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Physical activity of Canadian adults: Accelerometer results from the 2007 to 2009 Canadian Health Measures Survey

by Rachel C. Colley, Didier Garriguet, Ian Janssen, Cora L. Craig, Janine Clarke and Mark S. Tremblay

Abstract

Background
Rising obesity rates and declining fitness levels have increased interest in understanding what underlies these trends. This article presents the first directly measured data on physical activity and sedentary behaviour on a nationally representative sample of Canadians aged 20 to 79 years.

Data and methods
Data are from the 2007 to 2009 Canadian Health Measures Survey (CHMS). Physical activity was measured using accelerometry. Data are presented as time spent in sedentary, light, moderate and vigorous intensity movement as well as steps accumulated per day.

Results
An estimated 15% of Canadian adults accumulate 150 minutes of moderate-to-vigorous physical activity (MVPA) per week; 5% accumulate 150 minutes per week as at least 30 minutes of MVPA on 5 or more days a week. Men are more active than women and MVPA declines with increasing age and adiposity. Canadian adults are sedentary for approximately 9.5 hours per day (69% of waking hours). Men accumulate an average of 9,500 steps per day and women, 8,400 steps per day. The 10,000-steps-per-day target is achieved by 35% of adults.

Interpretation
Before the CHMS, objective measures of physical activity and sedentary behaviour were not available for a representative sample of Canadians. The findings indicate that 85% of adults are not active enough to meet Canada's new physical activity recommendation.

Keywords
Actical, exercise health measurement, motor activity, pedometer, physical fitness, public health, obesity, sedentary behaviour

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Regular physical activity is associated with a reduced risk of cardiovascular disease, some types of cancer, osteoporosis, diabetes, obesity, high blood pressure, depression, stress and anxiety.[1-5] As well, strong evidence suggests that higher levels of physical activity are associated with health benefits; in fact, the more activity, the greater the health benefit.[1-5] To determine whether Canadians are sufficiently active to obtain health benefits, the 2007 to 2009 Canadian Health Measures Survey (CHMS) used accelerometers to collect the first time-sequenced objective measures of physical activity for a nationally representative sample of 6- to 79-year-olds.

Before the CHMS, national trends in physical activity were derived from self-report surveys, the results of which suggested that the percentage of adults who perceive that they are active has been increasing.[6-8] In 2009, 52.5% of Canadian adults reported that they were at least moderately active during their leisure time.[6] Yet the prevalence of obesity has risen considerably in Canada over the past 25 years,[9] with a quarter of adults now obese.[10] Moreover, muscular strength and flexibility, typically maintained by regular physical activity, have declined since 1981.[10] If half of Canadians are, indeed, sufficiently active for health benefit, it is unlikely that such trends in obesity and fitness would be observed. These counterintuitive findings have increased interest in supplementing self-reported physical activity data with information from devices such as pedometers and accelerometers.

Canada is one of several countries that have recently, or are currently, revising their physical activity recommendations.[5,11,12] Efforts have been made to harmonize the revision and recommendation processes among

countries (for example, Canada, United States, United Kingdom, Australia), as well as with the World Health Organization (WHO).[13,14] This has led to a recommendation that adults should engage in at least 150 minutes per week of moderate-to-vigorous physical activity (MVPA), accumulated in bouts lasting at least 10 minutes.[5,11-14] The 150 minutes can be accumulated in a variety of ways (for example 30 minutes, 5 days a week). Accelerometry data from the CHMS allow for an objective assessment of how many Canadians are meeting this recommendation.

Health promotion efforts have historically focused on encouraging leisure-time physical activity (LTPA) of at least moderate intensity. But LTPA represents only a small fraction of total daily movement, and attention is being directed toward the roles of sedentary behaviour and incidental movement in obesity and health.[15-17] Time spent in sedentary pursuits is now recognized as not simply the absence of physical activity, but rather, a distinct set of behaviours with unique health effects independent of those associated with a lack of LTPA.[18-23] The use of accelerometers in the CHMS makes it possible to quantify time spent at various movement intensities, including sedentary levels.

In partnership with the Public Health Agency of Canada and Health Canada, Statistics Canada launched the CHMS in 2007. After a household interview, respondents went to a mobile examination centre where they underwent a series of direct health measures and received an accelerometer to wear for one week. This paper describes levels of measured physical activity in Canadian adults by age, sex and body weight status. Adherence to the new physical activity recommendations is also assessed.

Methods

Data source

The Canadian Health Measures Survey (CHMS),[24-27] is a nationally representative survey that covers the Canadian population aged 6 to 79 years living in private households at the time of the survey. Residents of Indian Reserves or Crown lands, institutions and certain remote regions, and full-time members of the Canadian Forces are excluded. Approximately 96% of Canadians are represented.

Ethics approval to conduct the survey was obtained from Health Canada's Research Ethics Board.[25] All respondents provided informed written consent. Participation was voluntary; respondents could opt out of any part of the survey at any time. Data were collected at 15 sites across Canada from March 2007 through February 2009.

The response rate for the selected households was 69.6%, meaning that a resident in 69.6% of the households provided the sex and date of birth of all household members. In each responding household, one or two members were chosen to participate in the CHMS; 88.0% of selected 20- to 79-year-olds completed the household questionnaire, and 83.1% of this group participated in the mobile examination centre component of the survey. Of the adults aged 20 to 79 years for whom an activity monitor was available, 91.7% had at least 1 valid day of data, and 82.9% had at least 4 valid days. After adjustments to account for the sampling strategy,[26] the final response rate for having at least 4 valid days was 42.2% (69.6% x 88.0% x 83.1% x 82.9%).

This article is based on 2,832 examination centre respondents aged 20 to 79 years who wore the monitor for at least 4 days (Table 1). Of those who accepted the accelerometer and returned it, 96.2% had at least 1 valid day of data, and 87.0% had at least 4 valid days (Table 2). The mean daily accelerometer wear time for all valid days was 14.0 hours. Older people aged 60 to 79 years had less daily wear time (13.5 hours) than did 20- to 39-year-olds (14.1 hours) (data not shown).

Physical activity outcomes are presented by body weight status. Adults were classified using published BMI ranges[28,29]: healthy weight (18.5 to 25.0 $kg \cdot m^{-2}$), overweight (25.0 to 29.9 $kg \cdot m^{-2}$), or obese (30.0 $kg \cdot m^{-2}$ or more).

Measurement procedures

Upon completion of their mobile examination centre visit, ambulatory respondents were asked to wear an Actical accelerometer (Phillips – Respironics, Oregon, USA) over their right hip on an elasticized belt during their waking hours for 7 days. The monitors were initialized to start collecting data at the first occurrence of midnight after the mobile examination centre appointment.

Table 1
Selected characteristics of weighted sample, by age group and sex, household population aged 20 to 79 years, Canada, March 2007 to February 2009

	Age group (years)					
	20 to 39		40 to 59		60 to 79	
Characteristic	Men	Women	Men	Women	Men	Women
Total sample (number)	**395**	**509**	**480**	**547**	**452**	**449**
Age (years)	30.0	30.0	48.3	49.5	67.3	67.2
Height (cm)	176.6	163.8	175.5	162.6	172.6	159.5
Weight (kg)	82.7	69.1	86.3	70.3	84.1	70.9
BMI (kg/m^2)†	26.5	25.8	28.0	26.6	28.2	27.9
BMI category (%)†						
Healthy weight	39.8	51.4	21.1	47.2	25.3	32.5
Overweight	40.7	24.2	56.0	30.7	43.4	38.8
Obese	18.4[E]	19.5	22.6[E]	21.6	31.0	28.3

† excludes pregnant women
[E] use with caution
Source: 2007 to 2009 Canadian Health Measures Survey.

Table 2
Unweighted distribution of respondents, by valid days of accelerometer wear (10 or more wear hours), age group and sex, household population aged 20 to 79 years, Canada, March 2007 to February 2009

Age group (years)/ Sex	Number of valid days of accelerometer wear									
	0†	1	2	3	4	5	6	7	1 or more	4 or more
	% of respondents									
Total	**3.8**	**2.6**	**2.7**	**3.9**	**5.6**	**12.0**	**21.0**	**48.4**	**96.2**	**87.0**
20 to 39										
Men	5.0	3.7	2.3	7.4	9.1	15.1	19.6	37.8	95.0	81.6
Women	4.8	3.7	3.7	3.3	6.0	11.0	21.8	45.8	95.2	84.6
40 to 59										
Men	2.8	2.0	2.4	3.4	5.0	11.4	23.6	49.3	97.2	89.4
Women	3.4	1.5	2.8	3.1	4.1	9.0	22.2	54.0	96.6	89.2
60 to 79										
Men	2.6	2.4	2.6	3.2	3.8	15.6	19.8	50.2	97.4	89.3
Women	4.1	2.3	2.3	3.7	5.8	11.3	18.3	52.0	95.9	87.5

† agreed to wear accelerometer, but returned device with no valid data
Source: 2007 to 2009 Canadian Health Measures Survey.

The monitors were returned in a prepaid envelope to Statistics Canada, where the data were downloaded and the monitor was checked to determine if it was still within the manufacturer's calibration specifications.[30]

The Actical (dimensions: 2.8 x 2.7 x 1.0 centimetres; weight: 17 grams) measures and records time-stamped acceleration in all directions, thereby indicating the intensity of physical activity. The digitized values are summed over a user-specified interval of 1 minute, resulting in a count value per minute (cpm). Accelerometer signals are also translated into steps accumulated per minute. The Actical has been validated to measure physical activity in adults[31] and children[32,33] and step counts in adults and children.[34] All data are blind to respondents while they are wearing the device.

Biologically implausible data were assessed to determine if files should be included in final analyses; the procedures applied to manage such data are described elsewhere.[30] Published guidelines were followed to identify and remove days with incomplete (invalid) accelerometer wear time.[30,38,39] A valid day was defined as 10 or more hours of wear time; respondents with 4 or more valid days were retained for analyses.[38] Wear time was defined by subtracting nonwear time from 24 hours. Nonwear time was defined as at least 60 consecutive minutes of zero counts, with allowance for 1 to 2 minutes of counts between 0 and 100.

Time spent in various levels of movement intensity—sedentary, light, moderate, vigorous—is based on the application of intensity cut-points corresponding to each intensity level (Table 3).

Adherence to various physical activity targets was examined:

1. New Canadian and Global WHO recommendation: 150 minutes of MVPA per week accumulated in 10-minute bouts. To count as a bout, 10 consecutive minutes of observations had to exceed the moderate intensity cut-point, with allowance for a maximum of two observations falling below the cut-point during that period (8 out of 10 minutes had to be above the cut-point).[5,12-14]
   a) Adherence defined as a weekly sum of 150 or more minutes of MVPA per week. If respondents had 4 to 6 valid days, their average daily MVPA was multiplied by 7 to obtain a weekly sum.
   b) Adherence defined as the probability of accumulating at least 30 minutes of MVPA on at least 5 days of the week.
2. 10,000 steps per day.[40-42]

To determine the probability that adults accumulate at least 30 minutes (or 15 minutes) of MVPA on at least 5 days per week, the analytical approach was harmonized with that used in the analysis of the 2003-2004 NHANES accelerometry data.[38] To maximize the sample size (important because only 48.4% of the sample aged 20 to 79 years who wore accelerometers had 7 valid days of wear), a Bayesian approach was used to incorporate the information from all respondents with 4 or more valid days. An individual's probability of being adherent (active at least 5 out of 7 days) was estimated using a Beta distribution for its observed combination

Table 3
Physical activity intensity cut-points for Actical accelerometer[35-37]

Intensity	Metabolic Equivalent (METS)	Example	Accelerometer count range (counts per minute)
Sedentary	1 to less than 2	Car travel, sitting, reclining, standing	Less than 100*
Light	2 to less than 3	Walking less than 3.2 km/h, light household cleaning, cooking	100 to less than 1,535
Moderate	3 to less than 6	Walking more than 3.2 km/h, cleaning (vacuuming, washing car), bicycling for pleasure	1,535 to less than 3,962
Vigorous	6 or more	Jogging, competitive team sport participation	3,962 or more

* including wear-time zeros

of active and wear days. The estimated population prevalence of adherence is the weighted average of these individual probabilities. Further detail is available elsewhere (http://riskfactor.cancer.gov/tools/nhanes_pam).[39]

Compared with other accelerometer models, the Actical has better instrument reliability,[43] and its omni-directional capability allows it to capture a wider range of movement than a uni-axial device such as the Actigraph used in NHANES. The Actical is also waterproof, which may have helped with compliance as respondents did not have to remove the device so often throughout the day.

Statistical analysis

All analyses were conducted with SAS Version 9.1 and were based on weighted data using respondents with 4 or more valid days. To account for the survey design of the CHMS, standard errors, coefficients of variation and 95% confidence intervals were estimated with the bootstrap technique.[44] Comparisons of physical activity among age and sex groupings were made with pairwise contrasts. Differences between estimates were tested for statistical significance, which was established at $p < 0.05$.

Table 4
Average daily minutes of activity at various levels of intensity and average daily step counts, by sex, age group and BMI category, household population aged 20 to 79 years, Canada, March 2007 to February 2009

Sex /Age group/ BMI category	Intensity of activity					
	Sedentary	Light	Moderate	Vigorous	Moderate-to-vigorous (MVPA)	Step counts
	Minutes per day					Average
Men	**575**	**246**	**24***	**3**	**27***	**9,544***
Age group (years)						
20 to 39†	571	253	28*	5	33*	9,926
40 to 59	570	258	24	3‡E	26	9,996*
60 to 79	594‡	208‡	15‡	2‡E	17‡	7,869‡
BMI category						
Healthy weight†	575	252	29*	5	35*	10,577*
Overweight	570	251	23*‡	3‡E	26*‡	9,491*
Obese	586	230	17*‡	2‡E	19*‡	8,342‡
Women	**585**	**238**	**18**	**3**	**21**	**8,385**
Age group (years)						
20 to 39†	572	249	20	4E	24	8,875
40 to 59	588	245	19	3	21	8,677
60 to 79	602‡	205‡	12‡	1‡E	12‡	6,970‡
BMI category						
Healthy weight†	589	234	21	4	25	8,819
Overweight	583	242	18	2E	20	8,506
Obese	583	243	12‡	<2‡	13‡	7,546‡

† reference category
* significantly different from estimate for women ($p<0.05$)
‡ significantly different from estimate for reference category ($p<0.05$)
E use with caution
Source: 2007 to 2009 Canadian Health Measures Survey.

Results

Age, sex and BMI

The majority of Canadian adults' waking hours—68% for men and 69% for women—are sedentary. Total average daily sedentary time is 575 minutes (9.6 hours) for men and 585 minutes (9.8 hours) for women (Table 4). Overall, men and women engage in about 4 hours per day of light physical activity.

At ages 20 to 39, men accumulate more MVPA than do women: 33 versus 24 minutes per day; a sex difference is not evident at ages 40 to 79 years. Healthy weight men average 35 minutes a day of MVPA, while overweight and obese men average significantly less: 26 and 19 minutes, respectively. Healthy weight women accumulate an average of 25 minutes of MVPA a day, while overweight women accumulate 20 minutes, and obese women, 13 minutes.

Meeting recommendations

According to the CHMS data, 15% of adults (17% of men and 14% of women) accumulate 150 minutes per week of MVPA in 10-minute bouts (Table 5). The percentage of adults accumulating 150 minutes on a regular basis—at least 30 minutes on at least 5 days a week—is 5%. Overall, about half (53%) are accumulating at least 30 minutes of MVPA 1 or more days per week, but almost as many (47%) do so less than one day a week (Table 6).

Step counts

Men average 9,500 steps per day, and women, 8,400 (Table 4). The daily average is significantly lower at ages 60 to 79 years: 7,900 steps for men and 7,000 steps for women. A significant sex difference is evident only in the 40-to-59-year age group (10,000 versus 8,700 steps per day). Obese men and women accumulate significantly fewer steps per day than do healthy weight adults. Just over a third (35%) of adults accumulate an average of 10,000 steps per day; older adults are significantly less likely than 20- to 39-year-olds to do so (Table 5).

Discussion

This article provides an overview of the physical activity levels of Canadians aged 20 to 79 years, based on the first objectively measured physical activity data collected for a representative sample of Canadians. The most important finding is that 15% of adults are meeting the revised physical activity recommendation. The majority—69%—of Canadian adults' waking hours are spent in sedentary pursuits.

Table 5
Percentage attaining selected physical activity criteria, by age group and sex, household population aged 20 to 79 years, Canada, March 2007 to February 2009

	Total			Men			Women		
		95% confidence interval			95% confidence interval			95% confidence interval	
Criterion/ Age group (years)	%	from	to	%	from	to	%	from	to
At least 30 minutes of moderate-to-vigorous physical activity, accumulated in bouts of at least 10 minutes, on at least 5 out of 7 days									
Total	**4.8**	**3.2**	**6.3**	**5.5**	**3.6**	**7.5**	**4.0**[E]	**2.5**	**5.5**
20 to 39[†]	4.5[E]	2.6	6.4	5.7[E]	3.3	8.2	3.3[E]	1.4	5.2
40 to 59	5.1[E]	2.9	7.3	5.5[E]	2.4	8.5	4.7[E]	2.6	6.8
60 to 79	4.5	3.1	6.0	5.3[E]	2.2	8.4	3.8[E]	2.0	5.6
More than 150 minutes a week of moderate-to-vigorous physical activity accumulated in bouts of at least 10 minutes									
Total	**15.4**	**10.9**	**19.8**	**17.1**	**11.3**	**23.0**	**13.7**	**10.1**	**17.3**
20 to 39[†]	17.4	11.2	23.7	21.1[E]	11.7	30.4	13.8[E]	7.8	19.8
40 to 59	14.6	9.4	19.8	15.1[E]	7.9	22.3	14.1	9.1	19.1
60 to 79	13.1	9.0	17.3	13.7[E]	8.1	19.3	12.6	8.3	16.9
Average more than 10,000 steps a day									
Total	**34.5**	**30.5**	**38.4**	**39.0***	**33.0**	**45.0**	**30.0**	**25.4**	**34.6**
20 to 39[†]	36.2	29.2	43.2	38.3	28.8	47.9	34.0	22.8	45.3
40 to 59	40.0	34.0	45.9	46.9*	36.8	56.9	33.1	27.8	38.5
60 to 79	20.3[‡]	14.0	26.7	24.1[‡]	16.5	31.7	17.0[‡E]	10.7	23.2

[†] reference category
* significantly different from estimate for women (p<0.05)
[‡] significantly different from estimate for reference category (p<0.05)
[E] use with caution
Source: 2007 to 2009 Canadian Health Measures Survey.

Table 6
Percentage attaining selected physical activity criteria, household population aged 20 to 79 years, Canada, March 2007 to February 2009

	Moderate-to-vigorous physical activity accumulated in bouts of at least 10 minutes					
	At least 15 minutes a day			At least 30 minutes a day		
		95% confidence interval			95% confidence interval	
Days active out of 7	%	from	to	%	from	to
Less than 1	36.7	31.5	41.8	46.6	42.7	50.5
At least 1	63.3	58.2	68.5	53.4	49.5	57.3
At least 2	41.2	35.3	47.1	29.6	25.3	33.9
At least 3	26.5	21.5	31.5	16.8	13.3	20.3
At least 4	16.2	12.5	19.8	9.4	6.9	11.9
At least 5	8.8	6.3	11.3	4.8	3.2	6.3

Source: 2007 to 2009 Canadian Health Measures Survey.

To obtain substantial health benefits, new WHO and Canadian guidelines[5,12,13] recommend that adults should accumulate at least 150 minutes of MVPA a week, a level achieved by 17% of men and 14% of women, according to the CHMS data. A considerable amount of the evidence in support of the 150-minutes-per-week recommendation suggests that frequent physical activity is important for health (that is, the 150 minutes should be spread across several days).[5] The percentage of Canadian adults reaching the 150-minutes-per-week recommendation by accumulating at least 30 minutes of MVPA on at least 5 days per week is about 5%.

CHMS data may provide insight into how the physical activity recommendations could be translated into practical messages. While the finding that 5% of Canadian adults accumulate 30 minutes of MVPA on 5 days per week is informative, further insight can be obtained by examining how close the remaining 95% come to this recommendation. Many adults are getting *some* physical activity, as 63% accumulate 15 minutes of MVPA at least *one* day a week. However, this means that more than a third (37%) do not reach even this modest level of activity. These findings provide targets for intervention and suggest a need to encourage a substantial share of Canadian adults to increase both the duration and frequency of their MVPA.

Objectively measured physical activity data from the 2005-2006 National Health and Nutrition Examination Survey (NHANES)[45] show that 3% of Americans aged 20 to 59 years were accumulating at least 30 minutes of MVPA in 10-minute bouts on 5 out of 7 days. CHMS data for the same age range show that the estimated prevalence is slightly higher in Canadian men (20 to 59 years: 6%), similar in Canadian women aged 20 to 39 years (3%), and higher in Canadian women aged 40 to 59 years (5%). The United States and Canada are both struggling with disturbing trends in obesity and chronic disease. Harmonization in health surveillance between countries

What is already known on this subject?

- Over the past 25 years, the prevalence of obesity has increased among Canadian adults.
- According to self-report estimates, 52.5% of Canadian adults are physically active.
- Moderate-to-vigorous physical activity (MVPA) is associated with health benefits.
- Sedentary behaviour is emerging as a negative contributor to health.

What does this study add?

- An estimated 15.4% of Canadian adults accumulate 150 or more minutes of moderate-to-vigorous MVPA in 10-minute bouts per week, and 4.8% do so at least 30 minutes on at least 5 days.
- A third of Canadian adults accumulate an average of 10,000 or more steps per day.
- On average, men accumulate 27 minutes a day of MVPA, and women, 21 minutes.
- Regardless of age group, men engage in more MVPA than do women.
- Men and women spend about 9.5 of their waking hours being sedentary.

may increase the efficiency with which efforts to encourage physical activity can be evaluated and implemented.

The CHMS finding that 15% of adults are meeting the 150 minutes of MVPA per week recommendation differs markedly from self-reported data. According to the Canadian Community Health Survey, more than half of adults are at least "moderately active" in their leisure time.[1,6,7] As population surveillance efforts such as the CHMS implement objective measures of physical activity, expected and substantive differences between self-reported and objective measures need to be examined and understood. Self-reported data are subject to bias,[46-49] typically resulting from social desirability and recall difficulties. Accelerometers are limited by their inability to capture some types of movement (for example, upper body, swimming), potential bias via the application of walking-based intensity cut-points, and the lack of contextual information about how physical activity is accumulated. Population surveillance that exploits the unique advantages of each methodology is desirable.

The CHMS data show that roughly a third of Canadian men and women achieved the well-known pedometer target of 10,000 steps per day. The average man takes approximately 9,500 steps per day, and the average woman, 8,400 steps. These figures are close to results of the 2005-2006 NHANES, which found that American adults averaged about 9,700 steps per day.[50] Collecting and reporting data from the pedometer function of the Actical offers some distinct advantages. Pedometers are now widely available and relatively economical for individuals to purchase. Furthermore, pedometer results are conceptually easier to understand than counts per minute data, and therefore, might lend themselves more easily to use in a variety of health and fitness settings.

"Sedentary" is increasingly being defined as a distinct subset of activities, rather than simply a lack of volitional physical activity of moderate or vigorous intensity.[23] Sedentary behaviour encompasses a broad range of activities (for instance, occupational sitting, TV watching, eating) that occur intermittently throughout the day.[17] According to the CHMS data, the majority (69%) of Canadian adults' accelerometer wear time was sedentary. This is higher than values observed in American analyses of the 2003-2004[51] and 2005-2006 NHANES,[45] which reported ranges of 50% to 60% of the day being spent in sedentary activities. With the sedentary end of the movement spectrum accounting for such a large share of a Canadian adult's day,[15] ongoing monitoring of this behaviour is needed. The CHMS sedentary time data constitute an objective baseline against which changes resulting from interventions and policy initiatives can be tracked and assessed.

