highest	17.2	15.4	19.2	613	29.0	28.4	29.6	23,935
Missing	12.6	11.0	14.3	452	11.4	11.1	11.8	9,993
Residence								
Urban	79.9	78.3	81.4	3,292	81.4	80.7	82.0	75,055
Rural	20.1	18.6	21.7	1,319	18.6	18.0	19.3	28,511
Health status								
Other chronic conditions								
No	25.9	23.9	28.0	1,043	65.7	65.2	66.2	62,931
Yes	74.1	72.0	76.1	3,568	34.3	33.8	34.8	40,635
Prior hospitalization								
No	86.6	85.2	87.9	3,873	94.7	94.4	94.9	96,627
Yes	13.4	12.1	14.8	738	5.3	5.1	5.6	6,939
Impact of health problems								
Often	29.0	27.0	31.1	1,374	12.1	11.7	12.5	14,663
Sometimes	21.3	19.5	23.2	1,029	13.9	13.6	14.3	15,785
Never	49.6	47.3	51.9	2,196	73.9	73.4	74.4	73,023
Missing	F	...	...	F	0.1	0.1	0.1	95
Risk factors								
Body mass index (BMI)								
Underweight	2.8	2.2	3.7	124	12.0	11.7	12.4	11,495
Normal	23.8	21.9	25.9	1,011	42.0	41.5	42.5	41,667
Overweight	36.3	34.2	38.5	1,709	29.7	29.2	30.2	31,801
Obese	35.0	33.0	37.0	1,637	13.5	13.1	13.8	15,416
Missing	2.1	1.7	2.6	130	2.8	2.7	3.0	3,187
Physical activity index								
Active	13.3	12.0	14.8	638	22.1	21.6	22.5	23,701
Moderate	19.7	18.0	21.5	879	21.3	20.9	21.7	22,818
Inactive	58.4	56.1	60.6	2,826	47.8	47.2	48.3	50,429
Missing	8.7	7.3	10.2	268	8.9	8.5	9.3	6,618
Smoking								
Never	30.9	28.7	33.1	1,243	37.8	37.3	38.3	35,230
Former	50.6	48.4	52.7	2,504	36.8	36.3	37.3	40,067
Current	18.4	16.8	20.1	858	25.2	24.7	25.7	28,054
Missing	F	...	...	F	0.2	0.2	0.3	215
Alcohol consumption								
Regular	35.3	33.2	37.4	1,543	54.8	54.2	55.4	54,569
Occasional	23.3	21.4	25.4	1,099	20.2	19.8	20.7	22,007
Former/Never drank	41.3	39.1	43.5	1,961	24.7	24.2	25.2	26,680
Missing	F	...	...	F	0.3	0.2	0.3	310
Daily fruit/vegetable consumption								
Fewer than 5 times	60.5	58.3	62.6	2,767	63.3	62.8	63.8	66,148
5 or more times	37.8	35.7	40.0	1,757	35.6	35.1	36.1	35,797
Missing	1.7	1.2	2.4	87	1.1	1.0	1.2	1,621
Care path								
Current insulin use								
Yes	21.5	19.5	23.6	964	0	...	...	0
No	78.5	76.4	80.5	3,643	99.9	99.9	100.0	103,510
Missing	F	...	...	F	0.1	0.0	0.1	56
GP consultation (past 12 months)								
Yes	93.2	91.9	94.4	4,320	80.8	80.4	81.2	83,631
No	6.5	5.3	7.8	269	18.9	18.5	19.3	19,601
Missing	F	...	...	22	0.3	0.2	0.3	334
Specialist consultation (past 12 months)								
Yes	42.4	40.4	44.5	1,828	28.3	27.8	28.8	29,286
No	57.4	55.3	59.5	2,773	71.5	71.1	72.0	74,137
Missing	F	...	...	F	0.2	0.1	0.2	143
Unmet health care needs								
Yes	86.7	85.3	88.0	3,946	87.4	87.0	87.7	89,621
No	13.1	11.8	14.6	657	12.6	12.2	12.9	13,874
Missing	F	...	...	F	0.1	0.0	0.1	71

F estimate not provided because of small sample size
... not applicable
Source: 2000/2001 Canadian Community Health Survey.

Table 3
Percentage hospitalized within two years of 2000/2001 Canadian Community Health Survey interview, by selected characteristics, household population aged 12 or older with type 2 diabetes, Canada excluding Quebec and territories

		95% confidence interval	
	%	from	to
Total	**24.0**	**22.2**	**25.9**
Socio-demographic			
Age group			
12 to 44	11.7	8.4	16.0
45 to 64	17.1	14.8	19.6
65 or older	33.6	30.6	36.8
Sex			
Male	24.0	21.5	26.6
Female	24.0	21.4	26.8
Household income quintile			
Lower	31.1	23.2	40.4
Lower-middle	33.3	28.0	39.1
Middle	28.3	24.7	32.2
Upper-middle	20.4	17.7	23.5
Highest	16.3	13.1	20.3
Missing	22.5	17.5	28.4
Residence			
Urban	23.7	21.6	26.0
Rural	25.1	21.8	28.6
Health status			
Other chronic conditions			
No	12.5	9.9	15.5
Yes	28.0	25.9	30.2
Prior hospitalization			
No	19.4	17.6	21.3
Yes	53.5	48.2	58.7
Impact of health problems			
Often	37.4	33.5	41.5
Sometimes	28.0	24.2	32.1
Never	14.5	12.5	16.8
Risk factors			
Body mass index (BMI)			
Underweight	28.6[E]	18.8	40.8
Normal	23.7	20.4	27.4
Overweight	24.5	21.3	28.0
Obese	23.1	20.3	26.1
Physical activity index			
Active	16.2	12.5	20.6
Moderate	17.1	14.2	20.6
Inactive	26.9	24.6	29.4
Smoking			
Never	19.3	16.2	22.8
Former	26.5	24.0	29.0
Current	25.3	21.0	30.1
Alcohol consumption			
Regular	18.1	15.7	20.7
Occasional	26.0	22.1	30.4
Former/Never drank	27.9	25.0	31.1
Daily fruit/vegetable consumption			
Fewer than 5 times	24.7	22.3	27.2
5 or more times	22.9	20.2	25.8
Care path			
Current insulin use			
Yes	34.9	30.1	39.9
No	21.0	19.3	22.9
GP consultation (past 12 months)			
Yes	24.0	22.2	25.8
No	24.2	16.6	33.9
Specialist consultation (past 12 months)			
Yes	30.4	27.5	33.6
No	19.2	17.2	21.4
Unmet health care needs			
Yes	28.1	23.1	33.7
No	23.3	21.4	25.3

[E] coefficient of variation between 16.6% and 33.3% (interpret with caution)
Source: 2000/2001 Canadian Community Health Survey.

Results

The characteristics of the T2DM cohort differed substantially from those of other Canadians (Table 2). The T2DM cohort was much older, more likely to be male, and tended to have a lower household income. For instance, almost half (45%) the cohort were aged 65 or older, compared with 16% of the rest of the population. The cohort was more likely to have chronic conditions other than diabetes and to have been hospitalized in the past year. They were more likely than other Canadians to be overweight or obese and physically inactive, but less likely to be current smokers or regular drinkers. Higher percentages of T2DM had consulted a GP or specialist in the year before their CCHS interview.

Given their generally less favourable health status, it is not surprising that in the two years after their CCHS interview, almost a quarter (24%) of the T2DM cohort were admitted to hospital (Table 3). But not all members of the cohort were equally likely to have been hospitalized.

As might be expected, hospitalization rates were higher among those who were older, lived in lower-income households, had co-morbidities, or reported having been hospitalized in the year before the CCHS interview. Around a third (34%) of cohort members aged 65 or older were hospitalized, compared with 12% of those aged 14 to 44. Similarly, about third of the T2DM cohort who lived in lower-income households were hospitalized versus 16% of those in the highest household income quintile. And fully 54% of the T2DM cohort who had been hospitalized in the year before the CCHS interview were admitted to hospital in the two years after the interview, compared with 19% who had no prior hospitalization. T2DM cohort members who never smoked were less likely than former or current smokers (19%, 27% and 25%, respectively) to be hospitalized. Regular drinkers had lower hospitalization rates than did occasional or non-drinkers. In terms of care path, equal percentages of those who did and did not have a recent consultation with GP were hospitalized (24%). However, 30% who had consulted a specialist were hospitalized, compared with 19% who had not done so.

Of course, many characteristics associated with high hospitalization rates are related to each other. For instance, older people with diabetes are more likely than their younger counterparts to have other chronic conditions and to have had a prior hospitalization. Smoking tends to be more prevalent among low- than high-income groups. When the potentially confounding effects of other variables were taken into account, the factors significantly associated with hosptialization among the T2DM cohort were: older age, male, lower reported health utility, presence of other chronic condition(s), impact of health problems, physical inactivity, smoking, alcohol consumption, insulin use, doctor consultations, and system response (high- or low-hospitalization region) (Table 4).

The strongest predictor of hospitalization in the two-year follow-up period was prior hospitalization (OR=3.0, 95% CI: 2.5 to 3.7). T2DM cohort members who had contacted a specialist in the year before their CCHS interview were more likely to be admitted, compared with those who had not (OR=1.4, 95% CI: 1.2 to 1.6). By contrast, those who had contacted a GP were less likely to be admitted to hospital in the next two years (OR=0.7, 95% CI 0.5-0.9). Cohort members who lived in health regions with generally higher hospitalization rates had significantly higher odds of hospitalization in the next two years (OR=2.6, 95% CI: 1.8 to 3.7).

Discussion

Linkage of the CCHS and the HMDB made it possible to identify a number of factors significantly related to all-cause hospitalization of people with type 2 diabetes. Because diabetes is, to a considerable extent, an ambulatory care

Table 4
Adjusted odds ratios relating selected characteristics to hospitalization within two years of 2000/2001 Canadian Community Health Survey, household population aged 12 or older with type 2 diabetes, Canada excluding Quebec and territories

	Adjusted odds ratio	95% confidence interval from	to
Socio-demographic			
Age group			
12 to 44†	1.0	...	...
45 to 64	1.3	0.9	1.8
65 or older	2.9**	2.1	4.1
Sex			
Male†	1.0	...	...
Female	0.8*	0.7	1.0
Household income quintile			
Lower	1.3	0.9	2.0
Lower-middle	1.3	1.0	1.8
Middle	1.1	0.8	1.4
Upper-middle	0.9	0.7	1.2
Highest†	1.0	...	...
Residence			
Urban†	1.0	...	...
Rural	0.9	0.7	1.1
Health status			
Health Utility Index (continuous)	0.5**	0.4	0.7
Other chronic conditions			
No†	1.0	...	...
Yes	1.5**	1.2	1.9
Prior hospitalization			
No†	1.0	...	...
Yes	3.0**	2.5	3.7
Impact of health problems			
Often	1.6**	1.3	2.0
Sometimes	1.6**	1.3	2.0
Never†	1.0	...	...
Risk factors			
Body mass index (BMI)			
Underweight	0.9	0.6	1.4
Normal†	1.0	...	...
Overweight	1.0	0.8	1.2
Obese	0.9	0.7	1.1
Physical activity index			
Active†	1.0	...	...
Moderate	1.0	0.8	1.4
Inactive	1.4*	1.0	1.8
Smoking			
Never†	1.0	...	...
Former	1.4**	1.2	1.7
Current	1.7**	1.4	2.2
Alcohol consumption			
Regular	0.7**	0.6	0.9
Occasional†	1.0	...	...
Former/Never drank	1.0	0.8	1.2
Daily fruit/vegetable consumption			
Fewer than 5 times	1.1	0.9	1.2
5 or more times†	1.0	...	...
Care path			
Current insulin use			
Yes	1.7**	1.4	2.0
No†	1.0	...	...
GP consultation (past 12 months)			
Yes	0.7**	0.5	0.9
No†	1.0	...	...
Specialist consultation (past 12 months)			
Yes	1.4**	1.2	1.6
No†	1.0	...	...
Unmet health care needs			
Yes	0.9	0.7	1.1
No†	1.0	...	...
System response (continuous)	2.6**	1.8	3.7

† reference category
* significantly different from reference category ($p < 0.05$)
* significantly different from reference category ($p < 0.01$)
... not applicable
Source: 2000/2001 Canadian Community Health Survey; Hospital Morbidity Database.

sensitive condition, it was assumed that hospitalization is an indirect indicator of poor outcome.

Age was obviously important. As well, females with diabetes had a lower risk of hospitalization than did males. Smoking, whether former and current, was a strong predictor of hospitalization; regular alcohol consumption had a protective effect.[36] As expected, having other chronic disease(s), prior hospitalization, and the impact of long-term physical and mental conditions on daily life were strong predictors of hospitalization.

T2DM cohort members who had consulted a specialist in the 12 months before their CCHS interview had a significantly higher risk of hospitalization over the next two years. Of course, the specialist consultation did not "cause" the hospitalization; rather, consulting a specialist was likely a reflection of disease severity.

At the health care system level, T2DM cohort members in high-hospital-use health regions had signficantly high odds of hospital admission.

Limitations

This analysis has several limitations, foremost among them, in the case of the CCHS, reliance on self-reports. An earlier study found that only about 75% of people with physician-diagnosed diabetes self-reported the condition to the CCHS, and their characteristics differ from those of people who do report diabetes.[37]

The analyses are limited to acute care hospitalizations. Information is not provided about the use of emergency rooms, where diabetes-related events such as hyperglycemia are often treated. As a result, the full extent of diabetes patients' use of hospitals is not represented.

Because the CCHS does not include residents of institutions, the linkage with hospital data is necessarily confined to the household population. An evaluation study of the linked data showed a high undercoverage rate among people aged 75 or older, many of whom live in institutions.[38] Consequently, the data presented here likely underestimate the strength of the relationship between diabetes and hospitalization. As well, Quebec residents were excluded from the analyses.

The analysis would have been stronger had it been possible to include the nature of the care respondents were receiving as a potential factor in their odds of

What is already known on this subject?

- Diabetes is "ambulatory care sensitive"—a condition largely manageable with appropriate community care.
- Well-known risk factors like smoking, drinking, and physical activity are important in managing the disease.
- Much less is known about the roles of GPs and specialists in the risk of hospitalization of people with diabetes.
- Regional variations in the use of health care services suggest that an individual's likelihood of hospitalization may, in part, reflect where he or she lives.

What does this study add?

- Data from the 2000/2001 Canadian Community Health Survey were linked with data from the Hospital Morbidity Database to determine care path and health system factors related to the likelihood that people with type 2 diabetes would be hospitalized over the subsequent two years.
- Among people with type 2 diabetes, consultation with a specialist was associated with a higher risk of hospitalization; this was likely a marker of disease severity.
- Regional hospital utilization patterns were highly significant for all-cause hospitalization.

hospitalization.[39] However, these data were not collected by the 2000/2001 CCHS. Such information (for example, use of haemoglobin A1C testing, foot care, eye exam) was collected in 2005 by the CCHS 3.1, but the data needed to examine subsequent hospital use are not yet available.

Sample size is an issue. Although the CCHS sample was constructed to allow the reporting of various conditions at the health region level, the study pertains to a relatively small group—people with type 2 diabetes—and a low-probability outcome—hospitalization. This combination makes it impossible to conduct analyses even at the provincial level, let alone the health region level. To overcome the problem of small sample size, combining surveys may be an option in the future.

Clinical variables related to hospitalization, such as physiologic characteristics, diagnoses and treatments, could not be considered in this study.

Conclusion

When the effects of demographic, socio-economic and health status characteristics were taken into account, physical inactivity and former or current smoking were significantly associated with an increased likelihood of all-cause hospitalization of people with type 2 diabetes. Specialist visits were positively related to hospitalization, but the relationship with general practitioner visits was negative. However, the fact of having seen a specialist is unlikely to be a risk factor for hospitalization, but rather, a marker for disease severity. Regional hospital use patterns were also significantly associated with all-cause hospitalization. Whether these factors would remain important if the focus was limited to diabetes-specific hospitalization can be a topic for future analyses. ■

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Regional patterns of risk for sexually transmitted infections in British Columbia

by Kathleen N. Deering, Mark W. Tyndall and Mieke Koehoorn

Abstract

Background

Although rates of sexually transmitted infection (STI) tend to be higher in urban Canada, the province of British Columbia has recently seen above-average rates in the northern health regions.

Data and methods

Data from the 2005 Canadian Community Health Survey were used to examine sexual behaviour risks by geography and age in British Columbia. Two outcomes were investigated: ever diagnosed with an STI, and did not use a condom during last sexual intercourse. Region was categorized as metropolitan and non-metropolitan (Northern, representing more rural and remote communities, and Southern). Multivariate logistic regression was used to determine associations between the two outcomes and region, age, and other socio-demographic variables. Normalized weights accounted for sampling design.

Results

In adjusted analysis, older age (25 to 49) and being female were significantly associated with previously having an STI and not using a condom during last sex. Being a non-drinker was inversely associated with the former outcome, and being an occasional drinker was inversely associated with both outcomes, compared with being a regular drinker. When stratified by region, the relationship between older age and not using a condom was particularly strong in Northern non-metropolitan regions.

Interpretation

The results highlight the importance of considering older individuals in the design of STI preventive interventions, particularly in non-metropolitan and rural and remote regions, where access to testing and treatment may be limited.

Keywords

condoms, risk behaviour, rural health, rural health services, sex behaviour, sexually transmitted diseases

Authors

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Since 1997, rates of sexually transmitted infections (STIs) have risen in Canada. In 2007, there were 224.0 reported cases of genital chlamydia per 100,000 population, up more than 70% from 1997.[1] The rate of gonorrhea in 2007 was much lower—36.1 cases per 100,000 population—but it was more than 120% above the 1997 rate. And while reported cases of infectious syphilis were relatively rare, with a rate of 3.7 per 100,000 population in 2007, this amounted to a fivefold increase over 1997.

Typically, STIs have been concentrated in urban areas in Canada.[2,3] Recent research, however, indicates that some STIs are becoming more prevalent in non-metropolitan areas. This has been observed in the Canadian province of British Columbia, where rates in northern health regions have exceeded the provincial average in the past several years.[4] The boom-and-bust nature of resource-based industries in these areas may be a factor in the upturn in STI rates,[5-12] as such economies have been associated with increases in risky sexual behavior.[7-12]

According to the Public Health Agency of Canada, risk factors for STIs include being younger than 25, having unprotected sex, previously having an STI, and having a new or more than two sexual partners in the past six months.[13] As well, STI rates tend to be high in urban areas.[2,3]

Most attention focuses on adolescents and younger adults, as they are frequently at highest risk for infection.[3,14,15] Those in northern health regions encounter particular barriers to STI testing and treatment, including geographic inaccessibility and limited hours of operation of clinics, local social norms, and negative interactions with local health care providers.[9,11] Similar barriers may exist for older Canadians, but less research has examined STI risks among adults.

This study uses data from Statistics Canada's 2005 Canadian Community Health Survey (CCHS) to investigate the relationship between age, geographic region and risk factors for STIs in British Columbia. In 2005, when the survey was

conducted, the population of the province was about 4.3 million.

Methods

Study sample

British Columbia respondents aged 15 to 49 who replied "yes" to "Have you ever had sexual intercourse?" in the Sexual Behaviour Module of the 2005 CCHS were eligible for inclusion in this study. Those who had never had sexual intercourse were not asked the questions in the Module, and were, therefore, excluded from this analysis (Figure 1).

Measures

Two outcomes were examined: 1) ever diagnosed with an STI; and 2) did not use a condom during last sexual intercourse.[16,17] Both outcomes are cited as risks for STIs in the *Canadian STD Guidelines*[13] and in earlier research.[18-21]

The question about previous STIs was asked of British Columbia residents aged 15 to 49 who had had sex in the past 12 months (n=6,833).

