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The clinical, methodological and subject matter specialists listed below have reviewed articles submitted for Volume 21 of *Health Reports*. The editors thank them for their valuable contributions of time and expertise.

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Neighbourhood variation in hospitalization for unintentional injury among children and teenagers

by Lisa N. Oliver and Dafna E. Kohen

Abstract

Background
Research suggests that living in more affluent neighbourhoods positively influences children's health. Relationships with injury are less clear. This study examines variations in rates of unintentional injury hospitalization by neighbourhood income for the population aged 0 to 19 in urban Canada.

Data and methods
Acute-care inpatient hospitalization discharge records from 2001/2002 through 2004/2005 for 0- to 19-year-olds were examined. Injuries were classified using the International Classification of Diseases. Census Dissemination Areas were used as neighbourhood proxies; income quintiles were calculated from the 2001 Census. Age-standardized rates of hospitalization per 10,000 person-years at risk were calculated for each type of injury, by sex, age group and neighbourhood income quintile.

Results
Children and teenagers in the lowest neighbourhood income quintile generally had a higher rate of unintentional injury hospitalization than did those in the highest. The pattern was particularly evident among children aged 0 to 9 in lower-income neighbourhoods for injuries due to land transportation, poisoning, fire, drowning/suffocation, being cut or pierced, and the natural environment.

Interpretation
Canadian children in lower-income neighbourhoods generally have higher rates of hospitalization due to unintentional injuries, compared with children in higher-income neighbourhoods.

Keywords
Child development, hospital records, social class, social conditions, socio-economic status, trauma, wounds and injuries

Authors
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Unintentional injury of children and teenagers has been identified as a public health problem in Canada.[1] In 2004, unintentional injuries were responsible for 30,345 hospitalizations of children and youth aged 0 to 19.[2] About one-fifth of all acute-care inpatient hospitalization costs for children in 2003/2004 were attributable to injuries and poisonings.[3] Severe injury and trauma in childhood are associated with disability and poor health-related quality of life in both the short- and long-term.[4-7] Moreover, unintentional injury is the leading cause of death among Canadian children and teenagers, accounting for 664 deaths in 2004.[8]

The neighbourhood environment has been identified as an important factor in children's health.[9-13] But while research suggests that living in more affluent neighbourhoods positively influences children's health, relationships with injury are less clear, and growing evidence indicates that associations depend on the type of injury.[14-22]

For several reasons, neighbourhood income may be related to childhood injury. The social and physical environments in lower-income neighbourhoods may place children at risk of injury.[23-26] As well, associations between neighbourhood income and injury may reflect individual and family factors. For instance, children in low-income families are less likely than those in more affluent families to use bicycle helmets,[27,28] and more likely to be exposed to hazards in the home.[29]

Previous studies have examined associations between neighbourhood disadvantage and childhood injury using self- or parent-reported survey data[30-32] or administrative data on hospitalizations and mortality.[22,33-35] Surveys, however, typically collect information about only one injury, and the reported prevalence of severe injuries (that is, resulting in hospitalization) is low. Studies based on administrative data tend to focus on a single hospital or city,[22,35] or do not

investigate a full range of unintentional injuries.[33,34]

To address some of these shortcomings, this study uses national hospital data to examine relationships between urban neighbourhood income and hospitalization for unintentional injury among children and teenagers.

Methods

The Hospital Morbidity Database (HMBD) contains discharge records for each hospital stay. Health Person-Oriented Information (HPOI), processed from the HMBD, links these records at the person level. HPOI includes the patient's age, sex, medical diagnoses, admission/discharge dates, and place of residence.

For this analysis, 87% of the hospital morbidity records were linked at the person level. Of the 13% that were not linked, 10% were for newborns (excluded), and 3% contained an invalid identifier. This study is based on 852,234 hospitalization records for children and youth aged 0 to 19 in urban Canada who had been discharged from acute-care hospitals during fiscal years (April to March) 2001/2002 to 2004/2005.

Injury classification

The International Classification of Diseases (ICD) was used to classify unintentional injuries. Not all Canadian provinces used the same version of the ICD during the study period; ICD codes were analysed by the version submitted (Appendix Table A).

The data represent "injury episodes," not the number of hospital discharges or unique individuals.

Hospital discharge records allow multiple diagnoses to be listed; records were included in this analysis if an unintentional injury appeared as a diagnosis at least once.

HPOI has a unique record for each hospital discharge. To prevent multiple counting of a single injury, an "injury episode" was constructed for people discharged and readmitted (for example, transferred between hospitals) on the same day. During the study period, there were 76,227 unintentional "injury episodes" for 0- to 19-year-olds, representing 73,244 individuals. The vast majority of these individuals (96.3%, n=70,537) were hospitalized once; 3.7% (n=2,707) had more than one unintentional injury hospitalization during the four years.

In all provinces except Quebec, multiple injury codes can be recorded for a single injury. A total of 349 hospitalizations (0.45% of all cases) had injury codes in multiple categories. A sample of cases with multiple injuries was examined, and because all appeared plausible (for instance, hypothermia and motor vehicle traffic injury), they were included in the study.

Definitions

Unintentional injury refers to all unintentional injuries excluding adverse effects or complications of medical and surgical care. Unintentional injuries were grouped into nine categories based on injury classifications from the Public Health Agency of Canada[36]: falls, land transportation, being struck, being cut/pierced, poisoning, fire, drowning/suffocation, natural environment, and other. This classification system was originated by the International Collaborative Effort on Injury.

Injuries from *falls* result from falls on ice/snow, furniture, playground equipment, trees, or cliffs. Falls involving transport vehicles, in water (for instance, drowning), and associated with fire are categorized elsewhere.

Land transportation injuries pertain to accidents on land involving pedestrians, cyclists, motorcycles, cars, pick-up trucks, vans, heavy transport vehicles, buses, trains, streetcars, industrial vehicles, and off-road vehicles.

Struck refers to injuries due to being struck by or against a thrown object, sports equipment, a person or crowd, or walking into an object.

Cut/Pierce injuries (including those due to machinery) result from contact with objects such as glass, knives, hand tools, lawnmowers, powered tools and household machinery, and contact with lifting devices, agricultural machinery or unspecified machinery.

Fire injuries result from fires in private dwelling, buildings, or other structures, outside of buildings (for example, forest fire), ignition of clothing, and from the burning of objects.

Poisoning includes accidental poisoning by exposure to medication, narcotics, pesticides, chemicals, gases and vapours.

Drowning/Suffocation (separate causes that were combined into one category) refers to drowning or submersion in a bathtub, swimming pool or natural body of water, and suffocation due to earth or other substances, obstruction of respiratory tract, confinement in a low-oxygen environment, or in bed.

Natural environment includes being bitten, stung or struck by an animal, insect, plant; exposure to noise, vibration, heat, cold, change in air pressure; and lack of food and water.

Other encompasses injuries due to firearms, overexertion, explosion of an object, exposure to electric current, sequelae or late effects of an event classified elsewhere, and non-land transportation accidents.

Dissemination Areas (DAs)—small geographic census units with a population of 400 to 700—were used as proxies for neighbourhoods. During data processing, the DAs in which patients lived were determined from their postal code by the Postal Code Conversion File + .[37] DA assignment was less precise in the province of Quebec, where hospital discharge records contain only the first three digits of the six-digit postal code. Sensitivity analyses that excluded Quebec did not produce significantly different results, so Quebec was included in all analyses. DAs in Census Metropolitan Areas (CMAs) or Census Agglomerations (CAs) were considered urban. CMAs are urban areas with a population of at least 100,000; CAs have an urban core of at least 10,000.[38]

Neighbourhood income quintiles were constructed from the 2001 Census using the average income per single-person equivalent in each DA, which adjusts for differences in household size. Average income per single-person equivalent was calculated by dividing the total household income of the DA by the total number of single-person equivalents. To account for variations in the cost of living across Canada, income quintiles were constructed within each CMA and CA. Income was suppressed in DAs with populations less than 250, and in such cases, was imputed from surrounding DAs with unsuppressed data.

A total of 1,086 unintentional injury hospitalizations (1.4%) were excluded from analyses because DA income data were not available: in 1,049 of these cases, this was because of a missing or invalid postal code; in 37 cases, income data could not be imputed because of suppression in surrounding DAs.

Statistical methods

Hospitalization rates for unintentional injuries were calculated based on the 2001 Census. Rates were age-standardized to account for the unequal distribution of the population by age across neighbourhood income quintiles.

Person-years at risk were used as the denominator for hospitalization rates. This was interpolated from the 2001 and 2006 Census using the mid-point of the fiscal year (October). The final denominator was the sum of the interpolated populations across the four fiscal years: 2001/2002 through 2004/2005. Rates per 10,000 person-years at risk were calculated by age group (0 to 9 and 10 to 19) and by sex for income quintiles; 95% confidence intervals were based on a Poisson distribution.

The t-test was used to determine if injury hospitalization rates in the highest neighbourhood income quintile differed significantly from the lower quintiles. A Linear Trend Test (LTT) was used to detect linear relationships between injury hospitalization rates and neighbourhood income quintiles.[39] An alpha level of $p<0.05$ was used to determine significance. SAS (version 9.1, SAS Institute, USA) software was used for all statistical analyses.

Results

Rates higher among males/teens

During the four years from 2001/2002 through 2004/2005, hospitalizations for unintentional injuries among 0- to 19-year-olds in urban areas totalled 76,227 (Table 1). Males accounted for two-thirds of these hospitalizations, so as might be expected, the crude hospitalization rate per 10,000 person-years at risk was much higher for males (40.8) than for females (21.6). Crude rates tended to rise with age from about 30 hospitalizations per 10,000 person-years at risk for children younger than 10 to almost 35 per 10,000 person-years at risk for 15- to 19-year-olds.

Falls were the leading cause of unintentional injury hospitalizations (43%), followed by injuries associated with land transportation (21%) (Figure 1). Another 11% of unintentional injury hospitalizations resulted from being struck. Relatively few were attributable to poisoning (5%), cut/pierce (3%), fire (2%), natural environment (2%), or drowning/suffocation (1%).

Because of the uneven age distribution of the population across neighbourhood income quintiles, unintentional injury hospitalization rates were age-standardized. The age-standardized rates fell from about 33 hospitalizations per 10,000 person-years at risk in the lowest-income neighbourhoods to about 30 per

Table 1
Number of hospitalizations for unintentional injury, person-years at risk and crude rate per 10,000 person-years at risk, urban population aged 0 to 19, Canada, 2001/2002 to 2004/2005

			Rate per 10,000 person-years at risk	
	Hospitalizations	Person-years at risk	Crude	Age-standardized
Total	**76,227**	**24,295,310**	**31.4**	**31.3**
Sex				
Male	50,653	12,426,567	40.8	40.7
Female	25,574	11,868,743	21.6	21.6
Age (years)				
0 to 4	16,212	5,391,425	30.1	...
5 to 9	16,556	6,008,589	27.6	...
10 to 14	20,972	6,395,095	32.8	...
15 to 19	22,487	6,500,201	34.6	...
Neighbourhood income quintile				
1 (lowest)	14,806	4,514,570	32.8	32.7
2	14,346	4,500,780	31.9	31.9
3	15,401	4,852,265	31.7	31.7
4	16,139	5,266,500	30.6	30.6
5 (highest)	15,535	5,161,195	30.1	29.9
Injury category†				
Falls	32,695	24,295,310	13.5	13.5
Land transportation	15,880	24,295,310	6.5	6.5
Struck	8,335	24,295,310	3.4	3.4
Poisoning	3,953	24,295,310	1.6	1.6
Cut/Pierce	2,230	24,295,310	0.9	0.9
Natural environment	1,760	24,295,310	0.7	0.7
Fire	1,750	24,295,310	0.7	0.7
Drowning/Suffocation	993	24,295,310	0.4	0.4
Other	8,980	24,295,310	3.7	3.7

† because multiple injuries were recorded, subcategories add to more than total
... not applicable
Source: 2001/2002 to 2004/2005 Hospital Morbidity Database.

Table 2
Age-standardized rate of unintentional injury hospitalizations per 10,000 person-years at risk, by injury category, neighbourhood income quintile, sex and age group, urban population aged 0 to 19, Canada, 2001/2002 to 2004/2005

					Sex								Age group (years)							
	Total				Male				Female				0 to 9				10 to 19			
		95% confidence interval				95% confidence interval				95% confidence interval				95% confidence interval				95% confidence interval		
Injury category/ Neighbourhood income quintile	Rate	from	to	LTT†	Rate	from	to	LTT†	Rate	from	to	LTT†	Rate	from	to	LTT	Rate	from	to	LTT†
Total																				
Total	31.3	31.1	31.6	-0.02*	40.7	40.4	41.1	-0.02*	21.6	21.3	21.8	-0.03*	28.7	28.4	29.0	-0.05*	33.7	33.4	34.0	0.0
1 (lowest)	32.7*	32.2	33.3		42.4*	41.6	43.3		22.8*	22.2	23.4		32.2*	31.5	33.0		33.2	32.5	34.0	
2	31.9*	31.4	32.4		41.1*	40.3	41.9		22.2*	21.6	22.9		29.8*	29.0	30.5		33.8	33.0	34.5	
3	31.7*	31.2	32.2		41.2*	40.4	42.0		21.7*	21.1	22.3		28.7*	28.0	29.4		34.4	33.7	35.1	
4	30.6*	30.1	31.1		39.7	39.0	40.5		20.9	20.4	21.5		27.2*	26.5	27.8		33.6	33.0	34.3	
5 (highest)	29.9	29.4	30.3		39.1	38.3	39.8		20.2	19.7	20.8		25.8	25.2	26.5		33.4	32.8	34.1	
Falls																				
Total	13.5	13.3	13.6	0.0	17.1	16.9	17.3	0.0	9.7	9.5	9.9	0.0	14.6	14.4	14.8	-0.02*	12.5	12.3	12.7	0.01*
1 (lowest)	13.5	13.2	13.9		17.1	16.5	17.6		9.9	9.5	10.3		15.2*	14.7	15.7		12.1*	11.6	12.5	
2	13.6	13.3	14.0		17.2	16.7	17.8		9.9	9.5	10.3		14.9	14.4	15.5		12.5	12.0	12.9	
3	13.4	13.1	13.7		16.9	16.4	17.4		9.7	9.3	10.1		14.5	14.0	15.0		12.4	12.0	12.8	
4	13.3	13.0	13.6		17.1	16.6	17.6		9.4	9.0	9.8		14.1	13.6	14.6		12.7	12.3	13.1	
5 (highest)	13.5	13.2	13.8		17.2	16.8	17.8		9.6	9.2	10.0		14.3	13.8	14.8		12.8	12.4	13.2	
Land transportation																				
Total	6.5	6.4	6.6	-0.1	8.8	8.6	8.9	0.0	4.2	4.1	4.3	-0.1	3.3	3.2	3.4	-0.12*	9.4	9.2	9.6	0.0
1 (lowest)	6.9*	6.6	7.1		9.2*	8.8	9.6		4.5*	4.2	4.8		4.2*	3.9	4.5		9.3*	8.9	9.7	
2	6.8*	6.6	7.1		9.1*	8.8	9.5		4.4*	4.1	4.7		3.5*	3.3	3.8		9.8*	9.4	10.2	
3	7.1*	6.8	7.3		9.5*	9.1	9.8		4.6*	4.3	4.9		3.5*	3.2	3.7		10.3*	9.9	10.7	
4	6.3*	6.1	6.6		8.5*	8.2	8.8		4.1*	3.8	4.3		3.1*	2.9	3.3		9.2*	8.9	9.6	
5 (highest)	5.7	5.5	5.9		7.7	7.4	8.0		3.6	3.3	3.8		2.5	2.3	2.7		8.5	8.2	8.9	
Struck																				
Total	3.4	3.4	3.5	0.07*	5.3	5.1	5.4	0.06*	1.5	1.4	1.6	0.08*	1.9	1.8	2.0	0.0	4.8	4.7	4.9	0.10*
1 (lowest)	3.0*	2.8	3.1		4.6*	4.3	4.9		1.3*	1.2	1.5		2.0	1.8	2.1		3.9*	3.6	4.2	
2	3.2*	3.0	3.3		4.9*	4.7	5.2		1.3*	1.2	1.5		1.9	1.7	2.1		4.3*	4.1	4.6	
3	3.3*	3.2	3.5		5.2*	4.9	5.5		1.4*	1.2	1.5		1.9	1.7	2.0		4.6*	4.4	4.9	
4	3.6	3.5	3.8		5.6	5.3	5.9		1.6	1.5	1.8		1.9	1.7	2.1		5.2*	4.9	5.4	
5 (highest)	3.9	3.7	4.0		5.8	5.5	6.1		1.8	1.7	2.0		1.8	1.6	2.0		5.7	5.5	6.0	
Poisoning																				
Total	1.6	1.6	1.7	-0.13*	1.7	1.7	1.8	-0.14*	1.5	1.4	1.6	-0.12*	2.3	2.2	2.4	-0.13*	1.0	1.0	1.1	-0.13*
1 (lowest)	2.2*	2.0	2.3		2.4*	2.2	2.6		2.0*	1.8	2.2		3.0*	2.8	3.2		1.4*	1.3	1.6	
2	1.7*	1.6	1.8		1.8*	1.7	2.0		1.6*	1.4	1.8		2.4*	2.2	2.6		1.2*	1.0	1.3	
3	1.5*	1.4	1.7		1.7*	1.5	1.8		1.4*	1.3	1.6		2.2*	2.0	2.4		0.9	0.8	1.1	
4	1.4	1.3	1.5		1.4	1.3	1.5		1.4*	1.2	1.5		1.9	1.8	2.1		0.9	0.8	1.0	
5 (highest)	1.3	1.2	1.4		1.4	1.2	1.5		1.2	1.0	1.3		1.7	1.6	1.9		0.9	0.8	1.0	
Cut/Pierce																				
Total	0.9	0.9	1.0	-0.13*	1.3	1.3	1.4	-0.11*	0.5	0.5	0.5	-0.18*	0.7	0.6	0.7	-0.10*	1.1	1.1	1.2	-0.14*
1 (lowest)	1.2*	1.1	1.3		1.7*	1.6	1.9		0.6*	0.5	0.7		0.9*	0.7	1.0		1.5*	1.3	1.6	
2	1.0*	0.9	1.1		1.5*	1.3	1.6		0.6*	0.5	0.7		0.7	0.6	0.8		1.3*	1.2	1.5	
3	0.9*	0.8	1.0		1.3	1.1	1.4		0.5*	0.4	0.6		0.7	0.6	0.8		1.1*	1.0	1.2	
4	0.8	0.7	0.9		1.2	1.1	1.3		0.4*	0.4	0.5		0.6	0.5	0.7		1.0	0.9	1.1	
5 (highest)	0.7	0.6	0.8		1.1	1.0	1.2		0.3	0.2	0.4		0.6	0.5	0.7		0.9	0.8	1.0	
Natural environment																				
Total	0.7	0.7	0.8	-0.1	0.8	0.7	0.8	-0.1	0.7	0.6	0.7	0.0	1.1	1.0	1.1	0.0	0.4	0.4	0.5	-0.1
1 (lowest)	0.8*	0.7	0.9		0.9*	0.8	1.0		0.7	0.6	0.8		1.1*	1.0	1.2		0.5*	0.4	0.6	
2	0.7*	0.6	0.8		0.7	0.6	0.8		0.7	0.6	0.8		1.1	0.9	1.2		0.4	0.3	0.5	
3	0.8*	0.8	0.9		0.9*	0.8	1.0		0.8	0.7	0.9		1.2*	1.0	1.3		0.5*	0.5	0.6	
4	0.7	0.6	0.8		0.8*	0.7	0.9		0.6	0.5	0.7		1.1*	1.0	1.2		0.4	0.3	0.4	
5 (highest)	0.6	0.5	0.7		0.6	0.5	0.7		0.6	0.6	0.8		0.9	0.8	1.0		0.4	0.3	0.4	
Fire																				
Total	0.7	0.7	0.8	-0.17*	0.9	0.8	0.9	-0.15*	0.6	0.5	0.6	-0.21*	1.1	1.0	1.2	-0.19*	0.4	0.3	0.4	-0.12*
1 (lowest)	1.0*	1.0	1.1		1.2*	1.1	1.3		0.9*	0.8	1.0		1.7*	1.5	1.8		0.5*	0.4	0.6	
2	0.8*	0.7	0.9		1.0*	0.8	1.1		0.7*	0.6	0.8		1.3*	1.1	1.4		0.4*	0.3	0.5	
3	0.6*	0.6	0.7		0.9*	0.8	1.0		0.4	0.3	0.5		0.9	0.8	1.1		0.4	0.3	0.5	
4	0.6	0.5	0.6		0.7	0.6	0.8		0.5	0.4	0.5		0.9	0.7	1.0		0.3	0.3	0.4	
5 (highest)	0.5	0.5	0.6		0.7	0.6	0.8		0.4	0.3	0.5		0.8	0.7	0.9		0.3	0.2	0.4	
Drowning/Suffocation																				
Total	0.4	0.4	0.4	-0.07*	0.5	0.5	0.6	-0.1	0.3	0.3	0.3	-0.1	0.7	0.7	0.8	-0.06*	0.1	0.1	0.2	-0.1
1 (lowest)	0.5*	0.4	0.5		0.6	0.5	0.7		0.3*	0.3	0.4		0.8*	0.7	0.9		0.2*	0.2	0.3	
2	0.4	0.4	0.5		0.5	0.5	0.6		0.3*	0.3	0.4		0.7	0.6	0.9		0.2	0.1	0.2	
3	0.4	0.3	0.4		0.5	0.4	0.6		0.3	0.2	0.4		0.7	0.6	0.8		0.1	0.1	0.2	
4	0.4	0.3	0.4		0.5	0.4	0.5		0.3*	0.3	0.4		0.7	0.6	0.8		0.2	0.1	0.2	
5 (highest)	0.4	0.3	0.4		0.5	0.4	0.6		0.2	0.2	0.3		0.6	0.5	0.7		0.1	0.1	0.2	
Other																				
Total	3.7	3.6	3.8	-0.02*	4.6	4.5	4.7	0.0	2.7	2.6	2.8	0.0	3.3	3.2	3.4	-0.06*	4.0	3.9	4.2	0.0
1 (lowest)	3.9*	3.7	4.0		5.1*	4.8	5.4		2.6	2.4	2.8		3.7*	3.5	4.0		4.0	3.7	4.3	
2	3.7*	3.5	3.9		4.5	4.2	4.8		2.9*	2.7	3.1		3.5*	3.2	3.7		3.9	3.7	4.2	
3	3.8*	3.6	4.0		4.8*	4.5	5.1		2.7	2.5	3.0		3.3*	3.1	3.5		4.2	4.0	4.5	
4	3.6	3.4	3.7		4.3	4.1	4.6		2.8	2.6	3.0		3.1	2.9	3.3		4.0	3.8	4.3	
5 (highest)	3.5	3.3	3.6		4.3	4.1	4.6		2.6	2.4	2.8		2.9	2.7	3.1		4.0	3.8	4.2	

† LTT=linear trend test coefficient
* significantly different from highest quintile ($p<0.05$)
Source: 2001/2002 to 2004/2005 Hospital Morbidity Database.

10,000 person-years at risk in the highest (Figure 2). This pattern applied to males and females and to children aged 0 to 9. However, among 10- to 19-year-olds, associations between neighbourhood income and injury hospitalizations were not statistically significant.

Low neighbourhood income/High hospitalization rates

For several causes of unintentional injury, children and teens in low-income neighbourhoods were more likely to be hospitalized than were their counterparts in high-income neighbourhoods (Table 2, Appendix Table B). Age-standardized rates of hospitalization due to *poisoning* and to being *cut/pierced* were significantly higher in the three lowest neighbourhood income quintiles than among those in the highest. Confirming this, the LTT was significant overall, by sex, and by age group. Similarly, rates of hospitalization due to *fires* tended to rise as neighbourhood income decreased. The LTT across the five income quintiles was significant for all age and sex groups.

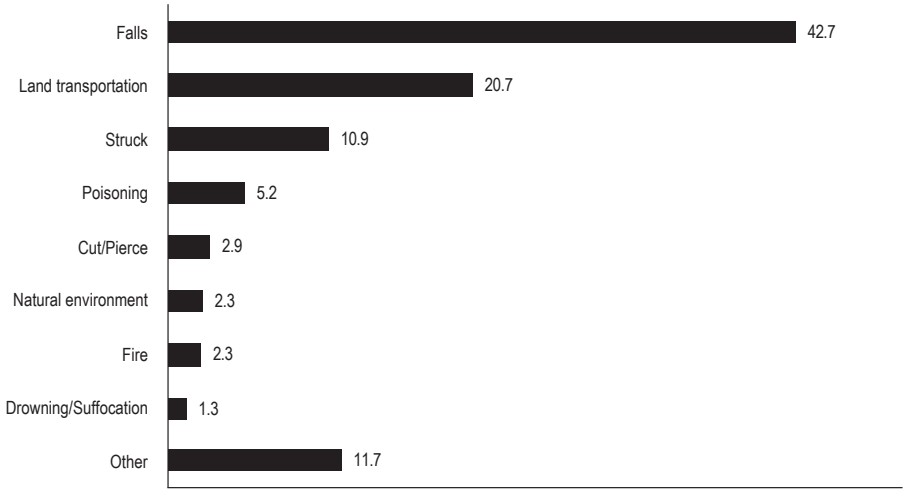
For a number of other causes, hospitalization rates were higher in lower-income neighbourhoods among children, but not teens. For instance, while children and teenagers in the lower-income neighbourhoods had signficantly higher rates of hospitalization for *drowning/ suffocation*, for *land transportation*, and for *other* causes than did those in the highest, the LTT was significant only among children aged 0 to 9.

Children aged 0 to 9 in the lowest-income neighbourhoods had significantly higher rates of hospitalization for *falls* than did those in the highest income quintile. By contrast, 10- to 19-year-olds in such neighbourhoods actually had a siginficantly lower rate of hospitalization for falls than did those in the highest-income neigbourhoods.

High neighbourhood income/High hospitalization rates

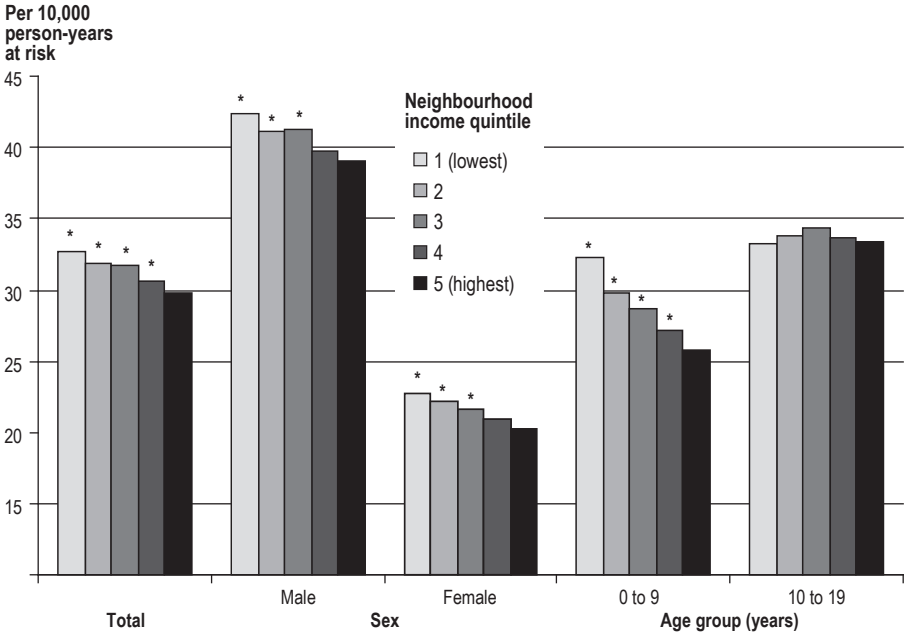
At ages 10 to 19, age-standardized rates of hospitalization due to being *struck* tended to rise with neighbourhood income

Figure 1
Percentage distribution of unintentional injury hospitalizations, by category, urban population aged 0 to 19, Canada, 2001/2002 to 2004/2005



Source: 2001/2002 to 2004/2005 Hospital Morbidity Database.

Figure 2
Rate of unintentional injury hospitalizations per 10,000 person-years at risk, by sex, age group and neighbourhood income quintile, urban population aged 0 to 19, Canada, 2001/2002 to 2004/2005



* significantly different from highest quintile ($p < 0.05$)
Source: 2001/2002 to 2004/2005 Hospital Morbidity Database.

quintile. The LTT was significant for the 10-to-19 age group, but not for children aged 0 to 9.

No gradient

For injuries due to the *natural environment,* no gradient by neighbourhood income was evident in hospitalization rates. For example, young people from middle-income neighbourhoods (quintile 3) had higher natural environment injury hospitalization rates than did those from the lowest neighbourhood income quintile.

Discussion

As has been found in other studies,[14,15,22,34,40] this analysis shows that rates of unintentional injury hospitalization among Canadian children and teenagers generally increased with neighbourhood disadvantage. The pattern was consistent for most types of unintentional injuries suggesting that they are related to the level of income in the neighbourhood where children live.

Rates of hospitalization for poisoning, being cut/pierced and fire were higher among children and teens in lower-income neighbourhoods. As well, for children aged 0 to 9 (but not 10- to 19-year-olds), associations between low neighbourhood income and hospitalizations for injuries related to falls and other unintentional causes were signficant.

However, hospitalization rates for all injury categories were not invariably higher for children in lower-income neighbourhoods. In fact, rates for injuries due to being struck were significantly higher among 10- to 19-year-olds in higher-income neighbourhoods. A possible explanation is that this category includes sports injuries, which may be more common in higher-income neighbourhoods. A study in England, Scotland and Wales found that rates of childhood sports-related fractures increased with area affluence.[41] A preliminary analysis of ICD codes for the causes of hospitalization in this study supported this theory: 29% of the struck injuries in the highest-income neighbourhoods were sports-related, compared with 24% of the struck injuries in the lowest income neighbourhoods.

Similar to findings reported in some,[42-44] but not all, [18,22] studies, children aged 0 to 9 in the lowest-income neighbourhoods had a higher rate of hospitalization for falls than did those in the highest-income neighbourhoods, but for 10- to 19-year-olds, the rate was lower in the lowest-income neighbourhoods. It is possible that the circumstances surrounding falls differ among younger and older children. For instance, hazards such as a lack of baby gates may expose young children to fall-related hospitalizations.

Strengths and limitations

Canadian studies of associations between neighbourhood income and childhood injury have typically used self-reported survey data, which do not provide information on diagnoses,[30-32] or administrative data that pertain only to a single city or hospital.[22,35] By contrast, the present analysis uses four years of population-based hospitalization data for children in urban Canada to produce rates by age and sex. Moreover, the rates in this article are likely conservative, because injury hospitalizations occurring outside the individual's province of residence were excluded, as were injuries to children and teenagers who died before hospital admission. And by design, individuals presenting only to emergency rooms, doctors offices or clinics were not included.

This study has several limitations. Because Quebec provides only the first three digits of the postal code, the assignment of neighbourhood income quintile was less precise than that in other provinces.

Research suggests that neighbourhood has independent effects on childhood injury even when controlling for individual and family factors.[45] Even so, the lack of information about family characteristics or children's behaviours that can influence injury risk[32,46] meant that the relative contributions of individual, family and neighbourhood factors could not be ascertained in this analysis.

This is an ecological study—associations observed at the neighbourhood level do not necessarily apply at the individual level. As well, the findings apply only to urban areas, and do not necessarily hold for rural areas. Data on the geographical location where the injury happened were also not available.

Implications for research

Childhood injury has been identified as a key policy area in Canada.[1] Results of the current study may be useful in the development of strategies to reduce childhood injury. In addition, the hospitalization rates presented here can be used to examine changes over time. It remains for future research to examine: how social and physical dimensions of the neighbourhood affect childhood injury; the relative influence of individual and

What is already known on this subject?

- In urban Canada, children and teenagers in lower-income neighbourhoods have higher rates of mortality due to unintentional injury.

What does this study add?

- Children and teenagers in lower-income urban neighbourhoods are more likely than those in higher-income neighbourhood to be hospitalized for unintentional injuries.
- The association between living in a lower-income neighbourhood and injury hospitalization was strongest among children aged 0 to 9.
- Injury hospitalization rates due to being struck were higher among 10- to 19-year-olds in higher-income neighbourhoods, compared with those in lower-income neighbourhoods.

neighbourhood factors; and if patterns are similar in rural neighbourhoods.

Conclusion

Unintentional childhood injury hospitalization in urban Canada varies by neighbourhood income. Hospitalizations due to fire, poisoning, drowning/suffocation, and being cut/pierced rose with decreasing neighbourhood income. Injury hospitalizations due to being struck showed a reverse gradient—increasing neighbourhood income quintile was associated with a higher rate of hospitalization. ■

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Appendix

Table A
International Classification of Disease versions used, by province and fiscal year

Province	Fiscal 2001	Fiscal 2002	Fiscal 2003	Fiscal 2004
Newfoundland and Labrador	ICD-10-CA	ICD-10-CA	ICD-10-CA	ICD-10-CA
Prince Edward Island	ICD-10-CA	ICD-10-CA	ICD-10-CA	ICD-10-CA
Nova Scotia	ICD-10-CA	ICD-10-CA	ICD-10-CA	ICD-10-CA
New Brunswick	ICD-9-CM	ICD-9-CM	ICD-10-CA	ICD-10-CA
Quebec	ICD-9	ICD-9	ICD-9	ICD-9
Ontario	ICD-9; ICD-9-CM	ICD-10-CA	ICD-10-CA	ICD-10-CA
Manitoba	ICD-9-CM	ICD-9-CM	ICD-9-CM	ICD-10-CA
Saskatchewan	ICD-9; ICD-9-CM; ICD-10-CA	ICD-10-CA	ICD-10-CA	ICD-10-CA
Alberta	ICD-9-CM	ICD-10-CA	ICD-10-CA	ICD-10-CA
British Columbia	ICD-10-CA	ICD-10-CA	ICD-10-CA	ICD-10-CA

ICD-10-CA= International Statistical Classification of Diseases and Related Health Problems, Tenth Revision, Canadian Adaptation
ICD-9-CM= International Statistical Classification of Diseases, Injuries and Causes of Death, Ninth Revision, Clinical Modification
ICD-9= International Statistical Classification of Diseases, Injuries and Causes of Death, Ninth Revision

Table B
Number of unintentional injury hospitalizations, by injury category, neighbourhood income quintile, sex and age group, urban population aged 0 to 19, Canada, 2001/2002 to 2004/2005

Injury category/ Neighbourhood income quintile	Total	Sex		Age group (years)	
		Male	Female	0 to 9	10 to 19
Total					
Total	76,227	50,653	25,574	32,768	43,459
1 (lowest)	14,806	9,679	5,127	7,396	7,410
2	14,346	9,448	4,898	6,435	7,911
3	15,401	10,282	5,119	6,491	8,910
4	16,139	10,772	5,367	6,595	9,544
5 (highest)	15,535	10,472	5,063	5,851	9,684
Falls					
Total	32,695	21,240	11,455	16,601	16,094
1 (lowest)	6,119	3,895	2,224	3,441	2,678
2	6,126	3,957	2,169	3,214	2,912
3	6,484	4,196	2,288	3,277	3,207
4	7,011	4,616	2,395	3,419	3,592
5 (highest)	6,955	4,576	2,379	3,250	3,705
Land transportation					
Total	15,880	10,896	4,984	3,753	12,127
1 (lowest)	2,995	2,022	973	914	2,081
2	3,033	2,081	952	743	2,290
3	3,447	2,365	1,082	781	2,666
4	3,365	2,316	1,049	748	2,617
5 (highest)	3,040	2,112	928	567	2,473
Struck					
Total	8,335	6,553	1,782	2,125	6,210
1 (lowest)	1,310	1,015	295	443	867
2	1,411	1,125	286	397	1,014
3	1,620	1,295	325	419	1,201
4	1,930	1,519	411	463	1,467
5 (highest)	2,064	1,599	465	403	1,661
Poisoning					
Total	3,953	2,161	1,792	2,622	1,331
1 (lowest)	1,053	590	463	732	321
2	796	438	358	526	270
3	752	417	335	510	242
4	722	369	353	471	251
5 (highest)	630	347	283	383	247
Cut/Pierce					
Total	2,230	1,656	574	764	1,466
1 (lowest)	527	388	139	194	333
2	464	333	131	149	315
3	438	319	119	151	287
4	429	321	108	144	285
5 (highest)	372	295	77	126	246
Natural environment					
Total	1,760	949	811	1,208	552
1 (lowest)	366	206	160	252	114
2	324	165	159	231	93
3	405	226	179	264	141
4	362	205	157	263	99
5 (highest)	303	147	156	198	105
Fire					
Total	1,750	1,084	666	1,268	482
1 (lowest)	508	294	214	398	110
2	380	225	155	283	97
3	309	217	92	211	98
4	297	183	114	207	90
5 (highest)	256	165	91	169	87
Drowning/Suffocation					
Total	993	635	358	810	183
1 (lowest)	233	151	82	189	44
2	201	128	73	165	36
3	187	115	72	160	27
4	200	119	81	158	42
5 (highest)	172	122	50	138	34
Other					
Total	8,980	5,726	3,254	3,769	5,211
1 (lowest)	1,765	1,170	595	870	895
2	1,679	1,037	642	760	919
3	1,844	1,194	650	746	1,098
4	1,889	1,171	718	748	1,141
5 (highest)	1,803	1,154	649	645	1,158

Source: 2001/2002 to 2004/2005 Hospital Morbidity Database.


