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Health inequalities associated with neighbourhood deprivation in the Quebec population with hypertension in primary prevention of cardiovascular disease

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Abstract

Introduction: Although a number of studies look at prevalence, incidence, treatment, mortality and morbidity in relation to hypertension, few have taken into account the effect of residential neighbourhood on these health indicators in the population diagnosed with hypertension.

Objectives: The objective of this study was to measure and compare prevalence, mortality, morbidity, use of medical resources and treatments in relation to the level of material and social deprivation of the area of residence, in a population with a diagnosis of hypertension in primary prevention for cardiovascular disease (CVD) in Quebec in 2006–2007.

Methods: This study is based on a secondary analysis of the medical administrative data of the Quebec health insurance board, the Régie de l'assurance maladie du Québec, for a cohort of 276 793 patients aged 30 years or older who had been diagnosed with hypertension in 2006 or 2007, but who did not have a known diagnosis of CVD. The health indicators adjusted for age and sex are prevalence, death, a cardiovascular event, physician visits, emergency department visits and use of antihypertensives. Twenty-five types of areas of residence were obtained by crossing the material and social deprivation quintiles.

Results: Compared with patients living in materially and socially advantaged areas, those living in deprived areas were at 46% higher risk of a cardiovascular event, 47% higher risk of being frequent emergency department visitors and 31% higher risk of being frequent users of a general practitioner's services, but 25% lower risk of being frequent users of medical specialists' services. Little or no variation was observed in the use of antihypertensives.

Conclusion: This study reveals the existence, in a CVD primary prevention context, of large variations in a number of health indicators among hypertensive patients owing to the material and social deprivation of residential neighbourhood. It is therefore important to take the socioeconomic context into account when planning interventions to prevent CVDs and their consequences.

Keywords: material deprivation, social deprivation, frequent users of services, hypertension, health indicator, cardiovascular disease, urban areas, rural areas

Introduction

Hypertension is a major public health concern: it is a risk factor for cardiovascular disease (CVD), kidney failure and mortality, and one of the most important in terms of disability-adjusted life years.[1-3] Kearney et al.[4] estimated the global prevalence of hypertension—generally defined as a systolic blood pressure equal to or above 140 mmHg and/or diastolic blood pressure equal to or above 90 mmHg— to be 26% in the adult population in 2000, and projected a 24% increase in developed countries and an 80% increase in developing countries by 2025. In contrast, Danaei et al.[5] found the average systolic blood pressure to be decreasing in both sexes worldwide between 1980 and 2008, with the prevalence of age-adjusted hypertension dropping from 33% to 29% for men and from 29% to 25% for women. This trend varies depending on the country and region, however. In addition, despite this downward trend, the absolute number of people with hypertension has increased as a result of the global population growth and aging. According to an Ontario study, 21% of the population aged 20 to 79 years had hypertension in 2006,[6] whereas the 2007–2009 Canadian Health Measures Survey[7] found that 19% of Canadians aged between 20 and 79 had hypertension and 20% had a blood pressure in the prehypertension range. The prevalence of hypertension remains lower in Canada than in the United States (29%) and England (30%).[8]

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The Institut national de la santé publique du Québec (INSPQ)[9-10] found that the adjusted prevalence of hypertension in Quebec rose from 15.8% in 2000 to 20.3% in 2007, with the prevalence changing faster for men than for women. At the same time, the adjusted incidence of hypertension fell for both sexes. The mortality rates for people with hypertension also decreased between 2000 and 2007 for both sexes, maybe because of better drug treatments.[9-10] A recent study[11] in 17 countries found the prevalence of hypertension to be nearly 40% in people between the ages of 35 and 70 years, with the definition of hypertension based on the self-reported use of an antihypertensive or on an average blood pressure of at least 140/90 mmHg (2 measurements). Less than half (46.5%) of the participants in this study were aware of their condition, and only one-third (32.5%) of those receiving treatment had controlled blood pressure.

According to the World Health Organization,[12] many factors or health determinants combine to affect the health of individuals. There are 3 types of health determinants: those that relate to people's individual characteristics (e.g. age, sex, comorbidities); those that relate to the social and physical characteristics of their areas of residence (e.g. neighbourhood socioeconomic status and rurality); and those that relate to the characteristics of the health care system and care practices.[13-16] Neighbourhood characteristics can affect those behaviours, including eating habits and physical activity,[17] that affect health.[18] Other factors likely to have an impact on health are the quality and availability of affordable housing,[19] poverty,[20] safety[21] and the sense of cohesion as a result of living in a well-organized and socially connected neighbourhood.[22]

The link between neighbourhood characteristics (socioeconomic status or rurality) and the prevalence and incidence of hypertension has been previously studied. In their 2013 study, Chow et al.[11] found that study participants who lived in urban communities in low-income countries were more aware of and treated and controlled their hypertension better than did the participants in rural communities. However, the awareness, treatment and control were similar for rural and urban residents in higher-income countries. In addition, blood pressure control was more frequent in high-income countries (40.7%).[11] Lee et al.[23] found a gradient between the prevalence of hypertension and income, whereas Aubé-Maurice et al.[24] showed that the incidence of hypertension was associated with the neighbourhood material and social deprivation, although this association differed depending on the case identification algorithm.