Limitations

Accelerometers have several important limitations, notably, potential underestimation of overall activity because they cannot accurately capture activities that are not step-based (for example, swimming, cycling). In addition, accelerometers do not measure the added energy expenditure associated with upper body movement (for example, weight-lifting, shoveling snow), load carrying, or walking up an incline. However, walking is far more common than swimming, cycling, and weight training among Canadian adults.[52]

Current understanding of the appropriate amount of physical activity required to obtain health benefit is based on epidemiological evidence from self-report surveys. The gap between self-reported LTPA and accelerometer-measured MVPA is poorly understood and is an important area of future research. For example, a survey respondent who reports participation in a 60-minute hockey game may accumulate only 20 to 30 minutes of MVPA on the accelerometer. To transform raw accelerometry data into usable information, intensity cut-points must be applied to separate the activity data into sedentary, light, moderate and vigorous. Because of the paucity of published literature available to set adult cut-points for the Actical, the cut-points used in the present analysis were based on a small number of studies.[36,37]

The overall response rate to the accelerometry component of CHMS was 42.2%. Although adjustments were made to the sampling weights to compensate, estimates could be biased by systematic differences between respondents and non-respondents. For example, given that non-respondents tended to be younger, male, and more obese than

people who wore the accelerometer for 4 or more days, these individuals might be less active. Thus, the physical activity data in this analysis could be slightly overestimated.

Conclusions

The CHMS accelerometry data indicate that Canadians are less active than self-reported estimates suggest. In light of this new measurement capability, relationships between physical activity and health will need to be re-examined. The broad range of health outcomes assessed in the CHMS will allow researchers to study the impact physical activity and sedentary behaviour on health more objectively than has ever been possible. Exploration of these relationships is needed to inform the design, delivery and priority of healthy active living initiatives. Ongoing collection of physical activity measures will also allow for assessments of the efficacy of health interventions. ■

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Physical activity of Canadian children and youth: Accelerometer results from the 2007 to 2009 Canadian Health Measures Survey

by Rachel C. Colley, Didier Garriguet, Ian Janssen, Cora L. Craig, Janine Clarke and Mark S. Tremblay

Abstract

Background
Physical activity is an important determinant of health and fitness. This study provides contemporary estimates of the physical activity levels of Canadians aged 6 to 19 years.

Data and methods
Data are from the 2007 to 2009 Canadian Health Measures Survey. The physical activity of a nationally representative sample was measured using accelerometers. Data are presented as time spent in sedentary, light, moderate and vigorous intensity movement, and in steps accumulated per day.

Results
An estimated 9% of boys and 4% of girls accumulate 60 minutes of moderate-to-vigorous physical activity on at least 6 days a week. Regardless of age group, boys are more active than girls. Canadian children and youth spend 8.6 hours per day—62% of their waking hours—in sedentary pursuits. Daily step counts average 12,100 for boys and 10,300 for girls.

Interpretation
Based on objective and robust measures, physical activity levels of Canadian children and youth are low.

Keywords
Actical, pedometer, sedentary behaviour, obesity, public health, motion sensor

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Growing evidence indicates that the health of Canadian children has deteriorated in the past few decades.[1-4] Childhood obesity has risen sharply[5-7]—a quarter of children and youth are now overweight or obese—and physical fitness has declined.[8] Yet paradoxically, according to self-reported data, the majority of Canadian youth are sufficiently active.[9,10] The contrast between current obesity and fitness trends and high levels of self-reported physical activity suggests a need for more objective monitoring of activity levels. The Canadian Health Measures Survey (CHMS) used accelerometers to collect time-sequenced data on physical activity and sedentary behaviour for a nationally representative sample that included children and adolescents aged 6 to 19 years.

Physical activity is associated with health benefits in children and youth,[11] and the more activity, the greater the benefit. Revised guidelines in several countries including Canada[12] recommend that for health benefits, children and adolescents aged 5 to 17 years should accumulate 60 minutes of moderate-to-vigorous physical activity (MVPA) each day.[11,13,14] Evidence also suggests that they should engage in *vigorous* physical activity at least 3 days a week. The accelerometer data from the CHMS make it possible to assess how many Canadian children and youth are attaining these levels.

Sedentary behaviour is associated with obesity and metabolic disease, independent of MVPA[1,15-19] However, measuring sedentary behaviour poses a challenge because it encompasses a broad range of activities (for example, sitting in classrooms, watching TV, talking on the phone, using a computer) that occur intermittently throughout the

day.[20] To date, surveillance has relied on self-reports of screen time, and thereby captured only a portion of total sedentary behaviour. Even so, self-reported screen time is considerable among Canadian youth, at 6 hours a day on weekdays, and more than 7 hours a day on weekends.[1]

Given the large share of time that young people spend in front of screens, an exclusive focus on MVPA is unlikely to substantially increase physical activity at the population level. Measurement approaches and intervention efforts must address both physical activity and sedentary behaviour. Accelerometers are capable of providing robust data to help track trends in both lifestyle choices.

In partnership with the Public Health Agency of Canada and Health Canada, Statistics Canada launched the CHMS in 2007. This article describes levels of accelerometer-measured activity in Canadian children and youth by age, sex and body weight status.

Methods

Data source

The CHMS[21-24] collected data from a nationally representative sample of the population aged 6 to 79 years living in private households at the time of the survey. Residents of Indian Reserves, Crown lands, institutions and certain remote regions, and full-time members of the Canadian Forces were excluded. Approximately 96% of Canadians were represented. The survey involved an interview in the respondent's home and a visit to a mobile examination centre for a series of physical measurements. Data were collected at 15 sites across Canada from March 2007 through February 2009.

Ethics approval to conduct the CHMS was obtained from Health Canada's Research Ethics Board.[22] Informed written consent was obtained from respondents aged 14 years or older. For younger children, a parent or legal guardian provided written consent, in addition to written assent from the child. Participation was voluntary; respondents could opt out of any part of the survey at any time.

The response rate for selected households was 69.6%, meaning that in 69.6% of these households, a resident provided the sex and date of birth of all household members. One or two members of each responding household were chosen to participate in the CHMS; 88.5% of selected 6- to 19-year-olds completed the household questionnaire, and 86.9% of this group participated in the mobile examination centre component. Of the children and youth who agreed to wear the accelerometer and returned the device, 87.4% had at least 1 valid day of data, and 76.3% had at least 4 valid days. After adjusting for the sampling strategy,[23,25] the final response rate for having a minimum of 4 valid days was 40.8% (69.6% x 88.5% x 86.9% x 76.3%). This article is based on 1,608 examination centre respondents aged 6 to 19 years who wore the accelerometer for 4 or more days (Table 1).

Of those who accepted the accelerometer and returned it, 95.4% had at least 1 valid day of data, and 84.8% had at least 4 valid days (Table 2). Adolescents (15 to 19 years) were slightly less likely than younger children to wear the accelerometer for 4 or more days. The mean daily accelerometer wear time for all valid days was 13.6 hours. Wear time was longer among 11- to 19-year-olds than among children aged 6 to 10 years.

Based on age- and sex-specific body mass index (BMI) cut-points adopted by the International Obesity Task Force,[26] children aged 6 to 17 years were classified as: not overweight or obese (including underweight and healthy weight); overweight; or obese. Adolescents aged 18 to 19 years were classified using adult BMI ranges: not overweight or obese (less than 25.0 $kg \cdot m^{-2}$); overweight (25.0 to 29.9 $kg \cdot m^{-2}$); or obese (30 $kg \cdot m^{-2}$ or more).[27,28]

Measurement of physical activity and sedentary behaviour

Upon completion of the mobile examination centre visit, ambulatory respondents were asked to wear an Actical accelerometer (Phillips – Respironics, Oregon, USA) over their right hip on an elasticized belt during their waking hours for 7 days. The Actical (dimensions: 2.8 x 2.7 x 1.0 centimetres; weight: 17 grams) measures and records time-stamped acceleration in all directions, thereby indicating the intensity of physical activity. The digitized values are summed over a user-specified interval of 1 minute, resulting

Table 1
Selected characteristics of weighted sample, by age group and sex, household population aged 6 to 19 years, Canada, March 2007 to February 2009

	Age group (years)					
	6 to 10		11 to 14		15 to 19	
Characteristics	Boys	Girls	Boys	Girls	Boys	Girls
Total sample (number)	**369**	**340**	**256**	**248**	**184**	**211**
Age (years)	8.2	8.1	12.5	12.3	17.0	16.9
Height (cm)	133.9	131.6	158.9	156.9	175.6	166.2
Weight (kg)	32.5	29.9	52.1	50.6	72.4	62.5
BMI (kg/m^2)	17.8	17.0	20.3	20.4	23.4	22.6
BMI category* (%)						
Not overweight/obese	74.4	82.5	72.5	70.5	71.2	79.6
Overweight	17.1[E]	12.6[E]	21.5	23.0[E]	16.4[E]	10.3[E]
Obese	8.1[E]	4.9[E]	6.0[E]	6.5[E]	F	10.1

* International Obesity Task Force classification[26] up to age 17; adult classification used for 18- to 19-year-olds[27,28]
[E] use with caution
F too unreliable to be published
Source: 2007 to 2009 Canadian Health Measures Survey.

Table 2
Unweighted distribution of respondents, by valid days of accelerometer wear (10 or more wear hours), age group and sex, household population aged 6 to 19 years, Canada, March 2007 to February 2009

Age group (years)/ Sex	Number of valid days of accelerometer wear									
	0†	1	2	3	4	5	6	7	1 or more	4 or more
	% of respondents									
Total	**4.6**	**2.9**	**3.6**	**4.1**	**8.2**	**12.7**	**24.0**	**39.8**	**95.4**	**84.8**
6 to 10										
Boys	2.7	2.4	3.2	1.5	6.4	11.5	24.7	47.7	97.3	90.2
Girls	4.2	2.4	2.1	1.8	6.6	13.4	22.1	47.4	95.8	89.5
11 to 14										
Boys	4.4	2.0	1.7	5.1	6.4	11.9	30.5	38.0	95.6	86.8
Girls	3.2	2.8	3.6	2.1	7.8	12.1	23.1	45.2	96.8	88.3
15 to 19										
Boys	9.7	5.4	5.4	8.1	12.8	12.8	20.9	24.8	90.3	71.3
Girls	5.1	2.9	6.9	8.0	11.3	15.0	22.6	28.1	94.9	77.0

† agreed to wear accelerometer, but returned device with no valid data
Source: 2007 to 2009 Canadian Health Measures Survey.

Table 3
Physical activity intensity cut-points for Actical accelerometer[29,30]

Intensity	Activity energy expenditure ($kcal \cdot kg^{-1} \cdot min^{-1}$)	Physical activity ratio (EE/BMR)	Example	Accelerometer count range (counts per minute)
Sedentary	Less than 0.01	Less than 1.5	Car travel, sitting, reclining, standing	Less than 100*
Light	0.01 to less than 0.04	1.5 to less than 3.0	Walking less than 3.2 km/h, light play	100 to less than 1,500
Moderate	0.04 to less than 0.10	3.0 to less than 6.0	Walking more than 3.2 km/h, aerobics	1,500 to less than 6,500
Vigorous	0.10 or more	6.0 or more	Jogging, running	6,500 or more

EE = energy expenditure
BMR = basal metabloic rate
* including wear-time zeros

in a count value per minute (cpm). Accelerometer signals are also recorded as steps per minute. The Actical has been validated to measure physical activity in adults[31] and children,[29,32] and step counts in adults and children.[33]

The Actical has better instrument reliability[34] than other accelerometer models, and its omni-directional capability allows it to capture a wider range of movement than a uni-axial device. The Actical is waterproof, which may help with compliance, as respondents do not have to remove the device so often throughout the day.

The monitors were initialized to start collecting data at midnight following the mobile examination centre appointment. All data were blind to respondents while they wore the device. The monitors were returned to Statistics Canada in a prepaid envelope, where the data were downloaded and the monitor was checked to determine if it was still within the manufacturer's calibration specifications.[35]

Biologically implausible data were assessed to determine whether files should be included in final analyses.[35] Published guidelines were followed to identify and remove days with incomplete (invalid) accelerometer wear time.[35,36] A valid day was defined as 10 or more hours of monitor wear time; respondents with 4 or more valid days were retained for analyses.[36] Wear time was determined by subtracting nonwear time from 24 hours. Nonwear time was defined as at least 60 consecutive minutes of zero counts, with allowance for 1 to 2 minutes of counts between 0 and 100.

Time spent at various levels of movement intensity (sedentary, light, moderate, vigorous) is based on cut-points corresponding to each intensity level (Table 3). Attainment of different physical activity targets was examined:

1. Canadian and World Health Organization (WHO) recommendations: 60 minutes of MVPA daily.[11,13,14] Adherence was defined as the probability of accumulating at least 60 minutes of MVPA at least 6 days a week. Because it is not possible to calculate the probability of accumulating 60 minutes of MVPA on 7 out of 7 days a week, "daily" in the physical activity recommendations is defined as at least 6 days out of a possible 7.
   - The probability of accumulating at least 30, 60 and 90 minutes of MVPA on at least 1, 2, 3, 4 or 5 days a week was also calculated.
   - The probability of accumulating any vigorous physical activity 3 days a week was also calculated.
2. Step-count equivalent of approximately 60 minutes per day of MVPA; that is, 13,500 steps.[37-40] This was calculated as:
   - The percentage with average daily step counts of at least 13,500.[38]
   - The probability of accumulating 13,500 steps a day on at least 6 days a week.

To determine the probability that children and youth accumulate at least 60 (or 30 or 90) minutes of MVPA at least 6 days (or less) a week, the analytical approach was harmonized with that used in the United States to analyze the 2003 to 2004 National Health and Nutritional Examination Survey (NHANES) accelerometry data.[36] To maximize the sample size (important because only 39.8% of the sample aged 6 to 19 years

had 7 valid days of wear), a Bayesian approach was used to incorporate the information from all individuals with 4 or more valid days. An individual's probability of being active at least 6 out of 7 days was estimated using a Beta distribution for its observed combination of active and wear days. The estimated population prevalence is the weighted average of these individual probabilities. Further detail can be obtained elsewhere (http://riskfactor.cancer.gov/tools/nhanes_pam).[41]

Statistical analysis

All analyses were conducted with SAS Version 9.1 and were based on weighted data for respondents with at least 4 valid days. To account for the survey design effects of the CHMS, standard errors, coefficients of variation, and 95% confidence intervals were estimated using the bootstrap technique.[25,42,43] Comparisons of physical activity among age/sex groupings were made with pairwise contrasts. Differences between estimates were tested for statistical significance at $p<0.05$.

Results

Most hours sedentary

Total daily sedentary time for Canadian children and youth averages 8.6 hours (507 minutes for boys; 524 minutes for girls), or 62% of their waking hours. Sedentary time rises with increasing age (Table 4). Another 4 hours a day are spent in light intensity physical activity.

Boys average just over an hour a day (61 minutes) of MVPA, and girls, 47 minutes. Depending on the age group, boys accumulate 11 to 14 more minutes a day of MVPA than do girls. Overweight and obese boys accumulate less MVPA (51 and 44 minutes a day, respectively), compared with boys who are neither overweight nor obese (65 minutes). This gradient is not evident in girls—regardless of their BMI, girls average 44 to 48 minutes of MVPA a day.

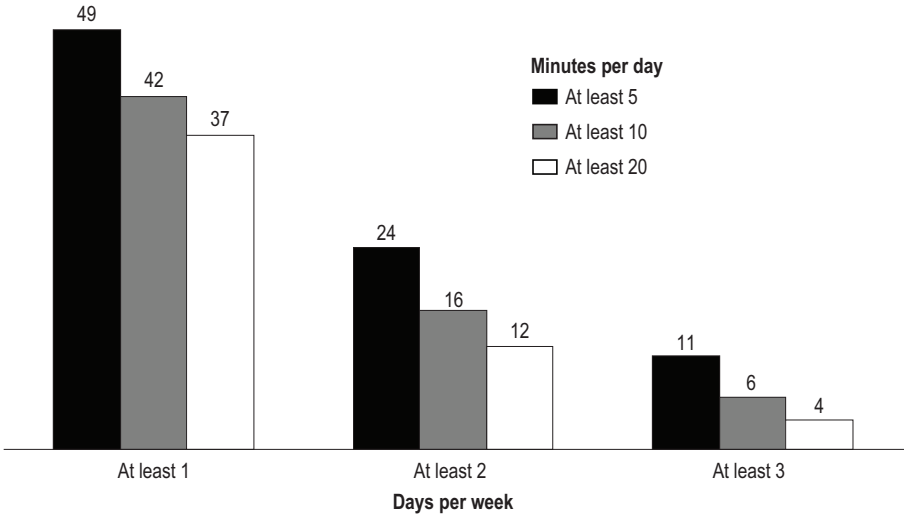
Almost all MVPA (97%) is accumulated at moderate intensity. Around 4% of Canadian children and

Table 4
Average daily minutes of activity at various levels of intensity and average daily step counts, by sex, age group and BMI category, household population aged 6 to 19 years, Canada, March 2007 to February 2009

Sex /Age group/ BMI category	Intensity of activity					Step counts
	Sedentary	Light	Moderate	Vigorous	Moderate-to-vigorous	
	Average minutes per day					Average
Boys	**507**	**260**	**59***	**2**	**61***	**12,121***
Age group (years)						
6 to 10†	445	298	67*	2	69*	13,217
11 to 14	524‡	252‡	58*	2	59*	11,857*
15 to 19	554*‡	230‡	52*‡	1	53*‡	11,267*‡
BMI category						
Not overweight/obese†	500*	262	64*	2	65*	12,584*
Overweight	524	260	50‡	1‡	51‡	11,188‡
Obese	536	248	43‡	<1‡	44‡	10,256
Girls	**524**	**252**	**46**	**1**	**47**	**10,327**
Age group (years)						
6 to 10†	446	306	56	2	58	11,745
11 to 14	527‡	250‡	46‡	2E	47‡	10,351‡
15 to 19	582‡	212‡	38‡	<3	39‡	9,204‡
BMI category						
Not overweight/obese†	524	249	46	2	48	10,224
Overweight	515	262	43	1E	44	10,450
Obese	544	263	47	<3	48	11,159

† reference category
* significantly different from estimate for girls ($p<0.05$)
‡ significantly different from estimate for reference category ($p<0.05$)
E use with caution
Source: 2007 to 2009 Canadian Health Measures Survey.

Figure 1
Percentage with at least 5, 10 and 20 minutes of vigorous physical activity a day, by number of days a week, household population aged 6 to 19 years, Canada, March 2007 to February 2009



Source: 2007 to 2009 Canadian Health Measures Survey.

youth accumulate 20 minutes of vigorous physical activity at least 3 days a week; 6% accumulate 10 minutes; and 11% accumulate 5 minutes (Figure 1).

Moderate-to-vigorous activity

According to results of the CHMS, 7% of Canadian children and youth (9% of boys and 4% of girls) accumulate at least 60 minutes of MVPA at least 6 days a week (Table 5). More than half of boys (53%) and a third (35%) of girls do so at least 3 days a week. The percentages accumulating 60 minutes of MVPA decline with increasing age (Figure 2).

Considerably higher percentages accumulate 30 minutes of MVPA a day: 29% of boys and 21% of girls do so at least 6 days a week. And substantial majorities of both sexes—83% of boys and 73% of girls—accumulate 30 minutes of MVPA at least 3 days a week.

Fewer than 2% children and youth accumulate 90 minutes of MVPA at least 6 days a week. However, 60% do so at least 1 day a week.

Step counts

Boys average 12,100 steps per day, and girls, 10,300 steps (Table 4). At ages 11 to 19 years, boys take more steps than do girls. Adolescents take fewer steps, compared with children aged 6 to 10 years. Overweight boys average significantly fewer steps than boys who are neither overweight nor obese, a relationship that does not exist for girls.

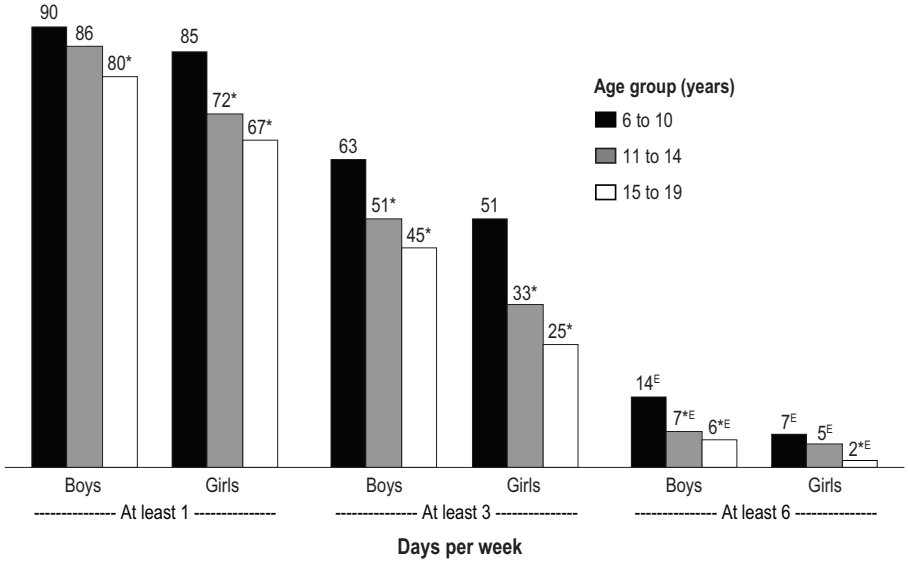
When the sum of step counts is averaged over valid days, 34% of boys and 19% of girls (27% overall) take at least 13,500 steps a day (Table 6). But the percentages accumulating 13,500 steps a day at least 6 days a week are much lower: 7% of boys and 3% of girls (5% overall).

Table 5
Percentage attaining selected physical activity criteria, by sex, household population aged 6 to 19 years, Canada, March 2007 to February 2009

Minutes of moderate-to-vigorous physical activity/Sex	Days active out of 7					
	At least 1	At least 2	At least 3	At least 4	At least 5	At least 6
At least 30						
Total	**94.9**	**87.6**	**77.7**	**64.5**	**47.1**	**25.3**
Boys	96.7*	91.1*	82.6*	70.1*	52.6*	29.0*
Girls	93.1	83.9	72.6	58.4	41.2	21.3
At least 60						
Total	**79.8**	**61.3**	**44.4**	**29.3**	**16.6**	**6.7**
Boys	85.2*	69.5*	52.9*	36.4*	21.5*	9.0*
Girls	73.9	52.6	35.4	21.7	11.3	4.1[E]
At least 90						
Total	**59.8**	**35.1**	**20.1**	**10.7**	**5.0[E]**	**1.7[E]**
Boys	66.3*	42.5*	26.0*	14.7*	7.1*[E]	2.5*[E]
Girls	52.9	27.3	13.7	6.5[E]	2.7[E]	<2

* significantly different from estimate for girls (p<0.05)
[E] use with caution
Source: 2007 to 2009 Canadian Health Measures Survey.

Figure 2
Percentage with at least 60 minutes of moderate-to-vigorous physical activity on at least 1, 3 or 6 days a week, by age group and sex, household population aged 6 to 19 years, Canada, March 2007 to February 2009



* significantly different from estimate for 6- to 10-year-olds of same sex (p<0.05)
[E] use with caution
Source: 2007 to 2009 Canadian Health Measures Survey.

Discussion

According to WHO and Canadian recommendations, to derive health benefits, children and youth should have at least 60 minutes of MVPA every day.[11,13,14] The CHMS data demonstrate that 7% attain this level of activity. A much higher percentage—44%—have 60 minutes of MVPA at least 3 days a week, which suggests that young Canadians tend to have long within-day sessions of activity rather than shorter episodes spread across more days of the week.

The new recommendations also state that the more physical activity, the greater the health benefit. Very few children and youth (less than 2%) have at least 90 minutes of MVPA on a daily basis. However, 60% attain this level

Table 6
Percentage attaining selected step-count, by age group and sex, household population aged 6 to 19 years, Canada, March 2007 to February 2009

Step count/ Age group (years)	Total	95% confidence interval		Boys	95% confidence interval		Girls	95% confidence interval	
	%	from	to	%	from	to	%	from	to
Average more than 13,500 steps per day									
Total	**26.5**	**17.3**	**35.7**	**33.7***	**23.1**	**44.2**	**18.8[E]**	**10.0**	**27.6**
6 to 10[†]	34.0	22.3	45.6	40.2	28.0	52.4	27.0[E]	14.3	39.7
11 to 14	26.8	19.7	33.9	31.3	22.6	40.0	20.7[E]	11.4	30.0
15 to 19	19.4[E]	8.8	30.0	29.5*[E]	13.6	45.4	11.0[‡E]	4.0	18.1
At least 13,500 steps on at least 6 days									
Total	**4.8[E]**	**2.8**	**6.8**	**6.7*[E]**	**4.1**	**9.2**	**2.8[E]**	**1.0**	**4.5**
6 to 10[†]	7.5[E]	3.4	11.6	9.7[E]	5.2	14.1	<9	...	...
11 to 14	4.6[E]	2.5	6.7	6.1[E]	2.6	9.5	2.7[E]	0.9	4.5
15 to 19	2.4[‡E]	0.8	4.1	4.2*[E‡]	1.4	7.1	<2[‡]	...	...