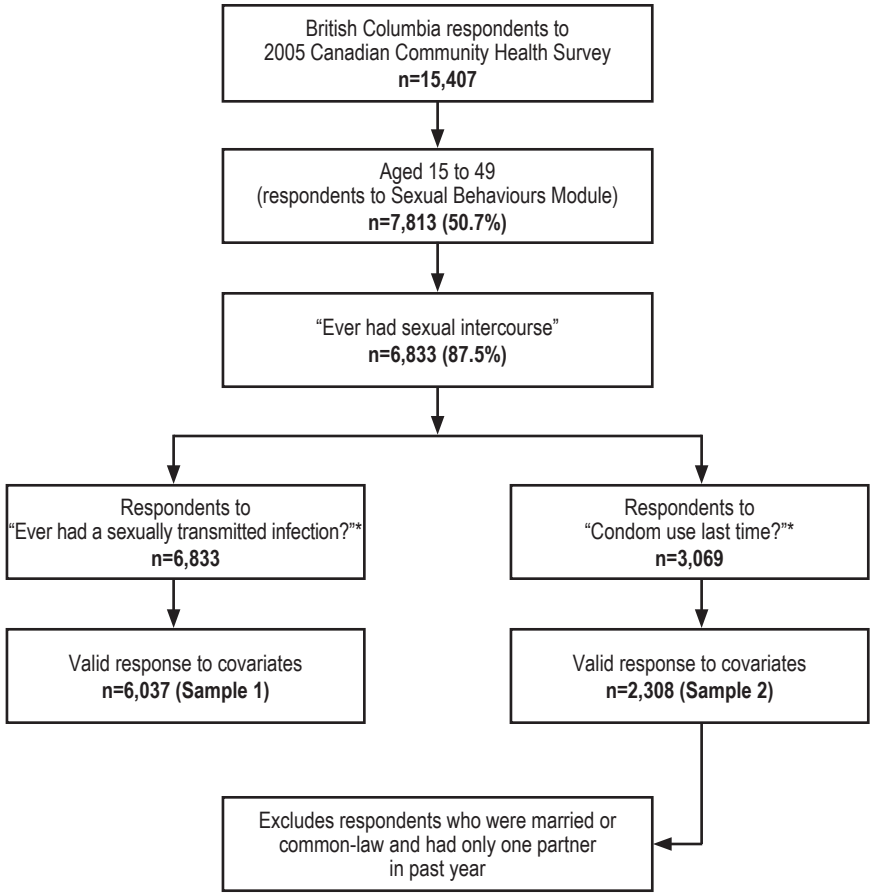
For condom use, Statistics Canada specified the subsample so as to capture a population at higher risk for STIs. Condom use was asked of those who had had sex in the past 12 months, and who were unmarried/not living common-law or married/living common-law but with more than one sexual partner in the past year (n=3,069).

For each outcome, respondents who answered "yes" or "no" and who had valid responses to the other variables used in this analysis were included in the final analytic subsamples: n=6,037 and n=2,308, respectively.

Region was defined as metropolitan and non-metropolitan, with the non-metropolitan regions further categorized as being in the north or south of the province. The public release database aggregated British Columbia respondents into 15 strata based on 16 health regions.[16] In this analysis, to investigate geographic differences, 2 of the 15 strata were categorized as "Northern non-metropolitan" (which comprises over half the area of province and approximately 8% of the population[22,23]); 8 as "Southern non-metropolitan"; and 5 as "metropolitan" (an urban area with a population of at least 100,000). It was hypothesized that the odds of having had an STI would be higher in metropolitan than non-metropolitan regions,[4] and that non-use of condoms would be higher in non-metropolitan regions, particularly the North, because of less access to STI clinics,[9-11] and because of the higher STI rates recently observed there.[4]

Two age groups were defined for this study: 15 to 24 and 25 to 49. It was hypothesized that the older age group would have greater odds of having had an STI, since they had more potential years of sexual activity than younger individuals, and that they would be less likely to use condoms because they perceive their relationships to be more stable and themselves at lower risk. Based on previous studies, it was hypothesized that women would be less likely than men to report using condoms, and more likely to have had an STI.[14,24-28] As well, it was expected that being married/common-law would reduce the odds of having had an STI.[29] The categories "married" and "common-law" included same-sex as well as heterosexual partnerships, although it

Figure 1
Derivation of study samples for sexual risk outcomes



* Respondents screened into the Sexual Behaviour Module of Canadian Community Health Survey who answered "yes," "don't know," "no answer" or "not stated" to "Have you ever had sexual intercourse?" were asked subsequent questions, including "Ever had a sexually transmitted infection" and "Condom use during last intercourse"; those who responded "no" were excluded from subsequent questions in Module. Sample 2 included only respondents who had sex in past year and who were unmarried/not living common-law, or married/living common-law, but with more than one sexual partner in past year.
Source: 2005 Canadian Community Health Survey.

was not possible to differentiate between the two. Because alcohol consumption has been associated with risky sexual behaviour[30,31] (and therefore, potentially, STIs), it was included in the models as a potential confounding variable. Alcohol use was grouped into currently non-drinker, occasional drinker and regular drinker. Education rather than income was used as an indicator of socio-economic status because education had less missing data, and because income may not be the best measure for younger respondents.

What is already known on this subject?

- Although rates of sexually transmitted infections (STI) tend to be high in urban areas, recent research indicates that some STIs are becoming prevalent in non-metropolitan regions.
- Relatively high STI rates have been recorded in the northern health regions of British Columbia.
- Much attention focuses on STI risks in young people, but little research is devoted to risks among adult Canadians, particularly in northern areas.

What does this study add?

- People in Southern non-metropolitan regions of British Columbia were significantly less likely than those in metropolitan regions to have had an STI; non-use of condoms did not differ significantly by region.
- Regardless of region of residence, being older (25 to 49) was significantly associated with not using condoms.
- Women were more likely than men to have had an STI and to have not used a condom the last time they had sexual intercourse.

Analysis

Weighted prevalence estimates and 95% confidence intervals were calculated for sample characteristics and each outcome, by age and region. A model was created for previous STI and for non-use of condom at last sexual intercourse. Variables associated with each outcome at the bivariate level ($p<0.10$) using the likelihood ratio test were entered into the multivariate (adjusted) logistic regression model. Region was forced into the model to determine the relationship between this variable and the outcomes. For non-use of condom at last sexual intercourse, models stratified by geography were created to explore the interaction between age and region. Models were adjusted for age, sex, marital status and education. Reported p-values are two-sided, and odds ratios are reported at 95% confidence intervals. Normalized sampling weights were applied to all analyses to account for the complex sampling design.[17,32] The analysis was completed using SAS/STAT software Version 9 (Copyright, 2005 SAS Institute Inc.).

Results

Sample characteristics

Given the inclusion and exclusion criteria used by Statistics Canada for asking the questions in the Sexual Behaviour Module, the two analytic samples differed by age and marital status (Table 1). Education and type of

Table 1
Selected characteristics of sexual risk study outcomes samples, household population aged 15 to 49, British Columbia, 2005

	Sample 1 Valid responses to "ever diagnosed with sexually transmitted infection" and covariates (n=6,037)	Sample 2 Valid responses to "condom use last time had sexual intercourse"† and covariates (n=2,308)
	%	%
Total	**100.0**	**100.0**
Geographic area		
Northern non-metropolitan	7.2	5.7
Southern non-metropolitan	36.4	35.4
Metropolitan	56.4	58.9
Age group		
15 to 24	20.6	48.3
25 to 49	79.4	51.7
Sex		
Men	49.5	54.7
Women	50.5	45.3
Marital status		
Married	49.5	2.7
Common-law	11.4	2.0
Widowed/Separated/Divorced	6.8	13.8
Single/Never married	32.3	81.4
Education		
Less than secondary graduation	8.4	11.9
Secondary graduation	17.6	20.5
Some postsecondary	15.0	21.7
Postsecondary graduation	58.9	45.9
Type of drinker		
Currently non-drinker	12.0	6.3
Occasional	15.0	13.1
Regular	73.0	80.6

† had sex in past year and were unmarried/not living common-law or married/living common-law, but with more than one sexual partner in past year
Note: Excludes people who never had sexual intercourse
Source: 2005 Canadian Community Health Survey.

drinker also varied between the samples, but to a lesser extent. The higher level of educational attainment in Sample 1 reflects the larger percentage of older respondents relative to Sample 2.

The samples were evenly distributed by sex, although women were slightly underrepresented in Sample 2. For both samples, the majority of respondents lived in metropolitan areas of British Columbia; 6% to 7% lived in Northern non-metropolitan regions.

Sexual behaviours

Just over 9% of sexually active British Columbia residents aged 15 to 49 reported having had an STI (Table 2). Regardless of age, the highest percentages were in metropolitan regions: 6.7% at ages 15 to 24; 10.8% at ages 25 to 49.

Of those who had sex in the past year and who were not married/not common-law, or who were married/common-law, but had more than one sexual partner in the past year, 44.3% reported not using a condom the last time they had sexual intercourse. At ages 25 to 49, the percentage was highest—62.5% —in Northern non-metropolitan regions. This compared with 58.0% of their counterparts in Southern non-metropolitan regions and 52.7% of those in metropolitan areas. At ages 15 to 24, the percentage did not differ substantially by region (around 45%).

Factors associated with having STI

At the bivariate level, all study variables were significantly associated with having had an STI (Table 3). In the multivariate model, residents of Southern non-metropolitan regions had significantly lower odds of having had an STI, compared with residents of metropolitan regions. The odds of having had an STI were significantly higher among 25- to 49-year-olds (compared with 15- to 24-year-olds), women (compared with men) and people with some postsecondary education (compared with postsecondary graduates), but significantly lower among those who were married (compared with single/never married) and among non-drinkers and occasional drinkers (compared with regular drinkers).

Non-use of condoms

In bivariate analysis, geographic region was the only selected covariate not significantly associated with condom non-use. Nonetheless, because the examination of geographic patterns was the primary aim of this study, it was retained in the final model. In the multivariate model, the odds of not using a condom also did not differ significantly for residents of Northern and Southern non-metropolitan regions, compared with residents of metropolitan regions (Table 3).

However, the odds of not using a condom were significantly higher for people aged 25 to 49 (compared with 15- to 24-year-olds) and women (compared with men), and significantly lower for people who reported being occasional drinkers (compared with regular drinkers) (Table 3). People with less than secondary graduation had significantly lower odds of not using a condom than did postsecondary graduates.

Separate multivariate analyses for each region showed that older age was associated with non-use of condoms in all regions (Table 4). The odds of condom non-use for older individuals were particularly strong in the northern non-metropolitan regions, even when adjusting for sex, education and type of drinker, indicating that this risk behaviour might be of more concern in this region. The odds of not using condoms were significantly higher for women compared with men in metropolitan and Southern non-metropolitan regions. Education and type of drinker were significant only in Southern non-metropolitan regions where people with less than secondary graduation and current non-drinkers had lower odds of not using condoms than did postsecondary graduates and regular drinkers, respectively.

Table 2
Percentage reporting sexual risk outcomes, by age group, household population aged 15 to 49, British Columbia, 2005

Age group/ Sexual risk outcome	Total	95% confidence interval		Northern non-metropolitan	95% confidence interval		Southern non-metropolitan	95% confidence interval		Metropolitan	95% confidence interval	
	%	from	to	%	from	to	%	from	to	%	from	to
Ever diagnosed with sexually transmitted infection												
Total	9.2	8.3	10.1	8.2	5.7	10.7	8.1	6.8	9.5	10.0	8.7	11.3
15 to 24	5.5	3.9	7.0	2.9	0.7	5.1	4.2	2.4	6.1	6.7	4.2	9.3
25 to 49	10.2	9.1	11.2	9.7	6.5	12.8	9.2	7.6	10.9	10.8	9.3	12.3
Did not use condom last time had sexual intercourse†												
Total	44.3	41.6	47.1	44.8	36.8	52.8	45.9	41.6	50.1	43.4	39.6	47.2
15 to 24	33.0	28.9	37.0	28.7	18.0	39.5	34.5	28.1	40.9	32.4	26.7	38.1
25 to 49	54.9	51.5	58.4	62.7	52.6	72.7	58.0	52.5	63.5	52.7	47.9	57.4

† had sex in past year and were unmarried/not living common-law or married/living common-law, but with more than one sexual partner in past year
Note: Excludes people who never had sexual intercourse
Source: 2005 Canadian Community Health Survey.

Discussion

Preventive interventions tend to be targeted at younger people, largely because they continue to have the highest rates of STIs.[4,33] In fact, the Public Health Agency of Canada recognizes being younger than 25 as a risk factor.[13,34] Nonetheless, from 1997 to 2007, STI rates rose faster among middle-aged Canadians than among younger adults.[35]

Table 3
Unadjusted and adjusted odds ratios relating sexual risk outcomes to selected characteristics, household population aged 15 to 49, British Columbia, 2005

	Ever diagnosed with sexually transmitted infection						Did not use condom last time had sexual intercourse					
		95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
Characteristics	Unadjusted odds ratio	from	to	Adjusted odds ratio	from	to	Unadjusted odds ratio	from	to	Adjusted odds ratio	from	to
Geographic area												
Northern non-metropolitan	0.79*	0.66	0.96	0.82	0.57	1.18	1.10	0.74	1.52	1.15	0.79	1.67
Southern non-metropolitan	0.87	0.73	1.03	0.79*	0.65	0.96	1.11	0.93	1.32	1.15	0.96	1.39
Metropolitan†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Likelihood ratio test (p-value)	6.37 (p=0.040)						1.31 (p=0.52)					
Age group												
15 to 24†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
25 to 49	1.96*	1.57	2.44	2.67*	1.96	3.62	2.48*	2.09	2.94	2.47*	2.05	2.97
Likelihood ratio test (p-value)	32.49 (p<0.001)						113.0 (p<0.001)					
Sex												
Women	1.27*	1.07	1.52	1.31*	1.09	1.57	1.45*	1.23	1.71	1.52*	1.28	1.80
Men†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Likelihood ratio test (p-value)	7.28 (p=0.007)						19.10 (p<0.001)					
Marital status												
Married	0.90	0.76	1.10	0.64*	0.51	0.81	...	...	...	...	...	...
Common-law	1.65*	1.26	2.16	1.27	0.96	1.69	...	...	...	...	...	...
Widowed/Separated/Divorced	1.76*	1.28	2.42	1.19	0.85	1.67	...	...	...	...	...	...
Single/Never married†	1.00	...	...	1.00	...	...		...	...		...	...
Likelihood ratio test (p-value)	34.79 (p<0.001)											
Education												
Less than secondary graduation	0.74	0.55	1.00	1.00	0.69	1.44	0.46*	0.35	0.61	0.70*	0.52	0.95
Secondary graduation	0.78*	0.63	0.96	0.93	0.71	1.20	0.65*	0.52	0.80	0.94	0.74	1.19
Some postsecondary	1.32*	1.08	1.60	1.60*	1.25	2.03	0.86	0.69	1.07	1.21	0.96	1.54
Postsecondary graduation†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Likelihood ratio test (p-value)	14.82 (p=0.002)						38.60 (p<0.001)			...		
Type of drinker												
Currently non-drinker	0.61*	0.44	0.83	0.59*	0.43	0.81	0.64*	0.45	0.91	0.89	0.68	1.13
Occasional	0.77	0.59	1.00	0.74*	0.57	0.97	0.85	0.67	1.09	0.58*	0.41	0.84
Regular†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Likelihood ratio test (p-value)	13.50 (p=0.001)						7.36 (p=0.025)					

* significantly different from estimate for reference category
† reference category
... not applicable
Notes: Excludes people who never had sexual intercourse. Marital status was removed from model for "Did not use condom last time had sexual intercourse," because sample includes only respondents who had sex in past year and who were unmarried/not living common-law or married/living common-law, but with more than one sexual partner in past year.
Source: 2005 Canadian Community Health Survey.

In the context of this trend, the results of the current analysis are thought-provoking. Non-use of condoms was more prevalent among British Columbians aged 25 to 49 than among those aged 15 to 24. This pattern held in all regions, even when sex, educational attainment and alcohol consumption were taken into account. A population-based American study also found that in most states, condom use decreased with age,[36] although it is not clear if the exclusion criteria were similar to those of the CCHS.

Little research has sought to explain condom non-use among 25- to 49-year-olds. It may be that older people experience more embarrassment in using condoms[37] and are less prepared to negotiate condom use. They may have comparatively little exposure to STI education,[38] or they may perceive that their partner is not open to condom use. As well, older individuals may depend more on alternate methods of birth control such as the contraceptive pill, be more likely to get tested for STIs, have a better idea of the STI status of their partner, and perceive that they are in partnerships with lower risk for STIs. Nonethless, condoms remain the only effective means of birth control that also prevent transmission of STIs, which are frequently asymptomatic. Additional research is required to investigate older Canadians' reasons for not using condoms, and their risk for STIs.

The odds of previous STIs were lower among residents of Southern non-metropolitan regions, compared with residents of metropolitan areas; the odds of previous STIs among residents of

Table 4
Unadjusted and adjusted odds ratios relating non-use of condoms at last sexual intercourse to selected characteristics, by geographic region, household population aged 15 to 49, British Columbia, 2005

	Did not use condom last time had sexual intercourse																	
	Northern non-metropolitan						Southern non-metropolitan						Metropolitan					
Characteristics	Unadjusted odds ratio	95% confidence interval		Adjusted odds ratio	95% confidence interval		Unadjusted odds ratio	95% confidence interval		Adjusted odds ratio	95% confidence interval		Unadjusted odds ratio	95% confidence interval		Adjusted odds ratio	95% confidence interval	
		from	to		from	to		from	to		from	to		from	to		from	to
Age																		
15 to 24†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
25 to 49	4.16*	2.00	8.66	4.10 *	1.82	9.26	2.62*	1.98	3.48	2.40*	1.76	3.25	2.32*	1.86	2.89	2.41*	1.88	3.09
Likelihood ratio test (p-value)	14.55 (p<0.001)						44.56 (p<0.001)			...			55.42 (p<0.001)					
Sex																		
Women	1.63	0.81	3.27	1.61	0.75	3.46	1.52*	1.15	2.00	1.59*	1.18	2.14	1.38*	1.12	1.72	1.47*	1.17	1.83
Men†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Likelihood ratio test (p-value)	1.91 (p=0.17)						8.69 (p=0.003)			...			8.71 (p=0.003)					
Education																		
Less than secondary	0.36*	0.13	0.97	0.66	0.22	1.97	0.35*	0.23	0.54	0.53*	0.33	0.85	0.58*	0.38	0.87	0.92	0.59	1.42
Secondary graduation	0.56	0.23	1.40	1.08	0.39	3.00	0.90	0.63	1.27	1.24	0.85	1.81	0.80	0.62	1.03	1.15	0.84	1.60
Some postsecondary	0.68	0.23	2.05	1.10	0.33	3.71	0.56*	0.38	0.82	0.74	0.49	1.12	0.69*	0.53	0.91	1.04	0.78	1.41
Postsecondary graduation†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Likelihood ratio test (p-value)	4.79 (p=0.19)						28.81 (p<0.001)						12.05 (p=0.007)					
Type of drinker																		
Currently not drinker	X	X	X	X	X	X	0.49	0.26	1.15	0.47*	0.23	0.96	0.76	0.50	1.16	0.68	0.44	1.05
Occasional	0.48	0.19	1.23	0.64	0.23	1.74	0.74	0.48	1.15	0.81	0.51	1.30	0.99	0.72	1.36	0.96	0.69	1.33
Regular†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Likelihood ratio test (p-value)	3.32 (p=0.19)						5.96 (p=0.051)						1.71 (p=0.430)					

* significantly different from estimate for reference category
† reference category
... not applicable
X suppressed to meet confidentiality requirements of *Statistics Act*
Notes: Marital status was removed from model, because sample includes only respondents who had sex in past year, and who were unmarried/not living common-law or married/living common-law, but with more than one sexual partner in past year.
Source: 2005 Canadian Community Health Survey.

Northern non-metropolitan regions did not differ significantly from those of metropolitan residents. People living in some urban neighbourhoods who have high STI risks[39] may not have been included in the CCHS, particularly if they were homeless or did not have access to telephones (the means by which CCHS interviewers contact potential participants). Alternatively, the lack of a significant difference in the self-reported prevalence of previous STIs between metropolitan and Northern non-metropolitan regions may reflect the recent increase in bacterial STIs in the latter.[4]

The prevalence of self-reported STIs in non-metropolitan regions may be underestimated if high-risk populations, particularly migrant men affiliated with resource-based industries, were missed during CCHS sampling.