In short, the association between deprivation—of an individual, area or country—and health indicators such as prevalence and incidence of hypertension are well documented. However, there are few studies on how neighbourhood characteristics affect mortality, morbidity, use of health services and prescription-drug treatment for a population diagnosed with hypertension in primary prevention for CVD. In addition, as a number of current studies do not have the statistical power to adequately evaluate vulnerable populations,[25] we set out to determine:

- if there is a higher risk of mortality and morbidity in this vulnerable population in deprived areas;
- who are the most frequent users of primary and secondary medical services;
- if people living in deprived areas receive treatment for their hypertension less often than those living in less deprived areas; and
- whether differences exist between urban and small town or rural areas.

Our objectives were to describe and compare the prevalence of hypertension in the primary prevention of CVD in 2006–2007 in the Quebec population, according to the level of material and social deprivation of the area of residence, as well as their mortality, morbidity, use of medical services and prescription-drug treatment. Because the material and social deprivation of the area generally differs depending on the living environment (urban or rural), comparisons were made both globally and by rurality.

Methods

Data sources

We conducted a secondary analysis of medical and administrative data from the list of beneficiaries, the medical services register and the Fichier des hospitalisations Med-Écho of the Quebec health insurance board, the Régie de l'assurance maladie du Québec (RAMQ).[26] The latter lists each patient's diagnoses, hospital admission and discharge dates, and treatment details.[27] The medical services register contains the attending physician's encrypted number, the procedure(s) performed, the diagnosis and the date the service was given. The list of beneficiaries includes patient's sex, date of birth and the geographical location of the place of residence (postal code). The Institut de la statistique du Québec death file lists the date and cause of death for all deaths that occurred in Quebec. Other data were provided by the RAMQ through the health care professionals' file (physician's encrypted number and medical specialty), the public prescription drug insurance plan eligibility file (participation start and end dates) and the file on drug services billed by pharmacists to the RAMQ (which contains all the drug reimbursement claims made by people covered by the public plan, with the drug code, the claim date and the length of treatment).

RAMQ covered the costs of medications for about 41% of the Quebec population in 2006 (i.e. seniors aged 65 years or older, welfare recipients, and everyone not covered by a private prescription-drug insurance plan). Dissemination areas[*] (DA) were associated with each patient's area of residence based on their postal code.[28] Data on material and social deprivation indices were provided by the INSPQ.[29] DA classification as part of a urban, small town or rural area was based on Statistics Canada data.[28] Data on DA population counts by age and sex were based on the

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[*] A DA is the smallest standard geographical area within the Census, with a population of 400 to 700 people.

2006 Census and were provided by Statistics Canada.[30]

This project was approved by the Université de Sherbrooke ethics boards and Quebec's information access commission, the Commission d'accès à l'information.

Population

The study cohort is made up of all the residents of Quebec aged 30 years or older who, between January 2006 and December 2007, had been hospitalized with a primary or secondary diagnosis of hypertension (ICD-9[†] 401 or ICD-10[‡] I10) or used at least 3 medical services with a hypertension diagnosis in 365 days of the study period. Although other algorithms have been validated[31] and have both good sensitivity and good specificity, we did not use them because they involved data from the medical records and prescription-drug files to which we did not have access for all patients. The case definition algorithm for hypertension most similar to ours was validated by Lix et al.[32] for Manitoba data (1 hospitalization or 2 services in 1 year) with a sensitivity of 51% and a specificity of 97%.

To keep only primary prevention of CVD patients in the cohort, we excluded cases with the following CVD diagnoses in the 4 years preceding the reference date (the first date with a hypertension diagnosis in the study period): ischemic heart disease (ICD-9 410–414 or ICD-10 I20–I25), heart failure (ICD-9 428 or ICD-10 I50) or a cerebrovascular disease (ICD-9 430–438 or ICD-10 I60–I69). Also excluded were all patients who had been seen by a doctor or hospitalized for pregnancy (ICD-9 630–676 and 760–779 or ICD-10 O00–O99 and Z32–Z39) in the 5 months following the reference date.[33] Finally, also excluded were patients for whom no DA could be defined or no information on the size of the population of their DA was available, as well as those in a DA for which the material and social deprivation value was unknown.

