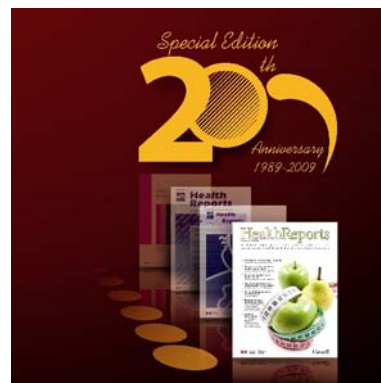



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- . not available for any reference period
- .. not available for specific reference period
- ... not applicable
- P preliminary
- r revised
- x suppressed to meet the confidentiality requirements of the Statistics Act
- E use with caution
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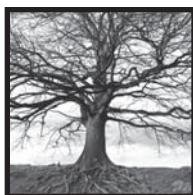
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□ **Social class, gender, and time use: Implications for the social determinants of body weight? 65**

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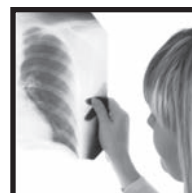
This study examines time-use patterns by indicators of socio-economic position, and considers the implications of variations in time use for the social gradient in weight.



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- **A comparison of individual and area-based socio-economic data for monitoring social inequalities in health..... 85**

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Despite some limitations, area-based socioeconomic measures are useful in assessing social inequalities in health. The inequalities that they identify are significant, consistent and reliable and can be tracked through time and for different geographic settings.

Peer reviewers

The clinical, methodological and subject matter specialists listed below have reviewed articles submitted for Volume 20 of *Health Reports*. The editors thank them for their valuable contributions of time and expertise.

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Guest Editorial

Health Reports' contribution to the analysis of chronic disease risk factors

Canada in context: Challenging our epi- demics of obesity and obesity-related chronic diseases



Diane T. Finegood, PhD

Professor

Department of Biomedical Physiology
and Kinesiology

Simon Fraser University;

Executive Director, The CAPTURE Project

Obesity and obesity-related chronic diseases account for the majority of deaths worldwide. While we tend to think of chronic diseases as problems primarily in high-income countries like Canada, 80% of chronic disease deaths occur in low- and middle-income countries.¹ In Canada, death rates due to chronic disease are relatively low in comparison to countries like China, India and Russia, and rates of mortality from chronic disease in Canada appear to be decreasing. Chen and Millar demonstrated in *Health Reports* nearly 10 years ago that reductions in mortality from cardiovascular disease in the 1980s and 1990s were due, in part, to reductions in the prevalence of heart disease, high blood pressure and smoking.² Although this report suggested that Canadians were getting healthier, we are still seeing significant increases in obesity and diabetes. Using data from the 1994/1995, 1996/1997, 1998/1999 and 2000/2001 National Population Health Survey and the 2000/2001 Canadian Community Health Survey, Millar and Young demonstrated both an increasing incidence and prevalence of diabetes associated with increases in obesity and physical inactivity.³

Obesity in Canada varies twofold between the provinces,⁴ and as Lix and colleagues demonstrate in this issue of *Health Reports*, obesity differs between those living in the north and the south of Canada.⁵ Using self-reported data obtained from the Canadian Community Health Surveys in 2000/2001 and 2005/2006 for Aboriginal and non-Aboriginal respondents from northern Canada (Yukon, Northwest Territories, and Nunavut) and southern Canada, Lix and colleagues found multiple differences between northern and southern Canadian Aboriginal populations with respect to obesity, smoking, drinking and physical activity. Changes over the five-year period between surveys indicate a growing gap between the northern and southern Aboriginal residents on many risk factors and a rapidly worsening health status among northern Canadian Aboriginal residents. Given the increased odds associated with obesity of developing a range of chronic diseases including asthma, arthritis, heart disease, high blood pressure and diabetes, the growing prevalence of overweight and obesity in Canada is definitely cause for concern, especially in some high-risk populations.⁴

In addition to documenting the prevalence of obesity and obesity-related chronic diseases, *Health Reports* has contributed to our understanding of the upstream behaviours associated with these conditions. In the present issue, Langlois and colleagues have used data from the 2004 Canadian Community Health Survey focused on nutrition to determine the relationships between dietary composition and obesity.⁶ Energy intake was consistently higher in obese as compared to non-obese men and women for both univariate and adjusted models. Of concern is the fact that differences between obese and non-obese respondents were on the order of only 200 kcal per day, which was less than 10% of total caloric intake.

Where is this difference in energy intake coming from? Langlois and colleagues found some relationships between total fat, saturated fat, monounsaturated fat, carbohydrate and fibre in men, although only total energy and fibre remained significant in their adjusted model. The 2004 Canadian Community Health Survey provided the first snapshot of Canadians' eating

habits in more than 30 years, and many of these habits are consistent with the growing epidemics of obesity and obesity-related chronic diseases. The majority of Canadians are not getting the recommended minimum number of servings of fruits and vegetables, or milk products.⁷ Many exceed the upper limits for calories from fat, and they are getting these fat calories from many of the items often referred to as "junk food," including pizza, hamburgers, cakes, cookies and donuts. Canadians are eating many of their meals outside the home, and consumption from fast-food outlets accounts for a significant portion of those meals.

Are Canadians also reducing their level of energy expenditure? Millar had reported in 1991 that Canadians were becoming more physically active,⁸ but more recent reports suggest many Canadians are engaged in sedentary behaviours such as television viewing and computer use, and the odds of being obese increased with hours of television watching.⁹ In the 1990s, Canadians were both starting and stopping programs of leisure time physical activity. While these changes in behaviour have many of the predictable correlations with sex, age, educational attainment and smoking status, the strength of these associations suggests there are many different phenotypes of active and inactive Canadians.¹⁰

Health Reports and the data available through Canada's health surveillance system give us the clear picture that Canadians are gaining weight, have an increased risk of obesity and obesity-related chronic diseases, and are not sufficiently active to burn off the excess calories consumed from a wide variety of food items available both inside and outside the home. Although our major surveys give us some ideas about who is at the greatest risk, we mostly have to look elsewhere for the evidence of what programs and policies will work, for whom, and under what conditions. Shields demonstrated using the Canadian Tobacco Use Monitoring Survey that smoking bans at home and at work encourage smokers to quit smoking.¹¹ New surveys and survey questions are needed to identify the most promising policy and program interventions. More tools like the School Health Action, Planning and Evaluation System¹² and The CAPTURE Project need to be widely adopted to support

learning from real-world intervention.¹³ While documenting the changes in health status and associated health behaviours is helpful, it is not enough if we are going to effectively challenge the epidemics of obesity and obesity-related chronic diseases.

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Diet composition and obesity among Canadian adults

Kellie Langlois, Didier Garriguet and Leanne Findlay

Abstract

Background

The contribution of specific nutrients to obesity has not been definitively established. The objective of this study was to determine if an association exists between obesity and the relative percentages of fats, carbohydrates, protein and fibre in the diets of Canadians.

Data and methods

The data are from the 2004 Canadian Community Health Survey—Nutrition. The analysis pertains to 6,454 respondents aged 18 or older who provided valid 24-hour dietary recall information and measured height and weight, and whose reported energy intake was considered plausible based on their predicted energy expenditure. Logistic regression models with obesity status as the main outcome were conducted, controlling for potential confounders. All analyses were based on weighted estimates.

Results

When the effect of the control variables was taken into account, total kilocalories consumed increased the odds of obesity in men, and fibre intake decreased the odds. Among women, only total kilocalories consumed was significantly associated with increased odds of obesity.

Interpretation

Higher consumption of kilocalories increased the odds of obesity, but the relative amounts of fats, carbohydrates and protein were generally not significant. The sole exception was an association between higher fibre intake and lower rates of obesity among men.

Keywords

carbohydrate, energy intake, fat, fibre, protein, 24-hour recall

Authors

Kellie Langlois (1-613-951-3806; Kellie.Langlois@statcan.gc.ca), Didier Garriguet (1-613-951-7187; Didier.Garriguet@statcan.gc.ca) and Leanne Findlay (1-613-951-4648; Leanne.Findlay@statcan.gc.ca) are with the Health Analysis Division at Statistics Canada, Ottawa, Ontario, K1A 0T6.

The prevalence of obesity has been rising in Canada in recent decades.¹ By 2004, 23.1% of adults were obese, nearly ten percentage points higher than in 1978 (13.8%).² Dietary composition—the relative proportions of calories coming from fats, carbohydrates and protein, and intake of fibre—has been suspected of playing a role in obesity.^{3,4} However, few studies have examined the association between excess weight and the consumption of these nutrients, and the results are inconsistent.⁵⁻¹² The unexpected and sometimes contradictory findings may be due to differences in sample size, time frames, and variations in how excess weight is measured. In addition, some of the studies could not account for key factors, including total energy intake⁵ and/or physical activity levels.⁹ Others were unable to adjust for under-reporting of calories consumed^{5,7-11}—a shortcoming of many nutrition studies.¹³⁻¹⁶

The objective of this study was to determine if an association exists between the relative percentages of fats, carbohydrates, protein and fibre in a diet and excess weight among Canadian adults. Unlike most earlier studies, the analysis is based on recent nationally representative Canadian

data. This analysis overcomes many of the shortcomings of past research by controlling for total energy intake, physical activity levels, and under-reporting. It is the first study to investigate the contribution of dietary composition to excess weight among Canadians.

Data and methods

The data are from the 2004 Canadian Community Health Survey—Nutrition, cycle 2.2, which was designed to collect information on the nutritional status of Canadians. The survey excludes members of the Canadian Forces; residents of the three territories, Indian reserves, institutions and some remote areas; and military and civilian residents of the Canadian Forces bases. Detailed descriptions of the survey design, sample and interview procedures are available in a published report.¹⁷

A total of 35,107 respondents completed an initial 24-hour dietary recall, of all foods and beverages consumed from midnight to midnight during the previous 24 hours. To maximize recall, the five-step Automated Multiple Pass Method^{18,19} was used:

- a quick list of the foods consumed;
- questions about commonly forgotten food categories;
- questions about the time and type of meals;
- questions to collect more detailed information about the foods and the quantities consumed; and
- a final review.

A subsample of 10,786 respondents completed a second 24-hour recall three to ten days later. The response rate to the first recall was 76.5%, and to the second, 72.8%. This study uses data from the first recall only. Even though the Automated Multiple Pass Method was developed to maximize recall, a validation study in the United States identified under-reporting of energy intake by 11%.²⁰

An advantage of the Canadian Community Health Survey is that, for about 60% of respondents, measured height and weight information is available. Actual measurements are more accurate for determining obesity than are self-reported height and weight, which tend to underestimate prevalence.²¹⁻²³ To minimize non-response bias, a special (adjusted) survey weight was created for respondents with measured height and weight, based on subject classes with similar

socio-demographic characteristics. The adjusted weights were used to produce all estimates in this study.

Previous analysis of Canadian Community Health Survey data identified a substantial percentage of respondents who under- or over-reported the number of kilocalories they consumed,¹³ thereby masking the relationship between energy intake and obesity. One technique to overcome under- and over-reporting is to limit the study population to respondents with plausible reported energy intakes.^{24,25} Respondents were identified as plausible reporters based on a comparison of their total predicted energy expenditure and their reported energy intake, according to the methodology of Garriguet.²⁶ An energy expenditure value was predicted for each respondent, based on age, weight, sex, height, physical activity and body mass index (BMI) category. The ratio of reported energy intake to predicted energy expenditure was then calculated. A range in the form of $[\exp(-SD); \exp(SD)]$ was assigned to this ratio, where SD represents a standard deviation. Taking into account intra-individual variation of energy intake, the error in predicted requirements and day-to-day variation, and the measurement error for total energy expenditure, SD was estimated at 35%, yielding a range of 0.70 to 1.42.²⁶ Based on the assumption of a weight-stable population, respondents whose ratio fell within this range were considered “plausible” respondents, that is, their reported energy intake was 70% to 142% of their predicted energy expenditure. More information on the identification of plausible respondents is available in a published report.²⁶

Only respondents aged 18 or older whose body mass index was based on measured height and weight were included in this study (n=12,092). Pregnant (n=100) and breast-feeding (n=69) women, respondents with null (n=4) or invalid (n=18) dietary intakes, and respondents with missing information on leisure-time physical activity (n=2) were excluded. Respondents classified as underweight (BMI less than 18.5) (n=249) were also excluded, because

the equations used to predict energy requirements apply only to people whose BMI is at least 18.5.⁴ Finally, under- (n=4,625) and over-reporters (n=1,013) were excluded. The sample on which this analysis is based consisted of 6,454 respondents (n=2,804 men and n=3,650 women) with plausible reported energy intake.

Definitions

Obesity was defined based on Health Canada’s body weight classification system,²⁷ adapted from the World Health Organization.²⁸ Respondents with a BMI equal to or more than 18.5 but less than 25 were considered normal weight; those whose BMI was equal to or more than 25 but less than 30 were considered overweight; and those whose BMI was 30 or more were considered obese. BMI was calculated based on measured height and weight, using the formula: $\text{weight (kg)} / \text{height (m)}^2$. Obese subjects were compared with normal and overweight respondents combined.

The Canadian Nutrient File is a computerized database developed by Health Canada that contains average values for the nutrients in foods available in Canada.²⁹ The Canadian Nutrient File (2001b Supplement)³⁰ was used to determine the energy and nutrient composition of the foods and beverages reported during the recalls.

Total energy intake is examined in 100s of kilocalories. Total fats, carbohydrates, and protein are presented as a percentage of total energy intake. Dietary fibre was examined in grams per 100 kilocalories. The breakdown of total fat (saturated, monounsaturated, and polyunsaturated) was also examined in terms of percentage of total energy intake.

Age was modeled according to the following groups: 18 to 24, 25 to 34, 35 to 44, 45 to 54, 55 to 64, 65 to 74, and 75 or older. These ranges were selected because previous analyses found that rates of obesity varied across these age groups,^{1,2} and the sample size permitted such a breakdown.

Household income was based on the number of people in the household and

total household income from all sources in the 12 months before the interview. Household income groups were derived by calculating the ratio between each respondent's total household income in the previous 12 months and Statistics Canada's low-income cut-off specific to the number of people in the household, the size of the community and the survey year.³¹ These adjusted income ratios are presented in quintiles. A missing category was included to reflect respondents for whom income information was not available.

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

An *ethnic origin* variable was included in the model, which, because of small sample sizes, was collapsed into three categories: White, Aboriginal, and other. Current information about obesity rates among Aboriginal people³² suggests that this should be a separate category.

Smoking status was classified as current smoker, former smoker, and never smoked.

Marital status was classified as married/common-law, widowed, separated/divorced, and never married.

Leisure-time physical activity refers to the three months before the interview. The duration and frequency of each reported activity (for example, walking, gardening, swimming and running) were assessed. Metabolic energy costs (METs)—the amount of energy required to participate in the activity per kilogram of body weight per hour of activity—were assigned to each activity and used to calculate each respondent's average daily energy expenditure (EE) by multiplying frequency by duration and MET value divided by 365 days. Based on their average daily energy expenditure, each respondent was classified as inactive (EE less than 1.5), moderately active (EE greater than or equal to 1.5, but less than 3.0), or active (EE 3.0 or more). (To identify plausible reporters, physical activity was broken down into four categories—sedentary, low-active,

active, very active—to be consistent with the methodology of Garriguet.)²⁶

Analysis

Descriptive statistics were used to examine the characteristics of Canadians who were obese. Chi-squares and t-tests were used to determine significant differences among the groups.

Logistic regression was used to determine the relationship between obesity and dietary composition and other covariates. Logistic regression models were conducted separately by sex. Established risk factors and/or characteristics known to be associated with obesity were included as control variables: age, marital status, education, race, income, smoking, leisure-time physical activity, and total energy intake.^{2,6,8,32,33} Models were run separately for each nutrient, unadjusted and then adjusted for the control variables. A final model was run with all nutrients and control variables simultaneously.

To account for the complex sampling design of the Canadian Community Health Survey, the bootstrap method was used to estimate standard errors, coefficients of variation, and confidence intervals.³⁴⁻³⁶ Significance levels were set at $p < 0.05$. Analyses were conducted using SAS version 9.1 (Statistical Analysis System, SAS Institute Inc., Cary, NC, USA). The bootstrapping technique was used with SUDAAN (version 10)³⁷ software.

Results

The sample

The sample of 6,454 respondents to the 2004 Canadian Community Health Survey, on which this analysis is based, was weighted to represent a population of 12.9 million aged 18 or older (Table 1). They were almost evenly divided between men and women. Nearly two-thirds (65%) were married. More than half (54%) were postsecondary graduates. One-quarter were smokers, and 29% were former smokers; 46% had never smoked. Almost 60% were

Table 1
Prevalence of selected characteristics of sample, household population aged 18 or older with plausible energy intake, Canada excluding territories, 2004

Characteristic	Sample size	Estimated population	
		Number '000	%
Total	6,454	12,918	100.0
Body mass index			
Obese	1,565	2,823	21.9
Not obese	4,889	10,094	78.1
Sex			
Men	2,804	6,485	50.2
Woman	3,650	6,432	49.8
Age group			
18 to 24	707	1,569	12.1
25 to 34	852	2,062	16.0
35 to 44	820	2,755	21.3
45 to 54	1,076	2,483	19.2
55 to 64	1,054	1,950	15.1
65 to 74	927	1,153	8.9
75 or older	1,018	946	7.3
Marital status			
Married/Common-law	3,300	8,328	64.5
Widowed	920	693	5.4
Separated/Divorced	698	1,059	8.2
Never married	1,534	2,834	21.9
Education			
Less than secondary graduation	1,670	2,406	18.8
Secondary graduation	1,120	2,335	18.3
Some postsecondary	592	1,169	9.1
Postsecondary graduation	3,033	6,874	53.8
Household income			
First quintile (lowest)	1,263	2,124	16.4
Second quintile	1,249	2,328	18.0
Third quintile	1,151	2,506	19.4
Fourth quintile	1,143	2,493	19.3
Fifth quintile (highest)	1,131	2,464	19.1
Missing	517	1,002	7.8
Ethnic origin			
White	5,837	10,736	83.1
Aboriginal (off-reserve)	225	190	1.5
Other	392	1,992	15.4
Smoking status			
Current smoker	1,565	3,238	25.1
Former smoker	2,003	3,697	28.6
Never smoked	2,884	5,973	46.3
Leisure-time physical activity			
Inactive	3,751	7,652	59.2
Moderately active	1,576	3,093	23.9
Active	1,127	2,173	16.8

Source: 2004 Canadian Community Health Survey—Nutrition.

inactive in their leisure time, and 22% were obese.

Prevalence of obesity

Men and women were equally likely to be obese (22%) (Table 2). For both sexes, the prevalence of obesity tended to rise with age, peaking in the 45 to 64 age range. However, among men but not women, prevalence dropped sharply at age 75 or older.

Marital status was related to obesity among women, but not among men. Compared with those who had never been married, women who were married, widowed, or separated/divorced were more likely to be obese.

As well, among women, but not men, household income was associated with obesity. Women in the lower three income quintiles were more likely than those in the highest quintile to be obese.

Education was related to obesity, especially among men. Men with secondary graduation or less were more likely than postsecondary graduates to be obese. Among women, the difference was significant only for those with less than secondary graduation.

For both sexes, those who were moderately active or active in their leisure time were less likely than those who were inactive to be obese.

Nutrition

Not surprisingly, obese men consumed significantly more calories (2,820 versus 2,600 calories) than did non-obese men (Table 3). As well, the diets of obese men contained higher percentages of total fat, saturated fat, and monounsaturated fat than was the case for non-obese men. On the other hand, obese men consumed relatively less carbohydrates and fibre than did their non-obese counterparts.

Among women, too, those who were obese consumed significantly more calories than did the non-obese (2,160 versus 1,970). And as was true for men, women who were obese consumed significantly less fibre than did non-obese women.

Each nutrient was modeled separately to examine its individual effect on

Table 2

Weighted prevalence of obesity, by sex and selected characteristics, household population aged 18 or older with plausible energy intake, Canada excluding territories, 2004

Characteristic	Men				Women			
	Estimated number '000	%	95% confidence interval		Estimated number '000	%	95% confidence interval	
			from	to			from	to
Total	6,485	21.7	18.9	24.9	6,432	22.0	19.2	25.0
Age group								
18 to 24 [†]	860	11.2 ^E	6.1	19.7	709	11.2 ^E	6.9	17.8
25 to 34	1,169	22.2 ^E	14.3	32.8	893	19.8 ^E	13.7	27.7
35 to 44	1,347	18.9 ^E	13.4	26.1	1,408	21.0 [*]	15.1	28.4
45 to 54	1,182	28.5 [*]	21.9	36.3	1,301	25.6 [*]	18.3	34.6
55 to 64	966	29.6 [*]	22.6	37.6	984	27.7 [*]	21.1	35.3
65 to 74	573	20.7 [*]	15.6	27.1	580	23.3 [*]	17.9	29.7
75 or older	389	14.9 ^E	8.8	24.1	556	21.8 [*]	16.6	28.0
Marital status								
Married/Common-law	4,293	22.5	19.1	26.3	4,036	23.0 [*]	19.3	27.2
Widowed	108	13.5 ^{‡E}	7.7	22.5	585	26.7 [*]	21.0	33.2
Separated/Divorced	434	26.3 ^E	17.3	37.9	626	25.0 ^{*E}	17.6	34.2
Never married [†]	1,649	19.2 ^E	13.4	26.8	1,185	14.5 ^E	9.5	21.5
Education								
Less than secondary graduation	1,153	28.3 [*]	21.5	36.2	1,254	30.3 [*]	23.4	38.3
Secondary graduation	1,058	36.5 ^{*†}	27.1	47.0	1,277	21.5	15.7	28.8
Some postsecondary	658	14.3 ^E	8.9	22.2	511	23.8 ^E	16.2	33.7
Postsecondary graduation [†]	3,587	16.8	13.8	20.3	3,287	18.6	15.3	22.5
Household income								
First quintile (lowest)	945	16.2 ^E	9.3	26.8	1,179	25.6 [*]	19.1	33.5
Second quintile	1,149	19.6 ^E	13.8	27.1	1,179	24.2 [*]	18.5	30.9
Third quintile	1,316	27.6	20.6	35.8	1,190	25.9 [*]	19.2	33.9
Fourth quintile	1,411	25.3	19.7	31.8	1,082	23.2	17.0	30.9
Fifth quintile (highest) [†]	1,285	21.6	17.1	27.0	1,180	14.0 ^E	8.6	22.0
Missing	380	9.1 ^{*E}	4.8	16.6	623	16.2 ^E	9.9	25.5
Ethnic origin								
White [†]	5,330	24.7	21.4	28.3	5,406	23.2	20.2	26.4
Aboriginal (off-reserve)	83	29.5 ^E	14.9	50.1	107	37.3 ^E	23.7	53.3
Other	F	F	F	F	920	12.9 ^{*E}	7.1	22.3
Smoking status								
Current smoker	1,775	19.8	14.8	26.0	1,463	23.3	17.4	30.5
Former smoker	2,211	27.8 [*]	22.2	34.3	1,486	24.1	18.8	30.4
Never smoked [†]	2,500	17.7	14.0	22.2	3,474	20.6	17.1	24.5
Leisure-time physical activity								
Inactive [†]	3,587	25.4	21.1	30.3	4,065	26.0	22.2	30.3
Moderately active	1,665	16.5 [*]	12.4	21.6	1,428	19.2 [*]	14.9	24.3
Active	1,233	18.1 ^{*†}	13.0	24.6	939	8.7 ^{*E}	5.5	13.5

* significantly different from estimate for reference group (p<0.05)

‡ significantly different from estimate for women (p<0.05)

† reference group

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%)

Note: Plausible respondents are those whose reported energy intake was 70% to 142% of their predicted energy expenditure.

Source: 2004 Canadian Community Health Survey—Nutrition.

obesity, in unadjusted models (no control variables), and then adjusted for other characteristics, including total energy intake (Table 4). The unadjusted logistic regression models showed increased odds of obesity among men with higher consumption of energy and total fat;

consumption of fibre decreased men's odds of obesity, and carbohydrates were also significant. When adjusted for covariates, total energy intake and fibre remained significantly associated with obesity among men: higher energy intake increased their odds of

Table 3
Daily intakes of selected nutrients, by sex and obesity status, household population aged 18 or older with plausible energy intake, Canada excluding territories, 2004

Nutrient	Men						Women					
	Obese			Not obese			Obese			Not obese		
	Average	95% confidence interval		Average	95% confidence interval		Average	95% confidence interval		Average	95% confidence interval	
		from	to		from	to		from	to		from	to
Energy intake (average in 100s of kilocalories)	28.2*	27.3	29.1	26.0	25.5	26.4	21.6*	20.9	22.3	19.7	19.3	20.0
Carbohydrates (% of energy)	45.8*	44.1	47.5	48.1	47.2	48.9	48.9	47.2	50.7	49.8	48.9	50.7
Protein (% of energy)	16.0	15.3	16.7	15.8	15.4	16.2	15.8	14.5	17.1	15.6	15.1	16.1
Total fat (% of energy)	34.3*	32.9	35.8	32.1	31.3	32.9	33.3	32.4	34.3	32.3	31.6	33.0
Saturated fat (% of energy)	11.5*	10.6	12.4	10.2	9.8	10.6	10.7	10.0	11.3	10.6	10.2	10.9
Monounsaturated fat (% of energy)	14.0*	13.4	14.7	13.0	12.6	13.4	13.4	13.0	13.9	12.9	12.6	13.2
Polyunsaturated fat (% of energy)	5.7	5.2	6.1	5.8	5.5	6.0	6.1	5.7	6.4	5.8	5.6	6.0
Fibre (average grams per 100 kilocalories)	0.7*	0.7	0.8	0.8	0.8	0.8	0.8*	0.8	0.9	0.9	0.9	0.9

* significantly different from estimate for non-obese (p<0.05)

Note: Plausible respondents are those whose reported energy intake was 70% to 142% of their predicted energy expenditure.

Source: 2004 Canadian Community Health Survey—Nutrition.

Table 4
Unadjusted and adjusted odds ratios relating obesity to selected nutrients, by sex, household population aged 18 or older with plausible energy intake, Canada excluding territories, 2004

Nutrient	Men					Women						
	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
Energy intake (in 100s of kilocalories)	1.06*	1.03	1.09	1.08*	1.05	1.11	1.09*	1.06	1.13	1.15*	1.11	1.19
Carbohydrates (% of energy)	0.98*	0.96	1.00	0.99	0.98	1.01	0.99	0.98	1.01	1.00	0.99	1.02
Protein (% of energy)	1.01	0.98	1.03	1.02	0.99	1.05	1.01	0.96	1.05	1.01	0.98	1.05
Total fat (% of energy)	1.03*	1.01	1.05	1.01	0.99	1.03	1.01	1.00	1.03	1.00	0.98	1.01
Fibre (grams per 100 kilocalories)	0.50*	0.31	0.79	0.58*	0.34	0.98	0.68	0.45	1.03	0.76	0.51	1.12

* significantly different from 1.00 (p<0.05)

Note: Plausible respondents are those whose reported energy intake was 70% to 142% of their predicted energy expenditure. Each nutrient was modeled separately. Adjusted models controlled for age, marital status, ethnic origin, education, income, smoking, leisure-time physical activity, and total energy intake.

Source: 2004 Canadian Community Health Survey—Nutrition.

obesity, whereas fibre decreased their odds. Among women, high total calorie intake increased the odds of obesity in univariate analysis and in the presence of controls, but no other dietary factor was significantly associated with obesity.

In the fully adjusted models, total energy intake and fibre remained significantly associated with obesity among men; no other nutrient was significant (Table 5). For women, total energy intake was the only dietary factor significantly related to obesity.

Discussion

The analysis of data from the 2004 Canadian Community Health Survey—Nutrition found that higher total energy intake significantly increased the odds of obesity for men and women, but the composition of their diets—the relative percentages of carbohydrates, protein, fats, and fibre—was generally not a factor. The sole exception was the association between higher fibre intake and lower rates of obesity among men. It seems that for obesity, quantity (total energy intake) is more important than quality (the balance of nutrients consumed).

Fat is one of the most studied nutrients in the obesity literature, and possibly, the most controversial. Because of the higher calorie count of fats (9 kilocalories per gram versus 4 kilocalories per gram for both carbohydrates and protein), it is reasonable to assume that higher fat intake contributes to higher energy intake, and perhaps, excess consumption. In fact, those who consume a low-fat diet often unintentionally reduce their total energy intake.³⁸ However, consistent with earlier research,⁵⁻⁷ this analysis found no association between total fat intake and obesity among men: obese men consumed more fat overall,

Table 5
Adjusted odds ratios relating obesity to selected characteristics, by sex,
household population aged 18 or older with plausible energy intake, Canada
excluding territories, 2004

Characteristics	Men			Women		
	Adjusted odds ratio	95% confidence interval from to		Adjusted odds ratio	95% confidence interval from to	
Nutrient						
Energy intake (in 100s of kilocalories)	1.08*	1.04	1.11	1.15*	1.11	1.20
Carbohydrates (% of energy)	1.01	0.99	1.04	1.03	0.99	1.07
Protein (% of energy)	1.02	0.99	1.06	1.04	0.99	1.09
Total fat (% of energy)	1.01	0.99	1.04	1.02	0.98	1.05
Fibre (grams per 100 kilocalories)	0.58*	0.34	0.99	0.69	0.45	1.05
Age group						
18 to 24†	1.00	...	...	1.00	...	...
25 to 34	2.75	0.91	8.30	2.27	0.95	5.40
35 to 44	2.84	0.89	9.03	2.62*	1.10	6.26
45 to 54	4.87*	1.58	15.07	4.11*	1.58	10.71
55 to 64	5.42*	1.75	16.79	4.22*	1.65	10.78
65 to 74	3.33*	1.02	10.83	3.27*	1.38	7.74
75 or older	2.51	0.72	8.70	2.71*	1.08	6.80
Marital status						
Married/Common-law	0.71	0.37	1.36	1.37	0.71	2.63
Widowed	0.39	0.13	1.13	1.51	0.68	3.34
Separated/Divorced	0.84	0.36	1.95	1.47	0.64	3.38
Never married†	1.00	...	...	1.00	...	...
Education						
Less than secondary graduation	2.41*	1.53	3.80	2.11*	1.21	3.69
Secondary graduation	3.02*	1.81	5.04	1.05	0.68	1.62
Some postsecondary	1.15	0.55	2.38	1.79	0.99	3.22
Postsecondary graduation†	1.00	...	...	1.00	...	...
Household income						
First quintile (lowest)	0.86	0.44	1.69	2.03	0.94	4.36
Second quintile	1.04	0.60	1.83	1.85	0.89	3.87
Third quintile	1.21	0.73	1.99	2.21*	1.12	4.37
Fourth quintile	1.14	0.73	1.77	1.48	0.74	2.96
Fifth quintile (highest)†	1.00	...	...	1.00	...	...
Missing	0.40*	0.18	0.85	1.31	0.50	3.47
Ethnic origin						
White†	1.00	...	...	1.00	...	...
Aboriginal (off-reserve)	1.36	0.49	3.79	1.90	0.79	4.56
Other	0.28*	0.12	0.66	0.45*	0.21	0.97
Smoking status						
Current smoker	0.60*	0.36	1.00	0.78	0.45	1.34
Former smoker	1.30	0.84	2.00	0.95	0.65	1.39
Never smoked†	1.00	...	...	1.00	...	...
Leisure-time physical activity						
Inactive†	1.00	...	...	1.00	...	...
Moderately active	0.67	0.43	1.05	0.68	0.46	1.01
Active	0.61	0.36	1.02	0.27*	0.15	0.48

* significantly different from estimate for reference category or from 1.00 for continuous variables ($p < 0.05$)

† reference category

... not applicable

Note: Plausible respondents are those whose reported energy intake was 70% to 142% of their predicted energy expenditure.

Source: 2004 Canadian Community Health Survey—Nutrition.

but when modeled in the presence of covariates, the relationship disappeared.

In this study, the relative percentages of total fat in the diets of obese and non-obese women did not differ significantly, so not surprisingly, no relationship emerged between fat intake and obesity. This is counter to the results of two earlier studies that found an association between women's fat intake and percent body fat⁸ and BMI.⁹ However, neither study accounted for under-reporting of energy intake, or more importantly, under-reporting of fat intake.^{39,40}

Some studies have examined specific types of fats, because it has been suggested that saturated, monounsaturated and polyunsaturated fats might have different effects on adiposity.⁴¹ As a supplementary analysis, the three types of fat were entered into the model instead of total fat. Monounsaturated fats increased the odds of obesity, and polyunsaturated fats decreased the odds of obesity among men, but not among women (Appendix Table A). No relationship with saturated fats emerged for either sex. These results are inconsistent with recent literature. A 2003 study of elderly people found a positive relationship between saturated fat intake and BMI among women (mono- and polyunsaturated fats were not examined).⁹ A 2002 study of post-menopausal women showed monounsaturated fats to be positively related to weight; no relationship was found for polyunsaturated or saturated fats.¹⁰ A 2008 ecological study found saturated fat and polyunsaturated fat intake to be positively associated with obesity prevalence, and monounsaturated fat intake to be negatively related,¹² which directly contradicts the present analysis. Both monounsaturated and polyunsaturated fats are considered "healthy" fats (they tend to lower blood cholesterol levels^{42,43}), so it is unclear why, in this study, one is associated with increased odds of obesity among men, while the other is associated with decreased odds.

In the unadjusted models, a higher percentage of calories coming from carbohydrates was negatively associated

What is already known on this subject?

- The few studies that have examined the association between diet composition and obesity have methodological limitations and yield conflicting results.
- No study has investigated the contribution of fats, carbohydrates, protein, and fibre to excess weight among Canadian adults.

What does this study add?

- The number of calories consumed is more important in obesity than is the composition of a diet in terms of the relative percentages of fats, carbohydrates, and protein consumed.
- Dietary fibre is associated with a reduced likelihood of obesity among Canadian men.

with obesity among men. While this is somewhat consistent with an earlier study in which carbohydrate intake remained significant even when adjusted for potential confounders,⁷ other research has shown no association between carbohydrate consumption and excess weight.^{6,8}

No significant relationship was found in this analysis between obesity and the percentage of calories derived from protein. This is consistent with several cross-sectional studies published in the 1990s.⁶⁻⁸ A 2006 prospective study found an inverse relationship between protein intake and five-year differences in waist circumference,⁴⁴ but a 1999 prospective study found the opposite—a positive relationship between protein intake and body weight.¹¹

Dietary fibre has been studied as a preventive factor in the development of obesity. It has been suggested that dietary fibre delays gastric emptying,

and thereby contributes to a sensation of fullness.⁴ In addition, foods rich in fibre tend to be low in calories.⁴ In the present study, dietary fibre was the only nutrient associated with obesity. While the relationship was significant only among men, the odds ratio for women (OR=0.69; CI: 0.45, 1.05) suggests the same direction of association. Previous studies, too, have yielded similar results,^{5-7,9} As well, numerous studies have identified fibre as protective against coronary heart disease,⁴⁵⁻⁴⁸ for which obesity is a risk factor.

The relationships between non-dietary covariates and obesity in the multivariate models are relatively consistent with other studies. Advancing age was associated with increased odds of obesity for both sexes, as were lower levels of education. The odds of obesity were significantly low among women who reported active leisure time, and although not significant among men, the odds ratio was borderline significant ($p=.057$ for active respondents).

Limitations

This study has a number of limitations. Because the 2004 Canadian Community Health Survey—Nutrition is cross-sectional, causality cannot be inferred. As well, the data pertain to food and beverage consumption for only one day. Results should be interpreted as regression-adjusted averages. The relatively low response rate among individuals with measured height and weight is also a limitation, although the use of the special survey weight adjusted for this shortcoming.

Another limitation is the measure of physical activity, which refers only to leisure time and neglects physical activity related to occupational or educational pursuits and transportation. In addition, the physical activity data were self-reported and so may be subject to recall errors.⁴⁹

As a measure of obesity, BMI is problematic for people who are very muscular or very thin. In addition, BMI does not indicate adiposity on specific areas of the body, which may be

associated with health risks (for example, abdominal fat). Nonetheless, BMI is the currently accepted indicator of obesity in epidemiological studies.

Excluding under- and over-reporters may have meant that some respondents who correctly reported their food intake, but consumed significantly more or less than usual that day, were omitted from the analysis. For example, no information was collected about whether respondents were dieting.

On the other hand, the inclusion of only plausible respondents is a strength of this study. Exploratory analyses that included under- and over-reporters found that higher total energy intake was associated with decreased odds of obesity, even controlling for covariates (data not shown). Since energy requirements increase with body weight, this is improbable. Moreover, the technique for identifying plausible respondents used in this study is more sophisticated than those employed in other studies, many of which simply apply an arbitrary range to calories consumed.^{6,50} In other studies, under-reporters have also been identified based on the ratio of total energy intake (EI) to basal metabolic rate (BMR); individuals whose EI:BMR ratio is less than 1.2 are typically excluded because such values are rare.⁵¹ However, this method does not take into account the other extreme of the distribution—large values can also be implausible. So despite the exclusion of a substantial number of respondents, compared with other techniques, the one used in this study has the advantage of correcting for under-reporting while ensuring that the characteristics of plausible respondents are representative of the total population.²⁶

Conclusion

Results of the present study provide further evidence that it is not what you eat, but rather, how much—the total number of calories consumed—that significantly contributes to obesity. The results also suggest that a diet rich in fibre is associated with a reduced risk of obesity.

This study highlights the importance of adjusting nutrition data for total energy intake and leisure-time physical activity, and especially, identifying and excluding respondents who substantially under-report the number of calories they consume. Restricting the analysis to “plausible” respondents is an important methodological advance; without this

correction, the association between calorie consumption and excess weight is lost or distorted.