[†] reference category
* significantly different from estimate for girls (p<0.05)
[‡] significantly different from estimate for reference category (p<0.05)
[E] use with caution
... not available
Source: 2007 to 2009 Canadian Health Measures Survey.

of activity 1 day a week, which again suggests that MVPA occurs in long, but relatively infrequent, intervals. Analyses of self-reported data from the CHMS household questionnaire might clarify whether respondents with these activity patterns are likely to report participation in physical education classes and/or organized sports. Combining analyses of measured and self-reported data may help target public health interventions.

The guidelines recommend that children and youth have some *vigorous* activity at least 3 days a week,[11,13,14] but do not specify how much. However, according to the CHMS, few accumulate even modest daily amounts; half of children and youth do not have even 5 minutes of vigorous activity on at least 1 day a week. A very small group—fewer than 4%—have 20 minutes of vigorous activity at least 3 days a week. It is possible that vigorous activity is underestimated in this sample because of the relatively high accelerometer cut-point (6,500 cpm), which is based on a single study[29] and is considerably above the cut-point used for adults (3,962 cpm).[44] Research to establish an evidence base for these cut-points is warranted.

Since 2005, the CANPLAY survey has collected pedometer data on a nationally representative sample of children and youth (www.cflri.ca).[45,46] The most recent analysis from that survey indicates that 31% of children and youth take a daily average of at least 13,500 steps,[1,45] similar to the corresponding CHMS figure of 27%. As well, both surveys show that boys take more steps compared with girls, and the number of steps per day declines by about 20% from the youngest to the oldest age group.

The CHMS data show that just under 5% of children and youth take 13,500 steps at least 6 days a week—a result consistent with the 7% value observed in the accelerometer count data for accumulating 60 minutes of MVPA at least 6 days a week. The agreement between the accelerometer and pedometer output is, of course, expected because the data come from the same device.

While the CHMS accelerometer data show that children and youth spend about 8.6 hours a day in sedentary pursuits, these data do not indicate what types of activities the 8.6 hours comprise. Given that other surveys have shown that Canadian youth spend at least 6 hours a day in front of screens,[1] much of the sedentary time identified by the CHMS is likely screen time. What happens during the remaining sedentary hours is less clear. Research combining accelerometer and self-reported data would be helpful in determining contexts in which sedentary behaviour occurs, and thereby, developing strategies and targets for intervention.

In the United States, physical activity was measured by accelerometry (Actigraph, Ft. Walton Beach, FL) as part of the 2003 to 2006 NHANES.[36] While the accelerometer models used in the NHANES and CHMS differed, data reduction and analytical approaches were harmonized,[35] thereby making results somewhat comparable. Canadian children and youth appear to be slightly more sedentary than their American counterparts: 8.6 versus 6 to 8 hours a day.[47] American children aged 6 to 11 years are more likely to accumulate 60 minutes of daily MVPA, compared with Canadian children aged 6 to 10 years. Conversely, Canadians aged 11 to 19 years are more likely than American adolescents to accumulate 60 minutes of daily MVPA. The percentage accumulating at least 60 minutes of MVPA at least 5 days a week is higher among adolescent boys in Canada than in the United States, but similar among adolescent girls in the two countries. Accelerometer data collected on a large sample of children aged 9 to 15 years in England indicate that even fewer (2.5%) accumulate 60 minutes of MVPA a day.[48] Ongoing measurement of physical activity levels in various countries with harmonized methodology will contribute important information to global health surveillance efforts.

Strengths and limitations

The consistency between the CHMS step-count data and findings from the CANPLAY survey (which uses a different type of pedometer) provides validation for both devices. It also suggests that comparisons between accelerometer- and pedometer-measured activity are possible, an important

What is already known on this subject?

- Low levels of physical activity and increased time devoted to sedentary pursuits are associated with childhood obesity.
- Obesity is rising and fitness is declining among Canadian children and youth.
- Yet according to self-reports, the majority of young Canadians are at least moderately active.

What does this study add?

- Boys and girls are sedentary about 8.5 hours a day.
- About 7% of Canadian children and youth accumulate at least 60 minutes of moderate-to-vigorous physical activity (MVPA) at least 6 days a week.
- On average, boys engage in an hour of MVPA per day, and girls, three-quarters of an hour.

finding because both devices will likely continue to be used in the future. A unique advantage of accelerometers is their ability to provide a daily profile of sedentary, light, moderate and vigorous movement. Pedometers are cheaper and have a lower analytical burden, thus allowing larger sample sizes, and in turn, finer breakdowns of results (for example, provincial/territorial). The consistency within direct measurement devices is notable, given the lack of correlation and high bias between self-reported and directly measured physical activity.[49,50]

Because accelerometers and pedometers cannot accurately capture activities that are not step-based, such as swimming and cycling, overall physical activity may be underestimated. As well, accelerometers and pedometers do not measure the added energy expenditure associated with upper body movement, load carrying, or walking up an incline.

The cut-points chosen to delineate sedentary behaviour and light, moderate and vigorous physical activity are based on limited data. Unlike other accelerometer models (for example, the Actigraph), few studies have published cut-points specifically for the Actical.[29-32,51]

The overall CHMS response rate was 40.8%. Although adjustments were made to the sampling weights to compensate, estimates may be biased by systematic differences between respondents and non-respondents. Non-respondents tended to be older, male and more obese, so they might be less active, and the data in this analysis could slightly overestimate physical activity.

Conclusion

Using data from the first cycle of the Canadian Health Measures Survey, this study examines accelerometer-measured physical activity and sedentary behaviour in a nationally representative sample of Canadian children and youth

Physical activity levels are low, with six out of ten waking hours devoted to sedentary pursuits. Persistence of these lifestyle choices among young people could hasten the onset and development of chronic diseases.[5,11] The CHMS data provide a baseline for tracking the effectiveness of interventions and policy initiatives aimed at reversing current trends in obesity and fitness.

Inconsistency between self-reported and directly measured physical activity data[49,50] has made understanding trends difficult.[52] As the number of measurement approaches grows, differences between physical activity outcomes when they are measured by self-report, pedometers, and accelerometers should be examined. One method does not replace another, and the unique strengths and limitations of each must be considered when choosing an analytical approach. ■

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Potential years of life lost at ages 25 to 74 among Status Indians, 1991 to 2001

by Michael Tjepkema, Russell Wilkins, Jennifer Pennock and Neil Goedhuis

Abstract

Background
Compared with other Canadians, First Nations peoples experience a disproportionate burden of illness and disease. Potential years of life lost (PYLL) before age 75 highlights the impact of youthful or early deaths.

Data and methods
The 1991 to 2001 Canadian census mortality follow-up study tracked a 15% sample of adults aged 25 or older over more than a decade. This study examined mortality among people aged 25 to 74—55,600 Status Indians (39,200 on reserve and 16,500 off reserve) and 2,475,700 non-Aboriginal adults—all of whom were enumerated by the 1991 census long-form questionnaire. Age-standardized PYLL rates were calculated, based on the number of person-years at risk before age 75.

Results
Status Indian adults had 2.5 times the risk of dying before age 75, compared with non-Aboriginal adults. Results did not differ greatly by residence on or off reserve. Relative and absolute inequalities were greatest for unintentional and intentional injuries. Socio-economic factors such as income, education, housing and employment explained a substantial share of the disparities in premature death.

Interpretation
Status Indian adults had higher rates of premature mortality. Socio-economic factors played an important role in those disparities. Injuries were important contributors to both relative and absolute inequalities.

Keywords
Aboriginal, cause of death, death rate, First Nations, indigenous, life expectancy, longevity, mortality

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Compared with other Canadians, First Nations peoples experience a disproportionate burden of illness and disease,[1-3] which is reflected in shorter life expectancy. For Status Indians, life expectancy at birth is 8 years less for men and 7 years less for women.[4] Life expectancy, however, tends to be dominated by deaths at older ages. A complementary way of examining mortality is to focus on premature mortality, specifically, potential years of life lost (PYLL) before age 75. PYLL sums the additional years people would have lived if they had had a full lifespan.[5]

The rate of premature death, and by extension, PYLL, is higher for Status Indians than for other Canadians.[6-9] Possible reasons include differences in broad social determinants of health, such as income, education, and housing quality[10] that are experienced over a lifetime.[11] Despite their importance,[12,13] these factors have not usually been included in analyses of mortality differences between Aboriginal and non-Aboriginal populations.[13] However, with the 1991 to 2001 Canadian census mortality follow-up study, it is possible to examine the effect of socio-economic variables on the disparity in premature death between Status Indian and non-Aboriginal adults.

This article presents estimates of PYLL at ages 25 to 74 for Status Indians living on or off reserve, identifies the causes of death for which disparities between Status Indians and non-Aboriginal Canadians were greatest, and examines the effects of socio-economic factors on those differences.

Methods

Data sources

The 1991 to 2001 Canadian census mortality follow-up study is a probabilistically linked cohort consisting of a 15% sample (n = 2,735,152) of the non-institutional population aged 25

or older, all of whom were enumerated via the 1991 census long-form questionnaire.[14] This cohort was tracked for mortality from June 4, 1991 through December 31, 2001.

Because names were not captured on the census database, but were needed for linkage to the mortality database, creation of the cohort required two probabilistic linkages. First, eligible census respondents were linked to a nominal list (name) file (abstracted from 1990 and 1991 tax-filer data and then encrypted) using common variables such as date of birth, postal code, and spousal date of birth (if applicable); 80% of eligible respondents were successfully matched. Second, the census plus encrypted names were matched to the Canadian Mortality Database.[15] Based on 1991 deaths, which could be identified independently in the Canadian Mortality Database and/or the name file, ascertainment of deaths among the cohort overall from 1991 to 2001 was estimated at 97%, and 95% to 96% among cohort members reporting any Aboriginal ancestry, Registered Indian status, or membership in an Indian Band or First Nation.

Eligibility

People enumerated by the 1991 census long-form questionnaire who had reached age 25 by census day were eligible to be part of the cohort. The long form, which was usually given to 1 in 5 households, was administered to all residents of Indian reserves, many remote and northern communities, and non-institutional collective dwellings. However, 78 Indian reserves, representing about 38,000 people, were either not enumerated or incompletely enumerated,[16] and thus, were not part of the cohort. As well, data quality reports found that the 1991 census missed 3.4% of Canadian residents; these individuals were more likely to be young, mobile, low income, of Aboriginal ancestry,[17] or homeless.

Because it was necessary to obtain encrypted names from taxation data, only tax-filers could be followed for mortality. Under Section 87 of the *Indian Act*, Status Indians are entitled to an exemption for income earned or considered to be earned on a reserve.[18]

Owing to the exclusion of institutional residents and non-tax-filers, life expectancy of the cohort at age 25 was 1 year longer for men and 2 years longer for women, compared with 1995 to 1997 life tables for all Canada. This bias would apply equally to Aboriginal and non-Aboriginal cohort members and should not appreciably affect relative differences between the two groups.

Analytical techniques

The cohort was divided into ten one-year follow-up periods (June 4, 1991 to June 3, 1992; June 4, 1992 to June 3, 1993; and so on) and one seven-month period (June 4, 2001 to December 31, 2001). Age was transformed from age at baseline (June 4, 1991) to age at the beginning of each year of follow-up. Deaths and person-years at risk were calculated separately for each follow-up period, and then pooled by five-year age group (determined at the beginning of each year of follow-up).

Deaths before age 75 were considered premature. The number of potential years of life lost (PYLL) was calculated by multiplying the number of deaths in each age group by the mean number of potential years of life lost for the same age group. For example, the death of someone aged 25 to 29 would contribute 47.5 potential years of life lost before age 75.

To calculate rates of PYLL, the number of person-years at risk (up to age 75) was determined for each five-year age group, and the rates were age-standardized to the Aboriginal population. The Aboriginal age distribution was based on those in the cohort who indicated an Aboriginal ancestry, registration under the *Indian Act of Canada*, or membership in an Indian Band or First Nation. Confidence intervals for the age-standardized rates were produced from variances derived using the Spiegelman method.[19]

Premature mortality (Cox models)

For each cohort member, person-days of follow-up were calculated from baseline (June 4, 1991) to the date of death, emigration (known only for 1991), end of study (December 31, 2001), or until the person reached age 75. Because exact date of birth was not available on the analysis file, age in completed years (as of June 4 of each follow-up year) was used to derive age at death and person-years of follow-up.

Cox proportional mortality hazard ratios were used to estimate the effect of socio-economic factors on the disparity in premature mortality between Status Indians and non-Aboriginal adults. All models were sex-specific and were run separately for Status Indians on and off reserve. The base model (Model 1) controlled only for age. Models 2 to 7 controlled for age and one other socio-economic factor. The full model (Model 8) controlled for age and all socio-economic factors simultaneously. Differences in excess mortality (1 minus the hazard ratio) comparing the full model to the base model were interpreted as estimates of the effect of the socio-economic variables on the disparities. The variables controlled for were age, marital status (married/common-law, not married), single parent (yes, no), educational attainment (less than secondary graduation, secondary graduation, postsecondary diploma, university degree), income adequacy quintile, labour force status (in, not in), crowding (more than one person per room; yes, no); home ownership (yes, no), dwelling in need of major repairs (yes, no), and urban population size (1 million or more; 500,000 to 999,999; 100,000 to 499,999; 10,000 to 99,999; less than 10,000).

Cause of death

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)[20] for deaths occurring from 1991 through 1999, and to the *Tenth Revision* (ICD-10)[21] for deaths occurring in 2000 or 2001. Deaths were also grouped by the Global Burden of

Disease categories, which underscore human development rather than the body system,[22] and by risk factors, namely, smoking-related,[23] alcohol-related[23] and drug-related diseases[24] or premature deaths that are potentially amenable to medical intervention.[23]

Definitions

Registered Indian status was determined by a direct census question: "Is this person a *Registered Indian* as defined by the Indian Act of Canada?" (yes, no). A respondent answering "yes" was considered a Status Indian.

Place of residence was determined for June 4, 1991; subsequent mobility was not tracked. Indian reserves were defined to include the following types of census subdivisions: Indian government district; Indian reserve; Indian settlement; Terres réservées; Village Cri; Village Naskapi; Village nordique. All other areas were classified as off reserve.

Results

Baseline characteristics

The demographic and socio-economic characteristics of Status Indian cohort members differed from those of non-Aboriginal members and also varied by on- or off-reserve residence (Appendix Table A). Compared with non-Aboriginal adults, Status Indians were younger and less likely to be legally married. Status Indians, particularly those living on reserves, were less likely to have completed secondary school, to be employed, and to be homeowners, and were more likely to be in the two lowest income adequacy quintiles and to live in crowded conditions and in dwellings needing major repairs.

Status Indians tended to die earlier than did non-Aboriginal people. Of all deaths of Status Indian cohort members that occurred at ages 25 to 74, 28% were at ages 65 to 74, compared with more than 50% of the non-Aboriginal deaths (Appendix Table B).

Table 1
Age-standardized rate ratios (RR) for potential years of life lost at ages 25 to 74 for Status Indian men living on and off reserve, compared with non-Aboriginal men, by cause of death, non-institutional cohort members, Canada, 1991 to 2001

	Total			On reserve			Off reserve		
		95% confidence interval			95% confidence interval			95% confidence interval	
	RR	from	to	RR	from	to	RR	from	to
All causes	**2.45**	**2.26**	**2.66**	**2.67**	**2.43**	**2.93**	**1.88**	**1.61**	**2.21**
Communicable, maternal, perinatal and nutritional conditions	1.42	1.01	2.01	1.49	0.99	2.26	1.25	0.72	2.17
Infectious and parasitic diseases	0.96	0.59	1.56	0.96	0.52	1.78	0.97	0.50	1.86
HIV/AIDS	0.72	0.36	1.43	0.74	0.31	1.77	0.67	0.28	1.65
Respiratory infections	5.86	3.69	9.32	6.58	3.98	10.88	4.01	1.45	11.05
Non-communicable diseases	1.76	1.60	1.93	1.85	1.67	2.06	1.50	1.22	1.85
Malignant neoplasms	0.97	0.81	1.16	0.93	0.76	1.14	1.06	0.73	1.54
Stomach cancer	2.01	1.14	3.54	1.86	0.94	3.67	2.38	0.87	6.52
Colon and rectal cancers	1.41	0.67	2.98	0.71	0.40	1.25	3.22	1.04	9.98
Pancreas cancer	0.83	0.46	1.48	0.54	0.22	1.33	1.67	0.81	3.46
Trachea, bronchus and lung cancers	0.86	0.68	1.10	0.75	0.56	1.00	1.16	0.76	1.78
Prostate cancer	1.11	0.67	1.84	0.92	0.46	1.87	1.71	0.88	3.31
Lymphomas and multiple myeloma	0.83	0.51	1.35	0.88	0.50	1.56	0.71	0.29	1.71
Diabetes mellitus	4.98	3.75	6.63	5.70	4.17	7.79	2.95	1.56	5.57
Neuropsychiatric conditions	4.21	2.98	5.95	4.76	3.20	7.06	2.78	1.52	5.07
Alcohol use disorders	13.08	9.04	18.93	15.29	10.24	22.84	7.25	3.17	16.58
Cardiovascular diseases	1.71	1.48	1.98	1.74	1.48	2.04	1.63	1.17	2.26
Ischemic heart disease	1.66	1.43	1.92	1.73	1.46	2.04	1.45	1.05	1.99
Cerebrovascular disease	1.88	1.05	3.37	1.45	0.93	2.27	3.00	0.92	9.77
Respiratory diseases	2.39	1.58	3.60	2.94	1.87	4.60	0.91	0.43	1.91
Chronic obstructive pulmonary disease	1.52	0.96	2.39	1.75	1.06	2.89	0.83	0.29	2.43
Digestive diseases	4.00	3.01	5.33	4.80	3.49	6.60	1.87	1.12	3.13
Cirrhosis of the liver	4.57	3.06	6.80	5.47	3.50	8.55	2.20	1.14	4.23
Genitourinary diseases	6.28	3.07	12.85	x	x	x	x	x	x
Injuries	3.72	3.23	4.27	4.09	3.49	4.78	2.74	2.08	3.61
Unintentional injuries	4.57	3.85	5.41	4.91	4.06	5.93	3.67	2.62	5.13
Road traffic accidents	4.09	3.11	5.37	4.54	3.37	6.13	2.88	1.62	5.15
Poisonings	3.12	2.01	4.83	2.79	1.67	4.67	3.94	1.89	8.20
Falls	2.56	1.41	4.63	2.85	1.57	5.17	1.76	0.34	9.16
Fires	6.53	2.99	14.30	7.68	3.21	18.40	3.52	1.15	10.80
Drownings	10.45	6.00	18.18	8.85	4.69	16.69	14.59	6.19	34.41
Intentional injuries	2.79	2.16	3.60	3.21	2.41	4.26	1.71	1.04	2.82
Self-inflicted injuries (suicide)	2.39	1.78	3.20	2.88	2.10	3.95	1.11	0.54	2.25
Violence (homicide)	6.84	3.95	11.83	6.29	3.10	12.75	8.22	4.14	16.36
Ill-defined	5.64	3.76	8.45	6.90	4.42	10.78	2.32	1.23	4.37
Risk factor-related									
Smoking-related	1.08	0.88	1.31	1.07	0.84	1.35	1.10	0.77	1.58
Alcohol-related	8.51	6.57	11.01	9.50	7.12	12.69	5.87	3.59	9.59
Drug-related	1.60	1.02	2.51	1.50	0.88	2.56	1.86	0.85	4.06
Amenable to medical intervention	1.43	1.09	1.87	1.42	1.05	1.92	1.43	0.81	2.54

x suppressed to meet the confidentiality requirements of the Statistics Act
Note: Reference population (person-years at risk) for age-standardization was taken from Aboriginal age distribution (five-year age groups).
Source: 1991 to 2001 Canadian census mortality follow-up study.

Table 2
Age-standardized rate ratios (RR) for potential years of life lost at ages 25 to 74 for Status Indian women living on and off reserve, compared with non-Aboriginal women, by cause of death, non-institutional cohort members, Canada, 1991 to 2001

	Total			On reserve			Off reserve		
		95% confidence interval			95% confidence interval			95% confidence interval	
	RR	from	to	RR	from	to	RR	from	to
All causes	**2.64**	**2.43**	**2.86**	**2.72**	**2.47**	**2.99**	**2.46**	**2.15**	**2.81**
Communicable, maternal, perinatal and nutritional conditions	4.79	3.35	6.85	3.95	2.81	5.55	6.64	3.47	12.71
Infectious and parasitic diseases	4.01	2.64	6.08	3.28	2.01	5.34	5.54	2.95	10.41
HIV/AIDS	3.42	1.52	7.73	1.30	0.37	4.56	7.92	3.06	20.50
Respiratory infections	8.19	4.43	15.14	6.55	4.00	10.73	11.92	3.69	38.45
Non-communicable diseases	2.12	1.95	2.31	2.15	1.95	2.38	2.05	1.76	2.39
Malignant neoplasms	1.22	1.06	1.40	1.14	0.98	1.32	1.40	1.06	1.85
Stomach cancer	1.58	0.83	2.97	1.40	0.69	2.88	1.87	0.58	5.96
Colon and rectal cancers	1.76	1.20	2.58	1.80	1.15	2.83	1.68	0.84	3.34
Pancreas cancer	0.73	0.40	1.32	0.86	0.44	1.69	0.44	0.13	1.52
Trachea, bronchus and lung cancers	1.00	0.77	1.30	1.10	0.81	1.49	0.76	0.45	1.30
Breast cancer	0.85	0.64	1.13	0.79	0.55	1.13	0.97	0.62	1.53
Cervix uteri cancer	3.93	2.34	6.62	3.32	2.05	5.37	5.37	1.99	14.47
Ovarian cancer	0.95	0.55	1.65	0.88	0.45	1.72	1.12	0.44	2.81
Lymphomas and multiple myeloma	0.71	0.38	1.34	0.69	0.33	1.47	0.75	0.24	2.34
Diabetes mellitus	7.61	5.80	9.99	9.06	6.76	12.14	4.56	2.76	7.53
Neuropsychiatric conditions	3.47	2.48	4.85	2.93	1.89	4.54	4.62	2.88	7.42
Alcohol use disorders	16.75	9.70	28.93	11.43	5.64	23.16	27.96	14.84	52.65
Cardiovascular diseases	2.66	2.27	3.13	2.89	2.38	3.52	2.19	1.71	2.81
Ischemic heart disease	2.22	1.80	2.74	2.34	1.83	3.00	1.99	1.36	2.90
Cerebrovascular disease	3.09	2.35	4.07	3.47	2.51	4.78	2.32	1.45	3.73
Respiratory diseases	3.57	2.20	5.80	4.39	2.52	7.65	1.78	0.97	3.25
Chronic obstructive pulmonary disease	1.52	0.96	2.40	1.53	0.93	2.53	1.42	0.57	3.55
Digestive diseases	7.49	5.80	9.69	7.72	5.63	10.60	6.93	4.82	9.99
Cirrhosis of the liver	9.63	7.08	13.10	8.63	5.83	12.76	11.65	7.53	18.00
Genitourinary diseases	3.71	2.20	6.27	3.18	1.78	5.66	4.72	2.10	10.59
Injuries	4.54	3.70	5.57	5.18	4.07	6.59	3.10	2.31	4.17
Unintentional injuries	5.27	4.09	6.81	5.72	4.22	7.76	4.27	2.99	6.09
Road traffic accidents	3.95	2.78	5.61	4.52	3.01	6.77	2.70	1.56	4.66
Poisonings	14.55	8.68	24.41	16.53	9.01	30.33	10.20	4.91	21.18
Falls	2.46	1.00	6.03	1.68	0.50	5.64	4.11	1.21	13.96
Fires	4.30	1.40	13.21	x	x	x	x	x	x
Drownings	6.52	2.27	18.70	x	x	x	x	x	x
Intentional injuries	3.73	2.58	5.39	4.86	3.26	7.24	1.24	0.65	2.39
Self-inflicted injuries (suicide)	2.79	1.75	4.44	3.71	2.26	6.10	0.76	0.30	1.94
Violence (homicide)	8.61	4.50	16.45	10.80	5.32	21.92	3.75	1.46	9.65
Ill-defined	3.90	2.47	6.15	2.99	1.85	4.85	5.88	2.75	12.58
Risk factor-related									
Smoking-related	1.18	0.88	1.59	1.26	0.86	1.83	1.00	0.67	1.49
Alcohol-related	13.34	9.99	17.80	11.80	8.23	16.92	16.42	11.17	24.13
Drug-related	6.60	4.29	10.16	7.42	4.42	12.46	4.75	2.68	8.39
Amenable to medical intervention	2.04	1.71	2.42	1.92	1.59	2.32	2.30	1.65	3.20

x suppressed to meet the confidentiality requirements of the Statistics Act
Note: Reference population (person-years at risk) for age-standardization was taken from Aboriginal age distribution (five-year age groups).
Source: 1991 to 2001 Canadian census mortality follow-up study.