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Socio-economic status and vitamin/mineral supplement use in Canada

by Hassanali Vatanparast, Jennifer L. Adolphe and Susan J. Whiting

Abstract

Background
The link between diet quality and socio-economic status (SES) may extend to the use of vitamin/mineral supplements. This article examines factors related to Canadians' use of such supplements, with emphasis on associations with household income and education.

Data and methods
The data are from the 2004 Canadian Community Health Survey—Nutrition (n= 35,107). The prevalence of vitamin/mineral supplement consumption during the previous month was recorded. Supplement use at the national level was estimated by age/sex groups, SES and chronic conditions. Logistic regression was used to determine significant associations between socio-economic factors and vitamin/mineral supplement use. Estimates of usual calcium intake from food and from food plus supplements were obtained using SIDE-IML.

Results
The prevalence of supplement use was significantly higher in females than in males in all age groups 14 or older. Age, being female, high household income and education, and being food-secure were positively associated with supplement use. Supplement use substantially increased the percentage of the population, particularly older adults, meeting the Adequate Intake level for calcium.

Interpretation
The reported use of vitamin/mineral supplements varies by age, sex and SES. The relatively low prevalence of use among Canadians of low SES is similar to findings from American studies. These individuals, already at risk for inadequate intake from food, do not make up the difference with vitamin/mineral supplements.

Keywords
calcium, diet, food security, nutrition, nutrition surveys, nutritional requirements

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The use of supplements can increase daily intake of vitamins and minerals (micronutrients) beyond what is obtained from food alone,[1,2] and thus, may confer health benefits, including chronic disease prevention.[3]

Some population groups have been identified as being at risk for low nutrient intakes.[4,5] Specifically, diet quality has been linked to socio-economic status (SES), with higher-quality diets being associated with greater affluence. People of lower SES tend to consume more high-calorie, nutrient-poor foods, whereas those of higher SES consume more whole grains, lean meats, fish, low-fat dairy products, and fresh vegetables and fruit.[6]

Vitamin/Mineral supplements offer the potential to improve the micronutrient intake of people with a nutrient-poor diet, in that the cost of regular retail supplements is less than that of foods such as fruits, vegetables, and dairy products.

However, according to the *inverse supplement hypothesis,*[7] people at risk for nutrient inadequacy, or in need of more nutrients because of disease risk, are not the ones who take supplements. In fact, a number of American studies have shown that the use of vitamin/mineral supplements is also related to SES. Seven of ten studies that examined the association between income and supplement use among adults and children found a positive association.[7-13] A higher level of education was also a strong predictor of supplement use.[1,7,8,10,11,14-17]

With data collected by the 2004 Canadian Community Health Survey (CCHS) (cycle 2.2), it is possible to determine if the inverse relationship between vitamin/mineral supplement consumption and SES prevails in Canada.[1,2,18] The objective of the 2004 CCHS was to provide estimates of dietary intake in terms of nutrients, foods, food groups, dietary supplements, and eating patterns, at the national and provincial levels for a representative sample of Canadians. Because the CCHS collects demographic, socio-economic, health status and food security data, associations between these factors and vitamin/mineral supplement use can be examined.

For this analysis, it was hypothesized that people of high SES are more likely than those of lower SES to take supplements, but that other factors (age, sex) are also significantly associated with supplement use. Calcium, one of the most common mineral supplements, is used to demonstrate the impact of supplements on total intake.

Data and methods

Data source

From January through December 2004, the CCHS (cycle 2.2) interviewed 35,107 respondents. The survey excludes residents of institutions, the territories, Indian reserves, crown lands and some remote areas; members of the regular Canadian Forces; and military and civilian residents of Canadian Forces bases.

Cycle 2.2 had two components: 1) a general health component containing demographic and health information including the use of vitamin and mineral supplements, and 2) a dietary intake component based on (a) 24-hour recall(s). The details of survey methodology and data collection have been described elsewhere.[19] This study pertains to all cycle 2.2 respondents aged 1 or older (n=34,818).

Definitions

Respondents were asked to provide the bottle or package of each supplement that they took, and if possible, the drug identification number, which the interviewer could immediately check against the Drug Product Database. For each supplement, respondents reported the amount taken per day, week or month during the last month. Average daily consumption of each supplement was derived from these data. The April 2008 release of CCHS 2.2 contains three files including vitamin/mineral supplement use information. For this analysis, data from two files—vitamin and mineral supplement details and vitamin and mineral summary—were used. The variables of interest were overall supplement use and calcium intake from supplements.

Total annual household income was classified into four categories based on the number of people in the household: *lowest* (less than $15,000 if 1 or 2 people; less than $20,000 if 3 or 4 people; and less than $30,000 if 5 or more people); *lower-middle* ($15,000 to $29,999 if 1 or 2 people; $20,000 to $39,999 if 3 or 4 people; and $30,000 to $50,000 if 5 or more people); *upper-middle* ($30,000 to $59,999 if 1 or 2 people; $40,000 to $79,000 if 3 or 4 people; $60,000 to $79,999 if 5 or more people); and *highest* ($60,000 or more if 1 or 2 people; $80,000 if 3 or more people).

Respondents' education was classified into four categories according to the highest level they had attained: less than secondary graduation; secondary graduation; some postsecondary; and postsecondary graduation. Because preliminary analyses showed secondary graduation to be an important cutoff in terms of supplement use, a new variable was created, categorizing education into two levels: less than secondary graduation and secondary graduation or more.

Food security status was based on 18 CCHS questions designed to determine if households had been able to afford the food they needed in the previous 12 months. The Statistics Canada derived variable defines four categories: food secure, food insecure without hunger, food insecure with moderate hunger, and food insecure with severe hunger.

Respondents aged 19 or older reported if they had been diagnosed by a medical professional with (a) chronic health condition(s) that had lasted or were expected to last six months or more. These included long-term mental conditions.

Information about dietary intake was collected from each respondent during a face-to-face interview. To help respondents recall what and how much they ate and drank in the past 24 hours, interviewers used the five-step Automated Multiple Pass Method.[20,21]

The calorie and nutrient content of the foods reported was derived from Health Canada's Canadian Nutrient File 2001b supplement, a recipe database, and a survey foods database containing foods not in the other databases.[19] A second recall was conducted 3 to 10 days later from a subset of about 30% of participants (n=10,786). Response rates to the first and second recalls were 76.5% and 72.8%, respectively.

Analytical techniques

Because a large majority—83%—of supplement users reported taking supplements every day the previous month (only 3.5% had taken supplements fewer than 15 days), for these analyses, it was assumed that all supplement users took them regularly.

Descriptive statistics were used to estimate the percentage of the population who took vitamin/mineral supplements, and the distribution of supplement users in various Dietary Reference Intake age/sex groups at the national level. Supplement use by adults (19 or older) was determined by household income, education, and food security status. Some analyses examined just two adult age groups: 19 to 50 and 51 or older.

The dietary intake data from the two 24-hour recalls were adjusted for within-subject variability to obtain between-subject distributions of estimated intakes; this process converts recall data that are not representative of habitual intake into estimates of usual intake.[19] This was done with the modified version of SIDE-IML (Software for Intakes Distribution Estimation).[19]

Calcium was chosen to illustrate the impact of taking a specific supplement.[22] Usual intake of calcium (mg/d) and the percentage of the population meeting the recommended value from food alone were calculated by age group and sex for the population aged 1 or older. The calculation was repeated after adding supplement intake values to food intake values, based on the first and second 24-hour recalls. Differences in calcium intake between supplement users and non-users were also examined.

Logistic regression was used to determine significant associations between supplement use and age, sex, household income, education, food security, chronic conditions, and urban/rural residence. Sampling weights were used to obtain unbiased estimates of population sizes. The bootstrap method, which takes the complex survey design into account, was used to estimate standard errors, coefficients of variation and confidence intervals. The absence

of overlapping 95% confidence intervals denoted statistical significance.[19] SPSS version 15 was used to merge CCHS 2.2 files, create new variables, and generate the final data set; SAS version 9, to obtain the usual intake of nutrients of interest using SIDE-IML; and STATA SE 10 for the other analyses, weighting and bootstrapping. Alpha was set at 0.05.

Results

Vitamin/Mineral supplements

Age was closely related to vitamin/mineral supplement use. Around 40% of children aged 1 to 8 took supplements (Table 1). The percentage declined through adolescence to less than 30% at ages 14 to 18 and then rose steadily with advancing age to about 60% among women and 40% among men aged 51 or older.

Overall, the prevalence of vitamin/mineral supplement use was significantly higher among females than males: 47% versus 34%. This difference prevailed among all age groups 14 or older and widened at older ages, with the greatest gap at ages 51 to 70. The highest prevalence of supplement use was among women aged 51 or older (60%), and the lowest, among boys aged 14 to 18 (23%).

Supplement use was generally more common among people in higher- than lower-income households (Figure 1). The exceptions were women aged 71 or older, among whom supplement use was high regardless of household income, and unexpectedly, men aged 19 to 30 and 71 or older in the lowest income households.

Supplement use also tended to rise with level of education (Figure 2). Among men, the difference between those who had not graduated from secondary school and those who had at least some postsecondary education was particularly pronounced.

Among women, as food insecurity became more severe, supplement use tended to decline (Table 2). Among men, the association between supplement use and food security followed a U-shaped pattern, with relatively high percentages of supplement users among those reporting the most severe level of food insecurity.

Many of the factors associated with taking supplements are, themselves, interrelated. For instance, household income and education are associated with each other, and food security tends to be associated with both. When logistic regression was used to control for these potentially confounding effects, age, sex, household income, education, food security and chronic conditions were found to be independently and significantly associated with supplement use.

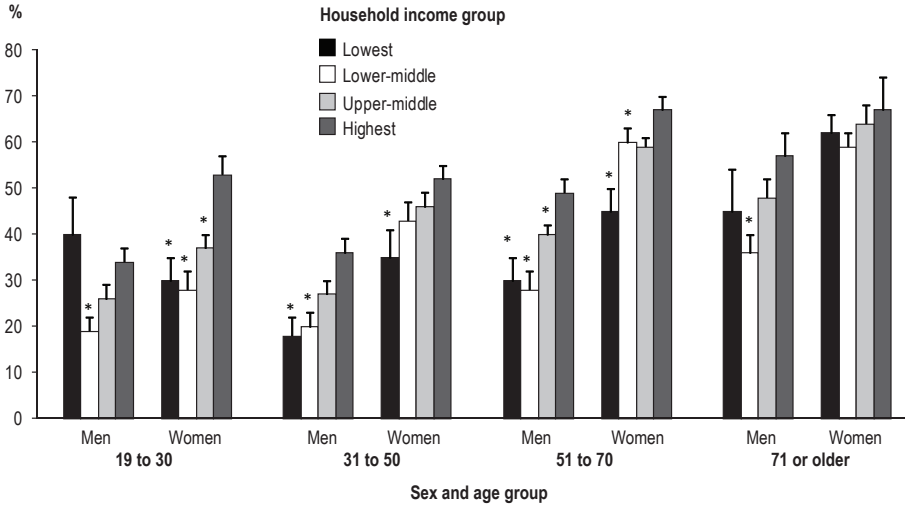
For example, compared with children aged 1 to 8, the only group significantly more likely to use supplements was women aged 51 or older; for all other age/sex groups, the odds of supplement use were significantly lower (Table 3). Household income and education were each independently related to supplement

Table 1
Prevalence of vitamin/mineral supplement use, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

	Male			Female		
		95% confidence interval			95% confidence interval	
Age group	%	from	to	%	from	to
Total	**33.5**	**32.0**	**34.9**	**46.9***	**45.5**	**48.3**
1 to 3	38.2	33.9	42.5	38.9	34.5	43.3
4 to 8	44.3	40.5	48.1	45.0	40.9	49.1
9 to 13	33.9	30.4	37.3	32.0	28.5	35.5
14 to 18	23.4	20.5	26.4	29.5*	26.5	32.5
19 to 30	27.9	24.5	31.3	37.4*	34.0	40.8
31 to 50	29.2	26.1	32.3	46.8*	43.6	50.1
51 to 70	40.2	37.3	43.2	60.3*	57.4	63.2
71 or older	44.9	40.5	49.3	60.1*	56.8	63.4

* significantly higher than males (p<0.05)
Source: 2004 Canadian Community Health Survey—Nutrition.

Figure 1
Prevalence of vitamin/mineral supplement use, by household income group, age group and sex, household population aged 19 or older, Canada excluding territories, 2004



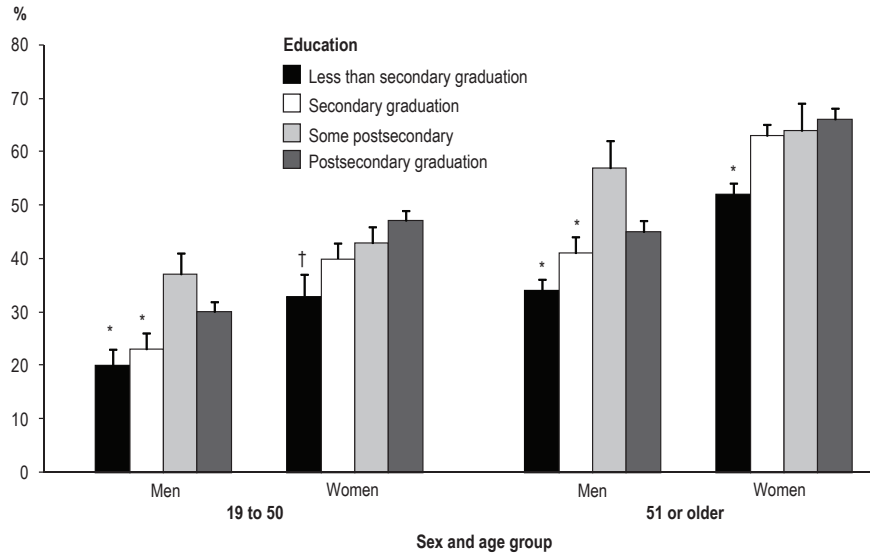
* significantly lower than highest income group (p<0.05)
Source: 2004 Canadian Community Health Survey—Nutrition.

Table 2
Prevalence of vitamin/mineral supplement use, by food security status, age group and sex, household population aged 19 or older, Canada excluding territories, 2004

Age group/Sex	Food secure	Food insecure		
		Low	Moderate	Severe
	%	%	%	%
19 to 50				
Men	29 ± 1	27 ± 6	16 ± 5*	31 ± 13
Women	44 ± 1	39 ± 5	35 ± 6	23 ± 9*
51 or older				
Men	42 ± 1	19 ± 9*	13 ± 10*	31 ± 19
Women	60 ± 1	61± 8	48 ± 13	50 ± 17

* significantly different from food secure (p<0.05)
Source: 2004 Canadian Community Health Survey—Nutrition.

Figure 2
Prevalence of vitamin/mineral supplement use, by education, age group and sex, household population aged 19 or older, Canada excluding territories, 2004



* significantly lower than some postsecondary and postsecondary graduation (p<0.05)
† significantly lower than postsecondary graduation (p<0.05)
Source: 2004 Canadian Community Health Survey—Nutrition.

use: even when the effects of the other variables were taken into account, the odds that people in the highest income households would take supplements were 1.6 times those of people in the lowest income households, and people with at least secondary graduation had 1.4 times the odds of taking supplements, compared with those who had not graduated from secondary school. The odds of taking supplements were significantly low among people with moderate food insecurity, compared with those who were food secure. People without chronic conditions were significantly less likely than those with chronic conditions to take supplements. No significant difference in supplement use emerged between rural and urban residents.

Calcium

The impact of taking supplements can be illustrated with calcium. Adequate intake (AI), the level that is considered to ensure nutritional adequacy, is 1,000 milligrams of calcium a day at ages 19 to 50, and rises to 1,200 milligrams a day at age 51 or older.[23]

Regardless of whether they took supplements, people in all age groups derived about the same amount of calcium from food (data not shown), and the majority were not meeting daily AI. The percentage meeting AI from food alone was highest (slightly more than 50%) among men aged 19 to 30, and lowest (less than 10%) among women older than 50 (Figure 3). In all age groups, higher percentages of men than women met AI based on diet alone.

The use of calcium supplements boosted the percentage of men and women of all ages meeting AI, but the effect was particularly pronounced among older women. For women aged 51 to 70, calcium intake from supplements increased the percentage at or above AI from 8% to 35%, and for those older than 70, from 5% to 29%. In fact, at these ages, higher percentages of women than men met calcium AI, a difference solely attributable to supplement use.

Discussion

The inverse supplement hypothesis,[9] which states that people at risk of nutritional inadequacy or in need of more nutrients because of disease risk are not the ones who take vitamin/mineral supplements, is supported by the CCHS data analysed in this study. In addition to sex and age, household income, education, food security status and having (a) chronic condition(s) were significantly related to supplement use.

The supplement use patterns reported here for Canadians resemble those of Americans, based on data from the 1999-2000 National Health and Nutrition Examination Survey (NHANES).[24] In both countries, a higher percentage of women than men used supplements; supplement use increased with age; and a higher level of education was positively associated with supplement use.[7,8,14,17]

Associations with household income and education in this and in an earlier

Table 3
Adjusted odds ratios showing factors associated with supplement use, by selected characteristics, household population aged 1 or older, Canada excluding territories, 2004

Characteristics	Adjusted odds ratio	95% confidence interval from	to	p value
Age group/Sex				
1 to 8 (both sexes)†	1.00	...	...	...
9 to 18				
Male	0.59*	0.51	0.68	<0.0001
Female	0.62*	0.53	0.73	<0.0001
19 to 50				
Men	0.41*	0.33	0.50	<0.0001
Women	0.81*	0.67	0.98	0.032
51 or older				
Men	0.75*	0.62	0.91	0.004
Women	1.70*	1.50	2.10	<0.0001
Household income				
Lowest†	1.00	...	...	...
Lower-middle	1.00	0.83	1.20	0.91
Upper-middle	1.20	1.00	1.40	0.02
Highest	1.60*	1.30	1.90	<0.0001
Education				
Less than secondary graduation†	1.00	...	...	...
Secondary graduation or more	1.40*	1.20	1.70	<0.0001
Food security				
Food secure†	1.00	...	...	...
Food insecure				
Low	0.93	0.72	1.20	0.6
Moderate	0.71*	0.53	0.95	0.02
Severe	0.78	0.43	1.40	0.41
Chronic condition(s)				
Yes†	1.00	...	...	...
No	0.87*	0.77	0.99	0.014
Residence				
Rural†	1.00	...	...	...
Urban	1.00	0.90	1.10	0.8

† reference category
* significantly different from reference category (p<0.05)
... not applicable
Source: 2004 Canadian Community Health Survey—Nutrition.

What is already known on this subject?

- Diet quality is linked to socio-economic status—higher-quality diets tend to be associated with greater affluence.
- Vitamin/Mineral supplements offer the possibility of improving micronutrient intake and achieving recommended levels among people who consume a nutrient-poor diet.
- Evidence points to a link between the use of supplements and income and education.

What does this study add?

- This is the first study based on nationally representative data to examine determinants of supplement use in Canada.
- In all age groups older than 14, a higher percentage of females than males took supplements.
- The prevalence of supplement use was highest among women aged 50 or older, at least 60% of whom reported taking vitamin/mineral supplements in the past month.
- Socio-economic gradients in supplement use were evident for most adult age/sex groups.
- These findings support the literature on supplement use from the United States and indicate a potential health disparity in access to vitamin/mineral supplementation.

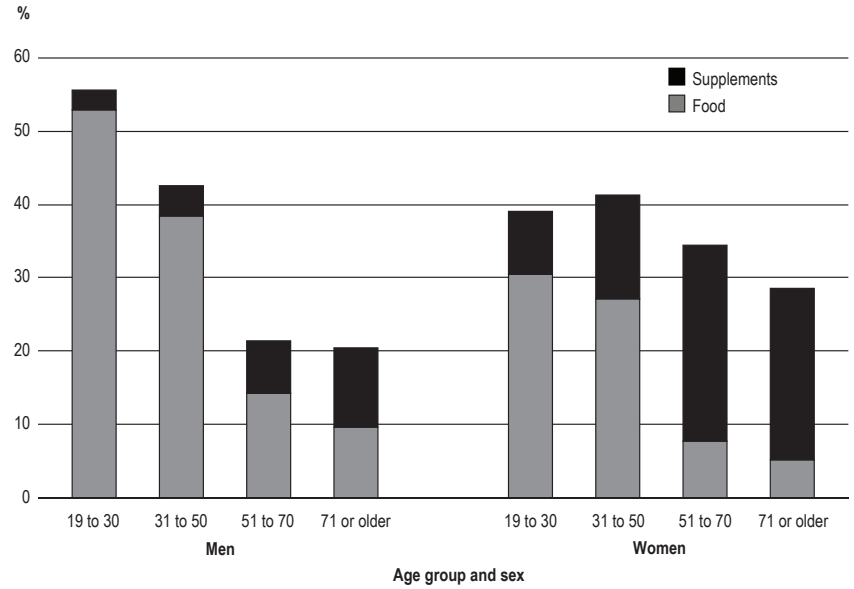
study,[24] and the additional relationship with food insecurity in this study, indicate relatively low supplement use among people of lower SES. As well, interviews and focus groups have revealed income, education, preferences, health issues and accessibility to be barriers to using supplements.[24]

A 2009 study[22] showed that Canadian adults' mean calcium intake from food alone was below recommended levels for most age/sex groups except young adult men, and that men had consistently higher intakes than women. In the present study, supplements had a relatively small impact on the percentage of men with adequate calcium intake, but the increase among women, particularly older women, was substantial, raising the percentage with adequate intake at least fourfold. In fact, because of the considerable amount of calcium older women derive from supplements, their total intake exceeded that of their male contemporaries.

Limitations

A limitation of this analysis is that the data on vitamin/mineral supplement use were self-reported and pertained to the month before the CCHS interview. By contrast, 24-hour recalls were used to collect data about food and beverage consumption. The second recall, in which about 30% of respondents participated, made it possible to reduce within-person variation to some extent and better estimate usual food and beverage consumption. With 83% of the CCHS respondents reporting daily use of supplements over the past month, it was assumed that this represented

Figure 3
Percentage meeting Adequate Intake for calcium from food and from food plus supplements, by age group and sex, household population aged 19 or older, Canada excluding territories, 2004



Source: 2004 Canadian Community Health Survey—Nutrition.

their usual practice. Nonetheless, the different data collection methods for food/beverage versus supplement intake, the different reference periods (previous day versus past month), and the lack of a within-person variability measure for supplement use could affect the estimate of total combined intake from food and from supplements. Unexpected results for some age/sex groups (for example, the high percentage of supplement users among men aged 19 to 30 in the lowest household income group) might be explained by high between-individual variability in supplement use, and possibly, by an irregular pattern of supplement use for clinical reasons in some subsets of respondents.

Conclusion

Data from the 2004 Canadian Community Health Survey provide evidence that SES indicators such as household income, education and food security are associated with vitamin/mineral supplement use, and that adults of lower SES are less likely to take supplements. This finding, consistent with research from the United States, reveals a potential health disparity with unequal uptake of vitamin/mineral supplementation. ■

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Trends in long-term care staffing by facility ownership in British Columbia, 1996 to 2006

by Margaret J. McGregor, Robert B. Tate, Lisa A. Ronald, Kimberlyn M. McGrail, Michelle B. Cox, Whitney Berta and Anne-Marie Broemeling

Abstract

Background
Long-term care facilities (nursing homes) in British Columbia consist of a mix of for-profit, not-for-profit non-government, and not-for-profit health-region-owned establishments. This study assesses the extent to which staffing levels have changed by facility ownership category.

Data and methods
With data from Statistics Canada's Residential Care Facilities Survey, various types of care hours per resident-day were examined from 1996 through 2006 for the province of British Columbia. Random effects linear regression modeling was used to investigate the effect of year and ownership on total nursing hours per resident-day, adjusting for resident demographics, case mix, and facility size.

Results
From 1996 to 2006, crude mean total nursing hours per resident-day rose from 1.95 to 2.13 hours in for-profit facilities ($p=0.06$); from 1.99 to 2.48 hours in not-for-profit non-government facilities ($p<0.001$); and from 2.25 to 3.30 hours in not-for-profit health-region-owned facilities ($p<0.001$). The adjusted rate of increase in total nursing hours per resident-day was significantly greater in not-for-profit health-region-owned facilities.

Interpretation
While total nursing hours per resident-day have increased in all facility groups, the rate of increase was greater in not-for-profit facilities operated by health authorities.

Keywords
aged, frail elderly, geriatrics, geriatric nursing, homes for the aged, nursing care, nursing homes, nursing staff

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Long-term care facilities (nursing homes) provide housing, support and direct care to frail seniors who are unable to function independently. Nursing care in these facilities is provided by a combination of registered nurses (RNs), licensed practical nurses (LPNs), and resident care aides. Higher total nursing[1,2] and RN[3,4] hours per resident day have been associated with better care. Thus, nursing hours per resident-day is considered to be one reasonable measure of nursing home quality.[5]

Long-term residential care in Canada is delivered by a mix of for-profit (proprietary) and not-for-profit (non-proprietary) non-government and government-owned facilities. This diversity of delivery models offers an opportunity to compare services by facility ownership—information that is useful to provincial governments faced with rising health care costs and challenged to provide the best "value for money."

Research, mainly in the United States, has found that not-for-profit ownership is associated with higher staffing levels,[6,7] lower staff turnover,[8] and better outcomes on a range of measures, compared with for-profit-ownership.[5-7,9] While the results of American analyses are intriguing, differences in the market mix may limit the generalizability of such findings to Canada.

Only three Canadian studies have quantitatively examined associations between staffing levels and facility ownership.[10-12] Analyses in Ontario and British Columbia found that for-profit facilities employed fewer nursing staff than did not-for-profit facilities.[10,12] By contrast, a Manitoba study reported no apparent differences in nursing staff levels between for-profit and not-for-profit facilities.[11]

The seniors in long-term care facilities today tend to be older, more disabled and closer to the end of life than were residents a decade ago.[13-15] This shift in the resident profile has placed new, more complex demands on staff. Yet despite these changes in the case mix of residents, data on nursing home staff have not been examined over time.

This analysis uses data from Statistics Canada's annual Residential Care

Facilities Survey to examine changes in staffing levels over the past decade in nursing homes in the province of British Columbia, by facility ownership.

Data and methods

Data source

Each year since 1974, Statistics Canada has conducted the Residential Care Facilities Survey (RCFS).[16] The questionnaire has not changed appreciably since the inception of the survey and covers facility type and size, resident demographics, case mix and staffing. Copies are available on Statistics Canada's website (www.statcan.gc.ca).

Each March, the questionnaire is mailed to the director of care in every long-term care facility with at least four beds, which is licensed by the provincial/territorial department of health and/or social services, and whose financial statements are not embedded in those of an acute-care hospital. During the subsequent four months, reminders are mailed to non-respondents, and if possible, the survey is administered by telephone.

In this analysis, the study "population" consists of British Columbia facilities that self-identified as providing residential care mainly to the "aged," and that responded to the RCFS at least once between April 1, 1996 and March 31, 2007 (Table 1). The analysis excluded: facilities with fewer than 10 beds or housing mostly residents who required minimal assistance (n=13); facilities reporting 0 residents in a given year (n=10); and facilities reporting extreme outliers for total direct care hours per resident-day in a given year (three times greater or three times less than the standard deviation from the mean of the study population) (n=132). If a facility's total direct care hours per resident-day more than doubled or were reduced to less than half over two consecutive years with no corresponding change in ownership, this was considered to be a reporting error, and the response for the survey year in question was excluded (n=66).

Facility size was defined as the mean number of licensed and staffed beds. Facilities were divided into two ownership categories: for-profit and not-for-profit. The for-profit group consisted of institutions that self-identified as proprietary, and included smaller private organizations and chain corporations. Not-for-profit facilities were subdivided into non-government (owned and operated by religious or lay not-for-profit societies) and health-region-owned (owned and/or operated by a regional governance structure responsible for the continuum of health services for the defined geographic regions). Not-for-profit facilities were categorized this way because research has revealed significantly lower hospitalization rates for care-sensitive outcomes in facilities that are health-region-owned.[17] At the beginning of the study period (1996), very few facilities were health-region-owned, but after the regionalization of health services in the late 1990s, the number increased substantially.

During the 1996-to-2006 period, the response rates to the RCFS were 56% for for-profit facilities, 77% for not-for-profit non-government facilities, and 66% for not-for-profit health-region-owned facilities. After the data exclusions, a total of 1,640 responses were analysed, representing 48% (577), 72% (781) and 51% (282) of the total potential responses for for-profit, not-for-profit non-government, and not-for-profit health-region-owned facilities, respectively (Table 1). The number of times facilities reported during the eleven-year period varied from 1 to 11, with 38% of facilities reporting 8 or more times.

Ethics approval for this study was obtained from the relevant academic and institutional ethics boards.

Measures

Staffing

Each facility's average number of paid hours per resident-day for every staff category (RN, LPN, care aide) was calculated by dividing the total reported number of paid hours in that staff category on March 31 of the survey year by the number of beds reported as being staffed and in operation, all divided by 365.25 days. For every year, mean RN hours per resident-day, total nursing (RN, LPN and care aide) hours per resident-day, RN hours as a proportion of total nursing hours, total therapist (occupational, physical and recreation therapy) hours per resident-day and activity aide hours per resident-day were calculated.

Table 1
Survey frame for Residential Care Facilities Survey, by ownership, British Columbia, 1996-to-2006 period

					Not-for-profit			
	Total		For-profit		Non-government		Health-region-owned	
Long-term care facilities	Facilities	Responses	Facilities	Responses	Facilities	Responses	Facilities	Responses
Surveyed	321	2,827	140	1,197	135	1,078	97	552
Responded at least once	281	1,861	111	667	127	828	86	366
Included in study	270	1,640	103	577	127	781	81	282

Notes: Because some facilities changed ownership during the 11-year period, the number by ownership type may not add to the total in each category. Hospital-based facilities were not included in the survey frame (N=66 in 1999, estimated from previous research[18]). Facilities excluded: fewer than 10 beds (N=13); reported 0 residents in a given year (N=10); total direct care hours per resident day +/- 3 standard deviations from mean for study population (N=132); total direct care hours per resident day more than doubled or were reduced to less than half over two consecutive years with no change in ownership (N=66).
Source: 1996 to 2006 Residential Care Facilities Survey.

Resident characteristics

The sex of facility residents was measured as the percentage male. Age of residents was measured as the percentage 85 or older. A facility's case mix was calculated as the percentage of residents whose care level was at least Type III (defined as needing 24-hour availability of professional nursing care and supervision; medical management and/or therapeutic care required), grouped into four categories: 0%; 1% to 49%; 50% to 99%; and 100%. A facility's annual mortality rate was total deaths divided by the total number of residents in care the same year.

Analyses

Descriptive data for facility response rates were calculated by ownership and by demographic and case mix characteristics for each year. Descriptive data for all staffing measures were produced by year and stratified by ownership. Each staffing measure was tested for the effect of year to assess linear trends over time.

A random effects linear regression model (PROC GENMOD, SAS v9.1) was used to examine the adjusted effect of year and ownership on total nursing hours per resident-day. The regression models adjusted for resident demographics (percentage male; percentage aged 85 or older), case mix (percentage of residents Type III or higher; annual mortality rate), and facility size (number of staffed and operating beds). Three separate regression models were produced: the first included survey year; the second included survey year and ownership; and the third included survey year, ownership, and the interaction of year and ownership.

To analyze the separate effect of the two types of not-for-profit ownership, the data for the adjusted models pertained to 1999 onward because there were very few health region-owned facilities before 1999. To be included in this analysis, facilities had to have responded to the RCFS at least twice in the 1999-to-2006 period.

Several tests were conducted to assess the robustness of results. Models were run with and without implementing the descriptive data exclusion rules. To assess the potential impact of frequency of response, the model was run to progressively exclude facilities responding less than three, four and five times during the period. In all cases, the direction and significance of the results were consistent with those reported in this study.

Results

Case mix

Between 1996 and 2006, the population of residents in British Columbia's nursing homes became older and frailer (Table 2). The percentage of residents aged 85 or older rose from 50% to 55%. The percentage of facilities with 100% of residents requiring Type III care or higher increased from 4% to 38%. The mean annual mortality rate of residents went from 11% to 17%.

Staffing levels

Trends in nursing home staffing levels differed by ownership (Table 3). In for-profit facilities, crude mean total nursing (RN, LPN and care aide) hours per resident-day increased from 1.95 (SD 0.62) in 1996 to 2.13 (SD 0.84) in 2006 (p=0.06). In not-for-profit non-government facilities, the increase was from 1.99 (SD 0.35) to 2.48 (SD 0.94) hours per resident-day (p<0.001), and in not-for-profit health-region-owned facilities, from 2.25 (SD 0.60) to 3.30 (SD 1.51) hours per resident-day (p<0.001). However, in each type of facility, RN hours as a proportion of total nursing hours did not change appreciably over the period, so the increases in total

Table 2
Case mix in long-term care facilities, British Columbia, 1996 to 2006

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006
Facilities											
Number	165	158	146	153	131	163	159	151	147	133	134
% of total surveyed	70.8	68.1	62.4	68.0	58.2	70.9	70.7	64.0	59.3	52.6	59.0
Residents aged 85 or older											
Mean proportion	0.50	0.52	0.51	0.54	0.54	0.54	0.54	0.55	0.52	0.54	0.55
Standard deviation	0.16	0.14	0.14	0.15	0.15	0.14	0.15	0.16	0.17	0.15	0.15
Male residents											
Mean proportion	0.30	0.29	0.28	0.27	0.28	0.28	0.27	0.28	0.29	0.28	0.29
Standard deviation	0.15	0.15	0.14	0.14	0.15	0.14	0.13	0.14	0.13	0.14	0.13
Mortality											
Mean annual rate*	0.11	0.12	0.12	0.13	0.13	0.14	0.14	0.16	0.17	0.17	0.17
Standard deviation	0.07	0.06	0.06	0.06	0.07	0.07	0.07	0.08	0.07	0.08	0.09
Facilities with all residents Type III† or higher‡											
Number	7	12	15	12	21	16	21	34	47	49	51
%	4.2	7.6	10.3	7.8	16.0	9.8	13.2	22.5	32.0	36.8	38.3

* total deaths divided by total residents in care in same year
† client needs 24-hour availability of professional nursing care and supervision; medical management and/or therapeutic care required
‡ client needs 24-hour monitoring by professional nursing staff, but not resources of acute-care hospital
Source: 1996 to 2006 Residential Care Facilities Survey.