The lack of a significant difference in the odds of having had an STI in metropolitan regions and Northern non-metropolitan regions may also be due to the survey year—2005. This year may have been too early in the North's resource-based boom to detect an upturn in the STI rate, though perhaps early enough to record an increase in unsafe behaviour such as not using condoms.

The stronger association between older age and condom non-use during last sex in Northern non-metropolitan region compared with the other two regions suggests an interaction effect between age and geographic location that should be investigated in future studies. Unobserved heterogeneity in different samples may be an issue for comparing the stratified analysis directly[40]; however, because the data exhibit effect modification, it is important to examine the stratified analysis, which still conveys information about the pattern of variation in the stratum-specific estimates.[41]

It may be particularly important to study factors that increase risk for STIs among older Canadians in northern and remote communities. In these large, sparsely populated areas, authorities often struggle to provide sexual health services.[42,43] Youth in northern British Columbia have limited opportunities to obtain STI testing and treatment[8-11]; it is likely that people of all ages in these regions encounter similar barriers.[10] Small populations in remote communities can reduce anonymity for those seeking STI testing and treatment and also result in individuals knowing their partners better, which could contribute to condom non-use.[42,44,45]

Strengths and limitations

This study is based on self-reported sexual behaviour, a subject that respondents may consider sensitive, thereby biasing their answers toward positive health behaviours. This may be more common

in regions with small populations, where privacy and confidentiality might be of more concern. About one in ten respondents (10.7%) did not answer the question about previous STIs, and 23.8% did not answer the question about condom use. Nonetheless, large samples were available for analysis of these two outcomes: 6,037 and 2,308, respectively.

While self-reported STIs are not a precise measure of prevalence, even STI surveillance does not capture all cases, many of which are asymptomatic and never formally diagnosed. However, self-reports of STIs have been used as an outcome in previous studies as a marker for risk.[29,46-48]

Because the type of condom (female versus male) was not specified, condom use may be underestimated.[14] If both types were used in a relationship, respondents might have replied negatively if the other partner had used condoms the last time they had intercourse. Since male condoms are used more commonly, women may have a greater chance than men of misinterpreting the question. In fact, consistent with other studies,[14,24,49] in this analysis, women were less likely than men to report using a condom.

By restricting the sample that could respond to condom use during last intercourse, Statistics Canada intended to target a "higher-risk" population (had sex in the past 12 months; were unmarried/not living common-law, or married/living common-law, but with more than one sexual partner in past year). However, this strategy may have missed some high-risk individuals, such as people in a relationship with someone who has other partners. At the same time, some low-risk individuals may have been included; for example, people who were not in a relationship and had only one sexual partner in the past year.

Because previous CCHS cycles did not ask the same questions, trends in STIs and non-use of condoms cannot be determined.

Conclusion

This study suggests the value of investigating geographic variations in factors associated with the risk of STIs. A comprehensive assessment of socio-cultural, socio-demographic and structural barriers to using condoms, to STI testing, and to getting treatment and information is vital for effective and site-specific prevention programs, and ultimately, reducing the incidence of STIs. Geographic analysis can help to target interventions and direct scarce resources toward areas with the greatest need.[50] Studies that use structural-level geographic space as a proxy for underlying risk factors for STIs can identify areas that may be overlooked by a traditional epidemiological approach.[3,40] As well, clusters of STI cases can indicate areas where residents are at greater risk.[35,51]

The results of this analysis also highlight the importance of considering older individuals in preventive interventions. Additional research is needed to explore factors associated with risks for STIs in older Canadians and their reasons for not using condoms. ■

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Health-promoting factors and good health among Canadians in mid- to late life

by Pamela L. Ramage-Morin, Margot Shields and Laurent Martel

Abstract

According to results from the Canadian Community Health Survey—Healthy Aging, 76% of Canadians in mid-life (45 to 64) and 56% of seniors reported good health in 2009. This is based on a definition of health composed of: positive self-perceived general and mental health, functional ability, and independence in activities of daily living. Good health existed even in the presence of chronic conditions such as high blood pressure, arthritis and back problems, all of which were common among people aged 45 or older. Eight modifiable factors were associated with good health: smoking status, body mass index, physical activity, diet, sleep, oral health, stress, and social participation. Eighty-four percent of the younger age group and 91% of seniors reported positive tendencies on four or more of these factors. The more factors on which positive tendencies were reported, the greater the likelihood of having good health.

Keywords

aging, chronic conditions, cross-sectional study, determinants of health, health status, health survey, IADL

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Like many nations, Canada is about to face an unprecedented era of population aging. From 8% fifty years ago, it is projected that Canadian seniors will comprise 23% to 25% of the population in about 25 years' time.[1] A major contributor to this demographic shift is the baby-boom cohort, defined as those born from 1946 to 1965. The senior ranks will swell rapidly starting in 2011 when the first baby-boomers turn 65. Based on data from the 2009 Canadian Community Health Survey (CCHS)—Healthy Aging, this article addresses issues faced by the senior population, comparing them with people in the 45 to 64 age range.

The far-reaching social and economic consequences of the increase of the senior population have provoked debate about the availability and sustainability of health care resources.[2-5] Central to this concern is the growing imbalance between the number of younger contributors to the social support system and the number of older beneficiaries of this support.[3] Currently, Canada has, on average, five people of working age (15 to 64) to support each senior; by 2030, it is projected (based on a medium-growth scenario) that there will be three workers for every person aged 65 or older.[1]

Advancing age brings a greater likelihood of developing chronic conditions, many of which result in the need for informal support, medical care, medications, and institutionalization.[6,7] In 2002, *Building on Values: The Future of Health Care in Canada - Final Report* focussed on the prevention of illness and disability, citing the importance of health practices related to smoking, diet and physical activity.[4] Preventing, delaying, or at the very least, reducing the severity of chronic conditions would not only enhance individuals' quality of life as they age, but might also ease demand on health care resources.[5,8]

The data

Estimates for this study were based primarily on the 2009 Canadian Community Health Survey (CCHS)—Healthy Aging. This cross-sectional survey collected information about the factors, influences and processes that contribute to healthy aging. The survey collected data from people aged 45 or older living in private dwellings in the ten provinces. The sampling frame excluded full-time members of the Canadian Forces and residents of the three territories, Indian reserves, Crown lands, some remote regions and institutions. The survey was conducted from December 1, 2008 through November 30, 2009, using Computer-Assisted Personal Interviewing. Response rates were 80.8% (household level), 92.1% (person level), and 74.4% (combined) for a final sample of 30,865 respondents. Men comprised 43% of the sample; 47% of respondents were aged 45 to 64.

The 2000/2001 CCHS was used for historical comparisons of the percentage of Canadians in good health. This cycle covered residents of the provinces and territories. Data collection took place from September 1, 2000 to November 3, 2001. The combined response rate was 84.7%, for a final sample size of 131,535. The responding sample for those aged 45 or older in the ten provinces was 60,892. Detailed documentation on the CCHS can be found on Statistics Canada's website. Unless otherwise stated, the following information pertains to the 2009 CCHS—Healthy Aging.

The primary outcome variable was self-reported *good health*. To be considered in good health, respondents had to meet four criteria: good functional health, independence in activities of daily living, positive self-perceived general health, and positive self-perceived mental health. These components of good health were self-reported and were not verified by any other source.

Functional health, defined as the absence of a disability, was based on questions about vision, hearing, speech, mobility, dexterity, cognitive abilities and chronic pain. A disability is total or partial reduction in the ability to perform an activity in a way or within limits considered normal. People without disabilities or with a fully corrected disability (wearing glasses, for example) had good functional health.

To be *independent in activities of daily living*, respondents had to report that they had no impairment on seven activities of daily living (ADL) and seven instrumental activities of daily living (IADL). The ADL activities were: feeding themselves, dressing themselves, taking care of their appearance, walking around, getting in or out of bed, bathing, and getting to the bathroom on time. The IADL activities were: using the telephone, travelling, shopping, cooking, doing housework, taking medicine, and handling money. Independence was assessed with a different and less extensive list of activities in 2000/2001: preparing meals, shopping for groceries or other necessities, everyday housework, heavy household chores (washing walls, yard work), personal care (washing, dressing or eating), and moving about inside the house. The wording of the questions also differed between 2000/2001 and 2009. In 2000/2001, respondents were asked if they needed help because of a health condition; in 2009, respondents were simply asked if they needed help. The 2009 question was less restrictive than in 2000/2001, and the list of activities was more extensive, so it is to be expected that respondents would be more likely to register a dependency in 2009, resulting in a larger percentage of people with dependencies.

Self-perceived health was based on the question, "In general, would you say your health is: …." Those who responded good, very good or excellent (versus fair or poor) were defined as having "positive" self-perceived health.

Self-perceived mental health was based on the question, "In general, would you say your mental health is: …." Those who responded good, very good or excellent (versus fair or poor) were defined as having "positive" self-perceived mental health. Because self-perceived mental health was not available on the 2000/2001 CCHS, mental health was assessed by considering the probability of having had a major depressive episode in the previous year. Those with a probability of 0.05 or less met the criterion for good mental health. The use of different measures of mental health in 2000/2001 and 2009 had no impact on the overall increase in good health (data not shown).

To be considered in overall good health, respondents had to be free of problems related to each of these four criteria—that is, they did not have a disability or dependency and reported that their mental and general health were good, very good or excellent. If no answer was provided for one of these measures, but the other three responses suggested the respondents were in good health, they were considered to be so. Respondents missing answers for two or more measures were excluded.

Socio-demographic variables included in the study were: sex, age, education and living arrangements. Respondents were grouped by *age*: seniors (age 65 or older) and adults in mid-life or the "younger" age group (45- to 64-year-olds). Age was included as a continuous variable in the logistic regression analysis. The *highest level of education* in the household was categorized as: less than secondary graduation, secondary graduation (including some postsecondary), or postsecondary graduation. For *living arrangements*, respondents were classified as living alone or not.

The presence of *chronic conditions* was established by asking respondents if a health professional had diagnosed them as having conditions that had lasted, or were expected to last, at least six months. Respondents were read a list of conditions. Only conditions associated with aging were included in this study: Alzheimer's disease or other dementia, arthritis, back problems, bowel disorders (such as Crohn's Disease, ulcerative colitis, Irritable Bowel Syndrome and bowel incontinence), chronic obstructive pulmonary disease (including chronic bronchitis and emphysema), diabetes, eye problems (cataracts or glaucoma), heart disease (including angina and ever having a heart attack), high blood pressure (including people who reported that they did not have high blood pressure but were on blood pressure medication), urinary incontinence, osteoporosis, and suffering from the effects of a stroke. The *number of chronic conditions* was categorized into five groups: none, 1, 2, 3, and 4 or more.

Eight factors with *health-promoting* potential were examined. *Smoking status* was divided into two categories: current daily smokers including former smokers who had quit daily smoking in the past 15 years, and people who had never smoked daily or who had quit daily smoking for 15 or more years. Based on *body mass index (BMI)*, respondents were classified as obese (BMI 30 kg/m^2 or more) or not (BMI less than 30 kg/m^2). Quality of *sleep* was determined by asking: "How often do you have trouble going to sleep or staying asleep?" Those who responded some/a little/none of the time were considered to sleep well, as opposed to those who answered most/all of the time. Fruit and vegetable consumption was used as an indicator of a good *diet*; respondents were divided into those who ate five or more servings a day and those who did not. People who responded good/very good/excellent to the question, "In general, would you say the health of your mouth is…?", were classified as having good *oral health*. *Physical activity* was measured by frequency of walking. Frequent walkers were those who responded "often (5 to 7 days)" to the question, "Over the past 7 days, how often did you take a walk outside your home or yard for any reason? For example, for pleasure or exercise, walking to work, walking the dog, etc." Frequent *social participation* was defined as participating in community-related activities at least weekly. Respondents were asked about activities that included other people: family or friendship activities outside the household; religious, sports, educational and recreation activities; volunteer work; activities with service organizations, and so on. Finally, respondents were asked, "Thinking about the amount of stress in your life, would you say that most days are: . . . ." Those who answered not at all/not very stressful were considered to have low daily *stress*, as opposed to those who answered a bit/quite a bit/extremely stressful.

This analysis was based on the population aged 45 or older. The data were weighted to reflect the age and sex distribution of the Canadian population in this age range. Weighted frequencies and cross-tabulations were used to estimate the percentages of people who: had chronic conditions, were in good health, and reported health-promoting factors. Logistic regression was used to model associations between health-promoting factors and good health, controlling for sex, age, household education, living arrangements, and number of chronic conditions. To account for survey design effects, standard errors and coefficients of variation were estimated with the bootstrap technique.[9,10] A significance level of $p < 0.05$ was used.

The current study has a number of limitations. The 2009 CCHS—Healthy Aging did not include residents of long-term health care institutions (less than 1% of 45- to 64-year-olds and 7% of seniors).[11] Given that older age and ill health are associated with moving to an institution, the sample becomes less representative of the entire senior population at successively older ages. The temporal order between health-promoting factors and good health cannot be established because the survey is cross-sectional. As well, chronic conditions were self-reported and were not verified by an external source. Cancer was not included as one of the chronic conditions because it was not possible to distinguish people without cancer from those in remission.

In cases where the selected respondent was, for reasons of physical or mental health, incapable of completing an interview, another household member supplied information about the selected respondent. Such proxy reporters can often provide accurate answers to most of survey questions, but information about more sensitive or personal matters is likely beyond the scope of their knowledge. As a result, some questions from the proxy interview were not answered. Efforts were made to keep proxy interviews to a minimum—2.2% (689) of the interviews were by proxy: 1.3% (192) of 45- to 64-year-olds and 3.0% (497) of seniors.

This study provides up-to-date estimates of the prevalence of chronic conditions, good health, and factors related to good health for the household population aged 45 or older. Health is defined by a composite measure that includes self-perceived general and mental health, functional abilities and independence in activities of daily living. Each component of health is self-reported; respondents' health status was not verified by any other source. Measures based on these criteria have been used in earlier studies[8,12] and are consistent with the World Health Organization concept of health as being more than simply the absence of disease or infirmity.[13] While chronic conditions are related to perceptions of health, functional abilities and independence, they are not part of the definition of health in this study. The presence of chronic conditions does not automatically exclude a person from reporting good health.

Eight factors that have the potential to affect health are examined in this analysis: smoking, body mass index (BMI), physical activity, diet, sleep, oral health, stress, and social participation. While not an exhaustive list, these are some of the major factors for which data are available on the CCHS—Healthy Aging. Because of the cross-sectional nature of the data, temporal order cannot be inferred from associations between these factors and health. Longitudinal research has shown that many of these factors are predictors of maintaining good health and recovering from illness.[12] However, it must be acknowledged that the relationships may also move in the reverse direction with health status affecting the selected factors.

The CCHS—Healthy Aging covers the *household* population; estimates from this survey do not represent the less than 1% of the population aged 45 to 64 and the 7% of seniors who reside in long-term health care institutions.[11]

Chronic conditions

The demographic shift over the last century took place in tandem with an *epidemiological transition* from mortality at younger ages as a result of infectious diseases, parasites and perinatal conditions to an era when degenerative diseases evolved as major health concerns.[14] Degenerative diseases develop over a lifetime of behaviours, lifestyle factors and environmental influences, and so are more evident at older ages.

Results of the 2009 CCHS—Healthy Aging show that seniors were more likely than people aged 45 to 64 to experience a number of specific chronic conditions (Table 1). More than half of seniors, compared with about one-quarter of 45- to 64-year-olds, reported hypertension or the use of high blood pressure medication. Hypertension is a risk factor for other vascular disorders and a major cause of death.[15] Arthritis does not cause death, but it can have a major impact on quality of life, because it is associated with disability, dependence, falls, fractures, and medication use.[16-19] The prevalence of arthritis among seniors (43%) was more than double the prevalence among people aged 45 to 64 (20%). Like arthritis, back problems can affect quality of life;[20] the prevalence of back problems was significantly higher among the older age group: 29% versus 25%. Although seniors were more likely than 45- to 64-year-olds to experience Alzheimer's disease or other dementia and the effects of a stroke, these conditions were not common in either age group. People with dementia and stroke have higher odds of living in long-term health care facilities,[6] so these conditions would not be expected to be highly prevalent in the household population.

Incontinence, too, is a predictor of moving to a health care institution,[6] and like Alzheimer's disease or other dementia and the effects of stroke, has a severe impact on health-related quality of life.[21] Even so, more than one in ten seniors in the household population reported urinary incontinence.

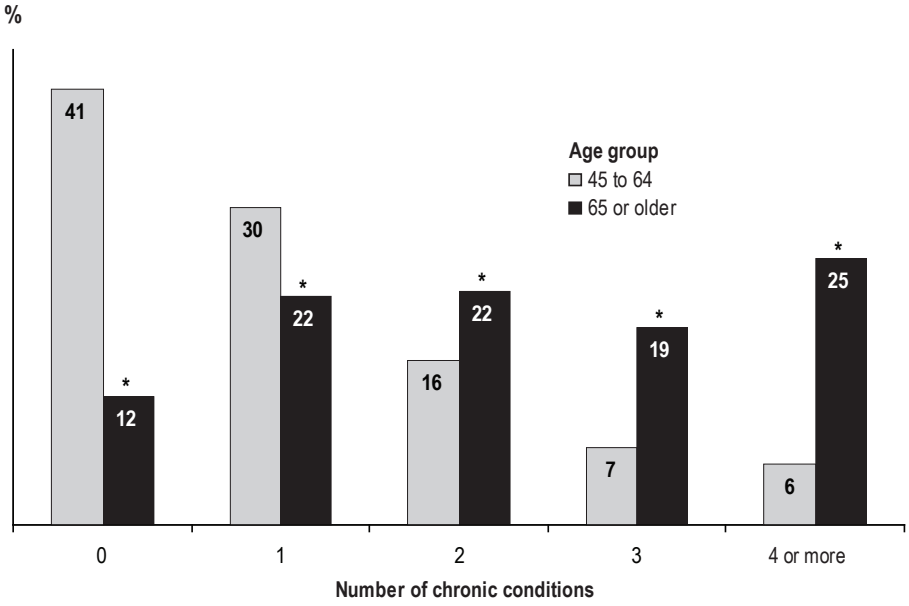
Not surprisingly, as people age, they are more likely to have multiple chronic conditions.[22] For example, 25% of seniors reported at least four chronic conditions, compared with 6% of 45- to 64-year olds (Figure 1). Coping with chronic conditions is challenging for the affected individuals,[20,23] and for family members, friends and caregivers if the conditions result in greater dependency, hospitalizations and further complications.[24-26]

Table 1
Prevalence of chronic conditions, by age group, household population aged 45 or older, Canada, 2009

	45 to 64			65 or older		
		95% confidence interval			95% confidence interval	
Chronic condition	%	from	to	%	from	to
High blood pressure	24.0	22.8	25.4	52.9*	51.7	54.1
Arthritis	20.3	19.2	21.6	43.4*	42.3	44.6
Back problems	25.0	23.8	26.3	28.6*	27.5	29.8
Eye problems (cataracts or glaucoma)	4.6	4.1	5.1	27.9*	26.8	28.9
Heart disease	6.9	6.3	7.6	22.6*	21.7	23.5
Osteoporosis	6.1	5.6	6.7	18.1*	17.2	19.0
Diabetes	8.6	7.8	9.5	17.2*	16.4	18.1
Urinary incontinence	3.3	2.8	3.8	11.7*	11.0	12.5
Chronic obstructive pulmonary disease	4.6	4.0	5.3	8.8*	8.1	9.6
Bowel disorder	5.1	4.6	5.8	6.4*	5.8	7.1
Stroke	1.1	0.9	1.4	4.2*	3.7	4.6
Alzheimer's disease	0.1[E]	0.1	0.2	1.6*	1.4	1.9

* significantly different from estimate for 45 to 64 age group ($p < 0.05$)
[E] use with caution (coefficient of variation 16.6% to 33.3%)
Source: 2009 Canadian Community Health Survey — Healthy Aging.

Figure 1
Percentage distribution of household population aged 45 to 64 and 65 or older, by number of diagnosed chronic conditions, Canada, 2009



* significantly different from estimate for 45 to 64 age group ($p < 0.05$)
Source: 2009 Canadian Community Health Survey — Healthy Aging.