Variables

The first variable examined was the prevalence of hypertension in CVD primary prevention in relation to material and social deprivation. For each sociogeographical unit selected, the prevalence numerator is the size of the study cohort and the prevalence denominator is the population of Quebec aged 30 years or older.

We also calculated the incidence of all-cause mortality and that of a given cardiovascular event—CVD mortality or hospitalization for a CVD (ICD-9: 410–414, 428 and 430–438; ICD-10: I20–I25, I50 and I60–I69)—for the entire cohort over the 2 years after the reference date. For the other dependent variables, the incidences were calculated based on number of people who survived the two-year period following the reference date. These other dependent variables are all-cause hospitalization; outpatient consultation (for any health problem) with a general practitioner, internist, cardiologist, endocrinologist or nephrologist; an emergency department visit; frequent outpatient medical consultations, regardless of specialty (42 services or more); frequent outpatient visits to a general practitioner (22 services or more); frequent outpatient visits to specialists (4 services or more) or frequent emergency department visits (4 services or more). To better take into account the Quebec context, the thresholds used to define frequent use were based on the population quartiles from a population with hypertension, diabetes or dyslipidemia diagnosed between 2006 and 2007 in Quebec. (Research information available on request.) For example, 25% (top quartile) of the patients in this population had received at least 22 services from a general practitioner. Patients who used health services above these thresholds were considered frequent users. Naessens et al.[34] chose to use a threshold of 10 consultations or more per year (with a total of 20 over 2 years) to identify frequent users of primary care. Measuring the proportion of these frequent users of health care is important because the use of care and the associated cost can be attributed to a relatively small fraction of the population. For example, in the United States, 5% of the population accounts for about 50% of all health costs.[35]

Finally, for the drug-related dependent variables, we calculated the proportion of prescription-drug users among the people eligible for the provincial drug insurance plan who survived the two-year period following the reference date. These variables are use of an antihypertensive, defined globally and by antihypertensive class (angiotensin-converting enzyme inhibitor, angiotensin II receptor antagonist, diuretic, beta blocker, calcium channel blocker, other). Patients are considered to have used a drug in a specific class if they presented at least one prescription in that class at the pharmacy within 2 years following the reference date.

To determine the rurality of a neighbourhood, we used the Statistical Area Classification developed by Statistics Canada.[36] Basic Statistical Area Classification units are municipalities. Each municipality belongs to a census metropolitan area (at least 100 000 inhabitants), a census agglomeration or small town (between 10 000 and 99 999 inhabitants), or a rural area or strong-to-no-influence metropolitan-influenced zone (if the municipality is not classified elsewhere). On the recommendation of Statistics Canada,[37] for the purpose of this analysis we grouped the small towns and rural areas into a single category, ''non-metropolitan areas.''

For level of deprivation, the INSPQ has developed a deprivation index using 6 socioeconomic indicators calculated at the DA level.[38-42] The material component of the index takes into account the proportion of people without a high school diploma, the employment-to-population ratio and the average income, while the social component was calculated using the proportion of people living alone, the proportion of separated, divorced or widowed people, and the proportion of

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[†] *International Classification of Diseases, 9th Revision.*

[‡] *International Classification of Diseases, 10th Revision.*

lone-parent families. DAs are classified by quintiles (i.e. 20% of the population), with Quintile 1 (Q1) the most advantaged and Quintile 5 (Q5) the most deprived. These categorizations were conducted separately for the material and social components, and were then combined, resulting in the 25 neighbourhood deprivation classes (Q1 × Q1 to Q5 × Q5).