Causes of death

Among Status Indians overall, non-communicable diseases accounted for the highest percentage of total potential years of life lost (PYLL) (53% for men, 69% for women), followed by injuries (38% and 21%) (Appendix Table C). Noteworthy contributors to total PYLL were cardiovascular diseases (19% and 14%), malignant neoplasms (13% and 25%), digestive diseases (6% and 9%), unintentional injuries (26% and 14%) such as road traffic accidents, and intentional injuries (11% and 7%) such as suicide.

The percentage distribution of total PYLL by major cause of death among Status Indians was generally similar whether they resided on or off reserve. However, the percentage of PYLL due to intentional injuries (suicide, homicide) was twice as high for Status Indian women living on than off reserve (8% versus 4%). Malignant neoplasms accounted for a larger share of total PYLL for Status Indian men living off than on reserve (17% versus 12%).

PYLL was also classified as being due to deaths caused by smoking-, alcohol- and drug-related diseases or to diseases that are potentially amenable to medical intervention (for example, cerebrovascular diseases, hypertension, breast cancer, pneumonia/influenza). For Status Indians, the percentages of PYLL attributable to deaths in these categories were: smoking-related (6% for both sexes), alcohol-related (8% for men and 7% for women), drug-related (2% and 5%), and amenable to medical intervention (8% and 20%). The percentages were similar for Status Indians living on and off reserve.

Relative inequalities

The age-standardized rate of PYLL was about two and half times as high for Status Indians as for non-Aboriginal adults, reflecting higher rate ratios for most causes of death (Tables 1 and 2). For all causes combined, the relative inequality was greater among Status Indian men living on than off reserve, but similar for Status Indian women on and off reserve.

Table 3
Age-standardized rate differences (RD) for potential years of life lost at ages 25 to 74 for Status Indian men living on and off reserve, compared with non-Aboriginal men, by cause of death, non-institutional cohort members, Canada, 1991 to 2001

	Total			On reserve			Off reserve		
		95% confidence interval			95% confidence interval			95% confidence interval	
	RD	from	to	RD	from	to	RD	from	to
All causes	**8,692**	**7,532**	**9,852**	**9,976**	**8,529**	**11,423**	**5,293**	**3,504**	**7,082**
Communicable, maternal, perinatal and nutritional conditions	194	-26	414	226	-53	504	116	-197	428
Infectious and parasitic diseases	-16	-208	176	-16	-260	228	-13	-272	245
HIV/AIDS	-100	-277	78	-93	-322	137	-116	-331	99
Respiratory infections	212	104	321	244	110	378	131	-43	306
Non-communicable diseases	2,669	2,094	3,244	3,003	2,330	3,676	1,757	660	2,854
Malignant neoplasms	-53	-330	224	-107	-406	193	98	-520	715
Stomach cancer	60	-7	128	52	-24	127	83	-61	226
Colon and rectal cancers	60	-93	212	-42	-100	17	321	-205	848
Pancreas cancer	-14	-51	24	-36	-75	2	52	-42	146
Trachea, bronchus and lung cancers	-58	-146	30	-104	-196	-12	69	-139	277
Prostate cancer	5	-20	30	-3	-33	26	32	-19	83
Lymphomas and multiple myeloma	-23	-78	32	-16	-84	52	-39	-124	45
Diabetes mellitus	378	252	503	446	286	605	185	9	361
Neuropsychiatric conditions	500	283	718	586	302	870	277	20	534
Alcohol use disorders	428	271	586	507	305	709	222	12	431
Cardiovascular diseases	878	569	1,188	912	568	1,255	774	116	1,432
Ischemic heart disease	530	333	727	589	359	819	360	-14	735
Cerebrovascular disease	124	-29	277	63	-27	154	282	-216	780
Respiratory diseases	129	40	217	180	60	299	-9	-72	54
Chronic obstructive pulmonary disease	26	-9	60	38	-6	82	-8	-53	37
Digestive diseases	549	347	752	695	423	967	160	-15	334
Cirrhosis of the liver	370	186	555	464	215	713	125	-24	273
Genitourinary diseases	184	33	335	x	x	x	x	x	x
Injuries	4,946	4,053	5,839	5,624	4,505	6,742	3,170	1,818	4,521
Unintentional injuries	3,351	2,677	4,025	3,670	2,847	4,493	2,508	1,372	3,644
Road traffic accidents	1,282	852	1,713	1,472	939	2,005	783	99	1,467
Poisonings	225	91	359	190	45	335	312	13	610
Falls	87	9	165	103	15	191	42	-118	203
Fires	199	36	362	240	21	459	90	-44	225
Drownings	476	234	719	396	148	644	685	96	1,274
Intentional injuries	1,511	931	2,091	1,861	1,108	2,613	601	-114	1,316
Self-inflicted injuries (suicide)	1,069	544	1,595	1,449	762	2,137	82	-524	689
Violence (homicide)	419	178	661	380	80	680	519	139	899
Ill-defined	883	468	1,297	1,124	561	1,687	251	-25	527
Risk factor-related									
Smoking-related	46	-81	173	41	-109	192	62	-174	298
Alcohol-related	967	706	1,228	1,095	763	1,427	627	263	991
Drug-related	102	-16	221	85	-48	218	146	-98	390
Amenable to medical intervention	306	32	580	303	1	605	311	-279	902

x suppressed to meet the confidentiality requirements of the Statistics Act
Note: Reference population (person-years at risk) for age-standardization was taken from Aboriginal age distribution (five-year age groups).
Source: 1991 to 2001 Canadian census mortality follow-up study.

Rate ratios for most communicable and non-communicable diseases were elevated—substantially for some causes. Among Status Indian men, these causes included alcohol use disorders, genitourinary diseases, respiratory infections, diabetes mellitus, and cirrhosis of the liver. Among Status Indian women, rate ratios were particularly high for alcohol use disorders, cirrhosis of the liver, respiratory infections, diabetes mellitus, and infectious and parasitic diseases.

Rate ratios were also high for deaths due to injuries, particularly drowning, violence, fires, road traffic accidents, and poisoning. The magnitude of these relative inequalities was greater among women living on reserve, notably so for suicides (self-inflicted injuries) and violence.

Rate ratios were high for alcohol-related deaths among Status Indians of both sexes, and for drug-related deaths among Status Indian women. However, rate ratios were not statistically elevated for smoking-related deaths, and modestly elevated for deaths amenable to medical intervention.

Absolute inequalities

Among Status Indian men, the overall rate difference, or "excess PYLL," was 8,692 years per 100,000 person-years at risk (9,976 years on reserve; 5,293 years off reserve) (Table 3). Among Status Indian women, excess PYLL was 5,128 years per 100,000 person-years at risk (5,386 years on reserve; 4,561 years off reserve) (Table 4).

More than half (57%) of excess PYLL among Status Indian men was due to injuries, followed by non-communicable diseases (31%) and communicable diseases (2%) (percentages not shown). Percentages were similar for those on and off reserve.

Results differed for Status Indian women, among whom non-communicable diseases contributed the largest share (53%) of excess PYLL, followed by injuries (35%) and communicable diseases (7%) (percentages not shown). The percentage due to injuries for Status Indian women living on reserve was

Table 4
Age-standardized rate differences (RD) for potential years of life lost at ages 25 to 74 for Status Indian women living on and off reserve, compared with non-Aboriginal women, by cause of death, non-institutional cohort members, Canada, 1991 to 2001

	Total			On reserve			Off reserve		
		95% confidence interval			95% confidence interval			95% confidence interval	
	RD	from	to	RD	from	to	RD	from	to
All causes	**5,128**	**4,487**	**5,769**	**5,386**	**4,582**	**6,189**	**4,561**	**3,535**	**5,588**
Communicable, maternal, perinatal and nutritional conditions	348	206	490	270	160	381	517	133	901
Infectious and parasitic diseases	162	84	240	123	44	201	245	67	422
HIV/AIDS	53	-1	107	7	-28	41	151	2	301
Respiratory infections	178	62	294	138	67	208	271	-69	610
Non-communicable diseases	2,742	2,314	3,169	2,825	2,309	3,341	2,572	1,814	3,331
Malignant neoplasms	341	81	601	219	-41	479	613	11	1,215
Stomach cancer	22	-15	59	15	-23	53	33	-49	115
Colon and rectal cancers	90	12	167	95	0	189	80	-56	215
Pancreas cancer	-14	-37	9	-7	-37	23	-29	-57	0
Trachea, bronchus and lung cancers	0	-78	77	30	-68	128	-70	-189	49
Breast cancer	-66	-169	38	-91	-213	31	-11	-199	177
Cervix uteri cancer	207	72	341	163	60	267	308	-60	675
Ovarian cancer	-4	-50	42	-11	-63	41	10	-80	101
Lymphomas and multiple myeloma	-24	-61	14	-25	-68	19	-20	-90	50
Diabetes mellitus	325	245	406	397	289	504	175	69	282
Neuropsychiatric conditions	223	125	320	174	63	285	327	137	517
Alcohol use disorders	195	115	275	129	45	213	334	161	507
Cardiovascular diseases	764	574	954	870	618	1,122	547	300	794
Ischemic heart disease	246	155	337	270	157	383	199	49	349
Cerebrovascular disease	253	155	350	298	169	428	160	29	291
Respiratory diseases	186	67	306	246	76	416	57	-19	132
Chronic obstructive pulmonary disease	17	-5	40	18	-7	43	14	-29	57
Digestive diseases	621	452	790	643	421	865	568	335	800
Cirrhosis of the liver	380	262	497	336	196	475	468	256	681
Genitourinary diseases	72	30	115	58	16	100	99	5	194
Injuries	1,800	1,364	2,236	2,126	1,530	2,723	1,070	618	1,521
Unintentional injuries	1,147	823	1,470	1,266	832	1,700	876	490	1,263
Road traffic accidents	493	283	703	588	304	872	284	47	522
Poisonings	399	197	600	457	180	733	271	61	480
Falls	17	-8	42	8	-16	32	37	-21	95
Fires	35	-8	79	x	x	x	x	x	x
Drownings	39	-5	82	x	x	x	x	x	x
Intentional injuries	604	316	891	853	445	1,261	54	-124	232
Self-inflicted injuries (suicide)	331	99	563	502	172	833	-45	-177	88
Violence (homicide)	272	103	442	351	111	590	98	-20	217
Ill-defined	238	103	373	164	53	275	402	44	759
Risk factor-related									
Smoking-related	68	-62	199	96	-79	271	-1	-151	149
Alcohol-related	525	390	661	460	299	622	657	412	901
Drug-related	530	276	783	607	258	957	354	106	602
Amenable to medical intervention	800	537	1,064	712	436	988	1,002	417	1,586

x suppressed to meet the confidentiality requirements of the Statistics Act
Note: Reference population (person-years at risk) for age-standardization was taken from Aboriginal age distribution (five-year age groups).
Source: 1991 to 2001 Canadian census mortality follow-up study.

39%, compared with 23% for those off reserve.

For Status Indian men, road traffic accidents and suicides were large contributors to excess PYLL. Suicide was a larger contributor for those living on reserve, and drowning, a larger contributor for those living off reserve. For Status Indian women, road traffic accidents and poisonings were large contributors to excess PYLL. Intentional injuries such as suicide and homicide were large contributors to excess PYLL for Status Indian women living on, but not off reserve.

The non-communicable diseases that were particularly large contributors to excess PYLL among Status Indian men were cardiovascular diseases, alcohol use disorders, and cirrhosis of the liver. The percentage of excess PYLL due to cardiovascular diseases was greater for Status Indian men off reserve than for those on reserve (percentages not shown). Among Status Indian women, rate differences were elevated for cardiovascular diseases, malignant neoplasms, and cirrhosis of the liver. The percentage of excess PYLL due to malignant neoplasms was higher for those living off reserve than for those on reserve (percentages not shown).

Alcohol-related deaths contributed about 10% of total excess PYLL for Status Indians of both sexes (percentages not shown). The percentages of total excess PYLL attributable to drug-related deaths and to deaths amenable to medical intervention were significantly elevated for Status Indian women.

Socio-economic factors

The magnitude of the difference between Status Indians and non-Aboriginal adults in the risk of dying before age 75 varied by residence on or off reserve and by socio-economic factors (Table 5).

Compared with non-Aboriginal men, the age-adjusted hazard ratios for Status Indian men were 1.92 and 1.58, respectively, for those living on and off reserve (Model 1). Models 2 to 7 each adjusted for age plus a single socio-economic factor. Except for

Table 5
Hazard ratios for death before age 75 among Status Indians living on and off reserve, compared with non-Aboriginal cohort members, controlling for selected demographic, economic, housing and geographic factors, by sex, non-institutional cohort members aged 25 to 74, Canada, 1991 to 2001

Model number and name	Adjusted for:	Men						Women					
		On reserve			Off reserve			On reserve			Off reserve		
		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
1 Age	Age	1.92	1.82	2.02	1.58	1.43	1.74	2.37	2.23	2.51	2.27	2.07	2.48
2 Family structure	Age + marital status + single parent	1.73	1.64	1.83	1.40	1.27	1.55	2.30	2.17	2.44	2.12	1.94	2.33
3 Education	Age + education	1.69	1.60	1.78	1.41	1.27	1.55	2.15	2.02	2.28	2.09	1.90	2.28
4 Income	Age + income	1.56	1.48	1.65	1.34	1.21	1.48	2.04	1.92	2.17	1.97	1.79	2.15
5 Work status	Age + labour force	1.65	1.56	1.74	1.41	1.27	1.55	2.12	2.00	2.25	2.11	1.92	2.31
6 Housing	Age + crowding + home ownership + major repairs needed	2.01	1.90	2.12	1.39	1.26	1.53	2.47	2.32	2.63	2.03	1.85	2.22
7 Geography	Age + urban population size	1.86	1.76	1.96	1.54	1.40	1.70	2.33	2.19	2.48	2.23	2.04	2.44
8 Full	Age + family structure + education + income + work status + housing + geography	1.41	1.34	1.49	1.09	0.99	1.21	1.92	1.80	2.05	1.70	1.55	1.87

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

What is known on this topic?

- The rate of potential years of life lost (PYLL) at ages 1 to 74 is higher for Status Indians than for non-Aboriginal people, with injury deaths the largest contributor to the disparity.
- Premature loss of life is an indicator of the overall health and well-being of a population.
- The effects of socio-economic factors on disparities in premature death are not usually studied.

What does this study add?

- PYLL rates at ages 25 to 74 for Status Indians are typically at least twice those for non-Aboriginal people.
- Both absolute and relative disparities are particularly elevated for injuries.
- Socio-economic indicators such as income, education, housing and employment explain a substantial share of excess premature mortality among Status Indian adults.

Models 6 (for Status Indians on reserve) and 7, which controlled for housing and geographic variables, respectively, the hazard ratios were attenuated, suggesting that each factor had an effect on the disparity. In the full model (Model 8), which controlled for all socio-economic factors simultaneously, the hazard ratios were reduced to 1.41 for Status Indian men on reserve, and to 1.09 for those living off reserve.

Results were similar for Status Indian women: in Model 1, the age-adjusted hazard ratios were 2.37 (on reserve) and 2.27 (off reserve), but in the full model, the hazard ratios were reduced to 1.92 and 1.70, respectively.

Discussion

This study emphasizes the burden of premature deaths among Status Indians of working-age. In other studies of PYLL, the effect of infant and child deaths tended to mask patterns among adults.

The rate of PYLL among Status Indians aged 25 to 74 was approximately two and a half times that of non-Aboriginal adults, and slightly higher for Status Indians living on reserve. Although not directly comparable, the results are consistent with two other studies of PYLL among Status Indians.[6,7]

As was found in other research,[6,25,26] PYLL rates for injury-related deaths were high for Status Indians. In absolute terms, unintentional and intentional injuries were large contributors to excess PYLL among Status Indian men and women.

Even so, the results indicate that chronic diseases are a growing cause of mortality among Status Indians, reflecting an epidemiological transition from infectious to non-communicable diseases.[10] Earlier studies too, have reported that in Aboriginal populations, the prevalence of diabetes is high and continues to increase,[27] and that cardiovascular diseases[28,29] and some cancers[8,30-33] are more common.

Differences between Status Indians residing on and off reserve were not large, although the overall PYLL rate was slightly higher among those on reserve. A Manitoba study found that disparities between Status Indians and other residents were greater in southern than in northern areas of the province.[7] Because the present analysis did not track mobility, the movement of Status Indians between reserves and other locations was not known. Had such information been

available, the geographic differences reported here might have been either reduced or accentuated.

This study demonstrated that socio-economic factors (education, income, housing, and labour force status) were important contributors to disparities in PYLL between Aboriginal and non-Aboriginal people. The results are consistent with other population-based research demonstrating that socio-economic status was an important contributor to health inequalities—specifically, chronic conditions, self-rated health and mortality.[8,34]

Limitations

Several limitations of this analysis must be acknowledged. Eligibility for the cohort was limited to people enumerated by the 1991 census long form. Because of systematic census long-form over-sampling of residents of Indian reserves and remote and northern communities, the cohort had an over-representation of the on-reserve and territorial populations. On the other hand, the 1991 census missed about 3.4% of the population, including residents of 78 Indian reserves (about 38,000 people).

As well, the cohort consists of census respondents who filed taxes in 1990 or 1991. Previous analysis demonstrated that this cohort is longer-lived than the total Canadian population. However, this should have little impact on estimates of relative inequality, because the healthy cohort effect would apply to both Status Indian and non-Aboriginal members. And despite the exclusion of non-tax filers, the socio-economic characteristics of those eligible to be linked and those actually linked to the name file were similar.

The results apply to the non-institutional population on June 4, 1991, not the population as a whole. Status Indians may be over-represented in the institutional population.

Ascertainment of deaths among Aboriginal cohort members is estimated to be slightly lower than for the cohort as a whole. Consequently, a small downward bias in calculated mortality rates for Status Indians is expected, and the true extent of disparities could be somewhat larger than indicated in this study.

Some suicides may have been misclassified as another cause of death such as drowning, poisoning or other injury. The reporting of suicides may also differ by jurisdiction (that is, reserves, towns, cities).

Conclusion

Rates of PYLL were significantly higher for Status Indians compared with non-Aboriginal adults. Non-communicable (chronic) diseases such as cardiovascular diseases and cancers were the largest contributors to total PYLL. However, injuries, especially unintentional injuries, were a major contributor to the disparities, highlighting the importance of injury prevention programs. Many of these health disparities are related to indicators of socio-economic status. ■

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Appendix

Table A
Selected characteristics of Status Indians living on and off reserve compared with non-Aboriginal men and women, non-institutional cohort members aged 25 to 74, Canada, 1991

	Men				Women			
	Status Indian			Non-Aboriginal	Status Indian			Non-Aboriginal
Characteristic	Total	On reserve	Off reserve		Total	On reserve	Off reserve	
Total number	**24,100**	**17,700**	**6,400**	**1,245,100**	**31,500**	**21,500**	**10,000**	**1,230,600**
Percentage	**100**	**100**	**100**	**100**	**100**	**100**	**100**	**100**
Age group								
25 to 34	42	42	43	28	45	45	45	30
35 to 44	28	28	29	27	28	27	29	28
45 to 54	16	17	16	19	15	15	15	18
55 to 64	9	9	8	15	8	8	7	13
65 to 74	5	5	4	11	4	4	4	11
Marital status								
Single (never married)	22	22	24	14	16	16	17	11
Common-law	18	17	20	7	17	16	19	6
Married	51	52	48	73	52	55	45	66
Previously married	9	9	9	7	15	13	18	16
Single parent	5	5	4	2	18	17	21	8
Tenure								
Collective dwelling	1	0	3	1	0	0	1	1
Band housing	44	60	1	0	41	59	1	0
Owner	34	29	46	75	32	27	43	72
Renter	22	11	50	24	27	13	55	27
Overcrowding	23	25	16	2	24	30	13	2
Dwelling in need of major repairs	34	39	22	7	33	39	21	7
Educational attainment								
Less than secondary graduation	59	61	53	33	55	58	49	32
Secondary graduation	33	32	35	38	29	27	32	36
Postsecondary diploma	7	6	9	13	13	12	15	19
University degree	2	1	3	16	3	2	4	13
Labour force status								
Employed	51	48	60	76	41	38	48	63
Unemployed	22	23	19	7	11	11	12	6
Not in labour force	27	30	20	17	48	51	41	32
Income adequacy quintile								
1 (lowest)	40	41	35	13	42	43	42	17
2	25	27	22	18	25	26	22	19
3	17	17	18	21	17	17	16	21
4	12	10	15	23	11	10	13	21
5 (highest)	6	5	9	24	5	4	7	21
Region								
Atlantic	5	6	2	8	5	6	2	8
Quebec	9	10	8	26	11	12	7	26
Ontario	18	17	21	37	17	15	22	37
Manitoba	20	23	12	4	17	19	13	4
Saskatchewan	12	12	11	3	13	14	11	3
Alberta	9	9	11	9	12	12	13	9
British Columbia	21	24	15	12	20	22	16	12
Territories	6	0	21	1	6	0	17	1
Community size								
1,000,000 or more	3	1	9	31	4	1	9	33
500,000 to 999,999	4	1	12	16	5	1	14	17
100,000 to 499,999	5	3	10	15	5	3	11	16
10,000 to 99,999	12	10	18	14	12	9	19	14
Less than 10,000	76	85	52	23	73	85	47	21
Living on a reserve								
Yes	73	100	0	0	68	100	0	0
No	27	0	100	100	32	0	100	100

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

Table B
Age distribution of deaths at ages 25 to 74 among Status Indian and non-Aboriginal men and women, non-institutional cohort members, Canada, 1991 to 2001

	Number		Percentage	
	Status Indian	Non-Aboriginal	Status Indian	Non-Aboriginal
Men	**1,842**	**80,251**	**100.0**	**100.0**
25 to 34	175	1,763	9.5	2.2
35 to 44	309	5,186	16.8	6.5
45 to 54	383	10,161	20.8	12.7
55 to 64	460	20,686	25.0	25.8
65 to 74	515	42,455	28.0	52.9
Women	**1,592**	**40,958**	**100.0**	**100.0**
25 to 34	100	771	6.3	1.9
35 to 44	284	3,223	17.8	7.9
45 to 54	313	6,239	19.7	15.2
55 to 64	443	10,008	27.8	24.4
65 to 74	452	20,717	28.4	50.6

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

Table C
Cohort members, deaths ascertained, age-standardized rates of potential years of life lost (PYLL) and distribution of PYLL by cause of death at ages 25 to 74 for Status Indians living on and off reserve, compared with non-Aboriginal men and women, non-institutional cohort members, Canada, 1991 to 2001