Good health

A sizeable percentage of people aged 45 or older were in good health, based on their self-perceived general and mental health, and measures of functional ability and independence (Figure 2). Understandably, the prevalence of good health declines with age, but even up to age 85, at least half the population were in good health in 2009. Among seniors, men were more likely than women to have good health, a difference that was not evident in the younger age group (Table 2). Higher levels of education were positively associated with good health, as was some form of shared living arrangement. As expected, the more chronic conditions people had, the less likely they were to have good health.

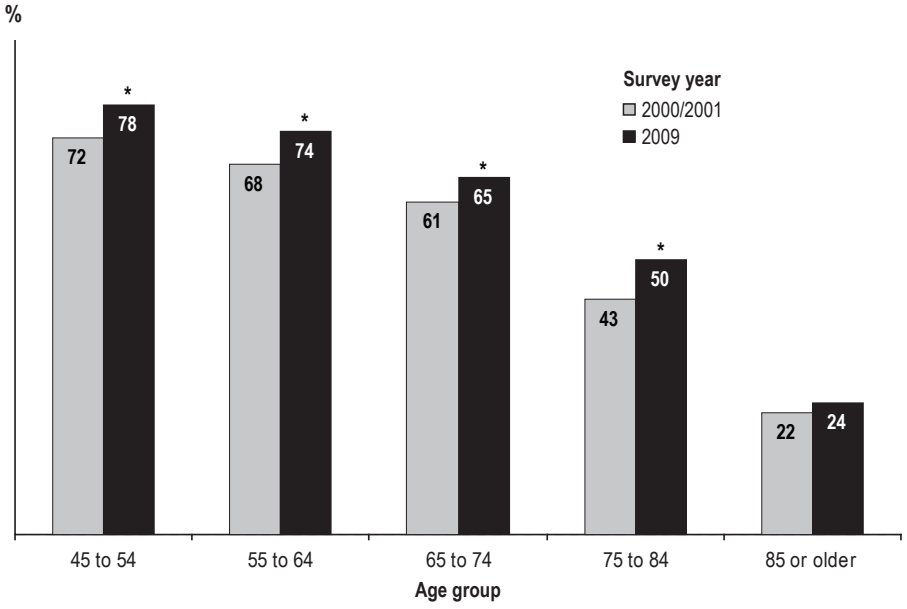
From 2000/2001 to 2009, the prevalence of good health rose significantly in almost every age group (Figure 2). The four factors comprising good health—self-perceived general health, self-perceived mental health, functional abilities and independence—each contributed to the overall increase (data not shown).

Only the oldest seniors (85 or older) did not have a significant increase in good health over the nine years. The percentages reporting good self-perceived general health and functional health increased significantly, but the percentage who were independent in activities of daily living (ADL/IADL) decreased slightly (data not shown). This decrease may reflect changes in the ADL/IADL questions between the 2000/2001 and 2009 CCHS (see *The data*). The decrease in the prevalence of independence in ADL/IADL likely offset increases in the other factors, resulting in no net change over the period in the percentage of seniors aged 85 or older in good health.

Health-promoting factors

The development of chronic conditions is not inevitable. While genetic predisposition plays a role, factors within individuals' control can prevent the development of chronic conditions or limit their severity. Eight potentially

Figure 2
Prevalence of good health, by age group, household population aged 45 or older, Canada, 2000/2001 and 2009



* significantly different from estimate for 2000/2001 ($p < 0.05$)
Note: Depression used instead of self-percieved mental health for 2000/2001.
Source: 2009 Canadian Community Health Survey — Healthy Aging; 2000/2001 Canadian Community Health Survey.

Table 2
Prevalence of good health, by age group and other selected characteristics, household population aged 45 or older, Canada, 2009

	45 to 64			65 or older		
		95% confidence interval			95% confidence interval	
Characteristics	%	from	to	%	from	to
Total	**76.2**	**74.9**	**77.5**	**55.5**	**54.3**	**56.7**
Socio-demographic factors						
Sex						
Men	76.5	74.5	78.4	59.0*	57.2	60.7
Women†	75.9	74.1	77.7	52.6	51.1	54.1
Education						
Less than secondary graduation	59.0*	54.1	63.8	46.5*	44.3	48.8
Secondary graduation†	71.3	68.2	74.3	54.7	52.0	57.3
Postsecondary graduation	79.1*	77.7	80.5	60.9*	59.2	62.6
Lives alone						
Yes	70.6*	67.8	73.2	50.1*	48.4	51.7
No†	77.1	75.7	78.5	57.8	56.2	59.3
Number of chronic conditions						
None	90.7	89.2	92.0	81.4	78.8	83.7
1	77.9*	75.4	80.1	74.0*	71.7	76.2
2	65.9*	62.5	69.2	62.1*	59.6	64.6
3	46.6*	41.9	51.5	48.9*	46.3	51.6
4 or more	31.8*	27.4	36.6	26.6*	24.5	28.8
Health-promoting factors						
Smoking status						
Current daily smoker/Quit in past 15 years†	69.7	67.3	72.0	50.3	47.7	53.0
Never smoked daily/Quit for 15 or more years	79.7*	78.2	81.1	56.7*	55.4	58.0
Body mass index (BMI)						
Obese†	69.5	66.4	72.4	46.4	43.6	49.3
Not obese	79.1*	77.7	80.4	59.5*	58.3	60.8
Sleeps well						
Yes	81.2*	79.9	82.4	61.2*	59.9	62.5
No†	59.8	56.5	63.0	40.5	37.9	43.2
Fruit/Vegetable consumption						
Five or more times per day	83.2*	81.6	84.7	62.9*	61.1	64.7
Less than five times per day†	72.7	70.9	74.4	52.8	51.4	54.3
Good oral health						
Yes	79.3*	78.0	80.6	58.3*	57.1	59.5
No†	54.2	50.2	58.1	34.2	31.2	37.2
Frequent walker						
Yes	79.2*	77.4	80.8	63.4*	61.7	65.0
No†	73.8	72.0	75.5	49.0	47.3	50.7
Frequent social participation						
Yes	79.2*	77.8	80.5	59.8*	58.5	61.1
No†	68.7	65.8	71.5	43.2	40.8	45.6
Low daily stress						
Yes	83.5*	81.7	85.1	60.7*	59.2	62.1
No†	72.5	70.7	74.3	48.8	46.9	50.7

† reference category; for number of chronic conditions, reference category is previous number
* significantly different from estimate for reference category ($p < 0.05$)
Source: 2009 Canadian Community Health Survey — Healthy Aging.

modifiable factors are examined in this study: smoking, BMI, physical activity, diet, sleep, oral health, stress, and social participation.

The vast majority of adults—84% of people aged 45 to 64 and and 91% of seniors—reported four or more positive tendencies with regard to these factors (Table 3). In fact, more than half (53%) of seniors reported at least six, compared with 37% of 45- to 64-year-olds.

Fully 82% of seniors had either never smoked daily or had quit for at least 15 years, compared with 65% of the younger cohort. As well, seniors were less likely to be obese and more likely to eat the recommended number of servings of fruit/vegetables. These differences may reflect a "healthy survivor effect," whereby people who are non-smokers, eat well, and watch their weight have a greater likelihood of longevity. Alternatively, some seniors with health-promoting tendencies may have had health problems and responded with positive changes. Other differences may be associated with retirement or other age-related changes in how they use their time. For example, 57% of seniors reported low daily stress, compared with 34% of adults in mid-life. Seniors were slightly more likely to report frequent social participation: 75% versus 72% of the younger age group.

For the remaining factors, there were no significant differences by age. More than three-quarters of each age group reported sleeping well, and almost 90% had good oral health. Fewer than half were frequent walkers, the measure of physical activity.

Associations with good health

As expected, the number of diagnosed chronic conditions was negatively associated with good health (Table 2). At the same time, the modifiable factors examined in this study were each positively associated with good health. People who refrained from smoking, walked frequently and were not obese were more likely to be in good health than were those who did not have these characteristics. Positive associations were also evident between good health and frequent social participation, low daily stress, sleeping well, good oral health, and eating fruit/vegetables five or more times a day.

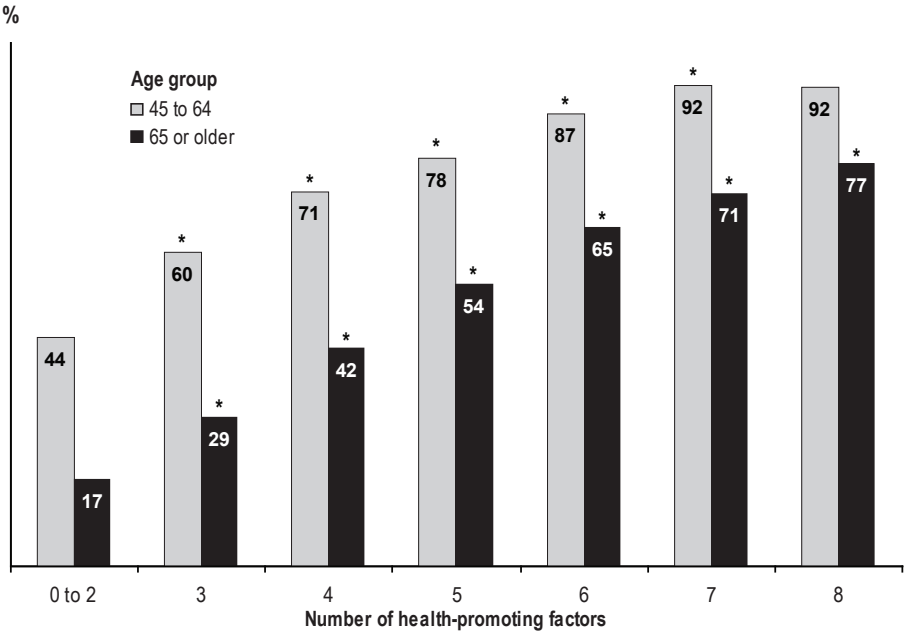
Health-promoting tendencies might be expected to cluster within individuals. However, when the eight factors were simultaneously controlled for in multivariate models along with socio-demographic factors, each was independently associated with good health for both age groups (Appendix Table A). For the most part, these

Table 3
Prevalence of health-promoting factors by age group, household population aged 45 or older, Canada, 2009

	45 to 64			65 or older		
		95% confidence interval			95% confidence interval	
Health-promoting factors	%	from	to	%	from	to
Never smoked daily/Quit for 15 or more years	65.4	64.0	66.8	81.8*	80.9	82.7
Not obese (body mass index less than 30 kg/m^2)	76.8	75.3	78.1	81.1*	80.1	82.0
Sleeps well	78.2	77.0	79.4	78.6	77.7	79.5
Fruit/Vegetable consumption five or more times per day	36.5	34.9	38.1	39.0*	37.7	40.3
Good oral health	87.7	86.7	88.7	88.4	87.6	89.1
Frequent walker	44.7	43.0	46.5	45.3	44.0	46.6
Frequent social participation	71.8	70.2	73.3	75.0*	73.9	76.1
Low daily stress	33.6	32.0	35.2	56.7*	55.5	57.9
Number of health-promoting factors						
0 to 2	5.5	4.9	6.2	2.4*	2.1	2.8
3	10.5	9.5	11.6	6.7*	6.1	7.3
4	20.4	19.0	21.8	14.6*	13.7	15.5
5	26.6	25.2	28.0	23.7*	22.7	24.7
6	21.9	20.6	23.3	27.1*	26.0	28.2
7	11.9	10.8	13.0	19.5*	18.5	20.5
8	3.2	2.7	3.9	6.0*	5.4	6.6

* significantly different from estimate for 45 to 64 age group ($p < 0.05$)
Source: 2009 Canadian Community Health Survey — Healthy Aging.

Figure 3
Prevalence of good health, by number of health-promoting factors and age group, household population aged 45 or older, Canada, 2009



* significantly different from estimate for previous category in same age group ($p < 0.05$)
Source: 2009 Canadian Community Health Survey — Healthy Aging; 2000/2001 Canadian Community Health Survey.

associations persisted even when the number of chronic conditions was taken into account (Appendix Table B).

The results of the analysis suggest that the benefits of health-promoting tendencies are cumulative (Figure 3). Generally, with every additional health-promoting factor, the likelihood of good health increased. More than three-quarters (77%) of seniors who reported positive tendencies on all eight factors were in good health; among people aged 45 to 64, the figure was 92%. Although advancing age was associated with poorer health, a senior with positive tendencies on five or more factors was more likely to be in good health than was a 45- to 64-year-old with positive tendencies on two or fewer factors.

Despite longitudinal evidence that many of the health-promoting factors have an impact on health,[27,28] the cross-sectional nature of the CCHS—Healthy Aging does not allow the temporal order of events to be established. It is possible and probable that relationships between the health-promoting factors and health also work in the opposite direction. Ill health, for example, may interfere with the ability to exercise regularly, sleep well, and socialize. The experience of coping with chronic conditions may prove stressful. And illness may leave people without the resources to manage their weight, prepare healthful meals or optimize their oral health. Nonetheless, the importance of these factors in promoting good health remains.

Conclusion

Canada's population is aging, and as the baby-boomers reach 65 during the next two decades, this demographic change will accelerate. The 2009 Canadian Community Health Survey—Healthy Aging indicates that even in the presence of some chronic conditions, 76% of people aged 45 to 64 and 56% of seniors living in private households (versus long-term health care institutions) had good health, based on their perceptions of general and mental health, functional abilities, and independence in activities of daily living. As well, Canadians in mid- to late life were slightly more likely

to be in good health in 2009 than they had been almost a decade earlier.

A number of factors over which individuals have some control were associated with good health. Not smoking, weight control, regular exercise, fruit/vegetable consumption, sleeping well, oral health, stress reduction, and participation in activities with family and friends had a cumulative association with good health. A large majority of respondents reported four or more of these health-promoting tendencies. ■

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Appendix

Table A
Adjusted odds ratios relating socio-demographic and health-promoting factors to good health, by age group, household population aged 45 or older, Canada, 2009

	45 to 64			65 or older		
	Adjusted odds ratio	95% confidence interval		Adjusted odds ratio	95% confidence interval	
Characteristics		from	to		from	to
Socio-demographic factors						
Sex						
Men	1.1	0.9	1.3	1.1*	1.0	1.3
Women†	1.0	…	…	1.0	…	…
Age (continuous)	0.96*	0.95	0.97	0.91*	0.90	0.92
Education						
Less than secondary graduation	0.7*	0.5	0.9	0.9	0.7	1.0
Secondary graduation†	1.0	…	…	1.0	…	…
Postsecondary graduation	1.2*	1.0	1.5	1.1	0.9	1.3
Lives alone						
Yes	0.8*	0.7	1.0	1.0	0.9	1.1
No†	1.0	…	…	1.0	…	…
Health-promoting factors						
Smoking status						
Current daily smoker/Quit in past 15 years†	1.0	…	…	1.0	…	…
Never smoked daily/Quit for 15 or more years	1.3*	1.1	1.5	1.5*	1.3	1.7
Body mass index (BMI)						
Obese†	1.0	…	…	1.0	…	…
Not obese	1.6*	1.3	1.9	2.0*	1.7	2.3
Sleeps well						
Yes	2.5*	2.1	2.9	2.0*	1.7	2.3
No†	1.0	…	…	1.0	…	…
Fruit/Vegetable consumption						
Five or more times per day	1.5*	1.3	1.7	1.3*	1.2	1.4
Less than five times per day†	1.0	…	…	1.0	…	…
Good oral health						
Yes	2.9*	2.4	3.5	2.1*	1.7	2.4
No†	1.0	…	…	1.0	…	…
Frequent walker						
Yes	1.2*	1.0	1.4	1.5*	1.3	1.6
No†	1.0	…	…	1.0	…	…
Frequent social participation						
Yes	1.4*	1.2	1.7	1.5*	1.4	1.7
No†	1.0	…	…	1.0	…	…
Low daily stress						
Yes	1.8*	1.5	2.1	1.7*	1.5	1.9
No†	1.0	…	…	1.0	…	…

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
... not applicable
Source: 2009 Canadian Community Health Survey — Healthy Aging.

Table B
Adjusted odds ratios relating socio-demographic factors, health-promoting factors and number of chronic conditions to good health, by age group, household population aged 45 or older, Canada, 2009

	45 to 64			65 or older		
		95% confidence interval			95% confidence interval	
Characteristics	Adjusted odds ratio	from	to	Adjusted odds ratio	from	to
Socio-demographic factors						
Sex						
Men	1.0	0.8	1.2	1.0	0.9	1.1
Women†	1.0	…	…	1.0	…	…
Age (continuous)	1.00	0.98	1.01	0.92*	0.92	0.93
Education						
Less than secondary graduation	0.7*	0.5	1.0	0.9	0.7	1.1
Secondary graduation†	1.0	…	…	1.0	…	…
Postsecondary graduation	1.2	1.0	1.4	1.1	0.9	1.3
Lives alone						
Yes	0.8	0.7	1.0	1.0	0.9	1.1
No†	1.0	…	…	1.0	…	…
Health-promoting factors						
Smoking status						
Current daily smoker/Quit in past 15 years†	1.0	…	…	1.0	…	…
Never smoked daily/Quit for 15 or more years	1.2	1.0	1.4	1.4*	1.2	1.6
Body mass index (BMI)						
Obese†	1.0	…	…	1.0	…	…
Not obese	1.1	0.9	1.3	1.6*	1.4	1.9
Sleeps well						
Yes	1.9*	1.6	2.2	1.7*	1.5	2.0
No†	1.0	…	…	1.0	…	…
Fruit/Vegetable consumption						
Five or more times per day	1.4*	1.2	1.7	1.3*	1.2	1.5
Less than five times per day†	1.0	…	…	1.0	…	…
Good oral health						
Yes	2.6*	2.1	3.2	1.8*	1.6	2.2
No†	1.0	…	…	1.0	…	…
Frequent walker						
Yes	1.2*	1.0	1.4	1.4*	1.2	1.6
No†	1.0	…	…	1.0	…	…
Frequent social participation						
Yes	1.4*	1.2	1.7	1.5*	1.3	1.7
No†	1.0	…	…	1.0	…	…
Low daily stress						
Yes	1.6*	1.4	1.9	1.6*	1.4	1.7
No†	1.0	…	…	1.0	…	…
Number of chronic conditions						
None†	1.0	…	…	1.0	…	…
1	0.4*	0.3	0.5	0.7*	0.6	0.9
2	0.2*	0.2	0.3	0.5*	0.4	0.6
3	0.1*	0.1	0.2	0.3*	0.2	0.4
4 or more	0.1*	0.1	0.1	0.1*	0.1	0.2

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
... not applicable
Source: 2009 Canadian Community Health Survey — Healthy Aging.


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An update on cancer survival

by Larry F. Ellison and Kathryn Wilkins

Abstract

Statistics Canada routinely produces cohort-based estimates for cancer survival; the most recent were based on cases diagnosed from 1992-2000. This report provides predicted survival estimates for cases diagnosed more recently. Using records from the Canadian Cancer Registry linked to the Canadian Vital Statistics Death Data Base, cancer- and age-specific estimates of relative survival have been calculated for 2004-2006. The five-year relative survival ratio (RSR) for all cancers combined was 62%, and ranged from 6% for pancreatic cancer to 98% for cancer of the thyroid. The RSR was typically higher at younger than older ages, with exceptions for some common cancers. From 1992-1994 to 2004-2006, the five-year RSR for a number of cancers increased—usually slightly, but in some cases, appreciably (for example, the age-standardized RSR for non-Hodgkin lymphoma rose from 51% to 63%; for leukemia, from 44% to 54%; and for liver, 9% to 17%).

Keywords

neoplasms, population surveillance, prognosis, registries, survival analysis

Authors

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A diagnosis of cancer does not usually mean that death is imminent. The five-year survival of Canadians diagnosed with invasive cancer is predicted to be, on average, 62% of that of an otherwise similar group of people without cancer. Of course, the term "cancer" is used to refer to myriad malignancies—each of which confers a distinct illness and prognosis. Some cancers are far more lethal, and within a shorter time-span, than are others.