These results pertain to adults, and it is unclear if they apply to individuals younger than age 18. Given the prevalence of overweight and obesity among young people, future research could usefully examine the association between diet

composition and excess weight among children and adolescents. ■

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Appendix

Table A
Adjusted odds ratios relating obesity to selected characteristics, by sex,
household population aged 18 or older with plausible energy intake, Canada
excluding territories, 2004

Characteristics	Men			Women		
	Adjusted odds ratio	95% confidence interval		Adjusted odds ratio	95% confidence interval	
		from	to		from	to
Nutrient						
Energy intake (in 100s of kilocalories)	1.08*	1.04	1.11	1.15*	1.11	1.20
Carbohydrates (% of energy)	1.01	0.99	1.04	1.02	0.99	1.06
Protein (% of energy)	1.02	0.99	1.06	1.04	0.99	1.08
Saturated fat (% of energy)	0.98	0.92	1.05	1.00	0.94	1.06
Monounsaturated fat (% of energy)	1.10*	1.02	1.18	1.01	0.95	1.08
Polyunsaturated fat (% of energy)	0.88*	0.78	0.99	1.03	0.94	1.14
Fibre (grams per 100 kilocalories)	0.68	0.38	1.21	0.66	0.42	1.03
Age group						
18 to 24†	1.00	...	...	1.00	...	...
25 to 34	2.79	0.93	8.41	2.25	0.94	5.37
35 to 44	2.85	0.90	8.97	2.64*	1.10	6.30
45 to 54	4.92*	1.60	15.11	4.02*	1.53	10.55
55 to 64	5.69*	1.85	17.53	4.06*	1.59	10.41
65 to 74	3.48*	1.07	11.29	3.22*	1.35	7.69
75 or older	2.56	0.73	8.91	2.67*	1.06	6.76
Marital status						
Married/Common-law	0.72	0.38	1.37	1.37	0.71	2.65
Widowed	0.38	0.13	1.09	1.52	0.68	3.39
Separated/Divorced	0.83	0.36	1.94	1.45	0.63	3.36
Never married†	1.00	...	...	1.00	...	...
Education						
Less than secondary graduation	2.49*	1.57	3.93	2.09*	1.20	3.64
Secondary graduation	3.06*	1.82	5.14	1.04	0.67	1.62
Some postsecondary	1.17	0.57	2.42	1.78	0.98	3.22
Postsecondary graduation†	1.00	...	...	1.00	...	...
Household income						
First quintile (lowest)	0.85	0.43	1.68	2.06	0.96	4.43
Second quintile	1.04	0.60	1.83	1.88	0.90	3.92
Third quintile	1.18	0.71	1.96	2.22*	1.12	4.39
Fourth quintile	1.16	0.74	1.81	1.51	0.76	2.99
Fifth quintile (highest)†	1.00	1.00	1.00	1.00	...	...
Missing	0.39*	0.17	0.86	1.34	0.51	3.52
Ethnic origin						
White†	1.00	...	...	1.00	...	...
Aboriginal (off-reserve)	1.41	0.49	4.08	1.86	0.77	4.50
Other	0.28*	0.12	0.69	0.43*	0.20	0.93
Smoking status						
Current smoker	0.59*	0.36	0.99	0.77	0.45	1.33
Former smoker	1.31	0.85	2.01	0.94	0.64	1.39
Never smoked†	1.00	...	...	1.00	...	...
Leisure-time physical activity						
Inactive†	1.00	...	...	1.00	...	...
Moderately active	0.65	0.41	1.02	0.68	0.46	1.00
Active	0.58*	0.35	0.98	0.26*	0.15	0.46

* significantly different from estimate for reference category or from 1.00 for continuous variables ($p < 0.05$)

† reference category

... not applicable

Note: Plausible respondents are those whose reported energy intake was 70% to 142% of their predicted energy expenditure.

Source: 2004 Canadian Community Health Survey—Nutrition.

Risk factors and chronic conditions among Aboriginal and non-Aboriginal populations

by Lisa M. Lix, Sharon Bruce, Joykrishna Sarkar and T. Kue Young

Abstract

Background

In Canada, the prevalence of behavioural risk factors and chronic conditions differs for Aboriginal and non-Aboriginal populations, but little research has examined changes over time. This study compares several major risk factors and chronic conditions in Aboriginal and non-Aboriginal populations not living on reserves in the North (Yukon, Northwest Territories, Nunavut) and in southern Canada at two time points.

Data and methods

The data are from cycle 1.1 (2000/2001) and cycle 3.1 (2005/2006) of the Canadian Community Health Survey: 115,990 respondents aged 20 or older, and 118,716 respondents, respectively. Overall, 3.8% of respondents reported Aboriginal cultural or racial background. Crude prevalence estimates, adjusted odds ratios, and bootstrap-derived confidence intervals were calculated for seven risk factors and nine chronic conditions at each time point.

Results

In 2000/2001, Aboriginal people in the North were more likely than those in southern Canada to be obese, smoke daily and have infrequent physical activity, but less likely report a number of chronic conditions. Between 2000/2001 and 2005/2006, the odds of reporting risk factors increased among Aboriginal people in the North, and differences in the prevalence of chronic diseases were less pronounced. Few differences between non-Aboriginal respondents in the North and in southern Canada were observed.

Interpretation

Compared with southern Canada, the profile of health is changing more rapidly for Aboriginal than non-Aboriginal populations in the North, and appears to be worsening for the former.

Keywords

chronic disease, drinking behaviour, exercise, health surveys, morbidity, obesity, smoking

Authors

Lisa M. Lix (1-306-966-1617; lisa.lix@usask.ca) is with the School of Public Health, University of Saskatchewan, 107 Wiggins Road, Saskatoon, Saskatchewan, S7N 5E5; Sharon Bruce and Joykrishna Sarkar are with the Department of Community Health Sciences, University of Manitoba; and T. Kue Young is with the Dalla Lana School of Public Health, University of Toronto.

In Canada, the prevalence of behavioural risk factors and chronic conditions varies between Aboriginal and non-Aboriginal populations, with Aboriginal people generally having less favourable outcomes. For example, obesity and overweight are more common among Aboriginal people than among other groups.¹⁻³ Also, the likelihood of having at least one chronic condition and specific conditions such as cardiovascular disease and diabetes is higher among Aboriginal people, even when differences in socio-demographic characteristics are taken into account.^{2,4}

Relatively little research has examined the health of Aboriginal people over time. This is particularly relevant for those in the North, who are experiencing rapid changes in their social, cultural and physical environments, which are likely to influence their health. For example, a recent study⁵ found that the self-reported prevalence of having a chronic condition rose in the North since 2000/2001; an increase was also observed in southern Canada, but it was smaller. That study also found a decrease in physical activity and an increase in obesity among residents of the North. However, differences between Aboriginal and non-Aboriginal populations were not investigated, so it was not clear if these trends prevailed only among Aboriginal people or were common to all people in the North.

The purpose of the current study is to compare changes over time in several major behavioural risk factors and chronic conditions among Aboriginal and non-Aboriginal populations in the North and in southern Canada who were not living on reserves.

Methods

Data source and study design

The data are from cycle 1.1 (2000/2001) and cycle 3.1 (2005/2006) of Statistics Canada's Canadian Community Health Survey. This national survey collects information about health status, determinants of health, and use of the health care system in the provinces and the territories. The survey covers approximately 98% of

the Canadian population aged 12 or older. It excludes residents of reserves and other government-owned land, institutional residents, full-time members of the Canadian Forces, and all residents (military and civilian) of Canadian Forces bases.

Cycle 1.1 was conducted from September 2000 to November 2001. The number of respondents was 131,535, and the overall response rate was 84.7%. The response rate in southern Canada ranged from 82.0% in Ontario to 88.8% in Nova Scotia. In the North (Yukon, Northwest Territories, Nunavut), the overall response rate was 78.3%.

Cycle 3.1 was conducted from January 2005 to January 2006. The number of respondents was 132,947, and the overall response rate was 78.9%. The response rate in southern Canada ranged from 76.4% in Quebec to 85.7% in Newfoundland and Labrador. In the North, the overall response rate was 83.3%, ranging from 81.6% in Yukon to 87.7% in Nunavut.

All respondents aged 20 or older to cycles 1.1 and 3.1 were included in this analysis: 115,990 in 2000/2001 and 118,716 in 2005/2006. The University of Manitoba Health Research Ethics Board approved this research. Permission to access the data was obtained from Statistics Canada. All analyses were conducted within the secure environment of the Statistics Canada Research Data Centre at the University of Manitoba.

Study measures

To distinguish *Aboriginal* and *non-Aboriginal* respondents in cycle 1.1 (2000/2001), the survey asked: "People living in Canada come from many different cultural and racial backgrounds. Are you . . . ?" The list of options included "Aboriginal Peoples of North America (North American Indian, Métis, Inuit/Eskimo)." For this study, those who responded positively to this option were assigned to the Aboriginal category; all other respondents were assigned to the non-Aboriginal category. Respondents were assigned to the Aboriginal category regardless of whether they reported being

Aboriginal singly or in combination with a non-Aboriginal background.

In cycle 3.1 (2005/2006), a new derived variable was used to determine whether respondents were Aboriginal or non-Aboriginal. This variable was derived from two other variables. From January to May 2005, information needed to derive this variable was collected using the question in which respondents reported their cultural or racial background; "Aboriginal (North American Indian, Métis, Inuit)" was on the list of answer categories. In June 2005, the approach was changed to make the Canadian Community Health Survey more consistent with the Census of Population and the Labour Force Survey. Respondents were asked directly, "Are you an Aboriginal person, that is, North American Indian, Métis or Inuit?" Before June 2005, respondents were able to report Aboriginal background in combination with other cultural or racial backgrounds, and they were assigned to the Aboriginal category regardless of whether they reported Aboriginal background singly or in combination with a non-Aboriginal background. Beginning in June 2005, respondents identifying themselves as Aboriginal were not asked the question about other cultural or racial backgrounds.

Respondents who indicated that they lived in Yukon, Northwest Territories or Nunavut were defined as residents of the *North*; all others were defined as southern Canada residents.

The outcome measures were obtained from five modules of the Canadian Community Health Survey: height and weight, smoking, alcohol use, physical activity, and chronic conditions. Because module content and question wording changed over time, careful attention was given to the selection of questions common to both cycle 1.1 and cycle 3.1.

Measures of behavioural risk factors were derived from the modules on height and weight, smoking, alcohol use, and physical activity. Data about height and weight were used to calculate body mass index (BMI) by dividing weight in kilograms by the square of height

in meters. Two categories of excess weight, based on Canadian guidelines,⁶ were defined: *overweight* (BMI 25.0 to 29.9) and *obese* (BMI 30.0 or more).

In the smoking module, respondents were asked whether they smoked daily, occasionally, or not at all. A single dichotomous variable of *daily smoking* (yes/no) was created.

Questions about the frequency of alcohol consumption were used to define mutually exclusive categories for type of drinker: regular, occasional, former, and never. Regular drinkers were respondents who reported that they had consumed alcohol at least once a month in the past 12 months. Occasional drinkers were those who consumed alcohol less than once a month in the past 12 months. Former drinkers had not consumed alcohol in the past 12 months, but reported ever having consumed alcohol. The data were used to create a dichotomous variable defined as *regular drinker* (yes/no). Respondents were also asked if they had consumed more than five drinks on a single occasion in the past 12 months, which was used as a measure of *heavy drinking*.⁷

The average monthly frequency of all physical activities that lasted at least 15 minutes during the three months before the date of the interview was used to assess participation in physical activity. Respondents were classified as participating in: regular physical activity if their average monthly frequency was 12 or more times (at least three times a week); occasional physical activity if their average monthly frequency was 4 to 11 times; and infrequent physical activity if their average monthly frequency was less than 4 times. These response categories were grouped to form a dichotomous variable: regular/occasional and *infrequent*.

Levels of physical activity were based on respondents' total daily energy expenditure during leisure time. Respondents were categorized as active (3.0 or more kilocalories per kilogram per day [kcal/kg/day]), moderately active (1.5 to 2.99 kcal/kg/day), or *inactive* (0 to 1.49 kcal/kg/day); the first two categories were combined. Leisure-time physical

activities included individual pursuits such as walking, running, swimming, fishing and gardening, and team sports such as ice hockey, basketball, volleyball and soccer.

In the *chronic conditions* module, respondents were asked if they had been diagnosed by a health professional with selected conditions. Dichotomous response variables (presence/absence) were defined for the following conditions: asthma, arthritis/rheumatism, bowel disorders, cancer, diabetes, emphysema/chronic obstructive pulmonary disease, heart disease, high blood pressure, and stroke. Cancer and emphysema/chronic obstructive pulmonary disease were reported too infrequently to yield reliable results for the North, and were, therefore, excluded. In addition, a dichotomous variable indicating the presence of *at least one chronic condition* was created; the conditions used to define this variable were: food allergies, other allergies, asthma, fibromyalgia, arthritis/rheumatism, high blood pressure, back problems, migraine headaches, chronic bronchitis, emphysema, chronic obstructive pulmonary disease, diabetes, epilepsy, heart disease, cancer, stomach or intestinal ulcers, urinary incontinence, bowel disorders, cataracts, glaucoma, thyroid condition, chronic fatigue syndrome, multiple chemical sensitivities, and any other long-term condition diagnosed by a health professional.

Analytical techniques

The percentage of respondents reporting each behavioural risk factor and chronic condition was calculated, along with 95% confidence intervals. Weighted multiple logistic regression, stratified by Aboriginal/non-Aboriginal, was used to test associations between residence in the North versus southern Canada and each of the risk factors and chronic conditions. Each model also included age group (20 to 44, 45 to 54, 55 to 64, 65 to 74, and 75 or older) and sex as covariates. The reference category was southern Canada. Data from cycles 1.1 and 3.1 were analyzed separately. Survey

Table 1
Ethnicity, sex and age group of off-reserve respondents aged 20 or older to Canadian Community Health Survey, by region and survey cycle, and comparison with 2001 Census of Canada data for off-reserve populations

	North		Southern Canada	
	Number	Percentage distribution	Number	Percentage distribution
Canadian Community Health Survey, cycle 1.1 (2000/2001)	2,074	100.0	113,916	100.0
Ethnicity				
Aboriginal	866	41.8	3,089	2.7
Non-Aboriginal	1,174	56.6	109,850	96.4
Sex				
Men	1,029	49.6	51,972	45.6
Women	1,045	50.4	61,944	54.4
Age group				
20 to 34	764	36.8	26,794	23.5
35 to 44	569	27.4	25,489	22.4
45 to 54	401	19.3	21,768	19.1
55 or older	340	16.4	39,865	35.0
Canadian Community Health Survey, cycle 3.1 (2005/2006)	2,166	100.0	116,550	100.0
Ethnicity				
Aboriginal	810	37.4	4,142	3.6
Non-Aboriginal	1,340	61.9	109,777	94.1
Sex				
Men	1,072	49.5	52,655	45.2
Women	1,094	50.5	63,895	54.8
Age group				
20 to 34	771	35.6	27,386	23.5
35 to 44	518	23.9	21,363	18.3
45 to 54	434	20.0	19,582	16.8
55 or older	443	20.5	48,219	41.4
2001 Census of Canada	44,885	100.0	21,629,755	100.0
Ethnicity†				
Aboriginal	16,615	37.0	390,115	1.8
Non-Aboriginal	28,280	63.0	21,239,640	98.2
Sex				
Men	22,580	50.3	10,458,780	48.4
Women	22,305	49.7	11,170,985	51.6
Age group				
20 to 34	16,145	36.0	5,832,035	27.0
35 to 44	12,290	27.4	5,017,815	23.2
45 to 54	9,685	21.6	4,353,925	20.1
55 or older	6,775	15.1	6,425,980	29.7

† based on Aboriginal identity, which refers to those who reported identifying with at least one Aboriginal group (North American Indian, Métis or Inuit) and those who did not report Aboriginal identity, but reported themselves as Registered or Treaty Indian, and/or Band or First Nations member

Note: Because of missing data, percentages may not add to 100.

Sources: 2000/2001 and 2005/2006 Canadian Community Health Survey; 2001 Census of Canada.

weights were used in all analyses; these weights ensure that the final estimates are representative of the surveyed populations of the North and southern Canada.

A bootstrap method was used to calculate 95% confidence intervals for the adjusted odds ratios.⁸⁻¹⁰ The bootstrap method randomly samples

with replacement from the original set of observations to obtain a sampling distribution for a population parameter (for example, odds ratio). SAS software, version 9.1, was used to conduct all analyses, and a significance level of $\alpha=.05$ was adopted.¹¹ A SAS macro developed at Statistics Canada was used to calculate the bootstrap confidence

intervals; these were based on a total of 500 samples, as recommended by the software developers.

Results

Characteristics of study population

Among respondents aged 20 or older to cycle 1.1 (2000/2001) of the Canadian

Community Health Survey who were not living on reserves, 2,074 resided in the North, and 113,916 in southern Canada (Table 1). The corresponding figures for cycle 3.1 (2005/2006) were 2,166 and 116,550.

In cycle 1.1, 41.8% of respondents in the North and 2.7% of those in southern Canada were Aboriginal; in cycle 3.1, the percentages were 37.4% and 3.6%, respectively. According to the

2001 Census,¹² 37.0% of residents of the North who did not live on reserves were Aboriginal; the figure for southern Canada was 1.8%.

In both survey cycles, approximately half of respondents in the North were male; in southern Canada, the percentage was around 45%. Census results show similar percentages of men and women in southern Canada.

Table 2
Crude prevalence of selected risk factors and major chronic conditions, by region and ethnicity, off-reserve population, Canada, 2000/2001 and 2005/2006

	North						Southern Canada					
	2000/2001			2005/2006			2000/2001			2005/2006		
	%	95% confidence interval		%	95% confidence interval		%	95% confidence interval		%	95% confidence interval	
		from	to		from	to		from	to		from	to
Aboriginal												
Risk factors												
Overweight	28.6	26.1	31.0	26.2	22.1	30.2	30.1	27.4	32.8	30.9	28.6	33.2
Obese	20.2	18.1	22.4	25.4	20.5	30.2	22.7	20.1	25.2	25.3	23.2	27.4
Daily smoker	52.5	50.0	55.0	50.2	45.7	54.8	45.4	42.4	48.4	36.2	33.7	38.6
Regular drinker	44.4	42.5	46.3	51.6	46.5	56.7	54.3	51.1	57.5	56.7	54.3	59.2
Heavy drinking	17.7	16.4	19.0	22.9	19.7	26.1	24.1	21.2	26.8	26.9	24.6	29.2
Infrequent physical activity	28.3	26.5	30.1	29.2	24.6	33.8	21.1	18.7	23.4	19.0	17.0	20.9
Inactive leisure time	52.7	50.5	55.0	58.0	53.0	63.1	49.2	46.4	51.9	47.1	44.5	49.6
Chronic conditions												
One or more chronic conditions	48.5	46.0	51.1	57.3	53.2	61.3	68.0	65.2	70.9	72.3	70.0	74.5
Arthritis	11.6	10.0	13.2	11.5	8.8	14.1	21.0	18.9	23.4	19.8	17.8	21.8
Hypertension	9.4	7.8	11.1	10.9	8.3	13.5	11.8	9.7	14.0	14.4	12.9	16.0
Asthma	6.1	4.9	7.4	6.3	4.0	8.5	13.1	11.0	15.3	10.7	9.2	12.1
Heart disease	5.1	3.9	6.2	2.7	1.3	4.1	4.5	3.3	5.8	4.9	3.9	5.8
Diabetes	3.2	2.1	4.3	3.8	2.2	5.4	6.4	5.1	7.7	6.4	5.3	7.4
Bowel disorder	1.7	0.8	2.6	2.6	0.9	4.4	2.3	1.5	3.1	5.3	4.2	6.3
Stroke	0.9	0.5	1.3	1.2	0.5	2.0	1.0	0.4	1.6	1.7	1.2	2.3
Non-Aboriginal												
Risk factors												
Overweight	28.8	26.0	31.5	34.0	30.9	37.1	26.9	26.5	27.3	33.7	33.3	34.2
Obese	18.5	15.9	21.0	21.1	18.3	23.9	12.3	12.0	12.5	15.6	15.2	15.9
Daily smoker	29.9	26.5	33.3	23.5	20.1	26.9	22.4	22.0	22.8	17.6	17.3	18.0
Regular drinker	65.3	62.0	68.5	66.8	63.0	70.5	61.0	60.5	61.4	64.3	63.8	64.7
Heavy drinking	36.1	33.0	39.2	38.5	34.8	42.2	45.8	45.4	46.2	43.0	42.5	43.4
Infrequent physical activity	19.2	16.5	22.0	18.5	15.9	21.1	21.6	21.2	22.0	18.0	17.7	18.3
Inactive leisure time	42.6	39.2	45.9	45.8	41.5	50.0	52.2	51.7	52.7	49.4	49.0	49.9
Chronic conditions												
One or more chronic conditions	61.6	58.1	65.1	62.2	57.8	66.5	66.4	65.9	66.8	69.7	69.4	70.3
Arthritis	13.7	12.1	15.4	14.9	12.5	17.3	17.2	16.9	17.5	18.5	18.2	18.8
Hypertension	9.4	7.6	11.2	11.3	9.3	13.2	14.4	14.1	14.7	17.0	16.7	17.3
Asthma	8.5	6.2	10.7	8.6	6.6	10.5	7.8	7.5	8.0	7.8	7.6	8.0
Heart disease	3.3	2.1	4.4	2.7	1.9	3.6	5.7	5.5	5.8	5.4	5.2	5.5
Diabetes	3.1	2.3	3.9	3.8	2.5	5.0	4.6	4.5	4.8	5.5	5.3	5.6
Bowel disorder	2.1	1.2	2.9	4.2	2.6	5.8	2.3	2.2	2.5	4.3	4.2	4.5
Stroke	0.3	0.0	0.7	0.5	0.2	0.8	1.2	1.1	1.3	1.2	1.1	1.3

Source: 2000/2001 and 2005/2006 Canadian Community Health Survey.

Respondents in the North tended to be younger than those in southern Canada. As a percentage of the population aged 20 or older, in both survey cycles, about 37% of respondents in the North were younger than 35, compared with about 24% of those in southern Canada; the corresponding percentages from the 2001 Census were 36.0% and 27.0%.

Risk factors

In 2000/2001 and 2005/2006, crude prevalence rates of daily smoking, infrequent physical activity and inactive leisure time were higher among Aboriginal people in the North than among those in southern Canada (Table 2). By contrast, overweight, obesity, regular drinking and heavy drinking were more prevalent among Aboriginal people in southern Canada.

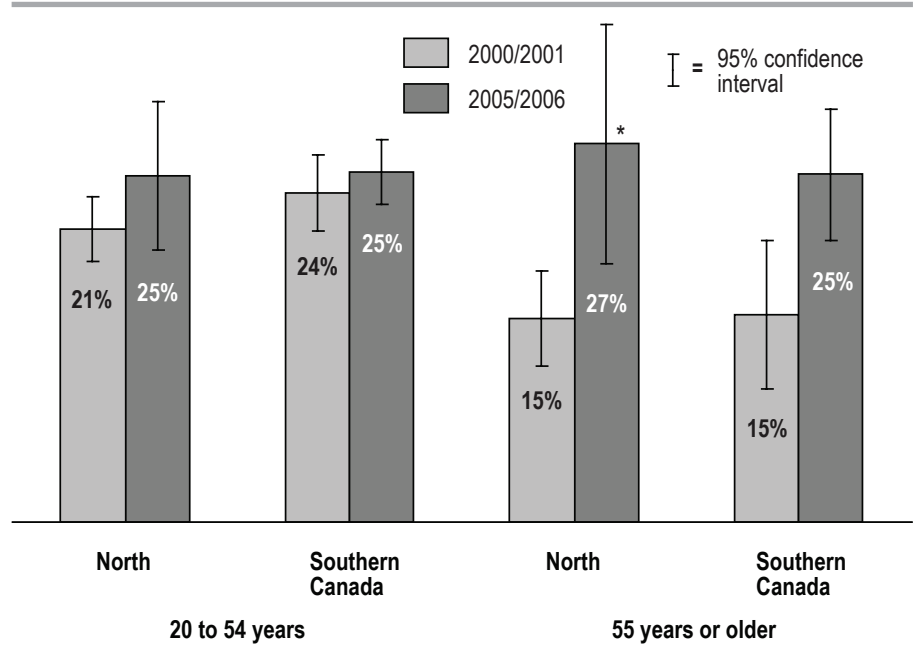
Among the non-Aboriginal population, overweight, obesity, daily smoking and regular drinking were more prevalent in the North than in southern Canada in 2000/2001 and 2005/2006.

From 2000/2001 to 2005/2006, the prevalence of obesity rose among all groups: Aboriginal and non-Aboriginal, in the North and in southern Canada (Table 2). However, among Aboriginal people, the largest increase was in the North (Table 2 and Figure 1).

During the same five-year period, the overall prevalence of daily smoking fell in all groups, but remained highest among Aboriginal people in the North (Table 2). The decrease in smoking prevalence among Aboriginal people was not statistically significant for those aged 20 to 54 in the North, although it was significant for their counterparts in southern Canada (Figure 2). At age 55 or older, smoking rates among Aboriginal people did not change significantly, regardless of where they lived.

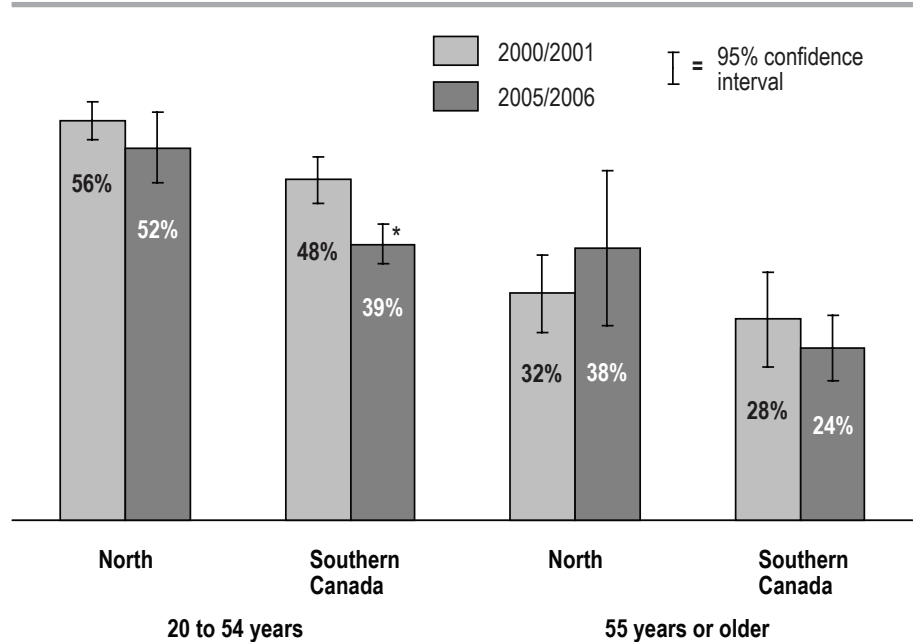
When the effects of the age and sex distributions of the various groups were taken into account, the odds of obesity, daily smoking, and infrequent physical activity were significantly higher for Aboriginal people in the North than for those in southern Canada (Table

Figure 1
Prevalence of obesity, by age group and region, Aboriginal off-reserve population aged 20 or older, Canada, 2000/2001 and 2005/2006



* significantly different from estimate for 2000/2001 (p<0.05)
Source: 2000/2001 and 2005/2006 Canadian Community Health Survey.

Figure 2
Prevalence of daily smoking, by age group and region, Aboriginal off-reserve population aged 20 or older, Canada, 2000/2001 and 2005/2006



* significantly different from estimate for 2000/2001 (p<0.05)
Source: 2000/2001 and 2005/2006 Canadian Community Health Survey.

Table 3

Age- and sex-adjusted odds ratios for selected risk factors and major chronic conditions for the North, by ethnicity, off-reserve population aged 20 or older, 2000/2001 and 2005/2006

	Aboriginal						Non-Aboriginal					
	2000/2001			2005/2006			2000/2001			2005/2006		
	Odds ratio	95% confidence interval		Odds ratio	95% confidence interval		Odds ratio	95% confidence interval		Odds ratio	95% confidence interval	
from		to	from		to	from		to	from		to	
Risk factors												
Overweight	1.00	0.85	1.18	0.83	0.66	1.05	0.93	0.81	1.08	1.03	0.89	1.19
Obese	1.30*	1.00	1.50	1.70*	1.30	2.20	1.30*	1.10	1.60	1.50*	1.20	1.70
Daily smoker	1.84*	1.57	2.14	3.20*	2.60	3.93	1.32*	1.12	1.55	1.33*	1.10	1.60
Regular drinker	0.81*	0.71	0.93	1.44*	1.14	1.81	1.00	0.86	1.18	1.04	0.87	1.23
Heavy drinking	0.80*	0.60	0.90	1.10	0.90	1.30	0.70*	0.60	0.80	1.00	0.80	1.10
Infrequent physical activity	1.21*	1.04	1.41	1.82*	1.40	2.37	0.92	0.77	1.09	1.14	0.96	1.35
Inactive leisure time	1.06	0.94	1.20	1.68*	1.35	2.11	0.68*	0.60	0.78	0.90	0.76	1.07
Chronic conditions												
One or more chronic conditions	0.50*	0.43	0.57	0.67*	0.55	0.82	0.85*	0.73	0.99	0.82	0.67	1.00
Arthritis	0.49*	0.40	0.60	0.65*	0.49	0.88	0.95	0.81	1.11	1.09	0.85	1.38
Hypertension	0.68*	0.52	0.89	0.86	0.62	1.18	0.75*	0.60	0.95	0.83	0.65	1.06
Asthma	0.49*	0.37	0.64	0.71	0.48	1.06	1.06	0.81	1.38	1.12	0.86	1.44
Heart disease	1.03	0.72	1.48	0.74	0.40	1.37	0.74	0.50	1.11	0.73	0.52	1.02
Diabetes	0.51*	0.34	0.78	0.75	0.45	1.25	0.83	0.62	1.10	0.87	0.59	1.29
Bowel disorder	0.80	0.41	1.57	0.61	0.29	1.28	0.89	0.56	1.41	1.06	0.70	1.59
Stroke	0.70	0.35	1.43	1.02	0.45	2.30	0.36	0.02	7.57	0.57	0.27	1.23

* significantly different from estimate for reference category ($p < 0.05$)

Note: Reference category is the southern Canada population.

Source: 2000/2001 and 2005/2006 Canadian Community Health Survey.

3). Moreover, these associations were stronger in 2005/2006 than they had been five years earlier.

In 2000/2001, the odds of regular drinking and heavy drinking among Aboriginal people were significantly lower in the North than in southern Canada. However, by 2005/2006, the odds of regular drinking were significantly higher among Aboriginal people in the North, and their odds of heavy drinking did not differ significantly from those of Aboriginal people in southern Canada.

In both 2000/2001 and 2005/2006, non-Aboriginal people in the North had significantly higher odds of obesity and daily smoking than did those in southern Canada. In 2000/2001, the odds of heavy drinking and inactive leisure time were significantly lower among non-Aboriginal people in the North than among those in southern Canada, but by 2005/2006, the differences were not statistically significant.

Chronic conditions

In 2000/2001 and 2005/2006, the crude prevalence of having at least one chronic condition, arthritis, diabetes and hypertension was higher in southern Canada than in the North among both Aboriginal and non-Aboriginal people (Table 2).

When the effects of the age and sex distribution of the population were taken into account, the odds of having one or more chronic conditions, arthritis, asthma, diabetes, and hypertension were significantly lower among Aboriginal people in the North than in southern Canada in 2000/2001 (Table 3). However, by 2005/2006, significantly lower odds were observed only for having one or more chronic conditions and arthritis; the odds ratios for the other chronic conditions were not statistically significant.

Non-Aboriginal people in the North had significantly lower odds of having one or more chronic conditions in 2000/2001, but not in 2005/2006. This

group also had significantly lower odds of hypertension in 2000/2001, but again, the odds were not statistically significant in 2005/2006.

Discussion

This analysis of data from the 2000/2001 and 2005/2006 Canadian Community Health Survey reveals substantial differences in the prevalence of behavioural risk factors and chronic conditions between Aboriginal people living off a reserve in the North and in southern Canada; fewer differences were evident between Northern and southern non-Aboriginal people. As well, among residents of the North, over the five-year period, the extent of change in the odds ratios for the risk factors was greater among the Aboriginal than the non-Aboriginal population.

By 2005/2006, most of the differences in the prevalence of chronic conditions between Aboriginal people in the North

What is already known on this subject?

- On many measures of health, Aboriginal populations in Canada have less favourable outcomes than do non-Aboriginal populations.
- Aboriginal populations in the North are experiencing rapid change in their social, cultural, and physical environments.
- Relatively little is known about changes in the prevalence of risk factors and chronic conditions among Aboriginal and non-Aboriginal populations in the North, compared with those in southern Canada.

What does this study add?

- Differences in self-reported measures of obesity, smoking, drinking, and physical activity between Aboriginal populations in the North and in southern Canada were significant.
- Changes from 2000/2001 to 2005/2006 indicate a growing gap between the two groups on many risk factors.
- In 2000/2001, Aboriginal people in the North were less likely than those in southern Canada to report specific chronic conditions, including arthritis, hypertension, asthma and diabetes, as well as having one or more chronic conditions. By 2005/2006, this was true only for arthritis and having one or more chronic conditions.
- By comparison, there were fewer differences between non-Aboriginal people in the North and in southern Canada, and less evidence of a widening gap over time.

and those in southern Canada were no longer statistically significant.

The study results suggest a widening gap in the prevalence of behavioural risk factors between Aboriginal populations

in the North and in southern Canada, and a narrowing gap between the two populations in the prevalence of some major chronic conditions. This may be preliminary evidence of the effect that the change in their behavioural risk factor profile is having on the health of Aboriginal people in the North.

The differences in the prevalence of behavioural risk factors and chronic conditions between Aboriginal and non-Aboriginal populations in the North and in southern Canada may be associated with a number of circumstances and characteristics, including access to and use of health services; knowledge, attitudes and beliefs about health; social determinants; and genetic predisposition.

Access to and use of the health care system, particularly in remote areas, may affect the detection and diagnosis of chronic diseases and the uptake of primary prevention services. For example, despite Canada's universal health care system, research has revealed variations in rates of use of primary care and specialist services by ethnicity¹³ and between Aboriginal and non-Aboriginal groups,^{14,15} even among those with chronic conditions whose need for health care should be consistently high.

Awareness of health risks, for example, of obesity, inactivity and smoking, is associated with health determinants such as ethnicity, income and education.¹⁶ Previous research also suggests the existence of differences in the genetic expression of some conditions, including multiple metabolic syndrome, which is characterized by a cluster of cardiovascular risk factors.¹⁷

Limitations

This study has a number of limitations. It relied on cross-sectional data collected at two time points to estimate change in behavioural risk factors and major chronic conditions rather than using repeated measurements of the same cohort to follow health trajectories.

The way in which the Aboriginal population was defined for this study should not be overlooked as a potential contributor to the findings.^{18,19} Canadian

Community Health Survey data on cultural or racial background were used to distinguish Aboriginal and non-Aboriginal populations. By contrast, the Census of Canada collects information on Aboriginal identity as well as origin.²⁰ Aboriginal identity includes individuals who report that they identify with at least one Aboriginal group (North American Indian, Métis, Inuit), and also those who do not report an Aboriginal identity but do report themselves as a Registered or Treaty Indian and/or Band or First Nations member. Individuals who report an Aboriginal cultural or racial background may not report an Aboriginal identity.

Canadian Community Health Survey data are available only for people living off reserves. According to the 2001 Census of Canada, no Nunavut residents lived on reserves, nor did 90% of Yukon residents (70% of Aboriginal people and 96% of non-Aboriginal people). However, in the Northwest Territories, just over half (51%) of the total population (29% of Aboriginal people and 73% of non-Aboriginal people) did not live on reserves.¹² In southern Canada, 99.0% of the population (70.8% of Aboriginal people and 99.9% of non-Aboriginal people) did not live on reserves.

This analysis is limited to the categories, "Aboriginal" and "non-Aboriginal," although these groups are not homogeneous. Within Aboriginal populations, disease burdens and risk factors may vary among First Nations, Inuit, and Métis peoples.

The self-reported data on which this study is based may underestimate the prevalence of some behavioural risk factors, such as overweight, obesity and smoking, and overestimate the prevalence of physical activity.²¹ As well, measures of overweight and obesity developed for European populations may not be appropriate for Aboriginal people,²² especially the Inuit.²³ Leisure-time physical activity does not account for activity at work, at school or at home.

As noted above, the diagnosis of chronic diseases may be influenced by the availability and use of health care

services, a factor that was not investigated in this study. Low reported prevalence of chronic conditions may reflect not so much the absence of disease as the lack of a diagnosis. As well, chronic condition prevalence estimates obtained from survey data may not be consistent with estimates from other population-based sources. Lix et al.²⁴ found, for example, that agreement between survey and administrative data was greatest for diabetes and hypertension, but was much lower for arthritis and heart disease.

Conclusion

Despite these limitations, the Canadian Community Health Survey is a rich source of information for investigating

behavioural risk factors, chronic conditions, and their correlates. Further analyses could explore the co-occurrence of multiple risk factors in Aboriginal and non-Aboriginal populations, their association with health determinants such as income, food security and health care use,²⁵ and potential causal models.²⁶ As well, data from more than one cycle could be combined^{1,27,28} to achieve sufficient sample size to enable comparisons among Aboriginal groups across Canadian regions.

In summary, the health of Aboriginal populations in the North appears to be worsening, compared with those in southern Canada and with non-Aboriginal people in both regions. Given

the potentially deleterious outcomes associated with behavioural risk factors and chronic conditions, population health surveillance will be important for Aboriginal populations in the North. ■

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Mortality of Métis and Registered Indian adults in Canada: An 11-year follow-up study

by Michael Tjepkema, Russell Wilkins, Sacha Senécal, Éric Guimond and Christopher Penney

Abstract

Background

Little information has been published about the mortality of the Métis people of Canada. This study describes mortality patterns among Métis and Registered Indian adults, compared with the non-Aboriginal population.

Data source and methods

The 1991 to 2001 Canadian census mortality follow-up study tracked mortality among a 15% sample of respondents aged 25 or older, including 11,800 Métis, 56,700 Registered Indians and 2,624,300 non-Aboriginal adults, all of whom were enumerated by the 1991 census long-form questionnaire.

Age-specific and age-standardized mortality rates and period life tables based on the number of person-years at risk were calculated across the various groups. Métis were defined by ethnic origin (ancestry).