Table 3
Selected measures of nursing hours in long-term care facilities, by ownership, British Columbia, 1996 to 2006

	1996	1997	1998	1999	2000	2001	2002	2003	2004	2005	2006	Linear regression coefficient for year of survey	95% confidence interval from	95% confidence interval to
Total nursing† hours per resident-day														
For-profit														
Mean number	1.95	2.04	2.11	2.13	2.10	2.17	2.17	2.26	2.18	2.33	2.13	0.023	-0.001	0.047
Standard deviation	0.62	0.49	0.61	0.54	0.52	0.71	0.63	0.73	0.76	0.76	0.84	...	...	...
Not-for-profit non-government														
Mean number	1.99	2.05	2.18	2.27	2.34	2.36	2.36	2.37	2.37	2.58	2.48	0.051***	0.031	0.071
Standard deviation	0.35	0.33	0.54	0.64	0.63	0.61	0.57	0.78	0.66	0.78	0.94	...	...	...
Not-for-profit health-region-owned														
Mean number	2.25	2.25	2.22	2.23	2.12	2.23	2.17	2.72	3.05	2.98	3.30	0.142***	0.092	0.191
Standard deviation	0.60	0.89	0.53	0.72	0.54	0.49	0.50	0.80	0.86	0.63	1.51	...	...	...
Registered nurse (RN) hours per resident-day														
For-profit														
Mean number	0.51	0.58	0.58	0.63	0.57	0.59	0.50	0.52	0.46	0.45	0.43	-0.014***	-0.022	-0.007
Standard deviation	0.23	0.20	0.24	0.35	0.20	0.42	0.18	0.20	0.20	0.18	0.25	...	...	...
Not-for-profit non-government														
Mean number	0.51	0.54	0.61	0.59	0.62	0.59	0.57	0.59	0.55	0.56	0.52	-0.0004	-0.007	0.006
Standard deviation	0.13	0.12	0.32	0.18	0.17	0.17	0.17	0.32	0.20	0.25	0.21	...	...	...
Not-for-profit health-region-owned														
Mean number	0.47	0.47	0.53	0.52	0.56	0.51	0.49	0.49	0.54	0.54	0.56	0.005	-0.008	0.019
Standard deviation	0.09	0.13	0.20	0.17	0.21	0.37	0.33	0.26	0.27	0.31	0.36	...	...	...
Registered nurse (RN) hours/ Total nursing† hours														
For-profit														
Mean proportion	0.27	0.28	0.28	0.30	0.27	0.29	0.24	0.23	0.26	0.24	0.27	-0.004	-0.010	0.002
Standard deviation	0.10	0.07	0.12	0.15	0.07	0.18	0.07	0.08	0.22	0.19	0.28	...	...	...
Not-for-profit non-government														
Mean proportion	0.26	0.27	0.29	0.27	0.28	0.26	0.26	0.25	0.25	0.24	0.28	-0.002	-0.007	0.003
Standard deviation	0.09	0.05	0.14	0.07	0.07	0.07	0.11	0.12	0.15	0.16	0.26	...	...	...
Not-for-profit health-region-owned														
Mean proportion	0.22	0.22	0.28	0.25	0.28	0.23	0.23	0.20	0.21	0.19	0.28	-0.004	-0.012	0.005
Standard deviation	0.07	0.08	0.23	0.11	0.14	0.18	0.16	0.12	0.16	0.11	0.31	...	...	...
Total therapist‡ and activity aide hours per resident-day														
For-profit														
Mean number	0.15	0.14	0.14	0.14	0.14	0.12	0.11	0.12	0.10	0.11	0.12	-0.004**	-0.007	-0.001
Standard deviation	0.13	0.05	0.07	0.06	0.05	0.06	0.05	0.06	0.06	0.07	0.07	...	...	...
Not-for-profit non-government														
Mean number	0.19	0.17	0.19	0.18	0.19	0.18	0.17	0.17	0.20	0.18	0.18	-0.001	-0.005	0.004
Standard deviation	0.15	0.08	0.19	0.08	0.08	0.08	0.09	0.08	0.25	0.09	0.10	...	...	...
Not-for-profit health-region-owned														
Mean number	0.20	0.10	0.15	0.27	0.31	0.22	0.21	0.23	0.22	0.20	0.22	-0.001	-0.014	0.012
Standard deviation	0.14	0.08	0.09	0.38	0.43	0.08	0.11	0.09	0.14	0.14	0.13	...	...	...

** p<0.01, ***p<0.001
† registered nurses. licensed practical nurses, care aides
‡ occupational, physical and recreation therapy
... not applicable
Source: 1996 to 2006 Residential Care Facilities Survey.

nursing hours per resident-day were almost entirely the result of increases in non-RN hours.

Total therapist/activity aide hours per resident-day decreased in for-profit facilities, but remained stable in both types of not-for-profit facilities.

Adjusted effect of year and ownership

When adjusting for resident demographics, case mix, mortality rate and facility size, there was a significant positive effect of year on mean total nursing hours per resident-day across the period (Table 4, Model 1). Compared with for-profit facilities, total nursing hours per resident-day were significantly higher in both types of not-for-profit facilities in the adjusted model (Table 4, Model 2). Finally, the rate of increase across time in total nursing hours per

Table 4
Linear regression models for adjusted effect of year, facility ownership, and year x ownership on mean total nursing hours per resident-day in long-term care facilities,† British Columbia, 1999 to 2006

	Model 1‡			Model 2‡			Model 3‡		
	Regression coefficient§	95% confidence interval		Regression coefficient§	95% confidence interval		Regression coefficient§	95% confidence interval	
		from	to		from	to		from	to
Year	0.039**	0.012	0.066	0.037**	0.010	0.064	0.004	-0.034	0.042
Ownership (reference=for-profit)									
Not-for-profit non-government	...	...	...	0.249**	0.064	0.434	0.184	-0.168	0.536
Not-for-profit health-region-owned	...	...	...	0.472***	0.279	0.666	-0.677*	-1.232	-0.123
Interaction (year x ownership)									
Year x not-for-profit non-government	...	...	...	...	...	...	0.008	-0.039	0.054
Year x not-for-profit health-region-owned	...	...	...	...	...	...	0.153***	0.076	0.230

* p<0.05, **p<0.01, ***p<0.001
† N=233 facilities (1,073 survey responses)
‡ adjusted for population mean values of % male residents, % residents aged 85 or older, % residents Type III or higher, annual mortality rate, and facility size
§ excludes 30 facilities responding only once in 1999-to-2006 period
... not applicable
Source: 1996 to 2006 Residential Care Facilities Survey.

resident-day was significantly greater for not-for-profit health-region-owned facilities, compared with for-profit facilities (Table 4, Model 3).

By 2006, not-for-profit health-region-owned facilities had an adjusted estimate of 61 more minutes per resident-day and not-for-profit non-government-owned facilities, 16 more minutes per resident-day, compared with for-profit facilities (Table 5).

Discussion

With data from Statistics Canada's Residential Care Facilities Survey, this study traced trends in staffing levels in British Columbia's nursing homes from 1996 to 2006. The estimates of total nursing hours per resident-day are similar to levels reported for Ontario,[10] but substantially below those in a cross-sectional British Columbia study.[12] This may reflect the data sources: the Ontario estimates were based on the same source as the current study (the RCFS), whereas the British Columbia study used data submitted to the province's Labour Relations Board by union and management before a contract dispute.

This analysis shows that since 1996, total nursing hours per resident-day rose for all three facility ownership groups, but increases in RN (the most highly trained staff) hours were negligible. That RN hours in British Columbia did not rise during a period of increasing resident clinical complexity is of particular note, given evidence of a link between RN staffing levels and quality of care.[3,4,17]

Consistent with earlier research,[6,7,9,10,12] total adjusted nursing hours per resident-day in British Columbia were significantly lower in for-profit facilities, compared with the two not-for-profit groups. One explanation may be the institutional mandate. Staff constitute one of the largest expenditure categories, so lowering costs by reducing staff time is a means of increasing profits.[19,20] Moreover, British Columbia has no formal regulation of minimum staffing levels, so facilities have some leeway in deciding what is appropriate, thereby enabling such a difference to persist.

Previous research in British Columbia[18] found lower hospital admission rates for a number of care-sensitive diagnoses in health-region-owned facilities, compared with both for-profit facilities and not-for-profit non-government facilities. The dramatically higher total nursing hours per resident-day in health region-owned facilities in the current study suggests that staffing levels may be one element driving these improved outcomes.

The high total nursing hours per resident-day in not-for-profit health-region-owned facilities is consistent with findings from Ontario,[10] but not Manitoba where staffing levels were found to be uniform for all ownership groups.[11]

While the difference in nursing hours per resident-day in for-profit and not-for-profit non-government facilities is statistically significant, the magnitude of the difference is small and may be

Table 5
Estimated difference in mean total nursing minutes per resident-day in long-term care facilities,† by facility ownership and year, British Columbia, 1999 to 2006

Ownership	1999	2000	2001	2002	2003	2004	2005	2006
	(minutes per resident-day)							
Non-profit non-government	12.6	13.2	13.8	14.4	15.0	15.0	15.6	16.2
Non-profit health-region-owned	- 3.6	5.4	14.4	24.0	33.0	42.0	51.0	60.6

† N=233 facilities (1,073 survey responses)
Notes: Random effects linear regression models adjusted for population mean values of % male residents, % residents aged 85 or older, % residents Type III or higher, mortality rate, and facility size. Reference category is for-profit. Models exclude 30 facilities that responded only once in the 1999-to-2006 period.
Source: 1996 to 2006 Residential Care Facilities Survey.

What is already known on this subject?

- American studies have found that not-for-profit ownership of nursing homes is associated with higher staffing levels, lower staff turnover, and better outcomes on a range of measures, compared with for-profit-ownership.
- Differences in the market mix may limit the generalizability of American findings to Canada.
- Only three Canadian studies have quantitatively examined associations between long-term care facility staffing levels and facility ownership, and the results have not been consistent.
- Seniors living in long-term care facilities today are older, more disabled and closer to the end of life than were residents a decade ago, but data on nursing home staff have not been examined over time.

What does this study add?

- Total nursing hours per resident day have increased over the past decade for all facility ownership groups in British Columbia.
- The rate of increase in not-for-profit facilities owned by a health region was significantly greater compared with for-profit facilities.
- Total nursing hours per resident day were also significantly lower in for-profit facilities, compared with not-for-profit facilities.

of questionable clinical significance. Nonetheless, given previous research demonstrating that one toileting episode takes approximately eight minutes,[21] even fairly small increases in nursing staff time may add meaningful quality to residents' lives.

Regardless of facility ownership, total nursing hours per resident-day in this study (2.13 to 3.30 hours) were below current recommendations.[2,22] The U.S. Centers for Medicare and Medicaid determined that 4.1 hours per resident-day (combined 2.8 hours for non-licensed and 1.3 hours for licensed) was the threshold below which poorer outcomes such as weight loss and pressure ulcers were more likely to occur.[2]

Limitations

This study has a number of limitations. Although the initial survey response rate was relatively good, outliers and inconsistent responses across time were concerns. Consequently, these data were excluded from the analysis. The regression models were run with and without these exclusions, and the significance and direction of the effect estimates were unchanged, but it is still possible that some bias was introduced by the decision rules.

A second limitation is the potential inclusion in the dataset of a small number of privately financed user-pay for-profit facilities. However, this subgroup represents fewer than 5% of facilities in British Columbia and is unlikely to have influenced the overall results.

A third limitation is that case mix adjustment was done at the facility level, not the resident level. Therefore, it was not possible to determine if the differences in staffing were due to differences in the underlying case mix of residents not captured by the facility-level data.

Another limitation is that while the outcome was staffing hours per resident-day, staffing hours per bed-day were measured, based on the assumption that facilities were operating at 100% capacity and that residents were always on site (versus in hospital, for example). The former assumption is reasonable given the long waitlists for admission to residential care facilities in most health regions. However, if occupancy rates differed across facilities by ownership, staffing hours per resident-day may have spuriously appeared lower or higher than they actually were.

Finally, staffing levels are only one measure of quality. Other staff-related measures such as the turnover rate,[23] and management practices[24] have been found to be highly correlated with the quality of care.

Conclusion

While total nursing hours per resident-day in all long-term residential care facility groups in British Columbia have increased over time, the percentage of RN hours did not rise substantially. As well, the rate of increase in nursing hours per resident-day varied considerably by ownership. Increases in staffing since 1996 were much greater in not-for-profit facilities operated by regional health authorities than in for-profit facilities and not-for-profit non-government facilities. ■

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Asthma and school functioning

by Dafna E. Kohen

Abstract

Background
The impact of asthma on school performance, particularly compared with that of other chronic conditions, is relatively unexplored, and the results of analyses that have been conducted are inconclusive. This article examines associations between asthma and school functioning.

Data and methods
The data are from the 1998/1999 National Longitudinal Survey of Children and Youth. The study pertains to a sample of 8,914 children aged 7 to 15. Descriptive and regression analyses were used to examine associations between asthma severity and scores on standardized math and reading tests, and maternal ratings of school performance. School absence and the use of educational services were considered as potential mediators. Comparisons were made with children who had other chronic conditions or no chronic conditions.

Results
Compared with children who did not have a chronic condition, children with asthma scored lower on standardized math and reading tests and had less favourable mother-reported school performance. Those with the most severe asthma had the poorest outcomes. These associations persisted when adjusting for child and family factors. The poorer scholastic outcomes were not mediated by school absence. However, the use of educational services appeared to mediate low math scores for children with severe asthma.

Interpretation
The relationship between asthma and children's school functioning may be of interest to physicians and educators. Educational support and remedial services may be beneficial.

Keywords
achievement, asthma severity, chronic illness, math performance, reading performance

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The prevalence of asthma has been increasing among Canadian children and youth.[1] Compared with other children, those with asthma are in poorer health, are limited in daily activities, and experience more visits to health care professionals and hospitalizations.[2,3] They also miss more school than children who do not have the condition.[3-10] In fact, asthma has been reported to be the leading cause of school absence.[11,12]

The increased absenteeism of children with asthma has been well documented,[5-10] but associations between asthma severity and absence are less clear. Some studies have found asthma severity to be related to school absences,[5,13] while others have not.[14-16]

Although frequent absences may mean that children with asthma do less well academically than those who do not have the condition,[9,10] the impact of asthma on school performance is relatively unexplored, and the results of the studies that have been conducted are inconclusive.[10] In a population-based sample of American children in Grades 1 to 12, Fowler et al.[17] noted a greater likelihood of grade failure among children with asthma compared with healthy children. Other research suggests associations between asthma and reading problems,[18] grade repetition,[19] learning disabilities,[17] and behaviour problems.[20-22]

On the other hand, a population-based cohort study by Silverstein et al.[8] reported no difference in school functioning between children who did and did not have asthma. Several other studies[4,14,23] have had similar findings.

These discrepant results may be attributable to differences in the definitions of asthma and of school performance; whether the analysis accounted for asthma severity; the inclusion of a control group; and the use of standardized versus caregiver-reported measures of school performance.

The current study is based on a cross-sectional sample of school-aged children from the third cycle (1998/1999) of Statistics Canada's National Longitudinal Survey of Children and Youth (NLSCY). Associations between asthma severity and standardized and parent-reported measures of school functioning are examined.

Methods

Data source and sample

Since 1994/1995, the NLSCY has collected information about Canadian children's development and factors related to their well-being.[24] This study presents cross-sectional estimates from the third NLSCY cycle, which obtained data for a sample of 38,035 children aged 0 to 15 years in the fall of 1998 and the spring of 1999. Cycle 3 was selected because it contains standardized and parent-reported school performance outcomes that were dropped in later cycles of the NLSCY.

The sample for this study consisted of 8,914 children aged 7 to 15 (Grade 2 and higher) who had complete data on the measures of interest. All analyses were weighted using a normalized population weight. To adjust the standard error estimates for the complex design of the survey, bootstrap techniques were used in the regression analyses.[25]

Measures

Although clinical information was not available, and questions about asthma severity were not specifically asked, the NLSCY collected data that can serve as proxies for severity:[26] past-year wheezing or whistling in the chest and regular use of inhalers. Three levels of severity were identified: low, moderate and severe (Appendix Table A).

Questions about socio-demographic characteristics, child health, school absences, and use of educational services were answered by the person most knowledgeable about the child (the biological mother in 92% of cases) in computer-assisted personal interviews.

Math and reading scores were based on standardized tests administered in the classroom with parental consent; these scores were available for only a subset of children.[24]

Analyses

Descriptive analyses were conducted by asthma severity for three measures of school performance: scores on standardized math tests and reading tests and maternal raatings of the child's scholastic functioning. Comparisons were made with children with no chronic conditions and children who had chronic conditions other than asthma.

Logistic regression was used to "validate" the survey-based categorization of asthma severity. Associations between asthma severity and maternal reports of child health (excellent/very good versus good/fair/poor) and activity limitations (yes/no) were compared with results for children without chronic conditions. These analyses revealed associations between asthma severity and other ratings of child health, thereby providing some validation for the categorization of asthma severity. Associations between asthma severity and school absence and the use of educational services were also examined.

Logistic regressions were then used to assess associations between asthma severity and scores on standardized math and reading tests and maternal ratings of school performance, controlling for child age and sex, maternal age, female family headship, maternal education, and household income.[2,27,28] In final regression models, school absences and the use of educational services were examined as mediating factors in the relationship between asthma severity and scholastic outcomes.

The sample sizes for the logistic regression models examining associations between asthma severity and *math scores* were: 4,742 (socio-demographic variables only); 4,616 (school absence included); and 4,739 (use of educational services included). The corresponding sample sizes for the *reading scores* model were 4,744, 4,418 and 4,615, and for the *mother-rated school performance* model, 8,723, 8,380 and 8,377.

Results

The sample

The characteristics of children varied depending on whether they had been diagnosed with asthma or other chronic conditions. Significantly high percentages of children with asthma or other chronic conditions were male, lived in mother-headed households, had poor health, had missed at least 7 days of school, and had received educational services (Table 1). Children who did not have a chronic condition were slightly younger than those with a condition other than asthma, but not significantly different in age from children with asthma. Children with severe asthma tended to have younger mothers than did other children.

Health status and activity limitations

As might be expected, the odds of less favourable health ratings were significantly high among children with asthma, even when other factors that could potentially be associated with health status were taken into account (Table 2). As well, a gradient was evident, with the odds of poor health increasing with asthma severity. For instance, children with the least severe asthma had twice the odds of poor health, compared with children without chronic conditions; for children with the most severe asthma, the odds of poor health were almost ten times higher. Children with a chronic condition other than asthma also had significantly high odds of poor health.

Similarly, children with asthma were more likely to have activity limitations, and the odds of activity limitations rose with asthma severity. Children with the least severe asthma had about three and a half times the odds of activity limitations, compared with those who had no chronic conditions; for children with the most severe asthma, the odds were more than twenty-two times higher. Children with a chronic condition other than asthma were also more likely to have activity limitations.

These associations between asthma severity and poor health and activity limitations are not surprising, but the gradients do support the categorization of asthma severity in this analysis.

Table 1
Characteristics of sample, household population aged 7 to 15 with complete data on measures of school functioning, 1998/1999 National Longitudinal Survey of Children and Youth

Characteristic	Total	No chronic condition	Asthma			No asthma, but other chronic condition	Statistical comparison
			Low	Moderate	Severe		
Total number	**8,914**	**5,626**	**513**	**438**	**482**	**1,855**	
Child							
Mean age† (standard deviation)	10.8 (2.6)	10.7 (2.7)‡	11.0 (2.6)	10.8 (2.6)	10.8 (2.5)	11.1 (2.6)§	F = 7.80*
Female (%)	49.6	52.4	43.1	41.8	42.3	47.1	χ^2= 176.18*
Family							
Mean maternal age† (standard deviation)	38.5 (5.53)	38.5 (5.5)‡	38.3 (5.3)‡	38.6 (5.3)	38.0 (5.4)§	38.9 (5.7)‡	F = 5.74*
Female-headed (%)	15.3	14.6	16.8	17.0	17.4	16.2	χ^2= 38.84*
Maternal education							
Less than secondary graduation (%)	13.1	13.4	13.1	11.4	11.8	13.0	χ^2=100.68*
Secondary graduation (%)	19.9	21.1	17.4	17.1	17.4	18.3	
Some postsecondary (%)	28.4	27.7	29.8	29.5	32.0	28.8	
Postsecondary graduation (%)	38.6	37.8	39.8	42.0	32.8	39.9	
Mother not currently employed (%)	6.6	6.6	7.5	8.1	4.6	6.4	χ^2=5.25
Mother not employed prior year (%)	18.7	18.8	20.1	17.9	19.9	18.0	χ^2=7.57
Income adequacy	3.66 (0.96)	3.66 (0.96)	3.65 (0.96)	3.68 (0.94)	3.59 (0.98)	3.67 (0.94)	F=0.58
Child health							
Health status							
Excellent (%)	53.4	62.5	44.3	32.0	13.7	43.8	χ^2=1543.27*
Very good (%)	33.0	29.8	41.9	46.0	42.1	35.0	
Good/Fair/Poor (%)	13.6	7.8	13.8	22.2	44.2	21.1	
Chronic condition (%)	29.7	0.0	39.6	58.2	69.7	100.0	
School functioning							
Days absent (%)							
0	39.0	41.8	37.6	30.6	28.0	35.4	χ^2=268.94*
1 to 3	46.0	44.9	47.6	53.9	50.6	45.7	
4 to 6	9.6	9.0	9.2	10.3	12.2	10.8	
7 or more	5.5	4.3	5.7	5.3	9.1	8.1	
Use of educational services (%)	6.6	2.6	6.3	9.1	11.2	17.0	χ^2=1164.24*

* $p < 0.05$; significantly different categories for continuous variables have different superscripted symbols
† continuous variable
Source: 1998/1999 National Longitudinal Survey of Children and Youth.

Math and reading scores/ Maternal ratings

Scores on standardized math and reading tests and maternal ratings of children's school performance were related to family structure, maternal education and employment, and household income (Tables 3 to 5, column 1). But even when the influence of these factors was taken into account, differences in standardized scores and maternal ratings emerged by asthma severity.

The odds of low math scores were significantly high for children with moderate or severe asthma, compared with children who had no chronic conditions. The odds of low reading scores were significantly high only for children with moderate asthma. And the odds that mothers would rate their child's school performance as poor were high for children whose asthma symptoms were low or severe, but did not reach statistical significance for the moderate group.

Children with other chronic conditions were also more likely to have low math and reading scores and poor maternal ratings of their school performance, compared with children who did not have chronic conditions.

School absence and use of educational services

Children with asthma were significantly more likely than those with no chronic conditions to have been absent from school and to have used educational services (Table 2). This was also the case for children with chronic conditions other than asthma.

Additional models examined the effects of these potential mediators—school absence and use of educational services—on the associations between the three measures of school functioning and asthma and other chronic conditions.

Being away from school was linearly associated with low scores on standardized *math* tests. That is, the children who missed the most days (a week or more) had about two and a half times the odds of low scores, compared with children who missed no days (Table 3, column 2). However, controlling for school absence did not appreciably diminish the odds of low math scores

Table 2
Odds ratios relating selected characteristics to poor health status, activity limitations, school absence and educational services , household population aged 7 to 15, Canada, 1998/1999

Characteristic	Poor health status (n=8,723)			Activity limitations (n=8,722)			School absence more than one week§ (n=8,380)			Use of educational services (n=8,377)		
	Odds ratio	95% confidence interval from	to	Odds ratio	95% confidence interval from	to	Odds ratio	95% confidence interval from	to	Odds ratio	95% confidence interval from	to
Child												
Age (continuous)	1.02	1.00	1.04	1.05*	1.02	1.08	1.15*	1.12	1.19	1.00	1.00	1.02
Female†	1.32*	1.20	1.45	1.32*	1.15	1.52	1.26*	1.09	1.46	0.72*	0.63	0.82
Family												
Older maternal age†	1.03*	1.02	1.03	1.00	0.99	1.01	0.99	0.98	1.01	0.98*	0.97	1.00
Female-headed†	0.88	0.77	1.00	0.95	0.78	1.16	1.40*	1.15	1.71	1.77*	1.50	2.09
Higher maternal education†	0.84*	0.80	0.88	0.87*	0.81	0.97	0.81*	0.76	0.88	0.85*	0.79	0.90
Mother not currently employed†	1.08	0.88	1.34	1.11	0.82	1.52	1.06	0.76	1.49	0.96	0.72	1.29
Mother not employed prior year†	1.22*	1.08	1.37	1.02	0.84	1.23	1.31*	1.08	1.59	1.28*	1.08	1.51
Higher income adequacy†	0.73*	0.69	0.78	0.95	0.87	1.03	0.88*	0.80	0.96	0.92	0.85	1.00
Chronic condition												
None‡	1.00	...	...	1.00	...	...	1.00	...	...	1.00	...	...
Asthma												
Low	1.98*	1.64	2.39	3.49*	2.56	4.75	2.03*	1.55	2.67	2.64*	2.00	3.49
Moderate	3.42*	2.85	4.11	6.61*	4.97	8.78	1.59*	1.14	2.21	4.08*	3.13	5.32
Severe	9.46*	8.06	11.10	21.55*	17.22	26.97	3.53*	2.74	4.55	5.38*	4.21	6.88
Other	2.92*	2.61	3.26	8.81*	7.32	10.60	2.05*	1.72	2.43	8.85*	7.58	10.34

* significantly different from estimate for reference category ($p < 0.05$)
† reference category is absence of characteristic
‡ reference category
§ interview date included as a control
... not applicable
Notes: All models control for province of residence. Because of rounding, an odds ratio with 1.00 as upper confidence limit is significant.
Source: 1998/1999 National Longitudinal Survey of Children and Youth.

among children with asthma or with other chronic conditions.

Children who used educational services were much more likely than those who had not to obtain low math scores (Table 3, column 3). Controlling for the use of educational services reduced the strength of the association between moderate asthma and low math scores, and for children with severe asthma, the association was no longer significant.

Unlike the results for math, school absence was not related to low scores on the standardized *reading* tests (Table 4, column 2). Moreover, including school absence in the model actually strengthened the association between moderate and severe asthma and low reading scores, suggesting the presence of a suppressor effect or a correlation between school absence and a variable that was not examined in this analysis.

The use of educational services, however, was associated with low reading scores (Table 4, column 3). Controlling for the use of educational services reduced the odds that children with moderate asthma would have low reading scores, and for those with severe asthma, the association was no longer significant.

School absence was related to poor *maternal ratings* of academic performance only for children who missed the fewest days (no more than 3) (Table 5, column 2). As well, controlling for days absent had almost no effect on the relationship between asthma and poor mother-reported school performance.

On the other hand, the use of educational services was associated with poor maternal ratings (Table 5, column 3). And when the use of educational services was taken into account, the strength of the association between asthma and poor maternal ratings was reduced.

Discussion

The estimates of asthma and asthma severity in this study differ from those derived from other contemporary sources. According to the 1998/1999 NLSCY, 16% of school-aged children had been diagnosed with asthma, well above the estimated 12%, based on the 1996/1997 National Population Health Survey (NPHS).[29] However, the NPHS figure includes children younger than age 4, and the low prevalence of asthma (8%) at these ages would reduce the overall prevalence rate.

In this study, about one-third of the children who had asthma were classified in the most severe category, whereas in Bussing et al.,[20] the figure was just over 18%. But Bussing et al. looked at

Table 3
Adjusted odds ratios relating selected characteristics to low scores on standardized math tests, household population aged 7 to 15, Canada, 1998/1999

Characteristic	Adjusted for socio-demographics and chronic conditions (n=4,742)			Adjusted for socio-demographics, school absences and chronic conditions (n=4,616)			Adjusted for socio-demographics, use of educational services and chronic conditions (n=4,739)		
	Odds ratio	95% confidence interval		Odds ratio	95% confidence interval		Odds ratio	95% confidence interval	
		from	to		from	to		from	to
Child									
Age (continuous)	1.01	0.98	1.05	1.01	0.97	1.05	1.01	0.99	1.02
Female†	1.06	0.90	1.26	1.02	0.86	1.21	1.02	0.99	1.06
Family									
Older maternal age†	0.98*	0.97	1.00	0.98*	0.96	1.00	0.98	0.97	1.00
Female-headed†	1.91*	1.53	2.37	1.91*	1.52	2.40	1.84*	1.46	2.32
Higher maternal education†	0.81*	0.75	0.88	0.81*	0.79	0.98	0.82*	0.75	0.90
Mother not currently employed†	0.74	0.49	1.12	0.72	0.47	1.11	0.71	0.46	1.09
Mother not employed prior year†	1.53*	1.24	1.88	1.59*	1.28	1.97	1.63*	1.31	2.04
Higher Income adequacy†	0.86*	0.80	0.96	0.88*	0.79	0.98	0.92	0.82	1.02
Days absent									
0‡	...	...	...	1.00	...	...	...	...	...
1 to 3	...	...	...	1.57*	1.28	1.93	...	...	...
4 to 6	...	...	...	2.05*	1.52	2.75	...	...	...
7 or more	...	...	...	2.41*	1.71	3.41	...	...	...
Use of educational services†	...	...	...	...	...	...	4.79*	3.72	6.17
Chronic condition									
None‡	1.00	...	...	1.00	...	...	1.00	...	...
Asthma									
Low	1.39	1.00	1.92	1.36	0.98	1.90	1.24	0.89	1.74
Moderate	1.90*	1.34	2.68	1.84*	1.30	2.62	1.61*	1.13	2.30
Severe	1.62*	1.17	2.25	1.59*	1.14	2.22	1.41	1.00	1.98
Other	1.75*	1.43	2.14	1.72*	1.40	2.11	1.37*	1.10	1.70

* significantly different from estimate for reference category ($p < 0.05$)
† reference category is absence of characteristic
‡ reference category
§ interview date included as a control
... not applicable
Notes: All models control for province of residence. Because of rounding, some odds ratios with 1.00 as upper confidence limit are significant.
Source: 1998/1999 National Longitudinal Survey of Children and Youth.

severity among children who had only asthma, whereas children with asthma in the present study may also have had other chronic conditions.

The association between asthma severity and school absence observed in this study has been found in other research, based on school administrative records[5-10] and on maternal reports.[3,4] However, in the literature, the relationship between school absence and school performance is less clear. The NLSCY results suggest that the associations between asthma and poor school performance are not due to absences.

On the other hand, the use of educational services seemed to mediate some of these associations, particularly for children with severe asthma. Unfortunately, with NLSCY data, it was not possible to determine what kind or how many services were used or where they were offered.

The variations in research findings may be related to the specific outcomes examined and to whether asthma severity was taken into account. Fowler et al.[17] found that children with asthma had more mother-reported learning difficulties than did healthy children, but according to school records, no more grade failure or suspension/expulsion. Similarly, other studies have not reported differences between children with asthma and their healthy peers on standardized tests of math, reading and overall performance,[6] though based on maternal reports, outcomes for children with asthma have been less favourable.

Thus, the NLSCY results are consistent with the literature for poor mother-reported school performance, but not for scores on standardized math and reading tests. However, the present study, unlike many others,[8,23,30] includes

Table 4
Adjusted odds ratios relating selected characteristics to low scores on standardized reading tests, household population aged 7 to 15, Canada, 1998/1999

Characteristic	Adjusted for socio-demographics and chronic conditions (n=4,744)			Adjusted for socio-demographics, school absences and chronic conditions (n=4,618)			Adjusted for socio-demographics, use of educational services and chronic conditions (n=4,615)		
	Odds ratio	95% confidence interval from	to	Odds ratio	95% confidence interval from	to	Odds ratio	95% confidence interval from	to
Child									
Age (continuous)	1.07*	1.04	1.11	1.07*	1.04	1.11	1.08*	1.04	1.11
Female†	0.90	0.78	1.04	0.91	0.78	1.06	0.95	0.81	1.10
Family									
Older maternal age†	0.99	0.97	1.00	0.99	0.97	1.00	0.99	0.97	1.00
Female-headed†	1.27*	1.05	1.55	1.34*	1.09	1.64	1.26*	1.03	1.55
Higher maternal education†	0.78*	0.72	0.84	0.76*	0.71	0.82	0.77*	0.71	0.83
Mother not currently employed†	0.76	0.54	1.08	0.78	0.55	1.10	0.75	0.53	1.06
Mother not employed prior year†	1.04	0.86	1.26	1.09	0.89	1.32	1.05	0.86	1.27
Higher Income adequacy†	0.71*	0.65	0.77	0.71*	0.64	0.77	0.71*	0.65	0.78
Days absent									
0‡	...	...	...	...	...	...	...	...	...
1 to 3	...	...	...	0.97	0.82	1.14	...	...	...
4 to 6	...	...	...	1.14	0.88	1.49	...	...	...
7 or more	...	...	...	0.90	0.63	1.28	...	...	...
Use of educational services†	...	...	...	...	...	...	2.76*	2.16	3.52
Chronic condition									
None‡	1.00	…	…	1.00	…	…	1.00	…	…
Asthma									
Low	0.82	0.59	1.15	0.86	0.62	1.20	0.78	0.56	1.09
Moderate	1.73*	1.28	2.32	1.83*	1.36	2.46	1.59*	1.17	2.15
Severe	1.23	0.91	1.67	1.36*	1.00	1.86	1.17	0.85	1.60
Other	1.52*	1.27	1.81	1.57*	1.31	1.88	1.35*	1.12	1.62

* significantly different from estimate for reference category ($p < 0.05$)
† reference category is absence of characteristic
‡ reference category
§ interview date included as a control
... not applicable
Note: All models control for province of residence.
Source: 1998/1999 National Longitudinal Survey of Children and Youth.

a control group of children with and without chronic conditions and uses a large population-based sample.

According to the NLSCY, most children, even those with severe asthma, had not been absent from school for many days: 96% of healthy children and 91% of children with severe asthma were reported to have missed fewer than 7 days. By contrast, Fowler et al,[17] found that just 58% of children with asthma missed no more than 5 days of school, substantially below the figure even for children with severe asthma in the present study. Although the models for the NLSCY analysis controlled for the number of days since school started, many interviews were completed early in the school year, which could be one reason why reported school absence was so low.

Consistent with other findings,[23] school absence was independently associated with low scores on standardized math tests. However, school absence did not mediate the association between asthma severity and math and reading scores and mother-rated performance. Even though children with asthma were more likely to miss school, it is possible that they and/or their parents compensated for the absences, perhaps through additional services within and outside the school. Future studies could examine these possibilities, as well as factors such as parenting practices and the provision of learning experiences in the home.