With records from the Canadian Cancer Registry (CCR) linked to the Canadian Vital Statistics Death Database, relative survival statistics have been calculated. Cohort-based survival estimates from cancer are routinely published by Statistics Canada[1]; the most recent pertained to cases diagnosed from 1992 to 2000. This report provides predicted survival estimates for cases diagnosed in 2004-2006. Duration- and age-specific relative survival estimates are derived for 23 of the most commonly occurring cancers in people aged 15 through 99; five-year survival estimates for cases diagnosed in 2004-2006 are compared with those diagnosed in 1992-1994.

Survival varies by type of cancer

For all cancers combined, the five-year relative survival ratio (RSR) was estimated at 62%—meaning that the predicted probability of surviving five years following a diagnosis of cancer in the years 2004-2006 was about three-fifths the survival probability of persons not diagnosed with cancer (Table 1). The ten-year RSR was nearly as high: 58%. Five-year RSRs ranged from 6% for pancreatic cancer to 98% for cancer of the thyroid. Relative survival was high for cancers of the prostate (96%) and testis (95%), skin melanoma (89%), and breast cancer (88%). Cancer sites for which five-year RSRs were low included esophagus (13%), lung and bronchus (16%), and liver (18%).

With some important exceptions for individual cancers, relative survival exhibited a general pattern of a fairly substantial decline in the year following diagnosis, a somewhat more gradual fall

The data

Cancer incidence data are from the July 2010 version of the Canadian Cancer Registry (CCR), a dynamic, person-oriented, population-based database maintained by Statistics Canada. The CCR contains information on cases diagnosed from 1992 onward, compiled from reports from every provincial/territorial cancer registry.

A file containing records of invasive cancer cases and *in situ* bladder cancer cases (the latter are reported for each province/territory except Ontario) was created using the multiple primary coding rules of the International Agency for Research on Cancer.[2] Cancer cases were classified based on the *International Classification of Diseases for Oncology, Third Edition*[3] and grouped using Surveillance, Epidemiology, and End Results (SEER) Program grouping definitions, with mesothelioma and Kaposi's sarcoma as separate groups.[4]

Mortality follow-up through December 31, 2006 was determined by record linkage to the Canadian Vital Statistics Death Database (excluding deaths registered in the province of Quebec), and from information reported by provincial/territorial cancer registries. For deaths reported by a provincial registry but not confirmed by record linkage, the date of death was assumed to be that submitted by the reporting registry.

Analyses were based on all primary cancers—an approach that is becoming standard practice, as the wisdom of restricting analyses to first primary cancers in an individual has been questioned.[5,6] The effect of including multiple cancers in survival analyses has been studied internationally[5,6] and in Canada.[7] Data from the province of Quebec were excluded from the analysis primarily because of issues in correctly ascertaining the vital status of cases. Records were also excluded if: age at diagnosis was younger than 15 or older than 99; diagnosis was established through autopsy or death certificate; or the year of birth or death was unknown.

Relative survival was estimated.[8] It is defined as the ratio of the observed survival of a group of people with cancer to the expected survival for people in the general population who are assumed to be free of cancer and otherwise have the same characteristics affecting survival as the group with cancer.[8] Survival analyses were based on a publicly available algorithm,[9] to which minor adaptations were made. Expected survival proportions were derived from sex-specific, complete provincial life tables using the Ederer II approach.[10] Further detail on the survival methodology used is provided elsewhere.[1]

The cohort-based method of cancer survival analysis includes only cases diagnosed within defined calendar years and with the potential to be followed over the full duration of interest (for example, five years). Long-term survival estimates derived using the cohort approach may not reflect the long-term survival experience expected for newly diagnosed individuals if the prognosis has changed recently. To address this issue, period analysis was introduced to derive more up-to-date estimates of long-term survival.[11,12] With this method, follow-up data do not relate to a fixed cohort of patients. Rather, estimates are based on the assumption that people diagnosed during the period of interest will experience the most recently observed conditional probabilities of survival. When survival is generally improving, a period estimate tends to be a conservative prediction of the survival that is eventually observed.[13-16]

Period-based survival estimates using CCR data have been published on an ad hoc basis[17-19] and not to the same level of detail as the cohort estimates. Cohort-based survival estimates dating back to cases diagnosed in 1992 are routinely published by Statistics Canada—the latest publication includes cases diagnosed as recently as 2000 and followed to 2005.[1]

For this report, relative survival ratios (RSR) for cases diagnosed in 1992-1994 were derived using the cohort method; predicted RSRs for 2004-2006 were derived using the period method. Age-standardized estimates were calculated using the direct method by weighting age-specific estimates for a given cancer to the age distribution of persons diagnosed with that cancer from 1992-2001.

over the next two years, then a smaller decline over the interval from three to five years after diagnosis. From five to ten years after diagnosis, the decline in survival was typically, but not invariably, small.

In the year after diagnosis, the most lethal cancer was pancreatic, with a one-year RSR of 21%. Other cancers with low one-year RSRs were esophageal (37%), lung and bronchus (39%) and liver (40%). From one to three years after diagnosis, RSRs for multiple myeloma, ovarian and esophageal cancer fell the most steeply of all cancers—each by slightly over 20 percentage points.

In the period from three to five years after diagnosis, the RSRs with the greatest declines were those for multiple myeloma and ovarian cancer, which fell by 13 and 11 percentage points, respectively. From five to ten years after diagnosis, RSRs for most cancers declined by less than 5 percentage points. The most notable exceptions included multiple myeloma and cancer of the larynx, which declined by 15 and 11 percentage points, respectively.

Among cancers with high survival, breast cancer had a relatively large RSR decline of 6 percentage points after five years. For cancers of the prostate, testis and thyroid, the RSR at ten years from diagnosis remained nearly at the same level as at one year (Figure 1).

Survival varies by age

Relative survival differed by age. For most cancers, the RSR was higher at younger than older ages, and for some cancers, the survival advantage at younger ages was quite marked. For example, at ages 15 through 44, the five-year RSR for cancer of the brain was 58%, compared with 9% at ages 65 through 74, and 4% at ages 75 through 99 (Table 2).

For other cancers, when diagnosis occurred before age 75, relative survival

Table 1
Predicted relative survival ratios, by type of cancer and survival duration, population aged 15 to 99 at diagnosis, Canada excluding Quebec, 2004 to 2006

	Survival duration											
	One-year			Three-year			Five-year			Ten-year		
	RSR	95% confidence interval		RSR	95% confidence interval		RSR	95% confidence interval		RSR	95% confidence interval	
Type of cancer	%	from	to	%	from	to	%	from	to	%	from	to
All cancers	**76**	**76**	**76**	**66**	**66**	**66**	**62**	**62**	**62**	**58**	**58**	**58**
Oral cavity and pharynx	82	81	83	67	66	68	63	61	64	55	54	57
Esophagus	37	36	39	17	15	18	13	12	15	11	10	12
Stomach	47	45	48	28	27	29	24	23	25	22	21	23
Colorectal	81	81	82	69	68	69	63	63	64	61	60	61
Liver	40	38	41	23	22	25	18	16	19	15	13	16
Pancreas	21	21	22	8	8	9	6	6	7	6	5	6
Larynx	85	83	87	71	69	73	64	62	66	53	50	56
Lung and bronchus	39	39	39	20	20	20	16	15	16	12	11	12
Skin melanoma	97	97	97	92	91	92	89	89	90	88	87	89
Breast	97	97	97	91	91	92	88	87	88	82	81	82
Cervix uteri	88	87	89	76	75	78	73	71	74	70	68	71
Corpus uteri	94	93	95	88	87	89	85	85	86	84	83	85
Ovary	74	73	76	53	52	55	42	41	44	35	33	36
Prostate	98	98	99	97	96	97	96	96	97	95	94	96
Testis	98	97	98	96	95	97	95	94	96	95	94	96
Bladder (including *in situ*)	86	85	86	77	76	78	73	72	74	69	67	70
Kidney and renal pelvis	79	78	80	71	70	72	67	66	68	63	62	64
Brain	46	44	47	27	26	28	23	21	24	18	17	19
Thyroid	98	98	99	98	97	98	98	97	98	97	96	98
Hodgkin lymphoma	92	90	93	87	86	89	85	83	87	80	78	82
Non-Hodgkin lymphoma	78	77	79	68	68	69	63	62	64	54	53	55
Multiple myeloma	73	71	74	50	49	52	37	35	38	22	20	24
Leukemias	70	69	71	61	59	62	55	54	56	46	44	47

Source: Canadian Cancer Registry, Statistics Canada and Provincial/Territorial Cancer Registries.

was similar across the four age groups 15 to 44, 45 to 54, 55 to 64 and 65 to 74, but was lower among people diagnosed between ages 75 and 99. To illustrate, the five-year RSR for colorectal cancer in the four younger age groups ranged from 65% to 68%, but was 58% in the oldest age group. The RSR for breast cancer was 87% to 90% in age groups younger than 75, but 82% among people diagnosed at ages 75 to 99.

Associations between age and survival emerge more clearly when finer age groups are examined. Breast cancer five-year relative survival has been reported elsewhere as 82% when diagnosed before age 40, and prostate cancer, as 82% for men aged 80 to 99.[20]

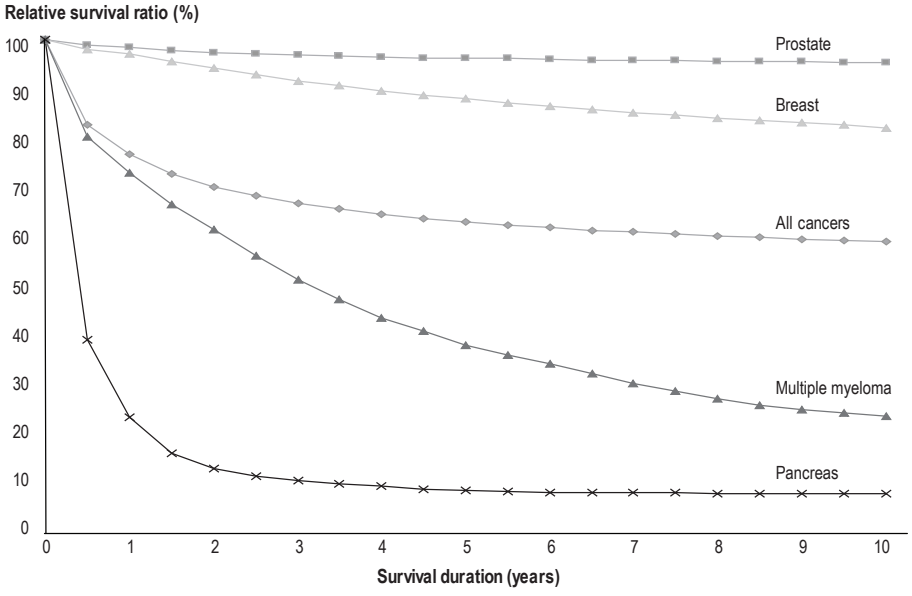
From 1992-1994 to 2004-2006, five-year relative survival for a number of cancers increased—usually slightly, but in some cases, appreciably (Figure 2). For example, the age-standardized RSR for non-Hodgkin lymphoma rose from 51% to 63%; that for leukemia, from 44% to 54%; and for liver, from 9% to 17%. For other cancers, age-standardized RSRs were stable (bladder, corpus uteri and pancreas) during the period. Increases in RSRs over time may reflect diagnosis at an earlier stage of the disease—when treatment is more effective or from which point survival is artefactually longer—or improvements in treatment.

Conclusion

Survival from cancer depends on the type of cancer and the age at diagnosis. Generally, relative survival is greater when cancer is diagnosed in early rather than later adulthood, but for some of the most common cancers, survival is less affected by age. The data suggest that since 1992-1994, the prognosis after diagnosis has generally improved somewhat—and notably so for a few cancers.

Statistics derived from an entire population's cancer survival experience provide a useful indicator of the disease's

Figure 1
Ten-year cumulative relative survival ratios, selected cancers, Canada excluding Quebec, 2004 to 2006



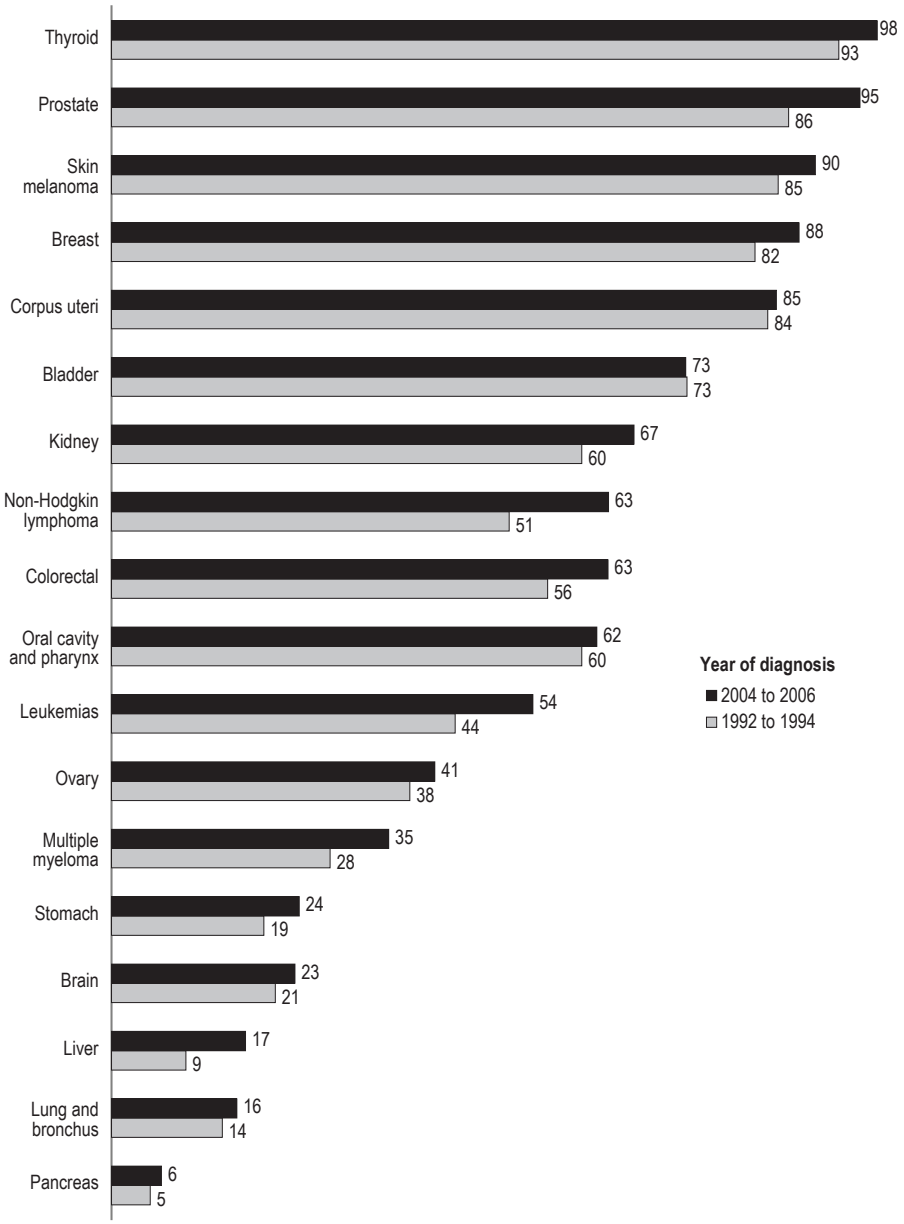
Source: Canadian Cancer Registry, Statistics Canada and Provincial/Territorial Cancer Registries.

Table 2
Predicted five-year relative survival ratios (RSR), by type of cancer and age group, population aged 15 to 99 at diagnosis, Canada excluding Quebec, 2004 to 2006

	Age group (years)														
	15 to 44			45 to 54			55 to 64			65 to 74			75 to 99		
	RSR	95% confidence interval		RSR	95% confidence interval		RSR	95% confidence interval		RSR	95% confidence interval		RSR	95% confidence interval	
Type of cancer	%	from	to	%	from	to	%	from	to	%	from	to	%	from	to
All cancers	**81**	**81**	**82**	**71**	**71**	**72**	**67**	**67**	**68**	**61**	**61**	**62**	**49**	**49**	**49**
Oral cavity and pharynx	82	79	84	71	68	73	62	60	65	56	53	58	53	50	57
Esophagus	18	12	26	16	12	20	16	13	18	14	12	16	10	8	12
Stomach	35	30	40	28	24	31	28	25	31	26	24	28	18	17	20
Colorectal	67	64	69	65	64	67	68	66	69	65	64	66	58	57	60
Liver	40	32	48	29	25	34	19	16	23	14	12	17	8	6	11
Pancreas	23	18	29	11	9	14	8	7	10	5	4	6	4	3	5
Larynx	82	70	90	70	64	75	66	62	69	60	56	64	63	57	69
Lung and bronchus	28	25	31	20	19	22	19	18	19	16	15	17	11	11	12
Skin melanoma	93	92	94	92	90	93	90	88	91	87	85	89	85	82	88
Breast	87	86	88	89	89	90	90	89	90	90	89	91	82	80	83
Cervix uteri	84	82	86	71	68	74	69	65	74	57	51	62	42	36	49
Corpus uteri	89	87	92	92	91	94	89	88	90	82	80	84	76	73	79
Ovary	73	70	76	57	54	60	44	41	46	32	30	35	20	18	23
Prostate	94	89	97	96	95	97	98	98	98	99	98	99	90	89	91
Testis	96	95	97	95	91	97	91	80	97	-	-	-	-	-	-
Bladder (including *in situ*)	87	83	91	82	79	84	80	79	82	76	74	78	64	62	66
Kidney and renal pelvis	85	82	87	75	73	77	71	69	73	65	63	67	54	51	56
Brain	58	55	61	27	24	31	13	11	15	9	7	11	4	2	5
Thyroid	100	99	100	99	98	100	98	96	99	94	91	97	86	79	92
Hodgkin lymphoma	95	93	96	86	81	90	81	74	87	57	48	65	41	31	51
Non-Hodgkin lymphoma	78	76	80	76	74	78	72	70	73	59	57	61	45	43	47
Multiple myeloma	64	55	71	61	56	65	50	46	53	34	31	37	21	19	24
Leukemias	68	65	70	71	68	74	66	64	69	55	52	57	38	36	40

- standard error >0.05
Source: Canadian Cancer Registry, Statistics Canada and Provincial/Territorial Cancer Registries.

Figure 2
Age-standardized five-year relative survival ratios for cases diagnosed in 1992 to 1994 and in 2004 to 2006, by type of cancer, population aged 15 to 99, Canada excluding Quebec



Source: Canadian Cancer Registry, Statistics Canada and Provincial/Territorial Cancer Registries.

burden. These estimates reflect the average survival time of large groups of people and do not necessarily reflect an individual's chances of surviving for a given period. The prognosis for a specific person diagnosed with cancer will take into account individual factors that may affect survival such as frailty, co-morbidity, stage of disease at detection, treatment modality, and response to treatment. Nonetheless, the data provide excellent information on the impact of various types of cancer following diagnosis. ■

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Validation of self-rated mental health

by Farah N. Mawani and Heather Gilmour

Abstract

Background
This article assesses the association between self-rated mental health and selected World Mental Health-Composite International Diagnostic Interview (WMH-CIDI)-measured disorders, self-reported diagnoses of mental disorders, and psychological distress in the Canadian population.

Data and methods
Data are from the 2002 Canadian Community Health Survey: Mental Health and Well-being. Weighted frequencies and cross-tabulations were used to estimate the prevalence of each mental morbidity measure and self-rated mental health by selected characteristics. Mean self-rated mental health scores were calculated for each mental morbidity measure. The association between self-rated mental health and each mental morbidity measure was analysed with logistic regression models.

Results
In 2002, an estimated 1.7 million Canadians aged 15 or older (7%) rated their mental health as fair or poor. Respondents classified with mental morbidity consistently reported lower mean self-rated mental health (SRMH) and had significantly higher odds of reporting fair/poor mental health than did those not classified with mental morbidity. Gradients in mean SRMH scores and odds of reporting fair/poor mental health by recency of WMH-CIDI-measured mental disorders were apparent. A sizeable percentage of respondents classified as having a mental morbidity did not perceive their mental health as fair/poor.