Results

Compared with non-Aboriginal members of the cohort, life expectancy at age 25 was 3.3 and 5.5 years shorter for Métis men and women, respectively, and 4.4 and 6.3 years shorter for Registered Indians. For both Aboriginal groups, mortality rate ratios were highest at younger ages. Mortality rate differences among Métis men were particularly elevated for external causes and circulatory, respiratory and digestive system diseases; among Métis women, for circulatory system diseases, cancers, and digestive and respiratory system diseases. Generally, rate differences for Registered Indian men and women were further elevated.

Conclusions

Métis adults had higher mortality rates compared with non-Aboriginal members of the cohort, but lower rates than did Registered Indians.

Keywords

Aboriginal, age-standardized mortality rates, First Nations, indigenous, longitudinal, non-institutional, record linkage, socio-economic

Authors

Michael Tjepkema (1-416-952-4620; Michael.Tjepkema@statcan.gc.ca) is with the Health Analysis Division at Statistics Canada in Toronto, Ontario, M4T 1M4, and Russell Wilkins (1-613-951-5305; Russell.Wilkins@statcan.gc.ca) is with the Health Analysis Division at Statistics Canada, Ottawa, Ontario, K1A 0T6. Sacha Senécal, Éric Guimond and Christopher Penney are with Indian and Northern Affairs Canada.

First Nations (North American Indians), Métis and Inuit are the three major Aboriginal groups in Canada. Research has consistently shown that First Nations have a much shorter life expectancy than that for Canada as a whole, and are at increased risk for causes of death that occur more frequently at younger ages, such as injuries and suicides.¹⁻¹⁶ The pattern is similar for Inuit.^{15,17,18} However, mortality patterns among Métis are largely unknown.¹⁹

The Métis people of Canada were originally descended from unions between European men and North American Indian women, primarily in Western Canada. The Métis have their own distinct culture and traditions.²⁰ While there is no single definition of Métis, the term generally includes any person of mixed North American Indian and European ancestry who self-identifies as Métis.¹⁹

On the 2006 census, individuals who self-identified as Métis represented about one-third (34%) of the total Aboriginal population of Canada.²¹ Compared with their population size, Métis have been under-represented in Aboriginal health research.^{22,23}

Mortality data for Métis are difficult to generate. Information on the Aboriginal ancestry, identity or status of decedents is not routinely collected on death registrations. Because, until recently,

there was no comprehensive national registry of Métis, their mortality cannot be studied directly—as has been done for Registered Indians. And because most Métis people do not live in areas where they constitute a high proportion of the total population, their mortality cannot be studied indirectly with an area-based approach²⁴—as has been done for Inuit.^{17,25}

The 1991 to 2001 Canadian census mortality follow-up study provides an unprecedented opportunity to examine mortality among Métis. The primary objective of this paper is to fill the data gap with regard to mortality among Métis adults; results for Registered Indians are presented to provide context. The specific objectives are to determine the risk of premature death among Métis and Registered Indians aged 25 or older, to calculate their remaining life expectancy and probability of survival to

age 75, and to identify the causes of death most responsible for excess mortality compared with non-Aboriginal adults.

Methods

Data sources

The Canadian census mortality follow-up study consists of a 15% sample (2,735,152) of the non-institutionalized population aged 25 or older, all of whom were enumerated via the 1991 census long-form questionnaire. This cohort was tracked for mortality from June 4, 1991 to December 31, 2001. Details of the construction and contents of the census mortality database have previously been reported.²⁶

Briefly, because the electronic census data files did not contain names, but names were needed to find the corresponding deaths, creation of the census mortality database required two linkages. First, the census file was linked to a nominal list (name) file (abstracted from tax-filer data and then encrypted). Then, the census plus encrypted name file was matched to the Canadian Mortality Database using methods of probabilistic record linkage,²⁷ an approach similar to that used for other mortality follow-up studies at Statistics Canada.²⁸ The resulting file contained anonymous information on demographic characteristics, socio-economic status, activity limitations, disability, and for individuals who died during the study period, cause and date of death.

Eligibility

Only people who were enumerated by the 1991 census long-form questionnaire, had attained age 25 by census day (June 4, 1991), and who were usual residents of Canada were eligible to be part of the mortality follow-up study cohort.

Data quality reports found that the 1991 census missed 3.4% of Canadian residents of all ages. Compared with the enumerated population, the missed individuals were more likely to be young, mobile, low-income, of Aboriginal ancestry,²⁹ or homeless. A total of 78 Indian reserves—representing about 38,000 people—were either not enumerated or incompletely enumerated

and so were excluded from the census database³⁰ and could not be part of the follow-up study cohort. The long-form questionnaire was generally given to 1 in 5 Canadian households. However, all residents of the Indian Reserves that were enumerated, of many remote and northern communities, and of non-institutional collective dwellings received a long-form. Because of the necessity of obtaining encrypted names from tax-filer data, only tax-filers could be followed for mortality.

Analytical techniques

For each cohort member, person-days of follow-up were calculated from the beginning of the study (June 4, 1991) to their date of death or emigration (ascertained from the name file and known for 1991 only), or the end of the study (December 31, 2001). Person-days of follow-up were divided by 365.25 to get person-years at risk.

Age- and sex-specific mortality rates by 5-year age groups (at baseline) were used to calculate age-standardized mortality rates (ASMRs) for subgroups, using the total cohort Aboriginal population structure (person-years at risk), both sexes together, as the standard population. In this case, the Aboriginal population consisted of anyone who indicated a North American Indian, Métis or Inuit ancestry, Registered Indian status, or membership in a North American Indian Band or First Nation. Corresponding 95% confidence intervals for the ASMRs were calculated as described by Carrière and Roos.³¹ A similar method was used to calculate confidence intervals for the ASMR rate ratios (RRs) and ASMR rate differences (RDs).

For age-specific analyses, cohort members were categorized by 10-year age group from 25-to-34 to 65-to-74 and 75 or older. The mortality rates within each of these age groups were age-standardized using 5-year age groups. For example, the mortality rate in the 25-to-34 age group was age-standardized using the Aboriginal population (as described in the previous paragraph) age distribution for 25-to-29- and 30-to-34-

year-olds. While most analyses used age at baseline (June 4, 1991), life table analyses used age at the beginning of each year of follow-up.

Period life tables for each sex, plus corresponding standard errors and 95% confidence intervals, were calculated according to the method of Chiang.³² These calculations were made after age was transformed from age at baseline to age at the beginning of each year of follow-up, and deaths and person-years at risk were calculated separately for each year (or partial year) of follow-up. Deaths and person-years at risk were then pooled by age at the beginning of each year of follow-up before calculation of the life tables.

Cox proportional mortality hazard ratios were calculated by sex, first controlling for age (years), and then further controlling for highest level of education (less than high school graduation, high school graduation, postsecondary diploma, university degree), income adequacy quintile (1 to 5), occupation skill level (professional, managerial, skilled/technical/supervisory, semi-skilled, unskilled, no occupation), community size (1 million or more; 500,000 to 999,999; 100,000 to 499,999; 10,000 to 99,999; less than 10,000), and place of birth (Canada or elsewhere). Place of birth was included in the models to reduce the healthy immigrant effect among non-Aboriginal cohort members. Detailed definitions of these variables have been previously provided.²⁶ Differences in excess mortality (1 minus the hazard ratio) comparing the two models were interpreted as estimates of the effect of the above-mentioned socio-economic variables on the extent of the disparities between Métis and other cohort members, and between Registered Indians and other cohort members.

The underlying cause of death of those who died during the study period had been previously coded to the World Health Organization's *International Classification of Diseases, Ninth Revision (ICD-9)*³³ for deaths occurring in the period 1991 through 1999, and to the *Tenth Revision (ICD-10)*³⁴ for deaths occurring in 2000 or 2001. For

analyses by cause of death, deaths were categorized according to cause groupings established by the Public Health Agency of Canada³⁵ and by the European Union Working Group on Socioeconomic Inequalities in Health.³⁶ Appendix Table A contains the list of ICD codes.

Defining Métis and Registered Indian populations

The Métis population can be defined in several ways from the Census, either using an identity concept or using an ancestry concept.³⁷ Because the 1991 census did not ask respondents to self-identify as an Aboriginal person (North American Indian, Métis, or Inuit), the ancestry approach was used. Census respondents were asked to which ethnic or cultural group(s) their ancestors belonged.³⁸ From a list of 15 groups, including Métis, respondents were instructed to check as many as applicable.

Registered Indian status was determined by a direct question: “Is this person a *Registered Indian* as defined by the Indian Act of Canada?” (Yes, No). Registered Indians could also report any ethnic origin, including Métis, and if so, such persons could be classified in both groups for this study. For this analysis, a total of 2,200 cohort members were classified as both Métis and Registered Indians.

Derivation of Métis within the cohort

Within the entire 2.7 million-person cohort of the mortality follow-up study, 19,100 persons indicated some Métis ancestry (Table 1). Of those, 11,800 reported only Métis ancestry or Métis plus other Aboriginal (with or without any other non-Aboriginal ancestry). The remaining 7,300 reported Métis and at least one non-Aboriginal ancestry, but no other Aboriginal ancestry. To simplify terminology, these two groupings will be referred to as “Métis plus other Aboriginal” and “Métis plus non-Aboriginal,” respectively. The composition of the two groupings was based on an analysis of 1996 census data that cross-classified ethnic origins by Aboriginal identity (not asked in 1991).³⁷

Table 1
Derivation of the “Métis” subset of entire cohort, non-institutional population aged 25 or older at baseline, Canada, 1991

Cohort subset	Total	Men	Women	Estimated Aboriginal identity(c)	Estimated Métis identity(c)
Entire cohort	2,735,200	1,358,400	1,376,800	Less than 1%	Less than 1%
Any Métis ancestry	19,100	9,100	10,000	66%	57%
(a) Métis plus non-Aboriginal	7,300	3,400	3,900	50%	48%
(b) Métis plus other Aboriginal	11,800	5,700	6,100	91%	73%

Notes: Any Métis ancestry includes the following ethnic origin categories: (a) Métis plus non-Aboriginal and no other Aboriginal origins; (b) Métis, Métis plus First Nations, Métis plus Inuit, Métis plus First Nations plus Inuit, Métis plus First Nations plus non-Aboriginal, Métis plus Inuit plus non-Aboriginal, Métis plus First Nations plus Inuit plus non-Aboriginal; for the remainder of this report, this group will be referred to as simply “Métis;” (c) based on 1996 census data showing ethnic origins or ancestry cross-classified by Aboriginal identity (First Nations, Inuit, Métis or combinations with or without non-Aboriginal origins).

Source: 1991 to 2001 Canadian census mortality follow-up study; 1996 Census of Canada (Guimond É, 2003).

The categories included in the “Métis plus other Aboriginal” grouping were those with any Métis ancestry for which the highest proportion of the category self-identified as Métis. Altogether, in the 1996 census data, 91% of the “Métis plus other Aboriginal” category self-identified as Aboriginal (73% Métis), and 50% of the “Métis plus non-Aboriginal” category self-identified as Aboriginal (48% Métis).

The socio-demographic characteristics of the entire mortality follow-up study cohort differed from those of the two Métis groupings (data not shown). The characteristics of the “Métis plus other Aboriginal” group were most distinctive, while those of the “Métis plus non-Aboriginal” group were intermediate between the entire cohort and the “Métis

plus other Aboriginal” group. Therefore, the only results shown in the remainder of this article are those for the former group. As well, the “Métis plus other Aboriginal” is referred to simply as “Métis.”

Results

The 1991 to 2001 Canadian census mortality follow-up study followed about 2.7 million persons, including 11,800 Métis and 56,700 Registered Indians, for 11 years. The latter two groups accounted for 120,920 and 577,380 person-years at risk, and 889 and 4,506 deaths, respectively, during that period (Table 2). Linkage rates to the name file (comparing cohort members to long-form census respondents) were lower

Table 2
Long-form census respondents, cohort members, linkage rate, deaths and person-years at risk, by sex and population group, non-institutional population aged 25 or older at baseline, Canada, 1991 to 2001

Sex and population group	Long-form census respondents	Cohort members	Linkage rate (%)	Number of deaths	Person-years at risk
Both sexes					
Non-Aboriginal	3,392,500	2,624,300	77	253,225	26,483,760
Métis	18,300	11,800	65	889	120,920
Registered Indians	106,300	56,700	53	4,506	577,380
Men					
Non-Aboriginal	1,647,300	1,307,800	79	149,335	13,066,360
Métis	9,300	5,700	62	512	57,960
Registered Indians	52,300	24,600	47	2,377	248,210
Women					
Non-Aboriginal	1,745,200	1,316,500	75	103,890	13,417,400
Métis	9,000	6,100	68	377	62,960
Registered Indians	54,000	32,100	59	2,129	329,180

Notes: Métis defined by ethnic origins as shown in Table 1 (the “Métis plus other Aboriginal” group). A total of 2,200 cohort members (800 men and 1,300 women) were classified both Métis and Registered Indians.

Source: 1991 to 2001 Canadian census mortality follow-up study.

for Métis (62% for men and 68% for women) than for non-Aboriginal cohort members (79% and 75%), but not as low as rates for Registered Indians (47% and 59%). Based on 1991 deaths that could be identified independently in the

Canadian Mortality Database and/or the name file, ascertainment of deaths in the cohort (from 1991 to 2001) was estimated at about 97% overall, and 95% to 96% among persons with any Aboriginal ancestry, Registered Indian

status or membership in an Indian Band or First Nation.

A comparison of the demographic and socio-economic characteristics of Métis cohort members with those of

Table 3

Percentage distribution of demographic, socio-economic and geographic characteristics of non-Aboriginal adults, Métis and Registered Indians, by sex, non-institutional population aged 25 or older at baseline, Canada, 1991

Characteristic	Men			Women		
	Non-Aboriginal	Métis	Registered Indians	Non-Aboriginal	Métis	Registered Indians
Number	1,307,800	5,700	24,600	1,316,500	6,100	32,100
	----- Percentage distribution -----			----- Percentage distribution -----		
Age group						
25 to 34	27	38	41	28	43	44
35 to 44	26	28	28	26	28	28
45 to 54	18	18	16	17	14	15
55 to 64	14	10	9	12	8	8
65 to 74	10	4	5	10	5	4
75 or older	5	2	2	6	2	2
Marital status						
Single (never married)	13	20	22	11	16	16
Common-law	7	19	18	6	17	17
Married	73	51	51	63	48	51
Previously married	7	9	10	19	19	16
Educational attainment						
Less than high school graduation	34	54	60	34	51	56
High school graduation	38	34	32	35	31	28
Postsecondary diploma	13	8	7	19	14	13
University degree	15	4	2	12	4	3
Labour force status						
Employed	73	61	50	59	47	40
Unemployed	6	18	21	5	10	11
Not in labour force	21	21	29	36	43	49
Income adequacy quintile						
Quintile 1 (lowest)	14	29	40	19	36	42
Quintile 2	19	24	26	19	22	25
Quintile 3	21	19	17	20	18	17
Quintile 4	23	17	12	20	14	11
Quintile 5 (highest)	23	11	6	21	9	5
Region						
Atlantic Canada	8	2	5	8	2	5
Quebec	26	8	9	26	7	10
Ontario	37	8	18	37	8	17
Prairies	16	69	41	16	69	42
British Columbia	12	6	21	12	5	20
Territories	1	8	6	< 1	8	6
Community size						
1,000,000 or more	31	6	3	32	5	4
500,000 to 999,999	16	14	4	17	15	5
100,000 to 499,999	15	5	5	16	6	5
10,000 to 99,999	14	15	12	14	16	12
Less than 10,000	23	59	76	21	58	73
Living on reserve						
Yes	< 1	7	73	< 1	8	68
No	100	93	27	100	92	32

Notes: Métis were defined based on the ancestry responses (see "Derivation of Métis within the cohort"). A total of 2,200 cohort members (800 men and 1,300 women) were classified both Métis and Registered Indians.

Source: 1991 to 2001 Canadian census mortality follow-up study.

all eligible Métis adults in the census population (weighted) revealed very few differences between the two (Appendix Table B); therefore, the sample of Métis was not biased with respect to those characteristics. Results were similar for Registered Indians (Appendix Table C).

The geographic distribution of Métis and Registered Indian cohort members differed from that of all eligible Métis and Registered Indian adults in the census population (weighted). The cohort had an over-representation of Métis and Registered Indians living in communities with less than 10,000 people, on reserves, or in the territories. These differences reflected the fact that all residents of participating Indian reserves and many remote and northern communities were enumerated using a long-form questionnaire (rather than the 1 in 5 ratio for most of the household population), and thus, were eligible for the cohort.

Characteristics of Métis and Registered Indian cohort members

Compared with non-Aboriginal members of the cohort, Métis were younger and less likely to be legally married, and more likely to be in a common-law relationship (Table 3). They were less likely to have completed high school and to be employed, and more likely to be in the lowest income quintile. Nearly 70% lived in Manitoba, Saskatchewan or Alberta (Prairies), and almost 60% lived in rural areas or communities with less than 10,000 population. Fewer than 10% lived on an Indian Reserve.

Registered Indian cohort members were similar to Métis with respect to age structure and marital status. Compared with Métis and non-Aboriginal cohort members, Registered Indians were less likely to be employed, and more likely to be in the lowest income quintile and to have lower educational attainment. In part because of over-sampling on reserves, about 70% of Registered Indian cohort members were living on a reserve at time of the census.

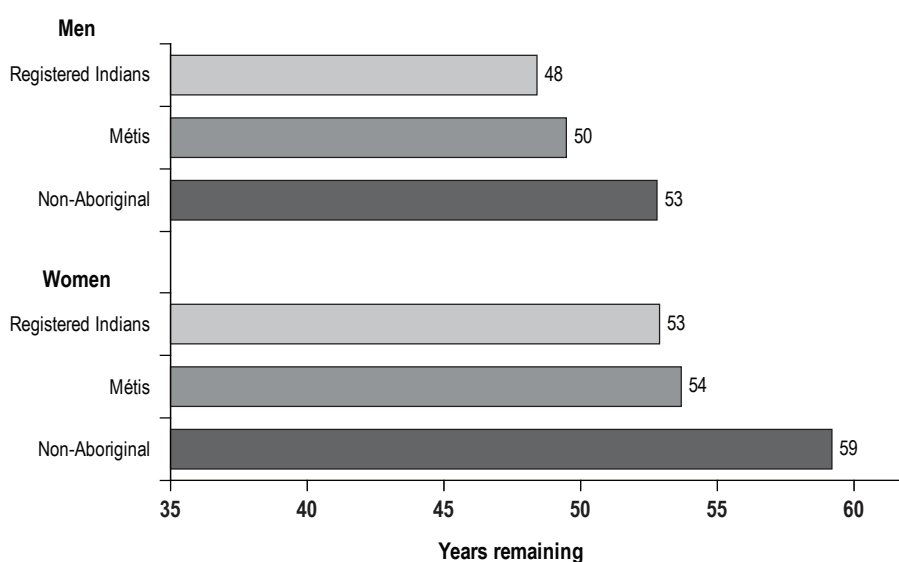
Life expectancy

For Métis adults of both sexes, remaining life expectancy at age 25 was substantially shorter than that of non-Aboriginal cohort members, but longer than that of Registered Indians.

At age 25, a Métis man could expect to live an additional 49.5 years, compared with 52.8 years for non-Aboriginal men

in the cohort, a difference of 3.3 years (Figure 1, Table 4). While Métis women had longer remaining life expectancy than Métis men, the gap between Métis women and non-Aboriginal women was wider. A 25-year old Métis woman could expect to live an additional 53.7 years, compared with 59.2 years for non-

Figure 1
Life expectancy at age 25 of Registered Indians, Métis and non-Aboriginal cohort members, by sex, non-institutional population aged 25 or older at baseline, Canada, 1991 to 2001



Note: Métis were defined based on the ancestry responses (see "Derivation of Métis within the cohort"). A total of 2,200 cohort members (800 men and 1,300 women) were classified both Métis and Registered Indians.

Source: 1991 to 2001 Canadian census mortality follow-up study.

Table 4
Life expectancy at age 25 and probability of survival from age 25 to 75 for Registered Indian, Métis and non-Aboriginal cohort members, non-institutional population aged 25 or older at baseline, Canada, 1991 to 2001

Sex and category	Years	Men		Women		
		95% confidence interval		95% confidence interval		
		from	to	from	to	
Life expectancy at age 25						
Non-Aboriginal	52.8	52.7	52.8	59.2	59.1	59.2
Métis	49.5	48.4	50.5	53.7	52.5	54.8
Registered Indians	48.4	47.9	49.0	52.9	52.4	53.4
Probability of survival to age 75	%			%		
Non-Aboriginal	64.3	64.1	64.5	79.4	79.2	79.6
Métis	56.7	52.7	60.6	63.3	59.1	67.5
Registered Indians	50.7	48.8	52.6	61.5	59.7	63.3

Note: Métis were defined based on the ancestry responses (see "Derivation of Métis within the cohort"). A total of 2,200 cohort members (800 men and 1,300 women) were classified both Métis and Registered Indians.

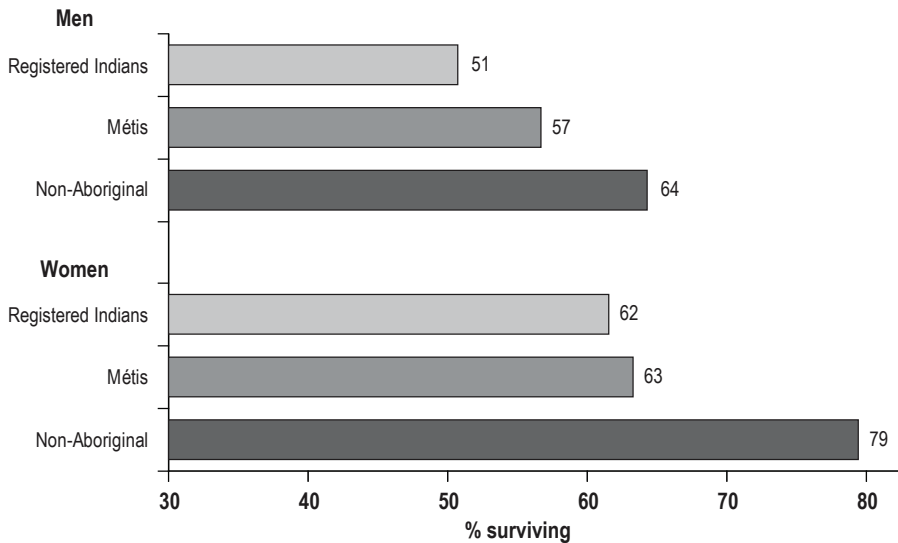
Source: 1991 to 2001 Canadian census mortality follow-up study.

Aboriginal women, a difference of 5.5 years.

For both sexes, life expectancy at age 25 was estimated to be about one year

longer for Métis than for Registered Indians (49.5 versus 48.4 years for men; 53.7 versus 52.9 years for women).

Figure 2
Probability of survival from age 25 to 75 of Registered Indians, Métis and non-Aboriginal cohort members, by sex, non-institutional population aged 25 or older at baseline, Canada, 1991 to 2001



Note: Métis were defined based on the ancestry responses (see "Derivation of Métis within the cohort"). A total of 2,200 cohort members (800 men and 1,300 women) were classified both Métis and Registered Indians.

Source: 1991 to 2001 Canadian census mortality follow-up study.

Table 5
Deaths, age-standardized mortality rates (ASMRs) per 100,000 person-years at risk, and rate ratios for Métis and Registered Indians compared with non-Aboriginal cohort members, by sex and age group, non-institutional population aged 25 or older at baseline, Canada, 1991 to 2001

Sex and age group at baseline	Métis							Registered Indians					Non-Aboriginal					
	Deaths	ASMR	95% confidence interval		Rate ratio	95% confidence interval		Deaths	ASMR	95% confidence interval		Rate ratio	95% confidence interval		Deaths	ASMR	95% confidence interval	
			from	to		from	to			from	to		from	to				
Men																		
Total 25 or older	512	781.3	715.6	853.0	1.38	1.26	1.51	2,377	886.5	851.5	923.1	1.56	1.50	1.63	149,335	566.7	563.4	569.9
25 to 34	58	257.7	199.2	333.3	2.45	1.89	3.18	327	310.2	278.3	345.7	2.95	2.64	3.30	3,922	105.1	101.9	108.5
35 to 44	60	362.1	281.2	466.4	1.75	1.36	2.25	357	508.9	458.8	564.5	2.46	2.21	2.73	7,515	207.3	202.6	212.0
45 to 54	96	935.9	766.2	1,143.2	1.63	1.34	2.00	429	1,077.0	979.8	1,183.9	1.88	1.71	2.07	14,045	573.0	563.6	582.6
55 to 64	114	2,033.5	1,692.1	2,443.6	1.25	1.04	1.51	489	2,411.1	2,206.6	2,634.6	1.49	1.36	1.63	30,798	1,621.3	1,603.0	1,639.7
65 to 74	88	4,480.7	3,635.9	5,521.9	1.06	0.86	1.31	466	4,951.0	4,521.1	5,421.9	1.17	1.07	1.28	49,499	4,227.7	4,190.7	4,265.2
75 or older	96	11,524.9	9,398.5	14,132.4	1.08	0.88	1.33	309	9,319.6	8,334.0	10,421.7	0.87	0.78	0.98	43,556	10,651.5	10,551.4	10,752.7
Women																		
Total 25 or older	377	549.0	495.6	608.2	1.72	1.55	1.91	2,129	623.7	597.7	650.8	1.96	1.87	2.04	103,890	318.9	316.5	321.2
25 to 34	32	115.3	81.5	163.0	2.22	1.56	3.14	248	168.3	148.6	190.6	3.23	2.84	3.69	2,081	52.0	49.8	54.3
35 to 44	50	274.3	207.9	361.9	2.09	1.58	2.76	307	335.3	299.8	375.0	2.56	2.28	2.87	4,885	131.2	127.5	134.9
45 to 54	61	667.2	519.1	857.5	1.99	1.54	2.55	380	766.0	692.7	847.1	2.28	2.06	2.53	7,666	336.1	328.6	343.7
55 to 64	67	1,427.8	1,123.1	1,815.2	1.69	1.33	2.15	448	1,837.5	1,674.9	2,015.8	2.18	1.98	2.39	14,025	844.0	830.0	858.3
65 to 74	99	3,952.4	3,238.0	4,824.5	1.77	1.45	2.17	405	3,478.8	3,155.8	3,834.9	1.56	1.42	1.72	29,208	2,227.9	2,202.4	2,253.7
75 or older	68	7,725.2	6,038.4	9,883.1	1.17	0.92	1.50	341	8,102.4	7,286.2	9,010.1	1.23	1.10	1.37	46,025	6,593.0	6,532.7	6,653.8

Notes: Reference population (person-years at risk) for age standardization was taken from the Aboriginal age distribution (5-year age groups). Métis were defined based on the ancestry responses (see "Derivation of Métis within the cohort"). A total of 2,200 cohort members (800 men and 1,300 women) were classified both Métis and Registered Indians.

Source: 1991 to 2001 Canadian census mortality follow-up study.

Probability of survival to age 75

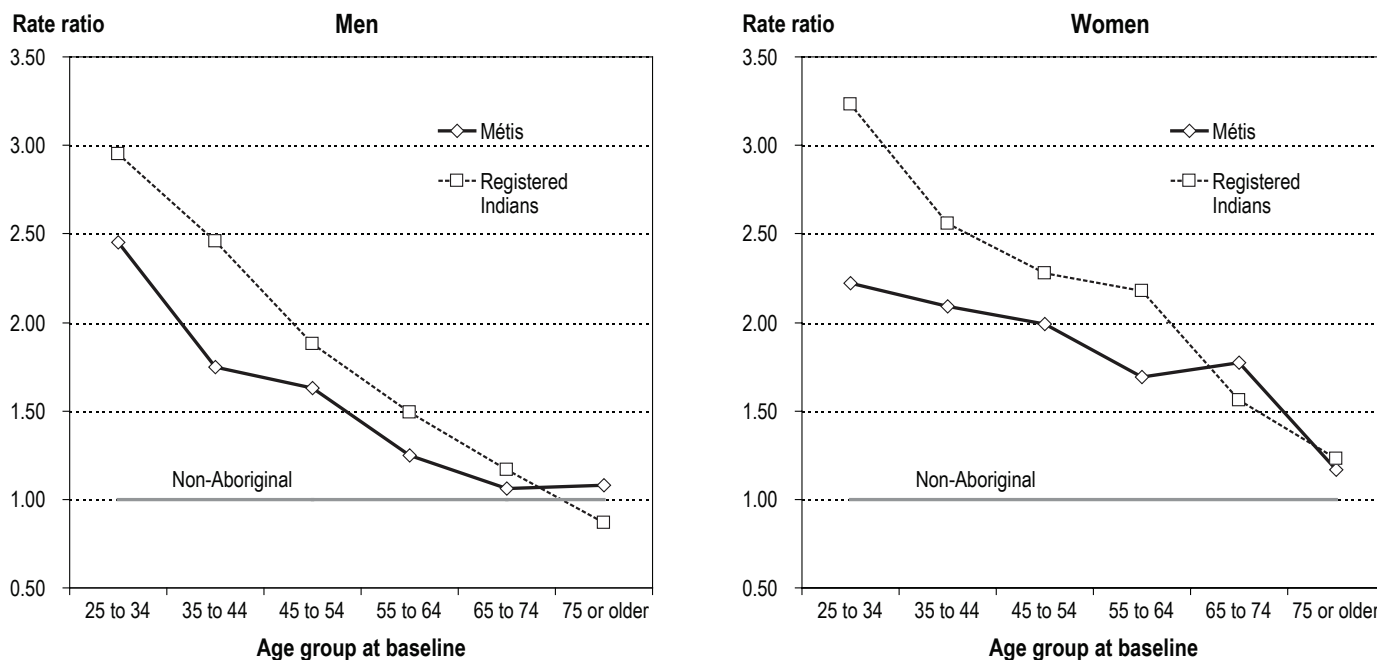
About 57% of Métis men were expected to survive to at least age 75 (conditional on survival to age 25), compared with 64% of non-Aboriginal men, a 7-percentage-point difference (Figure 2, Table 4). For Métis women, the corresponding figures were 63% and 79%, a 16-percentage-point difference.

The point estimates for survival to age 75 were lower for Registered Indians. About 51% of Registered Indian men were expected to survive to age 75, compared with 64% of non-Aboriginal men, a 13-percentage-point difference. For Registered Indian women, the corresponding figures were 62% and 79%, an 18-percentage-point difference.

Age-specific and age-standardized mortality rates

Table 5 shows age-standardized mortality rates (ASMR) per 100,000 person-years at risk for Métis, Registered Indians and non-Aboriginal cohort members, as well as ASMR rate ratios (RRs) for Métis and Registered Indians, compared with non-Aboriginal cohort

Figure 3
Age-specific mortality rate ratios comparing Métis and Registered Indians with non-Aboriginal cohort members, by sex and age group, non-institutional population aged 25 or older at baseline, Canada, 1991 to 2001



Note: Métis were defined based on the ancestry responses (see "Derivation of Métis within the cohort"). A total of 2,200 cohort members (800 men and 1,300 women) were classified both Métis and Registered Indians.

Source: 1991 to 2001 Canadian census mortality follow-up study.

members. Age-standardized mortality rates were significantly higher for Métis men (RR=1.38) and women (RR=1.72), and higher still for Registered Indian men (RR=1.56) and women (RR=1.96). For Métis and Registered Indians of both sexes, rate ratios were highest in the younger age groups and diminished with advancing age (Figure 3).

Causes of death

Among Métis men, the most common causes of death were circulatory system diseases (32% of the total ASMR), followed by all cancers (23%) and external causes such as suicides and motor vehicle accidents (18%)—a ranking similar to that of non-Aboriginal men (Appendix Table D). For Métis women, the most common causes of death were all cancers (33%), circulatory system diseases (29%), respiratory system diseases (7%), external causes (6%) and digestive system diseases (6%)—the same ranking as for non-

Aboriginal cohort women (Appendix Table E).

For Registered Indians, the ranking of causes of death was somewhat different. Among Registered Indian men, the most common causes were circulatory system diseases (28%), external causes (21%) and all cancers (18%). For Registered Indian women, the most common causes were circulatory system diseases (26%), all cancers (25%) and external causes (11%).

Tables 6 and 7 show age-standardized rate ratios and rate differences by major cause of death groupings for men and for women, respectively. (Appendix Tables D and E show the corresponding numbers of deaths.) Rate ratios for Métis men were elevated for most causes, particularly external causes (RR=2.65) such as drowning (RR=6.94), homicide (RR=4.76), poisoning (RR=3.52) and motor vehicle accidents (RR=3.22), and deaths from infectious (RR=1.74), endocrine (RR=1.86) and digestive

(RR=1.93) system diseases. Rate ratios for Métis women were also elevated, especially for poisoning (RR=6.71), infectious diseases (RR=2.99), digestive system diseases (RR=3.01), mental disorders (RR=2.90), and genitourinary (RR=2.97) and endocrine (RR=2.66) system diseases.

Rate ratios for Registered Indian men were even higher for most causes of death, notably external causes (RR=3.52), mental disorders (RR=3.30), endocrine (RR=3.18) and digestive system (RR=2.76) diseases. Rate ratios for Registered Indian women were especially high for infectious (RR=5.34), endocrine (RR=5.00) and digestive (RR=4.44) system diseases and external causes (RR=3.66).

Rate differences (RDs) for Métis men compared with non-Aboriginal men were highest for deaths from external causes (RD=89) and circulatory system diseases (RD=55), which together accounted for 67% of the total RD. Rate differences

Table 6

Rate ratios and rate differences per 100,000 person-years at risk for Métis and Registered Indians compared with non-Aboriginal cohort members, by cause of death, male non-institutional population aged 25 or older at baseline, Canada, 1991 to 2001

Cause of death	Métis						Registered Indians					
	Rate ratio	95% confidence interval		Rate difference	95% confidence interval		Rate ratio	95% confidence interval		Rate difference	95% confidence interval	
		from	to		from	to		from	to		from	to
All cause	1.38	1.26	1.51	214.6	145.9	283.3	1.56	1.50	1.63	319.9	284.0	355.8
Infectious diseases	1.74	1.02	2.95	9.8	-2.4	22.0	1.29	0.95	1.74	3.8	-1.3	8.9
Cancer	0.94	0.78	1.12	-11.7	-43.8	20.3	0.87	0.79	0.95	-25.1	-40.3	-9.9
Pancreas	1.02	0.46	2.29	0.2	-7.3	7.7	0.72	0.45	1.14	-2.6	-5.6	0.5
Prostate	1.04	0.58	1.85	0.6	-9.9	11.1	0.91	0.68	1.22	-1.6	-6.2	3.1
Urinary system	1.24	0.62	2.49	2.3	-6.2	10.9	1.38	1.00	1.91	3.7	-0.7	8.2
Trachea, bronchus and lung	1.21	0.91	1.61	11.8	-7.8	31.4	0.87	0.74	1.03	-7.2	-15.5	1.2
Lymph tissue and leukemia	0.61	0.29	1.30	-7.3	-15.9	1.4	0.72	0.52	1.00	-5.2	-9.7	-0.8
Esophagus and stomach	0.82	0.39	1.74	-2.2	-10.1	5.6	1.08	0.78	1.50	1.0	-3.4	5.5
Intestine and rectum	0.73	0.40	1.32	-6.3	-16.4	3.8	0.79	0.60	1.04	-4.8	-9.9	0.2
Other cancer	0.74	0.48	1.15	-10.2	-23.1	2.6	0.77	0.62	0.95	-9.1	-15.7	-2.5
Endocrine system diseases	1.86	1.22	2.83	14.5	1.3	27.8	3.18	2.69	3.75	36.9	28.2	45.7
Diabetes mellitus	2.02	1.28	3.18	13.6	1.4	25.8	3.48	2.92	4.16	33.1	25.0	41.2
Other endocrine	1.25	0.40	3.92	0.9	-4.3	6.1	2.05	1.31	3.21	3.8	0.5	7.1
Mental disorders	1.74	0.89	3.38	6.0	-3.4	15.4	3.30	2.60	4.19	18.7	12.4	25.0
Nervous system diseases	1.16	0.62	2.17	2.1	-7.4	11.5	0.96	0.68	1.35	-0.5	-4.8	3.7
Circulatory system diseases	1.29	1.11	1.50	55.4	17.6	93.2	1.28	1.18	1.38	53.2	34.6	71.9
Ischaemic heart disease	1.35	1.12	1.63	43.6	12.1	75.0	1.26	1.14	1.38	31.8	17.0	46.6
Cerebrovascular diseases	1.28	0.86	1.90	7.8	-6.4	22.1	1.26	1.03	1.53	7.2	0.2	14.3
Heart failure	1.21	0.57	2.53	1.6	-5.3	8.5	1.88	1.38	2.56	6.7	2.3	11.2
Other circulatory	1.07	0.73	1.58	2.4	-11.5	16.3	1.22	1.01	1.48	7.5	-0.2	15.1
Respiratory system diseases	1.46	1.07	2.01	18.4	0.1	36.8	1.63	1.41	1.89	25.0	15.5	34.5
Pneumonia	2.50	1.58	3.96	17.3	4.1	30.6	2.29	1.82	2.89	14.9	8.9	21.0
Bronchitis, emphysema and asthma	0.93	0.56	1.55	-1.5	-11.9	9.0	1.05	0.82	1.34	1.0	-4.6	6.6
Other respiratory	1.42	0.63	3.17	2.6	-4.6	9.8	2.45	1.81	3.32	9.1	4.5	13.7
Digestive system diseases	1.93	1.29	2.88	18.6	3.2	34.1	2.76	2.34	3.25	35.3	26.3	44.2
Cirrhosis of liver	1.66	0.86	3.21	5.6	-3.6	14.8	3.05	2.38	3.90	17.3	11.1	23.4
Other digestive	2.12	1.28	3.52	13.1	0.7	25.5	2.55	2.04	3.18	18.0	11.5	24.4
Genitourinary system diseases	1.50	0.75	3.02	3.9	-4.2	11.9	2.16	1.60	2.90	8.9	4.0	13.8
Musculoskeletal system diseases	2.50	0.80	7.79	2.4	-2.1	6.9	2.34	1.25	4.40	2.1	-0.2	4.5
Ill-defined conditions	1.24	0.55	2.80	2.0	-6.3	10.3	3.59	2.85	4.53	21.5	14.8	28.2
External causes	2.65	2.13	3.31	89.0	57.8	120.3	3.52	3.20	3.86	135.6	118.3	152.8
Fall	1.84	0.82	4.12	4.4	-3.4	12.2	2.15	1.50	3.10	6.1	2.0	10.1
Drowning	6.94	3.42	14.11	12.1	2.3	22.0	10.87	8.09	14.61	20.2	14.3	26.1
Suicide	1.60	1.03	2.50	12.9	-2.3	28.2	1.66	1.34	2.06	14.3	6.7	21.8
Homicide	4.76	1.77	12.86	6.1	-1.5	13.6	7.79	5.31	11.43	11.0	6.5	15.4
Poisoning	3.52	1.57	7.93	7.9	-1.0	16.8	4.22	2.95	6.04	10.1	5.6	14.7
Motor vehicle accident	3.22	2.08	4.97	25.6	9.6	41.6	4.43	3.68	5.32	39.6	30.6	48.6
Other external	3.28	2.02	5.32	19.9	6.1	33.7	4.93	4.05	6.02	34.4	26.2	42.6
Unknown/Other	2.09	0.86	5.11	4.2	-3.0	11.4	2.19	1.44	3.33	4.6	1.1	8.1
Smoking-related	1.14	0.90	1.43	12.4	-11.5	36.3	0.98	0.87	1.12	-1.4	-12.6	9.8
Alcohol-related	3.23	2.05	5.10	20.3	6.9	33.7	5.91	4.97	7.04	44.8	35.8	53.7
Amenable to medical intervention (younger than 75)	1.76	1.29	2.41	27.2	7.7	46.7	1.71	1.46	2.00	25.4	15.9	34.9

Notes: Reference population (person-years at risk) for age standardization was taken from the Aboriginal age distribution (5-year age groups). Rate ratios and rate differences were calculated by comparing the age-standardized mortality rates for Métis and Registered Indians to those for the entire cohort. Métis were defined based on the ancestry responses (see "Derivation of Métis within the cohort"). A total of 2,200 cohort members (800 men and 1,300 women) were classified both Métis and Registered Indians.