The worsening of health outcomes with asthma severity suggests that the conceptualization of asthma severity in this study captured a construct related to the child's health. Associations between asthma severity and school performance were less straightforward. Potential confounders such as maternal education, family structure and household income were taken into account, but other factors related to school performance could not

Table 5
Adjusted odds ratios relating selected characteristics to poor mother-rated school performance, household population aged 7 to 15, Canada, 1998/1999

Characteristics	Adjusted for socio-demographics and chronic conditions (n=4,742)			Adjusted for socio-demographics, school absences and chronic conditions (n=4,616)			Adjusted for socio-demographics, use of educational services and chronic conditions (n=4,739)		
	Odds ratio	95% confidence interval from	to	Odds ratio	95% confidence interval from	to	Odds ratio	95% confidence interval from	to
Child									
Age (continuous)	0.60*	0.59	0.62	0.60*	0.59	0.61	0.60*	0.58	0.61
Female†	0.71*	0.66	0.77	0.71*	0.65	0.77	0.73*	0.67	0.80
Family									
Older maternal age†	0.99	0.99	1.00	0.99*	0.98	1.00	0.99*	0.98	1.00
Female-headed†	1.28*	1.13	1.44	1.31*	1.16	1.48	1.24*	1.09	1.40
Higher maternal education†	0.82*	0.78	0.85	0.82*	0.78	0.85	0.82*	0.79	0.86
Mother not currently employed†	0.98	0.82	1.62	0.99	0.83	1.18	0.98	0.82	1.18
Mother not employed prior year†	1.01	0.91	1.13	1.05	0.94	1.18	1.03	0.92	1.15
Higher Income adequacy†	0.92*	0.88	0.97*	0.93*	0.88	0.98	0.94*	0.89	0.99
Days absent									
0‡	...	...	...	...	...	...	...	...	...
1 to 3	...	...	...	1.15*	1.05	1.26	...	...	...
4 to 6	...	...	...	1.11	0.95	1.29	...	...	...
7 or more	...	...	...	1.12	0.90	1.38	...	...	...
Use of educational services†	...	...	...	...	...	...	3.12*	2.72	3.70
Chronic condition									
None‡	1.00	…	…	1.00	…	…	1.00	…	…
Asthma									
Low	1.60*	1.35	1.88	1.63*	1.38	1.93	1.59*	1.34	1.88
Moderate	1.16	0.96	1.40	1.15	0.95	1.39	1.09	0.90	1.32
Severe	1.57*	1.32	1.88	1.55*	1.29	1.89	1.41*	1.17	1.69
Other	1.55*	1.40	1.72	1.56*	1.40	1.73	1.27*	1.13	1.41

* significantly different from estimate for reference category ($p < 0.05$)
† reference category is absence of characteristic
‡ reference category
§ interview date included as a control
... not applicable
Notes: All models control for province of residence. Because of rounding, some odds ratios with 1.00 as upper confidence limit are significant.
Source: 1998/1999 National Longitudinal Survey of Children and Youth.

be considered: the child's prior levels of performance, motivation, intelligence, and behavioural problems; parenting practices; resources and learning environments; and parental participation in school activities.[31-34]

Strengths and limitations

Although the analysis pertains to 1998/1999, the data source is undoubtedly a strength of the current study. Cycle 3 of the NLSCY collected data for a large, representative sample of children with various health conditions, thereby making it possible to compare those with asthma with healthy children and with children who had other chronic conditions. Standardized test results and mother-reported measures of school performance were available.

Even so, the NLSCY is limited in a number of ways. It was not designed to specifically address chronic illnesses and their association with children's school performance. The identification of children with asthma was based on maternal reports, not medical records. Although parental reports of children's chronic conditions have been demonstrated to be valid,[35] the reported prevalence of asthma may be underestimated as a result of undiagnosed cases.

The ability to generate classes of individuals with similar conditions (asthma of varying levels of severity with and without other chronic conditions) is limited. Guidelines for more rigorous methods of severity classification exist,[36] but they were not part of the NLSCY.

The three levels of asthma severity specified in this study are not homogeneous, and likely represent differences in asthma other than just severity. For example, to be in the

What is already known on this subject?

- The prevalence of asthma among Canadian children and youth has been increasing.
- Children with asthma miss more school than do children without the condition.
- Frequent school absences can interfere with learning, but the impact of asthma on school performance is relatively unexplored, and the results of the analyses that have been conducted are inconclusive.

What does this study add?

- Children with asthma scored lower on standardized math and reading tests and had less favourable mother-reported school performance than did children who did not have chronic conditions.
- Children with the most severe asthma had the poorest outcomes.
- These associations persisted even when adjusting for child and family factors.
- The poorer scholastic outcomes were not mediated by school absences, but the use of educational services appeared to mediate low math scores for children with severe asthma.

"severe" category, children had to be taking asthma medication, but still coughing or wheezing. This may not indicate the most severe asthma, but rather, that the children are not responding to the medication, are not receiving the appropriate dosage, or are not complying with the administration of the medication. Nevertheless, the consistency of the associations with ratings of health and with activity limitations suggests that the conceptualization of asthma severity in this study represents an aspect of poor health.

A high percentage of children with asthma, especially severe asthma (70%), had another chronic condition. The NLSCY sample for this group was not large enough to permit an in-depth investigation of the other conditions affecting the children with asthma nor of asthmatic children by severity.

Another factor to be considered is the reported use of asthma medication. The NLSCY question asks about inhalers. However, asthma treatment includes relievers (inhalers and puffers) and controllers (oral medication when a child becomes symptomatic).[3] Detailed information about the use of these medications was not available in the NLSCY.

A further complication is the uncertain effect of the medications on school performance. Taking medication may reduce and control symptoms and improve school performance. On the other hand, side-effects such as drowsiness and decreased attention, could interfere with academic attainment.[9,37] Further research is required to disentangle these associations.

A final limitation is the high non-response to the standardized math and reading tests.[24] Complete data on these measures were more likely to be available for children with asthma than for those who did not have the condition. Attrition analyses were performed to compare the group that had math and reading scores with the group that did not (Appendix Table B).

Conclusion

With data from Statistics Canada's National Longitudinal Survey of Children and Youth, this study examined associations between asthma severity and three measures of school performance. Compared with children who did not have chronic conditions, those with asthma tended to perform less well, and those with the most severe asthma had the poorest outcomes. Children with the most severe asthma had the greatest odds of missing more than a week of school, but their low scores on standardized math and reading tests and poor mother-rated academic performance were not mediated by school absences. The use of educational services, however, appeared to mediate the associations.

The increased risk of poor scholastic outcomes for children with asthma (and other chronic conditions) has implications for clinicians, teachers, and parents. The results suggest the importance of additional assistance such as educational services to improve the school performance of children with asthma. ■

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Appendix

Table A
Measures used in analyses

Variable	Description
Province of residence	Ontario as comparison group
Child characteristics	
Age	Years
Gender	Female
Maternal characteristics	
Age	Years
Education	Highest level: less than secondary graduation; secondary graduation; some postsecondary; postsecondary graduation
Currently employed	Yes/No
Employed prior year	Yes/No
Income adequacy	Based on household income and household size; range 1 to 5
Child health	
Asthma	Maternal report of ever having been diagnosed with asthma†
Asthma severity	Based on two items: child had wheezing or whistling in chest any time in previous 12 months; prescribed and regular use of Ventolin, inhalants or puffers for asthma
Low	Diagnosed asthma, but no wheezing or whistling and no use of medication
Moderate	Diagnosed asthma with reported wheezing or whistling OR use of medication
Severe	Diagnosed asthma with reported wheezing or whistling AND use of medication
Chronic condition	Presence of any of following: allergies, bronchitis, heart condition, epilepsy, cerebral palsy, kidney, mental handicap, learning disability, emotional problems
No chronic condition	No diagnosis of asthma or other chronic condition
Health status	Maternal rating of child's health as excellent/very good or good/fair/poor
Activity limitations	Long-term conditions or health problems that prevent or limit participation in school, play or sports (yes/no)
School functioning	
School absence	Maternal report of number of school days absent for any reason: 0, 1 to 3, 4 to 6, 7 or more‡
Use of educational services	Maternal report of receipt of special help because of physical, emotional, behavioural or other problem limiting kind or amount of school work child can do (yes/no)
Standardized math and reading tests	Shortened version of Mathematics Computation Test and Reading Comprehension Test of Canadian Achievement Tests (CAT/2): good/low§
Maternal rating of school performance	Maternal rating of child's performance in math, reading, writing and overall; range 4 to 20; dichotomized into good/poor

† phrasing of this item, consistent with other large studies, limits variability because of seasonality of child age
‡ number of days missed since start of school; analyses controlled for month and day of survey administration
§ because of ceiling effects on these tests, scores were dichotomized; scores above mean categorized as good, and scores below mean categorized as low

Table B
Odd ratios comparing characteristics of respondents with math and reading scores with characteristics of those who did not, household population aged 7 to 15, Canada, 1998/1999

Characteristic	Odds ratio	95% confidence interval from	to
Province			
Ontario†	1.00	…	…
Newfoundland	0.68*	0.53	0.88
Prince Edward Island	0.47*	0.28	0.78
Nova Scotia	0.42*	0.34	0.53
New Brunswick	0.48*	0.38	0.61
Quebec	1.17*	1.07	1.29
Manitoba	0.75*	0.63	0.91
Saskatchewan	0.77*	0.64	0.92
Alberta	0.79*	0.70	0.90
British Columbia	0.82*	0.73	0.92
Child			
Age (continuous)	1.03*	1.01	1.05
Female‡	0.85*	0.79	0.91
Family			
Older maternal age‡	1.00	0.99	1.00
Female-headed‡	1.18*	1.06	1.13
Higher maternal education‡	0.98	0.94	1.01
Mother not currently employed‡	0.82*	0.70	0.96
Mother not employed prior year‡	0.95	0.86	1.04
Higher Income adequacy‡	0.95	0.90	0.99
Chronic condition			
None†	1.00	…	…
Asthma			
Low	0.80*	0.71	0.91
Moderate	0.82*	0.71	0.95
Severe	0.72*	0.62	0.83

* significantly different from estimate for reference category ($p < 0.05$)
† reference category
‡ reference category is absence of characteristic
§ interview date included as a control
... not applicable
Source: 1998/1999 National Longitudinal Survey of Children and Youth.


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Recent trends in upper respiratory infections, ear infections and asthma among young Canadian children

by Eleanor M. Thomas

Abstract
Upper respiratory (nose and throat) infections, ear infections and asthma are common among young children. This article uses data from the National Longitudinal Survey of Children and Youth (NLSCY) to trace trends in the prevalence of these conditions among young children in Canada from 1994/1995 to 2008/2009. Gender, age and regional differences in the occurrence of these conditions are examined, and possible links with exposure to cigarette smoke are considered. The prevalence of upper respiratory infections among children aged 2 to 3 remained constant or declined in most regions of Canada between 1994/1995 and 2008/2009, but rose significantly in Quebec. Ear infections declined significantly in all regions. The prevalence of asthma among children aged 2 to 7 rose steadily until 2000/2001 and then declined. A wide range of environmental factors, including reduced exposure to cigarette smoke, may have contributed to these trends.

Keywords
common cold, ear diseases, otitis media, passive smoking, respiratory diseases, respiratory sounds

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Upper respiratory (nose and throat) infections, otitis media (ear infection and inflammation) and asthma affect large numbers of young children.[1-5] This article uses data from the National Longitudinal Survey of Children and Youth (NLSCY) to report trends from 1994/1995 to 2008/2009 in the prevalence of these conditions among children in Canada. Data on upper respiratory infections and ear infections are available for 2- to 3-year-olds, and data on asthma are available for children aged 2 to 7. Gender, age and regional differences in the occurrence of these conditions are examined. Possible links with exposure to cigarette smoke are considered.

Upper respiratory infections

Upper respiratory infections, including the common cold, are frequent among children, with 3 to 8 infections a year being typical.[6] In 1994/1995, 26% of Canadian children aged 2 to 3 years were reported by their parents as having upper respiratory infections "almost all the time," "often," or "from time to time" (Table 1). This percentage remained almost stable over the next 14 years: the 2008/2009 figure was 23%.

In 1994/1995, boys were more likely than girls to have frequent upper respiratory infections: 29% versus 23%. Thereafter, no male-female differences were apparent, because among boys (but not girls), the prevalence of frequent infections decreased.

Throughout the 1994/1995-to-2008/2009 period, the prevalence of frequent upper respiratory infections among 2- to 3-year-olds was lowest in the Atlantic provinces (Newfoundland and Labrador, Prince Edward Island, Nova Scotia, and New Brunswick), and highest in Quebec.

Table 1
Prevalence of "frequent" (almost all the time/often/from time to time) upper respiratory infections, by sex and region, household population aged 2 to 3, Canada excluding territories and Nunavut, 1994/1995 to 2008/2009

	1994/1995	2000/2001	2006/2007	2008/2009	Comparison between 1994/1995 and 2008/2009 (p-value)
			%		
Total	25.8	25.9	24.4	23.5	0.141
Sex					
Male	28.7*	26.7	24.2	23.1	0.010
Female†	22.7	25.0	24.6	24.0	0.571
Region					
Atlantic provinces	20.3	18.8*	17.6*	16.8*	0.153
Quebec†	28.0	36.8‡	41.1	38.9	0.003
Ontario	26.4	22.1*	19.7*	19.5*	0.013
Prairie provinces	24.3	22.4*	17.0*‡	19.3*	0.052
British Columbia	25.1	27.8*	25.6*	18.4*‡	0.081

† reference category
* significantly different from estimate for reference category (p<0.05)
‡ significantly different from estimate for previous survey cycle (p<0.05)
Source: 1994/1995 to 2008/2009 National Longitudinal Survey of Children and Youth.

In all provinces except Quebec, the prevalence of frequent upper respiratory infections declined over the 14 years. In Ontario, the percentage fell from 26% to 20%, and in the Prairie provinces (Manitoba, Saskatchewan and Alberta), from 24% to 19%. Declines in the Atlantic provinces and British Columbia did not reach statistical significance. By contrast, in Quebec, the percentage rose from 28% to 39%.

The significant increase in frequent upper respiratory infections in Quebec could partly reflect changes in child care funding in that province in 1997, which resulted in a substantial increase in the percentage of Quebec children in daycare centres.[7] Children in these settings have an increased risk of contracting colds and other infectious conditions, compared with children who are not in such centres.[6,8,9]

Otitis media

Otitis media (middle-ear infection or inflammation) is also common in childhood.[1,10] In 1994/1995, 67% of Canadian children aged 2 to 3 years had had at least one ear infection since birth (Table 2). The percentage with frequent (four or more) ear infections was 26%. However, by 2008/2009, the percentage who had had at least one ear infection had dropped to 50%, and the percentage who had had four or more had fallen to 13%.

Boys were more likely than girls to have had at least one (data not shown) or four or more ear infections (Table 2). From 1994/1995 to 2008/2009, the prevalence of at least one ear infection among boys declined from 70% to 53% (p<0.001), and among girls, from 64% to 47% (p<0.001). Similarly, the percentage of boys who had had frequent ear infections dropped from 30% to 14%; among girls, the decline was from 23% to 11%.

The Atlantic provinces and Quebec tended to have high ear infection rates, while in British Columbia, the rates tended to be low (Table 2). In all regions except Quebec, the prevalence of ear infections fell since 1994/1995. These variations may be linked to regional differences in upper respiratory infections, which increase the risk of ear infections.[3,4]

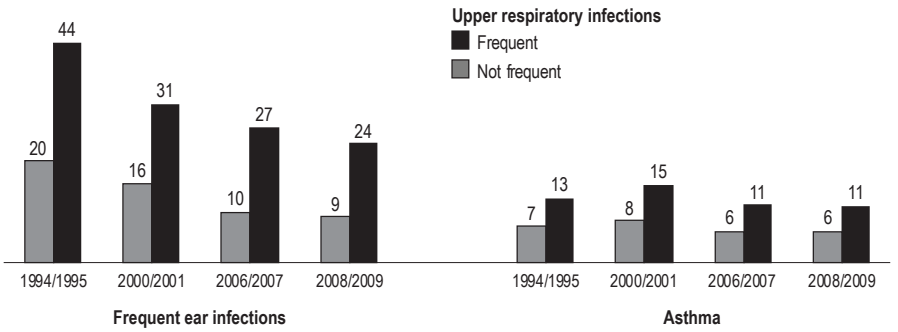
In fact, significant links were found between upper respiratory infections and ear infections in each of the four survey cycles (Figure 1). For example, in 1994/1995, 44% of children aged 2 to 3 with frequent upper respiratory infections were also reported to have had frequent ear infections since birth; this compared with 20% of children who rarely or never had upper respiratory infections (p<0.001). In 2008/2009, the prevalence of frequent ear infections was lower among both groups, but the difference between those who did and did not experience frequent upper respiratory infections remained significant, at 24% versus 9% (p<0.001).

Table 2
Prevalence of ear infections, by sex and region, household population aged 2 to 3, Canada excluding territories and Nunavut, 1994/1995 to 2008/2009

	1994/1995	2000/2001	2006/2007	2008/2009	Comparison between 1994/1995 and 2008/2009 (p-value)
			%		
At least one ear infection	66.9	62.6‡	51.5‡	50.2	<0.001
Frequent ear infections	26.3	19.8‡	14.2‡	12.6	<0.001
Sex					
Male	29.9*	21.2‡	16.2*‡	14.2*	<0.001
Female†	22.5	18.2‡	12.1‡	10.9	<0.001
Region					
Atlantic provinces	35.2*	22.6*‡	17.3*‡	16.0*	<0.001
Quebec	24.4	25.8*	22.0*	18.4*§	0.080
Ontario	25.3	19.7*‡	12.3‡	11.5*	<0.001
Prairie provinces	27.4	18.3*‡	11.5‡	10.5	<0.001
British Columbia†	25.8	9.6‡	9.2E	7.3E	<0.001

† reference category
* significantly different from estimate for reference category (p<0.05)
‡ significantly different from estimate for previous survey cycle (p<0.05)
§ significantly different from estimate for 2000/2001 (p<0.05)
E use with caution
Source: 1994/1995 to 2008/2009 National Longitudinal Survey of Children and Youth.

Figure 1
Prevalence of frequent ear infections and of asthma among children aged 2 to 3, by frequency of upper respiratory infections (URIs), Canada excluding territories and Nunavut, 1994/1995 to 2008/2009



Note: "Frequent" upper respiratory infections occurred "almost all the time," "often" or "from time to time."
Source: 1994/1995 to 2008/2009 National Longitudinal Survey of Children and Youth.

Asthma

In Canada and many other western countries, the prevalence of asthma among children increased steadily for several decades, and then levelled off or even declined.[11-14] Echoing trends in an earlier report on Canadian children aged 0 to 11,[14] the present study found that the percentage of children aged 2 to 7 who had been diagnosed with asthma rose from 11% in 1994/1995 to 13% in 2000/2001, but by 2008/2009, had fallen to 10% (Table 3).

Because the lifetime prevalence of health conditions increases with age, it is not surprising that at each NLSCY cycle, a higher percentage of 6- to 7-year-olds than 2- to 3-year-olds were reported to have been diagnosed with asthma. For example, in 2006/2007, 15% of children aged 6 to 7 had been diagnosed with asthma, compared with 8% of those aged 2 to 3. The increase in prevalence rates to 2000/2001 and the subsequent drop occurred in all age groups.

A significantly higher percentage of boys than girls had been diagnosed with asthma at each NLSCY cycle (Table 3). Among both sexes, asthma prevalence followed the general trend, rising from

Table 3
Prevalence of asthma, by sex, age and region, household population aged 2 to 7, Canada excluding territories and Nunavut, 1994/1995 to 2008/2009

	1994/1995	2000/2001	2006/2007	2008/2009	Comparison between 1994/1995 and 2008/2009 (p-value)
		%			
Total	11.5	13.2‡	11.5‡	9.8‡§	0.008
Sex					
Male	14.2*	16.2*‡	13.5*‡	11.4*‡§	0.006
Female†	8.7	10.0	9.4	7.9§	0.364
Age					
2 to 3	8.8*	10.1*	7.6*‡	7.4*§	0.135
4 to 5	11.6*	13.5	12.7	10.1‡§	0.185
6 to 7†	14.2	15.7	14.9	12.4§	0.178
Region					
Atlantic provinces	14.2*	15.2*	12.5‡	10.8*§	0.004
Quebec	11.2	15.5*‡	13.2	10.6§	0.686
Ontario	12.1	13.7*	10.9‡	9.8§	0.052
Prairie provinces	10.3	10.9	11.7	9.6‡	0.489
British Columbia†	10.2	9.2	10.1	7.9	0.174

† reference category
* significantly different from estimate for reference category (p<0.05)
‡ significantly different from estimate for previous survey cycle (p<0.05)
§ significantly different from estimate for 2000/2001 (p<0.05)
Source: 1994/1995 to 2008/2009 National Longitudinal Survey of Children and Youth.

The data

The data are from the National Longitudinal Survey of Children and Youth (NLSCY), which has been conducted every two years since 1994/1995. This report examines trends from 1994/1995 to 2008/2009 in the prevalence of upper respiratory infections and otitis media among children aged 2 to 3 years, and in the prevalence of asthma among children aged 2 to 7 years.

The information used in this analysis was provided to the NLSCY by the person most knowledgeable about the child, usually the mother. The prevalence of health conditions was based on the parent's response to the following questions:

- *Upper respiratory infections*: How often does this child have nose or throat infections (almost all the time, often, from time to time, rarely, or never)?
- *Otitis media*: Since birth, has this child had an ear infection (otitis)? If yes, how many times?
- *Asthma and asthma symptoms*: Has this child ever had asthma that was diagnosed by a health professional? Has this child had an asthma attack in the past 12 months? Has this child had wheezing or whistling in the chest any time in the last 12 months? Does this child take any of the following prescribed medications on a regular basis: Ventolin, inhalers, puffers for asthma?

Income status was measured as the ratio of household income to the low-income cut-off for the size and location of the child's household.

Cross-sectional survey weights were used for the analyses. For statistical tests, the variances and standard errors of all estimates were calculated using the bootstrap weights developed by Statistics Canada for each of the cross-sectional samples.

1994/1995 to 2000/2001, and then declining.

Previous studies have reported regional variations in the prevalence of childhood asthma,[14,15] with British Columbia and the Prairie provinces having lower rates than other regions. However, this pattern has changed markedly. Since 2000/2001, the prevalence of asthma among 2- to 7-year-olds declined in the Atlantic provinces, Quebec and Ontario, but remained relatively stable in British Columbia and the Prairies (Table 3). As a result, in 2006/2007 and 2008/2009, no significant regional differences in asthma prevalence emerged.

During the 1994/1995-to-2008/2009 period, the percentage of children with asthma who had had an asthma *attack* in the past 12 months fell steadily from 53% to 36% (data not shown).

As expected, rates of *wheezing and whistling in the chest* were much higher for children who had been diagnosed with asthma than for children overall (data not shown). However, while the prevalence of such symptoms among the general population of children aged 2 to 7 did not change over time (ranging between 17% and 20%), it dropped significantly among those with asthma (from 70% to 61%).

In 1994/1995, about 50% of children with asthma used asthma medication regularly, a rate that did not change significantly over the 14 years (data not shown).

Although boys were more likely than girls to have asthma, the severity of the condition did not appear to differ by sex: no differences emerged in the percentage who had had an asthma attack or experienced wheezing or whistling in the chest in the past year, or in the percentage who used asthma medication regularly (data not shown).

Asthma and upper respiratory infections

Upper respiratory infections are major asthma inducers.[2,5,12] In the present study, significant links were found between upper respiratory infections and asthma (Figure 1). For example, in 1994/1995, 13% of children aged 2 to 3 who had frequent upper respiratory infections had been diagnosed with asthma; by contrast, 7% of children who rarely or never had these infections had asthma ($p<0.003$). In 2008/2009, the figures were 11% and 6% ($p<0.002$).

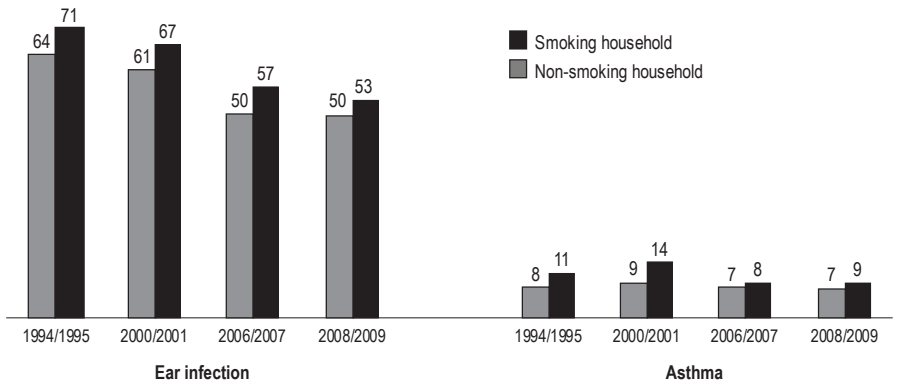
Environmental factors

A number of environmental factors may be related to the recent declines in childhood ear infections and asthma: changes in the population structure; changes in diagnostic practices; decreases in the prevalence of respiratory allergies[12]; improvements in air quality[16,17]; changes in hygiene practices (particularly, in child care settings); and reductions in children's exposure to cigarette smoke at home.[18] An investigation of most of these factors is beyond the scope of this paper, but the possible role of exposure to cigarette smoke can be considered.

The Canadian Tobacco Use Monitoring Survey (CTUMS) reported a steady decline in daily smoking among people aged 15 or older from 19% in 2000 to 13% in 2008,[19] and a simultaneous decrease in the percentage of children aged 0 to 11 who were regularly exposed to tobacco smoke at home from 24% to 6%.[20] NLSCY data also show a decline in the percentage of children aged 2 to 3 living in households where at least one parent smoked daily, from 39% in 1994/1995 to 20% in 2008/2009. These trends suggest that reduced exposure to tobacco smoke may be contributing to the decreased prevalence of ear infections and asthma among young children.

Exposure to cigarette smoke has been causally linked to ear infections.[18,21] According to NLSCY results, children in households where at least one parent was a daily smoker were more likely than children in non-smoking households to have had at least one ear infection since birth (Figure 2). However, since the early 1990s, regardless of whether they lived in a smoking- or non-smoking household, the percentage of children who had had ear infections dropped steadily, and the gap in prevalence between the two groups narrowed. In 1994/1995, 71% of children in households with a parent who smoked had had at least one ear infection, compared with 64% of those in non-smoking households ($p=0.012$); by 2008/2009, the corresponding figures were 53% and 50%, a difference that was not statistically significant. These trends are consistent with the hypothesis that reduced exposure to cigarette smoke contributed to declines in ear infections. But given the drop in the prevalence of ear infections among children in both smoking and non-smoking households, changes in other factors may have also played a role. The current lack of

Figure 2
Prevalence of at least one ear infection and of asthma among children aged 2 to 3, by household smoking, Canada excluding territories and Nunavut, 1994/1995 to 2008/2009



Source: 1994/1995 to 2008/2009 National Longitudinal Survey of Children and Youth.

a difference in the prevalence of ear infections between children in smoking and non-smoking households may indicate that adult smoking rates have become low enough that exposure to tobacco smoke is no longer a prominent cause of ear infections among young children.

The medical literature has also causally linked exposure to cigarette smoke with asthma.[18,21] For instance, legislation banning smoking in public places in Scotland was followed by decreases in the incidence of severe episodes of asthma among preschool and school-age children.[22]

In the early years covered by the present study (1994/1995 and 2000/2001), children in households where at least one parent was a daily smoker were more likely than those in non-smoking households to have been diagnosed with asthma (Figure 2). However, in 2006/2007 and in 2008/2009, no statistically significant differences were found in asthma prevalence between children in smoking and non-smoking households. Again, this suggests that reduced exposure to cigarette smoke contributed to declines in asthma over time, and that adult smoking rates have become low enough that parental smoking has ceased to be major cause of asthma in young children.

And even in households where a parent smokes, children's exposure may now be lower because of growing awareness of the dangers of second-hand smoke. According to the CTUMS results, in 2009, 47% of households where smoking was allowed inside the home imposed some restrictions.[19] Parents who smoke may, for example, do so outdoors or in restricted areas.

Smoking and household income

Rates of cigarette smoking tend to be relatively high among low-income groups.[23,24] For example, in 2008/2009, the prevalence of daily smoking by at least one parent in households below the low-income cut-off was 27%; in households at or above the low-income cut-off, the figure was 18%.

To determine if the associations between parental smoking and the prevalence of ear infections and asthma among children was related to factors other than smoking, low-income and higher-income households were examined separately. The patterns of ear infection and asthma prevalence reported above for children in smoking and non-smoking households were found for both the low- and higher-income groups. The decline over time in ear infections and asthma also occurred among children in smoking and non-smoking households in both income groups (data not shown). These findings suggest that the links between parental smoking and ear infections and asthma did not arise from unidentified factors associated with income.

Summary

From 1994/1995 to 2008/2009, the prevalence of upper respiratory infections among children aged 2 to 3 remained constant or declined in most regions of Canada, but rose significantly in Quebec. Ear infections declined in all regions. The prevalence of asthma among children aged 2 to 7 rose steadily until 2000/2001 and then fell. A wide range of environmental factors, including reduced exposure to cigarette smoke, may have contributed to these trends. An examination of possible mechanisms falls outside the scope of this paper, but is a topic for future research. ■

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Chronic pain at ages 12 to 44

by Pamela L. Ramage-Morin and Heather Gilmour

Abstract

According to results from the 2007/2008 Canadian Community Health Survey, about 1 in 10 Canadians aged 12 to 44—9% of males and 12% of females, an estimated 1.5 million people—experienced chronic pain. The prevalence of chronic pain increased with age and was significantly higher among people in households where the level of educational attainment was low and among the Aboriginal population. The most common pain-related chronic conditions at ages 12 to 44 were back problems and migraine headaches. Chronic pain prevented at least a few activities in the majority of sufferers. It was associated with activity limitations and needing help with everyday tasks, and had work-related implications. Individuals with chronic pain were frequent users of health care services, and were less likely than people without chronic pain to respond positively on measures of well-being, including mood and anxiety disorders.

Key words

ADL, anxiety disorders, cross-sectional studies, health status, health surveys, IADL, mood disorders, prevalence, quality of life

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Pain lasting for several months,[1] or persisting after an injury has healed,[2] is considered chronic. Chronic pain affects not only individuals, but also their families, the health care system, and society as a whole.[3] It may lead to other health concerns such as eating problems, sleep disturbances and fatigue.[4-6] Absences from school, work and social activities have been linked to chronic pain.[3,7,8] People may lose or change jobs, and in more extreme cases, cannot work at all.[3,5,9,10] Mental health may be compromised; chronic pain has been associated with anxiety, depression, loneliness, and suicide ideation and attempts.[11]

Although chronic pain is usually associated with aging, it is relatively common at younger ages. However, few large, population-based studies have examined chronic pain among non-elderly people.[4,12-14] Instead, research on pain at younger ages has focused on specific chronic conditions and pain sites,[15-17] small sectors of the population such as occupational or ethnic groups,[18-20] or convenience samples such as children attending certain schools or living in certain areas.[4,21] Results from such studies provide only a partial picture of chronic pain in younger people.

This population-based analysis uses data from the 2007/2008 Canadian Community Health Survey (CCHS). It provides estimates of the prevalence of chronic pain by socio-demographic characteristics for a sample of 57,660 respondents aged 12 to 44, representing the 14.6 million Canadians in that age range (Appendix Table A). Chronic pain is examined in relation to chronic conditions, impact on functioning, work characteristics, health care use, and general well-being and mental health.

The data

The cross-sectional Canadian Community Health Survey (CCHS) collects information about health status, health care use and health determinants for about 98% of the population aged 12 or older. It covers household residents in the provinces and territories; members of the Canadian Forces and residents of institutions, Indian reserves and other Aboriginal settlements, and some remote areas are excluded.

Data collection for cycle 4.1 began in January 2007 and continued over 24 months. The sample size was 131,959; the response rate was 76.4%. To account for survey design effects, in this analysis, standard errors and coefficients of variation were estimated using the bootstrap technique.[22,23] A significance level of $p < 0.05$ was used.

This analysis pertains to 57,660 CCHS respondents aged 12 to 44, representing an estimated 14.6 million Canadians (Appendix Table A). Proxy respondents (1,062) were excluded from the study sample. (The prevalence of pain did not differ significantly between proxy and non-proxy respondents). An estimated 63% of the study population were aged 25 to 44, and 69% were married or living in common-law relationships. The majority lived in households where at least one member was a postsecondary graduate (81%) and resided in urban areas (84%). An estimated 4% were Aboriginal; 76% defined their cultural or racial background as "White." An estimated 11% reported chronic pain, and more than half of these people characterized their pain as at least "moderate."

Respondents were asked, "Are you usually free of pain or discomfort?" Those who answered "No" were considered to have *chronic pain* and were asked to assess the usual intensity as "mild," "moderate" or "severe." They were also asked how many activities their pain prevents. Those who responded "a few," "some" or "most" (versus "none") were considered to have *pain that prevents activities.*

Respondents were categorized into four *age groups*: 12 to 17; 18 to 24; 25 to 34; and 35 to 44.

Among respondents aged 25 to 44, *marital status* was categorized as single (never married); married/common-law; or separated/divorced/widowed.

Based on the highest level of *education* in the household, respondents were grouped into four categories: less than secondary graduation, secondary graduation, some postsecondary, and postsecondary graduation.

Racial/Cultural group was defined as White, Aboriginal, or other (includes multiple racial/cultural origins).

Residence identified whether a respondent lived in an urban or rural area based on 2006 Census geography.

The presence of *chronic conditions* was established by asking respondents if a health professional had diagnosed them as having a condition that had lasted, or was expected to last, at least six months. The interviewer read a list of conditions. Individual conditions reported in this study included back problems (excluding fibroymyalgia and arthritis), arthritis, migraine, mood disorder, anxiety disorder, stomach/intestinal ulcers, bowel disorder/Crohn's disease or colitis, and diabetes.

A more comprehensive list of chronic conditions was used to estimate the total *number of chronic conditions* each respondent had. In addition to those listed above, cancer, asthma, high blood pressure, heart disease, effects of stroke, urinary incontinence, Alzheimer's disease or other dementia, emphysema, and chronic obstructive pulmonary disease were included. The count of chronic conditions was categorized into four groups: none, 1, 2, and 3 or more.

Activity restriction was based on a response of "often" or "sometimes" (versus "never") to the questions: "Does a long-term physical condition or mental condition or health problem, reduce the amount or the kind of activity you can do . . .

- . . . at home?"
- . . . at school?"
- . . . at work?"(respondents aged 25 to 44)
- . . . in other activities, for example, transportation or leisure?"

Perceived health was based on the question, "In general would you say your health is:…" The five response categories were combined into two groups: good/very good/excellent and fair/poor. A similar question was asked for *perceived mental health*.

Among respondents aged 25 to 44, *perceived work stress* at the main job or business in the past 12 months was measured by asking: "Would you say that most days at work were: not at all stressful? a bit stressful? quite a bit stressful? extremely stressful?" Respondents who answered "quite a bit" or "extremely stressful" were classified as having high perceived work stress.

Based on respondents' working status in the week before the interview, they were classified as *worked at a job last week*; *absent from work last week*; *did not have a job last week;* or *permanently unable to work.* These variables were restricted to respondents aged 25 to 44.

This study has a number of limitations. Respondents were not asked about the duration, frequency or site of their pain, and no distinction is made between cancer and non-cancer pain. Information on medications, especially those that may have an impact on pain, was not collected. The data are cross-sectional, so no conclusions can be made about temporal order, that is, whether pain led to activity limitations or vice versa. Finally, chronic conditions were self-reported and not verified by another source.