Interpretation
Although self-rated mental health is not a substitute for specific mental health measures it is potentially useful for monitoring general mental health.

Keywords
agoraphobia, bipolar disorder, depression, panic disorder, social phobia, perceived mental health, population health surveys

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Studies of the extent to which the widely used measure, self-rated *health*, captures *mental* health[1-3] suggest the need for a specific self-rated mental health (SRMH) measure. In fact, a number of surveys in Canada and worldwide have used such a measure: for example, the Ontario Health Survey: Mental Health Supplement; the Canadian Community Health Survey; and the World Mental Health Initiative Surveys in 28 countries.

Recent research has demonstrated associations between SRMH and social class,[4] family support and family cultural conflict,[5] community belonging,[6] service use,[7-11] continuation of antidepressant therapy,[12] and distress, activity restriction and social role functioning.[13] However, relatively little is known about what SRMH actually represents and how well it measures current mental health status and predicts future mental health status.[13] Only one study[13] has examined cross-sectional associations between SRMH and a range of validated mental health measures. The study found that SRMH was correlated more strongly with self-rated general health than with the mental health measures that were examined. The current study evaluates associations between SRMH and a wider range of mental health measures and uses different analytic techniques than the aforementioned study.

Data and methods

Data source

This analysis is based on data from the 2002 Canadian Community Health Survey cycle 1.2: Mental Health and Well-being, which began in May 2002 and was conducted over eight months. It is the only Statistics Canada population survey that includes both self-rated mental health and several specific and non-specific measures of mental morbidity. It covered people aged 15 or older living in private dwellings in the 10 provinces. Residents of institutions, Indian reserves, certain remote areas and the three territories, and full-time members of the Canadian Forces were excluded.

The sample was selected using the area frame for the Labour Force Survey. A multi-stage stratified cluster design was used to sample dwellings within

this area frame. One person aged 15 or older was randomly selected from each sampled household. Respondents were chosen to overrepresent young people (15 to 24) and seniors (65 or older), thereby ensuring adequate sample sizes for these age groups. More detailed descriptions of the design, sample and interview procedures can be found in other reports and on Statistics Canada's website.[14,15]

All interviews were conducted using a computer-assisted application. Most interviews (86%) were conducted in person; the remainder, by telephone. Proxy responses were not accepted. The responding sample comprised 36,984 persons aged 15 or older, for a response rate of 77%.

Analytical techniques

Cross-tabulations were used to estimate the prevalence of and characteristics associated with each mental morbidity and with levels of SRMH.

Mean SRMH scores were calculated for respondents with each mental morbidity. Significant differences in mean scores between respondents with and without each morbidity were examined.

Unadjusted logistic regression models were used to assess the association between each mental morbidity and SRMH. For each morbidity, multivariate logistic regression models that controlled for sex, age, marital status, education, household income, immigrant status and the presence of chronic physical conditions were also used. Proportional odds models were not used because the proportional odds assumption is not met.

All estimates and analyses were based on weighted data that reflect the age and sex distribution of the household population aged 15 or older in the 10 provinces in 2002. To account for survey design effects, standard errors and coefficients of variation were estimated with the bootstrap technique.[16-18]

Definitions

Self-rated mental health

Self-rated mental health was measured by asking respondents, "In general, would you say your mental health is: excellent? very good? good? fair? poor?" The responses were dichotomized: fair/poor and good/very good/excellent. To calculate *mean self-rated mental health* scores, responses were assigned a numerical value, with higher scores indicating better mental health: 5 (excellent); 4 (very good); 3 (good); 2 (fair); and 1 (poor).

Mental morbidity measures

In this study, "mental morbidity measures" refers collectively to three types of measures: World Mental Health version of the Composite International Diagnostic Interview (WMH-CIDI)-measured disorders (one-month, 2- to 12-month or lifetime); self-reported disorders that had been diagnosed by a health professional; and non-specific psychological distress. The mental morbidities examined are: depression, bipolar I, panic disorder and social phobia; self-reports of a diagnosis by a health professional of dysthymia, psychosis, schizophrenia and obsessive-compulsive disorder; and the K6 measure of psychological distress (defined on next page).

Respondents were classified with mental morbidity if they met the criteria for at least one WMH-CIDI-measured disorder; self-reported a diagnosis of at least one mental disorder; and/or were classified as having high or moderate distress.

WMH-CIDI-measured disorders

The Canadian Community Health Survey measured several mental disorders using the WMH-CIDI, an instrument based on definitions in the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition, Text Revision (DSM-IV®-TR).[19] The WMH-CIDI was designed to measure the prevalence of mental disorders at the community level, and can be administered by lay interviewers. In this analysis, four categories were created for each disorder to identify respondents who met the criteria for the disorder in the past month, in the past 2 to 12 months, in their lifetime but not in the past 12 months, or never.

Respondents who met the criteria for *lifetime major depressive episode* reported:

1. two or more weeks of depressed mood or loss of interest or pleasure and at least five symptoms associated with depression, which represent a change in functioning;
2. that symptoms cause clinically significant distress or impairment in social, occupational or other important areas of functioning; and
3. that symptoms are not better accounted for by bereavement, or symptoms last more than two months, or symptoms are characterized by marked functional impairment, preoccupation with worthlessness, suicidal ideation, or psychomotor retardation.

Respondents who met the criteria for *major depressive episode in the month or 2 to 12 months before the interview* reported:

1. meeting the criteria for lifetime major depressive episode;
2. having a major depressive episode in the month or 2 to 12 months before the interview; and
3. clinically significant distress or impairment in social, occupational or other important areas of functioning.

In this analysis, *depression* excludes respondents who also met the criteria for lifetime manic episode.

For *bipolar I,* respondents who met the criteria for a *lifetime manic* episode reported:

1. a distinct period of abnormally and persistently elevated, expansive or irritable mood lasting at least one week;
2. three or more of seven symptoms (or four or more if mood is only irritable) during the mood disturbance—inflated self-esteem or grandiosity; decreased need for sleep, more talkative than usual; flight of ideas or racing thoughts; distractibility; increase in

goal-oriented activity or psychomotor agitation; and excessive involvement in pleasurable activities with high potential for painful consequences; and
3. marked impairment in normal daily activities, occupational functioning or usual social activities or relationships with others; or mood disturbance includes psychotic features; or mood disturbance severe enough to require hospitalization.

Respondents who met the criteria for a *manic episode* in the *month or 2 to 12 months before the interview* reported:
1. meeting the criteria for a lifetime manic episode;
2. having a manic episode in the month or 2 to 12 months before to the interview; and
3. clinically significant distress or impairment in social, occupational or other important areas of functioning.

Respondents who met the criteria for *lifetime panic disorder* reported:
1. four or more recurrent, unexpected panic attacks; and
2. at least one of the attacks had been followed by a month or more of worry about having additional attacks, worry about the consequences of the attacks, or changes in behaviour related to the attacks.

Respondents who met the criteria for *panic disorder in the month or 2 to 12 months before the interview* reported:
1. meeting the criteria for lifetime panic disorder;
2. having a panic attack in the month or 2 to 12 months before the interview; and
3. significant emotional distress during a panic attack in the month or 2 to 12 months before the interview.

Respondents who met the criteria for *lifetime social phobia* reported:
1. marked and persistent fear of one or more social or performance situations in which he/she is exposed to unfamiliar people or to possible scrutiny by others and fear of acting in a way (or show anxiety symptoms) that will be humiliating or embarrassing;
2. that exposure to the feared situation(s) almost invariably provoke(s) anxiety;
3. that they recognize their fear is excessive or unreasonable;
4. that the feared situation(s) is(are) avoided or endured with intense anxiety or distress;
5. significant interference with normal routine, occupational or academic functioning, or social activities or relationships; and
6. that they were aged 18 or older the last time they strongly feared or avoided a social or performance situation; or did not know their age the last time they strongly feared or avoided a social or performance situation and were aged 18 or older; or that they strongly feared or avoided a social or performance situation for longer than six months.

Respondents who met the criteria for *social phobia in the month or 2 to 12 months before the interview* reported:
1. meeting the criteria for lifetime social phobia;
2. fearing or avoiding social or performance situation(s) in the month or 2 to 12 months before the interview; and
3. clinically significant distress or impairment in social, occupational or other important areas of functioning.

Respondents who met the criteria for *lifetime agoraphobia* reported:
1. anxiety about being in places or situations from which escape might be difficult or embarrassing and feared having a panic attack; and
2. avoiding situations associated with agoraphobia; or endured situations with marked distress or anxiety; or required the presence of a companion in the situations.

Respondents who met the criteria for *agoraphobia in the month or 2 to 12 months before the interview* reported:
1. meeting the lifetime Canadian Community Health Survey 1.2/ WMH-CIDI criteria for agoraphobia; and
2. fearing or avoiding the agoraphobic situations in the month or 2 to 12 months before the interview.

Respondents who met the criteria for any one of depression, bipolar I, panic disorder, social phobia, or agoraphobia in the month before the interview were classified as having *any WMH-CIDI disorder in the past month.* Similar categories were created for having *any WMH-CIDI disorder in the past 2 to 12 months,* and *any lifetime WMH-CIDI disorder*.

Respondents who met the criteria for two or more of depression, bipolar I, panic disorder, social phobia or agoraphobia in the month before the interview were classified as having *multiple WMH-CIDI disorders in the past month*. Similar categories were created for having *multiple WMH-CIDI disorders in the past 2-12 months*, and *multiple lifetime, but not in the past 12 months WMH-CIDI disorders*.

Self-reported mental disorders

The presence of *self-reported mental disorders* was determined by asking respondents about disorders that had been diagnosed by a health professional and that had lasted or were expected to last six months or longer. Interviewers read a list of mental disorders that included dysthymia, schizophrenia, psychosis and post-traumatic stress disorder. Respondents who reported any one of these were considered to have *any self-reported mental disorder*; those who reported two or more were considered to have *multiple self-reported mental disorders.*

Psychological distress (K6)

Psychological distress is a non-specific negative state of mental health. The 6-item (K6) measure is based on a subset of items from the WMH-CIDI.[20] It has been found to be at least as sensitive as the corresponding 10-item (K10) measure in discriminating between cases and non-cases of serious mental illness, and is therefore used more often in national surveys. The psychological distress score can range from 0 to 24 and is based on questions about the frequency of feeling "nervous," "hopeless," "restless or fidgety," "so depressed that nothing could cheer you up," "everything was an effort," and/or "worthless" in the past month. Higher scores indicate greater

distress. Scores were categorized as: high (13 to 24), moderate (9 to 12) and no distress (0 to 8).

Co-variates

Four *age groups* were established for this analysis: 15 to 24, 25 to 44, 45 to 64, and 65 or older.

Marital status was categorized as: married or common-law; widowed, separated or divorced; and never married.

Respondents were grouped into five categories based on the *highest level of education*: less than secondary graduation; secondary graduation; some postsecondary; college or trades graduation; and university graduation.

Household income was based on total self-reported household income from all sources in the previous 12 months. The ratio between total household income and the low-income cut-off corresponding to the number of people in the household and to community size was calculated. The ratios were adjusted by dividing them by the highest ratio for all Canadian Community Health Survey respondents. The adjusted ratios were grouped into deciles (10 groups, each containing approximately one-tenth of Canadians), which were collapsed into quintiles: lowest (deciles 1 and 2), low-middle (3 and 4), middle (5 and 6), high-middle (7 and 8), and highest (9 and 10).

Immigrant status was based on citizenship by birth and immigration to Canada. Respondents who were not born Canadian citizens and identified a year of immigration were classified as immigrants.

Respondents were asked about physical conditions that had been diagnosed by a health professional and that had lasted or were expected to last six months or longer. Interviewers read a list of conditions. For this analysis, 18 *chronic conditions* were considered: asthma, arthritis or rheumatism, back problems, high blood pressure, migraine, chronic bronchitis, emphysema, diabetes, epilepsy, heart disease, cancer, ulcers, the effects of a stroke, bowel disorder, thyroid disorder, cataracts, glaucoma, and dementia.

Results

In 2002, an estimated 1.7 million Canadians aged 15 or older (7%) rated their mental health as fair or poor; 2.0 million (8%) met the criteria for a WMH-CIDI-measured disorder; 496,000 (2%) reported having been diagnosed with a mental disorder; and 579,000 (2%) were classified with high distress and 1.3 million (5%) with moderate distress (Table 1).

Socio-demographic factors

The sex distribution of mental morbidity was consistent across most mental morbidity measures and SRMH. Women were more likely than men to report fair/poor SRMH, to meet the criteria for all WMH-CIDI-measured mental morbidities except bipolar 1 disorder (no significant differences) (Appendix Table A) and to self-report all mental morbidities except schizophrenia

Table 1
Number and percentage with fair/poor self-rated mental health, WMH-CIDI-measured disorder, self-reported diagnosed mental disorder and psychological distress, by selected characteristics, household population aged 15 or older, Canada excluding territories, 2002

	Fair/Poor self-rated mental health		WMH-CIDI-measured disorder (past 12 months)		Self-reported diagnosed mental disorder		Psychological distress			
							High		Moderate	
Characteristics	'000	%	'000	%	'000	%	'000	%	'000	%
Total	**1,715.2**	**6.9**	**2,037.0**	**8.4**	**496.0**	**2.0**	**579.2**	**2.3**	**1,305.1**	**5.2**
Sex										
Male†	742.5	6.0	758.9	6.3	207.3	1.7	244.4	2.0	576.9	4.7
Female	972.7	7.7*	1,278.0	10.4*	288.7	2.3*	334.8	2.6*	728.3	5.8*
Age group										
15 to 24†	255.3	6.2	474.4	11.6	58.8	1.4	97.4	2.4	310.1	7.5
25 to 44	654.1	6.9	882.4	9.5*	210.6	2.2*	239.2	2.5	485.6	5.1*
45 to 64	564.1	7.4*	563.9	7.6*	184.6	2.4*	185.1	2.4	361.2	4.8*
65 or older	241.7	6.5	116.3	3.3*	42.0	1.1	57.6	1.6*	148.2	4.0*
Marital status										
Married/Common-law†	827.7	5.4	952.2	6.4	225.9	1.5	275.9	1.8	624.1	4.1
Widowed/Separated/Divorced	394.4	12.3*	360.2	11.7*	104.0	3.3*	121.3	3.8*	223.1	7.0*
Never married	490.2	7.7*	722.5	11.6*	166.1	2.6*	182.0	2.9*	455.8	7.2*
Education										
Less than secondary graduation†	566.0	9.0	542.4	8.9	125.8	2.0	205.4	3.3	426.9	6.8
Secondary graduation	321.9	6.9*	389.7	8.5	76.9	1.6	115.7	2.5*	236.3	5.1*
Some postsecondary	148.5	7.1*	216.6	10.7*	55.6	2.7	53.8	2.6	125.6	6.1
College/Trades graduation	424.2	6.3*	541.2	8.3	138.7	2.1	131.7	2.0*	317.9	4.8*
University graduation	230.8	4.6*	331.2	6.9*	98.3	2.0	66.0	1.3*	188.3	3.8*
Household income quintile										
Lowest†	529.0	11.7	483.3	11.0	156.6	3.5	216.9	4.8	388.7	8.6
Low-middle	343.0	7.6*	384.6	8.8*	89.4	2.0*	112.9	2.5*	248.9	5.5*
Middle	269.4	5.9*	346.3	7.7*	84.2	1.8*	91.7	2.0*	176.9	3.9*
High-middle	248.5	5.6*	341.1	7.8*	67.8	1.5*	47.3[E]	1.1*[E]	194.9	4.4*
Highest	143.5	3.2*	291.0	6.7*	57.7	1.3*	45.3[E]	1.0*[E]	129.8	2.9*
Immigrant										
Yes	327.4	6.0*	307.2	5.7*	65.0	1.2*	103.6	1.9	283.5	5.2
No†	1,360.0	7.0	1,711.1	9.1	422.9	2.2	459.6	2.4	1,002.6	5.2
Chronic condition										
Yes	1,322.0	9.6*	1,375.6	10.4*	397.4	2.9*	469.7	3.4*	877.8	6.4*
No†	356.7	3.5	573.9	5.7	95.4	0.9	95.7	0.9	369.4	3.6

† reference category
* significantly different from estimate for reference category ($p<0.05$)
[E] coefficient of variation 16.6% to 33.3% (use with caution)
Source: 2002 Canadian Community Health Survey: Mental Health and Well-being.

(no significant differences) (Appendix Table B).

The age distribution of SRMH and mental morbidity differed depending on the measure. The prevalence of fair/poor SRMH was relatively constant across age groups—only 45- to 64-years-olds were more likely to report fair/poor SRMH than those in the youngest age group. The prevalence of WMH-CIDI-measured disorders decreased with advancing age. Similarly, people in the youngest age group were more likely than those in older age groups to report high psychological distress. The middle age groups were more likely than the youngest age group to report diagnosed mental disorders.

An income gradient was evident, with individuals in the lowest quintile more likely to rate their mental health as fair/poor than were those in higher quintiles. The gradient was similar for education, with individuals who had less than secondary graduation being more likely than those with higher levels of education to report fair/poor mental health. For WHM-CIDI-measured disorders, self-reported diagnosed mental disorders and psychological distress prevalence was also generally lower among higher-income groups. A similar pattern with education was present for psychological distress.

Mental morbidity measures

On average, those with a mental morbidity had lower SRMH scores than those without a morbidity (Table 3). A gradient in mean SRMH scores was apparent among those with a WMH-CIDI-measured disorder in the past month, compared with those with a disorder in the past 2 to 12 months, those with a history of the disorder (lifetime episode, but not in past 12 months), and those who had never experienced an episode.