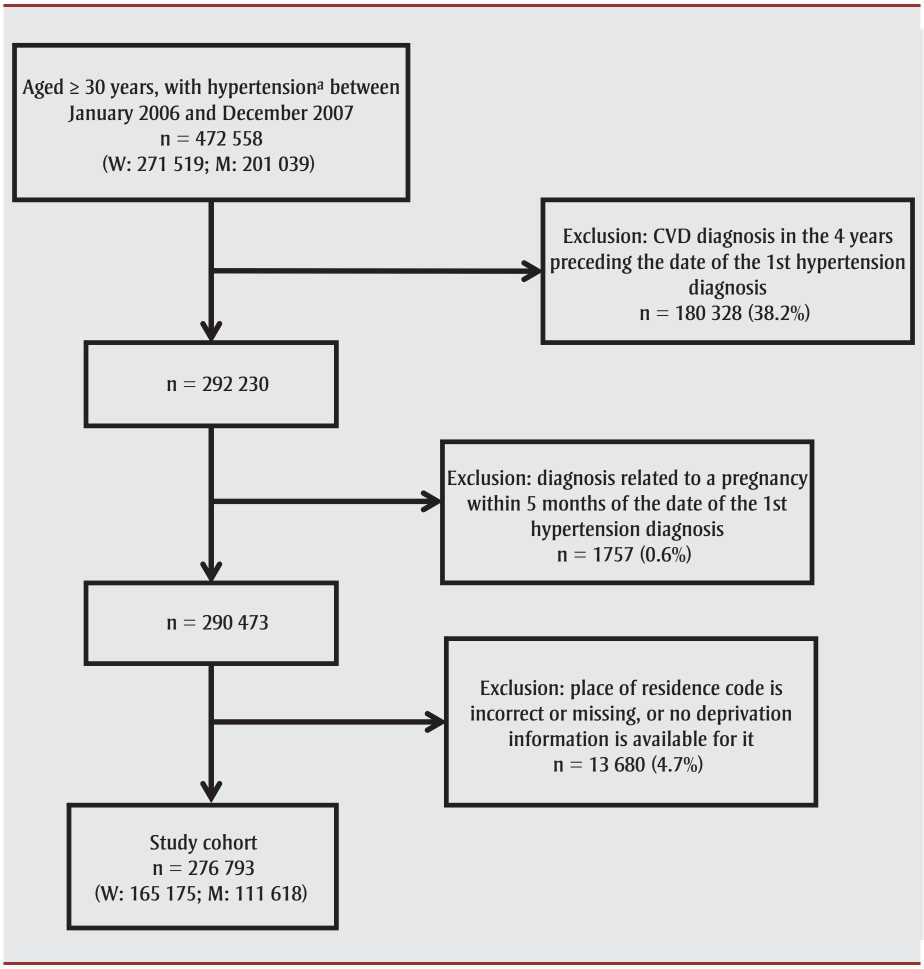
Statistical analyses

The analyses were done for the entire cohort and were stratified by type of neighbourhood (metropolitan and non-metropolitan areas). To determine whether the differences in health indicators between metropolitan and non-metropolitan areas were statistically significant, we used the chi-square test. Given the size of the study cohort (N = 276 793), minimal differences could prove statistically significant. Therefore, we also used the concept of clinical significance, where a variation of ±10% or more in the health indicators is considered clinically significant. For each dependent variable studied, the proportions were adjusted for age and sex. We measured the variability of the health indicators according to deprivation using a coefficient of variation (CV), which represents the ratio of the standard deviation to the mean. To compare the adjusted proportion of the class of interest (one of the 25 classes of neighbourhood material and social deprivation) and the proportion observed in the least materially and socially deprived class (Q1 × Q1), we calculated the relative risk (RR), which indicates the percentage increase or decrease in risk in relation to this class (Q1 × Q1) and with which we associated a confidence interval (CI).

Results

A total of 472 558 people aged 30 years or older met our inclusion criteria for the study period (1 January, 2006, to 31 December, 2007) (Figure 1). Of these, 180 328 (38.2%) had been diagnosed with CVD in the 4 years prior to the reference date or had possible pregnancy-related hypertension (n = 1757) and were excluded. Also excluded were 13 680 people for whom the place of residence was invalid or missing or who lived in DAs for which no socioeconomic information was available. The final cohort included 276 793 people.

FIGURE 1
Selection of the cohort studied



Abbreviations: CVD, cardiovascular disease; ICD, International Classification of Diseases; M, men; W, women.

[a] Hospitalized with a primary or secondary diagnosis of hypertension (ICD-9: 401 or ICD-10: I10) or used at least 3 medical services with a hypertension diagnosis in 365 days during the study period.

Of this number, about 70% were covered by the provincial drug insurance plan on the reference date, mainly because of age (mean age 66 years, with 57% of the cohort 65 years or older) (Table 1). Two-thirds lived in metropolitan areas and one-third in non-metropolitan areas (12% in small towns and 20% in rural areas). This distribution is roughly the same as that of the population of Quebec aged 30 years or older.

The distribution of the cohort according to the neighbourhood material and social deprivation is not uniform, owing to an over-representation of patients in the most deprived areas, in the fourth (Q4) and fifth (Q5) quintiles (Table 1). This would indicate a greater prevalence of hypertension in primary prevention in the deprived areas (Figure 2).