	Men				Women			
	Status Indians				Status Indians			
	Total	On reserve	Off reserve	Non-Aboriginal	Total	On reserve	Off reserve	Non-Aboriginal
Cohort members	**24,100**	**17,700**	**6,400**	**1,245,100**	**31,500**	**21,500**	**10,000**	**1,230,600**
Deaths ascertained	**1,842**	**1,443**	**399**	**80,251**	**1,592**	**1,122**	**470**	**40,958**
PYLL rate*	**14,676**	**15,960**	**11,277**	**5,984**	**8,261**	**8,519**	**7,695**	**3,134**
	Percentage							
PYLL rate by cause of death	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Communicable, maternal, perinatal and nutritional conditions	4.6	4.4	5.7	4.9	5.5	5.1	6.5	2.4
Infectious and parasitic diseases	2.6	2.2	4.0	4.0	3.0	2.5	4.0	1.3
HIV/AIDS	1.4	1.1	2.3	3.1	0.9	0.4	2.2	0.3
Respiratory infections	2.1	2.2	1.7	0.9	2.3	2.3	2.2	0.9
Non-communicable diseases	52.5	52.4	52.8	76.6	69.4	69.6	68.8	86.3
Malignant neoplasms	13.3	12.3	16.8	34.7	25.0	24.2	26.8	53.8
Stomach cancer	1.0	0.9	1.5	1.4	0.9	0.8	1.0	1.3
Colon and rectal cancers	1.3	1.0	2.6	3.5	2.8	2.8	2.7	4.4
Pancreas cancer	0.6	0.4	1.6	1.8	0.6	0.7	0.3	2.1
Trachea, bronchus, and lung cancers	3.6	3.1	5.7	10.9	4.3	4.7	3.4	11.7
Breast cancer	x	x	x	x	4.9	4.4	6.0	13.8
Cervix uteri cancer	x	x	x	x	3.0	3.0	2.8	1.6
Ovarian cancer	x	x	x	x	1.2	1.1	1.5	3.2
Prostate cancer	0.5	0.4	1.0	1.5	x	x	x	x
Lymphomas and multiple myeloma	1.1	1.1	1.2	2.5	0.8	0.8	0.9	2.7
Diabetes mellitus	4.3	4.6	3.2	2.1	5.6	6.6	3.4	1.8
Neuropsychiatric conditions	4.7	4.8	4.5	2.7	4.2	3.4	6.1	2.8
Alcohol use disorders	3.5	3.7	2.5	0.7	2.8	1.8	5.0	0.4
Cardiovascular diseases	18.8	18.3	20.4	28.0	13.9	17.8	15.2	18.1
Ischemic heart disease	12.6	12.5	12.9	19.1	6.7	7.0	6.1	8.9
Cerebrovascular disease	2.0	1.8	2.7	3.1	5.2	5.6	4.3	4.3
Respiratory diseases	2.0	2.3	1.0	2.5	3.2	3.7	2.0	2.8
Chronic obstructive pulmonary disease	0.8	0.9	0.5	1.7	0.8	0.8	0.7	1.7
Digestive diseases	6.1	6.6	4.1	3.8	9.2	9.0	9.7	3.4
Cirrhosis of the liver	3.6	3.9	2.7	2.2	5.5	4.7	7.3	1.5
Genitourinary diseases	1.5	x	x	0.8	1.5	1.3	1.9	0.8
Injuries	37.8	38.0	37.2	16.2	21.4	22.2	19.6	9.4
Unintentional injuries	25.8	25.9	25.6	8.2	13.9	13.8	14.1	5.0
Road traffic accidents	9.9	10.3	8.3	3.4	6.7	7.1	5.7	2.7
Poisonings	2.5	2.1	3.7	1.0	3.7	3.8	3.4	0.7
Falls	1.2	1.3	0.7	0.7	0.4	0.3	0.7	0.4
Fires	1.4	1.4	1.4	0.3	0.5	x	x	0.2
Drownings	3.0	2.6	4.8	0.4	0.5	x	x	0.2
Intentional injuries	11.1	11.2	10.8	7.5	6.6	8.0	3.7	4.1
Self-inflicted injuries (suicide)	8.3	8.9	6.0	7.0	4.0	5.0	1.8	3.6
Violence (homicide)	2.7	2.1	4.8	0.6	2.6	3.0	1.9	0.5
Ill-defined	5.1	5.2	4.4	2.3	3.7	3.1	5.1	1.8
Risk factor-related								
Smoking-related	6.3	5.9	7.8	15.4	6.0	6.1	5.7	14.9
Alcohol-related	8.2	8.4	7.4	2.5	7.4	6.2	10.2	1.4
Drug-related	2.1	1.9	3.0	1.6	5.1	4.9	5.4	2.1
Deaths amenable to medical intervention	7.7	7.4	8.8	10.0	19.8	19.4	20.9	23.9

* per 100,000 person-years at risk, age-standardized to Aboriginal age distribution (five-year age groups)
x suppressed to meet the confidentiality requirements of the Statistics Act
Source: 1991 to 2001 Canadian census mortality follow-up study.

Potential years of life lost at ages 25 to 74 among Métis and non-Status Indians, 1991 to 2001

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

Abstract

Background
Aboriginal peoples experience a disproportionate burden of disease, compared with other Canadians. However, relatively little information is available about mortality among Métis and non-Status Indians.

Methods
This study calculates potential years of life lost before age 75 (PYLL) for people aged 25 to 74 by all-cause and cause-specific mortality, and examines the effect of socio-economic factors on premature mortality. Age-specific and age-standardized PYLL rates were calculated for 11,600 Métis, 5,400 non-Status Indians, and 2,475,700 non-Aboriginal adults based on the number of person-years at risk up to age 75.

Results
Métis and non-Status Indian adults had about twice the risk of dying before age 75, compared with non-Aboriginal adults. While the largest percentage of PYLL was due to non-communicable diseases such as cardiovascular disease and cancer, relative and absolute inequalities were greatest for injuries. Socio-economic indicators such as income, education and employment explained a large share of the disparities in premature mortality.

Interpretation
The results highlight the losses of potential years of life due to chronic diseases, as well as the possible importance of injury prevention programs for Métis and non-Status Indians.

Keywords
Aboriginal, cause of death, death rate, First Nations, indigenous, life expectancy, longevity, mortality

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As a result of a complex set of social, economic and environmental circumstances,[1] Aboriginal peoples experience a disproportionate burden of disease, compared with other Canadians.[2,3] Life expectancy, the most basic of health indicators, is considerably shorter for Status Indians (First Nations registered under the Indian Act of Canada)[4,5] and for people living in the Inuit-inhabited areas of Canada (80% of whom are Inuit).[6] But methodological challenges limit the amount of mortality information available about Métis and non-Status Indians.[1] In fact, relative to their population size, these two Aboriginal groups have been under-represented in health research in general.[7,8]

Mortality data for Métis and non-Status Indians are difficult to generate. Aboriginal ancestry, identity or status is not routinely recorded on death registrations. And because most Métis and non-Status Indians do not live in areas where they constitute a high percentage of the total population, their mortality patterns cannot be studied indirectly with an area-based approach.[6,9] However, the 1991 to 2001 Canadian census mortality follow-up study has made it possible to examine a wide range of mortality indicators for Métis[10] and non-Status Indians.

Mortality studies typically include all ages, and are, therefore, dominated by deaths at older ages. Results of such studies may reveal only part of the picture, especially for Aboriginal groups, who tend to have a high proportion of younger people. Premature mortality (defined here as deaths before age 75) and potential years of life lost (PYLL) before age 75 highlight the loss to society as a result of early deaths.[11] Premature mortality and PYLL rates are elevated among Status Indians,[12-14] and injuries are an important contributor to these high levels,[13,14] but PYLL has not been

calculated for Métis and non-Status Indians.

The first objective of the present study was to examine PYLL at ages 25 to 74 by cause of death among Métis and non-Status Indians, compared with non-Aboriginal adults.

The second objective was to assess the influence of socio-economic factors on disparities in premature mortality. Aboriginal peoples tend to rank less favourably than other Canadians on most measures of socio-economic status.[15,16] Unlike other mortality studies, which incorporate few if any socio-economic factors, the census mortality follow-up study has made it possible to include many such variables.

Methods

Data sources

The 1991 to 2001 Canadian census mortality follow-up study is a probabilistically linked cohort consisting of a 15% sample (n = 2,735,152) of the non-institutionalized population aged 25 or older, all of whom were enumerated via the 1991 census long-form questionnaire.[17] This cohort was tracked for mortality from June 4, 1991 through December 31, 2001.

Names were not captured on the census database, but they were needed for linkage to the mortality database. Consequently, creation of the mortality follow-up cohort required two probabilistic linkages. First, eligible census respondents were linked to a nominal list (name) file (abstracted from 1990 and 1991 tax-filer data and then encrypted) using common variables such as date of birth, postal code, and spousal date of birth (if applicable); 80% of eligible respondents were successfully matched. Second, the census plus encrypted names were matched to the Canadian Mortality Database.[18] Based on 1991 deaths (which could be identified independently in the Canadian Mortality Database and/or the name file), ascertainment of deaths from 1991 to 2001 of cohort members overall was estimated to be at least 95% among those reporting any Aboriginal ancestry, Registered Indian status, or membership in an Indian Band or First Nation.

Eligibility

People enumerated by the 1991 census long-form questionnaire who had reached age 25 by census day were eligible to be part of the cohort. The long form, which was usually given to 1 in 5 households, was administered to all residents of Indian reserves, many remote and northern communities, and non-institutional collective dwellings. However, 78 Indian reserves, representing about 38,000 people, were either not enumerated or incompletely enumerated,[19] and thus, were not part of the cohort. As well, the 1991 census missed 3.4% of Canadian residents; these individuals were more likely to be young, mobile, low income, of Aboriginal ancestry,[20] or homeless.

Owing to the exclusion of institutional residents and non-tax-filers, life expectancy of the cohort at age 25 was 1 year longer for men and 2 years longer for women, compared with the 1995 to 1997 life tables for all Canada. This bias would apply equally to Aboriginal and non-Aboriginal respondents and should not appreciably affect relative differences between the two groups.

Analytical techniques

The cohort was divided into ten one-year follow-up periods (June 4, 1991 to June 3, 1992; June 4, 1992 to June 3, 1993; and so on) and one seven-month period (June 4, 2001 to December 31, 2001). Age was transformed from age at baseline (June 4, 1991) to age at the beginning of each year of follow-up. Deaths and person-years at risk were calculated separately for each follow-up period, and then pooled by five-year age group (determined at the beginning of each year of follow-up). Deaths before age 75 were considered premature. The number of potential years of life lost (PYLL) was calculated by multiplying the number of deaths in each age group by the mean number of PYLL for the same age group. For example, the death of someone aged 25 to 29 would contribute 47.5 PYLL before age 75.

To calculate rates of PYLL, the number of person-years at risk (up to age 75) was determined for each five-year age group and the rates were age-standardized to the Aboriginal population. The Aboriginal age distribution was based on cohort members who indicated an Aboriginal ancestry, registration under the *Indian Act of Canada*, or membership in an Indian Band or First Nation. Confidence intervals for the age-standardized rates were produced from variances derived using the Spiegelman method.[21]

Premature mortality (Cox models)

For each cohort member, person-days of follow-up were calculated from baseline (June 4, 1991) to the date of death, emigration (known only for 1991), end of study (December 31, 2001), or until that individual reached age 75. Because exact date of birth was not available on the analysis file, age in completed years (as of June 4 of each follow-up year) was used to derive age at death and person-years of follow-up.

Cox proportional mortality hazard ratios were used to estimate the effect of socio-economic factors on the disparity in premature mortality among Métis and non-Status Indians, compared with non-Aboriginal adults. The variables included were age, marital status (married/common-law, not married), single parent (yes, no), educational attainment (less than secondary graduation, secondary graduation, postsecondary diploma, university degree), income adequacy quintile, labour force status (in, out), crowding (more than one person per room; yes, no), home ownership (yes, no), major dwelling repairs needed (yes, no), and urban population size (1 million or more; 500,000 to 999,999; 100,000 to 499,999; 10,000 to 99,999; and less than 10,000). Definitions of the variables are available in a previously published report[17] or the census dictionary.[22] All models were sex-specific. The base model (Model 1) controlled only for age. Models 2 to 7 controlled for age and one other variable. The full model (Model 8) controlled for age and all other variables simultaneously. Differences in excess mortality (1 minus the hazard

ratio) comparing the full model to the base model were interpreted as estimates of the effect of the socio-economic variables on the disparities.

Cause of death

The cause of death of cohort members who died during the study period had previously been coded to the World Health Organization's *International Classification of Diseases, Ninth Revision* (ICD-9)[23] for deaths occurring from 1991 through 1999, and to the *Tenth Revision* (ICD-10)[24] for deaths occurring in 2000 or 2001. Deaths were also grouped by Global Burden of Disease categories, which underscore human development rather than the body system,[25] and by risk factors, namely, smoking-related,[26] alcohol-related[26] and drug-related diseases,[27] or deaths potentially amenable to medical intervention (for instance, deaths due to cerebrovascular diseases, hypertension, breast cancer and pneumonia/influenza).

Definitions

The 1991 census did not collect information on self-identification with an Aboriginal group (North American Indian, Métis, or Inuit). For this analysis, Métis and non-Status Indians were defined based on two census questions reflecting ancestry and Registered Indian status.

1. To determine ancestry, respondents were asked to which ethnic or cultural group(s) their ancestors belonged.[22] From a list of 15 groups, including North American Indian, Métis and Inuit/Eskimo, respondents were instructed to check as many as applicable.
2. 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).

In this study, respondents were considered Métis if they reported a single Métis ancestry (no other ancestries) or two or more Aboriginal ancestries with one being Métis. People were considered non-Status Indians if they reported a single North American Indian ancestry, but were not registered under the *Indian Act of Canada*.

Results

Characteristics differ

The demographic and socio-economic characteristics of Métis and non-Status Indian cohort members differed from those of non-Aboriginal members (Appendix Table A). Métis and non-Status Indians were younger and less likely to be legally married, to have completed secondary school, to be employed, and to be homeowners. They were more likely to be in the two lowest income adequacy quintiles, to live in crowded conditions, and to live in a dwelling needing major repairs. In 1991, nearly 7 out of 10 Métis cohort members were residents of Manitoba, Saskatchewan or Alberta, and about 7 out of 10 non-Status Indian cohort members were residents of Quebec, Ontario or British Columbia.

Age distribution of deaths

Of the deaths of cohort members that occurred during the 1991 to 2001 period, 71% among Métis and 76% among non-Status Indians were at ages 25 to 74, compared with 48% of the deaths among non-Aboriginal people (data not shown). And of those cohort members in this age range who died, Métis and non-Status Indians tended to be younger. For example, about 70% of Métis and non-Status Indian men and two-thirds of Métis and non-Status Indian women who

Table 1
Distribution of potential years of life lost (PYLL) by cause of death at ages 25 to 74 for Métis, non-Status Indian and non-Aboriginal men and women, non-institutional cohort members, Canada, 1991 to 2001

	Men			Women		
	Métis	Non-Status Indians	Non-Aboriginal	Métis	Non-Status Indians	Non-Aboriginal
Cohort members	**5,600**	**2,600**	**1,245,100**	**6,000**	**2,800**	**1,230,600**
Deaths acertained	**374**	**190**	**80,251**	**260**	**134**	**40,958**
PYLL rate*	**12,025**	**11,480**	**5,984**	**6,139**	**8,844**	**3,134**
	Percentage					
All causes	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**	**100.0**
Communicable, maternal, perinatal and nutritional conditions	5.8	5.3	4.9	4.9	4.6	2.4
Non-communicable diseases	56.7	63.5	76.6	77.2	70.3	86.3
Malignant neoplasms	18.3	19.2	34.7	35.9	36.0	53.8
Trachea, bronchus, and lung cancers	6.7	9.8	10.9	6.6	6.8	11.7
Breast cancer	x	x	x	6.2	10.9	13.8
Neuropsychiatric conditions	5.0	5.8	2.7	8.0	1.8	2.8
Cardiovascular diseases	23.0	25.5	28.0	15.9	19.6	18.1
Ischemic heart disease	16.3	20.8	19.1	7.8	6.4	8.9
Digestive diseases	4.5	6.3	3.8	6.7	10.1	3.4
Cirrhosis of the liver	2.1	4.7	2.2	4.6	8.9	1.5
Injuries	34.5	29.5	16.2	15.3	22.5	9.4
Unintentional injuries	22.4	19.7	8.2	11.6	16.1	5.0
Road traffic accidents	9.1	9.2	3.4	5.0	3.0	2.7
Poisonings	3.1	2.3	1.0	4.5	7.8	0.7
Intentional injuries	10.7	7.9	7.5	3.7	6.3	4.1
Self-inflicted injuries (suicide)	8.7	x	7.0	x	x	3.6
Ill-defined causes	2.9	1.7	2.3	2.5	2.6	1.8

* per 100,000 person-years at risk, age-standardized to Aboriginal age distribution (five-year age groups)
x suppressed to meet the confidentiality requirements of the Statistics Act
Source: 1991 to 2001 Canadian census mortality follow-up study

died were younger than 65, compared with around half of the non-Aboriginal decedents.

Distribution of adult PYLL

The percentage distribution of potential years of life lost (PYLL) by various causes of death differed by Aboriginal ancestry and sex. Non-communicable (chronic) diseases ranked first, accounting for 57% and 64% of total PYLL for Métis and non-Status Indian men, respectively, and for 77% and 70%, respectively, for Métis and non-Status Indian women. Nonetheless, these percentages were below the corresponding figures for non-Aboriginal adults (Table 1). Cardiovascular diseases were the largest non-communicable disease subcategory for men (23% for Métis; 26% for non-Status Indians); for women, malignant neoplasms (cancer) were the largest subcategory (36% for both Métis and non-Status Indians).

Injuries accounted for much higher percentages of PYLL among the Aboriginal groups than non-Aboriginal adults. For men, injuries made up 35% of Métis PYLL and 30% of non-Status Indian PYLL, compared with 16% of non-Aboriginal PYLL. For women, the corresponding figures were 15%, 23% and 9%.

Rates of PYLL

Age-standardized rates of PYLL were much higher for Aboriginal than non-Aboriginal adults (Table 2). Compared with non-Aboriginal adults, PYLL rate ratios for Métis and non-Status Indian cohort members were around twice as high. Among Métis men, rate ratios were highest in the younger age groups and lowest at ages 55 to 74. Among non-Status Indian men, the rate ratio peaked at ages 45 to 54 and was lowest at ages 65 to 74. The pattern was less clear for Aboriginal women, among whom rate ratios were relatively high at ages 65 to 74.

Causes of death

To obtain a complete picture of mortality patterns, it is necessary to examine both relative and absolute inequalities in causes of death. If a cause of death is rare, the relative inequality can be quite high but account for a negligible number of deaths. On the other hand, a common cause of death can account for a large number of deaths (and be a significant contributor to absolute inequality), even if the relative risk is only slightly elevated. Thus, measuring relative (rate ratios) and absolute inequalities (rate differences) between Aboriginal and non-Aboriginal adults highlights specific causes that might be important in developing public health programs.

For most causes, PYLL rate ratios were elevated among Métis and non-Status Indians. Métis men had particularly high rate ratios for rheumatic heart disease, hypertensive heart disease, unintentional injuries, and violence (Table 3). Non-Status Indian men had high rate ratios for neuropsychiatric conditions including alcohol use disorders, digestive diseases such as cirrhosis of the liver, and road traffic accidents.

PYLL rate ratios for Métis and non-Status Indian women were elevated for almost all causes. Among Métis women, rate ratios were especially high for respiratory infections, leukemia, alcohol use disorders, hypertensive heart disease, chronic obstructive pulmonary diseases, cirrhosis of the liver, and unintentional injuries, notably poisoning (Table 4). Among non-Status Indian women, rate ratios were high for communicable diseases, breast cancer, cervix uteri cancer, cerebrovascular disease, cirrhosis of the liver, and unintentional injuries, especially poisoning.

Rate ratios for alcohol- and drug-related diseases were higher for Métis and non-Status Indians of both sexes than for their non-Aboriginal counterparts;

Table 2
Deaths, rates of potential years of life lost (RPYLL)* and rate ratios (RR) for Métis and non-Status Indians compared with non-Aboriginal men and women, by age group, non-institutional cohort members, Canada, 1991 to 2001

	Métis							Non-Status Indians							Non-Aboriginal			
			95% confidence interval			95% confidence interval				95% confidence interval			95% confidence interval				95% confidence interval	
Sex/Age	Number of deaths	RPYLL	from	to	RR	from	to	Number of deaths	RPYLL	from	to	RR	from	to	Number of deaths	RPYLL	from	to
Men	**374**	**12,025**	**9,879**	**14,635**	**2.01**	**1.65**	**2.45**	**190**	**11,480**	**9,047**	**14,569**	**1.92**	**1.51**	**2.44**	**80,251**	**5,984**	**5,871**	**6,099**
25 to 34	25	9,160	6,188	13,558	2.21	1.49	3.28	10	7,570	4,072	14,070	1.82	0.98	3.4	1,763	4,149	3,960	4,347
35 to 44	58	10,251	7,923	13,263	2.13	1.64	2.76	25	8,624	5,824	12,770	1.79	1.21	2.65	5,186	4,821	4,691	4,954
45 to 54	81	15,251	12,261	18,968	1.84	1.48	2.29	50	20,906	15,842	27,589	2.52	1.91	3.33	10,161	8,291	8,131	8,455
55 to 64	101	18,401	15,118	22,397	1.27	1.04	1.55	54	28,197	21,576	36,851	1.95	1.49	2.54	20,686	14,489	14,291	14,689
65 to 74	109	17,844	14,598	21,812	1.39	1.13	1.69	51	16,297	12,037	22,066	1.27	0.93	1.71	42,455	12,876	12,740	13,014
Women	**260**	**6,139**	**5,000**	**7,537**	**1.96**	**1.59**	**2.41**	**134**	**8,844**	**6,456**	**12,115**	**2.82**	**2.06**	**3.87**	**40,958**	**3,134**	**3,062**	**3,207**
25 to 34	9	2,716	1,412	5,223	1.60	0.83	3.1	10	6,601	3,550	12,274	3.90	2.09	7.28	771	1,694	1,578	1,818
35 to 44	46	6,743	5,049	9,005	2.37	1.77	3.18	25	7,729	5,219	11,444	2.72	1.83	4.03	3,223	2,842	2,745	2,942
45 to 54	47	8,874	6,662	11,822	1.71	1.28	2.28	24	9,883	6,618	14,760	1.91	1.28	2.85	6,239	5,182	5,054	5,313
55 to 64	66	14,707	11,529	18,761	1.86	1.46	2.38	28	13,851	9,531	20,129	1.76	1.21	2.55	10,008	7,887	7,732	8,045
65 to 74	92	12,259	9,736	15,436	1.93	1.54	2.44	47	16,286	11,893	22,302	2.57	1.88	3.52	20,717	6,337	6,240	6,435

* per 100,000 person-years at risk
Source: 1991 to 2001 Canadian census mortality follow-up study.