Source: 1991 to 2001 Canadian census mortality follow-up study.

Table 7
Rate ratios and rate differences per 100,000 person-years at risk for Métis and Registered Indians compared with non-Aboriginal cohort members, by cause of death, female non-institutional population aged 25 or older at baseline, Canada, 1991 to 2001

Cause of death	Métis						Registered Indians					
	Rate ratio	95% confidence interval		Rate difference	95% confidence interval		Rate ratio	95% confidence interval		Rate difference	95% confidence interval	
		from	to		from	to		from	to		from	to
All cause	1.72	1.55	1.91	230.2	173.9	286.4	1.96	1.87	2.04	304.8	278.2	331.5
Infectious diseases	2.99	1.41	6.37	6.8	-0.9	14.5	5.34	4.11	6.94	14.9	10.3	19.4
Cancer	1.34	1.12	1.61	46.1	13.8	78.4	1.17	1.07	1.27	22.3	8.9	35.8
Pancreas	1.46	0.69	3.10	2.9	-4.0	9.8	1.14	0.77	1.70	0.9	-1.9	3.7
Breast	0.74	0.44	1.26	-7.4	-18.8	3.9	0.86	0.69	1.07	-4.0	-9.4	1.5
Urinary system	1.87	0.76	4.60	2.9	-2.7	8.4	1.31	0.78	2.18	1.0	-1.2	3.2
Trachea, bronchus and lung	1.69	1.20	2.39	20.1	3.2	36.9	1.04	0.86	1.27	1.2	-4.7	7.1
Lymph tissue and leukemia	1.22	0.63	2.35	2.3	-6.3	11.0	0.88	0.63	1.25	-1.3	-4.6	2.1
Esophagus and stomach	1.66	0.69	4.00	3.0	-3.7	9.8	1.14	0.71	1.81	0.6	-1.8	3.1
Intestine and rectum	1.30	0.75	2.25	4.5	-6.1	15.0	1.53	1.22	1.91	7.8	2.7	12.9
Uterus, ovary and adnexa	1.94	1.18	3.17	12.2	-0.2	24.7	1.46	1.13	1.87	6.0	1.3	10.7
Other cancer	1.22	0.77	1.92	5.0	-7.7	17.6	1.43	1.18	1.72	9.7	3.6	15.8
Endocrine system diseases	2.66	1.68	4.20	16.4	4.4	28.4	5.00	4.27	5.85	39.6	32.1	47.1
Mental disorders	2.90	1.55	5.40	10.1	0.5	19.6	2.63	1.96	3.51	8.6	4.6	12.6
Nervous system diseases	1.55	0.80	3.00	4.8	-4.1	13.6	0.85	0.57	1.27	-1.3	-4.2	1.7
Circulatory system diseases	1.71	1.42	2.06	67.0	37.0	97.0	1.74	1.60	1.89	69.5	56.0	83.0
Ischaemic heart disease	1.66	1.27	2.17	32.2	10.7	53.7	1.53	1.36	1.73	26.0	16.9	35.1
Cerebrovascular diseases	1.61	1.08	2.40	13.1	-0.6	26.9	1.91	1.62	2.26	19.5	12.7	26.3
Heart failure	1.66	0.74	3.72	3.2	-3.3	9.6	2.61	1.95	3.50	7.8	4.1	11.4
Other circulatory	1.98	1.35	2.90	18.5	4.2	32.8	1.85	1.55	2.22	16.2	9.9	22.5
Respiratory system diseases	2.00	1.37	2.93	19.7	4.7	34.7	2.60	2.24	3.02	31.5	24.0	39.1
Pneumonia	1.62	0.77	3.43	3.8	-3.7	11.4	3.12	2.45	3.99	13.1	8.5	17.8
Bronchitis, emphysema and asthma	2.03	1.19	3.44	10.2	-0.4	20.9	1.69	1.31	2.19	6.9	2.6	11.2
Other respiratory	2.58	1.16	5.76	5.7	-1.8	13.1	4.19	3.17	5.54	11.5	7.4	15.6
Digestive system diseases	3.01	2.00	4.52	22.9	9.0	36.8	4.44	3.80	5.18	39.2	31.6	46.8
Cirrhosis of liver	4.97	2.73	9.06	13.4	3.4	23.3	7.45	5.92	9.38	21.7	16.3	27.1
Other digestive	2.19	1.26	3.81	9.6	-0.2	19.3	3.18	2.56	3.94	17.5	12.1	22.9
Genitourinary system diseases	2.97	1.43	6.18	8.7	-0.9	18.4	3.19	2.40	4.25	9.7	5.8	13.7
Musculoskeletal system diseases	1.99	0.64	6.20	2.3	-2.9	7.6	3.38	2.28	5.02	5.5	2.5	8.6
Ill-defined conditions	2.18	0.97	4.92	4.8	-2.3	11.9	3.96	2.99	5.24	11.9	7.6	16.2
External causes	1.89	1.24	2.88	16.5	1.8	31.1	3.66	3.19	4.19	49.2	40.3	58.1
Suicide	0.85	0.27	2.64	-0.9	-6.3	4.6	1.86	1.32	2.61	4.9	1.4	8.4
Poisoning	6.71	2.75	16.36	6.8	-0.2	13.8	8.62	5.93	12.53	9.1	5.6	12.5
Motor vehicle accident	2.37	1.12	4.99	6.5	-1.8	14.8	4.62	3.61	5.90	17.1	12.0	22.1
Other external	1.59	0.76	3.35	4.1	-4.1	12.2	3.63	2.91	4.53	18.2	12.8	23.6
Unknown/Other	2.30	0.94	5.61	4.1	-2.4	10.6	2.29	1.54	3.43	4.1	1.2	7.0
Smoking-related	1.75	1.32	2.31	31.6	11.0	52.2	1.17	1.00	1.36	7.0	-0.5	14.5
Alcohol-related	6.22	3.42	11.32	14.8	4.4	25.3	10.06	8.05	12.56	25.7	19.9	31.5
Amenable to medical intervention (younger than 75)	1.83	1.40	2.41	37.5	15.1	60.0	2.06	1.84	2.31	47.8	37.4	58.3

Notes: Reference population (person-years at risk) for age standardization was taken from the Aboriginal age distribution (5-year age groups). Rate ratios and rate differences were calculated by comparing the age-standardized mortality rates for Métis and Registered Indians to those for the entire cohort. Métis were defined based on the ancestry responses (see "Derivation of Métis within the cohort"). A total of 2,200 cohort members (800 men and 1,300 women) were classified both Métis and Registered Indians.

Source: 1991 to 2001 Canadian census mortality follow-up study.

for Métis women compared with non-Aboriginal women were highest for deaths from circulatory system diseases (RD=67) and cancers (RD=46), accounting for 49% of the total rate difference.

Rate differences for Registered Indian men compared with non-Aboriginal men were highest for deaths from external causes (RD=136) and circulatory system diseases (RD=53), which together accounted for 59% of the total rate difference. Rate differences for Registered Indian women were highest for circulatory system diseases (RD=70) and external causes (RD=49), accounting for 39% of the total rate difference.

Deaths were also categorized as smoking-related, alcohol-related or amenable to medical intervention (for example, deaths before age 75 from breast and cervical cancer, infectious diseases, cerebrovascular disease, pneumonia or influenza) as defined by the European Union Working Group on Socioeconomic Inequalities in Health.³⁶ Rate ratios for smoking-related deaths were not significantly elevated for Métis men or for Registered Indian men, compared with non-Aboriginal men (Table 6). But they were significantly elevated for Métis (RR=1.75) and Registered Indian (RR=1.17) women (Table 7). Rate ratios for alcohol-related deaths were significantly higher among Métis and Registered Indians of both sexes. Rates of premature death (before age 75) considered amenable to medical intervention were also significantly higher for Métis and Registered Indians of both sexes.

Hazard ratios controlling for socio-economic variables

Age-adjusted all-cause mortality hazard ratios comparing Métis and Registered Indians to non-Aboriginal cohort members are shown in Appendix Tables F and G. Both Métis men and women had elevated hazard ratios (1.34 and 1.71, respectively). Controlling for income adequacy, educational attainment, occupation skill level, community size and immigration reduced the hazard

ratios substantially (to 1.11 and 1.51, respectively), which suggests that 68% and 28% of the differences in hazards were explained by these socio-economic variables. Age-adjusted hazard ratios for Registered Indian men and women of 1.50 and 1.93, respectively, were reduced to 1.19 and 1.66 when controlling for the socio-economic variables, which suggests that 62% and 29% of the differences were attributable to those variables.

Comparative perspective

In 1996, the mid-point of the follow-up period, remaining life expectancy at age 25 for Métis men was about what it had been for all men in Canada in 1986 (a 10-year lag) (Appendix Table H). For Métis women, remaining life expectancy at age 25 in 1996 was about what it had been for all women in 1973 (a 23-year lag).

For Registered Indian men aged 25 in 1996, remaining life expectancy was about what it had been for all men in Canada in 1979 (a 17-year lag), and for Registered Indian women, about what it had been for all women in Canada in 1968 (a 28-year lag).

Discussion

This is the first in-depth study to examine mortality patterns for a large sample of Métis adults across Canada. Métis and Registered Indians in this cohort had higher mortality rates, shorter life expectancy, and lower probability of survival to age 75, compared with the non-Aboriginal cohort members. This pattern of higher mortality is consistent with that previously described for First Nations in Canada.^{3-5,15} Elevated rates of premature mortality (dying before age 75) among Aboriginal people have also been reported in other studies.^{5,10}

Mortality rate ratios were highest in the younger age groups and diminished with advancing age—also noted in earlier studies.^{1,3,10} Part of this can be explained by the very high death rates from external causes (such as suicides and motor vehicle accidents) among Aboriginal youth and young adults.^{3,4,10}

Differentials in mortality varied by cause of death. For some causes, Métis and Registered Indians had much higher death rates, while for others such as cancer, death rates were either similar to or only slightly elevated compared with the non-Aboriginal members of the cohort.

Rate ratios for Métis and Registered Indian men were highest for deaths related to endocrine and digestive system diseases and external causes such as motor vehicle accidents, poisoning, drowning and homicide. Earlier studies have found these types of deaths to be more common among First Nations^{3,4,7,8,18} and to represent a major component of premature mortality.¹⁰ The higher rate ratios for deaths from endocrine system diseases likely reflect the higher prevalence of diabetes in the Aboriginal population.^{3,19,39-42}

Rate ratios for Métis and Registered Indian women were especially elevated for mental disorders and endocrine, digestive and genitourinary system diseases. For Métis women, rate ratios for external causes, although elevated, were less pronounced than for Métis men. For Registered Indian men and women, rate ratios for external causes were similarly elevated. Compared with non-Aboriginal cohort women, Métis and Registered Indian women had elevated rate ratios for all cancers combined and for most specific cancer sites (with the notable exception of breast cancer). These results differ from previous research on cancer mortality that tended to show excess mortality only for cancer of the cervix,^{13,44} gallbladder^{6,14} and kidney.⁴⁵

Métis and Registered Indians, especially women, had particularly elevated rates for alcohol-related deaths. These results for Registered Indians are consistent with previous research.^{2,4,46} age-standardized mortality rates for premature deaths (before age 75) that are amenable to medical care were elevated for Métis and Registered Indians, accounting for nearly one in five excess premature deaths for Métis men and for Registered Indians of both sexes, and

What is already known on this subject?

- Aboriginal peoples in Canada—First Nations, Métis and Inuit—are a young, diverse and growing population. However, in many databases, Aboriginal peoples cannot be identified, and consequently, basic health information that is routinely available for the general population is not readily available for Aboriginal peoples.
- Before this study, little was known about the mortality of Métis in Canada, although First Nations and Inuit have been shown to have high mortality rates, compared with the rest of the Canadian population.

What does this study add?

- Mortality rates for Métis were much higher than those for non-Aboriginal residents of Canada, especially for women.
- Rates were particularly elevated among Métis women for circulatory, digestive and respiratory system diseases; among Métis men, for external causes and circulatory, respiratory and digestive system diseases.
- Mortality rates among Registered Indians were higher than among Métis, although the causes for which the rates were particularly elevated were similar.
- Among Métis and Registered Indians, socio-economic indicators such as income, education and occupation explained roughly two-thirds of the excess mortality for men, and nearly 30% of that for women.

nearly one in ten excess premature deaths for Métis women.

Rate differences provide a different perspective by considering how rare or common a cause of death is, whereas rate ratios focus on relative risk. Rate differences were particularly high for deaths from circulatory system diseases and external causes, which together accounted for 67% of all excess mortality (the total rate difference) among Métis men, and about 59% among Registered Indian men.

Rate differences among Métis women were particularly high for circulatory system diseases and cancers, which together accounted for 49% of the excess mortality. Among Registered Indian women, 52% of excess mortality was attributable to circulatory system diseases, endocrine system diseases, and external causes of death.

Hazard regression analysis showed that substantial shares of these disparities in mortality (roughly two-thirds for Métis and Registered Indian men, and nearly 30% for Métis and Registered Indian women) were associated with their lower levels of income, education, occupation skill, and urban residence, compared with non-Aboriginal cohort members.

Limitations

To be eligible for inclusion in the Canadian census mortality follow-up study, a person had to have been enumerated by the 1991 census long form and been a tax-filer for the year 1990 or 1991. Under section 87 of the *Indian Act*, Registered Indians are entitled to a tax exemption for income earned or considered to be earned on a reserve.⁴⁷

As well as those who did not file a tax return, persons in long-term care facilities, senior's residences or prisons could not be included in the mortality follow-up study.

Compared with life tables for all Canada (1995 to 1997), the entire cohort had 1 year longer life expectancy for men and 2 years longer life expectancy at age 25 for women.

Linkage rates were lower among Métis (62% for Métis men and 68% for Métis

women), compared with non-Aboriginal adults (79% and 75%, respectively). However, the socio-economic profile of Métis cohort members was similar to that of all Métis long-form census respondents, suggesting that there was likely little or no linkage bias. Linkage rates for Registered Indians were even lower (47% for men and 59% for women), but again, analysis revealed that the demographic and socio-economic characteristics of those who were and were not linked were similar.

Ascertainment of deaths was estimated to be slightly lower (95% to 96%) among Aboriginal persons, compared with the cohort as a whole (97%). This would result in a slight downward bias in mortality rates calculated for Métis and Registered Indians, so the true extent of the disparities compared with non-Aboriginal cohort members could be slightly larger than indicated in this study.

Because questions about Aboriginal identity were not asked on the 1991 census, Métis were defined by ethnic origin (ancestry). However, based on 1996 census data cross-classified by Aboriginal identity, an estimated 73% of persons classified as Métis in this study would likely have identified as Métis. Nevertheless, the classification undoubtedly excluded many persons who might have identified as Métis, without indicating Métis ancestry (impossible to ascertain in 1991), or who reported categories of mixed Aboriginal and non-Aboriginal ancestry where half or less the population were expected to identify as Métis (and whose inclusion in the cohort would have biased the results). From 1996 to 2006, the self-identified Métis population increased by 91%.^{21,37} However, the Métis in this study were identified based on Métis ancestry reported in 1991; they were not necessarily the same as persons who self-identified as Métis in 2006.

Conclusion

The 1991 to 2001 census mortality follow-up study has made it possible to fill a data gap by examining mortality

among the Métis people of Canada. Métis and Registered Indian adults had higher mortality rates, compared with non-Aboriginal adults. At age 25, the life expectancy of Métis men was about three years shorter than that of non-Aboriginal men in the study cohort, and that of Métis women, about five years shorter. Life expectancy for Registered Indian men and women was about four and six years shorter, respectively. Mortality disparities between Métis and Registered Indians and non-Aboriginal cohort members varied by cause of death. Many of these deaths were potentially preventable (for example, intentional and unintentional injuries) or amenable to medical care or modification of

behavioural risk factors such as smoking or alcohol abuse. Furthermore, a substantial proportion of these disparities (roughly two-thirds for Métis and Registered Indian men, and nearly 30% for Métis and Registered Indian women) were explained by socio-economic differences.

These results provide baseline data about mortality patterns among Métis and Registered Indian adults that can be used to begin (for Métis) or continue (for Registered Indians) tracking changes over time. ■

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Appendix

Table A
ICD-9 and ICD-10 codes for selected causes of death

Category	ICD-9 codes	ICD-10 codes
Infectious diseases	001-139	A00-B99, U04
Cancer	140-239	C00-D48
Pancreas	157	C25
Breast	174-175	C50
Prostate	185	C61
Urinary system	188-189	C64-C68
Trachea, bronchus and lung	162	C33-C34
Lymph tissue and leukemia	200-208	C81-C96
Esophagus and stomach	150-151	C15-C16
Intestine and rectum	152-154, 159.0	C17-C21, C26.0
Uterus, ovary and adnexa	179-183	C53-C56, C57.0-C57.4, C58
Endocrine system diseases	240-279	E00-E99
Diabetes mellitus	250	E10-E14
Mental disorders	290-319	F00-F99
Nervous system diseases	320-389	G00-G99, H00-H95
Circulatory system diseases	390-459	I00-I99
Ischemic heart disease	410-414, 429.2	I20-25, I51.6
Cerebrovascular diseases	430-438	I60-I69
Heart failure	428	I50
Respiratory system diseases	460-519	J00-J99
Pneumonia	480-486	J12-J18
Bronchitis, emphysema and asthma	490-493, 496	J40-J46
Digestive system diseases	520-579	K00-K93
Cirrhosis of liver	571	K70, K73-K74
Genitourinary system diseases	580-629	N00-N99
Musculoskeletal system diseases	710-739	M00-M99
Ill-defined conditions	780-799	R00-R99
External causes	800-999	V01-Y98
Fall	880-888, 929.3	W00-W19, X59
Drowning	830, 832, 910	W65-W74, V90, V92
Suicide	950-959	X60-X84, Y87.0
Homicide	960-969	X85-X99, Y87.1
Poisoning	850-869	X40-X49
Motor vehicle accident	810-825, 929.0	V02-V04, V09.0, V09.2, V12-V14, V19.0-V19.2, V19.4-V19.6, V20-V79, V80.3-V80.5, V81.0-V81.1, V82.0-V82.1, V83-V86, V87.0-V87.8, V88.0-V88.8, V89.0, V89.2 Y85.0
Smoking-related	140-150, 161-163, 165, 490-494, 496	C00-C15, C30-C34, C39, J40-J44, J47
Alcohol-related	291, 303, 305.0, 425.5, 571.0-571.3, 577.0-577.1, 860	F10, I42.6, K70, K85, K86.0, X45
Amenable to medical intervention (younger than 75)	001-139, 174-175, 180, 201, 204-208, 401-405, 430-438, 480-487, 531-534, 540-543, 550-553, 560, 574-576, 630-677	A00-B99, U04, C50, C53, C81, C91-C95, I10-I15, I60-I69, J10-J18, K25-K28, K35-K38, K40-K46, K56, K80-K83, 000-099

Table B

Demographic, socio-economic and geographic characteristics of in-scope (eligible) Métis census respondents, compared with Métis cohort members, by sex, non-institutional population aged 25 or older at baseline, 1991

Characteristic	Men					Women				
	In-scope [†]		Cohort			In-scope [†]		Cohort		
	Number	%	Number	%	Ratio	Number	%	Number	%	Ratio
Total	25,300	100	5,700	100	1.00	26,600	100	6,100	100	1.00
Age group										
25 to 34	9,400	37	2,200	38	1.02	10,400	39	2,600	43	1.10
35 to 44	7,000	28	1,600	28	1.00	7,700	29	1,700	28	0.99
45 to 54	4,500	18	1,000	18	1.00	4,000	15	900	14	0.98
55 to 64	2,600	10	600	10	1.01	2,400	9	500	8	0.84
65 to 74	1,200	5	200	4	0.84	1,500	6	300	5	0.81
75 or older	600	3	100	2	0.93	700	3	100	2	0.75
Marital status										
Single (never married)	5,900	23	1,100	20	0.85	4,500	17	1,000	16	0.95
Common-law	4,400	17	1,100	19	1.11	4,000	15	1,000	17	1.14
Married	12,000	47	2,900	51	1.08	12,000	45	2,900	48	1.07
Previously married	3,000	12	500	9	0.79	6,200	23	1,200	19	0.81
Educational attainment										
Less than high school graduation	13,600	54	3,100	54	1.00	14,100	53	3,100	51	0.96
High school graduation	8,500	34	2,000	34	1.02	7,800	29	1,900	31	1.04
Postsecondary diploma	2,100	8	500	8	0.99	3,400	13	900	14	1.10
University degree	1,100	4	200	4	0.83	1,200	5	300	4	0.96
Labour force status										
Employed	15,400	61	3,500	61	1.01	11,900	45	2,900	47	1.05
Unemployed	4,200	16	1,000	18	1.10	2,700	10	600	10	1.01
Not in labour force	5,800	23	1,200	21	0.91	12,000	45	2,600	43	0.95
Income adequacy quintile										
Quintile 1 (lowest)	8,200	32	1,700	29	0.90	10,700	40	2,200	36	0.89
Quintile 2	5,700	23	1,400	24	1.05	5,700	21	1,400	22	1.05
Quintile 3	4,700	19	1,100	19	1.04	4,300	16	1,100	18	1.10
Quintile 4	4,200	16	1,000	17	1.05	3,500	13	900	14	1.08
Quintile 5 (highest)	2,500	10	600	11	1.04	2,300	9	600	9	1.08
Major source of income										
Wages and salaries	15,700	62	3,700	64	1.03	12,300	46	3,000	50	1.07
Self-employment	900	4	200	4	0.98	400	2	100	1	0.79
Government transfer payments	7,000	28	1,600	27	0.98	9,500	36	2,000	33	0.92
Investment	100	1	0	0	0.80	400	1	100	1	0.66
Other	500	2	100	2	0.98	700	3	200	3	1.33
Not applicable	1,000	4	200	3	0.72	3,400	13	700	12	0.96
Activity limitation										
Not stated	300	1	0	1	0.44	200	1	0	0	0.47
No	20,600	81	4,900	85	1.04	22,000	83	5,300	87	1.05
Yes	4,400	17	800	14	0.83	4,400	16	800	13	0.80
Community size										
1,000,000 or more	2,400	9	300	6	0.61	2,200	8	300	5	0.62
500,000 to 999,999	5,900	23	800	14	0.62	6,900	26	900	15	0.59
100,000 to 499,999	2,000	8	300	5	0.67	2,300	9	300	6	0.66
10,000 to 99,999	4,300	17	900	15	0.90	4,700	18	1,000	16	0.88
Less than 10,000	10,800	43	3,400	59	1.39	10,500	40	3,600	58	1.48
Region										
Atlantic Canada	400	2	100	2	1.07	500	2	100	2	1.00
Quebec	3,100	12	500	8	0.69	3,000	11	500	7	0.65
Ontario	2,700	11	500	8	0.74	3,000	11	500	8	0.71
Prairies	15,900	63	3,900	69	1.09	17,000	64	4,200	69	1.08
British Columbia	2,400	9	300	6	0.59	2,300	9	300	5	0.62
Territories	800	3	400	8	2.40	800	3	500	8	2.83
Living on reserve										
Yes	800	3	400	7	2.19	800	3	500	8	2.82
No	24,500	97	5,300	93	0.96	25,800	97	5,600	92	0.94

[†] weighted estimates

Notes: Métis were defined based on the ancestry responses (see "Derivation of Métis within the cohort"). A total of 2,200 cohort members (800 men and 1,300 women) were classified both Métis and Registered Indians.

Source: 1991 to 2001 Canadian census mortality follow-up study.

Table C

Demographic, socio-economic and geographic characteristics of in-scope (eligible) Registered Indian census respondents, compared with Registered Indian cohort members, by sex, non-institutional population aged 25 or older at baseline, 1991

Characteristic	Men					Women				
	In-scope [†]		Cohort		Ratio	In-scope [†]		Cohort		Ratio
	Number	%	Number	%		Number	%	Number	%	
Total	76,900	100	24,600	100	1.00	93,500	100	32,100	100	1.00
Age group										
25 to 34	31,000	40	10,100	41	1.02	37,600	40	14,100	44	1.09
35 to 44	20,000	26	6,800	28	1.06	24,800	27	8,800	28	1.04
45 to 54	12,100	16	4,000	16	1.02	14,600	16	4,800	15	0.96
55 to 64	7,500	10	2,100	9	0.89	8,800	9	2,500	8	0.83
65 to 74	4,000	5	1,100	5	0.86	5,000	5	1,300	4	0.75
75 or older	2,300	3	500	2	0.65	2,700	3	600	2	0.62
Marital status										
Single (never married)	18,800	24	5,400	22	0.89	16,300	17	5,100	16	0.91
Common-law	13,200	17	4,400	18	1.04	15,100	16	5,400	17	1.05
Married	36,000	47	12,500	51	1.08	42,900	46	16,500	51	1.12
Previously married	8,900	12	2,400	10	0.83	19,200	21	5,100	16	0.77
Educational attainment										
Less than high school graduation	45,500	59	14,700	60	1.01	51,900	55	18,000	56	1.01
High school graduation	24,200	31	7,900	32	1.02	26,800	29	9,100	28	0.99
Postsecondary diploma	5,400	7	1,700	7	0.95	11,900	13	4,100	13	0.99
University degree	1,700	2	400	2	0.67	2,900	3	900	3	0.91
Labour force status										
Employed	37,900	49	12,300	50	1.02	36,400	39	12,900	40	1.04
Unemployed	14,600	19	5,200	21	1.12	10,100	11	3,500	11	1.02
Not in labour force	24,400	32	7,000	29	0.90	47,000	50	15,600	49	0.97
Income adequacy quintile										
Quintile 1 (lowest)	31,900	41	9,700	40	0.95	42,200	45	13,600	42	0.94
Quintile 2	18,600	24	6,400	26	1.07	21,300	23	8,100	25	1.10
Quintile 3	12,400	16	4,300	17	1.07	14,500	15	5,400	17	1.08
Quintile 4	8,900	12	2,800	12	0.99	9,900	11	3,400	11	1.00
Quintile 5 (highest)	5,100	7	1,400	6	0.86	5,700	6	1,700	5	0.85
Major source of income										
Wages and salaries	40,500	53	13,500	55	1.04	38,400	41	13,700	43	1.04
Self-employment	1,600	2	400	2	0.74	1,000	1	300	1	0.88
Government transfer payments	29,700	39	9,500	39	1.00	36,100	39	11,600	36	0.93
Investment	400	1	100	0	0.77	1,000	1	300	1	0.80
Other	2,100	3	600	2	0.88	5,700	6	2,800	9	1.41
Not applicable	2,500	3	500	2	0.60	11,200	12	3,400	11	0.89
Activity limitation										
Not stated	3,300	4	300	1	0.27	3,200	3	300	1	0.31
No	61,700	80	21,100	86	1.07	75,800	81	27,600	86	1.06
Yes	11,800	15	3,200	13	0.85	14,500	15	4,200	13	0.84
Community size										
1,000,000 or more	5,100	7	800	3	0.47	7,300	8	1,200	4	0.48
500,000 to 999,999	6,800	9	1,000	4	0.45	11,300	12	1,700	5	0.44
100,000 to 499,999	6,400	8	1,100	5	0.56	9,200	10	1,700	5	0.55
10,000 to 99,999	11,900	15	2,900	12	0.77	16,900	18	4,000	12	0.69
Less than 10,000	46,700	61	18,800	76	1.26	48,800	52	23,500	73	1.40
Region										
Atlantic Canada	2,800	4	1,200	5	1.29	3,400	4	1,500	5	1.27
Quebec	8,200	11	2,200	9	0.85	9,600	10	3,400	10	1.02
Ontario	15,300	20	4,400	18	0.90	19,900	21	5,500	17	0.81
Prairies	30,400	39	10,100	41	1.04	36,900	39	13,500	42	1.07
British Columbia	17,100	22	5,200	21	0.95	20,200	22	6,400	20	0.92
Territories	3,100	4	1,500	6	1.47	3,400	4	1,800	6	1.50
Living on reserve										
Yes	40,800	53	18,000	73	1.38	38,400	41	22,000	68	1.67
No	36,100	47	6,500	27	0.57	55,100	59	10,100	32	0.54

[†] weighted estimates

Note: A total of 2,200 cohort members (800 men and 1,300 women) were classified both Métis and Registered Indians.

Source: 1991 to 2001 Canadian census mortality follow-up study.

Table D
Deaths and age-standardized mortality rates (ASMRs) per 100,000 person-years at risk for Métis and Registered Indians compared with non-Aboriginal cohort members, by cause of death, male non-institutional population aged 25 or older at baseline, Canada, 1991 to 2001

	Non-Aboriginal				Métis				Registered Indians			
	Deaths	ASMR	95% confidence interval		Deaths	ASMR	95% confidence interval		Deaths	ASMR	95% confidence interval	
			from	to			from	to			from	to
All cause	149,335	566.7	563.4	569.9	512	781.3	715.6	853.0	2,377	886.5	851.5	923.1
Infectious diseases	2,137	13.3	12.7	14.0	14	23.1	13.6	39.2	44	17.1	12.7	23.0
Cancer	49,489	187.6	185.8	189.4	119	175.9	146.6	211.0	448	162.5	148.1	178.3
Pancreas	2,338	9.1	8.7	9.5	6	9.3	4.2	20.9	18	6.5	4.1	10.4
Prostate	5,721	17.4	16.9	17.9	12	18.0	10.1	32.3	45	15.8	11.8	21.2
Urinary system	2,681	9.9	9.5	10.3	8	12.2	6.1	24.5	37	13.6	9.9	18.8
Trachea, bronchus and lung	15,210	56.8	55.8	57.8	48	68.6	51.6	91.3	138	49.6	42.0	58.6
Lymph tissue and leukemia	4,589	18.7	18.1	19.3	7	11.4	5.4	24.3	36	13.4	9.7	18.6
Esophagus and stomach	3,261	12.7	12.2	13.2	7	10.4	4.9	22.1	37	13.7	9.9	18.9
Intestine and rectum	6,153	23.1	22.5	23.8	11	16.8	9.2	30.6	51	18.3	13.9	24.1
Other cancer	9,338	39.2	38.4	40.2	20	29.0	18.7	45.1	82	30.1	24.2	37.4
Endocrine system diseases	4,584	17.0	16.4	17.5	22	31.5	20.7	48.0	147	53.9	45.8	63.3
Diabetes mellitus	3,715	13.3	12.9	13.8	19	26.9	17.1	42.4	127	46.4	39.0	55.2
Other endocrine	869	3.6	3.4	3.9	3	4.5	1.5	14.2	20	7.5	4.8	11.6
Mental disorders	2,357	8.1	7.7	8.5	9	14.1	7.3	27.4	70	26.8	21.2	33.9
Nervous system diseases	3,704	13.0	12.6	13.5	10	15.1	8.1	28.2	34	12.5	8.9	17.5
Circulatory system diseases	55,514	192.5	190.8	194.3	169	247.9	212.8	288.7	678	245.7	227.9	265.0
Ischaemic heart disease	34,937	123.2	121.8	124.6	111	166.8	138.2	201.3	426	155.0	140.9	170.5
Cerebrovascular diseases	8,638	28.2	27.5	28.8	25	36.0	24.2	53.5	99	35.4	29.1	43.1
Heart failure	2,505	7.7	7.4	8.0	7	9.3	4.4	19.4	41	14.4	10.6	19.6
Other circulatory	9,434	33.4	32.7	34.2	26	35.8	24.3	52.8	112	40.9	33.9	49.2
Respiratory system diseases	12,915	39.8	39.1	40.5	40	58.2	42.5	79.8	182	64.8	56.0	75.0
Pneumonia	3,717	11.6	11.2	12.0	19	28.9	18.2	45.7	74	26.5	21.1	33.3
Bronchitis, emphysema and asthma	7,288	22.0	21.5	22.5	15	20.5	12.3	34.1	65	23.0	18.0	29.3
Other respiratory	1,910	6.3	6.0	6.6	6	8.9	4.0	19.9	43	15.3	11.4	20.7
Digestive system diseases	5,155	20.0	19.4	20.7	25	38.7	25.9	57.6	149	55.3	47.1	65.0
Cirrhosis of liver	1,823	8.4	8.0	8.9	9	14.0	7.2	27.0	67	25.7	20.2	32.7
Other digestive	3,332	11.6	11.2	12.1	16	24.7	14.9	40.8	82	29.6	23.8	36.8
Genitourinary system diseases	2,394	7.7	7.4	8.0	8	11.5	5.7	23.2	45	16.6	12.4	22.2
Musculoskeletal system diseases	444	1.6	1.4	1.8	3	4.0	1.3	12.4	10	3.7	2.0	7.0
Ill-defined conditions	1,628	8.3	7.8	8.8	6	10.3	4.6	23.1	77	29.7	23.8	37.2
External causes	8,088	53.9	52.5	55.2	82	142.9	114.9	177.8	470	189.4	173.0	207.4
Fall	1,432	5.3	5.0	5.6	6	9.7	4.3	21.6	30	11.3	7.9	16.2
Drowning	268	2.0	1.8	2.3	8	14.2	7.1	28.5	55	22.2	17.0	28.9
Suicide	2,820	21.5	20.7	22.4	20	34.5	22.1	53.7	87	35.8	29.0	44.1
Homicide	197	1.6	1.4	1.9	4	7.7	2.9	20.5	31	12.6	8.8	17.9
Poisoning	383	3.1	2.8	3.5	6	11.1	4.9	24.7	33	13.2	9.4	18.6
Motor vehicle accident	1,630	11.6	10.9	12.2	21	37.2	24.2	57.2	126	51.1	42.9	60.9
Other external	1,358	8.7	8.2	9.3	17	28.7	17.7	46.4	108	43.1	35.7	52.1
Unknown/Other	926	3.8	3.6	4.1	5	8.1	3.3	19.6	23	8.4	5.6	12.7
Smoking-related	25,502	90.9	89.7	92.1	73	103.3	81.9	130.1	249	89.5	79.0	101.3
Alcohol-related	1,875	9.1	8.7	9.6	19	29.4	18.7	46.4	139	53.9	45.6	63.6
Amenable to medical intervention (younger than 75)	7,006	35.6	34.7	36.6	41	62.8	46.1	85.6	162	61.0	52.3	71.2

Notes: Reference population (person-years at risk) for age standardization was taken from the Aboriginal age distribution (5-year age groups). Métis were defined based on the ancestry responses (see "Derivation of Métis within the cohort"). A total of 2,200 cohort members (800 men and 1,300 women) were classified both Métis and Registered Indians.

Source: 1991 to 2001 Canadian census mortality follow-up study.