The results of the global analyses and the analyses by rurality are shown in Table 2. Although nearly all the values in the metropolitan and non-metropolitan areas are statistically significantly different, there is much less clinical significance to these differences (at least ±10%), including for the use of drugs. Among the results that indicate a clinically significant difference are the proportion of all-cause deaths and hospitalizations as well as the proportion of cardiovascular events, with the metropolitan areas having lower values than the non-metropolitan areas. In addi-

TABLE 1
Characteristics of the study cohort (n = 276 793) by rurality

Characteristics	Total	Metropolitan areas[a]	Non-metropolitan areas	
			Small towns[b]	Rural areas
Cohort studied, n (%)	276 793 (100)	188 107 (68.0)	33 127 (12.0)	55 559 (20.0)
Average age (SD), years	66.3 (12.7)	66.0 (12.7)	67.0 (12.5)	66.7 (12.4)
Age group in years, n (%)				
< 65	117 844 (42.6)	81 793 (43.5)	13 231 (39.9)	22 820 (41.1)
≥ 65	158 949 (57.4)	106 314 (56.5)	19 896 (60.1)	32 739 (58.9)
Sex, n (%)				
Female	165 175 (59.7)	112 663 (59.9)	20 299 (61.3)	32 213 (58.0)
Male	111 618 (40.3)	75 444 (40.1)	12 828 (38.7)	23 346 (42.0)
Material deprivation quintile, n (%)				
Q1[c]	48 585 (17.6)	44 908 (23.9)	2 097 (6.3)	1 580 (2.8)
Q2	53 203 (19.2)	42 833 (22.8)	5 887 (17.8)	4 483 (8.1)
Q3	57 577 (20.8)	39 721 (21.1)	8 661 (26.1)	9 195 (29.2)
Q4	59 302 (21.4)	34 506 (18.3)	8 562 (25.8)	16 234 (29.2)
Q5[d]	58 126 (21.0)	26 139 (13.9)	7 920 (23.9)	24 067 (43.3)
Social deprivation quintile, n (%)				
Q1[c]	47 248 (17.1)	29 772 (15.8)	4 438 (13.4)	13 038 (23.5)
Q2	50 861 (18.4)	28 227 (15.0)	5 403 (16.3)	17 231 (31.0)
Q3	55 106 (19.9)	33 892 (18.0)	6 532 (19.7)	14 682 (26.4)
Q4	60 820 (22.0)	45 199 (24.0)	7 417 (22.4)	8 204 (14.8)
Q5[d]	62 758 (22.7)	51 017 (27.1)	9 337 (28.2)	2 404 (4.3)
Combinations of material and social deprivation quintiles, n (%)				
Q1 × Q1	8 900 (3.2)	8 368 (4.4)	338 (1.0)	194 (0.4)
Q1 × Q2	7 340 (2.6)	6 629 (3.5)	439 (1.3)	272 (0.5)
Q1 × Q3	9 143 (3.3)	8 020 (4.3)	494 (1.5)	629 (1.1)
Q1 × Q4	11 137 (4.0)	10 488 (5.6)	321 (1.0)	328 (0.6)
Q1 × Q5	12 065 (4.4)	11 403 (6.1)	505 (1.5)	157 (0.3)
Q2 × Q1	8 649 (3.1)	7 177 (3.8)	813 (2.4)	659 (1.2)
Q2 × Q2	9 693 (3.5)	7 313 (3.9)	1 158 (3.5)	1 222 (2.2)
Q2 × Q3	10 745 (3.9)	7 962 (4.2)	1 555 (4.7)	1 228 (2.2)
Q2 × Q4	12 357 (4.5)	9 924 (5.3)	1 220 (3.7)	1 213 (2.2)
Q2 × Q5	11 759 (4.2)	10 457 (5.6)	1 141 (3.4)	161 (0.3)
Q3 × Q1	9 375 (3.4)	6 390 (3.4)	1 327 (4.0)	1 658 (3.0)
Q3 × Q2	10 888 (3.9)	6 186 (3.3)	1 755 (5.3)	2 947 (5.3)
Q3 × Q3	12 172 (4.4)	7 838 (4.2)	1 683 (5.1)	2 651 (4.8)
Q3 × Q4	12 797 (4.6)	9 165 (4.9)	2 081 (6.3)	1 551 (2.8)
Q3 × Q5	12 345 (4.5)	10 142 (5.4)	1 815 (3.6)	388 (0.7)
Q4 × Q1	9 636 (3.5)	5 087 (2.7)	1 183 (3.6)	3 366 (6.1)
Q4 × Q2	10 445 (3.8)	4 564 (2.4)	1 132 (3.4)	4 749 (8.6)
Q4 × Q3	12 305 (4.4)	5 970 (3.2)	1 727 (5.2)	4 608 (8.3)
Q4 × Q4	13 429 (4.8)	8 347 (4.4)	2 401 (7.2)	2 681 (4.8)
Q4 × Q5	13 487 (4.9)	10 538 (5.6)	2 119 (6.4)	830 (1.5)
Q5 × Q1	10 688 (3.9)	2 750 (1.5)	777 (2.4)	7 161 (12.9)
Q5 × Q2	12 495 (4.5)	3 535 (1.9)	919 (2.8)	8 041 (14.5)
Q5 × Q3	10 741 (3.9)	4 102 (2.2)	1 073 (3.2)	5 566 (10.0)