Table 3
Age-standardized rate ratios (RRs) and rate differences (RDs) for potential years of life lost at ages 25 to 74 for Métis and non-Status Indian men compared with non-Aboriginal men, by cause of death, non-institutional cohort members, Canada, 1991 to 2001

	Métis						Non-Status Indians					
		95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
	RR	from	to	RD	from	to	RR	from	to	RD	from	to
All causes	**2.01**	**1.65**	**2.45**	**6,040**	**3,675**	**8,406**	**1.92**	**1.51**	**2.44**	**5,496**	**2,759**	**8,234**
Communicable, maternal, perinatal and nutritional conditions	1.20	0.67	2.14	90	-226	406	1.78	0.70	4.57	358	-406	1,122
Infectious and parasitic diseases	1.12	0.57	2.19	48	-261	357	1.77	0.63	4.99	315	-437	1,067
HIV/AIDS	0.91	0.37	2.20	-33	-318	253	x	x	x	x	x	x
Respiratory infections	2.00	0.93	4.33	44	-22	110	x	x	x	x	x	x
Non-communicable diseases	1.42	1.16	1.73	1,463	461	2,466	x	x	x	x	x	x
Malignant neoplasms	1.17	0.76	1.80	262	-527	1,052	1.11	0.79	1.54	167	-411	745
Mouth and oropharynx cancers	0.68	0.15	3.00	-16	-67	35	x	x	x	x	x	x
Esophageal cancer	0.68	0.19	2.38	-15	-53	24	x	x	x	x	x	x
Stomach cancer	2.80	0.72	10.84	108	-119	335	x	x	x	x	x	x
Colon and rectal cancers	3.11	0.74	13.11	306	-341	953	0.72	0.23	2.30	-41	-162	81
Liver cancer	0.98	0.30	3.15	-1	-46	44	1.41	0.28	7.20	16	-75	107
Pancreas cancer	0.66	0.21	2.01	-27	-84	31	1.01	0.28	3.64	0	-100	101
Trachea, bronchus and lung cancers	1.23	0.79	1.90	95	-130	320	2.12	1.32	3.42	471	46	896
Prostate cancer	1.59	0.70	3.64	27	-33	86	1.30	0.50	3.42	14	-43	71
Bladder cancer	2.36	0.82	6.81	32	-26	90	x	x	x	x	x	x
Lymphomas and multiple myeloma	1.20	0.41	3.52	27	-147	201	x	x	x	x	x	x
Diabetes mellitus	1.37	0.67	2.82	35	-58	128	x	x	x	x	x	x
Endocrine disorders	0.23	0.06	0.94	-54	-80	-27	x	x	x	x	x	x
Neuropsychiatric conditions	2.89	1.62	5.17	295	37	554	3.73	1.77	7.85	426	-4	855
Alcohol use disorders	2.94	1.06	8.15	69	-36	174	8.15	3.18	20.90	254	-15	523
Cardiovascular diseases	1.48	1.16	1.89	593	146	1,039	1.98	1.41	2.78	1,213	386	2,040
Rheumatic heart disease	10.20	2.98	34.89	58	-18	133	x	x	x	x	x	x
Hypertensive heart disease	3.74	1.03	13.61	45	-31	121	x	x	x	x	x	x
Ischemic heart disease	1.62	1.21	2.17	500	118	881	2.50	1.71	3.66	1,213	443	1,983
Cerebrovascular disease	1.55	0.77	3.14	78	-75	232	1.92	0.74	4.97	129	-128	386
Inflammatory heart diseases	0.57	0.17	1.92	-26	-69	17	x	x	x	x	x	x
Respiratory diseases	1.17	0.57	2.40	16	-62	94	2.24	0.68	7.40	115	-132	363
Chronic obstructive pulmonary disease	1.55	0.66	3.66	28	-39	94	x	x	x	x	x	x
Digestive diseases	2.05	1.15	3.65	192	-23	407	3.27	1.72	6.25	416	31	800
Cirrhosis of the liver	1.74	0.76	4.00	77	-73	227	4.40	2.05	9.41	353	8	698
Genitourinary diseases	2.35	0.80	6.85	47	-40	133	x	x	x	x	x	x
Injuries	3.26	2.32	4.59	4,124	2,111	6,137	2.48	1.48	4.15	2,686	370	5,003
Unintentional injuries	4.56	2.97	7.01	3,348	1,531	5,165	2.93	1.58	5.42	1,810	123	3,498
Road traffic accidents	3.12	1.66	5.85	880	75	1,685	4.11	1.62	10.44	1,290	-292	2,873
Poisonings	3.83	1.59	9.25	300	-51	652	2.36	0.63	8.77	144	-182	470
Falls	2.39	0.79	7.26	78	-67	223	x	x	x	x	x	x
Drownings	14.80	4.24	51.68	696	-209	1,600	x	x	x	x	x	x
Intentional injuries	1.81	1.03	3.18	686	-169	1,542	1.75	0.62	4.92	629	-895	2,154
Self-inflicted injuries (suicide)	1.65	0.87	3.13	502	-310	1,315	x	x	x	x	x	x
Violence (homicide)	3.56	1.22	10.45	184	-84	453	x	x	x	x	x	x
Ill-defined	2.91	0.87	9.77	363	-305	1,031	0.83	0.26	2.65	-32	-216	153
Risk factor-related												
Smoking-related	1.20	0.84	1.71	118	-134	371	1.61	1.03	2.52	363	-69	794
Alcohol-related	4.70	2.54	8.68	476	109	843	5.39	2.89	10.07	566	138	994
Drug-related	1.83	0.87	3.86	142	-87	371	2.95	1.21	7.17	331	-109	772
Amenable to medical intervention	1.29	0.82	2.02	207	-207	621	1.53	0.73	3.18	379	-426	1,184

x suppressed to meet the confidentiality rexuirements of the Statistics Act
Source: 1991 to 2001 Canadian census mortality follow-up study.

the rate ratio for deaths due to diseases amenable to medical intervention was high among non-Status Indian women. The rate ratio for smoking-related diseases was significantly high for non-Status Indian men, but not women or for Métis of either sex.

Absolute inequalities as indicated by rate differences measure "excess" PYLL. Among men, excess PYLL for all-cause mortality was 6,040 per 100,000 person-years at risk for Métis, and 5,496 for non-Status Indians (Table 3). About two-thirds of the excess PYLL among Métis men was due to injuries (55%

Table 4
Age-standardized rate ratios (RRs) and rate differences (RDs) for potential years of life lost at ages 25 to 74 for Métis and non-Status Indian women compared with non-Aboriginal women, by cause of death, non-institutional cohort members, Canada, 1991 to 2001

	Métis						Non-Status Indians					
		95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
	RR	from	to	RD	from	to	RR	from	to	RD	from	to
All causes	**1.96**	**1.59**	**2.41**	**3,005**	**1,744**	**4,267**	**2.82**	**2.06**	**3.87**	**5,710**	**2,926**	**8,495**
Communicable, maternal, perinatal and nutritional conditions	5.19	1.59	16.95	384	-174	943	8.43	1.76	40.30	682	-522	1,886
Infectious and parasitic diseases	1.59	0.56	4.51	32	-56	120	x	x	x	x	x	x
Respiratory infections	13.77	2.76	68.78	316	-227	860	x	x	x	x	x	x
Non-communicable diseases	1.70	1.43	2.03	1,722	991	2,452	2.34	1.64	3.33	3,273	1,239	5,308
Malignant neoplasms	1.27	0.97	1.65	413	-102	928	2.18	1.26	3.78	1,829	-23	3,681
Stomach cancer	2.59	0.80	8.41	61	-55	176	x	x	x	x	x	x
Colon and rectal cancers	1.01	0.41	2.49	1	-107	108	1.26	0.43	3.74	31	-130	193
Pancreas cancer	0.74	0.18	3.01	-13	-67	40	x	x	x	x	x	x
Trachea, bronchus and lung cancers	1.12	0.69	1.81	35	-123	192	1.47	0.76	2.83	137	-145	418
Breast cancer	0.77	0.41	1.44	-99	-305	108	3.94	1.42	10.93	1,258	-462	2,977
Cervix uteri cancer	2.99	1.34	6.67	140	-24	304	4.10	1.44	11.64	218	-78	514
Ovarian cancer	1.64	0.67	3.98	56	-72	183	1.10	0.29	4.10	9	-118	136
Leukemia	3.95	1.25	12.49	135	-70	340	x	x	x	x	x	x
Diabetes mellitus	2.88	1.37	6.08	93	-11	196	1.87	0.49	7.12	43	-80	165
Neuropsychiatric conditions	4.98	2.73	9.07	359	96	623	1.33	0.35	5.03	30	-130	189
Alcohol use disorders	16.52	6.23	43.83	192	9	375	x	x	x	x	x	x
Cardiovascular diseases	1.72	1.26	2.36	332	86	578	3.05	1.87	4.99	943	258	1,629
Hypertensive heart disease	9.12	3.24	25.67	57	-7	121	x	x	x	x	x	x
Ischemic heart disease	1.94	1.22	3.08	189	10	369	1.98	1.05	3.74	197	-56	450
Cerebrovascular disease	1.48	0.75	2.89	58	-62	177	3.88	1.55	9.69	348	-80	776
Inflammatory heart diseases	1.53	0.27	8.55	10	-41	62	x	x	x	x	x	x
Respiratory diseases	3.87	1.77	8.47	208	-7	424	0.46	0.15	1.47	-39	-79	1
Chronic obstructive pulmonary disease	3.71	1.65	8.33	91	-8	189	x	x	x	x	x	x
Digestive diseases	4.07	2.12	7.83	294	43	545	6.93	3.53	13.62	567	124	1,010
Cirrhosis of the liver	6.42	2.80	14.72	238	7	470	13.31	6.27	28.24	542	108	975
Genitourinary diseases	2.48	0.68	9.11	40	-44	124	1.05	0.27	4.07	1	-37	39
Injuries	2.59	1.36	4.93	811	-31	1,653	4.27	2.18	8.38	1,665	210	3,119
Unintentional injuries	4.12	1.95	8.72	838	18	1,658	6.55	2.92	14.69	1,488	82	2,894
Road traffic accidents	1.85	0.82	4.18	143	-106	391	1.60	0.37	6.86	100	-288	488
Poisonings	23.27	7.38	73.40	655	-118	1,428	19.75	8.04	48.50	552	45	1,059
Intentional injuries	0.97	0.39	2.39	-8	-201	185	1.89	0.76	4.66	196	-179	570
Ill-defined	2.07	0.66	6.54	88	-106	282	2.10	0.52	8.46	91	-149	330
Risk factor-related												
Smoking-related	1.40	0.93	2.09	147	-61	356	1.90	0.97	3.72	334	-142	810
Alcohol-related	8.75	4.55	16.84	330	94	567	11.84	5.20	26.96	461	55	868
Drug-related	8.18	2.94	22.73	679	-103	1,462	5.95	2.43	14.56	468	-29	965
Amenable to medical intervention	1.87	1.18	2.97	675	10	1,340	4.26	2.20	8.24	2,514	349	4,679

x suppressed to meet the confidentiality requirements of the Statistics Act
Source: 1991 to 2001 Canadian census mortality follow-up study.

Table 5
Hazard ratios for death before age 75 among Métis and non-Status Indians compared with non-Aboriginal cohort members, controlling for selected demographic, economic, housing and geographic factors, by sex, non-institutional cohort members aged 25 to 74, Canada, 1991 to 2001

Model number and name	Adjusted for:	Men						Women					
		Métis			Non-Status Indians			Métis			Non-Status Indians		
		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
1 Age	Age	1.52	1.37	1.68	1.76	1.53	2.03	1.99	1.76	2.24	2.27	1.92	2.69
2 Family structure	Age + marital status + single parent	1.37	1.23	1.51	1.59	1.38	1.84	1.88	1.67	2.13	2.14	1.80	2.53
3 Education	Age + education	1.35	1.22	1.50	1.57	1.36	1.81	1.83	1.62	2.07	2.11	1.78	2.50
4 Income	Age + income	1.31	1.19	1.45	1.54	1.33	1.77	1.78	1.57	2.01	2.05	1.73	2.42
5 Work status	Age + labour force	1.38	1.25	1.53	1.59	1.38	1.83	1.85	1.64	2.09	2.14	1.80	2.53
6 Housing	Age + crowding + home ownership + major repairs needed	1.38	1.25	1.53	1.58	1.37	1.82	1.85	1.64	2.1	2.11	1.78	2.50
7 Geography	Age + urban population size	1.48	1.34	1.64	1.74	1.51	2.01	1.95	1.73	2.21	2.26	1.91	2.68
8 Full	Age + family structure + education + income + work status + housing + geography	1.11	1.00	1.23	1.28	1.11	1.48	1.57	1.39	1.78	1.83	1.54	2.16

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

unintentional, 11% intentional), and one-quarter was due to non-communicable diseases, notably, cardiovascular disease (data not shown). Among non-Status Indian men, injuries accounted for 48%, and non-communicable diseases, 45% of excess PYLL.

Excess PYLL was 3,005 per 100,000 person-years at risk for Métis women and 5,710 for non-Status Indian women (Table 4). More than half (57%) of the excess PYLL in both groups was due to non-communicable diseases (data not shown). Injuries accounted for 27% of excess PYLL for Métis women and 29% for non-Status Indian women; and communicable diseases, 13% and 12%, respectively. Results differed more for specific causes of death; for example, breast cancer was a major contributor to excess PYLL for non-Status Indian women (22%), but not for Métis women.

Socio-economic factors

Compared with non-Aboriginal men, the age-adjusted hazard ratio for dying before age 75 was 1.52 for Métis and 1.76 for non-Status Indians (Table 5, Model 1). However, socio-economic factors (such as education, income, housing, and labour force status) were important contributors to premature mortality. Six additional models (Models 2 to 7) were run, each adjusting for age and one other socio-economic variable. Except for Model 7, which controlled for geographic variables, the hazard ratios were attenuated compared with Model 1, suggesting that each variable had an effect on the disparity in premature mortality. In Model 8, which controlled for age and all the socio-economic factors simultaneously, the hazard ratios were reduced from 1.52 (Model 1) to 1.11 for Métis men and from 1.76 (Model 1) to 1.28 for non-Status Indian men. Among women, the corresponding reductions in hazard ratios were from 1.99 to 1.57 for Métis and from 2.27 to 1.83 for non-Status Indians.

Discussion

The PYLL rates for Métis and non-Status Indian members of the census mortality follow-up cohort were about twice those of non-Aboriginal members. Because this is the first study of PYLL among Métis and non-Status Indians, direct comparisons with earlier research are not possible. However, the estimates are consistent with calculations of PYLL (at ages 1 to 74) for Status Indians in Manitoba[12] and British Columbia.[13] Slightly lower rate ratios in the present study could reflect the exclusion of persons younger than 25, among whom PYLL rate disparities between Aboriginal and non-Aboriginal people are greatest.[28] As well, a companion article that examined PYLL among *Status Indian* members of the cohort reported rate ratios more than twice those of non-Aboriginal adults (see "Potential years of life lost at ages 25 to 74 among Status Indians, 1991 to 2001" in this issue).

Cardiovascular diseases, notably ischemic heart disease, were a major contributor to total PYLL for Métis, non-Status Indian and non-Aboriginal cohort members alike. Relative inequalities (compared with non-Aboriginal adults) for Métis and non-Status Indians were modestly elevated (ranging from 1.5 to 3.0), but due to the high incidence of cardiovascular disease deaths, they were large contributors to excess PYLL (about 10% for non-Status Indian and Métis men, and 17% to 22% for non-Status and Métis women). These findings confirm the growing importance of cardiovascular disease in various Aboriginal populations.[29,30] They also support studies showing the high prevalence of cardiovascular risk factors such as smoking,[31] obesity,[32] metabolic syndrome,[33,34] hypertension and type 2 diabetes[35] in some Aboriginal populations.

Cancer, too, was a significant contributor to total PYLL. For men,

Why is this study important?

- Relatively little mortality information exists about Métis and non-Status Indians.

What else is known on this topic?

- Rates of potential years of life lost are higher for First Nations registered under the *Indian Act* (Status Indians), with injury deaths the largest contributor.

What does this study add?

- For Métis and non-Status Indians, rates of potential years of life lost (at ages 25 to 74) were about twice as high as for non-Aboriginal people.
- Both absolute and relative inequalities were particularly elevated for injuries.
- Socio-economic factors such as income, education, housing and employment explained a substantial proportion of excess premature mortality among Métis and non-Status Indians.

relative inequalities among Métis and non-Status Indians men were slightly elevated, which resulted in somewhat higher absolute inequalities. For women, both relative and absolute cancer inequalities were substantially higher among Métis and non-Status Indians. Consistent with other research,[10,36-39] relative and absolute inequalities varied by cancer subtypes.

Earlier studies have shown Status Indians to be at greater risk of dying from intentional and unintentional injuries.[13,40] In this analysis, injury deaths made up a large share of total PYLL among Métis and non-Status Indian cohort members. Both absolute and relative inequalities were significantly elevated, with relative risks ranging from 2.5 to 4.3, and injuries contributing sizeable percentages of excess PYLL. These results illustrate the public health importance of injury prevention for Aboriginal adults.[12]

Compared with non-Aboriginal adults, the rates of PYLL for alcohol-related diseases were about five times higher for Métis and non-Status Indian men and more than eight times higher times for women. Moreover, these rates do not include deaths (due to injury, for example) in which alcohol may have been a contributing factor. A British Columbia study of Status Indians also reported a high age-standardized mortality rate for alcohol-related deaths.[13]

The disproportionate burden of illness and death among Aboriginal peoples is thought to be the product of a wide range of social determinants that are experienced throughout the lifetime.[16,41,42] The results of this analysis are similar to other population-based studies demonstrating the importance of socio-economic status as a contributor to health inequalities.[10,43] Factors such as education, income, housing, and labour force status were significantly associated with the disparity in premature mortality compared with non-Aboriginal adults. Nevertheless, these variables did not explain all of the disparity in premature death, suggesting that factors not assessed in this study contribute to the inequality.

Limitations

The results apply to non-institutional census respondents aged 25 or older who filed taxes. This cohort is healthier than the Canadian population overall, so caution should be exercised when generalizing these results to the entire Métis, non-Status Indian and non-Aboriginal adult populations (which include institutional residents and non-tax-filers).

A question on Aboriginal self-identity was not asked on the 1991 census. Therefore, this study used the ancestry-based definition. It is estimated that more than 90% of individuals defined as Métis or non-Status Indians in this study would also self-identify as Aboriginal. Nonetheless, changes in Aboriginal self-identification over the past 20 years[44] mean that care must be taken when comparing these results with those of more recent censuses.

Ascertainment of deaths among Aboriginal cohort members is estimated to be slightly lower than that for the cohort as a whole. This would be expected to exert a slight downward bias in calculated mortality rates for Métis and non-Status Indians, so the true extent of the disparities could be slightly larger than indicated here.

Due to the small number of cohort members who were non-Status Indian or Métis, confidence intervals for some causes of deaths were wide, thereby limiting the detection of statistically significant differences in PYLL between Métis or non-Status Indians and non-Aboriginal adults.

Conclusion

This study adds to the information about mortality among Métis and non-Status Indians in Canada. These two Aboriginal groups had significantly higher rates of potential years of life lost, compared with non-Aboriginal adults. As was the case for non-Aboriginal adults, the largest losses of potential years of life among Métis and non-Status Indians were due to non-communicable (chronic) diseases such as cancers and cardiovascular diseases. However, injuries were a major contributor to disparities in premature mortality, as were alcohol- and drug-related deaths. The findings highlight the prevalence of premature mortality due to chronic diseases and the public health importance of injury, alcohol and drug prevention programs. The results are also in line with other research demonstrating the significant role of socio-economic factors. ■

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Appendix

Table A
Selected characteristics of Métis, non-Status Indians and non-Aboriginal men and women, non-institutional cohort members aged 25 to 74, Canada, 1991

	Men			Women		
	Métis	Non-Status Indians	Non-Aboriginal	Métis	Non-Status Indians	Non-Aboriginal
Total number	**5,600**	**2,600**	**1,245,100**	**6,000**	**2,800**	**1,230,600**
	---------- Percentage ----------					
Percentage	100	100	100	100	100	100
Age group						
25 to 34	39	41	28	44	44	30
35 to 44	29	30	27	29	31	28
45 to 54	18	16	19	15	14	18
55 to 64	11	8	15	8	8	13
65 to 74	4	5	11	5	4	11
Marital status						
Single (never married)	20	19	14	16	16	11
Common-law	20	19	7	17	17	6
Married	51	54	73	49	50	66
Previously married	9	8	7	18	18	16
Single parent	3	2	2	20	16	8
Homeowner	55	54	75	51	52	72
Overcrowding	13	9	2	14	10	2
Dwelling in need of major repairs	25	20	7	25	17	7
Educational attainment						
Less than secondary graduation	53	51	33	50	46	32
Secondary graduation	35	39	38	31	37	36
Postsecondary diploma	8	7	13	14	13	19
University degree	4	3	16	5	3	13
Income adequacy quintile						
1 (lowest)	29	27	13	36	33	17
2	23	23	18	22	22	19
3	20	23	21	18	19	21
4	18	17	23	15	16	21
5 (highest)	11	10	24	9	10	21
Labour force status						
Employed	62	65	76	48	52	63
Unemployed	18	15	7	11	9	6
Not in labour force	19	20	17	42	39	32
Region						
Atlantic	2	7	8	2	7	8
Quebec	8	38	26	7	40	26
Ontario	8	19	37	8	18	37
Manitoba	24	6	4	24	5	4
Saskatchewan	22	8	3	23	8	3
Alberta	22	8	9	22	7	9
British Columbia	6	11	12	5	10	12
Territories	8	3	1	8	3	1
Community size						
1,000,000 or more	6	20	31	5	22	33
500,000 to 999,999	15	14	16	15	15	17
100,000 to 499,999	5	9	15	6	9	16
10,000 to 99,999	15	14	14	16	15	14
Less than 10,000	59	42	23	58	39	21
Living in First Nations community	7	7	0	8	5	0

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

Physical activity among First Nations people off reserve, Métis and Inuit

by Leanne C. Findlay

Abstract

Background
Research on physical activity among Aboriginal peoples has generally taken a pan-Aboriginal approach rather than considering First Nations people, Métis and Inuit separately. However, the groups differ geographically and culturally.

Data and methods
Data from the 2005 Canadian Community Health Survey were used to compare rates of active and moderately active leisure time (versus inactive) among First Nations people off reserve, Métis and Inuit with rates among non-Aboriginal people. Factors associated with active and moderately active leisure time were examined using logistic regression models. An active or moderately active lifestyle was studied in relation to self-perceived physical and mental health and the presence of chronic conditions.

Results
First Nations (people off reserve) and Métis people were significantly more likely than non-Aboriginal Canadians to have an active lifestyle. Being male, younger age and high educational attainment were associated with an increased likelihood of physically active leisure time. An active lifestyle was associated with an increased likelihood of excellent or very good self-perceived physical and mental health among Métis and among Aboriginal people overall. Level of leisure-time physical activity was not associated with chronic conditions for any Aboriginal group or for the non-Aboriginal population.

Interpretation
Aboriginal peoples generally have higher levels of leisure-time activity than do non-Aboriginal people.

Keywords
Aboriginal peoples, chronic disease, exercise, health status, leisure activities, mental health

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Previous research has suggested that Aboriginal people off reserve may be more active than their non-Aboriginal counterparts.[1,2] As well, according to results of a 2002/2003 survey, one-fifth of First Nations people living on reserves engaged in at least 30 minutes of moderate-to-vigorous activity four or more days per week. Whether they are Aboriginal[3,4] or non-Aboriginal,[2] physically active people are more likely than those who are less active to report excellent or very good health.

Studies of physical activity among Aboriginal people have tended to consider First Nations people, Métis and Inuit collectively rather than as separate groups, or have focused exclusively on First Nations people. However, geographic and cultural differences between the groups may be related to leisure-time physical activity. Increasingly, the need for research that makes distinctions between First Nations people, Métis people and Inuit is being recognized.[5]

Relatively little information is available about factors that may influence Aboriginal peoples' participation in physical activity. A 2006 review[6] found negative associations with age and body weight, and positive associations with education and perceived health. In addition, males were generally more active than females, and people with a supportive social environment were more likely to be physically active. However, this review cited mostly American data; little is known about the correlates of physical activity for Aboriginal people in Canada, and specifically, separate Aboriginal groups.

The current study has three goals: 1) to examine leisure-time physical activity among First Nations people living off reserve, Métis people and Inuit; 2) to determine factors associated with active and moderately active (compared with inactive) leisure time for the three groups; and 3) to examine the relationship between physical activity and health among Aboriginal people.

Methods

Data source

Data from the 2005 Canadian Community Health Survey (CCHS) were used to examine the leisure-time physical activity of First Nations people off reserve, Métis and Inuit aged 12 or older. The target population of the CCHS is all Canadians aged 12 or older. Excluded from the sampling frame are individuals living on Indian Reserves and on Crown Lands, institutional residents, full-time members of the Canadian Forces, and residents of certain remote regions. Coverage is in the range of 98% in the provinces; in the Territories, it is about 90% in the Yukon, 97% in the Northwest Territories and 71% in Nunavut, primarily because some remote regions are excluded. In Nunavut, the CCHS collects information in the 10 largest communities: Iqaluit, Rankin Inlet, Cambridge Bay, Kugluktuk are always in sample, plus one community from Cape Dorset, Pangnirtung, Igloolik or Pond Inlet is selected; plus one community from Baker Lake or Arviat. Households were selected using a complex cluster design based on the Labour Force Survey.

CCHS respondents were asked, "Are you an Aboriginal person, that is, North American Indian, Métis or Inuit?" (Although respondents self-identified as "North American Indian," the term "First Nations" is used throughout this study.) The 2005 sample included 3,414 respondents who self-identified as belonging to a single Aboriginal group (1,522 First Nations, 1,533 Métis, and 359 Inuit) and 129,494 respondents who were not Aboriginal. This analysis excludes 39 respondents who reported belonging to more than one Aboriginal group.