One in ten

In 2007/2008, more than 1.5 million Canadians aged 12 to 44—9% of males and 12% of females—reported chronic pain (Table 1). The prevalence of chronic pain rose with advancing age: among 12- to 17-year-olds, 2% of males and 6% of females reported chronic pain; at ages 35 to 44, the corresponding figures were 14% and 17%.

Consistent with previous research,[9,10,20,24,25] data from the 2007/2008 CCHS show that females aged 12 to 44 had higher odds of chronic pain than did males in that age range. However, the relationship was no longer significant when the presence of chronic conditions was considered, suggesting that they largely account for the association between gender and pain (data not shown).

Household educational attainment was associated with pain. People in households where no one had graduated from secondary school were almost twice as likely to report chronic pain as

Table 1
Prevalence of chronic pain, by sex and selected characteristics, household population aged 12 to 44, Canada, 2007/2008

	Males				Females			
	Estimated number		95% confidence interval		Estimated number		95% confidence interval	
Characteristic	'000	%	from	to	'000	%	from	to
Total with chronic pain	**669**	**9.1**	**8.6**	**9.6**	**867**	**11.9§**	**11.4**	**12.5**
Pain intensity								
Mild	257	3.5	3.2	3.8	303	4.2§	3.8	4.5
Moderate	323	4.4	4.0	4.8	451	6.2§	5.8	6.6
Severe	88	1.2	1.0	1.4	105	1.5	1.3	1.6
Age group								
12 to 17†	30	2.4	2.0	2.9	71	5.9§	5.0	6.7
18 to 24	99	6.5*	5.5	7.6	131	9.2*§	8.0	10.3
25 to 34	212	9.7*‡	8.7	10.7	261	11.8*‡§	10.9	12.7
35 to 44	327	13.7*‡	12.7	14.8	404	16.7*‡§	15.7	17.8
Marital status (ages 25 to 44)								
Single (never married)†	143	11.3	10.0	12.6	147	14.5§	12.9	16.1
Married/Common-law	356	11.5	10.6	12.4	437	13.6§	12.8	14.5
Separated/Divorced/Widowed	40	20.1*	16.1	24.1	80	20.1*	17.4	22.9
Highest level of education in household								
Less than secondary graduation	39	17.0*	14.0	20.1	39	19.0*	15.6	22.5
Secondary graduation	60	9.4	7.8	11.1	88	14.5*§	12.3	16.7
Some postsecondary	45	11.7*	9.4	13.9	57	13.8*	11.6	16.0
Postsecondary graduation†	450	8.7	8.1	9.3	610	11.4§	10.8	12.0
Missing	74	8.1	6.7	9.5	73	10.5§	8.7	12.3
Racial/Cultural group								
White†	503	9.3	8.7	9.8	619	11.6§	11.1	12.2
Aboriginal (off reserve)	46	15.4*	12.5	18.2	53	16.5*	13.9	19.1
Other (includes multiple racial/cultural origins)	101	7.1*	5.7	8.4	171	11.9§	10.4	13.4
Missing	19	9.7	6.7	12.7	23	13.3	9.4	17.1
Residence								
Urban†	536	8.7	8.2	9.3	721	11.8§	11.2	12.4
Rural	133	11.0*	9.8	12.2	146	12.6	11.5	13.6

† reference category
* significantly different from estimate for reference category (p<0.05)
‡ significantly different from preceding age group (p<0.05)
§ significantly different from estimate for males (p<0.05)
Source: 2007/2008 Canadian Community Health Survey, 24-month file.

were those in households with at least one postsecondary graduate.

Compared with people whose racial/cultural background was White, Aboriginal people were more likely to report pain. This may, in part, be explained by the higher prevalence of pain-related chronic conditions (back problems, migraine, arthritis, stomach/intestinal ulcers, anxiety disorders and mood disorders) among the Aboriginal population (data not shown).

And for males, chronic pain was more common among those in rural than urban areas.

Chronic conditions

Back problems were reported by more than 2 million people aged 12 to 44 (14% of males and 17% of females), about a third of whom also reported chronic pain (Table 2). Migraine headaches, too, were common at these ages, especially among females (17%), and almost a quarter of these females reported chronic pain. Arthritis, relatively uncommon at ages 12 to 44 (fewer than 5%), was highly associated with pain; about half of males and females with arthritis also reported chronic pain. Not surprisingly, the more chronic conditions people had, the more likely they were to report chronic pain.

Activity limitations

More than 60% of 12- to 44-year-olds with chronic pain reported experiencing activity limitations "sometimes" or "often," compared with 15% of those who did not have chronic pain (Table 3). These limitations touched all domains of life—home, school, work, transportation and leisure—and persisted in multivariate analysis that accounted for age, socio-demographic characteristics and chronic conditions (data not shown).

The majority of males (64%) and females (74%) with chronic pain reported that it not only limited but prevented at least a few activities. The prevalence of activity-preventing pain rose with age and was consistently higher among females than males. The difference between the sexes was particularly pronounced at ages 12 to 17: 66% of females with chronic pain reported that it prevented activities, compared with 42% of males.

Needing help

Activities of daily living (ADL) (activities vital to retaining independence) include personal care such as bathing, dressing, eating and taking medication, as well as moving about inside the house. *Instrumental activities of daily living (IADL)* further assess functional independence and include preparing meals, doing everyday housework, getting to appointments, running errands such as grocery shopping, and banking and paying bills. People who needed help with ADL or IADL tasks because of health problems were identified. Because most 12- to 17-year-olds, regardless of their health status, require help with many IADL, this variable was examined only for people aged 18 to 44.

Very few pain-free 18- to 44-year-olds needed help with ADL, but among those with chronic pain, 3% of men and 5% of women required assistance (Table 3). Similarly, while 2% of people without chronic pain needed help with IADL, the figures were 13% for men and 23%

Table 2
Percentage reporting chronic conditions and chronic pain, by sex, household population aged 12 to 44, Canada, 2007/2008

	Chronic condition				Prevalence of chronic pain among those with chronic condition			
	Estimated number		95% confidence interval		Estimated number		95% confidence interval	
	'000	%	from	to	'000	%	from	to
Males								
Chronic condition								
Back problems	1,058	14.4	13.8	15.1	313	29.6	27.5	31.7
Migraine	542	7.4	6.9	7.8	106	19.7	17.3	22.0
Mood disorder	277	3.8	3.5	4.1	81	29.2	25.1	33.4
Anxiety disorder	255	3.5	3.2	3.8	56	21.8	18.5	25.1
Arthritis	249	3.4	3.1	3.7	122	49.0	44.3	53.8
Stomach/Intestinal ulcers	165	2.3	2.0	2.5	44	26.6	21.1	32.1
Bowel disorder/Crohn's Disease or colitis	152	2.1	1.8	2.3	37	24.1	18.9	29.3
Diabetes	106	1.4	1.2	1.7	21[E]	19.7[E]	13.4	26.1
Number of chronic conditions								
None[†]	4,728	65.4	64.5	66.2	184	3.9	3.5	4.3
One	1,698	23.5	22.8	24.2	208	12.3*	11.0	13.6
Two	551	7.6	7.1	8.1	147	26.8*‡	23.9	29.6
Three or more	255	3.5	3.2	3.8	107	42.1*‡	37.6	46.7
Females								
Chronic condition								
Back problems	1,215	16.7§	16.1	17.4	408	33.6§	31.6	35.6
Migraine	1,220	16.8§	16.2	17.5	296	24.3§	22.6	26.0
Mood disorder	561	7.7§	7.3	8.2	177	31.7	28.9	34.5
Anxiety disorder	540	7.4§	7.0	7.9	156	28.9§	26.0	31.8
Arthritis	327	4.5§	4.2	4.8	160	48.9	45.2	52.6
Stomach/Intestinal ulcers	151	2.1	1.8	2.3	51	33.9§	29.1	38.6
Bowel disorder/Crohn's Disease or colitis	312	4.3§	4.0	4.6	98	31.5§	28.1	34.9
Diabetes	99	1.4	1.2	1.6	28	28.3	21.3	35.3
Number of chronic conditions								
None[†]	3,993	55.6§	54.7	56.4	169	4.2	3.7	4.7
One	1,830	25.5§	24.7	26.2	240	13.1*	12.0	14.2
Two	810	11.3§	10.7	11.8	190	23.5*‡	21.5	25.5
Three or more	555	7.7§	7.3	8.2	248	44.7*‡	41.8	47.6

[†] reference category
* significantly different from estimate for reference category (p<0.05)
‡ significantly different from preceding category (p<0.05)
§ significantly different from estimate for males (p<0.05)
[E] interpret with caution (coefficient of variation 16.6% to 33.3%)
Source: 2007/2008 Canadian Community Health Survey, 24-month file.

for women with chronic pain. Among people with chronic pain, women were more likely than men to need help moving about inside the house, doing housework, running errands, and preparing meals. The percentages of men and women with chronic pain who needed help with personal care or managing finances did not differ significantly (data not shown).

Employment

In the week before they were interviewed, the majority of 25- to 44-year-olds had worked at a job. However, while 87% of men and 72% of women who were pain-free had done so, the figures were 78% for men and 65% for women who reported chronic pain (Table 3). As these differences suggest, people with chronic pain were more likely than the no-pain group to be without a job in the week before their interview or to be permanently unable to work.

Workers with chronic pain were no more likely than those without chronic pain to be absent from their jobs. But possibly as a consequence of trying to cope with pain-related work limitations, those with chronic pain were more likely to report work stress.

Health care

Not surprisingly, people aged 12 to 44 with chronic pain were more likely than those without chronic pain to use a variety of health care services, including many not covered by public health insurance (Table 4). For example, 19% of males and 18% of females with chronic pain had consulted a physiotherapist in the previous 12 months, compared with 7% of males and females who were generally pain-free.

Well-being

As might be expected, people with chronic pain were less likely than those who were generally pain-free to assess their well-being positively (Table 5). While almost all (more than 95%) of 12- to 44-year-olds who were free of chronic pain described their health as good, very good or excellent, the percentages were considerably lower for those with chronic pain: 80% of males and 76% of females. As well, 23% of people with chronic pain reported that their health was worse than it had been a year earlier; this was the case for 7% of those who were pain-free.

People with chronic pain were less likely than those without it to be satisfied with their lives or to have a positive sense of community belonging. They were more likely to perceive life as stressful and were less likely to report good, very good or excellent mental health.

Mood disorders such as depression and dysthymia, and anxiety disorders such as a phobia and panic disorder are relatively common at ages 12 to 44, especially among females (Table 2). The prevalence of mood and anxiety orders was particularly high among people with chronic pain (Table 5). For example, 21% of females with chronic pain had a mood disorder and 18% had an anxiety disorder; among women who were pain-free, 6% reported a mood disorder, and 6%, an anxiety disorder.

Table 3
Measures of functioning and work characteristics, by sex and chronic pain status, household population aged 12 to 44, Canada, 2007/2008

	Males				Females			
	Estimated number '000	%	95% confidence interval from	to	Estimated number '000	%	95% confidence interval from	to
Activity limitation (sometimes/often)								
Chronic pain	417	62.4*	59.6	65.2	547	63.3*	61.1	65.5
No chronic pain†	970	14.6	13.9	15.3	980	15.3	14.7	16.0
Activity limitation at home (sometimes/often)								
Chronic pain	269	40.2*	37.4	43.0	426	49.2*‡	46.8	51.6
No chronic pain†	369	5.5	5.1	6.0	459	7.2‡	6.7	7.7
Activity limitation at school (sometimes/often)								
Chronic pain	31	21.3*	16.9	25.8	77	31.8*‡	27.5	36.2
No chronic pain†	139	5.0	4.4	5.5	191	6.8‡	6.1	7.5
Activity limitation at work (sometimes/often) (ages 25 to 44)								
Chronic pain	198	42.1*	38.5	45.7	227	44.5*	41.7	47.4
No chronic pain†	271	7.0	6.4	7.7	254	7.5	6.9	8.2
Activity limitation - other (sometimes or often)								
Chronic pain	300	44.9*	42.0	47.8	411	47.5*	45.2	49.7
No chronic pain†	432	6.5	6.0	7.0	475	7.4‡	7.0	7.9
Help needed for ADL								
Chronic pain	23	3.4*	2.4	4.4	47	5.4*‡	4.3	6.6
No chronic pain†	28	0.4	0.3	0.6	31	0.5	0.4	0.6
Help needed for IADL (ages 18 to 44)								
Chronic pain	85	13.3*	11.2	15.3	180	22.6*‡	20.4	24.8
No chronic pain†	89	1.6	1.4	1.9	122	2.3‡	2.0	2.6
Worked at a job last week (ages 25 to 44)								
Chronic pain	409	77.5*	74.8	80.2	425	65.3*‡	62.6	68.0
No chronic pain†	3,420	87.3	86.5	88.1	2,770	71.7‡	70.6	72.8
Absent from work last week (ages 25 to 44)								
Chronic pain	31	5.8	4.3	7.3	48	7.3	6.0	8.7
No chronic pain†	183	4.7	4.2	5.2	339	8.8‡	8.1	9.5
Did not have a job last week (ages 25 to 44)								
Chronic pain	57	10.8*	8.9	12.7	145	22.3*‡	19.9	24.7
No chronic pain†	297	7.6	6.9	8.2	743	19.2‡	18.3	20.2
Permanently unable to work (ages 25 to 44)								
Chronic pain	31	5.9*	4.6	7.3	33	5.0*	3.9	6.2
No chronic pain†	17E	0.4E	0.3	0.6	12E	0.3E	0.2	0.4
Work stress (ages 25 to 44)								
Chronic pain	193	40.3*	36.9	43.6	202	39.2*	36.1	42.3
No chronic pain†	1,132	29.2	28.2	30.3	1,059	31.5‡	30.3	32.8
Population reporting chronic pain that prevents a few/some/most activities	**424**	**63.5**	**60.9**	**66.1**	**634**	**73.6‡**	**71.4**	**75.9**
Age group								
12 to 17†	13	42.0	32.5	51.4	46	65.6‡	57.6	73.6
18 to 24	58	58.0*	50.1	65.9	93	71.9‡	65.6	78.2
25 to 34	139	65.7*	61.0	70.3	199	76.7*‡	72.8	80.6
35 to 44	215	65.8*	62.1	69.5	297	73.6‡	70.2	77.1
Number of activities prevented								
None	244	36.5	33.9	39.1	227	26.4‡	24.1	28.7
A few	210	31.4	28.9	34.0	316	36.7‡	34.3	39.0
Some	126	18.9	16.5	21.3	203	23.6‡	21.7	25.5
Most	88	13.1	11.4	14.9	115	13.3	11.8	14.9
Pain intensity								
Mild†	118	45.9	41.4	50.4	165	55.1‡	50.6	59.6
Moderate	231	71.5*	67.9	75.2	371	82.3*‡	79.7	85.0
Severe	75	85.6*	80.4	90.9	94	89.5*	85.5	93.5

† reference category
* significantly different from estimate for reference category (p<0.05)
‡ significantly different from estimate for males (p<0.05)
E interpret with caution (coefficient of variation 16.6% to 33.3%)
Source: 2007/2008 Canadian Community Health Survey, 24-month file.

Table 4
Health care use in past 12 months, by sex and chronic pain status, household population aged 12 to 44, Canada, 2007/2008

	Males				Females			
	Estimated number		95% confidence interval		Estimated number		95% confidence interval	
Characteristic	'000	%	from	to	'000	%	from	to
Consulted health care professional								
Chronic pain	622	93.0*	91.8	94.3	846	97.7*‡	97.0	98.5
No chronic pain†	5,919	89.0	88.4	89.6	6,125	96.0‡	95.6	96.3
Has regular medical doctor								
Chronic pain	511	76.5*	74.1	78.9	762	88.0*‡	86.4	89.6
No chronic pain†	4,862	73.1	72.4	73.9	5,398	84.6‡	83.9	85.3
Consulted family doctor/general practitioner								
Chronic pain	507	75.8*	73.5	78.1	756	87.4*‡	85.7	89.0
No chronic pain†	4,045	60.8	59.8	61.7	4,919	77.0‡	76.2	77.8
Consulted other medical doctor								
Chronic pain	214	32.1*	29.4	34.8	420	48.4*‡	46.0	50.9
No chronic pain†	985	14.8	14.1	15.4	1,843	28.8‡	28.0	29.7
Consulted nurse								
Chronic pain	92	13.8*	12.0	15.6	193	22.3*‡	20.3	24.3
No chronic pain†	541	8.1	7.7	8.6	903	14.1‡	13.5	14.8
Consulted chiropractor								
Chronic pain	139	20.7*	18.4	23.1	177	20.5*	18.5	22.4
No chronic pain†	644	9.7	9.2	10.1	705	11.0‡	10.5	11.6
Consulted physiotherapist								
Chronic pain	127	19.0*	16.7	21.4	176	20.3*	18.4	22.3
No chronic pain†	441	6.6	6.2	7.1	427	6.7	6.3	7.1
Consulted social worker/counsellor								
Chronic pain	47	7.1*	5.8	8.4	117	13.5*‡	11.9	15.1
No chronic pain†	279	4.2	3.8	4.5	427	6.7‡	6.3	7.1
Consulted psychologist								
Chronic pain	38	5.7*	4.6	6.9	89	10.3*‡	8.9	11.7
No chronic pain†	172	2.6	2.3	2.8	294	4.6‡	4.2	5.0

† reference category
* significantly different from estimate for reference category ($p<0.05$)
‡ significantly different from estimate for males ($p<0.05$)
Source: 2007/2008 Canadian Community Health Survey, 24-month file.

The relationships between chronic pain and measures of well-being persisted when potentially confounding socio-demographic characteristics and painful chronic conditions were taken into account (Table 5). In most cases, the associations between pain and well-being were present regardless of pain intensity (data not shown).

Summary

Chronic pain is common in younger Canadians. It affects daily activities, employment, health care use, and general and psycho-social well-being. The association between chronic pain and mood and anxiety disorders revealed in this study highlights the importance of monitoring younger people with chronic pain for these mental disorders. ■

Table 5
Prevalence of and adjusted odds ratios for well-being and mental health disorders, by sex and chronic pain status, household population aged 12 to 44, Canada, 2007/2008

	Males							Females						
	Estimated number '000	%	95% confidence interval from	to	Adjusted‡ odds ratio	95% confidence interval from	to	Estimated number '000	%	95% confidence interval from	to	Adjusted‡ odds ratio	95% confidence interval from	to
Positive self-perceived health														
Chronic pain	537	80.4*	78.3	82.6	0.3*	0.2	0.3	661	76.4*	74.4	78.5	0.2*	0.1	0.2
No chronic pain†	6,381	95.7	95.3	96.1	1.0	...	...	6,164	96.4	96.1	96.7	1.0	...	...
Self-perceived health worse than a year ago														
Chronic pain	151	22.5*	20.1	25.0	3.4*	2.8	4.2	198	22.9*	20.8	24.9	2.7*	2.3	3.3
No chronic pain†	444	6.7	6.2	7.2	1.0	...	...	474	7.4	6.9	7.9	1.0	...	...
Satisfied with life in general														
Chronic pain	549	82.2*	80.0	84.5	0.4*	0.3	0.5	711	82.4*	80.5	84.3	0.4*	0.4	0.5
No chronic pain†	6,235	93.6	93.2	94.1	1.0	...	...	6,001	94.0	93.6	94.4	1.0	...	...
Positive sense of community belonging														
Chronic pain	368	55.3*	52.5	58.1	0.8*	0.7	1.0	486	56.6*	54.3	59.0	0.8*	0.7	1.0
No chronic pain†	4,138	62.8	61.8	63.7	1.0	...	...	4,072	64.4	63.4	65.3	1.0	...	...
Perceived life stress														
Chronic pain	242	37.1*	34.2	40.0	1.8*	1.5	2.1	343	40.6*	38.1	43.0	1.6*	1.5	1.9
No chronic pain†	1,233	20.4	19.6	21.2	1.0	...	...	1,375	23.7	22.8	24.5	1.0	...	...
Positive self-perceived mental health														
Chronic pain	584	87.6*	85.7	89.5	0.3*	0.2	0.4	748	86.3*	84.6	88.1	0.3*	0.3	0.4
No chronic pain†	6,439	96.6	96.3	97.0	1.0	...	...	6,170	96.5	96.2	96.9	1.0	...	...
Anxiety disorder														
Chronic pain	56	8.3*	7.0	9.6	1.8*	1.4	2.4	156	18.0*	16.1	19.9	2.2*	1.8	2.6
No chronic pain†	199	3.0	2.7	3.3	1.0	...	...	384	6.0	5.6	6.5	1.0	...	...
Mood disorder														
Chronic pain	81	12.1*	10.2	14.0	2.9*	2.2	3.9	177	20.5*	18.5	22.4	2.3*	1.9	2.8
No chronic pain†	196	2.9	2.6	3.2	1.0	...	...	383	6.0	5.6	6.4	1.0	...	...

† reference category
* significantly different from estimate for reference category ($p<0.05$)
‡ adjusted for age, marital status, household, education, race/culture, urban/rural residence; arthritis, back problems, migraine headaches
... not applicable
Note: Because of rounding, odds ratios for which upper confidence intervals were 1.0 were statistically significant.
Source: 2007/2008 Canadian Community Health Survey, 24-month file.

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Appendix

Table A
Selected characteristics of study sample, household population aged 12 to 44, Canada, 2007/2008

	Sample size	Estimated number '000	%
Total	**57,660**	**14,607**	**100.0**
Chronic pain			
No	51,147	13,062	89.5
Yes	6,472	1,536	10.5
Missing	41	...	...
Pain intensity			
No chronic pain	51,147	13,062	89.5
Mild	2,314	560	3.8
Moderate	3,285	774	5.3
Severe	834	193	1.3
Missing	80	...	...
Sex			
Male	27,325	7,340	50.3
Female	30,335	7,267	49.7
Age group			
12 to 17	10,660	2,459	16.8
18 to 24	9,983	2,952	20.2
25 to 34	17,610	4,396	30.1
35 to 44	19,407	4,801	32.9
Marital status (ages 25 to 44)			
Single (never married)	10,145	2,276	24.8
Married/Common-law	23,822	6,312	68.7
Separated/Divorced/Widowed	3,004	599	6.5
Missing	46	...	...
Highest level of education in household			
Less than secondary graduation	2,384	431	3.3
Secondary graduation	5,487	1,243	9.6
Some postsecondary	3,223	805	6.2
Postsecondary graduation	40,423	10,508	80.9
Missing	6,143	...	...
Racial/Cultural group			
White	45,556	10,743	75.5
Aboriginal (off reserve)	4,280	621	4.4
Other (includes multiple racial/cultural origins)	6,504	2,870	20.2
Missing	1,320	...	...
Residence			
Urban	43,814	12,232	83.7
Rural	13,846	2,375	16.3

... not applicable
Notes: Excludes 1,062 proxy respondents. Because of rounding, detail may not add to totals.
Source: 2007/2008 Canadian Community Health Survey, 24-month file.


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H1N1 vaccination

by Heather Gilmour and Nancy Hofmann

Abstract
Early results (January to April) from the 2010 Canadian Community Health Survey show that an estimated 41% of Canadians (excluding those in the territories) aged 12 or older had been vaccinated for H1N1 by April 2010. The percentages were higher in the Atlantic provinces, Quebec and Saskatchewan than in Canada overall. Relatively high percentages of females and people aged 45 or older were vaccinated; the percentage of immigrants who had done so was relatively low. Being in a priority group (health-care worker, having children younger than 5 in the household, or having a chronic condition that could increase the risk for complications from H1N1) increased the likelihood of vaccination. A history of seasonal flu vaccination and having a regular doctor were also associated with H1N1 vaccination. Nearly three-quarters of those who had not been vaccinated reported that they did not think it was necessary.

Keywords
Immunization, influenza, pandemic, public health

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The H1N1 flu virus, a new influenza strain to which most people have no natural immunity, emerged in April 2009.[1] In June of that year, the World Health Organization (WHO) announced "the start of the 2009 influenza pandemic"[2] and raised its influenza pandemic alert to phase 6, the highest level. Phase 6 indicates that the same identified virus has caused sustained outbreaks in two or more countries in one WHO region and in at least one other country in another WHO region. A year later, 214 countries had reported H1N1 cases, with more than 18,000 deaths world-wide.[3] In Canada, 428 people died from H1N1, and thousands more were infected.[4] In August 2010, the WHO announced that the world was "now in the post-pandemic period."[5]

An integral part of the public health response to pandemic influenza is prevention through vaccination.[6] The Public Health Agency of Canada advised Canadians that the H1N1 vaccine was the best way to protect themselves and others from infection.[7] The federal government oversaw the purchase and distribution of the vaccine to the provinces, but each province was ultimately responsible for determining how it would be administered in its jurisdiction.[8] Beginning in the fall of 2009, vaccination clinics across the country offered the vaccine to Canadians.

Based on data from the 2010 Canadian Community Health Survey (CCHS), this study examines uptake of the H1N1 vaccine. Socio-demographic, priority group and health service characteristics of those who were vaccinated, along with reasons for not doing so, are analyzed.

Four in ten

By April 2010, an estimated 41% of Canadians aged 12 or older (11.6 million) living in the 10 provinces had had an H1N1 flu shot (Table 1). Data to

The data

Estimates are based on data collected from the 2010 Canadian Community Health Survey (CCHS) between January and April 2010. The CCHS covers the household population aged 12 or older in all provinces. It excludes members of the Canadian Forces; residents of Indian reserves, institutions, and some remote areas; and military and civilian residents of Canadian Forces bases. Data were collected by telephone (63.6%) and personal (36.4%) interview from a sample of 20,855 individuals. The response rate was 73.1%.

Respondents were asked, "Have you had the H1N1 shot?" Those who did not receive the shot were asked, "What are the reasons that you have not had the H1N1 flu shot?" The interviewer read a list of reasons that included: "have not gotten around to it," "you did not think it was necessary," "your doctor did not think it was necessary," "waiting time was too long," "bad reaction to previous shot." Response categories of "not available at time required," "not available at all in the area," and "did not know where to go/uninformed" were grouped as *access problems*. "Personal or family responsibilities," "transportation problems," and being "unable to leave the house because of a health problem" were grouped as *personal barriers*. The numbers indicating that they did not receive the H1N1 vaccination because of a "language problem" or "cost" were too low to be released and were included in the *other* category. Respondents could indicate as many reasons as applied. The H1N1 questions were asked only of respondents who were answering on their own behalf; proxy responses were not accepted.

To account for the complex design of the CCHS, the bootstrap method[9,10] was used to estimate standard errors, coefficients of variation and confidence intervals. The statistical significance level was set at <0.05.

Respondents were categorized into five *age groups*: 12 to 19; 20 to 44; 45 to 64; 65 to 84; and 85 or older.

Province pertains to the province of residence at the time of the interview. (Information about H1N1 vaccination in the three territories will be available when data for the entire year have been processed.)

Among respondents aged 25 or older, *marital status* was categorized as: married/common-law; separated/ divorced/ widowed; and single.

Highest level of household education refers to the highest level of educational attainment of at least one household member: less than secondary graduation, secondary graduation, some postsecondary, and postsecondary graduation.

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

Health-care workers were identified based on the North American Industry Classification System (NAICS) 2002: Ambulatory Health Care Services (code 621), Hospitals (622), and Nursing and Residential Care Facilities (623).[11] The classification was applied to respondents aged 15 to 75 who indicated that they had a job in the week before their CCHS interview.

Children aged 5 or younger in household indicates if a child(ren) in this age group was (were) living in the household of respondents aged 15 to 55.

Pregnant women were identified by asking women aged 15 to 49 in non-proxy interviews if they were pregnant. It is not known if pregnant women responding to the CCHS received the adjuvanted or unadjuvanted version of the vaccine that was recommended by WHO.[12] (Adjuvants are compounds added to vaccines that stimulate the immune response.)

Priority groups not examined in this study included those living in remote and isolated settings or communities and household contacts and care providers of persons at high risk.[8]

Respondents who indicated that they had been diagnosed with diabetes, heart disease, asthma, chronic obstructive pulmonary disease, cancer, Alzheimer's disease or dementia, or were classified as obese (children aged 12 to 17) or class III obese (adults) were considered to have conditions that put them at *high risk for complications* should they contract the H1N1 virus.[13] The presence of chronic conditions was established by asking respondents if a health professional had diagnosed them with a condition that had lasted, or was expected to last, at least six months. Interviewers read a list of conditions.

Body mass index (BMI) was calculated by dividing self-reported weight in kilograms by the square of self-reported height in metres. Adults aged 18 or older with a BMI of 40 or more were classified as obese class III; children aged 12 to 17 were identified as obese according to the age- and sex-specific BMI cut-points defined by Cole et al.[14]

The CCHS does not determine the presence of kidney disease, blood disorders, liver disease or AIDS, each of which was considered to increase the risk of complications from H1N1.[13] People with neurological disorders were also at greater risk, but the only disease in this category on the CCHS was Alzheimer's disease or dementia. People with weakened immune systems, for example, those taking cancer drugs, were also at greater risk; the CCHS could identify people who reported that they had cancer, but not if they were taking cancer drugs.

Respondents who indicated that they had ever received a *seasonal flu shot* were asked when they had last done so: less than 1 year ago; 1 to 2 years ago; 2 years ago or more; and never.

Having a *regular family doctor* was determined with the question, "Do you have a regular family doctor?"

the end of January 2010 indicate lower rates for Americans: 37% of 6-month to 17-year-olds and 20% of adults.[15] The percentage of Canadians vaccinated for H1N1 exceeded the percentage who typically get the seasonal flu shot (32% in 2007 and 2008).[16] By contrast, American adults were more likely to have been vaccinated against seasonal (39%) than H1N1 influenza (20%) during the 2009/2010 flu season.[17]

The percentage vaccinated for H1N1 surpassed the national figure (41%) in six provinces: Newfoundland and Labrador (69%), Prince Edward Island (62%), Nova Scotia (58%), New Brunswick (62%), Quebec (56%) and Saskatchewan (46%) (Figure 1, Table 1). In British Columbia (36%), Alberta (37%), Manitoba (37%) and Ontario (32%), percentages were below the national level.

Socio-demographic characteristics

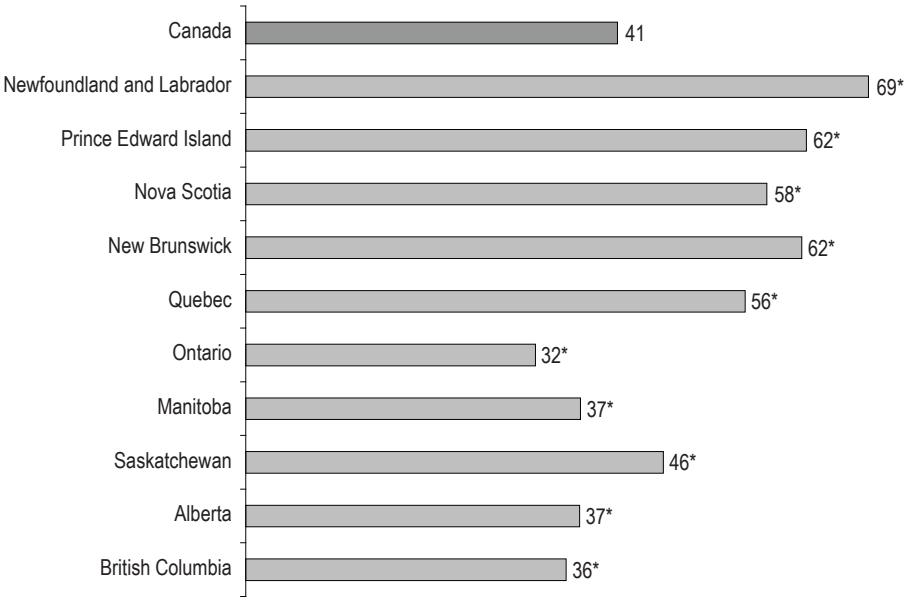
In Canada, females were more likely than males to report having had an H1N1 flu shot—45% versus 37% (Table 1). By contrast, in Australia,[18] Greece[19] and France,[20] women were *less* likely than men to report that they *intended* to get the H1N1vaccination, while studies in the Netherlands[21] and Malaysia[22] found

Table 1
Percentage vaccinated for H1N1, by selected characteristics, Canada excluding territories, 2010

Characteristic	Both sexes				Males				Females			
	Number '000	%	95% confidence interval from	to	Number '000	%	95% confidence interval from	to	Number '000	%	95% confidence interval from	to
Total	**11,609**	**41.3**	**40.2**	**42.4**	**5,141**	**37.1**	**35.6**	**38.7**	**6,468**	**45.4***	**43.9**	**46.8**
Age group												
12 to 19	1,200	37.0‡	34.1	39.8	586	35.6	31.7	39.5	614	38.3‡	34.2	42.5
20 to 44	3,673	32.2‡	30.6	33.8	1,542	26.9‡	24.6	29.1	2,131	37.6*‡	35.2	40.0
45 to 64	4,193	45.2‡	43.0	47.4	1,891	41.0‡	37.8	44.2	2,302	49.4*‡	46.5	52.2
65 to 84	2,326	60.9‡	58.7	63.1	1,053	60.7‡	57.5	64.0	1,273	61.0‡	58.2	63.8
85 or older	217	62.1‡	56.3	68.0	70	61.8‡	51.6	72.0	148	62.3‡	54.9	69.8
Marital status (age 25 or older)												
Married/Common-law†	7,232	45.5	43.9	47.2	3,454	42.3	40.1	44.6	3,778	48.9*	46.7	51.1
Widowed/Separated/Divorced	1,609	48.3	45.5	51.1	456	43.5	39.1	47.9	1,153	50.6*	47.0	54.1
Single	1,086	32.7‡	29.8	35.7	467	26.1‡	22.1	30.1	619	40.4*‡	36.2	44.6
Highest level of household education												
Less than secondary graduation†	865	49.9	46.7	53.1	345	46.6	41.9	51.3	520	52.4	48.1	56.7
Secondary graduation	1,007	36.7‡	33.7	39.7	412	31.0‡	26.9	35.1	595	42.1*‡	37.9	46.3
Some postsecondary	479	32.7‡	28.5	36.9	174	26.5‡	21.3	31.7	305	37.7*‡	31.0	44.5
Postsecondary graduation	8,477	42.3‡	40.9	43.6	3,850	38.7‡	36.8	40.6	4,627	45.8*‡	43.9	47.6
Immigrant status												
Immigrant	2,410	37.6‡	35.0	40.3	1,084	34.6	30.9	38.2	1,326	40.6*‡	37.0	44.1
Non-immigrant†	8,928	42.4	41.3	43.6	3,924	37.8	36.2	39.5	5,004	46.9*	45.3	48.5
Health care worker (ages 15 to 75)												
Yes	1,101	65.9‡	60.8	70.9	196	62.8‡	49.2	76.4	905	66.6‡	61.2	71.9
No†	5,200	34.8	33.3	36.3	2,780	32.9	30.9	34.9	2,420	37.3*	35.0	39.5
Children 5 or younger in household (ages 15 to 55)												
Yes	1,405	44.0‡	40.7	47.3	605	39.3‡	34.3	44.3	800	48.4*‡	43.9	52.8
No†	5,064	32.9	31.4	34.4	2,217	28.4	26.4	30.4	2,846	37.6*	35.4	39.8
Pregnant woman (ages 15 to 49)												
Yes	…	…	…	…	…	…	…	…	129	47.2	37.4	39.9
No†	…	…	…	…	…	…	…	…	2,907	37.8	35.6	57.0
High risk for complications§												
Yes	3,142	54.8‡	52.6	57.1	1,455	51.2‡	47.7	54.6	1,687	58.5*‡	55.6	61.5
No†	8,110	37.8	36.6	39.0	3,616	33.4	31.7	35.2	4,494	42.2*	40.5	43.8
Seasonal flu shot												
Less than 1 year ago	5,105	76.2‡	74.3	78.1	2,222	75.6‡	72.6	78.7	2,883	76.6‡	74.4	78.8
1 to less than 2 years ago	1,341	50.3‡	46.7	53.8	585	48.0‡	42.7	53.3	756	52.2‡	47.5	56.8
2 or more years ago	810	23.1‡	20.2	25.9	349	19.9‡	15.9	24.0	462	26.1*‡	22.2	30.1
Never	4,258	28.3‡	26.9	29.8	1,942	24.8‡	22.9	26.7	2,316	32.2*‡	30.0	34.4
Regular family doctor												
Yes	10,503	43.9‡	42.7	45.1	4,530	40.4‡	38.6	42.2	5,973	47.1*‡	45.5	48.6
No†	1,101	26.4	24.1	28.7	610	23.3	20.2	26.4	491	31.7*	27.5	35.8
Province												
Newfoundland and Labrador	301	69.2‡	63.8	74.6	131	63.5‡	55.4	71.5	170	74.4*‡	68.5	80.2
Prince Edward Island	75	62.3‡	56.3	68.3	32	55.9‡	46.5	65.2	43	68.2*‡	60.5	76.0
Nova Scotia	455	57.9‡	53.8	62.1	198	52.2‡	46.4	58.0	258	63.3*‡	57.2	69.3
New Brunswick	384	61.8‡	57.5	66.1	168	55.5‡	48.9	62.2	216	67.8*‡	62.5	73.0
Quebec	3,678	55.5‡	53.2	57.8	1,640	50.3‡	46.7	54.0	2,038	60.6*‡	57.5	63.6
Ontario	3,531	32.2‡	30.3	34.0	1,540	28.7‡	26.1	31.3	1,991	35.5*‡	32.9	38.0
Manitoba	356	37.2‡	33.2	41.2	171	36.6	30.7	42.6	185	37.7‡	31.4	44.0
Saskatchewan	377	46.4‡	42.5	50.4	168	41.6	37.1	46.2	209	51.2*	44.8	57.6
Alberta	1,103	37.1‡	33.9	40.2	470	30.7‡	26.7	34.7	633	43.8*	39.0	48.6
British Columbia	1,347	35.6‡	32.8	38.4	622	33.3‡	29.4	37.2	725	37.9‡	34.0	41.8

† reference category
* significantly different from estimate for males ($p<0.05$)
‡ significantly different from estimate for reference category ($p<0.05$); where reference category not indicated, estimate compared with Total
§ respondents with chronic conditions that could put them at high risk for complications from H1N1 virus: heart disease, diabetes, asthma, chronic obstructive pulmonary disease, Alzheimer's or dementia, cancer, any obesity for ages 12 to 17 and obesity class III for adults 18 or older
... not applicable
Source: 2010 Canadian Community Health Survey, partial content file January to April 2010.