The prevalence of fair/poor SRMH varied by individual mental morbidity measure and the timeframe of episode (Table 2). For WMH-CIDI-measured disorders, the prevalence of fair/poor SRMH ranged from almost 10% of

Table 2
Prevalence of fair/poor self-rated mental health, by mental morbidity measures, and odds ratios relating mental morbidity measures to fair/poor self-rated mental health, population aged 15 or older, Canada excluding territories, 2002

Mental morbidity measures	Prevalence of fair/poor self-rated mental health (%)	Model 1 (unadjusted) Odds ratio	95% confidence interval from	to	Model 2 (adjusted)‡ Odds ratio	95% confidence interval from	to
WMH-CIDI-measured disorder							
Any							
Past month	45.0§	12.4*	10.1	15.1	11.2*	9.1	13.9
Past 2 to 12 months	27.4§	6.6*	5.5	8.0	6.3*	5.2	7.7
Lifetime, not past 12 months	10.1§	2.5*	2.1	2.9	2.4*	2.0	2.8
Never†	3.5§	1.0	…	…	1.0	…	…
Depression							
Past month	58.1§	26.0*	19.5	34.5	22.4*	16.5	30.4
Past 2 to 12 months	32.7§	9.1*	7.4	11.2	8.1*	6.5	10.1
Lifetime, not past 12 months	9.7§	2.0*	1.7	2.4	1.9*	1.5	2.3
Never†	5.1§	1.0	…	…	1.0	…	…
Bipolar I							
Past month	51.9*	16.3*	10.0	26.5	13.1*	7.4	23.2
Past 2 to 12 months	39.0*	9.7*	6.9	13.6	7.4*	5.1	10.7
Lifetime, not past 12 months	22.3§	4.3*	3.2	5.8	3.4*	2.5	4.7
Never†	6.2§	1.0	…	…	1.0	…	…
Panic disorder							
Past month	49.0*	14.9*	10.7	20.8	11.4*	7.8	16.7
Past 2 to 12 months	32.9E*	7.6*	3.5	16.6	6.2*	2.8	13.9
Lifetime, not past 12 months	14.4*	2.6*	1.9	3.5	2.4*	1.8	3.2
Never†	6.0§	1.0	…	…	1.0	…	…
Social phobia							
Past month	45.2§	14.9*	11.6	19.0	13.7*	10.7	17.5
Past 2 to 12 months	30.9§	8.1*	6.2	10.5	7.6*	5.7	10.2
Lifetime, not past 12 months	16.0§	3.4*	2.8	4.2	3.4*	2.8	4.2
Never†	5.3§	1.0	…	…	1.0	…	…
Agoraphobia							
Past month	34.5E*	7.5*	4.4	12.9	5.5*	2.9	10.6
Past 2 to 12 months	31.3E*	6.5*	3.3	12.9	4.7*	2.3	9.9
Lifetime, not past 12 months	16.7E*	2.8*	1.7	4.8	2.8*	1.7	4.8
Never†	6.6§	1.0	…	…	1.0	…	…
Multiple							
Past month	73.4§	46.2*	30.2	70.7	37.3*	22.9	60.8
Past 2 to 12 months	38.5§	8.4*	6.0	11.8	6.8*	4.7	9.7
Lifetime, not past 12 months	15.2§	2.7*	2.0	3.6	2.6*	2.0	3.5
Never†	5.7§	1.0	…	…	1.0	…	…
Self-reported diagnosed mental disorder							
Any							
Yes	46.2*	13.4*	11.1	16.1	10.2*	8.4	12.6
No†	6.0	1.0	…	…	1.0	…	…
Dysthymia							
Yes	45.7*	11.7*	7.5	18.0	11.3*	6.8	18.7
No†	6.7	1.0	…	…	1.0	…	…
Schizophrenia							
Yes	53.5*	15.9*	8.7	29.1	11.5*	6.3	21.1
No†	6.7	1.0	…	…	1.0	…	…
Psychosis							
Yes	54.2*	16.9*	13.0	22.1	12.7*	9.5	17.1
No†	6.5	1.0	…	…	1.0	…	…
Post-traumatic stress disorder							
Yes	46.0*	12.3*	9.6	15.8	8.8*	6.7	11.7
No†	6.5	1.0	…	…	1.0	…	…
Multiple							
Yes	69.4*	31.7*	20.9	48.0	23.0*	14.5	36.4
No†	6.7	1.0	…	…	1.0	…	…
K6 - Psychological distress							
High (score 13 to 24)	61.2§	36.4*	30.0	44.1	28.2*	22.9	34.7
Moderate (score 9 to 12)	30.2§	10.0*	8.4	11.7	8.4*	7.1	10.0
None (score 0 to 8)†	4.2§	1.0	…	…	1.0	…	…

† reference category
* significantly different from estimate for reference category (p<0.05)
‡ models adjusted for socio-demographic and physical health characteristics; see Appendix Tables C, D and E
§ significantly different from values in all other categories (p<0.05); p-value adjusted for simultaneous comparisons
E coefficient of variation between 16.6% and 33.3% (interpret with caution)
... not applicable
Source: 2002 Canadian Community Health Survey: Mental Health and Well-being.

those meeting the criteria for lifetime depression, but not in the past 12 months to 58% for past-month depression. The prevalence of fair/poor SRMH was highest among those with a past month episode, lower among those with an episode in the past 2 to 12 months, still lower for those with an episode at some other time in their life, and lowest for those who had never had an episode.

Among people who reported that they had been diagnosed with a mental disorder, the overall prevalence of fair/poor SRMH was 46%, compared with 6% among those not reporting a mental disorder. The prevalence of fair/poor SRMH ranged from 46% among those reporting a diagnosis of dysthymia or post-traumatic stress disorder to 54% among those reporting a diagnosis of psychosis or schizophrenia. The highest prevalence of fair/poor SRMH (69%) was among people reporting multiple diagnoses of mental disorders.

Fully 61% of people with high distress reported fair/poor mental health, compared with 30% of those with moderate distress, and 4% of those with no distress.

People with a WMH-CIDI-measured disorder, a diagnosed mental disorder or moderate/high psychological distress had higher odds of reporting fair/poor mental health than did those without such mental morbidities (Table 2). The odds ratios were attenuated slightly in the models controlling for socio-demographic characteristics and the presence of chronic physical conditions, but the relationships persisted (Appendix Tables C, D, E).

Among all mental morbidity measures examined in this study, between 27% (multiple WMH-CIDI disorders in the past month) and 70% (moderate distress) of respondents classified with mental morbidity did not perceive their mental health as fair or poor (Table 2). In addition, 4% of respondents without any lifetime disorder, 6% of respondents without any self-reported disorder, and 4% of respondents without high distress perceived their health as fair or poor (Table 2).

Discussion

Socio-demographic distribution

Women were more likely than men to rate their mental health as fair/poor and to be classified with mental morbidity, corresponding to the general finding that women have a higher prevalence of most mental disorders and tend to report worse health than do men.[21] It is not clear if this is because of differences in objective health status stemming from biological or gender-based factors, or because of non-random differences, such as using different frames of reference and sources for comparison when assessing one's health.[21]

The age patterns for SRMH differ from those for some of the other measures of mental morbidity. The prevalence of WMH-CIDI-measured disorders decreases with age, while the prevalence of SRMH does not. These results are not entirely consistent with earlier research showing that the prevalence of anxiety and anger declines at successively older ages, while depression follows a U-shaped pattern, with younger and older adults having higher levels than middle-aged people.[22] The absence of a U-shaped pattern for depression in the current study may stem from the use of the WMH-CIDI depression module rather than the CES-D, or from the categorization of age into large groups. The discrepancy in the age pattern of SRMH compared with the age pattern of other mental health measures in these analyses may be because of biases introduced by WMH-CIDI measures; because SRMH is capturing something different than the other measures; or because different age groups use different frames of reference and sources of comparison when responding to the question. The WMH-CIDI depression module in the Canadian Community Health Survey has been validated with only clinical samples, not community-based samples for which it was designed.[23] The module may misclassify depression differentially by age.

The contradictory age pattern may also indicate that SRMH is capturing something beyond the presence of mental disorder or high distress, and that other factors that change with age are associated with self-rating of mental health. Ross and Mirowsky[22] suggest that although positive emotions (for example, satisfaction with life) increase, and negative emotions (for example, worry, anxiety, anger) decrease with age, the decrease in individuals' sense of power (as a result of physical decline, loss of job and loved ones, limited opportunities for the future, and a sense of having few years left to live) may contribute to a decline in mental health with age.

The age pattern of fair/poor SRMH may also result from different frames of reference and sources of comparison used by people of different ages. Respondents apply complex and multi-layered criteria when they rate their general health,[3] and different age groups use different referents. No work has determined, however, if referents for self-rated *mental* health also differ by age group.[2] Nor has research examined respondents' sources of comparison for their mental health. It is not known whether people compare their current mental health status with their mental health status when younger, with the mental health status of others in their age groups, families, or communities, or if these sources differ by age.

The results of the current study indicate a socio-economic gradient, with individuals in the lowest income and education quintiles most likely to report fair/poor mental health. This supports the findings of earlier studies that used several mental moribidity measures, including poor psychosocial health,[24] distress,[25,26] depression,[27,28] schizophrenia,[28] panic, phobias and generalized anxiety disorder.[28]

The results are also similar to those for self-reported *general* health. Most research examining socio-economic differences in self-rated health in Canada, the United States and Europe find that a relatively high percentage of people of lower socio-economic status report fair/poor health,[29-32] although in some developing countries, the gradients

Table 3
Mean and percentage distribution of self-rated mental health scores, by mental morbidity measures, household population aged 15 or older, Canada excluding territories, 2002

	Self-rated mental health score												
	Mean score			Percentage distribution									
		95% confidence interval		1 (Poor)		2 (Fair)		3 (Good)		4 (Very good)		5 (Excellent)	
Mental morbidity measures	Mean	from	to	'000	%	'000	%	'000	%	'000	%	'000	%
WMH-CIDI-measured disorder													
Any													
Past month	2.7*	2.6	2.7	132.6	16.4*	232.5	28.8*	268.7	33.3*	130.4	16.2*	43.0	5.3E*
Past 2 to 12 months	3.1*	3.0	3.2	57.3	5.3*	240.6	22.2*	419.7	38.7*	271.2	25.0*	96.2	8.9*
Lifetime, not past 12 months	3.7*	3.6	3.7	30.5	1.0E*	266.8	9.1*	941.2	31.9*	1,168.7	39.7	540.1	18.3*
Never†	4.0	4.0	4.0	55.5	0.3	629.5	3.2	4,645.1	23.9	7,972.0	41.1	6,102.9	31.5
Depression													
Past month	2.3*	2.1	2.4	81.5	26.1*	102.0	32.7*	94.6	30.3	24.9	8.0E*	F	F
Past 2 to 12 months	3.0*	2.9	3.1	45.1	7.0*	166.4	25.7*	243.8	37.7*	144.6	22.3*	47.6	7.3*
Lifetime, not past 12 months	3.6*	3.6	3.7	21.9	1.3E*	142.3	8.4*	563.2	33.2*	653.0	38.5	317.0	18.7*
Never†	3.9	3.9	4.0	133.0	0.6	990.5	4.5	5,546.1	25.1	8,915.8	40.3	6,544.0	29.6
Bipolar I													
Past month	2.5*	2.3	2.8	14.4	16.3E*	31.5	35.6*	24.3	27.5E	16.0	18.2E*	F	F
Past 2 to 12 months	2.8*	2.7	3.0	20.6	14.1E*	36.4	24.9*	45.9	31.4	32.6	22.3*	10.6	7.3E*
Lifetime, not past 12 months	3.3*	3.1	3.4	15.5	4.5E*	61.5	17.9*	115.9	33.7*	119.5	34.8	31.3	9.1E*
Never†	3.9	3.9	3.9	231.8	1.0	1,276.8	5.3	6,288.9	25.9	9,597.4	39.5	6,893.5	28.4
Panic disorder													
Past month	2.5*	2.3	2.7	38.8	23.0*	43.6	25.9*	50.8	30.2	28.0	16.6E*	F	F
Past 2 to 12 months	3.1*	2.6	3.5	F	F	F	F	8.3	25.3E	F	F	F	F
Lifetime, not past 12 months	3.6*	3.5	3.7	7.5	1.4E	67.8	12.9*	152.0	28.9	212.6	40.5	85.3	16.2*
Never†	3.9	3.9	3.9	206.7	0.9	1,217.0	5.2	6,078.7	25.8	9,356.1	39.7	6,720.4	28.5
Social phobia													
Past month	2.7*	2.5	2.8	50.0	15.1*	99.8	30.1*	108.0	32.6*	53.1	16.0*	F	F
Past 2 to 12 months	3.0*	2.9	3.1	39.8	9.6E*	88.2	21.4*	157.0	38.0*	90.3	21.8*	38.1	9.2*
Lifetime, not past 12 months	3.5*	3.4	3.6	20.1	1.7E*	168.5	14.3*	381.5	32.3*	441.2	37.4	169.7	14.4*
Never†	3.9	3.9	3.9	169.2	0.7	1,030.6	4.5	5,784.0	25.3	9,160.2	40.1	6,693.6	29.3
Agoraphobia													
Past month	2.9*	2.6	3.2	7.1	10.7E*	15.7	23.8E*	23.3	35.4E	14.3	21.7E*	F	F
Past 2 to 12 months	2.9*	2.7	3.1	F	F	25.7	25.4E*	45.4	44.8*	20.9	20.7E*	F	F
Lifetime, not past 12 months	3.6*	3.4	3.8	F	F	28.1	16.2E*	36.5	21.1	76.7	44.3	31.2	18.0E*
Never†	3.9	3.9	3.9	272.9	1.1	1,342.0	5.5	6,368.1	26.0	9,661.0	39.4	6,894.1	28.1
Multiple													
Past month	2.0*	1.8	2.1	44.2	34.5*	49.7	38.9*	26.8	21.0E	F	F	F	F
Past 2 to 12 months	2.8*	2.7	3.0	15.3	8.9E*	50.8	29.6*	64.5	37.6*	33.8	19.7E*	F	F
Lifetime, not past 12 months	3.5*	3.4	3.6	F	F	75.0	13.9*	175.5	32.4*	214.4	39.7	68.9	12.7*
Never†	3.9	3.9	3.9	192.1	0.8	1,172.1	4.9	6,115.7	25.7	9,459.9	39.8	6,834.8	28.8
Self-reported diagnosed mental disorder													
Any													
Yes	2.7*	2.6	2.8	73.1	14.7*	156.1	31.5*	161.1	32.5*	68.2	13.8*	37.4	7.6E*
No†	3.9	3.9	3.9	216.0	0.9	1,263.7	5.2	6,348.1	25.9	9,734.7	39.8	6,907.7	28.2
Dysthymia													
Yes	2.7*	2.5	3.0	10.2	12.2E*	28.0	33.5*	25.9	31.0E	14.9	17.9E*	F	F
No†	3.9	3.9	3.9	280.1	1.1	1,394.6	5.6	6,488.9	26.1	9,788.9	39.3	6,941.7	27.9
Schizophrenia													
Yes	2.6*	2.2	2.9	12.1	19.2E*	21.7	34.4E*	17.3	27.5E	F	F	F	F
No†	3.9	3.9	3.9	278.4	1.1	1,401.9	5.6	6,496.4	26.1	9,797.5	39.3	6,940.5	27.9
Psychosis													
Yes	2.5*	2.3	2.6	36.8	21.7*	55.2	32.5*	48.9	28.8	20.0	11.8E*	F	F
No†	3.9	3.9	3.9	252.9	1.0	1,366.0	5.5	6,464.9	26.1	9,784.3	39.4	6,937.7	28.0
Post-traumatic stress disorder													
Yes	2.7*	2.5	2.8	41.2	16.3*	75.3	29.7*	83.1	32.8*	33.0	13.0*	20.8	8.2E*
No†	3.9	3.9	3.9	248.7	1.0	1,347.0	5.5	6,427.9	26.0	9,771.0	39.5	6,924.9	28.0
Multiple													
Yes	2.1*	1.9	2.3	23.7	36.6*	21.3	33.0*	12.2	18.8E	5.7	8.8E*	F	F
No†	3.9	3.9	3.9	265.2	1.1	1,397.2	5.6	6,496.5	26.1	9,797.2	39.4	6,943.4	27.9
K-6 psychological distress													
High (score 13 to 24)	2.3*	2.2	2.4	144.0	24.9*	210.7	36.4*	158.5	27.4	48.0	8.3*	17.8	3.1E*
Moderate (score 9 to 12)	3.0*	2.9	3.1	67.1	5.2E*	326.6	25.0*	533.5	40.9*	271.5	20.8*	105.5	8.1*
None (score 0 to 8)†	4.0	3.9	4.0	78.5	0.3	879.9	3.8	5,786.0	25.1	9,466.9	41.1	6,809.1	29.6

† reference category
* significantly different from reference category (p<0.05)
E coefficient of variation 16.6% to 33.3% (use with caution)
F coefficient of variation greater than 33.3% (suppressed because of extreme sampling variability)
Source: 2002 Canadian Community Health Survey: Mental Health and Well-being.

are reversed.[33] Research has yet to examine SRMH in relation to clinically tested or observed mental health status, so it is not known if the correspondence of self-reporting of mental health status to tested or observed health status differs by socio-economic status.

Variation in SRMH by recency and morbidity measure

Since the SRMH measure implies the current situation, the gradients in the odds of reporting fair/poor mental health and in mean scores by recency of episode may indicate successful treatment and/or recovery in respondents with a lifetime disorder but no episode in the past 12 months.

Variations in the prevalence of fair/poor SRMH by individual mental morbidity measures may reflect differences in the burden of illness or stigma[34] associated with each mental morbidity.[28,35] The high prevalence of fair/poor SRMH among those reporting a diagnosis of schizophrenia corresponds to its characterization as the "most severe and debilitating mental illness.…characterized by delusions, hallucinations, disorganized behavior, negative symptoms (e.g., flat affect), and social/occupational dysfunction."[28] Because of the burden of the disorder, the stigma associated with it, or a combination of both, respondents reporting schizophrenia may be more likely to report fair/poor mental health than respondents reporting or meeting the criteria for other disorders.

The high prevalence of fair/poor SRMH among respondents reporting multiple diagnoses of mental disorders is consistent with the association between comorbidity and more severe psychiatric symptoms, more functional disability,[36] longer illness duration, less social competence, and greater use of services.[37]

The association of moderate and high distress with fair/poor SRMH is consistent with the design of the K6 measure to capture a non-specific negative state of mental health based on a subset of items from the Composite International Diagnostic Interview (CIDI), and the finding of a similar association by Fleishman and Zuvekas[13] using data from the US Medical Expenditure Panel Survey.

The persistence of all significant associations between fair/poor SRMH and mental morbidities in the multivariate models indicates that the associations are robust and independent of socio-demographic factors and the presence of chronic physical conditions.

Lack of correspondence with mental morbidity measures

The sizeable percentage of respondents classified with mental morbidity who did not perceive their mental health as fair or poor may be due to misclassification, lower severity of symptoms, lack of recency of symptoms, lower burden of morbidity, lack of insight into morbidity, successful treatment, or recovery. The SRMH measure may thereby underestimate the prevalence of mental morbidity, the size of this underestimate varying by morbidity. This limits the value of SRMH as a mental health measure for some uses such as investigating the etiology of mental morbidities or predicting the need for treatment of morbidities.

The small percentage of respondents classified *without* mental morbidity who perceived their mental health as fair/poor suggests that SRMH may be capturing subthreshold symptoms, and/or that factors other than mental morbidities influence self-perceptions of mental health. Although SRMH does not directly correspond with measured (or diagnosed) mental morbidities, perceptions are important in their own right. For example, they play an important role in treatment-seeking.[8]

Limitations

Previous versions of the Composite International Diagnostic Interview have been validated, but the World Mental Health version used in the Canadian Community Health Survey: Mental Health and Well-being has not. Therefore, it is not known to what extent clinical assessments made by health care professionals would agree with classifications based on these survey data.

Because the Canadian Community Health Survey did not have modules for some relatively common mental disorders (for example, generalized anxiety disorder), their association with self-rated mental health could not be assessed. Other mental disorders (dysthymia, schizophrenia, obsessive-compulsive disorder, psychosis) are only

What is already known on this subject?

- Increasingly, population health surveys are using a single-item ordinal question on self-rated mental health, but little is known about its association with measures of mental morbidity.
- Research suggests that self-rated mental health is associated with other mental morbidity measures, including non-specific psychological distress, depressive symptoms, activity limitations and physical and emotional role functioning, but is not a replacement for them.

What does this study add?

- Associations between self-rated mental health and a comprehensive array of mental morbidity measures were strong and consistent, with gradients in mean self-rated mental health scores and odds of reporting fair/poor mental health by recency of WMH-CIDI-measured mental disorders.
- A sizeable percentage of respondents classified with mental morbidity did not perceive their mental health as fair/poor.
- Careful consideration should be given to the strengths and limitations of self-rated mental health in survey analysis.

measured with self-reported diagnoses, for which the impact of reporting error is unknown. Respondents may have undiagnosed mental disorders that were not captured in the questions, or they may not have reported diagnoses because of stigma, recall bias or other factors. This could have resulted in some respondents with mental disorders not being identified, thereby leading to an underestimate of the association between self-reported mental disorders and SRMH.

Because of the cross-sectional design of this study, the temporal ordering of events cannot be inferred. It is not clear if fair/poor SRMH predicts mental morbidities, or if the presence of mental morbidities results in a self-rating of fair/poor.

The reference periods used for the mental morbidity measures varied: for SRMH, an unspecified reference period implying the present; for WMH-CIDI disorders, the past month, the past 12 months, or lifetime; for self-reported mental morbidities, disorders that had lasted or were expected to last 6 months or more; and for psychological distress, the past month. This may have resulted in underestimates of the associations between mental morbidity measures and SRMH when mental morbidity was not current. Nonetheless, this analysis reveals significant associations between all mental morbidity measures and fair/poor SRMH, demonstrating the strength of the relationship regardless of the reference period.

Conclusion

This is the first nationally representative study to examine associations between SRMH and selected measures of mental morbidity in the Canadian population. It supports previous research demonstrating that SRMH is associated with a range of mental health measures. The wide range of mental morbidity measures assessed, the large population-based survey, and the multivariate approach add strength to this analysis.

There were strong positive associations between all mental morbidity measures and SRMH, with stronger associations between past month prevalence and SRMH than past 2- to 12-month prevalence and SRMH, which, in turn, had stronger associations with SRMH than lifetime, but not past-12-month, disorder. On the other hand, for every mental morbidity measure, a sizeable percentage of respondents who did not perceive their mental health as fair or poor. Uncovering the reasons for this requires further investigation.