Measures

Respondents' *leisure-time physical activity* was based on a list of common activities (Appendix Table A). Respondents reported the number of times they had engaged in each activity during the previous three months and the average duration. Average daily energy expenditure was calculated for each activity by multiplying by an estimate of the energy cost of the activity (kilocalories per kilogram of body weight per hour, according to the Canadian Fitness and Lifestyle Research Institute guidelines). The energy expenditures were summed and used to classify respondents into one of three categories: active (3 or more kilocalories per kilogram of body weight per day); moderately active (1.5 to less than 3 kilocalories per kilogram per day); and inactive (less than 1.5 kilocalories per kilogram per day). Active leisure time is the equivalent of walking at least 1 hour every day; moderately active leisure time, half an hour per day.

Three health indicators were considered in the current study: *self-perceived health* (general); *self-perceived mental health*; and the presence of *chronic conditions* (for example, asthma, high blood pressure, arthritis) (Appendix Table B). Respondents were asked, "In general, would you say your [mental] health is…" The response options were: excellent, very good, good, fair, and poor. The number of chronic conditions a respondent reported was dichotomized to reflect the presence of one or more.

Several socio-demographic characteristics were examined as predictors of leisure-time physical activity: gender, age, number of dependants aged 0 to 17 in the household (asked of respondents aged 18 or older), marital status (married/common-law versus single/widowed/divorced/separated), and employment (yes or no). Age was classified into five groups: 12 to 17, 18 to 34, 35 to 49, 50 to 64, and 65 or older. Total annual household income was classified into three categories: less than $20,000; $20,000 to $39,999; and $40,000 or more. Education was classified as: less than secondary graduation, secondary graduation, some postsecondary, and postsecondary graduation.

Statistical analyses

Descriptive statistics on the socio-demographic characteristics, self-reported health indicators, and leisure-time physical activity of the study sample were calculated. To account for the younger age profile of the Aboriginal population, percentages for all health outcomes and leisure-time physical activities were age-standardized to the Aboriginal population. Chi-square comparisons were used to identify significant differences between each Aboriginal group and the non-Aboriginal population (but not between Aboriginal groups). Logistic regression was used to determine whether the socio-demographic factors were associated with active and/or moderately active leisure time, and to examine associations between the level of leisure-time activity and the measures of self-reported health. Separate models were fitted for each Aboriginal group and for the non-Aboriginal comparison group. Because of the relatively small sample for each Aboriginal group, models combining the three were also fitted. Sampling weights were used in all analyses. To account for the complex survey design, a bootstrapping technique was applied for variance estimation.[7]

Results

More active/Less healthy

First Nations people who lived off-reserve and Métis people were more likely than the non-Aboriginal population to be physically active in their leisure time: 37% and 39% versus 30% (Table 1). However, the percentage of Inuit who were physically active (31%) was not significantly different from the percentage for non-Aboriginal people.

Each Aboriginal group was more likely than the non-Aboriginal population to report their general and mental health as good/fair/poor rather than excellent/very good. As well, the prevalence of chronic conditions was higher among First Nations people off reserve (71%) and Métis (74%) people than among non-Aboriginal Canadians (64%). The comparatively low rate (65%) among Inuit may be associated with the CCHS question, which specified chronic conditions "diagnosed by a health professional." Inuit communities may have relatively few such people to make the diagonses.

Table 1
Physical activity, health and socio-demographic characteristics, by Aboriginal identity, household population aged 12 or older, Canada, 2005

Characteristics	First Nations off reserve (n=1,522)			Métis (n=1,533)			Inuit (n=359)			Non-Aboriginal (n=129,494)		
	%	Mean	se	%	Mean	se	%	Mean	se	%	Mean	se
Physical activity												
Active	37.0*	...	...	38.5*	...	...	30.7	...	...	29.9	...	...
Moderately active	22.1	...	...	21.8	...	...	24.5	...	...	25.0	...	...
Inactive	40.9	...	...	39.7	...	...	44.9	...	...	45.2	...	...
Health												
Self-rated health												
Good/Fair/Poor	48.3*	...	...	45.8*	...	...	51.3*	...	...	36.2	...	...
Excellent/Very good	51.7	...	...	54.2	...	...	48.7	...	...	63.8	...	...
Self-rated mental health												
Good/Fair/Poor	32.7*	...	...	30.0*	...	...	38.2*	...	...	24.5	...	...
Excellent/Very good	67.3	...	...	70.0	...	...	61.8	...	...	75.5	...	...
Chronic condition												
No	28.8*	...	...	26.1*	...	...	34.9	...	...	35.9	...	...
Yes	71.2	...	...	73.9	...	...	65.1	...	...	64.1	...	...
Socio-demographic												
Sex												
Male	51.9	...	...	50.6	...	...	56.4	...	...	49.3	...	...
Female	48.1	...	...	49.4	...	...	43.6	...	...	50.8	...	...
Age	...	35.2*	0.6	...	36.6*	0.7	...	33.3*	1.5	...	43.0	0.0
Marital status												
Married/Common-law	47.0*	...	...	52.8*	...	...	44.3*	...	...	59.0	...	...
Single/Widowed/Divorced/ Separated	53.1	...	...	47.2	...	...	55.7	...	...	41.0	...	...
Number of children in household†	...	0.9*	0.1	...	0.8*	0.1	...	1.3*	0.2	...	0.6	0.0
Education												
Less than secondary graduation	36.2*	...	...	36.0*	...	...	54.1*	...	...	23.7	...	...
Secondary graduation	15.5	...	...	14.8	...	...	7.1[E]	...	...	15.2	...	...
Some postsecondary	12.5	...	...	10.0	...	...	7.1[E]	...	...	8.8	...	...
Postsecondary graduation	35.9	...	...	39.3	...	...	31.8[E]	...	...	52.4	...	...
Employment												
Currently working	65.2*	...	...	68.4	...	...	60.1	...	...	69.2	...	...
Not working	34.8	...	...	31.6	...	...	39.9	...	...	30.9	...	...
Household income												
Less than $20,000	18.5*	...	...	14.5*	...	...	18.0*[E]	...	...	9.4	...	...
$20,000 to $39,999	25.8	...	...	21.2	...	...	23.6[E]	...	...	18.9	...	...
More than $40,000	55.8	...	...	64.3	...	...	58.4	...	...	71.7	...	...

* significantly different distribution from non-Aboriginal population (p<0.05)
† population aged 18 or older
se = standard error
... not applicable
Note: Chi-square comparisons have been age-standardized to Aboriginal population.
Source: 2005 Canadian Community Health Survey.

To some extent, these differences in physical activity and health reflect socio-demographic characteristics. Each Aboriginal group tended to be younger and to have more dependent children in their households than did non-Aboriginal Canadians. They were also more likely to live in rural areas, to be single, to live in households with low annual income, and to have less than secondary graduation. First Nations people off reserve were also significantly less likely to be employed.

Active leisure time

The first set of models examined socio-demographic characteristics that might be related to active (versus inactive) leisure time (Table 2). For First Nations people off reserve and Métis people, gender, education and age were significantly associated with active leisure time. The odds of being active were higher for males than for females. Individuals with higher levels of education were more likely to be active than were those who had not graduated from secondary school. And 12- to 17-year-olds had significantly higher odds of active leisure time than did people aged 18 to 34. The odds of active leisure time were significantly lower among First Nations people off reserve aged 35 to 64. For Inuit, no socio-demographic factors were significantly related to active leisure time, although the small sample size may have precluded the detection of significant associations.

To put the findings for each Aboriginal group in context, a model was fitted for non-Aboriginal Canadians. Most of the socio-demographic characteristics included in the model were significantly related to leisure-time physical activity. The odds of being active (versus inactive) were significantly higher for non-Aboriginal people who were male, whose education had advanced beyond secondary graduation, and who were aged 12 to 17. The odds of being active were significantly lower for those who lived in lower-income households (less than $40,000), who were married or in a common-law relationship, who had a relatively large number of young dependants in their household, who were employed, and who were aged 35 or older.

Moderately active leisure time

Fewer characteristics were associated with moderately active (versus inactive) leisure time (Table 3). For First Nations people off reserve, household income below $40,000 (rather than $40,000 or more) was associated with lower odds of moderately active leisure time. For Métis people, urban residence and

Table 2
Odds ratios relating active (versus inactive) leisure time to selected characteristics, by Aboriginal identity, household population aged 12 or older, Canada, 2005

	First Nations off reserve (n=1,522)			Métis (n=1,533)			Inuit (n=359)			Non-Aboriginal (n=129,494)		
	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
Sex												
Male	1.66*	1.07	2.59	1.72*	1.08	2.75	3.54	0.85	14.76	1.35*	1.28	1.42
Female†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Age group												
12 to 17	3.97*	1.24	12.68	3.88*	1.09	13.74	6.42	0.61	67.95	2.86*	2.50	3.27
18 to 34†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
35 to 49	0.53*	0.30	0.92	1.01	0.55	1.85	0.23	0.03	1.73	0.72*	0.68	0.76
50 to 64	0.38*	0.18	0.81	0.88	0.40	1.90	0.16	0.00	14.21	0.67*	0.63	0.72
65 or older	0.40	0.15	1.09	0.71	0.21	2.41	0.26	0.00	609.41	0.72*	0.65	0.79
Marital status												
Married/Common-law	0.89	0.54	1.47	0.58	0.31	1.12	1.06	0.26	4.25	0.73*	0.69	0.77
Single/Widowed/Divorced/Separated†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Number of children in household	0.96	0.78	1.18	1.20	0.92	1.57	1.17	0.68	2.01	0.96*	0.93	0.99
Education												
Less than secondary graduation†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Secondary graduation	0.82	0.40	1.70	2.00	0.81	4.94	0.62	0.02	19.24	1.41*	1.29	1.55
Some postsecondary	2.80*	1.24	6.31	2.27	0.78	6.55	2.72	0.15	48.60	1.57*	1.40	1.76
Postsecondary graduation	2.01*	1.13	3.59	3.82*	1.81	8.10	3.78	0.52	27.41	1.75*	1.62	1.89
Employment												
Working	0.60	0.34	1.05	0.69	0.36	1.33	0.63	0.12	3.26	0.74*	0.69	0.79
Not working†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Household income												
Less than $20,000	0.69	0.34	1.37	0.61	0.28	1.36	1.01	0.13	7.74	0.61*	0.57	0.67
$20,000 to $39,999	0.72	0.42	1.25	0.69	0.35	1.34	1.50	0.18	12.47	0.65*	0.61	0.69
More than $40,000†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...

† reference category
* significantly different from estimate for reference category (p<0.05)
... not applicable
Note: All models control for population density.
Source: 2005 Canadian Community Health Survey.

postsecondary graduation were associated with increased odds of moderate activity. None of the socio-demographic factors was associated with moderate activity among Inuit. However, among the non-Aboriginal population, being older, lower education and household income, being employed and being married were negatively associated with moderately active leisure time.

Leisure-time activity and self-perceived health

To determine if active or moderately active leisure time was associated with health status over and above socio-demographic characteristics, separate models were fitted for each Aboriginal group, for the three groups combined, and for the non-Aboriginal population.

Active leisure time was associated with self-perceived general and mental health for Métis people (Table 4). The estimates were not significant for First Nations people off reserve or Inuit, although the odds ratios were in the same direction. To overcome the small sample sizes, the three groups were considered together. In this case, active leisure time was associated with increased self-perceived general and mental health, even when controlling for socio-demographic characteristics. For non-Aboriginal Canadians both active and moderately active leisure time were associated with increased odds of reporting excellent or very good self-perceived health.

Neither active nor moderately active leisure time was associated with the presence of one or more chronic conditions for any Aboriginal group (alone or combined) or for the non-Aboriginal population.

Discussion

According to results of the 2005 Canadian Community Health Survey, First Nations people living off-reserve and Métis people were significantly more physically active in their leisure time

Table 3
Odds ratio relating moderately active leisure time (versus inactive) to selected characteristics, by Aboriginal identity, household population aged 12 or older, Canada, 2005

	First Nations off reserve (n=1,522)			Métis (n=1,533)			Inuit (n=359)			Non-Aboriginal (n=129,494)		
	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
Sex												
Male	1.00	0.59	1.68	1.03	0.64	1.65	1.01	0.26	3.90	1.03	0.98	1.08
Female†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Age group												
12 to 17	1.86	0.43	7.96	1.26	0.35	4.57	0.61	0.00	1008.97	1.73*	1.49	2.01
18 to 34†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
35 to 49	0.63	0.34	1.20	0.78	0.44	1.39	0.47	0.10	2.28	0.90*	0.84	0.96
50 to 64	0.81	0.39	1.67	0.76	0.38	1.53	1.45	0.27	7.85	0.91*	0.85	0.98
65 or older	1.76	0.63	4.93	1.38	0.44	4.34	0.35	0.00	2466.37	1.08	0.98	1.18
Marital status												
Married/Common-law	1.11	0.63	1.96	0.82	0.45	1.49	0.83	0.24	2.86	0.92*	0.87	0.97
Single/Widowed/Divorced/Separated†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Number of children in household	1.03	0.82	1.31	0.97	0.76	1.24	1.19	0.68	2.06	0.96*	0.93	0.99
Education												
Less than secondary graduation†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Secondary graduation	1.68	0.77	3.63	1.24	0.55	2.79	0.90	0.04	22.43	1.33*	1.22	1.46
Some postsecondary	1.29	0.52	3.15	0.89	0.36	2.23	1.10	0.19	6.31	1.48*	1.33	1.64
Postsecondary graduation	1.16	0.58	2.32	2.12*	1.15	3.89	1.46	0.36	5.86	1.63*	1.51	1.75
Employment												
Working	0.96	0.51	1.83	1.07	0.57	1.99	0.83	0.25	2.78	0.83*	0.77	0.88
Not working†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Household income												
Less than $20,000	0.48*	0.23	0.97	0.67	0.30	1.54	1.24	0.26	6.06	0.64*	0.59	0.69
$20,000 to $39,999	0.33*	0.18	0.62	0.90	0.49	1.65	1.03	0.21	5.01	0.72*	0.68	0.77
More than $40,000†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...

† reference category
* significantly different from estimate for reference category (p<0.05)
... not applicable
Note: All models control for population density.
Source: 2005 Canadian Community Health Survey.

than was the non-Aboriginal population. These results reinforce earlier findings,[1,2] although in this analysis, significant differences were not apparent for Inuit.

Many of the factors that influence leisure-time activity in the general population were significant for Aboriginal peoples.[2,6,8] Being male, younger age and higher educational attainment were associated with *active* leisure among First Nations people off reserve and Métis people. Fewer factors were associated with *moderately active* leisure among Aboriginal peoples (possibly because of small sample sizes), despite significant relationships for the non-Aboriginal population.

As reported in earlier studies,[2-4] whether they were Aboriginal or non-Aboriginal, physically active people were more likely than those who were less active to report excellent or very good general and mental health. However, moderately active leisure time was not positively associated with self-perceived general and mental health for Aboriginal people, which indicates a need for further research to determine the amount of activity required for associations to emerge.

Despite higher levels of physical activity, Aboriginal people tend to report poorer health. Earlier studies have shown a relatively high prevelance of obesity[8,9,10] and the associated complications of diabetes[11-13] and other chronic conditions[3] among the Aboriginal population.

It is often suggested that health disparities are driven by social rather than biological determinants.[14] For instance, smoking, poor housing conditions and lower income can negatively affect health.[15] When the influence of several social determinants was taken into account, active leisure time was associated with health only for Métis people.

A more complex relationship between physical activity and health may exist for Aboriginal people. It is possible that factors not considered in this analysis

Table 4
Adjusted odds ratios relating level of leisure time activity to self-rated general and mental health and presence of chronic condition(s), by Aboriginal identity, household population aged 12 or older, Canada, 2005

	First Nations off reserve (n=1,522)			Métis (n=1,533)			Inuit (n=359)			Total Aboriginal (n=3,414)			Non-Aboriginal (n=129,494)		
	Odds ratio	95% confidence interval		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		from	to
Self-rated health															
Active leisure time	1.50	0.93	2.41	3.48*	2.04	5.93	2.13	0.66	6.92	2.24*	1.59	3.17	2.16*	2.04	2.29
Moderately active leisure time	0.93	0.56	1.52	1.55	0.93	2.56	1.34	0.36	4.97	1.22	0.88	1.70	1.52*	1.44	1.61
Inactive leisure time†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Self-rated mental health															
Active leisure time	1.55	0.98	2.46	1.74*	1.00	3.03	0.62	0.18	2.18	1.58*	1.12	2.22	1.52*	1.43	1.62
Moderately active leisure time	1.47	0.90	2.40	1.12	0.67	1.85	1.69	0.61	4.71	1.31	0.94	1.81	1.29*	1.21	1.36
Inactive leisure time†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
One or more chronic conditions															
Active leisure time	1.62	0.93	2.81	0.82	0.47	1.44	3.39	0.92	12.44	1.24	0.84	1.82	0.93	0.87	0.98
Moderately active leisure time	1.70	0.95	3.05	0.69	0.39	1.20	1.38	0.46	4.15	1.12	0.76	1.64	1.04	0.98	1.10
Inactive leisure time†	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...

† reference category
* significantly different from estimate for reference category (p<0.05)
... not applicable
Note: All models control for age, sex, marital status, number of dependant children in household, education, employment status, household income, and population density.
Source: 2005 Canadian Community Health Survey.

What is already known on this subject?

- Aboriginal peoples in Canada have relatively high rates of obesity and diabetes.
- Active leisure time is associated with better health.
- Little information is available for the three Aboriginal groups—First Nations people off reserve, Métis, Inuit—separately.

What does this study add?

- First Nations people off reserve and Métis are more active than non-Aboriginal Canadians.
- Socio-demographic characteristics are associated with physically active leisure time.
- Active leisure time is associated with better self-perceived general and mental health for Aboriginal people.

may be influential. The well-being of Aboriginal people may have not only physical and mental components, but also emotional and spiritual aspects based on a holistic approach.[16,17] Wilson et al.[18] suggested that in addition to well-established social determinants (such as income and education), traditional activities may be significantly associated with the health of Aboriginal people.

In the current study, active and moderately active leisure time were not significantly related to the presence of chronic conditions. However, the data are cross-sectional, and it is not possible to determine temporal associations. In addition, the total number of conditions and the the severity of impairment were not considered. By contrast, previous research has demonstrated links between physical activity and specific chronic disease risk factors. For instance, Katzmarzyk[9] found an association between Aboriginal identity and obesity, and between physical activity and obesity. Physical activity has also been shown to be inversely associated with metabolic syndrome among men (which, in turn, is associated with an elevated risk for cardiovascular disease and diabetes).[19] Links between physical activity and specific chronic conditions among Aboriginal people warrant further investigation.

Strengths, limitations and future directions

The current study provides insight into the levels of leisure-time activity among a population-based sample of First Nations people off reserve, Métis people and the Inuit. Previous work in this area has not focused on factors associated with physical activity, or on associations between physical activity and the health of specific Aboriginal groups.

Some limitations should be acknowledged. Because the data are cross-sectional, it is not possible to determine the direction of relationships between physical activity and health in this study. Healthier people may be capable of active leisure time, rather than active leisure time leading to better health.

The specific activities in which Aboriginal people participated could not be identified. Moreover, the CCHS measure of physical activity may not be suited to Aboriginal people. It is based on a predetermined list of "common" activities that may not be prevalent in Aboriginal communities, while activities relevant to Aboriginal lifestyles are not included. For example, results from the First Nations Regional Longitudinal Health Survey revealed that hunting, trapping, berry-picking and food gathering (none of which were listed in the CCHS) were frequently cited as physical activities by First Nations people.[4] As well, self-rated health may not be construed in the same way by Aboriginal people because of a more holistic perspective[16] or because the CCHS categories are understood differently.

Similarly, the thresholds for *active*, *moderately active* and *inactive* leisure time may not be appropriate for Aboriginal people. They may not consider some of the activities listed by the CCHS as leisure, and therefore, do not include them among their leisure-time pursuits.[20] Kriska et al.[21] found that occupational activity was a greater contributor to total physical activity than was leisure time among Aboriginal people. If this is, indeed, the case, levels of physical activity may be underestimated in the current study. Additional research is necessary to determine if the measure of physical activity in the CCHS is appropriate for Aboriginal people.

Although First Nations people off reserve, Métis people and Inuit were examined separately, the leisure-time activities of even smaller groups with diverse traditions, history, and culture[10] might warrant attention. However, given that the current study was already limited by sample size, such research is not feasible using the CCHS. In fact, the failure to detect significant differences for factors potentially associated with leisure-time activity or between an active or moderately active lifestyle and health may be the result of small sample sizes.

Conclusion

The current study demonstrates that First Nations people off reserve and Métis people were more likely than non-Aboriginal Canadians to have an active lifestyle. The analysis highlights the importance of examining the three Aboriginal groups separately and the value of studying the relationship between physical activity and health. With an estimate of close to 1.2 million Aboriginal people in Canada in 2006,[22] further research is needed to identify factors associated with their physical and mental well-being. ■

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Appendix

Table A
Selected activities and metabolic equivalent of task (MET) value, 2005 Canadian Community Health Survey

Activity	MET value (kilocalories per kilogram per hour)
Jogging/Running	9.5
Basketball	6.0
Ice hockey	6.0
In-line skating/Rollerblading	5.0
Soccer	5.0
Volleyball	5.0
Bicycling	4.0
Downhill skiing/Snowboarding	4.0
Exercise class/Aerobics	4.0
Golfing	4.0
Ice skating	4.0
Tennis	4.0
Baseball/Softball	3.0
Fishing	3.0
Gardening/Yard work	3.0
Home exercises	3.0
Popular or social dance	3.0
Swimming	3.0
Walking for exercise	3.0
Weight training	3.0
Bowling	2.0
Other*	4.0

* mean MET value applied for all "other" activities

Table B
Chronic conditions listed in 2005 Canadian Community Health Survey

Condition
Food allergies
Other allergies
Asthma
Fibromyalgia
Arthritis/Rheumatism
Back problems
High blood pressure
Migraine headaches
Chronic bronchitis
Emphysema
Chronic obstructive pulmonary disease
Diabetes
Epilepsy
Heart disease
Cancer
Intestinal/Stomach ulcers
Effects of stroke
Urinary incontinence
Bowel disorder
Alzheimer's disease/Other dementia
Cataracts
Glaucoma
Thyroid condition
Chronic fatigue syndrome
Multiple chemical sensitivities
Schizophrenia
Mood disorder such as depression, bipolar disorder, mania, dysthymia
Anxiety disorder such as a phobia, obsessive compulsive disorder, panic disorder
Autism/Other developmental disorder
Learning disability
Eating disorder (anorexia, bulimia)
Other long-term physical or mental health condition diagnosed by health professional

Evaluation of the factor structure of the child-reported parenting questionnaire in the National Longitudinal Survey of Children and Youth

by Rübab G. Arim, Jennifer D. Shapka, V. Susan Dahinten and Brent F. Olson

Abstract

Background
The effect of parenting behaviours is important in child health and development research. This study evaluates three child-reported parenting behaviour scales (nurturance, rejection and monitoring) in the Canadian National Longitudinal Survey of Children and Youth (NLSCY).

Data and methods
The sample consisted of two longitudinal cohorts (n = 1,164) who were interviewed at ages 10 to 11, 12 to 13, and 14 to 15. The factor structure of each scale was evaluated using confirmatory factor analysis with weighted least squares estimation on polychoric correlation matrices.

Results
The 7-item NLSCY Parental Nurturance model appeared to be a good fit to the data for children aged 10 to 11 and 12 to 13, but not for those aged 14 to 15. The 7-item Parental Rejection model was not a good fit to the data across any of the three time points. The 5-item Parental Monitoring model was a good fit to the data across all three time points. Removal of one item from the nurturance and one item from the monitoring scale improved the fit to the data.

Interpretation
The revised models appeared to be useful in assessing parental nurturance and monitoring. The model for parental rejection was not confirmed for this sample of adolescents.

Keywords
child-rearing, data analysis, factor analysis, parent-child relations, questionnaires, rejection, validation studies

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Research has demonstrated significant relationships between parenting behaviours and child health and development.[1-6] For example, low parental nurturance and high parental rejection have been associated with anxiety, property offence and hyperactivity-inattention problems in adolescence.[3] But despite the considerable number of studies, relatively little is known about the quality of measures based on child-reported parenting behaviours.[7-9] In the absence of empirically validated measures, it is possible that some findings reflect spurious associations. This analysis addresses that gap by evaluating the factor structure of the child-reported parenting scales in Statistics Canada's National Longitudinal Survey of Children and Youth (NLSCY).