Continued on the following page

tion, a larger proportion of metropolitan area patients consult specialists, but a smaller proportion visit emergency departments.

Table 3 shows the variations for each health indicator after adjustment for age and sex within the 25 neighbourhood deprivation classes, overall and by rurality (metropolitan and non-metropolitan areas). Among the indicators that vary greatly with deprivation are the proportion of deaths and of cardiovascular events, the proportion of frequent visits to general practitioners and medical specialists, as well as the proportion of frequent visits to emergency departments. Little or no variation is seen in the use of antihypertensive drugs.

Compared with patients living in materially and socially advantaged areas (Q1 × Q1), patients living in the most materially and socially deprived areas (Q5 × Q5) were at a 58% higher risk of dying (RR = 1.58, 95% CI: 1.41–1.77), 46% higher risk of a cardiovascular event (RR = 1.46, 95% CI: 1.29–1.65), 47% more at risk of being frequent emergency department visitors (RR = 1.47, 95% CI: 1.40–1.55), and 31% more at risk of being frequent users of a general practitioner's services (RR = 1.31, 95% CI: 1.25–1.38) (Table 3). However, those patients living in the most materially and socially deprived areas had 25% less chance of being frequent users of medical specialists' services (RR = 0.75, 95% CI: 0.71–0.79).

Figure 2 shows the variations observed in the prevalence of hypertension in primary prevention of CVD according to material and social deprivation. This graph helps visualize variations that relate to an area's material deprivation and those that relate to its social deprivation, notably a significant gradient in prevalences toward the most deprived areas. Once adjusted for age and sex, however, the distribution by area type is much more uniform, although the gradient persists in the metropolitan areas.

Figures 3 to 5 show the variations for a selection of health indicators with a relatively high CV (Table 2), overall (Figure 3) and by rurality (Figures 4 and 5). The indicators adjusted for age and sex that

TABLE 1 (continued)
Characteristics of the study cohort (n = 276 793) by rurality

Characteristics	Total	Metropolitan areas[a]	Non-metropolitan areas	
			Small towns[b]	Rural areas
Q5 × Q4	11 110 (4.0)	7 275 (3.9)	1 394 (4.2)	2 431 (4.4)
Q5 × Q5	13 102 (4.7)	8 477 (4.5)	3 757 (11.3)	868 (1.6)

[a] Equivalent to a census metropolitan area (≥ 100 000 inhabitants).[36]