For specific morbidities, SRMH cannot be used to monitor trends, investigate etiology, predict the need for treatment, or determine if those who need treatment are receiving it. However, the strong and consistent association with a wide range of mental morbidity measures make it a potentially useful indicator for monitoring general mental health. In addition, SRMH captures individuals' perceptions of their mental health, which have implications for service use and treatment compliance.

SRMH is the only national-level mental health measure available from ongoing Statistics Canada health surveys. By contributing to understanding what SRMH represents, this study informs the use of this measure in ongoing surveys and as a health indicator. ■

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Appendix

Table A
Number and percentage classified with WMH-CIDI-measured disorder in past 12 months, by type of disorder and selected characteristics, household population aged 15 or older, Canada excluding territories, 2002

	Any		Depression		Bipolar I		Panic disorder		Social phobia		Agoraphobia		Multiple	
Characteristics	**'000**	**%**	**'000**	**%**	**'000**	**%**	**'000**	**%**	**'000**	**%**	**'000**	**%**	**'000**	**%**
Total	**2,037.0**	**8.4**	**981.1**	**4.0**	**239.4**	**1.0**	**376.0**	**1.5**	**746.1**	**3.0**	**183.4**	**0.7**	**399.5**	**1.6**
Sex														
Male†	758.9	6.3	355.6	2.9	116.8	1.0	125.4	1.0	313.5	2.6	44.2	0.4	164.0	1.3
Female	1,278.0	10.4*	625.5	5.0*	122.6	1.0	250.5	2.0*	432.6	3.4*	139.2	1.1*	235.5	1.9*
Age group														
15 to 24†	474.4	11.6	210.5	5.1	72.8	1.8	73.5	1.8	193.3	4.7	33.6	0.8	89.1	2.2
25 to 44	882.4	9.5*	407.6	4.3	114.3	1.2*	180.5	1.9	329.1	3.5*	85.0	0.9	194.5	2.1
45 to 64	563.9	7.6*	292.7	3.9*	51.9	0.7*	107.1	1.4	191.2	2.5*	50.9[E]	0.7[E]	102.8	1.4*
65 or older	116.3	3.3*	70.3	1.9*	F	F	14.8[E]	0.4*[E]	32.5[E]	0.9*[E]	13.9[E]	0.4*[E]	F	F
Marital status														
Married/Common-law†	952.2	6.4	435.7	2.8	101.3	0.7	193.2	1.3	348.9	2.3	78.3	0.5	171.7	1.1
Widowed/Separated/Divorced	360.2	11.7*	207.7	6.5*	38.7	1.2*	61.7	2.0*	99.3	3.1*	49.0[E]	1.5*[E]	75.3	2.4*
Never married	722.5	11.6*	336.6	5.3*	99.4	1.6*	121.1	1.9*	296.9	4.7*	56.2	0.9*	152.4	2.4*
Education														
Less than secondary graduation†	542.4	8.9	237.5	3.8	82.5	1.3	86.6	1.4	213.6	3.4	61.0[E]	1.0[E]	115.3	1.8
Secondary graduation	389.7	8.5	185.2	4.0	40.8	0.9*	95.6	2.1*	138.1	3.0	31.3[E]	0.7[E]	81.2	1.7
Some postsecondary	216.6	10.7*	101.2	4.9	29.5	1.4	40.8	2.0	78.9	3.8	27.1[E]	1.3[E]	42.7	2.1
College/Trades graduation	541.2	8.3	255.0	3.8	63.1	0.9	103.7	1.6	199.1	3.0	38.6[E]	0.6[E]	101.0	1.5
University graduation	331.2	6.9*	192.0	3.9	19.1[E]	0.4*[E]	48.9	1.0	114.1	2.3*	25.3[E]	0.5*[E]	57.9	1.2*
Household income quintile														
Lowest†	483.3	11.0	233.2	5.2	62.3	1.4	103.6	2.3	166.1	3.7	63.9[E]	1.4[E]	113.7	2.5
Low-middle	384.6	8.8*	185.9	4.1*	51.0	1.1	65.6	1.5*	143.8	3.2	31.3[E]	0.7*[E]	69.6	1.6*
Middle	346.3	7.7*	156.6	3.4*	43.5[E]	1.0*	70.5	1.6*	119.1	2.6*	30.5[E]	0.7*[E]	60.0	1.3*
High-middle	341.1	7.8*	168.9	3.8*	32.7[E]	0.7*[E]	57.9	1.3*	137.3	3.1	24.5[E]	0.6*[E]	71.0[E]	1.6*[E]
Highest	291.0	6.7*	127.7	2.9*	25.4[E]	0.6*[E]	60.3	1.4*	114.3	2.6*	20.9[E]	0.5*[E]	48.6	1.1*
Immigrant status														
Yes	307.2	5.7*	167.2	3.1*	34.6[E]	0.6*[E]	43.8[E]	0.8*[E]	96.8	1.8*	39.3[E]	0.7[E]	65.5[E]	1.2*[E]
No†	1,711.1	9.1	806.0	4.2	198.6	1.0	330.7	1.7	641.2	3.3	143.7	0.8	329.0	1.7
Chronic condition														
Yes	1,375.6	10.4*	674.3	4.9*	178.4	1.3*	278.9	2.1*	480.4	3.5*	126.3	0.9*	294.4	2.2*
No†	573.9	5.7	269.5	2.6	54.2	0.5	87.4	0.9	223.7	2.2	55.6[E]	0.5[E]	95.4	0.9

† reference category
* significantly different from estimate for reference category (p<0.05)
[E] coefficient of variation 16.6% to 33.3% (use with caution)
F coefficient of variation greater than 33.3% (suppressed because of extreme sampling variability)
Source: 2002 Canadian Community Health Survey: Mental Health and Well-being.

Table B
Number and percentage with self-reported diagnosed mental disorder, by selected characteristics, household population aged 15 or older, Canada excluding the territories, 2002

	Any		Dysthymia		Schizophrenia		Psychosis		Post-traumatic stress disorder		Multiple	
	'000	%	'000	%	'000	%	'000	%	'000	%	'000	%
Total	**496.0**	**2.0**	**83.5**	**0.3**	**63.2**	**0.3**	**169.9**	**0.7**	**253.4**	**1.0**	**64.8**	**0.3**
Sex												
Male†	207.3	1.7	30.2E	0.3E	38.3E	0.3E	65.9	0.5	106.1	0.9	29.1	0.2
Female	288.7	2.3*	53.4E	0.4*E	24.9E	0.2E	104.0	0.8*	147.3	1.2*	35.7	0.3
Age group												
15 to 24†	58.8	1.4	F	F	F	F	29.9E	0.7E	24.1E	0.6E	6.5E	0.2E
25 to 44	210.6	2.2*	36.7	0.4E	36.2E	0.4E	68.6	0.7	106.3	1.1*	31.3	0.3*
45 to 64	184.6	2.4*	33.2	0.4E	15.9E	0.2E	61.2	0.8	100.9	1.3*	23.6E	0.3*
65 or older	42.0	1.1	7.1E	0.2E	F	F	10.1E	0.3*E	22.2E	0.6E	F	F
Marital status												
Married/Common-law†	225.9	1.5	35.1E	0.2E	18.0E	0.1E	72.6	0.5	126.7	0.8	23.1E	0.2E
Widowed/Separated/Divorced	104.0	3.3*	19.2E	0.6*E	8.2E	0.3*E	33.5	1.0*	66.0	2.1*	20.5E	0.6*E
Never married	166.1	2.6*	29.2E	0.5*E	37.0E	0.6*E	63.8	1.0*	60.7	1.0	21.2E	0.3*E
Education												
Less than secondary graduation†	125.8	2.0	16.3E	0.3E	21.4	0.3E	41.8	0.7	68.2	1.1	20.0E	0.3E
Secondary graduation	76.9	1.6	6.4E	0.1E	F	F	30.0E	0.6E	34.5	0.7*	F	0.1*E
Some postsecondary	55.6	2.7	7.7E	0.4E	F	F	20.3E	1.0E	30.3E	1.5E	F	F
College/Trades graduation	138.7	2.1	25.0	0.4E	9.1E	0.1*E	48.6	0.7	77.0	1.2	17.3	0.3E
University graduation	98.3	2.0	28.2	0.6E	F	F	28.9	0.6	43.4	0.9	12.2E	0.3E
Household income quintile												
Lowest†	156.6	3.5	19.0E	0.4E	28.1	0.6	60.6	1.3	77.2	1.7	24.4	0.5
Low-middle	89.4	2.0*	14.2E	0.3E	F	F	32.9E	0.7*E	48.8	1.1*	11.8E	0.3*E
Middle	84.2	1.8*	16.3E	0.4E	F	F	24.8E	0.5*E	44.1E	1.0*E	F	F
High-middle	67.8	1.5*	F	F	F	F	20.0E	0.5*E	38.0	0.9*	9.7E	0.2*E
Highest	57.7	1.3*	F	F	F	F	20.0E	0.5*E	27.1E	0.6*E	6.8E	0.2*E
Immigrant												
Yes	65.0	1.2*	11.7E	0.2E	F	F	15.7E	0.3*E	38.7	0.7*	F	F
No†	422.9	2.2	68.1	0.4	57.1	0.3	152.7	0.8	211.4	1.1	57.2	0.3
Chronic condition												
Yes	397.4	2.9*	61.9	0.5*	46.4E	0.3*E	37.5	1.0*	217.7	1.6*	53.0	0.4*
No†	95.4	0.9	19.9E	0.2E	16.8E	0.2E	132.0	0.4	34.6	0.3	11.8E	0.1E

† reference category
* significantly different from estimate for reference category (p<0.05)
E coefficient of variation 16.6% to 33.3% (use with caution)
F coefficient of variation greater than 33.3% (suppressed because of extreme sampling variability)
Source: 2002 Canadian Community Health Survey: Mental Health and Well-being.

Table C
Adjusted odds ratios relating WMH-CIDI-measured disorders to fair/poor self-rated mental health, by type of disorder and selected characteristics, household population aged 15 or older, Canada excluding territories, 2002

	Any			Depression			Bipolar I			Panic disorder			Social phobia			Agoraphobia			Multiple		
		95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
Characteristics	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to
Recency of disorder																					
Past month	11.2*	9.1	13.9	22.4*	16.5	30.4	13.1*	7.4	23.2	11.4*	7.8	16.7	13.7*	10.7	17.5	5.5*	2.9	10.6	37.3*	22.9	60.8
Past 2 to 12 months	6.3*	5.2	7.7	8.1*	6.5	10.1	7.4*	5.1	10.7	6.2*	2.8	13.9	7.6*	5.7	10.2	4.7*	2.3	9.9	6.8*	4.7	9.7
Lifetime, not past 12 months	2.4*	2.0	2.8	1.9*	1.5	2.3	3.4*	2.5	4.7	2.4*	1.8	3.2	3.4*	2.8	4.2	2.8*	1.7	4.8	2.6*	2.0	3.5
Never†	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...
Sex																					
Male	1.1	0.9	1.2	1.0	0.9	1.2	0.9	0.8	1.1	1.0	0.9	1.1	1.0	0.9	1.1	1.0	0.9	1.1	1.0	0.9	1.1
Female†	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...
Age	1.0	0.99	1.0	0.99*	0.99	1.0	0.99*	0.99	1.0	0.99*	0.99	0.99	0.99*	0.99	1.0	0.99*	0.99	0.99	0.99*	0.99	0.99
Marital status																					
Married/Common-law†	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...
Widowed/Separated/Divorced	1.6*	1.4	1.9	1.6*	1.4	1.9	1.8*	1.5	2.1	1.9*	1.6	2.3	1.9*	1.6	2.2	1.9*	1.6	2.2	1.8*	1.6	2.2
Never married	1.3*	1.1	1.5	1.3*	1.1	1.5	1.3*	1.1	1.6	1.4*	1.2	1.6	1.3*	1.1	1.5	1.3*	1.1	1.6	1.4*	1.1	1.6
Education																					
Less than secondary graduation†	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...
Secondary graduation	0.9	0.7	1.0	0.8*	0.7	1.0	0.9	0.8	1.1	0.9	0.8	1.1	0.9	0.7	1.0	0.9	0.8	1.1	0.9	0.7	1.1
Some postsecondary	0.8	0.6	1.0	0.8	0.7	1.1	0.9	0.7	1.1	0.9	0.7	1.1	0.8	0.7	1.0	0.9	0.7	1.1	0.8	0.7	1.0
College/Trades graduation	0.8*	0.7	1.0	0.8*	0.7	0.9	0.9	0.7	1.0	0.9	0.7	1.0	0.8*	0.7	1.0	0.9*	0.7	1.0	0.9	0.7	1.0
University graduation	0.7*	0.6	0.9	0.6*	0.5	0.8	0.7*	0.6	0.9	0.8*	0.6	0.9	0.7*	0.6	0.9	0.7*	0.6	0.9	0.7*	0.6	0.9
Household income quintile																					
Lowest†	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...
Low-middle	0.7*	0.6	0.9	0.7*	0.6	0.8	0.7*	0.6	0.8	0.7*	0.6	0.9	0.7*	0.6	0.8	0.7*	0.6	0.8	0.7*	0.6	0.8
Middle	0.6*	0.5	0.7	0.6*	0.5	0.7	0.5*	0.5	0.7	0.6*	0.5	0.7	0.6*	0.5	0.7	0.5*	0.5	0.6	0.6*	0.5	0.7
High-middle	0.6*	0.5	0.7	0.5*	0.5	0.7	0.6*	0.5	0.7	0.6*	0.5	0.7	0.5*	0.4	0.7	0.5*	0.5	0.7	0.6*	0.5	0.7
Highest	0.3*	0.3	0.4	0.3*	0.3	0.4	0.3*	0.3	0.4	0.3*	0.3	0.4	0.3*	0.3	0.4	0.3*	0.3	0.4	0.3*	0.3	0.4
Immigrant																					
Yes	1.0	0.8	1.2	0.9	0.8	1.1	0.9	0.7	1.1	0.9	0.7	1.1	1.0	0.8	1.2	0.9	0.7	1.0	0.9	0.8	1.1
No†	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...
Chronic condition																					
Yes	2.4*	2.0	2.8	2.7*	2.3	3.1	2.8*	2.4	3.3	2.9*	2.4	3.4	2.7*	2.3	3.2	3.0*	2.6	3.5	2.8*	2.4	3.3
No†	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...

† reference category
* significantly different from estimate for reference category ($p<0.05$)
... not applicable
Note: Missing category included in models for household income and chronic condition to maximize sample size, but odds ratios not shown.
Source: 2002 Canadian Community Health Survey: Mental Health and Well-being.

Table D
Adjusted odds ratios relating self-reported diagnosed mental disorders to fair/poor self-rated mental health, by type of disorder and selected characteristics, household population aged 15 or older, Canada excluding territories, 2002

	Any			Dysthymia			Schizophrenia			Psychosis			Post-traumatic stress disorder			Multiple		
		95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
Characteristics	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to
Presence of disorder																		
Yes	10.2*	8.4	12.6	11.3*	6.8	18.7	11.5*	6.3	21.1	12.7*	9.5	17.1	8.8*	6.7	11.7	23.0*	14.5	36.4
No†	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…
Sex																		
Male	1.0	0.9	1.1	1.0	0.9	1.1	1.0	0.9	1.1	1.0	0.9	1.1	1.0	0.9	1.1	1.0	0.9	1.1
Female†	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…
Age	0.99*	0.99	0.99	0.99*	0.98	0.99	0.99*	0.98	0.99	0.99*	0.99	0.99	0.99*	0.99	0.99	0.99*	0.99	0.99
Marital status																		
Married/Common-law†	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…
Widowed/Separated/Divorced	1.8*	1.6	2.2	1.9*	1.6	2.2	1.9*	1.6	2.2	1.9*	1.6	2.2	1.9*	1.6	2.2	1.9*	1.6	2.2
Never married	1.3*	1.1	1.5	1.3*	1.1	1.5	1.3*	1.1	1.5	1.3*	1.1	1.5	1.3*	1.2	1.6	1.3*	1.1	1.6
Education																		
Less than secondary graduation†	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…
Secondary graduation	0.9	0.7	1.1	0.9	0.7	1.1	0.9	0.7	1.1	0.9	0.7	1.1	0.9	0.8	1.1	0.9	0.8	1.1
Some postsecondary	0.8	0.7	1.0	0.9	0.7	1.1	0.9	0.7	1.1	0.9	0.7	1.1	0.8	0.7	1.0	0.9	0.7	1.1
College/Trades graduation	0.8*	0.7	1.0	0.8*	0.7	1.0	0.9*	0.7	1.0	0.8*	0.7	1.0	0.8*	0.7	1.0	0.9*	0.7	1.0
University graduation	0.7*	0.6	0.8	0.7*	0.6	0.8	0.7*	0.6	0.9	0.7*	0.6	0.8	0.7*	0.6	0.8	0.7*	0.6	0.9
Household income quintile																		
Lowest†	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…
Low-middle	0.7*	0.6	0.9	0.7*	0.6	0.8	0.7*	0.6	0.8	0.7*	0.6	0.8	0.7*	0.6	0.8	0.7*	0.6	0.8
Middle	0.6*	0.5	0.7	0.5*	0.5	0.6	0.6*	0.5	0.7	0.6*	0.5	0.7	0.5*	0.5	0.7	0.5*	0.5	0.7
High-middle	0.6*	0.5	0.7	0.5*	0.4	0.7	0.5*	0.5	0.7	0.6*	0.5	0.7	0.6*	0.5	0.7	0.5*	0.5	0.7
Highest	0.4*	0.3	0.4	0.3*	0.3	0.4	0.3*	0.3	0.4	0.3*	0.3	0.4	0.3*	0.3	0.4	0.3*	0.3	0.4
Immigrant																		
Yes	0.9	0.8	1.1	0.9	0.7	1.0	0.9	0.7	1.0	0.9	0.7	1.1	0.9	0.7	1.1	0.9	0.7	1.0
No†	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…
Chronic condition																		
Yes	2.7*	2.4	3.2	3.0*	2.6	3.5	3.0*	2.6	3.5	2.9*	2.5	3.4	2.9*	2.5	3.3	3.0*	2.6	3.5
No†	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…	1.0	…	…

† reference category
* significantly different from reference category ($p<0.05$)
... not applicable
Note: Missing category included in models for household income and chronic condition to maximize sample size, but odds ratios not shown.
Source: 2002 Canadian Community Health Survey: Mental Health and Well-being.

Table E
Adjusted odds ratios relating psychological distress to fair/poor self-rated mental health, by selected characteristics, population aged 15 or older, Canada excluding territories, 2002

Characteristics	Odds ratio	95% confidence interval from	to
Level of distress			
High (score 13 to 24)	28.2*	22.9	34.7
Moderate (score 9 to 12)	8.4*	7.1	10.0
None (score 0 to 8)†	1.0	…	
Sex			
Male	1.0	0.9	1.1
Female†	1.0	…	…
Age	1.00*	0.99	1.00
Marital status			
Married/Common-law†	1.0	…	…
Widowed/Separated/Divorced	1.8*	1.5	2.1
Never married	1.3*	1.1	1.5
Education			
Less than secondary graduation†	1.0	…	…
Secondary graduation	0.9	0.8	1.1
Some postsecondary	0.9	0.7	1.1
College/Trades graduation	0.9	0.8	1.1
University graduation	0.8*	0.7	1.0
Household income quintile			
Lowest†	1.0	…	…
Low-middle	0.8*	0.7	1.0
Middle	0.7*	0.6	0.8
High-middle	0.7*	0.6	0.9
Highest	0.5*	0.4	0.6
Immigrant			
Yes	0.9	0.7	1.1
No†	1.0	…	…
Chronic condition			
Yes	2.3*	2.0	2.7
No†	1.0	…	…

† reference category
* significantly different from estimate for reference category ($p<0.05$)
... not applicable
Note: Missing category included in models for household income and chronic condition to maximize sample size, but odds ratios not shown.
Source: 2002 Canadian Community Health Survey: Mental Health and Well-being.


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Erratum

The last page of "The Manitoba Human Papillomavirus vaccine surveillance and evaluation system" was not included in the English print version of Volume 21, Number 2.

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