To date, no studies have evaluated the factor structure of the NLSCY child-reported parenting questionnaire. Because the parenting behaviours measured by this questionnaire are often included as risk or protective factors in NLSCY-based health research,[10] it is important that their quality be assessed.

The NLSCY is a high-profile survey, the results of which have the potential to influence policy on children's health and development.[11] It collects information about a representative sample of Canadian children and youth, which enhances the generalizability of findings. As well, because the data are longitudinal, the factor structure of the child-reported parenting questionnaire can be evaluated across time, thereby providing a stronger analytical framework for construct validation than would cross-sections of a study population.

Data and methods

The biennial NLSCY, conducted jointly by Statistics Canada and Human Resources and Skills Development Canada, began in 1994/1995. The target population for the first cycle was newborns through age 11. Households in Yukon, Nunavut, and the Northwest Territories, and children in institutional settings were excluded. The response rate was 87%, which resulted in 22,831 children in cycle 1 (1994/1995).[12] The response rates for these children in the second and third cycles were 67% and 65%, respectively.[13]

The household data were provided by the person most knowledgeable (PMK) about the child during a face-to-face or telephone interview. With the PMK's permission and in a private setting to ensure confidentiality, children aged 10 or older completed a separate questionnaire.[13]

The initial sample for this analysis consisted of two longitudinal cohorts: the first was made up of children aged 10 to 11 in 1998/1999 (cycle 3) who were re-interviewed at ages 12 to 13 in 2000/2001 (cycle 4), and at ages 14 to 15 in 2002/2003 (cycle 5); the second cohort was children aged 10 to 11 in 2000/2001 (cycle 4) who were re-interviewed at ages 12 to 13 in 2002/2003 (cycle 5), and at ages 14 to 15 in 2004/2005 (cycle 6).

Before the data for the two cohorts were combined, a series of independent sample t-tests (or chi-square tests for dichotomous variables) was performed to ensure that there were no systematic differences between the cohorts in demographic factors such as gender, household income and PMK education, or in parental nurturance, rejection and monitoring at each age. The findings indicated that socio-economic characteristics differed across cohorts, but these differences varied by age group and cohort. For example, PMKs of children in cohort 1 reported lower household income than did those in cohort 2 at ages 10 to 11, but the reverse was found at ages 14 to 15.

Nurturance was the only parenting variable for which a statistically significant difference emerged, with a small effect size at ages 10 to 11 and 12 to 13 (children in cohort 2 reported higher levels of nurturance than did children in cohort 1).

The response format for the questionnaire was changed from a 4-point scale in cycle 1 to a 5-point scale in subsequent cycles; some items were removed after cycle 1; and new items were added after cycle 2. To ensure the consistency of items and of the response scale, the sample was drawn from cycles 3 to 6.

The final sample for the study consisted of 1,164 children who were interviewed at ages 10 to 11, 12 to 13, and 14 to 15, and who had complete data on the three parenting behaviour scales. The impact of cycle-to-cycle attrition and attrition due to missing data was examined in a series of independent t-tests (or chi-square tests for dichotomous variables). The final sample had a somewhat higher socio-economic status than did the initial sample, but the effect size measures were small.

Of the children in the analysis, 53% were female; 75% lived with their biological parents; 15% lived in a single-parent household; and 59% lived in a household with an annual income of $50,000 or more when they were aged 10 to 11. Most PMKs (91%) had at least secondary graduation.

Parenting questionnaire

The child-reported parenting questionnaire was developed by Lempers et al.,[14] and was based on Schaefer's[15] Children's Report of Parental Behavior Inventory and on the Child Rearing Practices Report of Roberts et al.[16] The original 29-item questionnaire measured three parenting behaviours: nurturance, inconsistent rejection-oriented discipline, and monitoring. *Nurturance* denotes positive evaluation, expression of affection and equalitarian treatment. *Inconsistent rejection-oriented discipline* behaviours are negative affect, control, and hostility. *Monitoring* involves parental direction and supervision.[15,16] These three dimensions of parenting were supported through an exploratory factor analysis (EFA) using varimax rotation.[14] The alpha coefficient for all 29 items was .80. The authors did not provide the internal consistency scores for the three subscales, nor did they provide information on validity.

In the NLSCY version of the questionnaire, the wording of one item was modified, and 10 items (6 nurturance, 3 rejection, and 1 monitoring) were excluded, resulting in a 19-item scale. EFA based on the first cycle of data for children aged 10 to 11[12] revealed three factors that were labelled nurturance (7 items; alpha = .77), rejection (7 items; alpha = .59), and monitoring (5 items; alpha = .54).

Although the EFA revealed the underlying structure of this questionnaire, the low alphas suggest that a stronger empirical and conceptual evaluation of the measure is necessary to provide support for construct validity.[17] Confirmatory factor analysis (CFA) has been shown to be a highly effective approach to providing support for construct validation.[18] Unlike EFA, CFA of each parenting behaviour model (nurturance, rejection and monitoring) provides support for construct validity to the extent that the constructs are measured by the specified indicators, and are related in a theoretically predictable manner.

Data analysis

The three parenting behaviours—nurturance (for example, "my parents smile at me"), rejection (for example, "my parents hit me or threaten to do so"), and monitoring (for example, "my parents want to know exactly where I am and what I am doing")—were assessed using a 5-point response scale ranging from 0 (never) to 4 (always), with higher scores indicating that the child perceived more nurturing, rejection and monitoring. (The item "[my parents] let me go out any evening I want" in the monitoring scale was reverse-coded.)

Ordinal coefficient alpha was used to estimate the reliability of the three scales.[19] Across the three time points

(at ages 10 to 11, 12 to 13, and 14 to 15, respectively), the estimates of reliability were "high" for the nurturance scale (.90, .92, .94), "good" for the rejection scale (.75, .79, .83), and "acceptable-to-satisfactory" for the monitoring scale (.63, .65, .70)

A separate set of CFAs was conducted to evaluate the factor structure of each parenting scale across the three time points. Because of the construct-confirming nature of the study, the data were not weighted; the lack of generalizability of the findings at the population level is recognized.[20] The CFAs were run using the LISREL 8.80 program,[21] with weighted least squares (WLS) estimation[22] on polychoric covariance[23] and asymptotic variance/covariance matrices, which were computed using PRELIS[24] (version 2.80). Model fit was evaluated using the following global goodness-of-fit indices: the root mean square error of approximation[25] (RMSEA) and the 90% confidence interval (CI) for RMSEA; the comparative fit index[26] (CFI); and the standardized version of the Root Mean Squared Residual[27] (SRMR). An RMSEA less than or equal to .06, a CFI .95 or more, and a SRMR less than or equal to .08 indicated a good fit of the model to the data.[28] The 90% CI around the RMSEA statistics should contain .05 to indicate the possibility of a close fit.[29] In addition to the criteria for the goodness-of-fit statistics, the parameter estimates of all items[30] were considered, as well as the standardized residual matrix[31] to evaluate model fit. For this study, the standardized factor loading values were expected to be greater than or equal to .30,[17,32] and standardized residuals for each item to be consistently less than 4.0.[31]

Results

Nurturance

The 7-item NLSCY Parental Nurturance model (Table 1) was a good fit to the data for children aged 10 to 11 (RMSEA = .038, 90%CI = .024 to .053; CFI = .986; and SRMR = .035) and for children aged 12 to 13 (RMSEA = .039, 90%CI = .025 to .054; CFI = .989; and SRMR = .036), but not for those aged 14 to 15 (RMSEA = .078, 90%CI = .065 to .091; CFI = .981; and SRMR = .067). Although all items loaded significantly on the factor at each age group, the fourth item—"[my parents] and I solve a problem together whenever we disagree about something"—had consistently lower correlations with other items (Appendix Table A). This item taps into the construct of problem-solving and so may have a different meaning

Table 1
Factor loadings (FL), item uniqueness (IU), and range of residuals (RES) for items in single-factor models in child-reported parenting questionnaire, by age group of respondents, household population aged 10 to 15, Canada excluding territories, 1998/1999, 2000/2001, 2002/2003 and 2004/2005

	Ages 10 to 11				Ages 12 to 13				Ages 14 to 15			
			RES				RES				RES	
Parenting behaviour	FL	IU	from	to	FL	IU	from	to	FL	IU	from	to
Nurturance												
My parents . . .												
1. smile at me	.75	.44	-2.42	1.57	.76	.42	-2.71	-.05	.77	.41	-6.16	1.19
2. praise me	.68	.55	-3.50	1.57	.78	.40	-3.39	-.05	.91	.18	-7.91	1.19
3. listen to my ideas and opinions	.78	.40	-3.63	2.44	.83	.31	-4.29	4.11	.89	.20	-7.91	3.90
4. and I solve a problem together whenever we disagree	.67	.55	-3.53	2.44	.70	.51	-3.50	4.11	.79	.37	-7.29	3.90
5. make sure I know I am appreciated	.78	.40	-2.90	.15	.83	.32	-3.39	-1.43	.89	.21	-6.79	-2.55
6. speak of the good things I do	.85	.27	-3.53	.77	.89	.20	-4.29	.54	.91	.17	-7.22	1.68
7. seem proud of the things I do	.87	.25	-3.63	.77	.87	.24	-3.13	.54	.91	.17	-7.29	1.68
Rejection												
My parents . . .												
8. soon forget a rule they have made	.44	.81	-4.11	3.38	.55	.70	-4.93	1.69	.45	.80	-5.03	1.32
9. nag me about little things	.56	.69	-2.09	.54	.58	.66	-2.87	-.03	.66	.57	-4.54	.09
10. only keep rules when it suits them	.37	.87	-4.72	6.08	.50	.75	-5.99	5.18	.62	.61	-5.85	4.56
11. threaten punishment more often than they use it	.63	.61	-3.99	1.44	.67	.55	-5.99	-.03	.70	.51	-5.76	.09
12. enforce a rule or do not enforce a rule depending upon their mood	.55	.70	-5.07	6.08	.69	.53	-7.75	5.18	.69	.52	-5.51	4.56
13. hit me or threaten to do so	.79	.38	-5.07	3.11	.68	.54	-6.06	4.40	.79	.37	-5.51	.90
14. get angry and yell at me	.72	.48	-4.65	3.11	.77	.40	-7.75	4.40	.81	.35	-5.85	.90
Monitoring												
My parents . . .												
15. want to know exactly where I am and what I am doing	.66	.56	-3.28	.22	.71	.50	-2.07	1.24	.75	.44	-1.20	1.22
16. let me go out any evening I want	.12	.99	-.78	.87	.14	.98	-.91	.78	.25	.94	-3.38	3.02
17. do tell me what time to be home when I go out	.57	.68	-3.17	1.10	.63	.61	-2.26	1.24	.69	.52	-2.74	3.02
18. find out about my misbehavior	.54	.71	-3.28	.68	.42	.82	-2.07	1.39	.39	.85	-1.20	.75
19. take an interest in where I am going and who I am with	.73	.47	-3.17	.59	.75	.44	-2.26	1.39	.84	.30	-3.38	.75

Source: 1998/1999 to 2005/2006 National Longitudinal Survey of Children and Youth.

than nurturing. An examination of the parental nurturance questionnaires that were recently reviewed by Locke and Prinz,[33] confirmed that most nurturance scales did not include problem-solving items. In addition, at ages 14 to 15, five out of six standardized residuals were above 4.0 for the fourth item (range of residuals = -7.29 to 3.90), suggesting a high degree of error in prediction. Item 4 was removed from the scale, and a new set of CFAs were performed.

The revised 6-item Parental Nurturance model was a good fit to the data (RMSEA = .037, 90%CI = .018 to .055; RMSEA = .024, 90%CI = .001 to .045; RMSEA = .039, 90%CI = .022 to .058; CFI = .991; .997; .996; and SRMR = .029; .021; .020, at ages 10 to 11; 12 to 13, and 14 to 15, respectively) (Table 2). All items loaded significantly on the factor, and the standardized residuals were greatly reduced for each age group.

Rejection

The 7-item NLSCY Parental Rejection model was not a good fit to the data across any of the three time points (RMSEA = .069, 90%CI = .055 to .082; RMSEA = .078, 90%CI = .063 to .090; RMSEA = .070, 90%CI = .057 to .084; CFI = .889; .895; .936; and SRMR = .064; .079; .067, at ages 10 to 11, 12 to 13, and 14 to 15, respectively). Consequently, the model was not confirmed for this sample of adolescents. An inspection of the factor loadings and item uniqueness failed to identify specific items that were negatively influencing fit. The items generally had low loadings (although all items significantly loaded on the factor), high item uniqueness, and a wide range of residuals across three time points (Table 1).

Monitoring

The 5-item NLSCY Parental Monitoring model was a good fit to the data across all three time points (RMSEA = .035, 90%CI = .008 to .060; RMSEA = .001, 90%CI = .001 to .043; RMSEA = .041, 90%CI = .018 to .066; CFI = .982; .999; .988; and SRMR = .025; .012; .027, at ages 10 to 11, 12 to 13, and 14 to 15, respectively). All items loaded significantly on the factor. However, the second item—"[my parents] let me go out any evening I want"—had very low factor loadings and high item uniqueness across all three time points (Table 1). The ambiguous wording of the item lends itself to various interpretations. For example, some adolescents might regard being able to go out any evening they want as a lack of parental care, but others might view it as being granted appropriate independence and an indication of trust. This ambiguity was noted by Lempers et al.,[14] who showed that the item loaded weakly on the Parental Nurturance scale ($\lambda < .30$) rather than on the Parental Monitoring scale. The item was removed from the NLSCY scale, and a new set of CFAs were run.

The revised 4-item Parental Monitoring model was a good fit to the data across all three time points (RMSEA = .060, 90%CI = .028 to .098; RMSEA = .033, 90%CI = .001 to .075; RMSEA = .000, 90%CI = .001 to .052; CFI = .978; .994; 1.00; and SRMR = .027; .018; .010, at ages 10 to 11, 12 to 13, and 14 to 15, respectively). All items significantly loaded on the factor, and the problems with the parameter estimates were resolved (Table 2).

Discussion

The aim of this study was to assess the construct validity of the child-reported parenting measures in the NLSCY. The only model with a good fit (based

Table 2
Factor loadings (FL), item uniqueness (IU), and range of residuals (RES) for items in revised parental nurturance and monitoring models in child-reported parenting questionnaire, by age group of respondents, household population aged 10 to 15, Canada excluding territories, 1998/1999, 2000/2001, 2002/2003 and 2004/2005

	Ages 10 to 11				Ages 12 to 13				Ages 14 to 15			
			RES				RES				RES	
Parenting behaviour	FL	IU	from	to	FL	IU	from	to	FL	IU	from	to
Nurturance (revised model)*												
My parents . . .												
1. smile at me	.74	.45	-2.55	1.75	.75	.44	-2.37	1.15	.76	.42	-3.45	3.35
2. praise me	.68	.54	-3.52	1.75	.76	.42	-2.67	1.15	.90	.20	-2.65	3.35
3. listen to my ideas and opinions	.76	.42	-2.80	1.12	.80	.36	-2.79	.10	.80	.36	-1.80	.47
5. make sure I know I am appreciated	.77	.41	-2.99	1.12	.82	.32	-2.67	.10	.88	.22	-2.49	.47
6. speak of the good things I do	.86	.26	-2.99	.65	.89	.20	-2.79	1.01	.91	.18	-3.45	3.66
7. seem proud of the things I do	.86	.26	-3.52	.65	.87	.25	-2.35	1.01	.91	.18	-2.65	3.66
Monitoring (revised model)†												
My parents . . .												
15. want to know exactly where I am and what I am doing	.66	.56	-3.20	.29	.71	.44	-2.13	1.30	.75	.44	-.92	1.15
17. do tell me what time to be home when I go out	.56	.68	-3.18	1.35	.62	.36	-2.14	1.30	.67	.55	-1.02	1.15
18. find out about my misbehavior	.53	.72	-3.20	.93	.42	.32	-2.13	1.39	.38	.85	-.92	1.12
19. take an interest in where I am going and who I am with	.73	.47	-3.18	.93	.75	.20	-2.14	1.39	.84	.30	-1.02	1.12

* excludes item 4 from original scale (my parents and I solve a problem together whenever we disagree)
† excludes item 16 from original scale (my parents let me go out any evening I want)
Source: 1998/1999 to 2005/2006 National Longitudinal Survey of Children and Youth.

What is already known on this subject?

- Analyses based on data from the National Longitudinal Survey of Children and Youth data (NLSCY) often include child-reported parenting behaviours as risk or protective factors.
- Little is known about the quality of the NLSCY parenting behaviour scales, as no studies have assessed their validity.

What does this study add?

- The 5-item Parental Monitoring model was a good fit to the data.
- The 7-item NLSCY Parental Nurturance model was a good fit to the data for children aged 10 to 11 and 12 to 13, but not for 14- to 15-year-olds.
- The 7-item Parental Rejection model was not a good fit to the data; consequently, the model was not confirmed for the sample of adolescents in the study.
- Removal of one item from the Parental Monitoring scale and one item from the Parental Nurturance scale improved the fit to the data.
- Use of the revised models is recommended for research exploring relationships between parenting behaviour and child outcomes.

on global goodness-of-fit statistics criteria) across all three time points was the Parental Monitoring scale. Further, removal of one conceptually and empirically weak item improved the measurement properties of the scale. Based on these findings, use of the revised scale is recommended.

From the perspective of terminological precision, "parental monitoring" may not capture the essence of the construct. Monitoring has been defined as a "prevention or intervention" technique used by parents.[34,35] However, most measures of monitoring assess parental knowledge, which originates mainly from the child's willingness to disclose rather than parents' efforts to supervise.[36-38] Therefore, it is recommended that "parental knowledge" or "monitoring efforts" be used as a new label for the current Parental Monitoring scale.

The Parental Nurturance scale was initially confirmed only for times 1 and 2 (at ages 10 to 11 and 12 to 13), but not at time 3 (at ages 14 to 15). Inclusion of the problem-solving item could not be conceptually justified. When this item was removed, the model was confirmed for all time points. Therefore, use of the revised scale is recommended.

The factor structure of the Parental Rejection scale was not confirmed. In addition to rejection, the items that constitute the scale encompass behaviours such as inconsistency and harshness. In fact, the original name was the "inconsistent rejection-oriented discipline" scale.[14] Sabatelli and Waldron[39] have suggested that although an EFA may provide support for the interrelationships among specific items in a scale, those items may not represent a theoretically coherent set of indicators for a particular construct. This appears to be the case for the Parental Rejection scale. Research is warranted to establish the defining features of the rejection construct, and to review related constructs (for instance, harsh parenting) to clarify the conceptual relationships between them.

Limitations

This study has a number of methodological limitations. First, although the sample was relatively large, it may not be representative. Many participants were excluded because of longitudinal attrition or non-completion of the parenting questionnaire. In fact, analyses of missing data revealed higher socio-economic status (SES) for the final sample compared with the initial sample. Therefore, the findings may not apply to a sample with low SES. As well, owing to the construct-confirming goal of the study, missing data were not imputed. A replication study would be useful to compare these findings with those obtained from a larger, more representative sample.

A second potential limitation is use of the same sample to confirm the NLSCY models and the revised models. From a strict CFA point of view, removing one item from a model may require a new, independent dataset to confirm the revised model.[40] However, the revisions to the original models were minor and not completely exploratory; they were conceptually driven based on careful inspection of items.

Conclusion

Although the results of this analysis raise concerns about the construct conceptualization and item content of the three NLSCY child-reported parenting scales, the two revised models appear to be useful in assessing nurturance and monitoring for adolescents aged 10 to 15. Research is needed to evaluate the predictive utility of these scales by examining their association with child health and development. ■

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Appendix

Table A
Polychoric correlation coefficients of child-reported parental behaviour scale items at three time points, by type of scale and age group of respondents, household population aged 10 to 15, Canada excluding territories, 1998/1999, 2000/2001, 2002/2003 and 2004/2005

Number	Item	Age group	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Nurturance																						
1	1	10 to 11	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2	2	10 to 11	.53	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3	3	10 to 11	.53	.52	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4	4	10 to 11	.47	.41	.57	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5	5	10 to 11	.56	.51	.60	.51	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
6	6	10 to 11	.59	.56	.61	.51	.62	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
7	7	10 to 11	.60	.52	.61	.53	.63	.75	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8	1	12 to 13	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9	2	12 to 13	...	...	...	...	...	...	...	.59	...	...	...	...	...	...	...	...	...	...	...	...
10	3	12 to 13	...	...	...	...	...	...	...	.59	.60	...	...	...	...	...	...	...	...	...	...	...
11	4	12 to 13	...	...	...	...	...	...	...	.50	.50	.64	...	...	...	...	...	...	...	...	...	...
12	5	12 to 13	...	...	...	...	...	...	...	.60	.58	.66	.55	...	...	...	...	...	...	...	...	...
13	6	12 to 13	...	...	...	...	...	...	...	.63	.67	.67	.57	.72	...	...	...	...	...	...	...	...
14	7	12 to 13	...	...	...	...	...	...	...	.62	.62	.67	.56	.71	.78	...	...	...	...	...	...	...
15	1	14 to 15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
16	2	14 to 15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	.71	...	...	...	...	...
17	3	14 to 15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	.59	.70	...	...	...	...
18	4	14 to 15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	.50	.60	.74	...	...	...
19	5	14 to 15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	.65	.77	.71	.61	...	...
20	6	14 to 15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	.65	.79	.71	.61	.78	...
21	7	14 to 15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	.66	.78	.72	.61	.78	.84
Rejection																						
1	1	10 to 11	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2	2	10 to 11	.24	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3	3	10 to 11	.25	.18	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4	4	10 to 11	.24	.36	.12	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5	5	10 to 11	.27	.28	.35	.31	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
6	6	10 to 11	.22	.39	.16	.52	.31	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
7	7	10 to 11	.29	.39	.19	.42	.30	.61	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8	1	12 to 13	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
9	2	12 to 13	...	...	...	...	...	...	...	.31	...	...	...	...	...	...	...	...	...	...	...	...
10	3	12 to 13	...	...	...	...	...	...	...	.32	.23	...	...	...	...	...	...	...	...	...	...	...
11	4	12 to 13	...	...	...	...	...	...	...	.30	.39	.19	...	...	...	...	...	...	...	...	...	...
12	5	12 to 13	...	...	...	...	...	...	...	.38	.37	.45	.38	...	...	...	...	...	...	...	...	...
13	6	12 to 13	...	...	...	...	...	...	...	.24	.31	.19	.44	.31	...	...	...	...	...	...	...	...
14	7	12 to 13	...	...	...	...	...	...	...	.32	.42	.32	.51	.37	.59	...	...	...	...	...	...	...
15	1	14 to 15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
16	2	14 to 15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	.25	...	...	...	...	...
17	3	14 to 15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	.31	.38	...	...	...	...
18	4	14 to 15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	.29	.46	.31	...	...	...
19	5	14 to 15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	.34	.39	.51	.45	...	...
20	6	14 to 15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	.25	.40	.38	.50	.44	...
21	7	14 to 15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	.25	.51	.37	.53	.45	.65
Monitoring																						
1	1	10 to 11	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
2	2	10 to 11	.06	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
3	3	10 to 11	.38	.10	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
4	4	10 to 11	.29	.08	.33	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
5	5	10 to 11	.48	.07	.36	.40	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
6	1	12 to 13	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
7	2	12 to 13	...	...	...	...	...	.08	...	...	...	...	...	...	...	...	...	...	...	...	...	...
8	3	12 to 13	...	...	...	...	...	.46	.08	...	...	...	...	...	...	...	...	...	...	...	...	...
9	4	12 to 13	...	...	...	...	...	.26	.08	.28	...	...	...	...	...	...	...	...	...	...	...	...
10	5	12 to 13	...	...	...	...	...	.53	.11	.44	.33	...	...	...	...	...	...	...	...	...	...	...
11	1	14 to 15	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...	...
12	2	14 to 15	...	...	...	...	...	...	...	...	...	...	.21	...	...	...	...	...	...	...	...	...
13	3	14 to 15	...	...	...	...	...	...	...	...	...	...	.51	.25	...	...	...	...	...	...	...	...
14	4	14 to 15	...	...	...	...	...	...	...	...	...	...	.27	.09	.25	...	...	...	...	...	...	...
15	5	14 to 15	...	...	...	...	...	...	...	...	...	...	.62	.15	.56	.33	...	...	...	...	...	...

... not applicable
Source: 1998/1999 to 2005/2006 National Longitudinal Survey of Children and Youth.