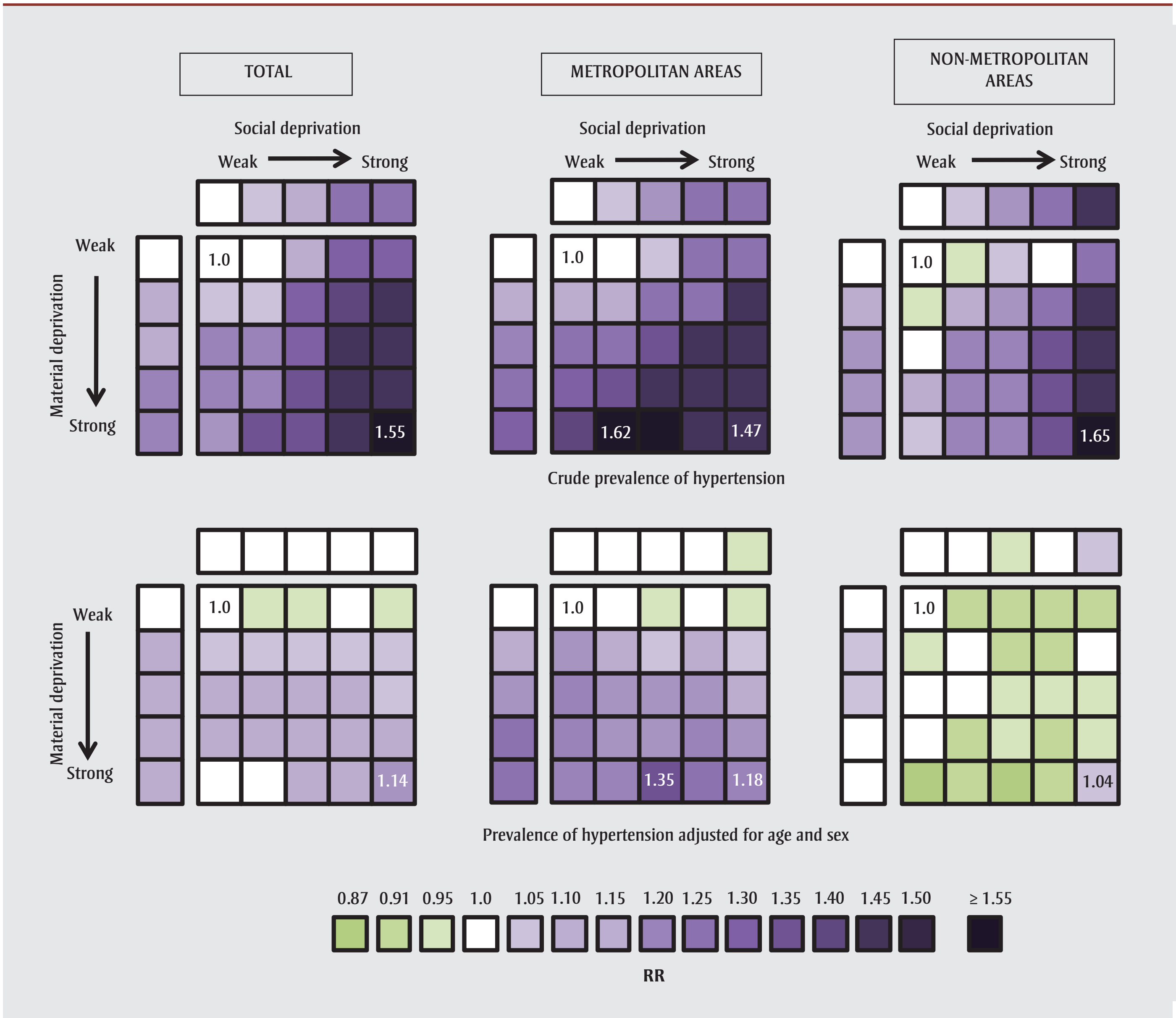
[b] Small town (10 000–99 999 inhabitants) or census agglomeration and rural area or strong-to-no-influence metropolitan-influenced zone grouped into a single category on the recommendation of Statistics Canada.[37]

[c] Most advantaged.

[d] Most deprived.

present a significant general gradient from the least deprived areas to the most deprived areas (Figure 3) are the proportion of deaths, the proportion of cardiovascular events and the proportion of frequent users of outpatient services (general practitioner, emergency). The relationship is inverse for the adjusted proportion of frequent users of medical specialists' services, as people living in the most advantaged areas use specialists' services more frequently. The 2 types of deprivation seem

FIGURE 2
Inequalities in the prevalence of hypertension in CVD primary prevention by neighbourhood deprivation and rurality (metropolitan or non-metropolitan areas): relative risks



Abbreviations: CVD, cardiovascular disease; RR, relative risk.

Note: The RR in an area is the prevalence (crude and adjusted for age and sex) in that area divided by the prevalence (crude and adjusted for age and sex) in the most materially and socially advantaged area.

TABLE 2
Description of the health indicators in patients (≥ 30 years) with hypertension, in primary prevention of CVD, overall and by rurality (metropolitan or non-metropolitan areas), Quebec, January 2006–December 2007