Figure 1
Percentage vaccinated for H1N1, by province, household population aged 12 or older, Canada excluding territories, 2010



* significantly different from estimate for Canada (p<0.05)
Source: 2010 Canadian Community Health Survey, partial content file January to April 2010.

no significant differences between the sexes in intentions to be vaccinated. However, intentions may not reflect ultimate behaviour and could change during a pandemic or be influenced by cultural issues, media coverage, or vaccine promotion campaigns.[19,22]

Compared with seasonal influenza,[2,23,24] the H1N1 virus affected a much younger age group. Possible reasons include pre-existing immunity in older people due to prior exposure to H1N1 strains, or less contact with younger age groups.[2,25] Nonetheless, the age pattern of H1N1 vaccination paralleled that of the seasonal flu shot,[16,26-28] with the percentage immunized generally rising with age: an estimated 45% at ages 45 to 64 and just over 60% at age 65 or older. To some extent, this may be because older people were more likely than younger age groups to have chronic conditions that could put them at risk for complications from H1N1 (data not shown).

Single people were less likely to have been vaccinated than were people with a partner, an association that persisted even when the generally younger age distribution of single people was taken into account (data not shown).

Residents of households where no member had graduated from secondary school were more likely to have been vaccinated (50%) than were those in households where the level of educational attainment was higher. However, the apparent association between education and H1N1 vaccination did not persist in multivariate analysis controlling for socio-demographic, priority group and health service variables (data not shown).

Immigrants were less likely than non-immigrants to have been vaccinated: 38% versus 42%.

Priority groups

While the Government of Canada obtained enough H1N1 vaccine for all Canadians, certain populations were given priority for early immunization.[7,13] The priority groups that could be assessed with CCHS data were health-care workers, children aged 6 months to 5 years, pregnant women, and people with certain chronic conditions.

Vaccination of health-care workers helps reduce transmission of the virus to patients at risk of complications from influenza.[29,30] Health-care workers were nearly twice as likely as other Canadians to have had an H1N1 shot: 66% versus 35% (Table 1). In the United States, the percentage of health-care workers vaccinated was much lower, at 37%.[31]

Although children aged 6 months through 5 years were not covered by the CCHS, it was possible to identify respondents who lived in a household with children in this age range. Such respondents were more likely to have received the H1N1 vaccine than were those who did not live with young children (44% versus 33%) (Table 1). Similarly, a French study[20] found that the presence of a child in the household was associated with greater acceptability of the H1N1 vaccine, compared with households with no child. The French study also found that only a small percentage (4%) of parents who stated that they would accept the H1N1 vaccination for themselves would refuse it for their children. If this relationship prevails in Canada, the majority of people with children younger than 5 years in the household who received the H1N1 vaccine themselves would have also ensured their young children were vaccinated.

While the percentage of pregnant women vaccinated against the H1N1 virus exceeded the percentage for women who were not pregnant (47% versus 38%), the difference was not statistically significant.

The presence of chronic conditions (see *The data*) increases the risk of complications from H1N1 influenza.[14] People with such conditions were more likely to have been vaccinated than were those without them (55% versus 38%).

Health care use

People who get annual flu shots or who have a regular doctor may have health-care attitudes and practices that predispose them to be vaccinated

against the H1N1 virus. In fact, 76% of Canadians who had had the seasonal flu shot within the last year, and half (50%) of those who had done so one or two years earlier, had the H1N1 vaccine; this compared with 23% of those whose last flu shot had been more than two years earlier, and 28% of those who had never had a flu shot.

About four in ten (44%) Canadians with a regular family doctor were vaccinated, compared with 26% of those without a regular doctor. It is not known if respondents sought the advice of their doctors about the H1N1 vaccine. However, a survey of Canadian family physicians and paediatricians estimated that 75% of them intended to recommend the vaccine to their patients.[32]

Why not?

The majority of Canadians aged 12 or older—59% or 16.5 million—did not get vaccinated against the H1N1 virus. The most frequent reason was "did not think it was necessary," cited by 74% of those not vaccinated (Table 2). This is consistent with results of a small survey conducted by the Strategic Counsel,[33] which found that 67% of Canadians were not worried that they would catch the H1N1 virus, and that 78% believed that the media had exaggerated the threat. An EKOS survey found that 53% of Canadians believed that the level of concern about H1N1 was exaggerated, given the level of risk.[34] Studies of attitudes in other countries also found that the belief that the illness did not pose a serious threat[35] or that vaccination was not necessary[18,36] were leading reasons for not intending to be vaccinated.

Males were more likely than females to give "did not think it was necessary" as a reason for not getting the H1N1 vaccine (76% versus 73%). At ages 85 or older, this reason was cited by a smaller percentage of people: 60% (data not shown). The percentages of the non-vaccinated who said that they did not think that vaccination was necessary ranged from about two-thirds in Nova Scotia, New Brunswick and Manitoba to 80% in Quebec (data not shown).

"Have not gotten around to it yet" was the second most common reason for not being vaccinated, reported by 13% of Canadians who did not get the H1N1 shot. Males were more likely than females to give this reason: 14% versus 11%.

Fear was cited as a reason for not being vaccinated by 7% of those who did not receive the H1N1 vaccination. Women were more likely than men to report fear (9% versus 5%). Although the nature of the fear was not specified, studies from other countries found concerns about safety and side-effects.[17-20,35,37-39]

Relatively few people who were not vaccinated (3% or less) cited access problems (for example, not available at time required, not available in area, respondent did not know where to go), their doctor advising them they did not need it, long wait times, a previous bad reaction, personal barriers (family responsibilities, being unable to leave the house because of a health problem, or transportation problems) (Table 2).

Concluding remarks

The information in this article about who did and did not get vaccinated against H1N1 will aid in the evaluation of the program, support public health planning and help target messages about vaccination in the event of another pandemic. Province of residence, socio-demographic characteristics, belonging to a priority group, and health service factors were associated with the likelihood of receiving the H1N1 vaccination. As in other studies, the belief that the vaccination was not necessary was the most common reason for non-vaccination. ■

Table 2
Reasons for not getting H1N1 vaccination, household population aged 12 or older who were not vaccinated, Canada excluding territories, 2010

	Both sexes				Males				Females			
			95% confidence interval				95% confidence interval				95% confidence interval	
Reason	Number '000	%	from	to	Number '000	%	from	to	Number '000	%	from	to
Did not think it was necessary	12,137	74.2	72.8	75.6	6,525	75.7	73.8	77.7	5,612	72.5*	70.6	74.4
Have not gotten around to it	2,088	12.8	11.7	13.8	1,208	14.0	12.5	15.6	879	11.4*	10.0	12.7
Fear	1,067	6.5	5.8	7.3	413	4.8	3.8	5.7	654	8.5*	7.4	9.6
Access problems	555	3.4	2.9	3.9	290	3.4	2.6	4.1	265	3.4	2.7	4.2
Doctor did not think it was necessary	385	2.4	1.9	2.8	154	1.8	1.2	2.4	231	3.0*	2.3	3.6
Waiting time too long	347	2.1	1.7	2.6	228	2.7	1.9	3.4	119	1.5*	1.1	2.0
Bad reaction to previous flu shot	342	2.1	1.7	2.5	119[E]	1.4[E]	0.9	1.9	223	2.9*	2.1	3.7
Personal barriers	186	1.1	0.9	1.4	81[E]	0.9[E]	0.6	1.3	105	1.4	0.9	1.8
Other	501	3.1	2.5	3.6	247	2.9	2.0	3.7	255	3.3	2.6	4.0

* significantly different from estimate for males ($p<0.05$)
[E] use with caution (coefficient of variation 16.6% to 33.3%)
Note: Respondents could give more than one reason.
Source: 2010 Canadian Community Health Survey, partial content file January to April 2010.

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Combining nutrient intake from food/beverages and vitamin/mineral supplements

by Didier Garriguet

Abstract

Background
To calculate total intake of a nutrient and estimate inadequate intake for a population, the amounts derived from food/beverages and from vitamin/mineral supplements must be combined. The two methods Statistics Canada has suggested present problems of interpretation.

Data and methods
Data collected from 34,386 respondents to the 2004 Canadian Community Health Survey—Nutrition were used to compare four methods of combining nutrient intake from food/beverages and vitamin/mineral supplements: adding average intake from supplements to the 24-hour food/beverage recall and estimating the usual distribution in the population (Method 1); estimating usual individual intake from food/beverages and adding intake from supplements (Method 2); and dividing the population into supplement users and non-users and applying Method 1 or Method 2 and combining the estimates based on the percentages of users and non-users (Methods 3 and 4).

Results
Interpretation problems arise with Methods 1 and 2; for example, the percentage of the population with inadequate intake of vitamin C and folate equivalents falls outside the expected minimum-maximum range. These interpretation problems are not observed with Methods 3 and 4.

Interpretation
Interpretation problems that may arise in combining food and supplement intake of a given nutrient are overcome if the population is divided into supplement users and non-users before Method 1 or Method 2 is applied.

Keywords
nutrition surveys, 24-hour dietary recall, vitamin and mineral supplements, usual intake

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The 2004 Canadian Community Health Survey (CCHS)—Nutrition was the first in more than 30 years to study Canadians' eating habits. One of the goals was to determine total usual intake of selected nutrients. To that end, the CCHS collected information about food and beverage consumption, based on a 24-hour recall.

To calculate the usual distribution of intake of a nutrient in a population or to estimate the percentage of people above or below certain thresholds, within-person variations must be taken into account.[1] This is because what people eat and drink varies from day to day. If two or more dietary recalls are available for at least a subsample of the population, the daily distribution of a nutrient in the entire population can be adjusted with a computer application such as the Software for Intake Distribution Estimation (SIDE)[2,3] to derive *usual* intake. With the data collected in the CCHS, Statistics Canada and Health Canada produced usual intake from food/beverages for an extensive array of nutrients.[4-6]

However, as well as from food/beverages, many nutrients, notably vitamins and minerals, are derived from supplements. Thus, estimates of total consumption of any nutrient must include supplement intake.

Consumption of vitamin/mineral supplements was not part of the CCHS 24-hour dietary recall. This information was obtained from questions about consumption frequency during the past month, the aim of which was to directly estimate usual intake. However, calculations of usual intake of any nutrient from food/beverages must be derived from daily, not monthly, intake.

Statistics Canada has suggested two ways to combine nutrient intake from food/beverages with that from supplements.[7] The first transforms vitamin/mineral supplement intake into daily consumption using the daily average and assumes no within-individual variation, adds this to daily intake from food/beverages, and derives total usual intake of the nutrient. For the second method, usual intake distribution from food/beverages (derived from daily consumption) is added to usual intake of supplements (derived from monthly consumption).

The analysis in this study demonstrates that these two methods of combining nutrient intake from food/beverages and from supplements can create interpretation problems, for example, in estimating the prevalence of inadequacy. Two alternatives are proposed, based on partitioning the data between supplement users and non-users. Finally, the four methods are compared.

Data source

The 2004 CCHS was designed to gather data about the household population's food/beverage consumption and nutrient intake. The survey excluded members of the regular Canadian Forces; residents of the three territories, Indian reserves, institutions and some remote areas; and all residents (military and civilian) of Canadian Forces bases. A detailed description of the survey design, sample and interview procedures is available in a published report.[8]

The 2004 CCHS estimated food/beverage consumption with 24-hour dietary recalls, using the five-step automated multiple-pass method[9,10] to help respondents remember what and how much they ate and drank the previous day. A total of 35,107 people responded to an initial recall, and a subsample of 10,786 took part in a second recall three to ten days later. The response rates were 76.5% and 72.8%, respectively.

This study pertains to people aged 1 or older. Children younger than 1 (288), pregnant women (175), nursing women (92), breastfeeding children (104), and respondents with no dietary intake (16) or invalid dietary intake (45) were excluded from the analysis. A total of 34,386 people were included in the study, 10,591 of whom responded to the second 24-hour dietary recall.

Use of vitamin/mineral supplements was not part of the dietary recall. Instead, respondents were asked: "In the past month, did you take any vitamins or minerals?" If so, they were asked to get the supplement containers from which the drug identification number or product name and concentration of main ingredients could be obtained. The interviewer then asked: "In the past month, how often did you usually take this supplement?", and if not daily, the interviewer asked: "On the days that you took it, how many times did you usually take this supplement?" "How many pills or tablets, capsules or teaspoons did you usually take each time?" was asked to obtain an estimate of the quantities consumed. Based on answers to these questions, variables were derived indicating the number of days per month that supplements were taken and the average quantity consumed per day. More information about these derived variables is available in the survey documentation[11]

The nutrient content of food and beverages reported in the recalls was derived from Health Canada's Canadian Nutrient File (Supplement 2001b).[12] The composition of supplements was taken from the September 2003 Drug Product Database (DPD)[13] in the case of drug identification numbers listed at the time of collection, and from the spring 2005 DPD in the case of drug identification numbers that were missing or incorrect at the time of collection.

Methods proposed by Statistics Canada

After an examination of various means that have been used to combine nutrient intake from food and supplements and to estimate the percentage of the population below a given threshold,[1,14,15] Statistics Canada suggested two methods:

Method 1 (add, shrink)

- Add the average intake of the selected nutrient from vitamin and mineral supplements to the first 24-hour dietary recall, and if available, to the second recall.
- Adjust the first dietary recall with the second using SIDE.[2,3]
- Calculate the percentage of the population whose total intake of the selected nutrient is below a given threshold using the estimated average requirement (EAR) cut-off method.

Method 2 (shrink, add)

- Calculate usual individual dietary intake of the selected nutrient based on the two dietary recalls using SIDE.[2,3]
- Add the average intake of the selected nutrient from supplements.
- Calculate the percentage of the population with total intake of the selected nutrient below a given threshold, such as the EAR.

SIDE produces a usual intake distribution based on back-transformed Blom scores that represent a perfect theoretical normal distribution (Method 1), and the empirical distribution based on individual shrunken means (Method 2). Even if applied only to food sources, these estimates will differ. Method 2 may be more robust to the assumption of perfect normality of the usual intake distribution, but at the cost of being more variable than Method 1, especially in the tails of the distribution.

Estimates of vitamin/mineral supplement consumption represent the long-run average, or usual average intake. It is used as is in Method 2. For Method 1, within-individual variation is assumed to be null, and therefore,

Table 1
Percentage distribution of frequency of use of vitamin/mineral supplements in past month, household population aged 1 or older who used supplement, Canada excluding territories, 2004

	Days consumed in past month			
Supplement	30 or 31	20 to 29	10 to 19	1 to 9
		%		
Vitamin C	80.7	2.3	7.7	9.3
Vitamin D	83.9	2.2	7.0	6.9
Calcium	84.8	2.2	6.7	6.3
Thiamin	82.2	2.5	7.8	7.5
Riboflavin	82.4	2.5	7.7	7.5
Vitamin B6	82.2	2.5	7.7	7.5
Vitamin B12	82.0	2.4	7.7	7.8
Folic acid	82.5	2.5	7.7	7.3
Magnesium	85.9	2.0	6.4	5.7
Zinc	85.7	2.1	6.4	5.8
Phosphore	82.5	2.5	7.5	7.5
Potassium	85.8	2.3	6.3	5.6

Source: Canadian Community Health Survey - Nutrition, detailed vitamins and minerals file, 2004.

for respondents who reported taking supplements in the past month, each recall is assumed to have the same average supplement consumption on both days. Because more than 80% of people who took common supplements did so daily (Table 1), that assumption is reasonable. In fact, a simulation of daily intake based on the actual frequency of supplement consumption reveals only minor differences from results for Method 1 (data not shown).

The data were weighted to represent the Canadian population. The bootstrap method[16-18] was used to calculate standard errors and confidence intervals. The statistical significance level was set at 0.05.

Interpretation problems with Methods 1 and 2

Each method of combining intake of a selected nutrient from food/beverages and from supplements has expected minimum and maximum values for the estimate of the prevalence of inadequate intake.

Maximum value

The expected maximum value is based on the fact that adding supplements to the diet cannot change the percentage of the population with inadequate intake of the selected nutrient from *food alone.*

The maximum can be estimated with Method 1 or Method 2, although it is reasonable to use the same method to calculate the maximum and total usual intake. In addition, a single distribution for supplement users and non-users or separate distributions can be assumed. Methods 1 and 2, however, are based on a single distribution.

Minimum value

The expected minimum value of the prevalence of inadequate intake of a selected nutrient is based on the fact that adding supplements to total intake cannot change the percentage of *supplement non-users* whose intake of that nutrient is inadequate.

The minimum value of inadequate intake can be estimated with Methods 1 or 2, but it relies only on the the distribution of supplement non-users. The estimate of the minimum value of inadequate intake is based on the assumption that no one who takes the supplement has inadequate intake of that nutrient (that is, everyone who takes it has adequate intake).

Vitamin C

Vitamin C is the supplement most commonly taken by Canadians, either alone or as an ingredient of other supplements (data not shown). Depending on their age and sex, the percentage of Canadians who take vitamin C supplements ranges from about 20% to more than 40% (Table 2).

However, substantial shares of the population have relatively low total intake of vitamin C. For example, based on Method 1, an estimated 13.2% of men aged 19 to 30 had intake below the the estimated average requirement (EAR) (single distribution, data not shown). Logically, adding supplements to total intake should not increase the percentage of this group below the EAR. Assuming separate distributions for supplement users and non-users yields a maximum of 13.1% with inadequate vitamin C intake (Table 3). Among supplement non-users (74.9% of the men in this age group), 13.3% had inadequate vitamin C intake. The minimum value of the estimate of the percentage with inadequate intake is then set at 9.9%.

Table 2
Prevalence of use of supplements containing vitamin C, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

Age group	Both sexes	Male	Female
	%		
1 to 3	36.2	...	...
4 to 8	43.7	...	...
9 to 13	...	31.9	30.4
14 to 18	...	20.9	24.2
19 to 30	...	25.1	29.2
31 to 50	...	24.7	34.7
51 to 70	...	31.9	37.4
71 or older	...	31.6	38.1

... not applicable
Source: Canadian Community Health Survey - Nutrition, 2004.

If Method 2 is used to set the limits for the prevalence of inadequate vitamin C intake, the maximum values are 14.2% assuming a single distribution (data not shown) and 13.8% assuming separate distributions; the minimum value is 10.8% (Table 3). Although there are few differences between the minimum and maximum values using a single or separate distributions, an advantage of separate distributions is that the maximum will always exceed the minimum.

For analytical purposes, it is useful to determine if the 95% confidence interval for the estimate of the percentage of the population with inadequate intake falls outside the range defined by the expected minimum and maximum values. But even point estimates falling outside this range can create interpretation difficulties. Since the expected minimum and maximum values are also estimates, they have standard errors and confidence intervals. For the purpose of comparison, they will be treated as point estimates.

When Method 1 is used to combine intake from food/beverages and supplements, the 95% confidence intervals of the estimates of the prevalence of inadequate vitamin C intake among teenagers (14 to 18) and young adult women (19 to 30) are outside the expected minimum-maximum value range, clearly presenting an interpretation problem (Table 3). Three other point estimates fall outside the range, although their confidence intervals overlap it. While these last estimates may not be statistically different, questions about their interpretation still arise.

When Method 2 is used to combine vitamin C from food/beverages and supplements, none of the 95% confidence intervals for the prevalence of inadequacy is outside the expected minimum-maximum value range, but seven of the 10 publishable point estimates fall below this range, again raising questions of interpretation.

The distribution of usual intake in the total population is based on average intake and between-individual variation. Total variance for daily

Table 3
Prevalence of vitamin C intake below estimated average requirement (EAR) using Method 1 and Method 2 for combining intake from food/beverages and supplements, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

	Below EAR				
	Expected values for estimate of % of population			95% confidence interval	
	Minimum	Maximum	%	from	to
Method 1 (add, shrink)					
1 to 3 (both sexes)	F	F	F	...	...
4 to 8 (both sexes)	F	F	F	...	...
9 to 13					
Males	F	F	2.5[E]	1.5	3.6
Females	F	F	3.3[E]	1.9	4.7
14 to 18					
Males	6.0[E]	7.1[E]	11.2[†]	8.6	13.8
Females	4.8[E]	5.6[E]	9.5[†]	7.2	11.7
19 to 30					
Men	9.9[E]	13.1[E]	14.7[‡]	11.0	18.4
Women	10.4[E]	10.7[E]	16.3[†]	13.0	19.6
31 to 50					
Men	18.5	23.5	22.6	19.3	25.9
Women	12.8	19.7	16.0	13.4	18.5
51 to 70					
Men	18.5	24.8	20.5	17.8	23.2
Women	11.4	14.5	16.0[‡]	13.6	18.3
71 or older					
Men	25.8	32.7	24.6[‡]	20.7	28.5
Women	15.2	20.4	18.3	15.8	20.7
Method 2 (shrink, add)					
1 to 3 (both sexes)	F	F	F	...	...
4 to 8 (both sexes)	F	F	F	...	...
9 to 13					
Males	F	F	F	...	...
Females	F	F	0.9[E*]	0.0	1.8
14 to 18					
Males	8.5[E]	10.0[E]	6.9[E†*]	4.2	9.6
Females	4.6[E]	5.4[E]	4.5[E†*]	2.0	7.0
19 to 30					
Men	10.8[E]	13.8[E]	11.4[E]	6.0	16.7
Women	10.5[E]	10.6[E]	8.5[†*]	4.2	12.8
31 to 50					
Men	18.8	23.8	19.1	14.1	24.1
Women	13.4	20.3	14.7	11.3	18.1
51 to 70					
Men	18.5	25.4	17.9[†]	14.5	21.2
Women	11.6	14.5	10.1[†*]	7.5	12.7
71 or older					
Men	25.1	33.1	23.8[†]	19.3	28.4
Women	15.1	20.2	13.2[†*]	10.2	16.2

† confidence interval outside minimum-maximum value interval
‡ point estimate outside minimum-maximum value interval
* significantly different from estimate for Method 1
E use with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be published
... not applicable
Notes: Minimum and maximum values estimated with Method 1 using separate distributions and are combined with (1-α)*percent below EAR from non-users plus α*percent below EAR from users, where α is percentage of supplement users. Based on assumption that all supplement users meet EAR. For those not taking supplements, maximum value represents highest possible percentage below EAR. Minimum and maximum values estimated with Method 2 using separate empirical distributions that were combined.
Source: Canadian Community Health Survey - Nutrition 2004.

intake includes between- and within-individual variation. SIDE removes within-individual variation by shrinking the daily intake distribution by the ratio of within-individual variation over the total variation ratio. When supplements are added to intake using Method 1, the skew of average intake shifts to the right; that is, the percentage of the population with relatively high levels of intake increases. Within-individual variation does not change, since the same intake from supplements is added to each recall for supplement users. However, the total variance changes because the average intake of some individuals changes. Consequently, the ratio will change (Table 4). With a smaller shrinkage factor, using the EAR cut-point method, the area beneath the curve can increase even if average intake increases. This explains the estimates above the maximum produced by Method 1. Even small changes in within-individual variation combined with different daily intake averages and normality transformations can lead to interpretation problems, as seen with Method 2.

Dividing the data

In light of the potential for interpretation problems, it is necessary to combine nutrient intake from food/beverages and from supplements in such a way that estimates of the prevalence of inadequacy fall within the expected minimum-maximum range. Methods 1 and 2 could be extended by using separate distributions.

Method 3 (divide, add, shrink):

- Divide the population according to whether they obtain the selected nutrient from supplements.
- Using SIDE and the EAR cut-point method, estimate the percentage of supplement *non-users* whose intake of the selected nutrient from food/beverages is below a given threshold.
- Using Method 1, estimate the percentage of supplement *users* whose intake of the nutrient from both food/beverages and

Table 4
Ratio of within-individual variance over total variance for vitamin C intake, by age group, sex and use of supplements, household population aged 1 or older, Canada excluding territories, 2004

	Vitamin C intake from food/beverages only						Vitamin C intake from food/beverages and supplements			
	One distribution		Supplement non-users		Supplement users		Total population (Method 1)		Supplement users	
Age group/ Sex	Ratio	Standard error	Ratio	Standard error	Ratio	Standard error	Ratio	Standard error	Ratio	Standard error
1 to 3 (both sexes)	0.53	0.03	0.53	0.04	0.52	0.06	0.42†	0.03	0.34†	0.05
4 to 8 (both sexes)	0.69	0.05	0.81*	0.05	0.57	0.07	0.54†	0.03	0.41†	0.05
9 to 13										
Males	0.68	0.03	0.69	0.04	0.66	0.06	0.48†	0.03	0.27†	0.04
Females	0.72	0.03	0.71	0.04	0.72	0.06	0.49†	0.03	0.30†	0.05
14 to 18										
Males	0.66	0.03	0.67	0.03	0.64	0.07	0.45†	0.02	0.20†	0.03
Females	0.67	0.03	0.69	0.04	0.67	0.07	0.44†	0.03	0.19†	0.03
19 to 30										
Men	0.72	0.04	0.75	0.04	0.65	0.09	0.49†	0.03	0.17†	0.04
Women	0.72*	0.04	0.65*	0.04	0.88	0.07	0.37†	0.02	0.27†	0.03
31 to 50										
Men	0.61	0.04	0.64	0.05	0.55	0.08	0.36†	0.03	0.15†	0.04
Women	0.53	0.03	0.56	0.04	0.49	0.05	0.29†	0.02	0.14†	0.03
51 to 70										
Men	0.58	0.03	0.60	0.03	0.55	0.07	0.31†	0.02	0.11†	0.03
Women	0.61	0.03	0.59	0.03	0.67	0.05	0.25†	0.02	0.15†	0.02
71 or older										
Men	0.51	0.03	0.54	0.04	0.49	0.07	0.27†	0.02	0.09†	0.03
Women	0.53	0.02	0.52	0.03	0.54	0.04	0.19†	0.01	0.12†	0.02

* significantly different from estimate for supplement users
† significantly different from estimate for food/beverages only population in same age/sex group
Source: Canadian Community Health Survey - Nutrition 2004.

supplements is below a given threshold.

- Calculate the combined overall estimate of inadequate intake of the nutrient (based on the percentages for supplement users and non-users) with the following formula:

$$P[X_T < EAR] = (1-\alpha)P[X_{SNU} < EAR] + \alpha P[X_{SU} < EAR]$$

where X_T represents total nutrient intake; X_{SNU}, supplement non-users' nutrient intake from food/beverages; X_{SU}, supplement users' total nutrient intake; and α, the percentage of supplement users.

Method 4 (divide, shrink, add):

- Divide the population according to whether they obtain the selected nutrient from supplements.
- Using SIDE, calculate supplement *non-users'* usual individual intake of the nutrient from food/beverages.
- Calculate supplement *users'* usual intake of the nutrient from food/beverages; add their average intake from supplements.
- Add the results for the two populations and calculate the percentage of the total population whose total intake of the nutrient is below a given threshold, such as the EAR.

With Method 3, the 95% confidence intervals for the prevalence of inadequate vitamin C intake are not outside the expected minimum-maximum range for any of the 10 age/sex groups with publishable results (Table 5). And only for women aged 19 to 30 was the point estimate of the prevalence of inadequate vitamin C intake outside that range (0.08% above the maximum). Even with a much smaller shrinkage factor for supplement users (Table 5), average consumption of vitamin C including supplements results in fewer than 3% of the population below the EAR. Coupled with the probability of being a consumer, most of the combined estimates of inadequate vitamin C intake depend on the percentage of supplement non-users whose intake from food/beverages is inadequate.

With Method 4 (Table 5), by design, every estimate of the prevalence of inadequate vitamin C intake is equal to or within the minimum-maximum value range.

Comparing methods

Method 1 differs significantly from the other three, among which there is no statistically significant difference. However, compared with Method 3, Method 4 yields a more variable prevalence of inadequate vitamin C intake with wider 95% confidence intervals.

Published estimates of usual intake of vitamin C from food/beverages, as

Table 5
Prevalence of vitamin C intake below estimated average requirement (EAR) using Method 3 and Method 4 for combining intake from food/beverages and supplements, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

	Below EAR				
	Expected values for estimate of % of population			95% confidence interval	
	Minimum	Maximum	%	from	to
Method 3 (divide, add, shrink)					
1 to 3 (both sexes)	F	F	F	...	...
4 to 8 (both sexes)	F	F	F	...	...
9 to 13					
Males	F	F	F	...	...
Females	F	F	F	...	...
14 to 18					
Males	6.0[E]	7.1[E]	6.2[E*]	3.4	9.1
Females	4.8[E]	5.6[E]	5.2[E*]	2.7	7.7
19 to 30					
Men	9.9[E]	13.1[E]	10.5[E]	5.0	16.0
Women	10.4[E]	10.7[E]	10.8[E†]	6.2	15.4
31 to 50					
Men	18.5	23.5	19.0	14.1	23.9
Women	12.8	19.7	13.3	9.7	16.8
51 to 70					
Men	18.5	24.8	18.8	15.1	22.6
Women	11.4	14.5	11.7*	8.5	14.8
71 or older					
Men	25.8	32.7	26.7	22.1	31.3
Women	15.2	20.4	15.4	12.0	18.7
Method 4 (divide, shrink, add)					
1 to 3 (both sexes)	F	F	F	...	...
4 to 8 (both sexes)	F	F	F	...	...
9 to 13					
Males	F	F	F	...	...
Females	F	F	F	...	...
14 to 18					
Males	8.5[E]	10.0[E]	8.5[E]	3.6	13.4
Females	4.6[E]	5.4[E]	4.6[E*]	2.0	7.3
19 to 30					
Men	10.8[E]	13.8[E]	11.1[E]	4.7	17.4
Women	10.5[E]	10.6[E]	10.5[E*]	5.9	15.0
31 to 50					
Men	18.8	23.8	19.2	13.1	25.3
Women	13.4	20.3	13.6	9.8	17.4
51 to 70					
Men	18.5	25.4	18.7	15.1	22.2
Women	11.6	14.5	11.7*	8.7	14.7
71 or older					
Men	25.1	33.1	25.9	21.3	30.6
Women	15.1	20.2	15.1	11.3	19.0

† point estimate outside minimum-maximum value interval
* significantly different from estimate for Method 1
E use with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be published
... not applicable

Notes: Minimum and maximum values for Method 3 estimated with Method 1 using separate distributions and are combined with (1-α)*percent below EAR from non-users plus α*percent below EAR from users, where α is percentage of supplement users. Based on assumption that all supplement users meet EAR. For those not taking supplements, maximum value represents highest possible percentage below EAR. Minimum and maximum values for Method 4 estimated with Method 2 using separate empirical distributions that were combined.

Source: Canadian Community Health Survey - Nutrition 2004.

in the *Compendium of Tables*,[4-6] use the EAR cut-point method to calculate the percentage of the population with inadequate intake based a single distribution, thereby assuming the same average intake and variance components for supplement users and non-users. Therefore, this estimate might be used for the maximum value. In such a case, without the differences being significant, one estimate using Method 3 and two estimates using Method 4 will be outside the expected minimum-maximum value range (data not shown).

Other nutrients

Interpretation problems are not limited to vitamin C (Appendix Table A). Appendix Tables B to G show estimates for vitamin D, calcium and dietary folate equivalents (including folic acid) based on the four methods of combining intake from food/beverages and from supplements. The vitamin D (Tables B and C) and calcium (Tables D and E) data present the percentages of each age/sex group below the adequate intake (AI) level. AI is used as a cut-off, but it does not represent the percentage of the population with inadequate intake. By contrast, the EAR is used for dietary folate equivalents (Tables F and G), so it is possible to discuss inadequate folate intake. (A 2009 study[19] demonstrated that folate concentrations in some food groups actually exceed what is in the database; the calculations presented here use an adjustment factor to estimate dietary folate equivalents intake.)

For calcium, no interpretation problems arise. The results obtained with the four methods are not significantly different, and all point estimates fall within the expected minimum-maximum range (Tables B and C).

For vitamin D, there are no statistically significant differences between the four Methods (Tables D and E). None of the confidence intervals falls completely outside the expected minimum-maximum value range, but some are below the minimum for Methods 1 and 2. These interpretation problems are solved with Methods 3 or 4.

For dietary folate equivalents, Method 1 results differ from the other three (Tables F and G). With Method 1, some confidence intervals for the estimate of the prevalence of inadequacy are completely outside the expected minimum-maximum value range. With Method 2, some point estimates fall outside that interval, but, the confidence intervals overlap the minimum-maximum value range. Methods 3 and 4 do not have interpretation problems.

Recommendations, limitations and conclusion

Combining nutrient intake from food/beverages with that from supplements is challenging. Problems can arise as early as the survey interview stage if some questions about supplement use were not understood by respondents. Although a review was carried out, it is possible that some answers resulted in high but plausible values for supplement use. Those high values may account for part of the large increase in between-person variation.