Table E

Deaths and age-standardized mortality rates (ASMRs) per 100,000 person-years at risk, for Métis and Registered Indians compared with non-Aboriginal cohort members, by cause of death, female non-institutional population aged 25 or older at baseline, Canada, 1991 to 2001

	Non-Aboriginal				Métis				Registered Indians			
	Deaths	ASMR	95% confidence interval		Deaths	ASMR	95% confidence interval		Deaths	ASMR	95% confidence interval	
			from	to			from	to			from	to
All cause	103,890	318.9	316.5	321.2	377	549.0	495.6	608.2	2,129	623.7	597.7	650.8
Infectious diseases	995	3.4	3.2	3.7	7	10.2	4.8	21.7	62	18.3	14.2	23.5
Cancer	34,325	134.0	132.4	135.7	122	180.1	150.6	215.4	531	156.3	143.6	170.3
Pancreas	1,874	6.3	6.0	6.6	7	9.2	4.3	19.4	25	7.2	4.8	10.6
Breast	6,357	28.9	28.1	29.8	14	21.5	12.7	36.4	83	25.0	20.1	31.0
Urinary system	1,041	3.3	3.1	3.5	5	6.2	2.5	15.1	15	4.3	2.6	7.2
Trachea, bronchus and lung	7,080	28.9	28.1	29.7	33	49.0	34.7	69.0	102	30.1	24.8	36.5
Lymph tissue and leukemia	2,980	10.8	10.4	11.3	9	13.2	6.8	25.4	33	9.6	6.8	13.5
Esophagus and stomach	1,323	4.6	4.3	4.9	5	7.7	3.2	18.4	18	5.3	3.3	8.3
Intestine and rectum	4,406	14.8	14.3	15.4	13	19.3	11.1	33.4	77	22.6	18.1	28.3
Uterus, ovary and adnexa	3,024	13.1	12.5	13.6	16	25.3	15.5	41.3	64	19.0	14.9	24.3
Other cancer	6,105	22.8	22.2	23.5	19	27.8	17.6	43.8	111	32.6	27.0	39.2
Endocrine system diseases	3,472	9.9	9.5	10.3	19	26.3	16.7	41.6	168	49.5	42.6	57.6
Mental disorders	2,435	5.3	5.1	5.6	10	15.4	8.2	28.6	47	13.9	10.5	18.5
Nervous system diseases	3,095	8.7	8.3	9.0	9	13.4	6.9	25.9	25	7.4	5.0	10.9
Circulatory system diseases	39,066	94.0	92.9	95.1	115	160.9	133.6	193.9	570	163.4	150.5	177.5
Ischaemic heart disease	20,432	48.8	48.0	49.6	57	81.0	62.1	105.7	261	74.8	66.2	84.5
Cerebrovascular diseases	8,835	21.4	20.9	21.9	25	34.5	23.2	51.4	141	40.9	34.7	48.3
Heart failure	2,531	4.8	4.6	5.0	6	8.0	3.6	17.9	46	12.6	9.4	16.8
Other circulatory	7,268	18.9	18.4	19.5	27	37.4	25.5	54.8	122	35.1	29.4	42.0
Respiratory system diseases	8,072	19.7	19.2	20.2	27	39.5	27.0	57.7	178	51.3	44.2	59.4
Pneumonia	2,927	6.2	5.9	6.5	7	10.0	4.7	21.2	67	19.3	15.2	24.6
Bronchitis, emphysema and asthma	3,788	9.9	9.6	10.3	14	20.1	11.9	34.2	59	16.8	13.0	21.7
Other respiratory	1,357	3.6	3.4	3.8	6	9.3	4.2	20.7	52	15.1	11.5	19.8
Digestive system diseases	3,872	11.4	11.0	11.9	24	34.3	22.9	51.4	170	50.6	43.5	58.8
Cirrhosis of liver	767	3.4	3.1	3.6	11	16.7	9.2	30.3	83	25.0	20.2	31.1
Other digestive	3,105	8.0	7.7	8.4	13	17.6	10.1	30.6	87	25.6	20.7	31.6
Genitourinary system diseases	1,829	4.4	4.2	4.7	8	13.2	6.3	27.4	49	14.2	10.7	18.8
Musculoskeletal system diseases	745	2.3	2.1	2.5	3	4.6	1.5	14.4	26	7.9	5.3	11.5
Ill-defined conditions	1,146	4.0	3.7	4.3	6	8.8	3.9	19.7	53	15.9	12.2	20.8
External causes	3,899	18.5	17.8	19.2	22	35.0	23.0	53.2	225	67.7	59.4	77.2
Suicide	745	5.7	5.3	6.1	3	4.8	1.6	15.0	35	10.6	7.6	14.7
Poisoning	175	1.2	1.0	1.4	5	8.0	3.3	19.2	34	10.3	7.3	14.4
Motor vehicle accident	752	4.7	4.4	5.1	7	11.2	5.3	23.5	72	21.8	17.3	27.5
Other external	2,227	6.9	6.5	7.3	7	11.0	5.2	23.1	84	25.1	20.3	31.1
Unknown/Other	939	3.2	2.9	3.4	5	7.3	3.0	17.7	25	7.3	4.9	10.8
Smoking-related	11,846	42.2	41.4	43.1	50	73.8	55.9	97.6	169	49.3	42.4	57.3
Alcohol-related	585	2.8	2.6	3.1	11	17.7	9.8	31.9	94	28.5	23.3	34.9
Amenable to medical intervention (younger than 75)	8,160	45.0	43.9	46.0	52	82.5	62.9	108.3	306	92.8	83.0	103.8

Notes: Reference population (person-years at risk) for age standardization was taken from the Aboriginal age distribution (5-year age groups). Métis were defined based on the ancestry responses (see "Derivation of Métis within the cohort"). A total of 2,200 cohort members (800 men and 1,300 women) were classified both Métis and Registered Indians.

Source: 1991 to 2001 Canadian census mortality follow-up study.

Table F
Unadjusted and adjusted all-cause mortality hazard ratios for Métis and non-Aboriginal members, by sex, non-institutionalized population aged 25 or older at baseline, Canada 1991 to 2001

	Men						Women					
	Unadjusted			Adjusted			Unadjusted			Adjusted		
	Hazard ratio	95% confidence interval		Hazard ratio	95% confidence interval		Hazard ratio	95% confidence interval		Hazard ratio	95% confidence interval	
from		to	from		to	from		to	from		to	
Population group												
Métis	1.34*	1.23	1.46	1.11*	1.01	1.21	1.71*	1.54	1.89	1.51*	1.36	1.67
Non-Aboriginal†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Age (years)	1.10*	1.10	1.10	1.09*	1.09	1.09	1.10*	1.10	1.10	1.09*	1.09	1.09
Highest educational attainment												
Less than high school graduation	...	...	...	1.37*	1.34	1.40	...	...	...	1.24*	1.20	1.28
High school graduation	...	...	...	1.23*	1.21	1.26	...	...	...	1.14*	1.10	1.18
Postsecondary diploma	...	...	...	1.10*	1.07	1.13	...	...	...	1.06*	1.03	1.10
University degree†	...	...	...	1.00	...	...	...	...	...	1.00	...	...
Income adequacy quintile												
Quintile 1 (lowest)	...	...	...	1.40*	1.38	1.43	...	...	...	1.29*	1.26	1.31
Quintile 2	...	...	...	1.18*	1.16	1.20	...	...	...	1.13*	1.10	1.15
Quintile 3	...	...	...	1.09*	1.07	1.11	...	...	...	1.08*	1.05	1.10
Quintile 4	...	...	...	1.04*	1.02	1.06	...	...	...	1.04*	1.01	1.06
Quintile 5 (highest)†	...	...	...	1.00	...	...	...	...	...	1.00	...	...
Occupation - skilled-based categories												
Professional†	...	...	...	1.00	...	...	...	...	...	1.00	...	...
Managerial	...	...	...	0.99	0.96	1.03	...	...	...	1.12*	1.05	1.20
Skilled/Technical/Supervisory	...	...	...	1.09*	1.06	1.13	...	...	...	1.13*	1.07	1.18
Semi-skilled	...	...	...	1.19*	1.15	1.23	...	...	...	1.12*	1.07	1.18
Unskilled	...	...	...	1.29*	1.24	1.34	...	...	...	1.21*	1.14	1.28
No occupation	...	...	...	1.65*	1.60	1.71	...	...	...	1.50*	1.43	1.56
Community size												
1,000,000 or more†	...	...	...	1.00	...	...	...	...	...	1.00	...	...
500,000 to 999,999	...	...	...	0.99	0.98	1.01	...	...	...	1.02*	1.00	1.04
100,000 to 499,999	...	...	...	0.99	0.98	1.01	...	...	...	1.08*	1.06	1.10
10,000 to 99,999	...	...	...	1.00*	0.99	1.02	...	...	...	1.04*	1.02	1.06
Less than 10,000	...	...	...	0.96*	0.94	0.97	...	...	...	1.03*	1.01	1.05
Place of birth												
Canada†	...	...	...	1.00	...	...	...	...	...	1.00	...	...
Foreign-born	...	...	...	0.76*	0.75	0.77	...	...	...	0.87*	0.85	0.88

† reference category

* significantly different from reference category (p < 0.05)

... not applicable

Notes: Métis were defined based on the ancestry responses (see "Derivation of Métis within the cohort"). A total of 2,200 cohort members (800 men and 1,300 women) were classified both Métis and Registered Indians.

Source: 1991 to 2001 Canadian census mortality follow-up study.

Table G

Unadjusted and adjusted all-cause mortality hazard ratios for Registered Indians and non-Aboriginal cohort members, by sex, non-institutionalized population aged 25 or older at baseline, Canada 1991 to 2001

	Men						Women					
	Unadjusted			Adjusted			Unadjusted			Adjusted		
	Hazard ratio	95% confidence interval		Hazard ratio	95% confidence interval		Hazard ratio	95% confidence interval		Hazard ratio	95% confidence interval	
from		to	from		to	from		to	from		to	
Population group												
Registered Indian	1.50*	1.44	1.57	1.19*	1.14	1.24	1.93*	1.85	2.01	1.66*	1.59	1.74
Non-Aboriginal†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Age (years)	1.10*	1.10	1.10	1.09*	1.09	1.09	1.10*	1.10	1.10	1.09*	1.09	1.09
Highest educational attainment												
Less than high school graduation	...	...	...	1.37*	1.34	1.40	...	...	...	1.24*	1.20	1.28
High school graduation	...	...	...	1.24*	1.21	1.27	...	...	...	1.14*	1.11	1.18
Postsecondary diploma	...	...	...	1.10*	1.07	1.13	...	...	...	1.06*	1.03	1.10
University degree†	...	...	...	1.00	...	...	...	...	...	1.00	...	...
Income adequacy quintile												
Quintile 1 (lowest)	...	...	...	1.41*	1.38	1.43	...	...	...	1.29*	1.27	1.32
Quintile 2	...	...	...	1.18*	1.16	1.20	...	...	...	1.13*	1.11	1.16
Quintile 3	...	...	...	1.09*	1.07	1.11	...	...	...	1.07*	1.05	1.10
Quintile 4	...	...	...	1.04*	1.02	1.06	...	...	...	1.04*	1.02	1.07
Quintile 5 (highest)†	...	...	...	1.00	...	...	...	...	...	1.00	...	...
Occupation - skilled-based categories												
Professional†	...	...	...	1.00	...	...	...	...	...	1.00	...	...
Managerial	...	...	...	0.99	0.96	1.03	...	...	...	1.12*	1.05	1.19
Skilled/Technical/Supervisory	...	...	...	1.09*	1.06	1.13	...	...	...	1.13*	1.08	1.18
Semi-skilled	...	...	...	1.19*	1.15	1.23	...	...	...	1.12*	1.07	1.18
Unskilled	...	...	...	1.29*	1.25	1.34	...	...	...	1.21*	1.15	1.28
No occupation	...	...	...	1.66*	1.61	1.71	...	...	...	1.51*	1.45	1.58
Community size												
1,000,000 or more†	...	...	...	1.00	...	...	...	...	...	1.00	...	...
500,000 to 999,999	...	...	...	0.99	0.98	1.01	...	...	...	1.02*	1.00	1.04
100,000 to 499,999	...	...	...	0.99	0.98	1.01	...	...	...	1.08*	1.06	1.10
10,000 to 99,999	...	...	...	1.00	0.99	1.02	...	...	...	1.04*	1.02	1.06
Less than 10,000	...	...	...	0.96*	0.94	0.97	...	...	...	1.04*	1.01	1.05
Place of birth												
Canada†	...	...	...	1.00	...	...	...	...	...	1.00	...	...
Foreign-born	...	...	...	0.76*	0.75	0.77	...	...	...	0.87*	0.85	0.88

† reference category

* significantly different from reference category (p < 0.05)

... not applicable

Note: A total of 2,200 cohort members (800 men and 1,300 women) were classified both Métis and Registered Indians.**Source:** 1991 to 2001 Canadian census mortality follow-up study.

Table H
Life expectancy at age 25 and percentage surviving to age 75 (conditional on surviving to age 25), Canada, various years

Years	Men		Women	
	Life expectancy at age 25	Surviving to age 75	Life expectancy at age 25	Surviving to age 75
	Years	%	Years	%
1955 to 1957	46.63	46.0	50.96	60.9
1960 to 1962	46.94	46.3	51.84	63.4
1965 to 1967	46.92	46.3	52.57	65.6
1970 to 1972	47.21	46.9	53.41	67.5
1975 to 1977	47.63	48.4	54.29	69.4
1980 to 1982	48.81	52.0	55.29	71.8
1985 to 1987	49.52	54.8	55.77	73.3
1990 to 1992	50.89	59.2	56.77	75.7
1995 to 1997	51.58	61.7	56.96	76.6
2000 to 2002	52.96	66.0	57.76	78.3

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Guest Editorial

Health Reports' contribution to the analysis of the social determinants of health

Health inequalities research in Canada: From data liberation to research proliferation to ?



James R. Dunn

CIHR-PHAC Chair in Applied Public Health;
Associate Professor, Department of Health, Aging and Society, McMaster University;
Scientist, Centre for Research on Inner City Health, St. Michael's Hospital;
Fellow, Successful Societies Program, Canadian Institute for Advanced Research;
Deputy Editor, *Journal of Epidemiology & Community Health*

I can remember distinctly in 1992, when I started working on research in the area of health inequalities, the topic was very much on the fringe of health research in Canada, and precious little was available by way of data, studies or any kind of publication on the topic. The fledgling Canadian Institute for Advanced Research had produced a few working papers that attempted to synthesize findings that came mainly from the U.S., the U.K. and Scandinavia, but apart from Michael Wolfson's study on the relationship between career earnings and the probability of death in retired Canadian civil servants (the pattern showed the same social gradient that was evident in studies outside of Canada), only a very small body of research addressed health inequalities in Canada. How things have changed.

By the mid-1990s, it was much more common to see the terms "population health" and "health

inequalities" in conference presentations and in an increasing number of publications, although not without controversy. Proponents of health promotion rightly claimed that a concern for health inequalities was already part of that field. (In fact, health promotion was concerned with *health inequities*, but the field could never fully disentangle itself from health behaviour modification.)

Around this time, Statistics Canada conducted the first wave of the National Population Health Survey and began the Data Liberation Initiative. These were watershed developments. Before the Data Liberation Initiative, researchers outside Statistics Canada could not easily gain access to powerful data for health inequalities research. Soon after the launch of the Initiative and the release of public-use versions of major surveys (at least to academic research institutions), Statistics Canada's Research Data Centres were established. They have since matured to allow widespread access to data among university researchers. Other institutions that hold health care administrative data are following this move toward greater access, notably in British Columbia, with the creation of the health data platform, and in Ontario, with plans to establish satellite centres of the Institute for Clinical and Evaluative Sciences.

These developments have made it possible for us to enjoy a much more favourable research environment than we had 15 or 20 years ago. The authors of the papers in this edition of *Health Reports*, and of other papers published in *Health Reports* in the past, owe a debt of gratitude to Statistics Canada, the Canadian Institute for Health Information and the university community for access to the raw materials that they used for their outstanding research.

The most recent innovation in data development for health inequalities research figures centrally in a number of recent contributions to *Health Reports*. The Canadian Census Mortality Follow-up Study¹ is a powerful database allowing the investigation of a wide variety of social and economic determinants of mortality risk, by a number of causes, for different population groups. Macintosh, et al.² use this database and the Canadian Community Health

Survey to investigate income gradients in health-adjusted life expectancy in Canada from 1991 to 2001. In another paper, Tjepkema, et al.³ use the Census Mortality Follow-up Study to examine patterns of mortality among the Canadian Métis population. Wilkins et al.⁴ used census data in an area-based approach to study life expectancy for the Canadian Inuit population. The two latter papers are each extremely important, as they quantify the significant mortality disadvantage faced by these Aboriginal groups with a precision that was previously not possible.

McLaren, et al.⁵ employ the General Social Survey, a data source not usually connected with health research, to draw inferences about time use trends between 1986 and 2005. The purpose is to identify changes in time use that could be plausibly linked to the increasing prevalence of obesity over the same period. They find that higher-income men spent more time in paid work, less time preparing meals/eating at home, and less time sleeping than did lower-income men, all of which may be contributing factors in the rising levels of obesity among higher-income men. Both men and women with more education, however, were found to spend more time reading, less time watching television, and more time in physically active leisure (in 2005), which may help to explain the lower obesity rates among higher-education populations that have been reported in other studies. Although the absence of health outcome measures in the General Social Survey prevents the authors from drawing conclusions about the relationship between time use and obesity, this article represents a clever use of data and presents a thought-provoking hypothesis about factors that may contribute to an important public health problem.

We have been fortunate that Statistics Canada and other institutions have had the talent, leadership and commitment to make data available and to pursue innovations in data development that have benefited researchers across the country. But more is needed. One of the most valuable research outputs to emerge from Statistics Canada is Russell Wilkins' long-term series (since 1971) on inequalities in mortality by neighbourhood income.⁶ This is one of the few indicators of health inequalities that

has been consistently measured and reported over time, and it is imperative that more of this kind of monitoring be done to provide an empirical barometer for health inequalities in this country. Why is this so important? Well, in the words of Fraser Mustard, founder of the Canadian Institute for Advanced Research and a pioneer in health inequalities research in Canada: “No data, no problem, no action.”

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Income disparities in health-adjusted life expectancy for Canadian adults, 1991 to 2001

by Cameron N. McIntosh, Philippe Finès, Russell Wilkins and Michael C. Wolfson

Abstract

Background

Health-adjusted life expectancy is a summary measure of population health that combines mortality and morbidity data into a single index. This article profiles differences in health-adjusted life expectancy across income categories for a representative sample of the Canadian population.

Data and methods

Mortality data were obtained from the 1991-2001 Canadian census mortality follow-up study, which linked a 15% sample of the 1991 adult non-institutional population with 11 years of death records from the Canadian Mortality Data Base. Information on morbidity was obtained from the Health Utilities Index Mark 3 instrument on the 2000/2001 Canadian Community Health Survey. The Sullivan method was used to compute health-adjusted life expectancy for national deciles of population ranked by income.

Main results

For both sexes, and with few exceptions, a nearly linear gradient across income deciles emerged for health-adjusted life expectancy at age 25. Compared with people in higher-income deciles, those in lower-income deciles had fewer years of health-adjusted life expectancy. These disparities were substantially larger than those revealed by life expectancy alone.

Interpretation

These findings highlight the generally worse health-related quality of life of lower-income groups. The results demonstrate that assessments of socio-economic disparities in health should include the effects of both mortality and morbidity.

Keywords

health inequalities, Health Utilities Index, life expectancy, socio-economic, Sullivan method

Authors

Cameron N. McIntosh (1-613-949-4135; Cameron.McIntosh@ps.sp.gc.ca) is with Public Safety Canada. Philippe Finès (1-613-951-3896; Philippe.Fines@statcan.gc.ca) and Russell Wilkins (1-613-951-5305; Russell.Wilkins@statcan.gc.ca) are with the Health Analysis Division at Statistics Canada. Michael C. Wolfson (1-613-951-8216; Michael.Wolfson@statcan.gc.ca) is with Statistics Canada, Ottawa, Ontario, K1A 0T6.

The dramatic increase in life expectancy in Canada and other economically developed nations during the last century stands as testimony to the success of improvements in public health and advances in medical care.¹ But despite these gains in longevity, inequalities in health outcomes across different subpopulations are still pervasive in Canada and other industrialized countries.²⁻⁶

Irrespective of how socio-economic status is defined and measured (by income, educational attainment or occupational prestige), mortality rates show a gradual but systematic increase at successively lower levels of the socio-economic hierarchy. Nonetheless, time-series analyses for Canada suggest that, in absolute terms, socio-economic differences in mortality have been diminishing over recent decades, with the specific patterns dependent on sex and the cause of death considered.^{7,8}

Mortality, however, is only one aspect of population health. It is now widely recognized that information on morbidity (including disability and reduced health-related quality of life) is crucial for monitoring health trends, setting priorities, and conducting cost-effectiveness analysis of population-level interventions. Because morbidity varies by socio-economic status,^{2,3,9-12} a complete assessment of health disparities

requires summary measures reflecting the effects of differences in both mortality and morbidity across socio-economic categories.¹³⁻¹⁵ Accordingly, a variety of summary measures, which integrate information on mortality and morbidity into a single numeric index, have been developed.¹⁶⁻¹⁸

A number of studies in Canada have calculated summary measures in order to examine broad national patterns of mortality and morbidity,¹⁹ regional variations in population health,²⁰ the population health impact of specific diseases and risk factors,²¹⁻²⁵ and whether population health has been improving over time.^{7,26,27} Few investigations in the Canadian context have focused on socio-economic differences in summary measures of population health, and those that have done so have relied primarily on macro-level indicators (such as neighbourhood income) rather than micro-level indicators (such as household income),²⁸⁻³⁰ thereby almost

certainly attenuating the association between socio-economic status and health. One Canadian study used micro-level indicators for analyses of socio-economic disparities in health, but only within a single province.³¹

This article examines socio-economic differences in health for a nationally representative sample of the adult population of Canada, using a summary measure known as *health-adjusted life expectancy*.³² By weighting years of life according to their quality, health-adjusted life expectancy converts the conventional, purely mortality-driven life expectancy measure into expected equivalent years of full health. This study combines mortality data from the 1991-2001 Canadian census mortality follow-up study³³ with information about health-related quality of life from the 2000/2001 Canadian Community Health Survey to estimate health-adjusted life expectancy for different income groups.

Data and methods

Data source

The 1991-2001 Canadian census mortality follow-up study

Death data were obtained from the 1991-2001 Canadian census mortality follow-up study, conducted by Statistics Canada in collaboration with the Canadian Population Health Initiative. With probabilistic linkage techniques, a 15% sample ($n = 2,735,152$) of the non-institutional population aged 25 or older who completed the 1991 census long-form questionnaire (the cohort) was matched to 11 years of death records (June 4, 1991 to December 31, 2001) from the Canadian Mortality Data Base. The linked file contains information on various demographic characteristics, socio-economic status, activity limitations, disability, and cause and date of death. Additional methodological details on the construction and contents of the linked file have previously been reported.³³

The Canadian Community Health Survey

Data on health-related quality of life were derived from the 2000/2001 Canadian Community Health Survey (cycle 1.1). The Canadian Community Health Survey is an ongoing cross-sectional survey that collects information on health status, health determinants, and health care utilization. It is representative of the household population aged 12 or older in all provinces and territories, excluding residents of institutions, of Indian Reserves and Crown Lands, of Canadian Forces bases (military and civilian residents) and of certain remote regions, and full-time members of the Canadian Forces. The response rate for cycle 1.1 was 84.7%. For consistency with the Canadian census mortality follow-up study, the present investigation was restricted to respondents aged 25 or older ($n = 106,283$). More detailed descriptions of the Canadian Community Health Survey design, sample, and interview procedures can be found in other published reports and on the Statistics Canada website.^{34,35}

Definitions

Income deciles

For the census mortality linked file, deciles (tenths) of population ranked by income adequacy were created. First, for each economic family or unattached individual in the non-institutional census population of all ages, total pre-tax, post-transfer income from all sources was pooled across all economic family members and divided by the weighted family size (or “equivalent person unit” scale). An economic family is a grouping of two or more individuals living in the same household or dwelling unit who are related by blood, marriage or adoption.³⁶ Unattached individuals are economic families of size 1. Under the weighting system, the first person received a weight of 1.0, the second person, 0.4, and all subsequent persons, 0.3. Next, adjusted family income was partitioned into deciles, using the same cut-points for the entire country. For the

Canadian Community Health Survey, income deciles were constructed in the same manner, except that total household income was used rather than total economic family income.

Because of the high proportion of missing income data on the Canadian Community Health Survey (21.5%, compared with 1.4% for the census), the extent of possible bias was addressed by performing two sets of analyses. The first set completely excluded cases with missing income deciles, and the second set was conducted after the missing decile information was filled in using hot deck imputation.³⁷ In the latter procedure, groups of Canadian Community Health Survey respondents matched on age, sex and educational attainment were created. For the cases with missing income deciles in each of these groups, a decile value was randomly selected from the pool of complete cases (the “donor” cases). Because the hot deck imputation did not appreciably alter the results (data not shown), all of the analyses presented here are based on cases with originally complete income data from the Canadian Community Health Survey.

Analytical techniques

Health-adjusted life expectancy

Health-adjusted life expectancy was estimated using a modified version of the Sullivan³⁸ method. Chiang’s³⁹ method was used to calculate abridged (five-year age group) period life tables, corresponding standard errors, and 95% confidence intervals for each population subgroup of interest (by age, sex and income decile). Before computing the life tables, it was necessary to: (1) transform baseline age to age at the beginning of each year of follow-up; (2) calculate deaths and person-years at risk separately for each year (or partial year) of follow-up; and (3) pool deaths and person-years at risk at the beginning of each year of follow-up.³³

Health-related quality of life weights were derived from the Health Utilities Index Mark 3 instrument (HUI3),^{40,41} administered to all respondents to the 2000/2001 Canadian

Community Health Survey. The health utilities index measures eight basic domains or attributes of health status: vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain. Each attribute has five or six levels, ranging from normal to severely limited functioning. For example, the levels of ambulation range from 1 (“able to walk around the neighbourhood without difficulty, and without walking equipment”) to 6 (“unable to walk at all”). Respondents were asked a standard set of questions on usual functional ability or capacity, which can be mapped to the levels of the eight attributes. A respondent’s health status was thus represented by an eight-element vector listing each of the attribute levels, which were then summarized by a weighted scoring function into a single value representing overall health-related quality of life. The global score has a theoretical range of -0.36 (the worst possible health state) to 1.00 (the best possible health state), where 0.00 represents a health state equivalent to death.

Mean global health utilities index scores were computed from the Canadian Community Health Survey for each population subgroup (by age, sex and income decile). Ten-year rather than five-year age groups were used with the Canadian Community Health Survey data to ensure stability of the mean estimates. Therefore, for computing health-adjusted life expectancy at ten-year intervals (for ages 25 through 75), the appropriate life table elements for five-year age groups from the census-mortality linked data were collapsed (for example, combining ages 25 to 29 with ages 30 to 34). Survey sampling weights were applied to correct the point estimates of the health utilities index means for unequal selection probabilities, post-stratification adjustments, and unit non-response. The Rao-Wu bootstrap technique was used to adjust the standard errors and 95% confidence intervals for the effects of stratification and clustering.^{42,43}

After the life table values and corresponding mean global health utilities index scores were assembled, health-adjusted life expectancy was computed

using the following formula, separately by sex and within each income decile:

$$HALE_x = \frac{\sum_{i=x}^w (L_i * H_i)}{l_x}$$

where:

- *HALE* is health-adjusted life expectancy;
- *x* is the exact age for which HALE is estimated (25 to 75, by ten-year intervals);
- *i* is an indicator representing the lower limit (*x*) of the age interval (*x*, *x + a*);
- *L_i* is the number of life years lived by the age group (*x*, *x + a*);
- *l_x* is the number of survivors at age *x*;

- *H_i* is the mean global health utilities index score for the age group (*x*, *x + a*), with *H_i* = 1.00 indicating full health; and
- *w* is the total number of age groups in the life table.

Thus, the higher the average level of health-related quality of life for a given age group on a scale with an upper limit of 1.00 (full health), the closer health-adjusted life expectancy will be to conventional life expectancy.

The variance of health-adjusted life expectancy was estimated by adapting methods proposed by Mathers⁴⁴ (see Health Canada, 2004²⁸), which take into account stochastic fluctuations in the observed death rates and the mean global health utilities index scores. All analyses were performed using a combination of SAS Version 9.1 for Windows (SAS

Table 1
Sample sizes for 1991-2001 Canadian census mortality follow-up study and corresponding weighted population estimates for 2000/2001 Canadian Community Health Survey

Variable	Census mortality follow-up study counts		Canadian Community Health Survey estimates	
	Number	Percentage	Millions	Percentage
Total	2,735,200	100.0	25.81	100.0
Sex				
Men	1,358,400	49.7	12.71	49.2
Women	1,376,800	50.3	13.1	50.8
Age group				
25 to 34	772,400	28.2	4.17	20.4
35 to 44	718,500	26.3	5.32	26.0
45 to 54	469,600	17.2	4.45	21.8
55 to 64	352,200	12.9	2.84	13.9
65 to 74	272,000	9.9	2.16	10.6
75 or older	150,400	5.5	1.5	7.3
Income decile				
Decile 1 (lowest)	226,600	8.3	2.02	7.8
Decile 2	238,700	8.7	2.02	7.8
Decile 3	256,500	9.4	2.02	7.8
Decile 4	269,600	9.9	1.93	7.5
Decile 5	276,500	10.1	1.94	7.5
Decile 6	279,000	10.2	2.2	8.5
Decile 7	283,300	10.4	1.79	6.9
Decile 8	286,400	10.5	2.24	8.7
Decile 9	289,300	10.6	2.03	7.9
Decile 10 (highest)	289,000	10.6	2.05	7.9
Missing	39,600	1.4	5.56	21.5

Notes: Census data were rounded to nearest 100. Percentages were calculated before rounding. Canadian Community Health Survey estimates were weighted to reflect target population size. All income data for the census mortality follow-up were available, but economic family size information was lacking for residents of non-institutional collective dwellings, so adjusted income could not be calculated for 39,600 individuals.

Sources: 1991-2001 Canadian census mortality follow-up study; 2000/2001 Canadian Community Health Survey (cycle 1.1).

Institute, Cary North Carolina) and Microsoft Excel 2002 for Windows.

Health-adjusted life expectancy by educational attainment

To verify the robustness of the association between health-adjusted life expectancy and socio-economic status, differences were also estimated for varying levels of education. For both the census mortality linked file and the Canadian Community Health Survey, self-reported information on highest level of education was grouped into four categories: less than secondary graduation, secondary graduation (or trades certificate), postsecondary certificate or diploma (short of a university bachelor's degree), and university degree (bachelor's or higher).

Results

Sample characteristics

For the most part, the distribution by age, sex and income decile was similar in the census mortality follow-up study and the Canadian Community Health Survey (Table 1). However, the Canadian Community Health Survey had considerably more missing data on the income decile (21.5%) than did the census mortality data (1.4%). As well, 1,565 respondents (about 1.5% of those aged 25 or older) to the Canadian Community Health Survey were missing data on the health utilities index, and were excluded from the analyses.

Disparities in mortality

For both men and women, a clear socio-economic gradient emerged for remaining life expectancy at age 25, as well as for the percentage expected to survive to age 75 (Table 2). From the lowest to the highest income deciles, a gradual yet steady increase in remaining life expectancy at age 25 was evident. For men, the difference in life expectancy between the extreme deciles was 7.4 years, and for women, 4.5 years. The proportion expected to survive to age 75 also climbed steadily, with 51% of men in the lowest income decile expected

Table 2
Remaining life expectancy at age 25 and percent expected to survive to age 75, by income decile and sex, Canada, 1991-2001

Income decile in 1991	Men			Women		
	Years	95% confidence interval		Years	95% confidence interval	
from		to	from		to	
Remaining life expectancy at age 25						
Decile 1 (lowest)	48.6	48.4	48.9	56.5	56.2	56.7
Decile 2	49.5	49.3	49.8	57.0	56.8	57.2
Decile 3	51.1	50.9	51.3	58.2	58.0	58.4
Decile 4	52.1	51.9	52.3	59.1	58.9	59.3
Decile 5	52.9	52.7	53.1	59.4	59.2	59.6
Decile 6	53.2	53.0	53.3	59.8	59.5	60.0
Decile 7	53.8	53.6	54.0	59.9	59.7	60.1
Decile 8	54.4	54.2	54.5	60.1	59.9	60.3
Decile 9	54.8	54.6	54.9	60.6	60.3	60.8
Decile 10 (highest)	56.0	55.8	56.2	61.0	60.8	61.1
Difference: Decile 10 minus Decile 1	7.4	7.1	7.7	4.5	4.2	4.8
Percent expected to survive to age 75						
	%	from	to	%	from	to
Decile 1 (lowest)	51.2	50.4	52.1	69.4	68.7	70.1
Decile 2	53.6	52.7	54.5	73.1	72.4	73.8
Decile 3	58.7	58.0	59.5	76.6	75.9	77.2
Decile 4	61.7	61.0	62.4	78.9	78.3	79.5
Decile 5	64.2	63.5	64.9	80.1	79.5	80.7
Decile 6	65.4	64.7	66.1	80.8	80.2	81.4
Decile 7	67.3	66.6	67.9	81.7	81.1	82.3
Decile 8	69.1	68.4	69.7	82.0	81.4	82.6
Decile 9	70.9	70.3	71.5	83.4	82.8	83.9
Decile 10 (highest)	74.6	74.0	75.1	84.4	83.9	85.0
Difference: Decile 10 minus Decile 1	23.3	22.3	24.3	15.0	14.2	15.9

Source: 1991-2001 Canadian census mortality follow-up study.

Table 3
Mean health utilities index scores for Canadian Community Health Survey respondents aged 25 to 34, by income decile and sex, 2000/2001

Income decile in 2000/2001	Men			Women		
	Health utilities index score	95% confidence interval		Health utilities index score	95% confidence interval	
from		to	from		to	
Decile 1 (lowest)	0.864	0.841	0.886	0.865	0.850	0.879
Decile 2	0.893	0.874	0.913	0.885	0.870	0.900
Decile 3	0.907	0.889	0.925	0.892	0.870	0.914
Decile 4	0.922	0.909	0.935	0.905	0.889	0.920
Decile 5	0.922	0.906	0.937	0.913	0.898	0.927
Decile 6	0.933	0.922	0.944	0.915	0.904	0.926
Decile 7	0.927	0.915	0.939	0.930	0.919	0.942
Decile 8	0.938	0.928	0.947	0.925	0.911	0.939
Decile 9	0.936	0.920	0.951	0.935	0.925	0.945
Decile 10 (highest)	0.951	0.942	0.959	0.943	0.933	0.953
Difference: Decile 10 minus Decile 1	0.087	0.063	0.111	0.078	0.060	0.096

Note: Health utilities index scores based on HUI3.

Source: 2000/2001 Canadian Community Health Survey (cycle 1.1)

to reach age 75, compared with 75% of those in the highest income decile. The corresponding figures for women were 69% versus 84%, a smaller inter-decile gap.

Disparities in health-related quality of life

Average health-related quality of life scores also exhibited appreciable socio-economic gradients. Table 3 shows mean health utilities index scores by income adequacy decile for people aged 25 to 34. For both sexes, mean scores tended to rise with income.

It is useful to evaluate these disparities in terms of a criterion called the *minimal clinically important difference*, which is the smallest difference that reflects a meaningful impact on (or change in) health-related quality of life.⁴⁵ For global scores on the health utilities index—in particular, the Mark 3 version used here—a minimal clinically important difference of 0.03 has been established through a combination of empirical research and expert opinion.⁴⁶ In the present study, the difference in mean global health utilities index scores between men in the highest income group (decile 10) and those in the lowest (decile 1) was 0.087, almost three times the minimal clinically important difference. The corresponding difference for women was 0.078.

Disparities in health-adjusted life expectancy

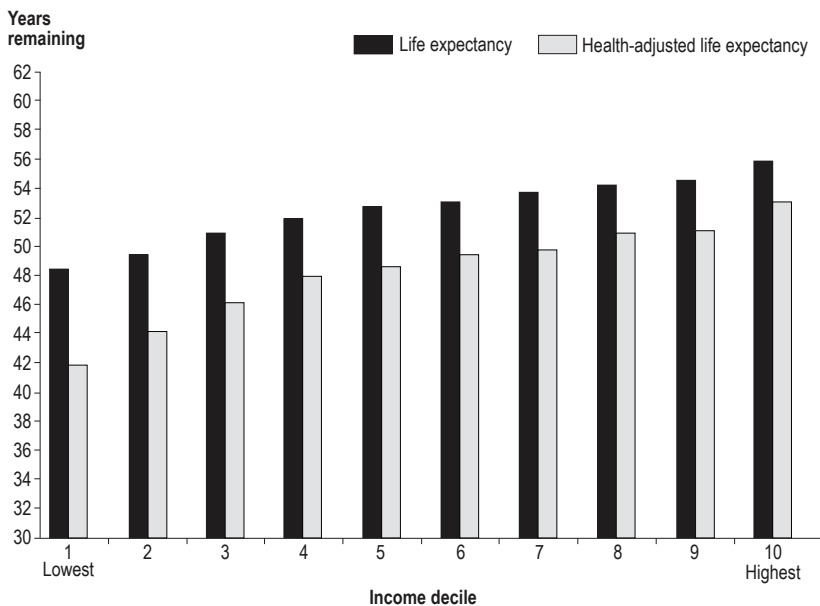
Remaining health-adjusted life expectancy at age 25 is shown in Table 4, and disparities across the income deciles in both conventional life expectancy and health-adjusted life expectancy are displayed in Figures 1 and 2. As with conventional life expectancy, for both sexes, the results for health-adjusted life expectancy demonstrated a nearly linear gradient with respect to income. Disparities in health-adjusted life expectancy between the highest and lowest deciles were 11.4 years for men and 9.7 years for women, whereas the corresponding disparities in conventional

Table 4
Remaining health-adjusted life expectancy (years) at age 25, by income decile and sex, Canada, 1991-2001

Income decile	Men			Women		
	Years	95% confidence interval		Years	95% confidence interval	
		from	to		from	to
Decile 1 (lowest)	42.0	40.8	43.2	48.1	47.4	48.7
Decile 2	43.1	42.4	43.8	50.2	49.7	50.7
Decile 3	46.5	45.9	47.1	52.6	52.1	53.1
Decile 4	47.3	46.5	48.1	52.8	52.1	53.5
Decile 5	49.2	48.6	49.8	54.0	53.3	54.8
Decile 6	49.2	48.5	49.9	54.9	54.2	55.6
Decile 7	50.4	49.8	51.1	55.1	54.3	56.0
Decile 8	51.1	50.4	51.8	56.0	54.9	57.1
Decile 9	51.6	50.9	52.4	56.6	55.8	57.5
Decile 10 (highest)	53.4	52.9	54.0	57.8	56.3	59.2
Difference: Decile 10 minus Decile 1	11.4	10.1	12.7	9.7	8.1	11.3

Source: 1991-2001 Canadian census mortality follow-up study; 2000/2001 Canadian Community Health Survey (cycle 1.1).

Figure 1
Remaining life expectancy and health-adjusted life expectancy at age 25, by income decile, men, Canada, 1991-2001



Source: 1991-2001 Canadian census mortality follow-up study; 2000/2001 Canadian Community Health Survey (cycle 1.1).

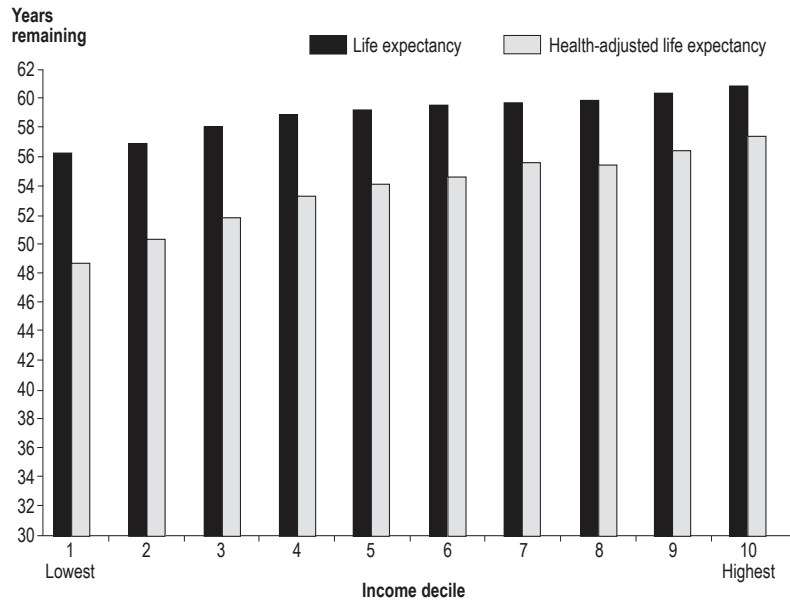
life expectancy were only 7.4 years and 4.5 years, respectively.

Health disparities across education levels

The results of the supplemental analyses of health disparities across educational

attainment categories are shown in Appendix Tables A, B and C. Without exception, all of the health indicators (life expectancy, survival probabilities, mean health utilities index scores, and health-adjusted life expectancy) showed

Figure 2
Remaining life expectancy and health-adjusted life expectancy at age 25, by income decile, women, Canada, 1991-2001



Source: 1991-2001 Canadian census mortality follow-up study; 2000/2001 Canadian Community Health Survey (cycle 1.1).

steady improvement with increasing levels of education.

Discussion

This study indicates strong and consistent evidence of socio-economic disparities in health. Income-related disparities in health-adjusted life expectancy were found to be considerably larger than those for the conventional life expectancy indicator. For both men and women at age 25, the difference in remaining health-adjusted life expectancy between the highest and lowest income groups was about 4 years more than the corresponding disparity in life expectancy. These results highlight the generally worse morbidity that lower-income groups experience in addition to their higher mortality. The findings are consistent with those of other Canadian investigations using area-level²⁸⁻³⁰ and individual-level³¹ indicators of health and socio-economic status, and with numerous studies of socio-economic differences in health expectancy in the United States and Europe.¹³⁻¹⁵ This information suggests

that the remediation of both fatal and non-fatal health outcomes may have the potential to substantially reduce health disparities related to socio-economic circumstances in Canada.

Some additional perspective on the magnitude of socio-economic disparities in health-adjusted life expectancy can be provided through comparisons with the impact of specific health conditions. For example, Manuel and colleagues²³ found that all cancers, which represented the greatest burden of disease in the population, reduced health-adjusted life expectancy *at birth* by 2.8 years for men and by 2.5 years for women. By contrast, in this analysis, which examines health-adjusted life expectancy *at age 25*, the difference between the highest income decile and the overall average was estimated at 5.9 years for men and 4.2 years for women—around twice the impact of all cancers combined. Because of differences in methodology and data sources, these findings and those of Manuel and colleagues²³ are not completely comparable. But methodological differences alone are

unlikely to account for such large discrepancies between the impact of a major disease which has been the object of tremendous research and clinical effort (such as the “war on cancer” in the United States, declared in 1971),⁴⁷ and the impact of socio-economic factors, which remain, by comparison, relatively poorly understood. Further research examining pathways by which socio-economic status affects health is warranted to understand how such large differences are generated and to point to potential areas for intervention.

Limitations

The results of this study pertain to the *non-institutionalized* population aged 25 or older (except that the mortality data included people who were institutionalized after the 1991 Census). Future work should investigate ways of including the morbidity and mortality experience of institutional residents—the most disabled segment of the population—as well as that of people younger than 25, to get a more comprehensive picture of morbidity and mortality in relation to socio-economic status.

The Canadian Community Health Survey data may be affected by a certain element of self-selection, since not everyone contacted agreed to participate in the survey. The health utilities index data from the survey may be subject to self-report error, and may not perfectly reflect the health-related quality of life of the 1991-2001 Canadian census mortality cohort. However, a more representative and temporally consistent source of data on health-related quality of life was not available.

Data on income were missing for a large share of the Canadian Community Health Survey sample. However, imputing the missing income deciles and then recalculating the estimates with complete decile information for the survey component did not substantially change the results (data not shown).

The person-equivalence scale used to compute adjusted household income was only one of many possible approaches. For example, other Canadian studies

What is already known on this subject?

- Findings from Canada and other countries have consistently demonstrated that accounting for morbidity as well as mortality reveals even greater socio-economic disparities in health outcomes, because of the generally worse morbidity experience of disadvantaged persons.

What does this study add?

- This is the first study to provide nationally representative estimates of socio-economic inequalities in health-adjusted life expectancy for the adult household population of Canada, using individual-level measures of socio-economic status, mortality and morbidity.
- For both sexes, disparities in health-adjusted life expectancy between the highest and lowest income groups were substantially greater than those for life expectancy alone.

have used the ratio of total income to the Statistics Canada low income cut-off established for the applicable family and community size group.³³ In addition, a variety of alternative indicators of socio-economic status (such as education or occupational prestige) could be used to examine gradients in health. Nonetheless, it is well known that the socio-economic gradient in health is robust to the choice of measurement method. Recomputation of the same set of estimates (for life expectancy, survival probabilities, mean health utilities index score, and health-adjusted life expectancy) for another indicator of socio-economic status (educational attainment) yielded essentially the same pattern of results (Appendix Tables A, B and C).

While the measurement properties of the health utilities index have been

supported in numerous studies,^{40,46,48} other reliable and valid measures of health-related quality of life can be used in the computation of health-adjusted life expectancy, such as the EuroQol Five Dimensions Index⁴⁹ and the Short-Form Six Dimensions Index.⁵⁰ However, the health utilities index was the only such measure available from the Canadian Community Health Survey, which, in turn, was the only nationally representative source of health-related quality of life data with a sample of sufficient size. Future studies in the Canadian context could use other instruments if they are included on national surveys. Alternatively, weights could be assigned to particular levels of disability based on expert opinion.^{29,30,51} Comparison of the current results and those obtained with such alternative methods would show the sensitivity of health-adjusted life expectancy and of the corresponding socio-economic gradient to changes in the way health-related quality of life is measured.

The 1991-2001 Canadian census mortality follow-up study dataset contained only baseline (1991) information on family income, and the Canadian Community Health Survey provided only cross-sectional estimates of morbidity. Since these characteristics are expected to change over time, it would have been preferable to have income and morbidity information for each year of follow-up, thus providing the input for a more dynamic, multistate life table or microsimulation-based approach to computing health-adjusted life expectancy.⁵²

Mathers' method⁴⁴ for calculating the variance of health-adjusted life expectancy assumes that the rates of mortality and morbidity are uncorrelated, but violations of this assumption could result in underestimation of the variance using his method.⁵³ Because individual risk functions for the two variables were not known, it was not possible to estimate the correlation between morbidity and mortality from the present data. Nevertheless, the bias introduced in the variance estimate may have been reduced because all the calculations were

done by age, sex and income decile, which themselves explain a substantial amount of the variance in health-related quality of life and mortality.

Although life expectancy, survival probabilities, the health utilities index, and health-adjusted life expectancy were each found to be associated with income in the current study, causality cannot be inferred. In a study of the effects of poverty and material hardship on mortality in Finland, Martikainen and colleagues⁵⁴ concluded that a large part of the association observed between income and mortality was not due to a direct causal impact, but rather to the mutual dependence of mortality and income on other background factors such as educational attainment and occupational prestige. Identifying the true causal mechanisms underlying the socio-economic gradient in health is important, since the effectiveness of interventions may rest on correctly understanding the forces involved. The real drivers of health inequalities could be differences in education and occupation. It has also been suggested that poorer health status may be an antecedent to both lower incomes and earlier mortality ("reverse causality").⁵⁵ Although health status affects socio-economic status to some degree (for example, chronic illness can result in foregone income and reduced opportunities), several prospective studies have demonstrated that forward causality (socio-economic status influencing health) is more important in generating the observed socio-economic gradient in health.⁵⁶⁻⁵⁹ Nevertheless, the current descriptive analysis makes no claims about the causal mechanisms underlying the observed health disparities.

Conclusion

The 1991-2001 census mortality follow-up study has opened a wide range of opportunities for analyzing socio-economic correlates of health in Canada. The health disparities estimates presented here are novel in that they use Canadian microdata on socio-economic status, mortality and morbidity for

a large, representative sample of the household population aged 25 or older. The results provide comprehensive, robust, and policy-relevant information on the distribution of health outcomes by socio-economic status. This study may be useful to identify areas in which interventions for reducing health disparities would yield the greatest benefits. ■

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Appendix

Table A
Remaining life expectancy at age 25 and percent expected to survive to age 75, by highest level of educational attainment and sex, Canada, 1991-2001

Educational attainment in 1991	Men			Women		
	Years	95% confidence interval		Years	95% confidence interval	
		from	to		from	to
Remaining life expectancy at age 25						
Less than secondary graduation (lowest)	50.8	50.7	50.9	57.8	57.7	57.8
Secondary graduation	53.2	53.1	53.2	59.6	59.4	59.7
Postsecondary diploma	55.1	54.8	55.3	60.7	60.5	60.8
University degree (highest)	56.4	56.2	56.6	61.5	61.3	61.8
Difference: highest minus lowest	5.6	5.4	5.8	3.8	3.5	4.0
Percent expected to survive to age 75	%	from	to	%	from	to
Less than secondary graduation (lowest)	58.6	58.3	59	75.8	75.5	76.1
Secondary graduation	65.6	65.3	66	80.5	80.2	80.9
Postsecondary diploma	71	70.2	71.7	83	82.5	83.4
University degree (highest)	76.1	75.5	76.7	85.4	84.7	86
Difference: highest minus lowest	17.4	16.8	18.1	9.6	8.9	10.3

Source: 1991-2001 Canadian census mortality follow-up study.

Table B
Mean health utilities index scores for Canadian Community Health Survey respondents aged 25 to 34, by highest level of educational attainment and sex, 2000/2001

Educational attainment	Men			Women		
	Health utilities index score	95% confidence interval		Health utilities index score	95% confidence interval	
		from	to		from	to
Less than secondary graduation (lowest)	0.868	0.848	0.888	0.835	0.814	0.857
Secondary graduation	0.912	0.905	0.92	0.895	0.888	0.902
Postsecondary diploma	0.934	0.925	0.943	0.916	0.909	0.923
University degree (highest)	0.946	0.938	0.953	0.942	0.936	0.947
Difference: highest minus lowest	0.078	0.057	0.099	0.107	0.084	0.129

Note: Health utilities index scores based on HUI3.

Source: 2000/2001 Canadian Community Health Survey (cycle 1.1).

Table C
Remaining health-adjusted life expectancy at age 25, by highest level of educational attainment and sex, Canada, 1991-2001

Educational attainment	Men			Women		
	Years	95% confidence interval		Years	95% confidence interval	
		from	to		from	to
Less than secondary graduation (lowest)	44.1	43.7	44.4	48.2	47.9	48.6
Secondary graduation	48.5	48.1	48.9	53.3	53.0	53.6
Postsecondary diploma	51.4	50.8	52.0	55.6	55.1	56.0
University degree (highest)	53.3	52.8	53.8	57.9	57.2	58.6
Difference: highest minus lowest	9.3	8.6	9.9	9.7	8.9	10.5

Source: 1991-2001 Canadian census mortality follow-up study; 2000/2001 Canadian Community Health Survey (cycle 1.1).

Social class, gender, and time use: Implications for the social determinants of body weight?

by *Lindsay McLaren, Jenny Godley and Ian A.S. MacNairn*

Abstract

Background

The social gradient in body weight (for example, obesity) departs from the social gradient in other health outcomes. Innovative approaches are needed to understand the observed patterns. This study examines time-use patterns by indicators of socio-economic position, and considers the implications of variations in time use for the social gradient in weight reported in other studies.

Data and methods

The data are from respondents aged 25 to 64 to Canada's 1986 and 2005 General Social Surveys, which focused on time use. Participation in various activities was examined by sex, and by personal income and education, stratified by sex, in both years.

Results

Higher-income men and women were more likely than those of lower income to spend time in paid work, commuting and eating out, and less likely to spend time sleeping. Men and women with higher education were more likely than those with lower education to spend time in physical activity (2005 only) and reading. These time-use patterns plausibly contribute to the social gradient in obesity reported in other Canadian studies.

Interpretation

The findings suggest that there is value in looking beyond a narrow range of health behaviours toward broader measures of daily routines to gain insight into the social determinants of weight and health.

Keywords

gender, obesity, population, social class, time use, trends

Authors

Lindsay McLaren (1-403-210-9424; lmclaren@ucalgary.ca) is with the Department of Community Health Sciences at the University of Calgary, 3330 Hospital Dr. NW, Calgary AB, T2N 4N1; Jenny Godley is with the Department of Sociology; and at the time of writing, Ian A.S. MacNairn was in the Bachelor of Health Sciences Program at the University of Calgary.

The social gradient in health refers to the consistent association between socio-economic position and health status, whereby higher socio-economic position is associated with better health status across an array of health outcomes.¹⁻⁴ The social gradient in body weight (body mass index (BMI), obesity) departs from this consistent pattern. Sex differences are apparent, with an inverse association (higher socio-economic position—lower BMI) more prominent for women than men.⁵ Further differences by indicator of socio-economic position are evident; for example, recent Canadian data show a positive association with income for men (that is, higher income—higher likelihood of overweight/obesity) that is not observed in women, while an inverse association between education and overweight/obesity has been observed for both women and (less consistently) for men.⁶⁻⁸

Several studies have examined mediators of the association between socio-economic position and BMI/obesity.^{7,9,10} In general, these studies have focused on a limited range of health behaviours with plausible biological links to weight, such as diet, physical activity, and smoking. One study found that women of higher socio-economic position reported

more physical activity and higher fruit/vegetable intake, which helped explain their lower obesity risk.⁷ Other studies found that higher-income men reported a lower likelihood of smoking⁹ and less physical activity,⁷ which helped to explain their higher obesity risk. On the other hand, a longitudinal study found that the association between social class

in childhood and obesity in adulthood was not attenuated by health behaviours in adulthood (for example, smoking, diet, physical activity).¹¹

To build on the contribution of these studies, this analysis examines the association between socio-economic position (personal income, education) and a broader array of activities (overall daily routines or lifestyles), and considers the implications for the social gradient of weight reported in other studies. The period during which obesity prevalence increased markedly in Canada⁶ has been characterized by social change that is not necessarily captured in measurements of a limited range of health behaviours. The past several decades have seen changes in population composition (for example, some adults are now caring for both children and elderly parents), availability and use of technology (for example, the ubiquity of computers), gender roles (for example, the increasing participation of women in the paid labour force), and the size and structure of cities (for example, time spent travelling, usually by car).^{12,13} It is plausible that these trends have implications for the social gradient in body weight, and the aim of this article is to explore this possibility using *time use* data.

The approach is in line with a sociological view of lifestyle¹⁴ that includes the daily choices made by individuals within a context that is socially, culturally and economically constrained. Body weight is one manifestation of class-based inequality that plausibly reflects these everyday processes. A useful theoretical framework for the intersection of class and lifestyle as it pertains to body weight is that of Bourdieu, and in particular, his concept of *habitus*.¹⁵⁻¹⁸ *Habitus* refers to the embodiment of social structures in individuals such that the body (appearance, style, behavioural affinities, etc.) is a social metaphor for status. According to this framework, class incorporates an individual's standing on several dimensions of capital: economic capital (income, wealth), cultural capital (accumulated educational or experiential

resources and associated dispositions), and social capital (resources derived from social relationships and engagement).^{17,19} These forms of capital can take on symbolic value when they are recognized by society as having prestige or legitimacy.

The nuances observed in the social gradient in weight (variations by sex and by indicators of socio-economic position) likely reflect not just economic circumstances (such as the ability to afford nutritious foods),^{20,21} but also social dimensions (for example, implications of social engagement and connections for appearance and weight)²² cultural dimensions (for example, affinity for specific standards of weight/health; sense of control/empowerment)^{23,24} and symbolic dimensions (for example, attributes of the socially desirable body, which differ for men and women).⁸ These processes and forms of capital are reflected in how people spend their time. By examining time use data, it is possible to explore a wide range of activities such as time spent in paid work, reading, cultural events, and civic or voluntary activities. These activities may reflect, and/or contribute to one's economic, cultural, and social capital. As well, they may be related to weight in a variety of ways (Appendix Table A)—directly, through increased caloric

intake or decreased physical exertion, and indirectly, through pathways such as social norms that encourage a particular appearance or set of values toward weight.²⁵⁻²⁷ Daily activities may also be associated with weight through biological pathways. For example, changes in thyroid-stimulating hormone secretion that accompany sleep debt may lead to weight gain.²⁹ Activation of the hypothalamic-pituitary-adrenal axis and the sympathetic nervous system in response to psychosocial stress, such as that experienced by people with a lower socio-economic position,³⁰ may also lead to weight gain.³¹ These direct and indirect pathways between lifestyle and weight are not mutually exclusive, nor is this an exhaustive list.

The purpose of this study is to examine variations in time spent in different activities, by two conventional indicators of socio-economic position: personal income and education. Although the data source does not contain information about body weight, it has notable advantages: 1) the ability to tap into a much broader array of daily activities than has been examined in other studies of this topic, and 2) greater measurement validity than other forms of self-report for the assessment of behaviours.^{32,33} The results are interpreted with reference to data on the social gradient in weight, as reported in other Canadian studies (Text Table 1). In particular, an attempt is made to identify lifestyle patterns that may help explain an association between education and BMI/obesity that is consistently inverse for women, and that is inverse, but less consistently so, for men; and an association between income and BMI/obesity that recent Canadian studies suggest is positive for men, and curvilinear (perhaps in transition) for women.

Data and methods

The data are from the public use files of Statistics Canada's General Social Survey, a cross-sectional telephone survey that has been conducted approximately every year since 1985. Details are available at

Text Table 1
Association between income/education and body mass index/obesity among Canadian men and women, based on recent studies

Variables	Nature of association
Income and body mass index/obesity	
Men	Currently positive; ^{6-8,28} previously inverse, ²⁸ or nonsignificant [†]
Women	Currently curvilinear ⁶ or nonsignificant, ⁷ though tending toward inverse; ⁸ previously inverse [†]
Education and body mass index/obesity	
Men	Inverse, currently ^{6,8} and in past, [†] but less consistent than in women ⁷
Women	Inverse, currently ⁶⁻⁸ and in past [†]

[†] unpublished (McLaren L, Auld CM, Godley J, Still D, Gauvin L. Examining the association between socioeconomic position and body mass index in 1978 and 2005 among Canadian working-age women and men)

www.statcan.gc.ca. Briefly, the target population is household residents aged 15 or older in the ten provinces; residents of the territories and full-time residents of institutions are excluded. A stratified cluster sampling approach with random-digit dialing was employed.

This study concerns working-age (25 to 64) respondents to two survey cycles that had time use as the core topic: cycle 2 (1986) and cycle 19 (2005).

Personal income and highest attained education were used as indicators of socioeconomic position. Personal income, adjusted for inflation with the Bank of Canada's online inflation calculator, was grouped into three categories as equal in size as possible across the two cycles. Categories were created separately for men and women to reflect their different income distributions (women's income was lower than men's, particularly in 1986). The income groups for men were: lower (\$0 to \$18,363 in 1986, and \$0 to \$29,999 in 2005), middle (\$18,364 to \$30,605 in 1986, and \$30,000 to \$49,999 in 2005), and higher (\$30,606 or more in 1986, and \$50,000 or more in 2005). The income groups for women were: lower (\$0 to \$6,120 in 1986, and \$0 to \$9,999 in 2005), middle (\$6,121 to \$18,363 in 1986, and \$10,000 to \$29,999 in 2005), and higher (\$18,364 or more in 1986, and \$30,000 or more in 2005).

Two educational attainment categories were defined: university degree (bachelor's or higher) versus less than university degree. A five-category breakdown was also considered, but the university degree/less than university degree dichotomy captured the main findings.

The 1986 core sample contained 6,705 respondents aged 25 to 64, 6,584 of whom (98.2%) provided time-use data (n=3,007 men and n=3,577 women). Income data were missing for 731 men (24.3%) and 815 women (22.8%). Men with missing income data in 1986 spent ($p<0.05$) more time in paid work and personal care, and less time in household work and food preparation/meals at home than did men with complete income data. Women with missing income data in

1986 spent ($p<0.05$) more time sleeping, and less time caregiving and socializing than did women with complete income data. Education data were missing for 34 men (1.1%).

The 2005 sample contained 13,519 respondents aged 25 to 64, all of whom provided time-use data (n=6,006 men and n=7,513 women). Income data were missing for 1,174 men (19.5%) and 1,661 women (22.1%). Men with missing income data in 2005 spent ($p<0.05$) more time in personal activities, sleeping and other, and less time in household work, food preparation/meals at home, caregiving and civic/voluntary activities than did men with complete income data. Women with missing income data in 2005 spent ($p<0.05$) more time in food preparation/meals at home, personal care and sleep, and less time commuting, eating out and attending entertainment than did women with complete income data. Education data were missing for 68 men (1.1%) and 76 women (1.0%). Those with missing data were excluded from analyses involving income and education.

Time spent (minutes) in various activities was derived from a time use diary (details are available at www.statcan.gc.ca). Respondents were asked to consecutively report their daily activities during a 24-hour reference period starting at 4:00 a.m. They identified the main activity in which they were engaged and the start and end time of that activity. All seven days of the week were represented, with days assigned randomly to respondents. The information from the diary was coded at Statistics Canada (n=99 codes in 1986 and n=182 codes in 2005, representing individual activities). Based on cross-cycle concordance tables, 17 groupings of codes that were comparable in 1986 and 2005 were created (Appendix Table A). On average, these groupings accounted for 92.7% of the 24-hour period in 1986 and 94.8% in 2005. The remaining time—7.3% in 1986 and 5.2% in 2005—was comprised of time for which no activity was reported or codes for which two or more individual

activities of interest were conflated (for example, "other media/communication" contained elements that fit in both "computer and television" and "less physically active leisure," which were examined separately in this analysis). The diversity of activities increased during the 20 years. Consequently, 1986 and 2005 groupings are not identical, but are as comparable as possible while still allowing for real change in how people spend their time.

Because the time-use variables were heavily skewed (positive skew with a large number of zero values), binary logistic regression with zero time spent as the reference was used. The exception was sleep, the reference category for which was the bottom tertile of the distribution of time spent. Multinomial logistic regression with time use presented as three- and four-category outcomes was also run, but the binary outcome captured the main findings. For each activity group, time use (zero, more than zero) was first regressed on sex. Time use (zero, more than zero) was then regressed on personal income and education (in the same model) for each activity group, stratified by sex. (Although three personal income categories were examined, for ease of presentation, comparisons between the highest and lowest are shown.) Stata/IC version 10.1 software was used. Appropriate sampling weights were applied in all analyses, as directed in the General Social Survey user guides.

Results

Narrowing the gender gap?

Time-use data for men and women in 1986 and 2005 convey a general sense of changes in lifestyle over the two decades (Table 1). Because the time-use groupings in the two surveys were not identical, between-survey statistical tests could not be conducted. Instead, change over time was examined, based on an arbitrary change value of 25%.

Among men, average daily time increased for household work (48 to 65 minutes), food preparation/meals at home

Table 1
Average minutes spent in 24-hour period, by activity and sex, household population aged 25 to 64, Canada excluding territories, 1986 and 2005

Activity	Men						Women					
	1986 (n=3,007)			2005 (n=6,006)			1986 (n=3,577)			2005 (n=7,513)		
	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range	Mean	SD	Range
Paid work	305.2	266.8	0 to 1,440	315.6	283.7	0 to 1,400	157.4	223.2	0 to 1,125	209.9 [†]	250.8	0 to 1,335
Commuting	30.4	45.4	0 to 690	32.9	52.5	0 to 1,080	14.8	30.7	0 to 520	21.7 [†]	42.6	0 to 1,045
Household work	47.7	103.8	0 to 975	65.2 [†]	121.5	0 to 880	88.9	108.4	0 to 750	101.2	130.0	0 to 1,260
Food preparation/Meals at home	17.2	35.5	0 to 480	27.1 [†]	40.9	0 to 570	83.8	79.6	0 to 740	56.9 [†]	60.4	0 to 990
Restaurant meals/Eating out	28.6	47.4	0 to 750	23.5	43.1	0 to 780	19.4	37.5	0 to 370	21.0	45.2	0 to 910
Shopping/Services	45.3	94.0	0 to 675	36.3	78.9	0 to 1,245	66.6	102.0	0 to 770	56.7	90.6	0 to 1,110
Caregiving	19.3	58.0	0 to 715	24.2 [†]	64.2	0 to 860	49.7	96.1	0 to 930	49.5	106.2	0 to 1,080
Civic, voluntary, religious activities	13.2	65.2	0 to 1,080	18.8 [†]	76.2	0 to 935	18.9	68.3	0 to 930	22.9	76.5	0 to 1,005
School/Education	13.8	78.0	0 to 1,005	10.1 [†]	67.3	0 to 975	14.1	71.1	0 to 855	12.6	72.3	0 to 1,075
Personal activities and care	54.2	72.4	0 to 1,440	50.3	65.2	0 to 1,080	64.8	75.3	0 to 1,440	60.5	69.6	0 to 1,035
Sleep	483.3	140.7	0 to 1,440	489.2	125.3	0 to 1,440	496.3	128.3	0 to 1,440	502.5	119.5	0 to 1,440
Socializing	51.4	111.8	0 to 810	53.7	113.2	0 to 1,065	56.7	110.7	0 to 830	58.5	112.9	0 to 1,075
Entertainment (attend)	6.0	33.2	0 to 660	7.5	45.4	0 to 745	5.6	30.2	0 to 665	7.3 [†]	42.9	0 to 845
Leisure (physically active)	19.1	64.7	0 to 793	28.0 [†]	75.3	0 to 855	9.9	36.2	0 to 660	22.5 [†]	59.1	0 to 1,075
Leisure (less physically active)	25.2	59.6	0 to 670	19.7	61.1	0 to 840	43.1	81.5	0 to 645	21.6 [†]	59.2	0 to 1,245
Television/Computer	150.6	146.3	0 to 990	146.4	147.7	0 to 1,305	122.1	126.3	0 to 885	118.6	126.5	0 to 1,410
Reading	25.7	57.1	0 to 765	16.0 [†]	44.1	0 to 540	22.5	51.6	0 to 600	21.1	52.8	0 to 900
Other	103.8	89.4	0 to 915	75.5 [†]	77.7	0 to 1,225	105.4	83.3	0 to 1,215	74.9 [†]	72.9	0 to 1,140

[†] greater than 25% increase in mean number of minutes between 1986 and 2005

[‡] greater than 25% decrease in mean number of minutes between 1986 and 2005

SD = standard deviation

Note: Mean values include those who reported zero time spent on each activity.

Source: 1986 and 2005 General Social Surveys.

Table 2
Odds ratios for women's participation in selected activities compared with men, household population aged 25 to 64, Canada excluding territories, 1986 and 2005

Activity	1986 (n=6,584)			2005 (n=13,519)		
	Odds ratio [†]	95% confidence interval		Odds ratio [†]	95% confidence interval	
		from	to		from	to
Paid work	0.35*	0.31	0.40	0.55*	0.50	0.60
Commuting	0.39*	0.35	0.45	0.58*	0.54	0.63
Household work	4.10*	3.60	4.60	2.80*	2.60	3.10
Food preparation/Meals at home	9.10*	7.80	10.60	3.00*	2.70	3.30
Restaurant meals/Eating out	0.54*	0.47	0.61	0.71*	0.65	0.78
Shopping/Services	1.80*	1.60	2.00	1.80*	1.70	2.00
Caregiving	2.60*	2.30	3.00	1.60*	1.50	1.80
Civic, voluntary, religious activities	1.80*	1.40	2.20	1.40*	1.20	1.60
School/Education	1.50*	1.20	1.90	1.50*	1.20	1.80
Personal activities and care	1.50*	1.20	1.80	1.30*	1.20	1.50
Sleep [‡]	1.40*	1.20	1.60	1.30*	1.10	1.40
Socializing	1.30*	1.20	1.50	1.30*	1.20	1.40
Entertainment (attending)	1.01	0.74	1.40	1.10	0.88	1.30
Leisure (physically active)	0.73*	0.61	0.88	1.10	0.96	1.20
Leisure (less physically active)	1.80*	1.60	2.10	1.30*	1.20	1.40
Television/Computer	0.75*	0.65	0.87	0.77*	0.70	0.85
Reading	0.95	0.83	1.10	1.30*	1.20	1.50
Other	1.20	0.77	1.80	1.10	0.92	1.20

[†] reference category is men

[‡] comparison is with bottom tertile of distribution of time spent sleeping

* significantly different from estimate for men (p < 0.01)

Source: 1986 and 2005 General Social Surveys.

(17 to 27 minutes), caregiving (19 to 24 minutes), civic/voluntary activities (13 to 19 minutes) and physically active leisure (19 to 28 minutes). Men's average time decreased for school/education (14 to 10 minutes) and reading (26 to 16 minutes). The time that men spent in paid work (305 versus 316 minutes) and commuting (30 versus 33 minutes) did not change substantially.

Over the same period, among women, average time increased for paid work (157 to 210 minutes), commuting (15 to 22 minutes) and physically active leisure (10 to 23 minutes). Women's average time decreased for food preparation/meals at home (84 to 57 minutes) and less physically active leisure (43 to 22 minutes).

Sex differences persist

Despite substantial changes in the amount of time devoted to specific activities over the 20-year period, sex differences persisted (Table 2). In both 1986 and 2005, women were significantly less likely than men to spend time in paid

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Table 3

Odds ratios relating participation in selected activities to personal income and education, by sex, household population aged 25 to 64, Canada excluding territories, 1986 and 2005

Activity (1986 time-use variable)	Higher income [†] (adjusted for education)						University degree [†] (adjusted for income)					
	1986			2005			1986			2005		
	Odds ratio	95% confidence interval from to		Odds ratio	95% confidence interval from to		Odds ratio	95% confidence interval from to		Odds ratio	95% confidence interval from to	
Paid work												
Men	3.70**	2.80	5.00	2.70**	2.20	3.20	1.20	0.83	1.60	1.00	0.85	1.20
Women	12.20**	9.10	16.30	8.30**	6.70	10.40	0.88	0.61	1.30	1.00	0.86	1.20
Commuting												
Men	3.50**	2.60	4.60	2.70**	2.20	3.20	1.20	0.90	1.70	0.88	0.75	1.04
Women	15.60**	11.40	21.40	9.30**	7.30	11.80	0.68*	0.47	0.97	0.94	0.81	1.10
Household work												
Men	0.87	0.65	1.10	1.10	0.96	1.40	1.02	0.75	1.40	0.89	0.76	1.04
Women	0.38**	0.29	0.50	0.55**	0.45	0.66	0.91	0.65	1.30	0.88	0.75	1.02
Meals at home												
Men	0.72*	0.55	0.95	0.86	0.72	1.03	1.60**	1.20	2.10	1.20	0.99	1.40
Women	0.27**	0.18	0.40	0.55**	0.45	0.69	0.70	0.43	1.10	0.92	0.78	1.10
Eating out												
Men	2.30**	1.70	3.00	2.00**	1.60	2.40	1.30	0.96	1.70	0.96	0.82	1.10
Women	6.00**	4.50	7.90	3.90**	3.10	4.80	0.95	0.68	1.30	1.10	0.91	1.20
Shopping/Services												
Men	1.10	0.83	1.50	0.91	0.75	1.10	1.90**	1.40	2.60	1.30**	1.10	1.50
Women	0.95	0.74	1.20	0.99	0.84	1.20	1.20	0.87	1.70	1.10	0.92	1.20
Caregiving												
Men	1.50*	1.05	2.00	1.50**	1.20	1.80	1.70**	1.30	2.40	1.20	0.98	1.40
Women	0.56**	0.43	0.72	0.56**	0.47	0.66	1.60**	1.20	2.30	1.30**	1.10	1.50
Civic/Voluntary												
Men	1.30	0.73	2.30	1.00	0.76	1.30	0.75	0.41	1.40	1.10	0.88	1.40
Women	0.48*	0.27	0.88	0.78*	0.62	0.96	1.80	0.89	3.80	0.80*	0.66	0.97
School/Education												
Men	0.54*	0.30	0.97	0.24**	0.15	0.39	4.60**	2.70	7.80	2.40**	1.50	3.60
Women	1.10	0.70	1.80	0.51**	0.34	0.75	2.70**	1.40	5.20	2.60**	1.90	3.50
Personal activities												
Men	1.50	0.98	2.40	1.40*	1.10	1.70	1.80*	1.10	3.10	1.10	0.88	1.40
Women	3.30**	2.00	5.30	2.00**	1.60	2.50	1.20	0.64	2.10	0.90	0.72	1.10
Sleep[‡]												
Men	0.55**	0.41	0.74	0.60**	0.50	0.74	0.87	0.64	1.20	1.10	0.94	1.30
Women	0.61**	0.47	0.81	0.52**	0.43	0.64	1.10	0.80	1.60	1.10	0.95	1.30
Socializing												
Men	0.76	0.57	1.01	0.96	0.79	1.20	0.89	0.65	1.20	0.88	0.74	1.04
Women	0.61**	0.47	0.80	0.79**	0.67	0.94	1.30	0.87	1.80	1.00	0.88	1.20
Entertainment (attend)												
Men	3.30**	1.40	7.40	1.70*	1.10	2.70	1.40	0.73	2.50	1.30	0.90	1.90
Women	1.30	0.70	2.30	1.20	0.77	1.80	0.79	0.39	1.60	1.20	0.89	1.70
Physically active leisure												
Men	0.94	0.65	1.30	1.10	0.92	1.40	1.40	0.96	2.10	1.50**	1.20	1.80
Women	0.54**	0.36	0.79	1.20	0.95	1.40	1.50	0.95	2.30	1.30**	1.10	1.60
Other leisure												
Men	0.77	0.57	1.03	0.71**	0.57	0.88	1.50*	1.10	2.00	1.30*	1.05	1.50
Women	0.56**	0.42	0.73	0.66**	0.55	0.80	1.60*	1.10	2.20	1.20	0.99	1.40
Television/Computer												
Men	0.99	0.75	1.40	0.77*	0.62	0.97	0.56**	0.41	0.78	0.87	0.72	1.10
Women	0.60**	0.46	0.78	0.80*	0.65	0.98	0.78	0.56	1.10	0.74**	0.63	0.87
Reading												
Men	1.50**	1.10	2.00	0.87	0.70	1.10	1.50**	1.10	2.10	2.30**	1.90	2.80
Women	1.04	0.79	1.40	0.91	0.75	1.10	2.00**	1.40	2.70	1.60**	1.40	1.90
Other												
Men	0.98	0.41	2.30	0.91	0.65	1.30	1.20	0.41	3.50	1.30	0.97	1.80
Women	0.17**	0.07	0.44	0.84	0.61	1.10	1.40	0.55	3.80	1.20	0.92	1.60

[†] lowest category is reference (lower-income group; less than university degree)

[‡] comparison is with bottom tertile of distribution of time spent sleeping

* significantly different from estimate for reference category (p < 0.05)

** significantly different from estimate for reference category (p < 0.01)

Notes: In 1986, of the 2,263 men, 33.6% (n=760) were in the higher-income group, 35.3% (798) were in the middle-income group (not shown), and 31.2% (n=705) were in the lower-income group; 16.2% (n=366) had a university degree or more, and 83.8% (n=1,897) had less than a university degree. Of the 2,754 women; 26.6% (n=733) were in the higher-income group, 31.6% (871) were in the middle-income group (not shown), and 41.8% (n=1,150) were in the lower-income group; 12.8% (n=351) had a university degree or more, and 87.3% (n=2,403) had less than a university degree. In 2005, of the 4,827 men, 45.6% (n=2,203) were in the higher-income group, 29.9% (n=1,445) were in the middle-income group (not shown), and 24.4% (n=1,179) were in the lower-income group; 28.1% (n=1,358) had a university degree or more, and 71.9% (n=3,469) had less than a university degree. Of the 5,842 women; 48.2% (n=2,816) were in the higher-income group, 32.8% (n=1,916) were in the middle-income group (not shown), and 19.0% (n=1,110) were in the lower-income group; 28.5% (n=1,664) had a university degree or more, and 71.5% (n=4,178) had less than a university degree.

Source: 1986 and 2005 General Social Surveys.

What is already known on this subject?

- The social gradient in body weight departs from the social gradient in other health outcomes, showing variation by sex and by aspect of socio-economic position.
- Studies of the social gradient in weight have tended to focus on health behaviours with obvious links to body weight.
- The period during which obesity prevalence has risen has been characterized by social changes that may not be captured by a narrow range of health behaviours.

What does this study add?

- Higher-income men and women were more likely than those with lower incomes to spend time in paid work, eating out and commuting, and less likely to spend time sleeping.
- Men and women with university degrees were more likely than those who were not university graduates to spend time in physical activity and reading.
- The findings demonstrate the value of adopting a broader view of lifestyle in research on the social drivers of health outcomes; time-use data offer a useful tool for this task.

work, commuting, eating out and television/computer use. They were more likely than men to spend time in household work, food preparation/meals at home, shopping/services, caregiving, civic/voluntary activities, school/education, personal activities, sleep, socializing and less physically active leisure.

While women were not as likely as men to report physically active leisure in 1986, by 2005 the difference was

not significant. And in 2005, women were more likely than men to spend time reading, a difference that was not observed in 1986.

Income and education

The results of binary logistic regression reveal several consistent associations between men's time use and their income and education (Table 3). In both 1986 and 2005, with the effects of educational attainment taken into account, higher-income men were more likely than lower-income men to spend time in paid work, commuting, eating out and attending entertainment events, and less likely to spend time sleeping. For example, the odds that higher-income men would spend time in paid work and commuting were more than three and a half times greater than the odds for lower-income men in 1986, and more than two and a half times greater in 2005. In both years, higher-income men had twice the odds of eating out, compared with lower-income men. Spending time watching television/using the computer was negatively associated with education in 1986 and with income in 2005. Physical activity was not associated with income or education for men in 1986, but was positively associated with education in 2005.