A second challenge lies in the attempt to combine *daily* intake from food/beverages with *usual* intake from supplements. However, because more than 80% of people who took supplements did so daily, the effect is likely minimal. For daily supplement intake, it would be preferable to estimate within-individual variation. But the interpretation problems resulting from a large decrease in the ratio of within-individual variation over total variation will persist. Addressing these collection-related limitations will not solve the interpretation problems.

This analysis demonstrates that estimates of inadequate intake of nutrients have minimum and maximum values, outside of which values logically should not fall. Confidence intervals for estimates of inadequate total intake that fall outside these expected minimum-maximum ranges are hard to interpret, and although there may be no statistical difference, even point estimates that fall outside these limits can create interpretation issues.

Conclusion

The use of Method 1 to combine nutrient intake from food/beverages with that from supplements is not recommended, because several confidence intervals for the estimates of the prevalence of inadequacy fall outside the expected minimum-maximum value range. While the 95% confidence intervals for Methods 2, 3 and 4 overlap the minimum-maximum values, Method 2 estimates can fall outside the interval. Methods 3 and 4, which are based on the original Methods 1 and 2, are easier to interpret.

This study focused on estimating the percentage of the population whose nutrient intake was below a certain threshold. These methods can also be used to calculate the percentiles of the distribution by combining the two distributions on a prorated basis (Method 3) or by appending the datasets and using empirical percentiles (Method 4). ■

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Annexe

Table A
Prevalence of use of calcium, vitamin D and dietary folate equivalents supplements in past month, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

Age group/ Sex	Calcium	Vitamin D	Dietary folate equivalents
		%	
1 to 3 (both sexes)	20.7	34.9	30.7
4 to 8 (both sexes)	27.7	40.9	38.7
9 to 13			
Males	16.4	24.9	24.0
Females	15.0	23.1	22.2
14 to 18			
Males	13.5	14.6	13.8
Females	14.7	16.6	15.0
19 to 30			
Men	18.3	19.1	17.6
Women	23.5	22.2	22.9
31 to 50			
Men	19.6	18.7	19.3
Women	33.4	30.6	29.2
51 to 70			
Men	28.9	27.5	26.0
Women	49.4	45.0	31.2
71 or older			
Men	27.2	28.6	25.2
Women	46.0	43.0	28.5

Source: Canadian Community Health Survey - Nutrition 2004.

Table B
Prevalence of calcium intake below adequate intake (AI) using Method 1 and Method 2 for combining intake from food/beverages and supplements, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

	Below AI				
	Expected values for estimate of % of population			95% confidence interval	
	Minimum	Maximum	%	from	to
Method 1 (add, shrink)					
1 to 3 (both sexes)	2.5[E]	2.9[E]	2.7[E]	1.5	3.8
4 to 8 (both sexes)	15.3	22.9	19.1	15.6	22.7
9 to 13					
Males	53.8	63.2	60.5	55.1	65.9
Females	72.5	83.6	81.3	76.5	86.1
14 to 18					
Males	45.1	51.7	49.5	43.8	55.2
Females	71.1	83.8	81.1	77.1	85.1
19 to 30					
Men	41.2	47.3	44.6	37.8	51.4
Women	55.9	69.8	60.8	54.8	66.9
31 to 50					
Men	51.5	61.5	57.8	53.0	62.6
Women	48.9	72.6	58.6	54.2	63.0
51 to 70					
Men	61.5	86.2	78.1	74.7	81.5
Women	47.7	91.8	66.8	63.8	69.8
71 or older					
Men	66.1	89.9	79.9	74.3	85.5
Women	51.6	94.7	73.3	69.4	77.2
Method 2 (shrink, add)					
1 to 3 (both sexes)	F	2.7[E]	2.1[E]	0.9	3.3
4 to 8 (both sexes)	15.9	23.8	20.0	16.0	24.0
9 to 13					
Males	53.9	63.1	61.6	56.7	66.5
Females	72.9	83.8	82.4	77.9	86.9
14 to 18					
Males	46.5	53.2	51.2	46.3	56.1
Females	71.6	84.7	82.5	78.9	86.0
19 to 30					
Men	40.6	46.7	44.2	37.0	51.4
Women	57.4	71.1	63.6	58.1	69.1
31 to 50					
Men	52.3	63.2	58.9	54.1	63.6
Women	50.1	74.0	62.1	57.8	66.4
51 to 70					
Men	61.8	86.6	79.7	76.6	82.9
Women	47.8	91.4	67.7	64.5	71.0
71 or older					
Men	66.2	90.1	81.9	77.6	86.2
Women	51.7	94.7	75.3	71.9	78.7

[E] use with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be published
Notes: Minimum and maximum values estimated with Method 1 using separate distributions and are combined with (1-α)*percent below AI from supplement non-users plus α*percent below AI from users, where α is percentage of supplement users. Based on assumption that all supplement users have intake at or above AI. Minimum and maximum values estimated with Method 2 using separate empirical distributions that were combined.
Source: Canadian Community Health Survey - Nutrition 2004.

Table C
Prevalence of calcium intake below adequate intake (AI) using Method 3 and Method 4 for combining intake from food/beverages and supplements, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

	Below AI				
	Expected values for estimate of % of population			95% confidence interval	
	Minimum	Maximum	%	from	to
Method 3 (divide, add, shrink)					
1 to 3 (both sexes)	2.5[E]	2.9[E]	2.6[E]	1.5	3.8
4 to 8 (both sexes)	15.3	22.9	18.7	15.2	22.2
9 to 13					
Males	53.8	63.2	60.9	55.5	66.4
Females	72.5	83.6	81.9	77.1	86.8
14 to 18					
Males	45.1	51.7	49.9	44.0	55.8
Females	71.1	83.8	81.8	77.7	85.8
19 to 30					
Men	41.2	47.3	45.0	37.7	52.2
Women	55.9	69.8	61.7	55.7	67.6
31 to 50					
Men	51.5	61.5	57.5	52.6	62.4
Women	48.9	72.6	60.0	55.5	64.4
51 to 70					
Men	61.5	86.2	79.6	76.2	83.0
Women	47.7	91.8	68.1	65.1	71.1
71 or older					
Men	66.1	89.9	81.0	75.9	86.0
Women	51.6	94.7	74.6	71.3	77.9
Method 4 (divide, shrink, add)					
1 to 3 (both sexes)	F	2.7[E]	2.1[E]	0.7	3.5
4 to 8 (both sexes)	15.9	23.8	19.5	15.2	23.9
9 to 13					
Males	53.9	63.1	61.5	56.6	66.5
Females	72.9	83.8	82.9	78.4	87.4
14 to 18					
Males	46.5	53.2	51.6	46.4	56.7
Females	71.6	84.7	82.8	79.2	86.4
19 to 30					
Men	40.6	46.7	43.8	36.0	51.6
Women	57.4	71.1	63.9	58.5	69.4
31 to 50					
Men	52.3	63.2	58.9	53.7	64.1
Women	50.1	74.0	61.9	57.8	66.1
51 to 70					
Men	61.8	86.6	80.0	76.6	83.3
Women	47.8	91.4	68.3	65.2	71.4
71 or older					
Men	66.2	90.1	81.6	77.1	86.2
Women	51.7	94.7	74.7	70.7	78.7

[E] use with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be published
Notes: Minimum and maximum values for Method 3 estimated with Method 1 using separate distributions and are combined with (1-α)*percent below AI from supplement non-users plus α*percent below AI from users, where α is percentage of supplement users. Based on assumption that all supplement users have intake at or above AI. Minimum and maximum values for Method 4 estimated with Method 2 using separate empirical distributions that were combined.
Source: Canadian Community Health Survey - Nutrition 2004.

Table D
Prevalence of vitamin D intake below adequate intake (AI) using Method 1 and Method 2 for combining intake from food/beverages and supplements, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

	Below AI				
	Expected values for estimate of % of population			95% confidence interval	
	Minimum	Maximum	%	from	to
Method 1 (add, shrink)					
1 to 3 (both sexes)	22.8	31.9	21.4†	18.5	24.3
4 to 8 (both sexes)	20.0	39.0	20.8	18.3	23.3
9 to 13					
Males	20.2	26.5	20.7	17.1	24.4
Females	38.7	47.4	35.3†	30.8	39.7
14 to 18					
Males	21.6	24.1	21.7	18.1	25.4
Females	48.5	57.9	45.8†	41.6	50.1
19 to 30					
Men	40.1	47.4	36.4†	30.3	42.5
Women	51.7	64.8	47.0†	41.8	52.2
31 to 50					
Men	39.8	47.9	38.5†	33.7	43.3
Women	41.2	58.8	38.3†	33.8	42.7
51 to 70					
Men	60.8	80.0	63.7	59.2	68.3
Women	50.1	91.3	59.9	56.1	63.6
71 or older					
Men	69.0	96.3	80.1	75.1	85.2
Women	54.4	97.1	73.6	67.6	79.5
Method 2 (shrink, add)					
1 to 3 (both sexes)	22.5	32.2	22.2†	18.8	25.6
4 to 8 (both sexes)	20.8	40.6	23.2	20.4	26.1
9 to 13					
Males	21.4	28.0	21.8	17.3	26.3
Females	38.3	47.6	38.1†	33.1	43.1
14 to 18					
Males	22.9	25.5	22.8†	18.2	27.4
Females	48.8	58.1	50.8	45.9	55.7
19 to 30					
Men	38.7	45.9	39.0	32.9	45.1
Women	52.2	65.6	52.7	47.4	57.9
31 to 50					
Men	41.2	49.4	41.3	35.4	47.1
Women	42.5	60.3	43.0	36.7	49.3
51 to 70					
Men	60.6	79.9	62.4	56.9	67.9
Women	50.3	91.4	58.5	54.4	62.7
71 or older					
Men	69.6	96.9	80.6	76.8	84.5
Women	55.3	98.2	74.6	68.9	80.3

† point estimate outside minimum and maximum value interval

Notes: Minimum and maximum values estimated with Method 1 using separate distributions and are combined with (1-α)*percent below AI from supplement non-users plus α*percent below AI from users, where α is percentage of supplement users. Based on assumption that all supplement users have intake at or above AI. Minimum and maximum values estimated with Method 2 using separate empirical distributions that were combined.

Source: Canadian Community Health Survey - Nutrition 2004.

Table E
Prevalence of vitamin D intake below adequate intake (AI) using Method 3 and Method 4 for combining intake from food/beverages and supplements, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

	Below AI				
	Expected values for estimate of % of population			95% confidence interval	
	Minimum	Maximum	%	from	to
Method 3 (divide, add, shrink)					
1 to 3 (both sexes)	22.8	31.9	23.1	19.5	26.6
4 to 8 (both sexes)	20.0	39.0	20.4	16.9	23.9
9 to 13					
Males	20.2	26.5	20.3	15.5	25.1
Females	38.7	47.4	39.1	33.3	45.0
14 to 18					
Males	21.6	24.1	21.9	17.4	26.3
Females	48.5	57.9	49.6	44.5	54.7
19 to 30					
Men	40.1	47.4	40.4	33.7	47.0
Women	51.7	64.8	52.6	46.6	58.5
31 to 50					
Men	39.8	47.9	40.2	33.8	46.5
Women	41.2	58.8	42.3	34.8	49.8
51 to 70					
Men	60.8	80.0	64.9	60.1	69.7
Women	50.1	91.3	57.6	53.1	62.2
71 or older					
Men	69.0	96.3	80.1	75.7	84.4
Women	54.4	97.1	75.9	72.1	79.8
Method 4 (divide, shrink, add)					
1 to 3 (both sexes)	22.5	32.2	22.9	19.4	26.4
4 to 8 (both sexes)	20.8	40.6	21.7	18.3	25.2
9 to 13					
Males	21.4	28.0	21.8	16.5	27.1
Females	38.3	47.6	38.9	33.5	44.2
14 to 18					
Males	22.9	25.5	23.2	18.3	28.1
Females	48.8	58.1	50.1	45.3	54.9
19 to 30					
Men	38.7	45.9	39.4	33.4	45.3
Women	52.2	65.6	53.0	47.6	58.4
31 to 50					
Men	41.2	49.4	42.1	35.6	48.5
Women	42.5	60.3	44.0	35.8	52.2
51 to 70					
Men	60.6	79.9	64.0	58.8	69.3
Women	50.3	91.4	58.1	53.5	62.7
71 or older					
Men	69.6	96.9	80.4	76.5	84.2
Women	55.3	98.2	77.0	73.3	80.7

Notes: Minimum and maximum values for Method 3 estimated with Method 1 using separate distributions and are combined with (1-α)*percent below AI from supplement non-users plus α*percent below AI from users, where α is percentage of supplement users. Based on assumption that all supplement users have intake at or above AI. Minimum and maximum values for Method 4 estimated with Method 2 using separate empirical distributions that were combined.
Source: Canadian Community Health Survey - Nutrition 2004.

Table F
Prevalence of dietary folate equivalents intake below estimated average requirement (EAR) using Method 1 and Method 2 for combining intake from food/beverages and supplements, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

	Below EAR				
	Expected values for estimate of % of population			95% confidence interval	
	Minimum	Maximum	%	from	to
Method 1 (add, shrink)					
1 to 3 (both sexes)	2.7[E]	2.7[E]	3.1[E†]	1.7	4.6
4 to 8 (both sexes)	<3	<3	<3	...	...
9 to 13					
Males	<3	<3	<3	...	...
Females	<3	<3	2.9[E†]	1.5	4.3
14 to 18					
Males	<3	<3	4.1[E*]	2.6	5.7
Females	11.4	13.1	14.4[†]	11.6	17.2
19 to 30					
Men	<3	<3	3.6[E*]	2.1	5.1
Women	8.7[E]	9.5[E]	15.2[*]	12.1	18.3
31 to 50					
Men	F	F	7.9[*]	6.0	9.9
Women	8.3[E]	15.1[E]	14.6	12.0	17.3
51 to 70					
Men	5.9[E]	7.2[E]	11.1[*]	8.7	13.4
Women	10.9[E]	17.8	18.4[†]	15.9	20.8
71 or older					
Men	13.1[E]	14.5[E]	15.9[†]	11.9	19.9
Women	24.4	31.5	23.8[†]	20.9	26.8
Method 2 (shrink, add)					
1 to 3 (both sexes)	F	F	2.0[E†]	0.8	3.1
4 to 8 (both sexes)	<3	<3	<3	...	...
9 to 13					
Males	<3	<3	<3	...	...
Females	F	F	<3	...	...
14 to 18					
Males	<3	F	F	...	...
Females	11.7	13.6	11.3[†]	7.9	14.7
19 to 30					
Men	<3	<3	<3		
Women	8.3[E]	9.0[E]	8.0[†‡]	3.5	12.4
31 to 50					
Men	F	F	F	...	...
Women	8.4[E]	15.4[E]	10.0[E]	5.9	14.0
51 to 70					
Men	6.3[E]	7.5[E]	6.5[E‡]	3.5	9.6
Women	10.8[E]	17.9	13.5[‡]	9.9	17.2
71 or older					
Men	13.8[E]	15.3[E]	11.2[E†]	6.0	16.5
Women	24.4	31.5	24.6	20.0	29.1

* confidence interval outside minimum and maximum value interval
† point estimate outside minimum and maximum value interval
‡ significantly different from estimate for Method 1
E use with caution (coefficient of variation 16.6 to 33.3%)
<3 coefficient of variation more than 33.3%, but limits of confidence interval included within interval (0.0, 3.0)
F too unreliable to be published
... not applicable

Notes: Minimum and maximum values estimated with Method 1 using separate distributions and combined with (1-α)*percent below EAR from supplement non-users plus α*percent below EAR from users, where α is percentage of supplement users. Based on assumption that all supplement users meet EAR. Minimum and maximum values estimated with Method 2 using separate empirical distributions that were combined.

Source: Canadian Community Health Survey - Nutrition 2004.

Table G
Prevalence of dietary folate equivalents intake below estimated average requirement (EAR) using Method 3 and Method 4 for combining intake from food/beverages and supplements, by age group and sex, household population aged 1 or older, Canada excluding territories, 2004

	Below EAR				
	Expected values for estimate of % of population			95% confidence interval	
	Minimum	Maximum	%	from	to
Method 3 (divide, add, shrink)					
1 to 3 (both sexes)	2.7[E]	2.7[E]	2.7[E]	1.1	4.3
4 to 8 (both sexes)	<3	<3	<3	...	...
9 to 13					
Males	<3	<3	<3	...	...
Females	<3	<3	<3	...	...
14 to 18					
Males	<3	<3	<3	...	...
Females	11.4	13.1	11.5	7.9	15.1
19 to 30					
Men	<3	<3	<3	...	...
Women	8.7[E]	9.5[E]	8.8[E†]	4.2	13.4
31 to 50					
Men	F	F	F	...	...
Women	8.3[E]	15.1[E]	8.4[E†]	4.2	12.7
51 to 70					
Men	5.9[E]	7.2[E]	5.9[E†]	2.8	9.1
Women	10.9[E]	17.8	11.2[E†]	6.8	15.7
71 or older					
Men	13.1[E]	14.5[E]	13.3[E]	7.0	19.6
Women	24.4	31.5	24.5	18.5	30.5
Method 4 (divide, shrink, add)					
1 to 3 (both sexes)	F	F	F	...	...
4 to 8 (both sexes)	<3	<3	<3	...	...
9 to 13					
Males	<3	<3	<3	...	...
Females	F	F	F	...	...
14 to 18					
Males	<3	F	<3	...	...
Females	11.7	13.6	11.7	8.2	15.2
19 to 30					
Men	<3	<3	<3	...	...
Women	8.3[E]	9.0[E]	8.3[E†]	3.5	13.1
31 to 50					
Men	F	F	F	...	...
Women	8.4[E]	15.4[E]	8.4[E†]	4.4	12.5
51 to 70					
Men	6.3[E]	7.5[E]	6.3[E†]	2.9	9.7
Women	10.8[E]	17.9	11.1[E†]	6.4	15.8
71 or older					
Men	13.8[E]	15.3[E]	13.9[E]	6.7	21.2
Women	24.4	31.5	24.5	19.2	29.9

† significantly different from estimate for Method 1
E use with caution (coefficient of variation 16.6 to 33.3%)
<3 coefficient of variation more than 33.3%, but limits of confidence interval included within interval (0.0, 3.0)
F too unreliable to be published
... not applicable

Notes: Minimum and maximum values for Method 3 estimated with Method 1 using separate distributions and combined with (1-α)*percent below EAR from supplement non-users plus α*percent below EAR from users, where α is percentage of supplement users. Based on assumption that all supplement users meet EAR. Minimum and maximum values for Method 4 estimated with Method 2 using separate empirical distributions that were combined.

Source: Canadian Community Health Survey - Nutrition 2004.

Validation of cognitive functioning categories in the Canadian Community Health Survey—Healthy Aging

by Leanne Findlay, Julie Bernier, Holly Tuokko, Susan Kirkland and Heather Gilmour

Abstract

Background
The objective of this study was to validate categories of cognitive functioning using data from the 2009 Canadian Community Health Survey (CCHS)—Healthy Aging Cognition Module.

Data and methods
Four measures of cognitive functioning—immediate and delayed recall (memory), and animal-naming and the Mental Alternation Test (executive functioning)—were coded into five categories for the Canadian household population aged 45 or older. The scores for each measure were standardized to t-scores that controlled for age, sex and education. Respondents were classified into five cognitive functioning categories. Cross-tabulations, stratum-specific likelihood ratios and multinomial logit regression were used to assess associations between levels of cognitive functioning and various health outcomes: self-reported general and mental health status, memory and problem-solving ability, activities of daily living, life satisfaction, loneliness, depression, and chronic conditions.

Results
Results supported the use of five levels of cognitive functioning for all four outcomes on the CCHS—Healthy Aging sample overall and by age group (45 to 64, 65 or older) and language group (English, French).

Interpretation
These categories can be used in future work on cognitive functioning based on the CCHS—Healthy Aging.

Keywords
activities of daily living, cognitive disorders, data collection, memory disorders, mental recall, survey methods

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While cognitive decline is not an inevitable consequence of aging, it is more prevalent at older ages.[1] In 2006, one in seven Canadians (13.7% of the total population) was aged 65 or older.[2] Among these seniors, the percentage aged 80 or older continues to grow, as does the number of centenarians. These trends suggest that a rise in the prevalence of cognitive impairment can be anticipated.

Mild cognitive decline heightens the risk of further deterioration,[3-5] but seniors with relatively low levels of impairment may not be identified in cognition studies, which typically focus on people diagnosed with dementia.[6] Nonetheless, a substantial share of the senior population is affected. According to the 1991 Canadian Study of Health and Aging (CSHA), about 17% of Canadians aged 65 or older had mild impairment, often labelled "cognitive impairment—no dementia or CIND."[7] Similarly, data from the Health and Retirement Survey indicate that 22% of Americans aged 71 or older had CIND.[6] Consequently, examination of the prevalence of various levels of cognitive well-being is warranted.

The last national survey to include measures of cognitive functioning among seniors was the CSHA.[7] The present analysis uses data from the Cognition Module of the 2009 Canadian Community Health Survey (CCHS)—Healthy Aging to validate a categorization of levels of cognitive functioning in the Canadian household population aged 45 or older. Five categories of four measures of cognitive functioning are examined for the entire sample, and by age group and language.

Methods

Data source

The 2009 Canadian Community Health Survey (CCHS)—Healthy Aging is a population-based, cross-sectional survey. The sampling frame consisted of people aged 45 or older living in private dwellings in the ten provinces. The survey excluded residents of the three territories, some remote regions, institutions, Indian reserves or Crown lands, and military bases (military and civilian), and full-time members of the Canadian Forces. Data collection took

place from December 1, 2008 through November 30, 2009 using Computer-Assisted Personal Interviewing.

The purpose of the Cognition Module of the survey was to examine cognitive functioning (as opposed to cognitive impairment) across the lifespan. The Module was administered in English and French to *non-proxy* respondents who consented to participate. This differed from the main component of the survey, for which proxy responses were accepted if the mental or physical health of selected participants prevented them from completing the interview (2.2% of the sample). Preliminary analyses suggested that respondents interviewed by proxy were more likely than those who answered on their own behalf to have dementia or to have suffered a stroke. Exclusion of these respondents from the Cognition Module means that the data may slightly overestimate cognitive functioning in the household population.

The overall response rate to the Cognition Module was 62.3% (N = 25,864), compared with 74.4% (N = 30,865) for the entire CCHS—Healthy Aging.

Cognition Module variables

Previous studies have used clinical and non-clinical means to assess cognitive functioning. The Mini-Mental State Examination (MMSE)[8] and the Modified Mini-Mental State Examination (3MS)[9] are the instruments most commonly employed in clinical settings.[10-12] However, when clinical assessment is not possible (in large, survey-based studies), other measures must be used.

Cognition may be defined in terms of domains, including memory and executive functioning (for example, planning, problem-solving, and anticipation of outcomes).[13] The 2009 CCHS—Healthy Aging Cognition Module includes four cognitive tasks: two relating to memory (immediate and delayed recall) and two relating to executive functioning (animal-naming and the Mental Alternation Test). These tasks are similar to those used in other population-based surveys,[14] as well as in community-based studies.[15-18]

Recall tasks

A modified version of the Rey Auditory Verbal Learning Test (RAVLT) was administered to CCHS—Healthy Aging respondents. The test involves memorizing 15 common unrelated words (for example, drum, curtain, bell) and performing two recall trials: one immediate and one delayed. The delayed recall trial took place five minutes after the immediate recall trial (the other cognitive tasks were performed between the recalls). Survey-administered tests of immediate and delayed recall have been shown to be related to each other in a consistent way, to have similar consistency across racial groups,[19] and to have good construct validity.[20]

Animal-naming

To test semantic fluency, respondents were given one minute in which to name as many items as possible from a category, in this case, animals. Different types of the same species were counted (for example, robin and parrot counted for two points), but different varieties of the same type (for example, American robin and European robin) received only one point. The animal-naming test has been widely administered, demonstrated to be appropriate for evaluating different populations, and sensitive to different types of brain abnormalities, and it correlates with other tests of verbal fluency. [21]

Mental Alternation Test

The Mental Alternation Test (MAT) assesses processing speed.[17,22] Respondents are asked recite the alphabet, and then to count from 1 to 26. They then have 30 seconds in which to alternate between numbers and letters in the sequence 1-A, 2-B, 3-C, etc. The maximum possible score is 51.

Of those who completed any part of the CCHS—Healthy Aging Cognition Module, 85.9% responded to the immediate recall, 75.5% to the delayed recall, 92.6% to animal-naming, and 90.9% to the Mental Alternation Test. Existing French versions of the recall and animal-naming instruments were used for interviews conducted in French; the English version of the MAT was translated into French.

The various measures reflect independent markers of cognitive functioning, and may have different associations with health outcomes. For example, memory impairment may be important for the early detection of dementia,[23] and declines in executive functioning, as well as memory, may influence activities of daily living.[24] It is also possible that subgroups respond differently to the various measures of cognitive functioning. For instance, people aged 45 to 64 may not demonstrate the same patterns of cognitive functioning as seniors, and patterns may vary by language group.

Socio-demographic characteristics

Cognitive functioning is typically evaluated in terms of age, sex and education, factors known to be related to cognitive performance.[6,7,10-12,25-28] For instance, results from the English Longitudinal Study of Aging revealed better cognitive performance among younger people, women and individuals with higher education.[14]

Respondents to the CCHS—Healthy Aging reported their sex, age in years and highest level of education. Ten education levels were specified. The language of the interview (English or French) was recorded by the interviewer; respondents who did not complete the CCHS—Healthy Aging in either English or French were excluded from the Cognition Module.

Analysis variables

Numerous physical and psychological correlates of impaired cognitive functioning have been identified (Table 1). Cognitive difficulties have been associated with lower self-rated health,[29,30] depression,[31-33] loneliness,[34,35] decreased life satisfaction,[36,37] and reduced ability to perform instrumental activities of daily living.[24,38-40] People with

Table 1
Selected characteristics of 2009 Canadian Community Health Survey—Healthy Aging Cognition Module respondents, household population aged 45 or older, Canada excluding territories

Characteristic	%	Mean	Standard error
Socio-demographic			
Sex			
Women	51.9	...	...
Men	48.1	...	...
Age	...	60.5	0.04
Marital status			
Married	73.5	...	...
Single	26.5	...	...
Language			
English	76.7	...	...
French	23.3	...	...
Education			
Grade 8 or lower (Quebec Secondary II or lower)	9.2	...	...
Grades 9 or 10	8.0	...	...
Grades 11 to 13	3.9	...	...
Secondary graduation	19.1	...	...
Some postsecondary	5.4	...	...
Trades certificate/diploma	13.7	...	...
College/CEGEP certificate/diploma	17.1	...	...
University certificate below bachelor's degree	3.2	...	...
Bachelor's degree	12.2	...	...
University certificate above bachelor's degree	8.3	...	...
Province			
Newfoundland and Labrador	1.7	...	...
Prince Edward Island	0.4	...	...
Nova Scotia	3.1	...	...
New Brunswick	2.4	...	...
Quebec	24.6	...	...
Ontario	38.3	...	...
Manitoba	3.4	...	...
Saskachewan	2.9		
Alberta	9.3	...	...
British Columbia	13.8		
Cognitive outcomes			
Immediate recall	...	5.5	0.10
Delayed recall	...	4.0	0.12
Animal naming	...	17.9	0.03
Mental Alternation Test	...	22.6	0.03
Health outcomes			
Self-perceived health			
Excellent/Very good/Good	84.8	...	...
Fair/Poor	15.2	...	...
Self-perceived mental health			
Excellent/Very good/Good	94.2	...	...
Fair/Poor	5.8	...	...
Life satisfaction			
Not low	84.4	...	...
Low	15.6	...	...
Likelihood of depression			
Less than 0.9 probability	94.3	...	...
0.9 probability or higher	5.7	...	...
Loneliness			
Not high	87.8	...	...
High	12.2	...	...
Activities of daily living			
No problems	90.2	...	...
Mild/Moderate/Severe/Total problems	9.8	...	...
Memory			
Able to remember most things	75.9	...	...
Somewhat forgetful/Very forgetful/Unable to remember anything	24.1	...	...
Ability to think clearly and solve problems			
Able to think clearly/solve problems	91.9	...	...
Having a little/some/great deal of difficulty	8.1	...	...
Chronic conditions			
Neurological disorder	2.7	...	...
Vascular disorder	44.1	...	...
Psychiatric disorder	10.5	...	...

... not applicable
Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module.

cerebrovascular disease,[29] diabetes,[33,41-44] hypertension,[45] or stroke[12,46] are more likely to be cognitively impaired than are individuals without these conditions. Psychiatric disorders have also been associated with poor cognitive functioning.[47,48]

Self-perceived health

CCHS—Healthy Aging respondents were asked about their general and mental health: "In general, would you say your [mental] health is. . . ." The response options—"excellent," "very good," "good," "fair," and "poor"—were dichotomized to reflect good (excellent/very good/good) versus poor (fair/poor) health.

Activities of daily living

Questions about respondents' ability to perform activities of daily living (ADL) were based on the OARS Multidimential Assessment Questionnaire.[49] An overall summary measure of ratings on the ADL capacity-instrumental and physical dimensions was derived. A score of 0 indicates no functional impairment; 1 = mild impairment; 2 = moderate impairment; 3 = severe impairment; and 4 = total impairment. Responses were dichotomized to identify respondents with no impairment versus mild/moderate/severe/total impairment.

Life satisfaction

On a scale from 0 to 10, with 0 representing very dissatisfied and 10, very satisfied, respondents were asked: "How do you feel about your life as a whole right now?" Scores were dichotomized to identify those whose life satisfaction was low (at least 1 standard deviation below the mean) versus not low.

Depression

The CCHS—Healthy Aging measure of depression is a shortened version of the World Health Organization Composite International Diagnostic Interview (CIDI) Scale, which is based on the DSM-III-R and the Diagnostic Criteria for the Research of the ICD-10. The depression subscale pertains to people who felt depressed or lost interest in

things for two or more weeks in the past year. For the CCHS—Healthy Aging, a derived variable was created based on the depression score, indicating the probability that respondents would have been diagnosed as having experienced a major depressive episode in the past 12 months if they had completed the Long-Form CIDI. A probability of 0 was assigned to respondents who replied negatively to the stem question (did not have depression for two or more weeks in the past year); a cut-off value of 0.9 was used to distinguish those with a high probability of depression (above 0.9) from those with a lower probability.

Loneliness

The 3-Item Loneliness Scale[50] measures an individual's reported loneliness. On a 3-point Likert scale ("hardly ever," "some of the time," and "often"), CCHS—Healthy Aging respondents answered the questions: "How often do you feel:

- that you lack of companionship?"
- left out?"
- isolated from others?"

Higher scores indicate greater loneliness. Scores were dichotomized to identify those with high loneliness (at least 1 standard deviation above the mean) versus not high loneliness.

Self-reported cognition (Health Utilities Index)

The Health Utilities Index (HUI) Mark III assesses functional health status in eight domains: vision, hearing, speech, ambulation, dexterity, emotion, cognition, and pain.[51,52] The HUI has been shown to have strong reliability and validity in general,[53] as well as for patients with lower cognitive functioning.[54]

Only the cognition subscale of the HUI was pertinent to the current study. The items of interest were: "How would you describe your usual ability to:

- remember things (able to remember most things; somewhat forgetful; very forgetful; unable to remember anything at all)."
- think and solve day-to-day problems (able to think clearly and solve problems; having a little difficulty; having some difficulty; having a great deal of difficulty; unable to think or solve problems)."

Items were dichotomized as "able to remember most things" versus at least "somewhat forgetful," and "able to think clearly and solve problems" versus having "at least some difficulty."

Chronic conditions

Respondents were asked if they had been diagnosed with specific long-term health conditions. Conditions relevant to the current analysis were grouped into neurological (Alzheimer's Disease or other dementia, Parkinson's Disease, effects of stroke), vascular (high blood pressure, diabetes, heart attack, heart disease), and psychiatric (mood disorder or anxiety) disorders.

Analytical techniques

T-score creation

Selecting cut-points to identify impairment implies that definitive lines demarcate "normal" from "dysfunctional" scores. It is more likely that cognitive functioning operates on a continuum and that several categories are more appropriate as indicators of impairment.[4] Consequently, for this analysis, multiple categories of cognitive functioning were identified.[55] T-scores that control for age, sex and education can be calculated for each cognitive measure. Using the sample data for the current study, five categories of cognitive functioning were created, representing t-scores of 0 to 34, 35 to 44, 45 to 54, 55 to 64, and 65 or more.

To generate t-scores from the results of each of the four cognitive tasks, raw scores were converted to scaled scores (mean = 10, standard deviation = 3); higher scaled scores indicate better performance.[55] Scaled scores were regressed separately for each task on age, sex and education. In this manner, equations were created for each dependent variable (cognitive outcome) in the form:

$$DV = \text{intercept} + b(\text{age}) + b(\text{education}) + b(\text{gender})$$

Each respondent's predicted scaled score was generated from this equation (that is, independent of age, sex and education). The respondent's predicted score was subtracted from the actual scaled score to determine the residual, indicating how well the individual performed, compared with what would be expected based on his/her age, sex and education. Finally, residual scores were converted to t-scores with the following equation:

$$T = \{[(\text{residual}/\text{standard deviation of the residual}) \times 10] + 50\}$$

Thus, the t-scores are independent of age, sex and education; are normally distributed; have a mean of 50 and a standard deviation of 10; and are independent of a unit of measurement.[55]

Validation

Once t-scores were created and individuals were assigned to one of the five cognitive function categories, the first step in empirically validating the categories was to examine cross-tabulations of the categories by health outcome.

Stratum-specific likelihood ratios (SSLRs) were calculated to determine the accuracy of assigning individuals to levels of cognitive functioning based on the health outcomes.[56-58] SSLRs are generalizable and independent of actual probabilities in the population.[59] The likelihood that people in each cognitive functioning category (stratum) will experience a certain outcome (for example, fair/poor self-rated health) is given relative to their likelihood of experiencing a positive outcome (in this example, excellent/very good/good self-rated health), according to the formula:

$$SSLR = (x_{1g}/n_1)/(x_{0g}/n_0)$$

where x_{1g} is the number of people with the health outcome (fair/poor health) in the gth stratum; n_1 is the total number of people with the health outcome; x_{0g} is the number of people without the health outcome (in good health) in the

gth stratum; and n_0 is the total number of people without the health outcome.

An SSLR of 10 or more indicates that the health outcome is highly likely; an SSLR below 0.1 indicates that it is highly unlikely.[56,57] It is anticipated that SSLRs would be high when a poor health outcome is more likely, and low when a poor health outcome is unlikely.

The final step was to examine all relevant health variables as predictors of cognitive functioning, comparing lower levels of functioning to the highest category (t-scores of 65 or more) for each cognitive outcome. Because the dependent variable (cognitive functioning category) comprised five levels, a multinomial logit regression analysis was used. The odds of reporting a health problem (for example, fair/poor health) should be greatest for those in the lowest (versus the highest) cognitive functioning category, with odds decreasing for those in progressively higher categories of functioning.

Results are presented only for the immediate recall outcome; results were similar for delayed recall, animal-naming, and the MAT (Appendix Tables A to I). Correlations between the four outcome variables were moderate (immediate recall with delayed recall, r = .69; immediate recall with animal-naming, r = .36, immediate recall with MAT, r = .34; delayed recall with animal-naming, r = .33, delayed recall with MAT, r = .30; animal-naming with MAT, r = .45; all p's $\leq$ .001). Survey sampling weights were applied to all point-estimates to account for the complex survey design of the CCHS—Healthy Aging.