Consistencies over the 20-years period were also evident among women (Table 3). In 1986 and 2005, higher-income women were significantly more likely than lower-income women to spend time in paid work, commuting, eating out and personal activities, and less likely to spend time sleeping, doing household work, meals at home and socializing, with level of education taken into account. For example, in 1986, higher-income women's odds of spending time in paid work were 12 times greater than those of lower-income women, and in 2005, 8 times greater. Similarly, the odds of commuting among higher-income women were more than 15 times as great as the odds for lower-income women in 1986, and about 9 times greater in 2005. As well, the odds that higher-income women would spend time eating

out were 6 times those of lower-income women in 1986, and 4 times greater in 2005. In both years, women's odds of spending time caregiving were positively associated with education and negatively associated with income. Women's odds of spending time reading were positively associated with education (but not income) in 1986 and 2005. Their odds of watching television/using the computer were negatively associated with income in both 1986 and 2005, and with education in 2005. Spending time in physically active leisure was negatively associated with women's income in 1986, but positively associated with their education in 2005.

Discussion

This analysis examines how women and men spent their time in 1986 and 2005, by personal income and education, in order to detect lifestyle patterns that may contribute to understanding the social gradient of body weight.

A comparison of 1986 and 2005 data reveals that the gender division in time use was tempered somewhat by change over time. For instance, although men continued to spend more time in paid work and commuting than did women in 2005, the time women spent in these activities had increased substantially since 1986. And while women continued to devote more time to domestic activities than did men in 2005, the time men spent in these activities increased. These results are in line with other studies reporting that the gender division in domestic (unpaid) versus paid work—though not eliminated—may be narrowing.^{34,35} Sex differences in the prevalence of obesity in Canada have also narrowed over the past 15 to 20 years;²⁸ whether these trends are causally related is a topic for further exploration.

Overall, the amount of physically active leisure time increased among both sexes between 1986 and 2005, consistent with other reports.^{36,37} This would appear to be contrary to recent increases in the prevalence of obesity.⁶ Other studies, however, have acknowledged the

equivocal nature of the association,²⁹ noting, for instance, that leisure-time physical activity is only one aspect of overall energy expenditure.³⁸

Other plausible factors contributing to the upturn in obesity prevalence are an increase in the number of meals eaten in restaurants (which tend to be higher in calories than meals prepared at home³⁹) and a decrease in sleep.²⁹ The General Social Survey time-use data in this study, however, do not show such patterns across the sample as a whole, nor did an earlier analysis of these data that looked specifically at sleep.⁴⁰ It is possible that changes in these behaviours occurred, but the methods used in this analysis failed to pick them up. It is also possible that patterns in these activities by socio-economic characteristics are more important than results for the sample as a whole.

In fact, the binary logistic regression results in this analysis lend support to that possibility. In both years, higher-income men were more likely than lower-income men to spend time in paid work, commuting and eating out, and less likely to spend time sleeping. This time-use profile of higher-income men may help explain the positive association between income and BMI that has been observed for men in Canada.^{6,13,17,28} Such activities could promote weight gain through time trade-offs⁴¹ (for example, more time at work leaves less time for physical activity), higher calorie intake (if home-prepared meals are replaced by restaurant meals), and biological pathways associated with less sleep. In the context of Bourdieu's concept of *habitus*, larger body size for a higher-income man may reflect an array of bio-behavioural and social pathways, including a lifestyle in which activities outside the home predominate and a society that values physical presence in men.

The time-use pattern that emerges for higher-income women is similar to that for higher-income men in terms of paid work, commuting, eating out and sleeping. However, in contrast to the positive income-obesity association

among men, the association among women appears to be curvilinear.^{6,7} If the high-income lifestyle does, indeed, promote weight gain among men, why and how are women protected?

The disparity may be attributable to gender differences in the physical characteristics that are considered desirable.⁸ Because this analysis is based on personal (rather than household) income, the high-income women in the sample would mainly work outside the home. Compared with other women, they may be exposed to different norms with regard to weight, notably, implicit or explicit promotion of thinness.^{25,26} If these normative effects are opposite in direction to those for men,⁸ this may help explain why a comparable lifestyle profile yields different weight outcomes for high-income men and women. As well, the time-use data show that higher-income women were more likely than lower-income women to spend time in personal activities (for example, resting/relaxation and personal grooming), a difference that was not observed as consistently among men. Time spent on these activities may indicate greater concern about appearance.

For both sexes, education was positively associated with physically active leisure time (in 2005) and with reading in both years. Physical activity is consistent with, and may contribute to, lower obesity in men and women with higher education.^{6,8} That these associations were more clear-cut in 2005 than in 1986 echoes recent data that show widening gaps in physical activity by educational attainment.⁴² And although reading is physically inactive, it may be less conducive to weight gain than other sedentary leisure pursuits.⁴³ In relation to Bourdieu's concept of *habitus*, a portrait emerges of the educated adult as one for whom a slimmer body plausibly reflects an array of biological, behavioural, psychological and social pathways. These pathways might include a lifestyle characterized by physical activity and educational/cultural pursuits, and a resulting sense of control and empowerment. This, in turn, may

heighten the desire for and capacity to achieve well-being and a healthy weight within a social milieu where thinness, especially among women, is valued.

Limitations

The primary limitation of this study is the absence of data on body weight in the 1986 and 2005 General Social Survey. Nonetheless, the survey has other advantages: the ability to study a much broader array of daily activities than has been examined in earlier studies, and compared with other self-reported data, greater measurement validity for the assessment of behaviours.^{32,33}

The study focuses on individuals, which is contrary to recommendations that household units be studied when examining time use.^{34,44} Nonetheless, the findings are similar to those reported for dual-earner families,³⁴ which lends support to their validity.

Conclusion

The time-use data in this analysis provide a starting point for a holistic exploration of class, lifestyle and weight and demonstrate the value of adopting a broader view of lifestyle in research on the social drivers of health outcomes. The time-use patterns that emerge plausibly contribute to the social gradient in obesity reported in other Canadian studies. The results illustrate the benefits of looking beyond a narrow range of health behaviours toward broader measures of daily routines to gain insight into the social determinants of weight and health. ■

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Appendix

Table A
Derived time-use variables: groupings, examples of constituent items, and examples of possible pathways linking activity with body weight

Derived time-use variable	Examples of constituent items	Examples of possible pathways linking activity with body weight
Paid work	<ul style="list-style-type: none"> work for pay overtime 	<ul style="list-style-type: none"> physical (in)exertion psycho-social stress social norms
Commuting	<ul style="list-style-type: none"> travel to/from work (one item only) 	<ul style="list-style-type: none"> physical (in)exertion
Household work	<ul style="list-style-type: none"> dusting/vacuuming laundry outdoor cleaning 	<ul style="list-style-type: none"> physical exertion
Food preparation/Meals at home	<ul style="list-style-type: none"> meal preparation food/meal cleanup 	<ul style="list-style-type: none"> caloric intake
Restaurant meals/Eating out	<ul style="list-style-type: none"> restaurant meals meals/snacks at work 	<ul style="list-style-type: none"> caloric intake
Shopping/Services	<ul style="list-style-type: none"> everyday shopping (for example, food, clothing) personal care (for example, hairdresser) 	<ul style="list-style-type: none"> caloric intake physical (in)exertion
Caregiving	<ul style="list-style-type: none"> baby/child care care of household adults 	<ul style="list-style-type: none"> physical exertion psycho-social stress
Civic, voluntary, religious activities	<ul style="list-style-type: none"> child/youth/family organization fraternal/social organization political/civic activities 	<ul style="list-style-type: none"> psycho-social stress social norms
School/Education	<ul style="list-style-type: none"> full-time classes special/occasional lectures homework 	<ul style="list-style-type: none"> physical (in)exertion psycho-social stress social norms
Personal activities and care	<ul style="list-style-type: none"> washing, dressing resting, relaxing 	<ul style="list-style-type: none"> psycho-social stress other biological pathways
Sleep	<ul style="list-style-type: none"> essential sleep naps, incidental sleep 	<ul style="list-style-type: none"> other biological pathways
Socializing	<ul style="list-style-type: none"> socializing (private residence) socializing (bars, clubs) 	<ul style="list-style-type: none"> psycho-social stress caloric intake social norms
Entertainment (attend)	<ul style="list-style-type: none"> sports events pop music, concerts museums, art galleries 	<ul style="list-style-type: none"> psycho-social stress physical (in)exertion
Leisure (physically active)	<ul style="list-style-type: none"> sports (football, tennis) walk/hike physical exercise (yoga, aerobics) 	<ul style="list-style-type: none"> physical exertion
Leisure (less physically active)	<ul style="list-style-type: none"> hobbies, crafts playing music 	<ul style="list-style-type: none"> psycho-social stress physical in exertion
Television/Computer	<ul style="list-style-type: none"> video games surfing the web/e-mail watching TV 	<ul style="list-style-type: none"> physical in exertion caloric intake
Reading	<ul style="list-style-type: none"> reading books reading magazines, newspapers 	<ul style="list-style-type: none"> physical in exertion
Other	<ul style="list-style-type: none"> no activity reported codes overlap two or more above groupings 	<ul style="list-style-type: none"> not applicable

Source: 1986 and 2005 General Social Survey.

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Smokers' use of acute care hospitals—A prospective study

by Kathryn Wilkins, Margot Shields and Michelle Rotermann

Abstract

Background

Previous Canadian estimates of hospital use by smoking history have been derived by applying disease-specific "smoking-attributable fractions" to administrative data. For this analysis, health survey data were linked to hospitalization data at an individual level, permitting prospective measures of hospital use by smoking status and age.

Data and methods

Data for 28,255 respondents (outside Quebec) to the 2000/2001 Canadian Community Health Survey (CCHS) were linked to the Hospital Person-Oriented Information Database. Days in hospital over four years were quantified for each respondent and examined in relation to smoking status in 2000/2001. Multiple logistic regression was used to examine the association between smoking and hospitalization, while controlling for confounders.

Results

During the four years after their CCHS interview, current daily smokers and former daily smokers who had quit in the past five years averaged more than twice as many days in hospital as did never-daily smokers. Altogether, excess hospital days for current and former smokers aged 45 to 74 numbered 7.1 million over four years, and accounted for 32% of all hospital days used by people in this age group.

Keywords

health surveys, medical record linkage, risk factors

Authors

Kathryn Wilkins (613-951-1769; kathryn.wilkins@statcan.gc.ca), Margot Shields (613-951-4177; margot.shields@statcan.gc.ca), and Michelle Rotermann (613-951-3166; michelle.rotermann@statcan.gc.ca) are with the Health Analysis Division at Statistics Canada, Ottawa, Ontario K1A 0T6.

Hospital care for smoking-related illnesses constitutes an important part of the health care burden. However, because hospital administrative records contain only limited information, quantifying hospital use according to patients' personal characteristics is challenging. For example, although smoking may have contributed to the illness for which a person is hospitalized, no information on smoking history is captured in the administrative discharge abstract.

An indirect method of assessing the impact of smoking on hospital use has been to apply the "attributable fraction" for diseases that have been shown to be etiologically associated with smoking. The attributable fraction is the proportion by which the incidence of a disease would be reduced in the population if smoking were eliminated. Smoking-attributable days in hospital are calculated by multiplying each disease- and age-specific fraction (based on the literature) by the total number of hospital days for that disease. Since the early 1980s, studies in Canada and elsewhere have employed this approach to estimate health care use associated with smoking.¹⁻⁶

Estimates derived from the attributable-fraction approach are limited in several ways. First, calculations are based on disease-specific risk estimates in the literature, so their precision

depends on the quality of the underlying evidence. Second, the attributable-fraction approach does not include conditions for which there is currently insufficient understanding of their true association with smoking. Third, this approach does not cover smokers' higher risks of complications after surgery and slower recovery time.⁷⁻¹⁵

A more accurate technique for quantifying smoking-related hospital use involves the collection of baseline data from a cohort, and monitoring their hospital use over a period of time. Few studies have employed this method, probably because of the considerable resources required for follow-up.^{16,17} A similar, but less expensive, method entails linking survey data from a specified baseline year with administrative data covering a subsequent follow-up period.¹⁸⁻²⁰ Recent linkage of health

survey data to hospital administrative data offers an opportunity to study the association between smoking status and use of acute care hospitals in Canada.

The objective of this study was to quantify the likelihood of hospitalization, and estimate time spent in hospital, according to smoking status. The study is based on a sample of respondents aged 45 to 74 to the 2000/2001 Canadian Community Health Survey, whose hospitalization experience was monitored prospectively for four years through linkage of the survey data with the Hospital Person-Oriented Information database.

Methods

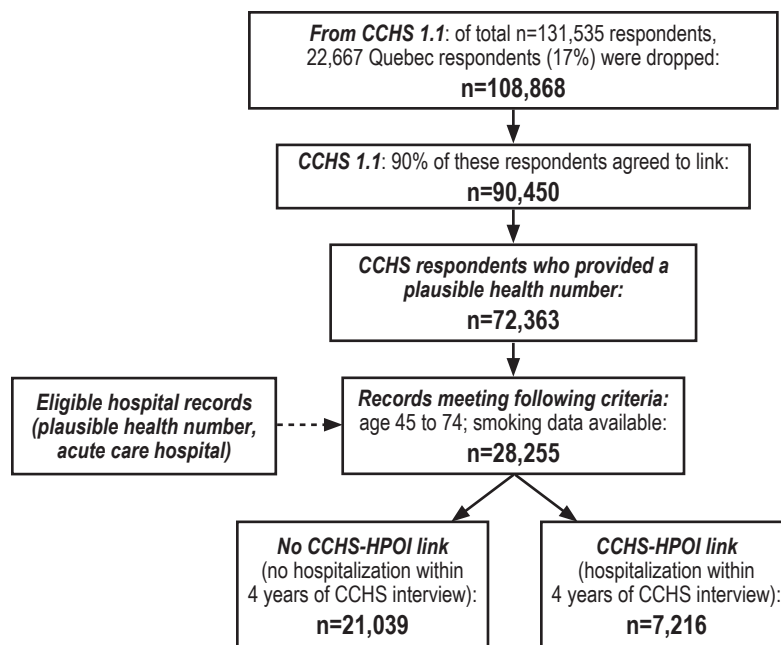
Data source

Canadian Community Health Survey

Data on smoking and other personal characteristics are from the 2000/2001 Canadian Community Health Survey (CCHS). The survey collects cross-sectional information about the health of Canadians on an ongoing basis. It covers the non-institutionalized household population aged 12 or older in all provinces and territories, except members of the regular Canadian Forces and residents of Indian reserves, of Canadian Forces bases (military and civilian) and of some remote areas. A description of the methodology has been previously reported.²¹

The overall response rate to the 2000/2001 CCHS was 85%; the total sample numbered 131,535. Insufficient information was available in the hospital data for Quebec residents' records to be linked (see *Hospitalization data*); therefore, the 22,667 (17%) CCHS respondents in Quebec were dropped. Of the 108,868 respondents who remained, 90,450 had given permission for their survey data to be linked to administrative data. Check-digit algorithms were used to verify the plausibility of the health numbers they provided; 72,363 provided a plausible health number. Respondents aged 45 to 74 numbered 28,288, but data on smoking status were not available for 33 of them (Figure 1). Approximately

Figure 1
Creation of analysis file



Source: 2000/2001 Canadian Community Health Survey (CCHS) and 2000-2005 Hospital Person-Oriented Information (HPOI).

half of them had been surveyed by telephone, and the other half, in person (data not shown).

Survey weights were produced by Statistics Canada to adjust for non-response to the CCHS, as well as for the exclusion of records of respondents who did not provide plausible health numbers or give permission for linkage to administrative health data. These weights were applied to the analysis file; the weighted data were representative of the Canadian household population residing outside Quebec.

Hospitalization data

Statistics Canada's Hospital Person-Oriented Information database (HPOI) is a person-level dataset derived from discharge records of inpatients in most of the acute care hospitals and some psychiatric, chronic and rehabilitation hospitals across Canada.²² The discharge records contain demographic (for example, date of birth, postal code), administrative (health number, admission and separation dates) and clinical information,²³ and are compiled

into the Hospital Morbidity Database by the Canadian Institute for Health Information.²⁴ During processing at Statistics Canada, about 3% of Hospital Morbidity Database records for patients aged 12 or older were excluded because of missing or invalid health numbers.²² Because this analysis was restricted to records for hospitalizations in acute care hospitals, a further 2% of records from non-acute care institutions were excluded.

After processing to ensure the consistency of demographic information among records assumed to pertain to the same person, two stages of linkage were carried out. First, HPOI records were created by linking records for the same patient, based on health number, postal code and date of birth. Probabilistic linkage routines were then used to match the CCHS with HPOI records.

A recently published evaluation of the linkage between the CCHS and HPOI reported high coverage for the population younger than age 75. The estimated number of people aged 12

to 74 who were hospitalized, based on the number of CCHS records that were matched to HPOI records, was 96.4% of the number hospitalized according to HPOI records alone.²⁵ To further assess the comparability of the linked file with the original CCHS file (excluding Quebec respondents, but including respondents who did not give permission for linkage), the population distribution by smoking status (percentage who are current smokers, never-smokers, former smokers who quit within five years, former smokers who quit for more than five years) was compared between the two files; the distributions were nearly identical (data not shown).

CCHS interviews were conducted from September 1, 2000 until November 3, 2001. Starting from the date of the CCHS interview, HPOI records were searched prospectively for four years (1,462 days) for each respondent. Thus, in theory, each respondent had an equal period of eligibility for hospitalization. Censoring before the end of the four-year period because of events such as death or moving out of the province could not be accounted for because information about these events was not available or incomplete. However, it was expected that such occurrences would be relatively rare in the age group studied and would have a minimal effect on the results of the analysis. Probabilistic linkage of the 28,288 CCHS records to HPOI records yielded 7,229 matches, indicating that 26% of CCHS respondents outside Quebec had been hospitalized at least once during the four-year follow-up. No matching HPOI records within the four-year follow-up were found for the remaining 21,059 respondents, who were, therefore, categorized as not having been hospitalized. No information on smoking status was available for 13 of those who had been hospitalized and for 20 of those who had not. These records were deleted, yielding final samples of 7,216 and 21,039, respectively.

Analytical techniques

Frequencies, cross-tabulations and means were employed to estimate

smoking prevalence, the proportions of persons hospitalized, and hospital days used. All tabulations were produced by age group, and all computations were carried out with weighted data. Variance on estimates was calculated with the bootstrap technique to account for the complex design of the survey.^{26,27}

Preliminary analysis revealed that relatively few (7%) CCHS respondents aged 75 or older were current daily smokers. As well, for the population aged 75 or older, correspondence between the CCHS and HPOI is substantially lower than for younger people—largely because the CCHS does not cover the institutionalized population.²⁵ Therefore, the analysis excluded people aged 75 or older.

Four multiple logistic regression models were fitted to assess the association between smoking status (as ascertained during the CCHS interview) and the odds of hospitalization, while controlling for potential confounders. The first model contained control variables for age and sex; to that model were added variables reflecting socio-economic status (Model 2), urban/rural residence (Model 3), and physician consultations, leisure-time physical activity, body mass index and level of alcohol consumption (Model 4). To maximize sample size, variables for missing values on household income, leisure-time physical activity and body mass index were included. Cox proportional hazards regression, useful in assessing time-to-first-event, was also considered as a means of studying this association. However, because time-to-hospitalization was unrelated to the purpose of the regression (to assess the possible influence of socio-economic status and other risk factors on the association between smoking and hospitalization), logistic regression was considered an appropriate approach.

Definitions

Respondents were assigned to one of four categories, based on daily smoking: current daily smoker; former daily smoker who quit sometime in the five years before the date of the CCHS

interview (recent quitters); former daily smoker who quit more than five years before the date of the interview (long-term quitters); and never a daily smoker.

To be consistent with low-risk drinking guidelines,²⁸ seven categories of alcohol consumption were specified: weekly binge (at least five drinks in one occasion, at least once a week during past year); heavy (ten drinks or more in past week for women; fifteen or more for men); moderate (two to nine drinks in past week for women; two to fourteen for men); light (one drink in past week); occasional (at least one drink in past year, but none in past week); former (at least one drink in lifetime, but none in past year); and lifetime abstainer.

Household income groups were derived by calculating the ratio between total household income from all sources in the previous 12 months and Statistics Canada's low-income cut-off specific to the number of people in the household, the size of the community, and the survey year. These adjusted income ratios were sorted and grouped into within-province quintiles (five groups, each containing one-fifth of the population in each province).

Days in hospital were calculated by summing the lengths of stay for each hospitalized CCHS respondent; totals were cross-tabulated by age group and smoking status category. Respondents categorized as not having been hospitalized were included and counted as contributing zero days.

The average number of days in hospital was calculated by dividing the weighted total number of days for each age group and smoking category by the corresponding weighted population count. For each age group and smoking category, the average number of excess hospital days was calculated by subtracting the average number of days for never-smokers from the corresponding average number of days for each smoking category. Then the total number of excess days in hospital was calculated by multiplying the average number of excess days in each age group and smoking category by the population

in each of these groups. Finally, the percentage of all days in hospital that were excess days was calculated by dividing the number of excess days by the number of total days. All estimates were produced for each age group and smoking category.

Results

Of Canadians (minus Quebec residents) aged 45 to 74 in 2000/2001, an estimated 19% were current daily smokers; 6% were former daily smokers who had quit in the past five years (recent quitter); 30% were former daily smokers who had quit for more than five years (long-term quitter); and 44% had never smoked daily (Table 1). The percentage of current daily smokers in the 45-to-54 age group was higher than in the older age groups.

Over the subsequent four-year period, 14% of people aged 45 to 54

were hospitalized—a figure that rose in successively older age groups to 35% of 65- to 74-year-olds (Table 2). When smoking status was considered, the likelihood of hospitalization during the four years ranged from a low of 12% of never-smokers aged 45 to 54 to a high of 43% of 65- to 74-year-olds who were current daily smokers or recent quitters.

In each age group, the percentage of current daily smokers who were hospitalized substantially exceeded the percentage among those who had never smoked daily. In all age groups, recent quitters were also significantly more likely to have been hospitalized than were people who had never smoked daily. This pattern held for long-term quitters except at ages 55 to 64: the percentage of long-term quitters hospitalized was not statistically different from the percentage for people who had never smoked daily.

Adjusted for age and sex, the odds of hospitalization for current daily smokers were 80% higher than those for never daily smokers (Table 3, Model 1). The odds ratios for former daily smokers were also significantly elevated, at 1.6 for recent quitters, and 1.3 for long-term quitters. Even as other control variables were added (level of education and income in Model 2; urban/rural residence in Model 3; and family doctor consultation, level of leisure-time physical activity, body mass index category and level of alcohol consumption in Model 4), the odds ratios for all smoking categories remained at nearly the same levels.

More hospital days

The time current and former daily smokers spent in hospital was disproportionate to their share of the population. Current daily smokers aged 45 to 74 accounted for 19% of the population in that age

Table 1
Smoking status, by age group, household population aged 45 to 74, Canada excluding Quebec, 2000/2001

Age group	Current daily smoker				Recent quitter (5 or fewer years)				Long-term quitter (more than 5 years)				Never smoked daily			
	Estimated number '000	%	95% confidence interval		Estimated number '000	%	95% confidence interval		Estimated number '000	%	95% confidence interval		Estimated number '000	%	95% confidence interval	
			from	to			from	to			from	to			from	to
Total 45 to 74	1,361.8	19.4	18.7	20.1	444.1	6.3	5.9	6.7	2,098.9	29.9	29.1	30.8	3107.9	44.3	43.4	45.3
45 to 54	783.1	23.2	22.1	24.3	227.4	6.7	6.1	7.4	839.9	24.9	23.6	26.1	1525.0	45.2	43.7	46.7
55 to 64	388.0	19.0*	17.7	20.3	129.3	6.3	5.6	7.0	663.2	32.5*	31.0	33.9	861.8	42.2*	40.5	43.9
65 to 74	190.7	12.0*	10.9	13.0	87.4	5.5*	4.7	6.3	595.8	37.4*	35.7	39.0	721.1	45.2	43.4	47.0

* significantly different from estimate for ages 45-54 ($p < 0.05$)

Note: Estimates are based on a sample of 28,255 respondents to 2000/2001 Canadian Community Health Survey.

Source: 2000/2001 Canadian Community Health Survey.

Table 2
Percentage hospitalized over subsequent four years, by age group and smoking status, household population aged 45 to 74 in 2000/2001, Canada excluding Quebec

Age group	Total			Current daily smoker			Recent quitter (5 or fewer years)			Long-term quitter (more than 5 years)			Never smoked daily		
	%	95% confidence interval		%	95% confidence interval		%	95% confidence interval		%	95% confidence interval		%	95% confidence interval	
		from	to		from	to		from	to		from	to		from	to
45 to 54	14.4	13.4	15.4	18.6*	16.6	20.6	17.6*	13.5	21.7	14.8*	12.5	17.1	11.6	10.4	12.9
55 to 64	23.1	21.7	24.5	28.7*	25.2	32.1	27.1*	22.0	32.1	22.9	20.5	25.3	20.1	17.9	22.4
65 to 74	35.1	33.3	36.9	43.1*	38.6	47.6	42.6*	35.8	49.4	38.2*	35.6	40.9	29.5	26.8	32.2

* significantly different from estimate for "never smoked daily" ($p < 0.05$)

Source: 2000/2001 Canadian Community Health Survey linked to 2000-2005 Hospital Person-Oriented Information.

Table 3
Adjusted odds ratios relating smoking status to hospitalization over subsequent four years, controlling for selected characteristics, household population aged 45 to 74 in 2000/2001, Canada excluding Quebec

	Model 1			Model 2			Model 3			Model 4		
	Adjusted odds ratio	95% confidence interval from to		Adjusted odds ratio	95% confidence interval from to		Adjusted odds ratio	95% confidence interval from to		Adjusted odds ratio	95% confidence interval from to	
Smoking status												
Current daily	1.8*	1.6	2.0	1.6*	1.5	1.9	1.6*	1.4	1.8	1.7*	1.5	1.9
Recent quitter (5 or fewer years)	1.6*	1.4	2.0	1.6*	1.3	1.9	1.6*	1.3	1.9	1.5*	1.3	1.8
Long-term quitter (more than 5 years)	1.3*	1.2	1.5	1.3*	1.2	1.5	1.3*	1.2	1.4	1.3*	1.2	1.5
Never smoked daily†	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...
Age (continuous)												
	1.1*	1.1	1.1	1.1*	1.1	1.1	1.1*	1.1	1.1	1.1*	1.1	1.1
Sex												
Men	1.0	0.9	1.1	1.1	1.0	1.2	1.1	1.0	1.2	1.2*	1.0	1.3
Women†	1.0	...	...	1.0	...	...	1.0	...	...	1.0	...	...
Education												
Less than secondary graduation	1.2*	1.0	1.3	1.1	1.0	1.2	1.0	0.9	1.1
Secondary graduation	1.0	0.9	1.2	1.0	0.9	1.2	1.0	0.9	1.2
Some postsecondary	1.2	1.0	1.4	1.2	1.0	1.4	1.2	1.0	1.4
Postsecondary graduation†	1.0	...	...	1.0	...	...	1.0	...	...
Household income quintile												
1 (lowest)	1.5*	1.3	1.8	1.6*	1.4	1.9	1.4*	1.2	1.7
2	1.3*	1.1	1.5	1.3*	1.1	1.5	1.2	1.0	1.4
3	1.0	0.9	1.2	1.1	0.9	1.2	1.0	0.9	1.2
4	1.1	1.0	1.3	1.2*	1.0	1.3	1.1	1.0	1.3
5 (highest)†	1.0	...	...	1.0	...	...	1.0	...	...
Urban/Rural residence												
Census Metropolitan Area (CMA)†	1.0	...	...	1.0	...	...
Non-CMA: urban	1.4*	1.3	1.6	1.4*	1.3	1.6
Non-CMA: rural	1.3*	1.2	1.5	1.3*	1.2	1.5
Consulted family doctor/general practitioner in past 12 months												
Yes	1.8*	1.5	2.1
No†	1.0	...	...
Leisure-time physical activity level												
Active (3 or more KKD)†	1.0	...	...
Moderately active (1.5 to 2.9 KKD)	1.0	0.9	1.2
Inactive (Less than 1.5 KKD)	1.3*	1.2	1.5
BMI category (range kg/m²)												
Underweight (less than 18.5)	1.4*	1.0	1.9
Normal weight (18.5 to 24.9)†	1.0	...	...
Overweight (25.0 to 29.9)	1.1	1.0	1.2
Obese Class I (30.0 to 34.9)	1.2*	1.1	1.4
Obese Class II (35.0 to 39.9)	1.7*	1.3	2.3
Obese Class III (40.0 or more)	1.8*	1.3	2.6
Level of alcohol consumption												
Weekly binge drinker	1.0	0.8	1.3
Heavy last week	0.8	0.7	1.1
Moderate last week†	1.0	...	...
Light last week	1.2*	1.0	1.5
Occasional drinker	1.3*	1.1	1.4
Former drinker	1.5*	1.3	1.7
Lifetime abstainer	1.3	1.0	1.6

† reference category

* significantly different from reference category (p < 0.05)

... not applicable

KKD: kilocalories per kilogram per day

Source: 2000/2001 Canadian Community Health Survey linked to 2000-2005 Hospital Person-Oriented Information.

range in 2000/2001, but they used 29% of hospital days for that age group (Table 4). Recent quitters constituted 6% of the population, but accounted for 10% of hospital days. Long-term quitters used a percentage of hospital days (32%) that more closely reflected their share of the population (30%). Finally, people who had never smoked daily made up 44% of the population, but used 30% of hospital days.

The mean number of days in hospital per person (including those who were not hospitalized during the study period) was significantly higher for current daily smokers than for people who had never smoked daily. In each age group, the

average for current daily smokers was more than double that for never-daily smokers (Table 5). Recent quitters also averaged significantly more days in hospital, compared with never-daily smokers.

For long-term quitters aged 45 to 64, average days in hospital did not statistically exceed averages for never-daily smokers. However, average days in hospital for long-term quitters aged 65 to 74 (6.8 days) significantly surpassed the average for never-daily smokers in this age group (4.3 days).

Current daily smokers' average number of *excess* hospital days ranged from 1.5 days at ages 45 to 54 to 6.0 days

at ages 65 to 74. Recent quitters' excess days averaged 0.9 at ages 45 to 54, 2.6 at ages 55 to 64, and 8.4 days at ages 65 to 74. For long-term quitters, average excess days at ages 45 to 64 did not differ significantly from zero; those aged 65 to 74 averaged 2.6 excess days, which was significantly lower than the average of 8.4 excess days for recent quitters.

In total, current and former daily smokers aged 45 to 74 used an excess of 7.1 million hospital days over the four-year study period, which accounted for nearly one-third (32%) of all days spent in hospital by people these ages (Table 6). This proportion was consistent in all three age groups. When the analysis

Table 4
Number of days and percentage distribution of days in hospital over subsequent four years, by age group and smoking status, household population aged 45 to 74 in 2000/2001, Canada excluding Quebec

Age group	Total estimated number of hospital days '000	Current daily smoker				Recent quitter (5 or fewer years)				Long-term quitter (more than 5 years)				Never smoked daily			
		Estimated number of hospital days '000	Percent of			Estimated number of hospital days '000	Percent of			Estimated number of hospital days '000	Percent of			Estimated number of hospital days '000	Percent of		
			hospital days	age group [†]	age group [†]		hospital days	age group [†]	age group [†]		hospital days	age group [†]	age group [†]		hospital days	age group [†]	age group [†]
Total 45 to 74	21,853.5	6,250.7	28.6	19.4	2,164.9	9.9	6.3	6,892.6	31.5	29.9	6,545.3	30.0	44.3				
45 to 54	5,060.1	1,999.2	39.5	23.2	430.1	8.5	6.7	1,062.4	21.0	24.9	1,568.4	31.0	45.2				
55 to 64	6,558.8	2,298.6	35.0	19.0	622.5	9.5	6.3	1,753.3	26.7	32.5	1,884.4	28.7	42.2				
65 to 74	10,234.6	1,952.9	19.1	12.0	1,112.3	10.9	5.5	4,076.9	39.8	37.4	3,092.6	30.2	45.2				

[†] shown to facilitate comparisons between percentage of people comprised by age group and percentage of hospital days used

Source: 2000/2001 Canadian Community Health Survey linked to 2000-2005 Hospital Person-Oriented Information.

Table 5
Average number of days and excess days hospitalized over subsequent four years, by age group and smoking status, household population aged 45 to 74 in 2000/2001, Canada excluding Quebec

Age group	Current daily smoker			Recent quitter (5 or fewer years)			Long-term quitter (more than 5 years)			Never smoked daily		
	%	95% confidence interval		%	95% confidence interval		%	95% confidence interval		%	95% confidence interval	
		from	to		from	to		from	to		from	to
Average number of days in hospital over four years												
45 to 54	2.6*	2.0	3.1	1.9*	1.1	2.6	1.3	0.9	1.6	1.0	0.8	1.3
55 to 64	5.9*	3.9	7.9	4.8*	3.2	6.4	2.6	2.2	3.1	2.2	1.7	2.6
65 to 74	10.2*	8.0	12.5	12.7*	8.4	17.1	6.8*	6.0	7.7	4.3	3.6	5.0
Average number of excess[†] days in hospital over four years among current and former daily smokers												
45 to 54	1.5	0.9	2.2	0.9	0.1	1.7	0.2	-0.2	0.7	...	...	...
55 to 64	3.7	1.7	5.8	2.6	1.0	4.3	0.5	-0.2	1.1	...	...	...
65 to 74	6.0	3.6	8.3	8.4	4.0	12.9	2.6	1.4	3.7	...	...	...

* significantly different from estimate for "never smoked daily" (p < 0.05)

[†] calculated by subtracting estimate for "never smoked daily" from total average number of days for corresponding age group; detail may not add to total because of rounding

... not applicable

Note: Average number of days in hospital is based on total population (including those not hospitalized).

Source: 2000/2001 Canadian Community Health Survey linked to 2000-2005 Hospital Person-Oriented Information.

Table 6
Number of excess days[†] hospitalized over subsequent four years, by age group and smoking status, household population aged 45 to 74 in 2000/2001, Canada excluding Quebec

	Current daily smoker	Recent quitter (5 or fewer years)	Long-term quitter (more than 5 years)	Total current daily and former daily smoker	% [‡]
	Estimated number '000	Estimated number '000	Estimated number '000	Estimated number '000	
Total 45 to 74	3,779.0	1,273.6	2,023.6	7,076.2	32.4
45 to 54	1,193.8	196.2	198.6	1,588.6	31.4
55 to 64	1,450.2	339.7	303.1	2,093.0	31.9
65 to 74	1,135.1	737.6	1,521.9	3,394.6	33.2

[†] average number of excess days (Table 5) multiplied by number of people in corresponding age group and smoking category (Table 1)

[‡] calculated by dividing number of excess days by total number of days (Table 4)

Source: 2000/2001 Canadian Community Health Survey linked to 2000-2005 Hospital Person-Oriented Information.

was repeated for the sexes separately, the excess was 36% of all days for men, and 28% of all days for women (data not shown).

Discussion

For the first time, population-based estimates of acute care hospital use in Canada (excluding Quebec) in relation to the smoking status of patients have been prospectively estimated—using linked survey and administrative data. The results indicate that excess days spent in hospital by current and former daily smokers aged 45 to 74 account for nearly one-third of all days spent in hospital by people in this age range. Furthermore, the elevated likelihood of hospitalization for current and former smokers is not explained by other characteristics, including socio-economic status.

The relatively lower averages of excess hospital days for former daily smokers who had quit more than five years before their CCHS interview underscores the benefit of long-term cessation. This finding is consistent with research reported by the United States Surgeon General showing improvements in mortality risk with time since quitting.²⁹

A previous study reported increases in hospital admissions for former smokers during the year in which they quit, leading the investigators to speculate that the onset of illness may have motivated their quitting.³⁰ This may explain the high

average number of excess hospital days for quitters of five years or less in the 65 to 74 age group in the current study.

Previous Canadian studies of various smoking-related outcomes (for example, health care use, direct and indirect costs, and mortality) have been based on the attributable-fraction methodology, making comparisons with the current study problematic.^{2,3,6} The aim of the current study was to quantify hospital use according to the patient's smoking status, without regard to the age-specific, smoking-attributable fraction of the patient's diagnosis.

Comparisons with studies from other countries based on methodology similar to the current study are also limited—by differences in study endpoints, smoking prevalence, and follow-up time. For example, in a 16-year follow-up of a nationally representative cohort in Finland, male smokers used 70% more hospital days, and female smokers, 49% more, than did never smokers.¹⁷ In a 30-month prospective study in Japan, the per capita cost of hospital inpatient care was 33% higher for male smokers, compared with non-smokers, but did not differ among females.¹⁶ In Scotland, the odds of hospitalization for a cohort followed for 7.5 years were significantly higher for smokers and former smokers.¹⁹ Despite the variety of methodological approaches among studies, the consistent finding is that smoking is a factor in an appreciable proportion of hospital care.

What is already known on this subject?

- Smoking causes a variety of diseases and premature death.
- Previous Canadian estimates of smoking-related hospital days—derived from applying disease-specific risk estimates to administrative data—have indicated that smoking accounts for a substantial share of acute care.

What does this study add?

- With population-based survey data linked to hospitalization data, acute care hospital use by smoking status has been prospectively estimated for the cohort of respondents (except those in Quebec) to the 2000/2001 Canadian Community Health Survey.
- Smokers and former smokers had higher odds of hospitalization, even when controlling for influences other than smoking.
- Former smokers aged 45 to 64 who had quit for more than five years averaged no more days in hospital than did never-daily smokers.
- Compared with never-daily smokers, excess days used by current daily and former daily smokers aged 45 to 74 amounted to nearly one-third of all acute care hospital days used by the population in this age range.

Limitations

An important limitation of this study is the exclusion of residents of Quebec, where the prevalence of smoking was higher in 2000/2001.³¹ Exclusion of the institutionalized and on-reserve populations further added to the undercounting of hospital days used. Although CCHS respondents for whom a valid health number was not available and those who did not give permission to

link their survey data with administrative data were also omitted, Statistics Canada produced special survey weights to adjust for these exclusions.

The hospital care received by smokers is underestimated in this analysis. Data on use of the emergency and outpatient departments were not available. As well, because data were available only from acute care hospitals, specialized facilities such as psychiatric and rehabilitation centres were excluded. And the extent to which exposure to second-hand smoke may have been related to days in hospital could not be estimated.