Because the response rate for the Cognition Module was lower than that for the full CCHS—Healthy Aging, separate sampling weights were created for use with the cognitive outcome variables sample. All analyses were performed with SAS 9.1 and SAS-callable SUDAAN. Standard errors in modelling were computed using a bootstrapping technique.[60]

Results

Descriptive statistics

As expected,[55] the distribution of immediate recall scores across cognitive functioning categories was normal, with the most common category (39% of respondents) being t-scores in the 45-to-54 range (Table 2). Approximately 6% of respondents scored in the lowest category, and 8%, in the highest.

People who reported fair/poor general health were more likely to have relatively low immediate recall scores. About 9% of them had scores in the lowest category, compared with 6% overall. Conversely, 5% of those with fair/poor health had immediate recall scores in the in the highest category, compared with 8% overall. This pattern was even more pronounced for self-reported mental health. Similarly, relatively high

Table 2
Percentage distribution of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by immediate recall score and selected health characteristics, household population aged 45 or older, Canada excluding territories

	Immediate recall t-score				
Health characteristic	Low 0 to 34	35 to 44	45 to 54	55 to 64	High 65 or more
			%		
Total	**5.6**	**24.5**	**39.2**	**23.0**	**7.6**
Self-perceived health					
Fair/Poor	8.5	28.6	39.8	18.1	5.1
Excellent/Very good/Good	5.1	23.8	39.1	23.8	8.1
Self-perceived mental health					
Fair/Poor	14.9[E]	32.2	32.3	16.6	3.9[E]
Excellent/Very good/Good	5.1	24.1	39.6	23.4	7.9
Activities of daily living					
No problems	5.3	24.1	39.2	23.5	7.9
Mild/Moderate/Severe/Total problems	8.6	28.4	39.3	18.4	5.3[E]
Life satisfaction					
Low	7.8	30.7	38.2	18.0	5.3
Not low	5.2	23.4	39.4	23.9	8.0
Depression					
0.9 probability or higher	5.8[E]	25.7	39.3	18.3	10.8[E]
Less than 0.9 probability	5.5	24.4	39.3	23.4	7.4
Loneliness					
High	9.1	28.4	36.8	19.5	6.3
Not high	5.1	24.0	39.6	23.5	7.8
Memory					
Able to remember most things	5.0	24.0	39.5	23.6	7.9
Somewhat forgetful/Very forgetful/Unable to remember anything	7.6	26.4	38.2	21.0	6.8
Ability to think clearly and solve problems					
Able to think clearly/solve problems	5.2	23.8	39.4	23.7	7.9
Having a little/some/great deal of difficulty/unable	10.5	33.9	36.6	14.8	4.3[E]
Neurological disorder					
Yes	9.0[E]	30.3	41.1	16.0	F
No	5.6	24.4	39.1	23.2	7.7
Vascular disorder					
Yes	5.0	24.0	41.0	23.0	7.0
No	6.1	25.0	37.9	22.9	8.1
Psychiatric disorder					
Yes	9.6[E]	26.3	37.6	19.3	7.2[E]
No	5.2	24.3	39.4	23.4	7.7

[E] interpret with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be reported (coefficient of variation greater than 33.3%)
Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module.

percentages of people who reported difficulties with activities of daily living, lower life satisfaction and loneliness had low immediate recall scores. By contrast, no pattern emerged for depression.

The HUI cognitive functioning variables were associated with immediate recall scores. Respondents who reported that they were at least somewhat forgetful and who had at least some difficulties thinking clearly and solving problems were more likely than others to have immediate recall scores in the lowest category and less likely to have scores in the highest category.

The presence of a neurological or psychiatric disorder was related to cognitive functioning. Relatively high percentages of people who reported such conditions had low immediate recall scores. However, this was not the case for people with vascular disorders.

Stratum-specific likelihood ratios

In general, the stratum-specific likelihood ratios (SSLR) supported the cognitive functioning categories: the higher their immediate recall score, the less likely were respondents to have negative health characteristics. (Although the SSLR patterns were generally as anticipated, some differences emerged for delayed recall, animal-naming and MAT–Appendix Tables D to F).

SSLRs for fair/poor self-rated general and mental health, difficulties with activities of daily living, low life satisfaction and loneliness decreased as immediate recall scores rose (Table 3). In general, depression also followed the expected pattern, with the highest SSLR for the lowest immediate recall score category. The two HUI cognition variables also demonstrated the anticipated pattern.

Similarly, the SSLRs for neurological and psychiatric disorders followed the expected pattern in that the likelihood of the conditions was associated with low immediate recall scores; no association was shown for vascular disorders.

Multinomial logistic regression

The final step was to examine the odds of being in a low immediate recall score category given the presence of a negative health characteristic. The highest t-score category was set as the reference group (Table 4). As expected, scoring in the lowest immediate recall category was associated with the highest odds of poor health. For instance, compared with people whose immediate recall scores were in the highest category, those with scores in the lowest category had more than twice the odds of being in fair/poor general health, almost six times the odds of being in fair/poor mental health, and more than twice the odds of having difficulties with activities of daily living. Results were similar for low life satisfaction and loneliness. Not surprisingly, people with the lowest immediate recall scores had almost twice the odds of reporting that they were at least somewhat forgetful, and almost four times the odds of reporting that they had some difficulty thinking clearly and solving problems, compared with people with the highest immediate recall scores. However, no association was shown between depression and immediate recall scores.

People with immediate recall scores in the lowest category had more than three times the odds of reporting a neurological condition and twice the odds of reporting a psychiatric disorder. (Odds ratios were generally similar for the other three measures of cognitive functioning, with the exception of psychiatric disorders and the MAT—Appendix Tables G, H and I).

Table 3
Stratum-specific likelihood ratios (SSLR) for selected health characteristics of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by immediate recall score, household population aged 45 or older, Canada excluding territories

	Immediate recall t-score														
	0 to 34			35 to 44			45 to 54			55 to 64			65 or more		
		95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
Health characteristic	SSLR	from	to	SSLR	from	to	SSLR	from	to	SSLR	from	to	SSLR	from	to
Low self-rated health	1.66	1.65	1.67	1.20	1.19	1.20	1.02	1.01	1.02	0.76	0.76	0.76	0.63	0.62	0.63
Low self-rated mental health	2.93	2.92	2.95	1.34	1.34	1.34	0.82	0.81	0.82	0.71	0.71	0.72	0.50	0.49	0.51
Difficulties with activities of daily living	1.62	1.61	1.63	1.18	1.17	1.18	1.00	1.00	1.00	0.79	0.78	0.79	0.67	0.66	0.67
Low life satisfaction	1.49	1.49	1.50	1.31	1.31	1.31	0.97	0.97	0.97	0.75	0.75	0.75	0.66	0.66	0.66
High probability of depression	1.07	1.06	1.08	1.05	1.05	1.06	1.00	1.00	1.00	0.78	0.78	0.79	1.46	1.45	1.47
High loneliness	1.79	1.78	1.80	1.18	1.18	1.19	0.93	0.93	0.93	0.83	0.82	0.83	0.80	0.80	0.81
Unable to remember things	1.51	1.50	1.52	1.10	1.10	1.10	0.97	0.97	0.97	0.89	0.89	0.89	0.86	0.86	0.87
Unable to think/solve problems	2.00	1.99	2.01	1.43	1.42	1.43	0.93	0.93	0.93	0.62	0.62	0.63	0.54	0.53	0.54
Neurological disorder	1.61	1.59	1.63	1.24	1.24	1.25	1.05	1.05	1.05	0.69	0.68	0.69	0.47	0.47	0.48
Vascular disorder	0.82	0.82	0.82	0.96	0.96	0.96	1.08	1.08	1.08	1.00	1.00	1.01	0.86	0.86	0.86
Psychiatric disorder	1.86	1.85	1.87	1.08	1.08	1.09	0.95	0.95	0.96	0.82	0.82	0.83	0.94	0.93	0.94

Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module.

Table 4
Odds ratios relating selected health status characteristics of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by immediate recall score, household population aged 45 or older, Canada excluding territories

			Immediate recall t-score											
			0 to 34			35 to 44			45 to 54			55 to 64		
Health characteristic	Adjusted degrees of freedom	Adjusted chi-square	Odds ratio	95% confidence interval from	to	Odds ratio	95% confidence interval from	to	Odds ratio	95% confidence interval from	to	Odds ratio	95% confidence interval from	to
Low self-rated health	3.59	32.89	2.64	1.64	4.26	1.90	1.35	2.68	1.62	1.15	2.26	1.21	0.85	1.71
Low self-rated mental health	3.17	45.51	5.86	3.10	11.08	2.68	1.72	4.17	1.63	1.04	2.56	1.42	0.86	2.35
Difficulties with activities of daily living	3.63	25.65	2.42	1.51	3.90	1.76	1.19	2.59	1.50	1.03	2.18	1.17	0.79	1.74
Low life satisfaction	3.62	35.90	2.27	1.45	3.53	1.99	1.45	2.72	1.47	1.10	1.97	1.14	0.84	1.54
High probability of depression	3.71	6.19	0.73	0.39	1.39	0.72	0.43	1.23	0.69	0.41	1.15	0.54	0.31	0.92
High loneliness	3.93	27.73	2.23	1.47	3.39	1.48	1.05	2.06	1.16	0.83	1.61	1.03	0.74	1.44
Unable to remember things	3.84	16.23	1.76	1.20	2.58	1.28	0.97	1.69	1.12	0.86	1.47	1.03	0.77	1.38
Unable to think/solve problems	3.71	45.13	3.71	1.94	7.08	2.64	1.45	4.83	1.72	0.95	3.13	1.16	0.62	2.15
Neurological disorder	3.87	17.69	3.40	1.47	7.86	2.62	1.20	5.74	2.22	1.01	4.84	1.45	0.66	3.21
Vascular disorder	3.83	8.94	0.95	0.72	1.26	1.12	0.92	1.36	1.26	1.05	1.51	1.17	0.95	1.43
Psychiatric disorder	3.73	16.52	1.99	1.17	3.36	1.16	0.78	1.73	1.02	0.69	1.50	0.88	0.58	1.33

Note: Comparison group is 65 or more t-score category.
Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module.

Subgroup analyses

Validation conducted for people aged 45 to 64 and for those aged 65 or older, as well as for English and French respondents, yielded results similar to those obtained for the entire sample (results available upon request). Whether they were in the younger or older age group, English or French, respondents demonstrated similar patterns between health outcomes and the five categories of cognitive functioning (in both cross-tabulations and SSLR comparisons).

Regardless of their age group, people with low immediate recall scores were more likely to have fair/poor self-rated general and mental health, difficulties with activities of daily living, low life satisfaction, loneliness, less ability to think and solve problems, and neurological disorders, compared with people whose scores placed them in higher immediate recall categories. The only differences between the younger and older cohort were in memory and psychiatric disorders—lower immediate recall scores were not strongly associated with ability to remember things and psychiatric disorders among 45- to 64-year-olds, but they were for seniors.

For English and French respondents, lower immediate recall scores were associated with fair/poor self-rated general and mental health, difficulties with activities of daily living, low life satisfaction, loneliness, lower self-rated cognition, neurological disorders, and psychiatric disorders. Depression and vascular disorders were not associated with immediate recall scores for either language group

Discussion

The results of the current study confirm that categories of cognitive functioning can be described from the CCHS—Healthy Aging Cognition Module. Four tests of cognitive functioning—immediate recall, delayed recall, animal-naming and the Mental Alternation Test—were validated based on literature-supported correlates of cognitive functioning. Lower cognitive functioning (notably, t-scores less than 34) was associated with poorer self-rated general and mental health, difficulties with activities of daily living, lower life satisfaction, and loneliness. As might be expected, self-reported cognitive difficulties (forgetfulness and difficulty thinking clearly and solving problems) were associated with low immediate recall scores. The fact that the strongest correlates of the cognitive functioning categories were self-rated mental health and difficulties thinking clearly and solving problems lends the greatest support to the use of the categories presented in this analysis.

Cognitive functioning was not associated with the probability of depression. However, the literature on this subject is inconsistent. Some studies have found no association between depression and cognition,[61] while others have shown a relationship, even accounting for socio-economic factors.[33] Beirman et al.[31] suggested a non-linear relationship between depression and cognitive decline, with elevated levels of depression (and anxiety) in the early stages of decline, but diminished levels as deterioration progresses. Further research on the association between depression and cognitive functioning is obviously necessary.

While neurological and psychiatric disorders were associated with lower cognitive functioning, no patterns emerged for vascular disorders. Previous work, too, has suggested that heart

disease, hypertension and diabetes are not necessarily associated with cognitive decline, especially over and above other risk factors such as low educational attainment.[33,62,63]

Limitations and future directions

A major strength of the current study is the large, nationally representative sample. However, several limitations should be acknowledged.

Proxy responses were not accepted for the Cognition Module. Other research has shown that individuals for whom proxy responses are provided tended to perform poorly on cognitive measures and were more likely to have dementia.[20] Thus, the CCHS—Healthy Aging data may underestimate the prevalence of lower cognitive functioning in the Canadian household population.

The CCHS—Healthy Aging Cognition Module used non-clinical measures of cognitive functioning. A clinical assessment would have allowed a test of sensitivity and specificity of the measures in identifying cognitive decline or dementia. This may explain why relationships were not found between vascular disorders (and/or depression) and the cognition categories. Muller et al.[64] found a significant relation between cardiovascular disease and MMSE scores, but not administered tests.

The longitudinal assessment of cognitive functioning among the population is warranted. Such studies would allow researchers to focus on associations between specific risk factors (or correlates) and cognitive functioning over time. For instance, Wilson et al.[36] found that loneliness was associated with a more rapid cognitive decline in elderly people.

Conclusions

Based on the results of tests of immediate and delayed recall, animal-naming, and the MAT in the CCHS—Healthy Aging Cognition Module, five categories describing low to high cognitive functioning were created. These categories were validated for the household population aged 45 or older overall, and by age group and language.

The aging of Canada's population will likely be accompanied by a growing number of people experiencing cognitive decline. CCHS—Healthy Aging data can contribute an understanding of the prevalence of this condition in the household population. This validation study enhances the analytic value of the information in the Cognition Module. ■

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Appendix

Table A
Percentage distribution of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by delayed recall score and selected health characteristics, household population aged 45 or older, Canada excluding territories

	Delayed recall t-score				
Health characteristic	Low 0 to 34	35 to 44	45 to 54	55 to 64	High 65 or more
			%		
Total	**5.6**	**23.7**	**39.2**	**23.4**	**8.1**
Self-perceived health					
Fair/Poor	5.8	29.1	40.6	19.2	5.2
Excellent/Very good/Good	5.6	22.8	39.0	24.1	8.5
Self-perceived mental health					
Fair/Poor	6.2[E]	36.2	40.6	12.9	4.2[E]
Excellent/Very good/Good	5.6	23.0	39.1	24.0	8.3
Activities of daily living					
No problems	6.6	31.4	38.1	18.0	5.9[E]
Mild/Moderate/Severe/Total problems	5.5	23.0	39.3	23.9	8.3
Life satisfaction					
Low	8.1	27.8	40.3	18.4	5.4
Not low	5.2	22.9	39.0	24.4	8.6
Depression					
0.9 probability or higher	6.9[E]	25.9	38.4	20.0	8.7[E]
Less than 0.9 probability	5.5	23.5	39.3	23.7	8.1
Loneliness					
High	7.9	26.0	38.5	21.0	6.6
Not high	5.3	23.3	39.4	23.7	8.3
Memory					
Able to remember most things	5.4	22.9	39.3	23.8	8.6
Somewhat forgetful/Very forgetful/Unable to remember anything	6.3	26.3	38.8	22.3	6.4
Ability to think clearly and solve problems					
Able to think clearly/solve problems	5.3	23.4	39.2	23.8	8.3
Having a little/some/great deal of difficulty/unable	9.9	27.1	39.2	19.1	4.6[E]
Neurological disorder					
Yes	9.8[E]	32.1	39.0	16.6	F
No	5.5	23.5	39.2	23.6	8.2
Vascular disorder					
Yes	4.6	25.0	39.8	23.0	7.6
No	6.4	22.7	38.8	23.7	8.4
Psychiatric disorder					
Yes	7.3	26.9	39.4	20.1	6.3
No	5.4	23.3	39.2	23.8	8.3

[E] interpret with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be reported (coefficient of variation greater than 33.3%)
Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module.

Table B
Percentage distribution of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by animal-naming score and selected health characteristics, household population aged 45 or older, Canada excluding territories

	Animal-naming t-score				
Health characteristic	Low 0 to 34	35 to 44	45 to 54	55 to 64	High 65 or more
			%		
Total	**7.4**	**24.9**	**36.6**	**23.2**	**7.8**
Self-perceived health					
Fair/Poor	9.0	30.0	37.3	18.4	5.3
Excellent/Very good/Good	7.1	24.0	36.5	24.0	8.3
Self-perceived mental health					
Fair/Poor	12.7	31.5	34.1	16.4	5.4[E]
Excellent/Very good/Good	7.1	24.5	36.8	23.6	8.0
Activities of daily living					
No problems	7.4	24.3	36.5	23.8	8.0
Mild/Moderate/Severe/Total problems	7.6	31.2	37.5	18.0	5.7
Life satisfaction					
Low	12.4	30.3	32.8	18.1	6.3
Not low	6.6	23.9	37.3	24.2	8.1
Depression					
0.9 probability or higher	9.2[E]	22.5	34.6	26.2	7.5
Less than 0.9 probability	7.3	25.0	36.7	23.1	7.8
Loneliness					
High	9.6	28.7	34.0	20.6	7.0
Not high	7.1	24.4	37.0	23.6	7.9
Memory					
Able to remember most things	6.7	24.4	37.1	23.5	8.3
Somewhat forgetful/Very forgetful/Unable to remember anything	9.7	26.6	35.2	22.4	6.2
Ability to think clearly and solve problems					
Able to think clearly/solve problems	6.9	24.5	36.7	23.8	8.1
Having a little/some/great deal of difficulty/unable	13.4	30.3	35.2	16.5	4.6[E]
Neurological disorder					
Yes	12.2	26.9	39.2	16.7	5.1[E]
No	7.3	24.9	36.5	23.4	7.9
Vascular disorder					
Yes	7.0	24.7	38.7	22.9	6.8
No	7.8	25.2	34.9	23.5	8.6
Psychiatric disorder					
Yes	8.3	27.3	37.3	21.9	5.2
No	7.3	24.7	36.5	23.4	8.1

[E] interpret with caution (coefficient of variation 16.6% to 33.3%)
Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module.

Table C
Percentage distribution of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by Mental Alternation Test score and selected health characteristics, household population aged 45 or older, Canada excluding territories

	Mental Alternation Test t-score				
Health characteristic	Low 0 to 34	35 to 44	45 to 54	55 to 64	High 65 or more
			%		
Total	6.5	23.2	36.4	26.0	7.9
Self-perceived health					
Fair/Poor	8.4	32.4	36.7	17.7	4.9
Excellent/Very good/Good	6.1	21.7	36.3	27.4	8.4
Self-perceived mental health					
Fair/Poor	10.0	32.8	32.1	20.3	4.8[E]
Excellent/Very good/Good	6.2	22.7	36.6	26.4	8.1
Activities of daily living					
No problems	6.4	22.4	36.2	26.8	8.2
Mild/Moderate/Severe/Total problems	7.3	30.6	37.6	19.2	5.3
Life satisfaction					
Low	9.0	28.9	34.6	21.8	5.6
Not low	6.0	22.2	36.8	26.8	8.3
Depression					
0.9 probability or higher	6.9[E]	25.1	34.7	28.1	5.2[E]
Less than 0.9 probability	6.4	23.0	36.6	25.9	8.1
Loneliness					
High	8.6	26.6	36.1	22.7	6.0
Not high	6.2	22.7	36.5	26.4	8.2
Memory					
Able to remember most things	6.2	22.3	36.6	26.5	8.4
Somewhat forgetful/Very forgetful/Unable to remember anything	7.3	26.1	35.6	24.5	6.4
Ability to think clearly and solve problems					
Able to think clearly/solve problems	6.0	22.6	36.3	26.8	8.3
Having a little/some/great deal of difficulty/unable	11.4	30.8	36.8	17.5	3.6
Neurological disorder					
Yes	11.9[E]	29.5	34.2	18.6	5.8[E]
No	6.3	23.1	36.4	26.3	8.0
Vascular disorder					
Yes	6.4	24.7	37.2	23.6	8.2
No	6.5	22.0	35.8	28.0	7.7
Psychiatric disorder					
Yes	7.1	25.6	33.4	27.4	6.6[E]
No	6.4	23.0	36.7	25.9	8.1

[E] interpret with caution (coefficient of variation 16.6% to 33.3%)
Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module.

Table D
Stratum-specific likelihood ratios (SSLR) for selected health characteristics of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by delayed recall score category, household population aged 45 or older, Canada excluding territories

	Delayed recall t-score														
	0 to 34			35 to 44			45 to 54			55 to 64			65 or more		
		95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
Health characteristic	SSLR	from	to	SSLR	from	to	SSLR	from	to	SSLR	from	to	SSLR	from	to
Low self-rated health	1.03	1.02	1.04	1.28	1.27	1.28	1.04	1.04	1.04	0.80	0.80	0.80	0.62	0.61	0.62
Low self-rated mental health	1.10	1.09	1.11	1.57	1.57	1.58	1.04	1.03	1.04	0.54	0.53	0.54	0.51	0.50	0.52
Difficulties with activities of daily living	1.19	1.18	1.20	1.37	1.36	1.37	0.97	0.97	0.97	0.75	0.75	0.75	0.71	0.71	0.72
Low life satisfaction	1.57	1.56	1.58	1.21	1.21	1.22	1.03	1.03	1.04	0.76	0.75	0.76	0.63	0.62	0.63
High probability of depression	1.09	1.08	1.10	1.11	1.10	1.11	0.96	0.96	0.97	0.87	0.86	0.87	1.20	1.19	1.21
High loneliness	1.49	1.48	1.50	1.12	1.11	1.12	0.98	0.98	0.98	0.88	0.88	0.89	0.79	0.79	0.80
Unable to remember things	1.16	1.15	1.16	1.15	1.14	1.15	0.99	0.98	0.99	0.94	0.94	0.94	0.74	0.74	0.75
Unable to think/solve problems	1.87	1.85	1.88	1.16	1.15	1.16	1.00	1.00	1.00	0.81	0.80	0.81	0.56	0.55	0.56
Neurological disorder	1.77	1.75	1.79	1.37	1.36	1.38	0.99	0.99	1.00	0.70	0.70	0.71	0.31	0.31	0.32
Vascular disorder	0.71	0.71	0.72	1.10	1.10	1.10	1.03	1.03	1.03	0.97	0.97	0.97	0.91	0.90	0.91
Psychiatric disorder	1.34	1.33	1.35	1.16	1.15	1.16	1.00	1.00	1.01	0.84	0.84	0.85	0.77	0.76	0.77

Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module.

Table E
Stratum-specific likelihood ratios (SSLR) for selected health characteristics of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by animal-naming score category, household population aged 45 or older, Canada excluding territories

	Animal-naming t-score														
	0 to 34			35 to 44			45 to 54			55 to 64			65 or more		
		95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
Health characteristic	SSLR	from	to	SSLR	from	to	SSLR	from	to	SSLR	from	to	SSLR	from	to
Low self-rated health	1.27	1.26	1.27	1.25	1.24	1.25	1.02	1.02	1.02	0.77	0.76	0.77	0.64	0.64	0.65
Low self-rated mental health	1.78	1.77	1.79	1.29	1.28	1.29	0.93	0.92	0.93	0.69	0.69	0.70	0.67	0.67	0.68
Difficulties with activities of daily living	1.02	1.01	1.03	1.28	1.28	1.29	1.03	1.03	1.03	0.76	0.75	0.76	0.71	0.71	0.72
Low life satisfaction	1.89	1.89	1.90	1.27	1.27	1.27	0.88	0.88	0.88	0.75	0.75	0.75	0.78	0.78	0.79
High probability of depression	1.20	1.19	1.20	0.87	0.87	0.87	0.98	0.98	0.98	1.16	1.16	1.17	0.86	0.85	0.86
High loneliness	1.36	1.35	1.37	1.18	1.17	1.18	0.92	0.92	0.92	0.87	0.87	0.88	0.89	0.88	0.89
Unable to remember things	1.43	1.43	1.44	1.09	1.09	1.09	0.95	0.95	0.95	0.95	0.95	0.96	0.75	0.74	0.75
Unable to think/solve problems	1.94	1.93	1.95	1.24	1.23	1.24	0.96	0.96	0.96	0.69	0.69	0.70	0.57	0.57	0.58
Neurological disorder	1.67	1.66	1.69	1.08	1.07	1.09	1.07	1.07	1.08	0.71	0.71	0.72	0.64	0.63	0.65
Vascular disorder	0.90	0.89	0.90	0.98	0.98	0.98	1.11	1.11	1.11	0.97	0.97	0.98	0.78	0.78	0.79
Psychiatric disorder	1.13	1.12	1.13	1.11	1.10	1.11	1.02	1.02	1.02	0.94	0.93	0.94	0.64	0.64	0.65

Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module.

Table F
Stratum-specific likelihood ratios (SSLR) for selected health characteristics of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by Mental Alternation Test score category, household population aged 45 or older, Canada excluding territories

	Mental Alternation Test t-score														
	0 to 34			35 to 44			45 to 54			55 to 64			65 or more		
		95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
Health characteristic	SSLR	from	to	SSLR	from	to	SSLR	from	to	SSLR	from	to	SSLR	from	to
Low self-rated health	1.36	1.35	1.37	1.49	1.49	1.50	1.01	1.01	1.01	0.64	0.64	0.65	0.58	0.58	0.59
Low self-rated mental health	1.61	1.59	1.62	1.45	1.44	1.45	0.88	0.87	0.88	0.77	0.76	0.77	0.59	0.59	0.60
Difficulties with activities of daily living	1.15	1.15	1.16	1.36	1.36	1.37	1.04	1.03	1.04	0.72	0.71	0.72	0.65	0.64	0.65
Low life satisfaction	1.51	1.50	1.52	1.31	1.30	1.31	0.94	0.94	0.94	0.81	0.81	0.82	0.68	0.68	0.68
High probability of depression	1.11	1.10	1.12	1.04	1.04	1.05	0.97	0.97	0.98	1.08	1.08	1.09	0.65	0.64	0.66
High loneliness	1.40	1.39	1.41	1.17	1.17	1.17	0.99	0.99	0.99	0.86	0.86	0.86	0.73	0.72	0.73
Unable to remember things	1.18	1.17	1.18	1.17	1.17	1.17	0.97	0.97	0.98	0.93	0.92	0.93	0.77	0.76	0.77
Unable to think/solve problems	1.88	1.87	1.89	1.36	1.36	1.37	1.01	1.01	1.01	0.65	0.65	0.66	0.43	0.43	0.44
Neurological disorder	1.88	1.86	1.90	1.28	1.27	1.29	0.94	0.94	0.94	0.71	0.70	0.71	0.73	0.72	0.74
Vascular disorder	0.98	0.97	0.98	1.12	1.12	1.12	1.04	1.04	1.04	0.84	0.84	0.84	1.06	1.05	1.06
Psychiatric disorder	1.11	1.10	1.12	1.12	1.11	1.12	0.91	0.91	0.91	1.06	1.05	1.06	0.81	0.81	0.82

Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module.

Table G
Odds ratios relating selected health status characteristics of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by delayed recall score, household population aged 45 or older, Canada excluding territories

			Delayed recall t-score												
			0 to 34			35 to 44			45 to 54			55 to 64			
				95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval		
Health characteristic	Adjusted degrees of freedom	Adjusted chi-square	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to
Low self-rated health	3.89	28.86	1.67	1.10	2.53	2.07	1.44	2.98	1.69	1.21	2.35	1.30	0.91	1.83
Low self-rated mental health	3.43	38.94	2.16	1.24	3.74	3.08	1.91	4.98	2.03	1.29	3.21	1.05	0.65	1.69
Difficulties with activities of daily living	3.30	23.94	1.67	0.97	2.90	1.92	1.18	3.14	1.36	0.84	2.21	1.05	0.64	1.73
Low life satisfaction	3.71	29.47	2.51	1.64	3.82	1.93	1.40	2.67	1.65	1.24	2.20	1.21	0.89	1.65
High probability of depression	3.86	3.07	1.17	0.60	2.27	1.02	0.63	1.67	0.90	0.56	1.47	0.78	0.46	1.34
High loneliness	3.97	12.05	1.88	1.22	2.89	1.41	1.00	1.98	1.23	0.88	1.73	1.11	0.79	1.57
Unable to remember things	3.93	10.67	1.56	1.07	2.27	1.55	1.17	2.04	1.33	1.01	1.74	1.26	0.94	1.70
Unable to think/solve problems	3.77	18.96	3.36	1.72	6.58	2.09	1.15	3.80	1.80	0.98	3.30	1.45	0.76	2.75
Neurological disorder	3.77	20.40	5.65	2.34	13.66	4.38	1.97	9.72	3.17	1.43	7.06	2.25	0.98	5.14
Vascular disorder	3.93	12.07	0.79	0.58	1.07	1.21	0.96	1.53	1.13	0.92	1.40	1.07	0.86	1.32
Psychiatric disorder	3.88	9.67	1.75	1.07	2.84	1.51	1.04	2.19	1.31	0.91	1.88	1.10	0.75	1.61

Note: Comparison group is 65 or more t-score category.
Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module.

Table H
Odds ratios relating selected health status characteristics of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by animal-naming score, household population aged 45 or older, Canada excluding territories

			Animal-naming t-score											
			0 to 34			35 to 44			45 to 54			55 to 64		
				95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
Health characteristic	Adjusted degrees of freedom	Adjusted chi-square	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to
Low self-rated health	3.82	39.18	1.97	1.42	2.75	1.95	1.50	2.53	1.59	1.24	2.04	1.19	0.91	1.57
Low self-rated mental health	3.62	27.76	2.64	1.59	4.38	1.91	1.19	3.06	1.38	0.88	2.14	1.03	0.69	1.55
Difficulties with activities of daily living	3.92	34.77	1.43	0.98	2.09	1.80	1.30	2.48	1.44	1.05	1.97	1.06	0.77	1.47
Low life satisfaction	3.70	57.94	2.42	1.70	3.43	1.62	1.23	2.14	1.12	0.85	1.48	0.96	0.71	1.28
High probability of depression	3.55	3.60	1.31	0.76	2.25	0.94	0.66	1.33	0.98	0.70	1.39	1.18	0.82	1.72
High loneliness	3.86	14.20	1.53	1.02	2.30	1.33	0.97	1.82	1.04	0.77	1.40	0.98	0.72	1.34
Unable to remember things	3.68	19.96	1.92	1.43	2.58	1.46	1.17	1.81	1.27	1.03	1.56	1.28	1.01	1.61
Unable to think/solve problems	3.67	36.37	3.38	2.09	5.47	2.16	1.44	3.24	1.67	1.12	2.50	1.21	0.77	1.90
Neurological disorder	3.78	13.17	2.61	1.20	5.66	1.68	0.84	3.37	1.67	0.85	3.30	1.11	0.51	2.41
Vascular disorder	3.90	13.50	1.14	0.87	1.50	1.25	1.03	1.52	1.41	1.17	1.71	1.24	1.02	1.52
Psychiatric disorder	3.68	7.87	1.75	1.16	2.65	1.72	1.25	2.36	1.59	1.18	2.13	1.46	1.06	2.00

Note: Comparison group is 65 or more t-score category.
Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module.

Table I
Odds ratios relating selected health status characteristics of respondents to 2009 Canadian Community Health Survey—Healthy Aging Cognition Module, by Mental Alternation Test score, household population aged 45 or older, Canada excluding territories

			Mental Alternation Test t-score											
			0 to 34			35 to 44			45 to 54			55 to 64		
				95% confidence interval			95% confidence interval			95% confidence interval			95% confidence interval	
Health characteristic	Adjusted degrees of freedom	Adjusted chi-square	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to	Odds ratio	from	to
Low self-rated health	3.83	99.35	2.34	1.67	3.28	2.56	1.95	3.37	1.74	1.31	2.30	1.11	0.84	1.46
Low self-rated mental health	3.78	26.20	2.71	1.55	4.74	2.44	1.38	4.32	1.48	0.86	2.55	1.30	0.74	2.27
Difficulties with activities of daily living	3.92	57.02	1.78	1.25	2.51	2.10	1.58	2.79	1.60	1.20	2.12	1.10	0.83	1.47
Low life satisfaction	3.89	42.25	2.23	1.54	3.23	1.92	1.44	2.57	1.39	1.06	1.81	1.20	0.90	1.59
High probability of depression	3.90	4.80	1.69	0.93	3.07	1.70	1.07	2.71	1.48	0.94	2.32	1.68	1.06	2.67
High loneliness	3.78	16.45	1.92	1.26	2.92	1.60	1.18	2.19	1.36	1.00	1.85	1.18	0.86	1.62
Unable to remember things	3.89	15.72	1.53	1.11	2.11	1.52	1.19	1.94	1.27	1.01	1.58	1.20	0.94	1.54
Unable to think/solve problems	3.59	47.03	4.35	2.67	7.09	3.15	2.15	4.60	2.34	1.61	3.39	1.51	1.00	2.29
Neurological disorder	3.87	21.92	2.58	1.28	5.22	1.76	0.98	3.16	1.29	0.70	2.36	0.97	0.51	1.83
Vascular disorder	3.95	17.98	0.92	0.71	1.20	1.06	0.87	1.30	0.98	0.81	1.18	0.80	0.65	0.97
Psychiatric disorder	3.93	4.96	1.37	0.83	2.25	1.37	0.90	2.09	1.12	0.75	1.68	1.30	0.86	1.96

Note: Comparison group is 65 or more t-score category.
Source: 2009 Canadian Community Health Survey—Healthy Aging Cognition Module.

Erratum

Errors were discovered in the article, "Income disparities in health-adjusted life expectancy for Canadian adults, 1991 to 2001," by Cameron McIntosh, Philippe Finès, Russell Wilkins and Michael C. Wolfson in **Health Reports***, Volume 20, Number 4. Corrections were made in August, 2010.*

Data errors were found in:

Table 4 (Remaining health-adjusted life expectancy (years) at age 25, by income decile and sex, Canada, 1991-2001);
Figure 1 (Remaining life expectancy and health-adjusted life expectancy at age 25, by income decile, men, Canada, 1991-2001); Figure 2 (Remaining life expectancy and health-adjusted life expectancy at age 25, by income decile, women, Canada, 1991-2001); and Appendix Table C (Remaining health-adjusted life expectancy (years) at age 25, by educational attainment and sex, Canada, 1991-2001).

The data in these tables and charts for both the HTML and PDF versions were corrected and replaced.

The text was revised to reflect these corrections:

Results
Disparities in health-adjusted life expectancy

Third sentence (page 59):

Disparities in health-adjusted life expectancy between the highest and lowest deciles were 14.1 years for men and 9.5 years for women, whereas the corresponding disparities in conventional life expectancy were only 7.4 and 4.5 years, respectively.

Discussion

First paragraph, third sentence (page 60):

For both men and women at age 25, the difference in remaining health-adjusted life expectancy between the highest and lowest income groups was much larger than the corresponding difference in overall life expectancy: 6.8 years more for men, and 5.0 years more for women.

Second paragraph, third sentence (page 60):

By contrast, in this analysis, which examines health-adjusted life expectancy at age 25, the difference between the highest income decile and the overall average was estimated at 5.8 years for men and 3.1 years for women. For men, this was around twice the impact of all cancers combined, while for women, it was about the same as the impact for all cancers combined.