The maximum response category for the 2000/2001 CCHS question asked of former daily smokers about time since quitting was “more than 5 years ago.” A more detailed breakdown (for example, 5 to 10 years; 10 years or more) would have permitted an examination of the length of cessation time that is required before hospital use by former smokers might fully drop to the level of people who have never smoked. As well, information on intensity of exposure to smoking (pack-years) was not available.

Smoking status was assessed only at the beginning of the period and may have changed during the subsequent four years. Current smokers could have quit, and former smokers could have resumed.

Previous research based on longitudinal data indicates that within a two-year period, 13% of daily smokers had quit.³² However, among former smokers, recidivism was particularly high in the first two years—approximately 20% had relapsed. Although the full extent to which such changes may have diluted or biased the observed associations cannot be quantified, it is likely that the association with hospitalization observed for people classified as recent quitters (quit in past five years) was stronger than it would have been if recidivists had been excluded.

Factors other than smoking that could not be included in the analysis may account for some of the excess hospitalization among smokers. Such factors might include a propensity for risk-taking, poorer nutritional status and less frequent primary and preventive care.

Data from the CCHS were self-reported by respondents; no independent verification of the information was undertaken. The degree to which the data may be biased because of reporting error is unknown. For example, any tendency to deny or underreport smoking would contribute to misclassification, which would weaken the strength of the

association between hospital use and smoking.

Probabilistic linkage was used to match hospitalization records to survey records; some false links or missed links may have resulted.

Conclusion

This analysis illustrates the value of linking administrative to survey data by being the first Canadian study to directly quantify time spent in hospital according to smoking status. The precision of the association between hospitalization and smoking status was enhanced by controlling for other possible influences such as obesity and socio-economic status. ■

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A comparison of individual and area-based socio-economic data for monitoring social inequalities in health

by Robert Pampalon, Denis Hamel and Philippe Gamache

Abstract

Background

Area-based indicators are commonly used to measure and track health outcomes by socio-economic group. This is largely because of the absence of socio-economic information about individuals in health administrative databases. The literature shows that the magnitude of differences in health outcomes varies depending on whether the socio-economic indicators are at the individual level or are area-based. This study compares the two types of indicators.

Data and methods

The data are from a file linking the results of the 1991 Census with deaths that occurred from 1991 to 2000—a 15% sample of the Canadian population aged 25 or older. The socio-economic indicator used for comparison is a material and social deprivation index, in individual and area-based versions. The health indicators are life expectancy and disability-free life expectancy, and risks of mortality and disability.

Results

The individual version of the deprivation index yields wider gaps in life expectancy and disability-free life expectancy than does the area-based version. These gaps vary by sex and geographic setting. However, both versions are associated with inequalities in mortality and disability, independent of each other.

Interpretation

Despite some limitations, area-based socio-economic indicators are useful in assessing inequalities in health. The inequalities that they identify are significant, consistent and reliable and can be tracked through time and for different geographic settings.

Keywords

area-based measure, deprivation, disability-free life expectancy, geography, life expectancy, social inequalities

Authors

Robert Pampalon (1-418-650-5115, ext. 5719, robert.pampalon@inspq.qc.ca), Denis Hamel (denis.hamel@inspq.qc.ca) and Philippe Gamache (philippe.gamache@inspq.qc.ca) are with the Unité des études et analyses de l'état de santé de la population, Institut national de santé publique du Québec, 945 Wolfe Avenue, Quebec, Quebec, G1V 5B3.

Indicators of health status and the health care system in Canada are available in publications such as the *Federal Report on Comparable Health Indicators* (2002, 2004 and 2006)¹ and the annual online series, *Health Indicators*, which has been produced since 2002.² These sources provide more than one hundred indicators, by sex, age group, province and health region, but only one indicator, health-adjusted life expectancy, is connected to a socio-economic measure—average neighbourhood income.¹ Therefore, it is not surprising that participants in a recent conference³ recommended that health indicators take the concept of equity into account, specifically, that they incorporate socio-economic status and place of residence (urban or rural).

Data from national surveys such as the Canadian Community Health Survey can be used for this purpose.⁴ Administrative databases, such as those for deaths or hospitalizations—essential for describing the health status of the population or the use of health care services—can also be used. But because administrative databases contain no socio-economic information about the persons concerned, it is necessary to introduce area-

based indicators in such databases for monitoring social inequalities in health.

However, the magnitude of the health inequalities that are identified can vary depending on whether the socio-economic data pertain to individuals or are area-based. Some earlier studies have reported that relationships between health indicators and socio-economic conditions are stronger when those conditions are measured at the individual level.⁵⁻¹⁰ Other studies have found that the

magnitude of health inequalities based on individual and area-based data is similar, for the entire population,¹¹ or a portion of it.^{12,13} These divergent findings do not appear to be attributable to the size of the geographic unit, but rather to the health indicator itself and to the nature and formulation of the socio-economic indicators that are used. However, all the authors agree that individual and area-based socio-economic indicators do not reflect the same reality; that they are based on different constructs; and that they contribute independently to the health gaps observed.^{5,11-13}

In Canada, just one study has examined this issue,¹⁴ estimating, for a representative sample of Manitobans, the contribution of household income and average neighbourhood income (enumeration area) to mortality, disability, nursing home admissions, morbidity related to care and hospitalization, mental health problems, and fertility from 1986 to 1989. On all these outcomes, except disability and the prevalence of mental health problems, the variations associated with each income decile were comparable at the individual and area-based levels. For disability and mental health problems, variations by household income were larger than by neighbourhood income. As well, the study identified comparable gaps between urban and rural environments for all health outcomes, except disability and mental health problems. For disability, the contribution of income was greater in urban environments for both the individual and area-based measures.

These findings demonstrate that if area-based indicators are used to monitor health status, it is necessary to recognize that they reflect not only the characteristics of the population, but also those of the physical and social setting. Therefore, the study of area-based indicators is important—to estimate their contribution to health and to determine how they vary by geographic setting. An American team, in fact, has undertaken such research.¹⁵

The recent availability of a file linking 1991 Census of Canada data to

deaths that occurred from 1991 to 2001 offers an opportunity to compare the respective contributions of individual and area-based data to health indicators derived from administrative databases.¹⁰ The present study examines how the individual and area-based versions of a deprivation index contribute to estimates of life expectancy and disability-free life expectancy.¹⁶ The objectives are first to compare the size of the life expectancy and disability-free life expectancy gaps between the individual and area-based versions of the index, and then to determine if each version contributes independently to those gaps.

Data and methods

The data are from a linkage between 1991 Census of Canada data and records of deaths that occurred from June 4, 1991 to December 31, 2001.¹⁰ The data constitute a 15% sample of the non-institutionalized population aged 25 or older. This study concerns 99% of that population ($n = 2,708,300$), that is, people to whom it was possible to assign a deprivation index.

Geographic breakdown

The study pertains to the Canadian population as a whole and to four geographic settings based on the Statistical Area Classification developed by Statistics Canada¹⁷ that reflect the urban-rural continuum: (1) the largest CMAs (census metropolitan areas)—Toronto, Montreal and Vancouver; (2) other CMAs (population more than 100,000); (3) census agglomerations (population 10,000 to 100,000); and (4) metropolitan influenced zones, hereafter called “small towns and rural” (municipalities with a population less than 10,000).

Deprivation index

The deprivation index is a Canada-level version of an area-based index developed for Quebec,¹⁸⁻²⁰ using 1991 enumeration areas (contiguous residential blocks, each containing an average of about 700 residents).²¹ The deprivation index,

derived from the proposals of Peter Townsend,²² embodies two forms of deprivation: material and social. Material deprivation refers to the lack of the goods and conveniences that are part of modern life; social deprivation refers to the fragility of the social network, from the family to the community. The deprivation index in this analysis combines six socio-economic indicators:²³⁻²⁸ no high school diploma; employment; income; being widowed, separated or divorced; living alone; and being in a lone-parent family.

For the area-based version of the index, these indicators are expressed as a percentage or average (for income) by enumeration area. These indicators are grouped under the two dimensions of deprivation (material and social), obtained from principal component analysis. The material dimension reflects education, employment, and income; the social dimension reflects marital status and the structure of the household or family. On both dimensions of deprivation, enumeration areas were divided into population quintiles (20% groups), from the most advantaged (quintile 1) to the least advantaged (quintile 5) based on a factor score. This was done for Canada as a whole and for each geographic setting, based on the principal component analysis (and factor scores) carried out in each setting.

The individual version of the index uses the six socio-economic indicators selected for the enumeration area version in either binary form (for example, having or not having a job) or continuous form (income). The income measure differs slightly—personal income is used for people living alone or in non-family households; for other people, family income adjusted for family size is used. The six indicators were grouped under the material and social dimensions of deprivation, using the standardized scoring coefficients drawn from the various principal component analyses. Individuals were then distributed into population quintiles from the most advantaged (quintile 1) to the least advantaged (quintile 5) on each of the two dimensions according to the factor

score. This was done for Canada as a whole and for each geographic setting.

For the social dimension of deprivation, it was not possible to distribute individuals among quintiles. With the indicators comprising this dimension—marital status (widowed, separated or divorced), living alone, and living in a lone-parent family—it was possible to distinguish only two groups: (1) people who tended to have none of these characteristics (about 80% of the population); and (2) people who tended to have at least one of these characteristics (about 20% of the population). Consequently, the comparison between the individual and enumeration area versions of the social dimension of deprivation pertains to these two groups, one consisting of quintiles 1, 2, 3 and 4 (most advantaged), and the other consisting of quintile 5 (least advantaged). More details on the construction of the index are provided in the Appendix.

Health indicators

Two health indicators¹⁰ are considered here: mortality and disability.²¹ It was possible to assign a deprivation index to 98% of those who had died ($n = 255,780$) or who reported a disability ($n = 352,400$) in the 1991 Census.

Life expectancy and disability-free life expectancy at age 25 were calculated. Disability-free life expectancy¹⁶ is the number of years someone aged 25 (between 1991 and 2001) could expect to live without activity limitations or disability. The life expectancy and disability-free life expectancy calculations are based on the methods of Chiang²⁹ and Sullivan,³⁰ respectively, adapted for survival.¹⁰ Confidence intervals of 95% were calculated for both indicators.^{29,31}

To verify whether the individual and enumeration area-based versions of the deprivation index both contribute to the health gaps between quintiles and whether they do so independently, two measures included in the calculation of disability-free life expectancy were used: the proportional hazards ratio for

mortality from 1991 to 2001 and the relative risk of disability in 1991. They were modelled using Cox regression³² (mortality) and negative binomial regression³³ (disability). Separate models were produced for the material and social dimensions of deprivation, and the mortality and disability risks were adjusted for age, sex, geographic setting and the other dimension of deprivation. A first model estimated the contribution of the individual version of the deprivation index alone, and then with the area-based version of the index. A second model estimated the contribution of the area-based version of the deprivation index alone, and then with the individual version of the index. Mortality and disability risks were calculated for the extreme quintiles of material deprivation (quintile 1 versus quintile 5) and social deprivation (quintiles 1, 2, 3, 4 versus quintile 5). They may be interpreted as follows: a value of 2.00 means that the risk of mortality or disability of the least advantaged group is two times greater than that of the most advantaged group. The calculations were made using the SAS procedures PHREG and GENMOD.

Finally, the possibility that the absence of a deprivation index for 1% of the population and 2% of deceased persons or persons with disabilities could bias the estimates of life expectancy and disability-free life expectancy was checked. To do this, everyone for whom a deprivation index could not be calculated was considered to belong to the least advantaged group (quintile 5), and new estimates of life expectancy and disability-free life expectancy were produced. These proved to be similar to those already obtained.

Results

Life expectancy

The individual and enumeration area versions of the deprivation index show gaps in life expectancy at age 25 that vary in magnitude (Figure 1). On the *material* dimension, the calculations using data for individuals yield life expectancy estimates that range from 61.2 years for

the most advantaged (quintile 1) to 52.4 years for the least advantaged (quintile 5)—a difference of 8.8 years (CI: 8.0; 9.6). The corresponding values using enumeration area data are 57.5 years and 54 years—a difference of 3.5 years (CI: 3.7; 4.2).

On the *social* dimension of deprivation, the difference in life expectancy between the most advantaged group (quintiles 1, 2, 3 and 4) and the least advantaged group (quintile 5) is 3.9 years (CI: 3.7; 4.2) using data for individuals, and 2 years (CI: 1.8; 2.0) using data for enumeration areas.

Disability-free life expectancy

For disability-free life expectancy, the gaps persist (Figure 2). On the *material* dimension of deprivation, the difference in disability-free life expectancy at age 25 between the most advantaged group and the least advantaged group is 14 years (CI: 13.2; 14.8), using data for individuals. With enumeration area data, the gap is 5.1 years (CI: 4.9; 5.3).

On the *social* dimension of deprivation, the difference in disability-free life expectancy between the most advantaged group and the least advantaged group is 5.3 years (CI: 5.1; 5.5) using data for individuals, and 2.8 years (CI: 2.6; 3.0) with data for enumeration areas.

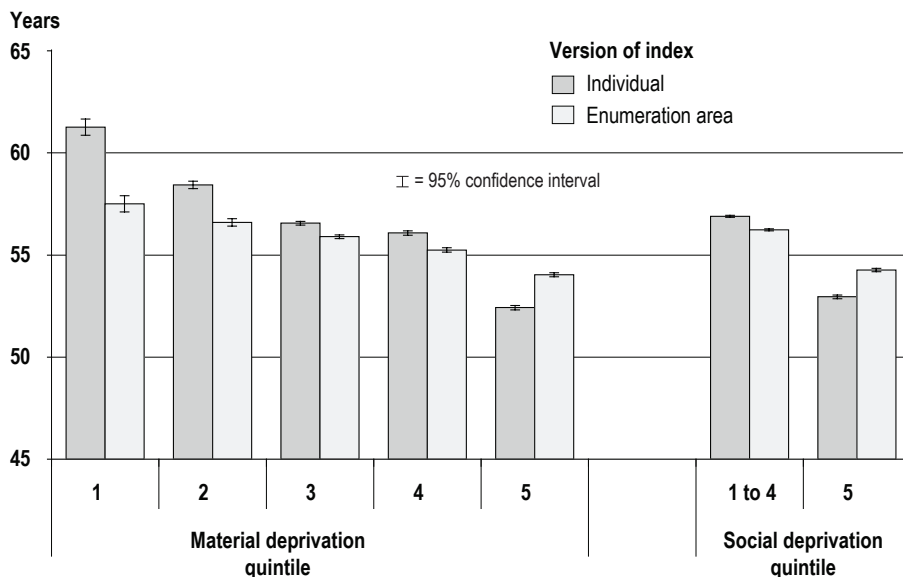
Differences between men and women

Disadvantage-based inequalities in life expectancy and disability-free life expectancy at age 25 are greater among men than among women, regardless of whether individual or enumeration area data are used (Table 1). However, for life expectancy, differences in magnitude are greater among women than among men. For example, on the material dimension of deprivation, the gap in women's life expectancy is 8.1 years using individual data and 2.8 years using enumeration area data; among men, the gaps are 9.5 years and 4.2 years, respectively.

Geographic setting

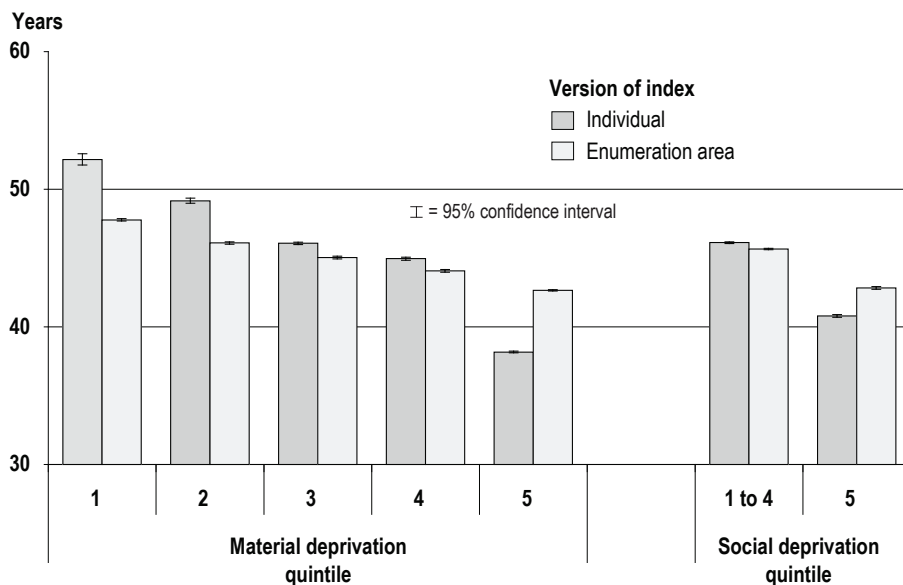
Disadvantage-based inequalities in life expectancy and disability-free life

Figure 1
Life expectancy at age 25 according to individual and enumeration area versions of deprivation index, by material and social deprivation quintile, Canada, 1991 to 2001



Source: Census mortality follow-up study, 1991 to 2001.

Figure 2
Disability-free life expectancy at age 25 according to individual and enumeration area versions of deprivation index, by material and social deprivation quintile, Canada, 1991 to 2001



Source: Census mortality follow-up study, 1991 to 2001.

expectancy emerge for all geographic settings, regardless of the version of the deprivation index. However, the size of inequalities related to material deprivation varies according to the version used. With individual data, gaps in life expectancy are greater in CAs (8.6 years) and in small towns and rural areas (7.4 years) than in the largest CMAs (5.4 years) and other CMAs (6.4 years) (Figure 3). But with enumeration area data, only the other CMAs have a wider life expectancy gap (4 years) than do the other community size categories.

For disability-free life expectancy, the use of data for individuals to assess material deprivation yields greater differences between quintiles in CAs (13.7 years) than elsewhere (Figure 4). But with data for enumeration areas, the differences between quintiles in disability-free life expectancy in small towns and rural areas (11.4 years) exceed those in the largest CMAs (10.2 years). Conversely, the data for enumeration areas show greater differences between quintiles in the other CMAs (6.7 years) than elsewhere, and narrower gaps in small towns and rural areas (3.1 years) than in the largest CMAs (4.5 years).

Independent associations

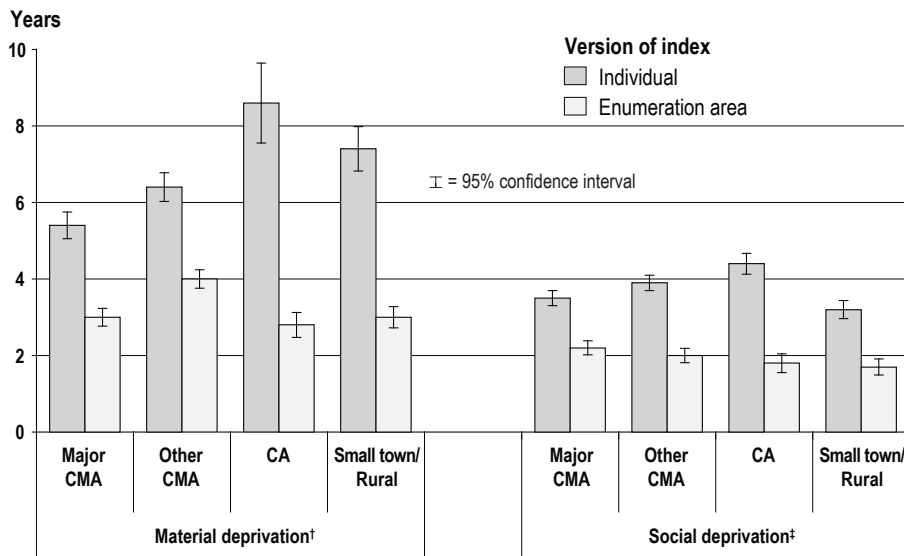
Nonetheless, both versions of the index contribute significantly to the life expectancy and disability-free life expectancy gaps observed. The proportional mortality risk in the 1991-to-2001 period and the relative risk of disability in 1991 between the most and least advantaged groups are independently associated with both material and social deprivation (Table 2). With regard to material deprivation, the contribution of the individual version substantially exceeds that of the enumeration area version. For example, the relative risk of disability for the least advantaged versus the most advantaged group is 211% greater when the calculation is made with individual data, but 6% greater when enumeration area data are used.

Table 1
Life expectancy and disability-free life expectancy at age 25 highest and lowest quintiles of material and social deprivation, by sex and individual and enumeration area versions of index, Canada, 1991 to 2001

Deprivation Version of index	Life expectancy						Disability-free life expectancy					
	Men			Women			Men			Women		
	Years	95% confidence interval		Years	95% confidence interval		Years	95% confidence interval		Years	95% confidence interval	
		from	to		from	to		from	to		from	to
Total	52.6	52.6	52.7	59.0	59.0	59.1	43.3	43.3	43.4	46.9	46.9	47.0
Material deprivation												
<i>Individual</i>												
Quintile 1	57.7	57.4	58.1	64.8	64.1	65.5	50.7	50.3	51.0	53.7	52.9	54.4
Quintile 5	48.2	48.0	48.3	56.7	56.6	56.8	34.3	34.1	34.5	42.0	41.9	42.2
Quintile 1 minus quintile 5	9.5	9.2	9.9	8.1	7.4	8.9	16.3	16.0	16.7	11.7	10.9	12.4
<i>Enumeration area</i>												
Quintile 1	54.8	54.6	54.9	60.3	60.1	60.4	46.5	46.4	46.7	49.0	48.9	49.2
Quintile 5	50.6	50.5	50.7	57.5	57.4	57.6	40.5	40.4	40.7	44.8	44.7	44.9
Quintile 1 minus quintile 5	4.2	4.0	4.4	2.8	2.6	2.9	6.0	5.9	6.1	4.2	4.1	4.4
Social deprivation												
<i>Individual</i>												
Quintiles 1 to 4	53.3	53.3	53.4	60.4	60.3	60.5	44.3	44.2	44.3	48.0	47.9	48.1
Quintile 5	48.7	48.5	48.8	57.2	57.1	57.3	37.8	37.7	38.0	43.8	43.7	43.9
Quintiles 1 to 4 minus quintile 5	4.7	4.5	4.8	3.2	3.1	3.3	6.4	6.4	6.5	4.2	4.1	4.3
<i>Enumeration area</i>												
Quintiles 1 to 4	53.2	53.1	53.2	59.3	59.2	59.4	43.9	43.9	44.0	47.4	47.3	47.5
Quintile 5	50.5	50.3	50.6	58.1	57.9	58.2	40.5	40.4	40.7	45.1	45.0	45.2
Quintiles 1 to 4 minus quintile 5	2.7	2.6	2.8	1.2	1.2	1.3	3.4	3.3	3.5	2.3	2.2	2.3

Source: Census mortality follow-up study, 1991 to 2001.

Figure 3
Difference in life expectancy at age 25 between highest and lowest quintiles (Q) of material[†] and social[‡] deprivation, by version of index and geographic setting, Canada, 1991 to 2001



[†] material deprivation (Q1 minus Q5)

[‡] social deprivation (Q4Q3Q2Q1 minus Q5)

Note: Major CMA (census metropolitan area): Toronto, Montreal and Vancouver; other CMA: population 100,000 or more; CA (census agglomeration): population 10,000 or more; small town/rural: population less than 10,000.

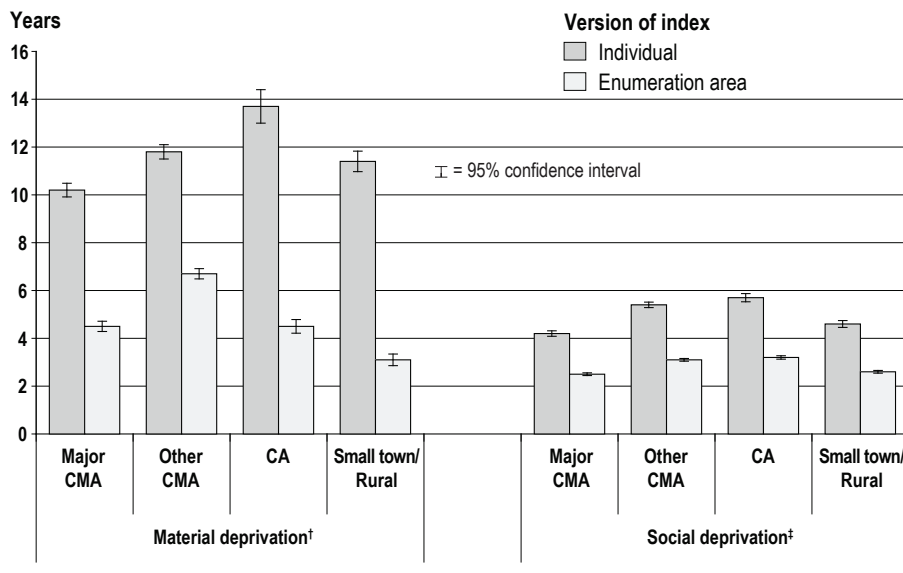
Source: Census mortality follow-up study, 1991 to 2001.

With regard to social deprivation, the two versions of the index yield closer estimates.

Discussion

The individual and enumeration area versions of the deprivation index reveal major disparities in life expectancy and disability-free life expectancy at age 25 for the material and social forms of disadvantage. The direction of these disparities is the same for the two versions of the index: an increase in disadvantage is accompanied by a reduction in life expectancy, with or without disability. However, the size of the disparities varies. Life expectancy and disability-free life expectancy gaps between the groups at the ends of the advantaged-disadvantaged continuum are much greater when measured at the individual level. This applies to the Canadian population as a whole, to men and women, and to each geographic setting.

Figure 4
Difference in disability-free life expectancy at age 25, between highest and lowest quintiles (Q) of material[†] and social[‡] deprivation, by version of index and geographic setting, Canada, 1991 to 2001



[†] material deprivation (Q1 minus Q5)

[‡] social deprivation (Q4Q3Q2Q1 minus Q5)

Note: Major CMA (census metropolitan area): Toronto, Montreal and Vancouver; other CMA: population 100,000 or more; CA (census agglomeration): population 10,000 or more; small town/rural: population less than 10,000.

Source: Census mortality follow-up study, 1991 to 2001.

Table 2
Contribution of individual and enumeration area versions of material and social deprivation index to proportional risk of mortality (1991 to 2001) and relative risk of disability (1991), Canada

Deprivation	Mortality (1991 to 2001)			Disability (1991)		
	Proportional risk [†]	95% confidence interval		Relative risk [‡]	95% confidence interval	
		from	to		from	to
Material deprivation						
Individual version of index [model 1]						
alone	2.03	1.99	2.07	3.17	3.09	3.26
and enumeration area version	1.96	1.92	1.99	3.11	3.03	3.20
Enumeration area version of index [model 2]						
alone	1.36	1.34	1.38	1.15	1.09	1.20
and individual version	1.12	1.10	1.13	1.06	1.04	1.09
Social deprivation						
Individual version of index [model 1]						
alone	1.39	1.38	1.41	1.51	1.49	1.53
and enumeration area version	1.37	1.35	1.38	1.50	1.48	1.53
Enumeration area version of index [model 2]						
alone	1.21	1.20	1.22	1.14	1.10	1.17
and individual version	1.15	1.14	1.16	1.12	1.10	1.13

[†] proportional risk between quintile 5 and quintile 1 (material deprivation) and between quintile 5 and quintiles 1 to 4 (social deprivation); adjusted for age, sex, geographic setting and other form of deprivation

[‡] relative risk between quintile 5 and quintile 1 (material deprivation) and between quintile 5 and quintiles 1 to 4 (social deprivation); adjusted for age, sex, geographic setting and other form of deprivation

Source: Census mortality follow-up study, 1991 to 2001.

Consistent with the literature, these results suggest that associations between health and socio-economic characteristics are stronger when the latter are measured at the individual rather than the area level.⁵⁻⁹ An examination of each of the six indicators that make up the deprivation index shows that the individual version is more effective at identifying vulnerable or advantaged populations (Table 3). Also, the results corroborate the findings of the Manitoba study¹⁴ with regard to disability, and those of the national study¹⁰ with regard to life expectancy at age 25.

The results of the present study show greater divergences between individual and enumeration area measures among women than among men. Thus, it appears that enumeration area indicators underestimate disadvantage-based life expectancy differences to a greater extent among women than among men. The national study,¹⁰ which used the same file, also revealed larger divergences for women between the individual and enumeration area measures. As well, a study⁵ conducted in the Renfrew district in Scotland reported a steady increase in mortality among men with both the level of deprivation in the postal code zone and manual labourer status; for women, only manual labourer status influenced mortality.

According to the results of this analysis, the largest discrepancies between individual and area-based measures are by geographic setting. It appears that the enumeration area version of the deprivation index underestimates life expectancy and disability-free life expectancy gaps between quintiles in CAs and in small towns and rural areas. No similar finding was reported in the international literature or in the Manitoba study. However, comparisons of social inequalities between urban and rural environments are not exempt from statistical artifacts, especially those related to differences in the small geographic units included in the analysis. For example, the range of social disparities between these units is greater in urban than in rural areas, whereas the

Table 3
Socio-economic characteristics of population, by material and social deprivation quintile and area-based and individual versions of deprivation index, Canada, 1991

	No high school diploma		Employment/Population		Average income		Separated, divorced, widowed		Living alone		Lone-parent families	
	Area	Individual	Area	Individual	Area	Individual	Area	Individual	Area	Individual	Area	Individual
	%		ratio		\$		%		%		%	
Total	37.4	37.4	65.5	65.5	26,389	26,389	13.3	13.3	11.2	11.2	6.3	6.3
Material deprivation												
Quintile 1	19.4	0.0	73.0	100.0	37,493	47,341	11.8	12.5	12.3	17.7	4.6	4.6
Quintile 2	29.7	0.6	70.5	97.6	28,308	29,789	12.1	7.5	10.2	4.6	5.4	6.2
Quintile 3	37.1	19.9	67.7	59.1	25,102	23,746	13.0	13.9	10.4	12.7	6.0	5.3
Quintile 4	44.8	66.8	63.3	64.0	22,310	18,683	14.2	8.1	11.3	4.2	6.8	7.3
Quintile 5	56.9	100.0	52.6	6.4	18,105	12,244	15.4	24.2	11.9	16.9	8.8	8.3
Social deprivation												
Quintiles 1, 2, 3, 4	37.1	35.1	67.1	69.5	27,097	27,214	10.9	0.0	7.9	0.0	5.6	0.0
Quintile 5	38.5	46.4	58.8	49.6	23,564	23,091	22.7	66.2	24.7	56.1	9.2	31.5

Note: See Appendix for statistical definition of characteristics.
Source: Census mortality follow-up study, 1991 to 2001.

What is already known on this subject?

- In Canada, social inequalities in health are monitored mainly with the use of area-based socio-economic indicators.
- The size of these inequalities can vary depending on whether the socio-economic indicator is area-based or at the individual level.

What does this study add?

- This study uses a Canadian index of material and social deprivation as a socio-economic indicator to examine differences in Canada as a whole and in selected geographic settings.
- Inequalities in life expectancy, with or without disability, are greater when measured at the individual level, especially in certain geographic settings.
- Both the individual and the area-based versions of the deprivation index are associated with inequalities in mortality and disability.
- Despite their limitations, area-based indicators continue to be appropriate measures for monitoring social inequalities in health.

size and social homogeneity of these units is less in rural areas.^{34,35} Also, in Canada, correspondence between postal codes (in death certificates) and enumeration areas (for identifying socio-economic data) is more imprecise in CAs, small towns and rural areas than in CMAs.³⁶ While this lack of precision did not affect the results of the current study (the file provided optimal correspondence¹⁰), this issue could arise in routine mortality tracking.

As other researchers have found,^{5,11-13} the results show that both the individual and area versions of the deprivation index are associated with differences in mortality and disability in Canada. These two versions reflect different realities that can be related to the compositional and contextual factors to which reference is made in interpreting local inequalities in health.^{37,38} As well, it appears that the material and social forms of deprivation simultaneously affect the differences observed. Enumeration area measures often cover only the material dimension (for example, income) of deprivation, while social factors, such as social isolation, are also powerful determinants of health.^{39,40}

Limitations

This study has limitations. It presents a deprivation index based on six socio-economic indicators that could have been

designed and combined differently, on both the individual and area-based levels.

This analysis attempted to reflect the multiplicity of social determinants of health and to maximize the comparability of the two scales. Other determinants, such as immigrant or Aboriginal status, could have been used, and their influence on the results for the major CMAs, CAs, and small towns and rural areas might have been different.^{41,42} Nonetheless, such characteristics could be added to the deprivation index in modelling social inequalities in health.

Finally, this study is limited to two health indicators—life expectancy and disability-free life expectancy; studies examining other measures might yield different results. Even so, these two indicators are broad measures of health status, and they are in the forefront of health status monitoring in Canada.^{2,4}

Conclusion

This study suggests that area-based socio-economic indicators detect only a portion of social inequalities in health, a portion that varies by gender and geographic setting. Ultimately, these indicators are only markers of inequalities. For such inequalities to be better understood, etiological studies that incorporate the various health determinants in both their individual and their area-based forms are

necessary. But as long as administrative databases lack individual socio-economic information, the use of area-based indicators for monitoring social inequalities in health will be unavoidable.

Several advantages of area-based indicators emerge from this study:⁴³ they cover a broad socio-economic spectrum (in both material and social terms); they characterize the entire population (males and females, from various geographic

settings); they produce estimates that are statistically reliable and consistent with individual indicators (the direction of the relationships is identical); and they detect sizable inequalities between groups. Lastly, with area-based indicators, such inequalities can be tracked through time and by geographic location. For these reasons, and despite their limitations, area-based indicators continue to be

appropriate tools for monitoring social inequalities in health. ■

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Appendix

Table A
Socio-economic characteristics

Characteristic	Area-based [†]			Individual		
	Label	Description	Possible values	Label	Description	Possible values
Income	INCOME	Average total personal income for persons aged 15 or older and reporting income	Transformed and normalized. Values = -3.57 to 15.68	INCIND	For unattached individual, total personal income; otherwise, family income adjusted for family size	Normalized between -1 and +1 [‡] Values < -1 to -1 Values > 1 to 1
Education	EDUC	Percentage aged 15 or older without high school diploma	Transformed and normalized. Values = -3.58 to 3.67	EDUCIND	High school diploma	Absence = 1 Presence = -1
Employment	EMPL	Ratio of employment to population aged 15 or older	Transformed and normalized. Values = -3.43 to 2.54	EMPLIND	Person is working	Working = 1 Not working = -1
Separated/Divorced/ Widowed	S_D_W	Percentage aged 15 or older separated/divorced/widowed	Transformed and normalized. Values = -2.30 to 8.85	S_D_WIND	Separated, divorced or widowed	Separated/Divorced/ Widowed = 1 Other = -1
Unattached individuals	UNATT	Percentage aged 15 or older living alone	Transformed and normalized. Values = -2.89 to 2.93	UNATTIND	Living alone	Living alone = 1 Not living alone = -1
Lone-parent families	LONE	Percentage of families that are lone-parent families	Transformed and normalized. Values = -3.39 to 2.87	LONEIND	Living in lone-parent family	Lone-parent family = 1 Other = -1

[†] income, education, employment, separated/divorced/widowed and unattached individual adjusted to account for age and sex distribution in each enumeration area

[‡] if income follows normal distribution, nearly 70% of normalized income values will be between -1 and 1; since other individual indicators are dichotomous, normalized income values must be brought back between -1 and 1 to prevent this variable from assuming too much importance

In both the individual and enumeration area versions of the deprivation index, the socio-economic characteristics were combined using factor weights (standardized scoring coefficients) obtained from area-based principal component analyses. These weights are shown in Table B. At the national level, the material and social deprivation factor scores for each enumeration area and each participant in the cohort result from the following equations:

Enumeration area version of index:

Material deprivation: $(0.0903 \times S_D_W) + (-0.0162 \times LONE) + (0.1009 \times UNATT) + (-0.3609 \times EMPL) + (0.4690 \times EDUC) + (-0.4046 \times INCOME)$

Social deprivation: $(0.4415 \times S_D_W) + (0.3463 \times LONE) + (0.4130 \times UNATT) + (-0.0294 \times EMPL) + (0.1380 \times EDUC) + (-0.0203 \times INCOME)$

Individual version of index:

Material deprivation: $(0.0903 \times S_D_WIND) + (-0.0162 \times LONEIND) + (0.1009 \times UNATTIND) + (-0.3609 \times EMPLIND) + (0.4690 \times EDUCIND) + (-0.4046 \times INCIND)$

Social deprivation: $(0.4415 \times S_D_WIND) + (0.3463 \times LONEIND) + (0.4130 \times UNATTIND) + (-0.0294 \times EMPLIND) + (0.1380 \times EDUCIND) + (-0.0203 \times INCIND)$

Table B
Factor weights of socio-economic characteristics, by community size, Canada, 1991

Characteristic	Canada		Largest census metropolitan areas (CMA)		Other census metropolitan areas (CMA)		Census agglomerations (CA)		Small towns and rural	
	Material deprivation	Social deprivation	Material deprivation	Social deprivation	Material deprivation	Social deprivation	Material deprivation	Social deprivation	Material deprivation	Social deprivation
Separated/divorced/widowed	0.0903	0.4415	0.0880	0.4410	0.1066	0.4424	0.1137	0.4316	0.0462	0.4532
Lone-parent families	-0.0162	0.3463	-0.0909	0.2734	-0.0478	0.2887	0.0126	0.3365	-0.1005	0.3692
Unattached individuals	0.1009	0.4130	0.1795	0.4834	0.2131	0.4938	0.1640	0.4396	0.0920	0.4091
Employment	-0.3609	-0.0294	-0.3205	-0.0140	-0.3774	-0.0906	-0.4583	-0.1592	-0.3660	0.0299
Education	0.4690	0.1380	0.4728	0.2093	0.5032	0.2118	0.4541	0.1218	0.4058	0.0533
Income	-0.4046	-0.0203	-0.3865	-0.0223	-0.3693	-0.0048	-0.3775	-0.0027	-0.4100	-0.0426

Note: Largest CMAs (census metropolitan areas): Toronto, Montreal and Vancouver; other CMAs: population 100,000 or more; CAs (census agglomerations): population 10,000 or more; small towns and rural: population less than 10,000.