Health indicators[a]	Total			Metropolitan areas[b]			Non-metropolitan areas[c]			p-value[d]	Variation (as %)[e]
	n	N	%	n	N	%	n	N	%		
Prevalence of hypertension in primary prevention of CVD	276 793	4 697 515	5.9	188 107	3 143 625	6.0	88 686	1 553 415	5.7	< .001	−5.0
Death	**15 104**	**276 793**	**5.5**	**9 677**	**188 107**	**5.1**	**5 427**	**88 686**	**6.1**	**< .001**	**19.6**
Cardiovascular event	**14 050**	**276 793**	**5.1**	**8 665**	**188 107**	**4.6**	**5 385**	**88 686**	**6.1**	**< .001**	**32.6**
All-cause hospitalization	**87 395**	**261 689**	**33.4**	**56 387**	**178 430**	**31.6**	**31 008**	**83 259**	**37.2**	**< .001**	**17.7**
Number of consultations											
General practitioner (≥1)	256 657	261 689	98.1	174 853	178 430	98.0	81 804	83 259	98.3	< .001	0.3
Specialist (≥1)	**103 207**	**261 689**	**39.4**	**73 809**	**178 430**	**41.4**	**29 398**	**83 259**	**35.3**	**< .001**	**−14.7**
Cardiologist (≥1)	**64 140**	**261 689**	**24.5**	**47 873**	**178 430**	**26.8**	**16 267**	**83 259**	**19.5**	**< .001**	**−27.2**
Internist (≥1)	**42 269**	**261 689**	**16.2**	**27 766**	**178 430**	**15.6**	**14 503**	**83 259**	**17.4**	**< .001**	**11.5**
Emergency departments (≥1)	**119 916**	**261 689**	**45.8**	**76 171**	**178 430**	**42.7**	**43 745**	**83 259**	**52.5**	**< .001**	**22.9**
Frequent users											
Outpatient clinics (≥42)	60 452	261 689	23.1	41 434	178 430	23.2	19 018	83 259	22.8	.0319	−1.7
General practitioners (≥22)	**66 601**	**261 689**	**25.4**	**43 157**	**178 430**	**24.2**	**23 444**	**83 259**	**28.2**	**< .001**	**16.5**
Specialists (≥4)	**48 899**	**261 689**	**18.7**	**36 713**	**178 430**	**20.6**	**12 186**	**83 259**	**14.6**	**< .001**	**−29.1**
Emergency departments (≥4)	**63 992**	**261 689**	**24.5**	**41 131**	**178 430**	**23.1**	**22 861**	**83 259**	**27.5**	**< .001**	**19.0**
Antihypertensive	175 204	183 156	95.7	115 376	120 833	95.5	59 828	62 323	96.0	< .001	0.5
ACEI/ARB	136 061	183 156	74.3	89 617	120 833	74.2	46 444	62 323	74.5	.0991	0.4
Diuretic	117 660	183 156	64.2	78 632	120 833	65.1	39 028	62 323	62.6	< .001	−3.8
Calcium channel blocker	85 305	183 156	46.6	55 288	120 833	45.8	30 017	62 323	48.2	< .001	5.2
Beta blocker	63 678	183 156	34.8	41 139	120 833	34.0	22 539	62 323	36.2	< .001	6.5

Abbreviations: ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker II; CVD, cardiovascular disease.

Note: The bolded indicators indicate a variation of ≥10% between the values for the metropolitan areas and those for the non-metropolitan areas.

[a] Calculated in the 2 years following the reference date.

[b] Equivalent to a census metropolitan area (≥ 100 000 inhabitants).

[c] Small towns (10 000–99 999 inhabitants) and rural areas.

[d] Chi-square test for the difference in proportion between metropolitan and non-metropolitan areas.

[e] Percentage variation between the rate obtained for non-metropolitan areas and that obtained for metropolitan areas.

to play an equivalent role for some indicators (proportion of deaths, proportion of frequent users of general practitioners' services), while for other indicators (proportion of cardiovascular events, proportion of frequent emergency department visitors or frequent users of specialists' services) material deprivation predominates.

The gradients observed in the metropolitan areas (Figure 4) are similar to those seen overall (Figure 3), probably because these areas account for two-thirds of the cohort studied. The analyses stratified according to rurality reveal larger variations in the non-metropolitan areas (Figure 5) than in the metropolitan areas (Figure 4). These variations are not surprising because samples are smaller in these areas, resulting in a larger variance in the estimation of proportions. Overall, however, for most of the variables studied, the results are consistent, except perhaps for mortality and cardiovascular events, where greater instability in the estimates is observed.

Discussion

This study shows significant variations for a number of health indicators, depending on the area's material and social deprivation. Even after adjusting for age and sex, the risk of death was higher by 58%, the risk of a cardiovascular event higher by 46%, the risk of hospitalization (all causes) higher by 18% and the prevalence of hypertension higher by 14% for people living in the most materially and socially deprived areas (Q5 × Q5) than for people living in the least materially and socially deprived areas (Q1 × Q1). In addition, the adjusted proportion of frequent users of primary care services was much larger in the more deprived areas, with 47% more frequent emergency department visitors and 31% more frequent users of general practitioners' services. Previous studies have shown that people with a lower socioeconomic status make greater use of outpatient medical services, including emergency department services.[43] In our study, the patients in the most deprived areas not only visited emergency departments more frequently, confirming the results of another Canadian study,[44] but also consulted general practitioners more

TABLE 3

Variation in health indicators in patients (≥ 30 years) with hypertension in primary prevention of cardiovascular disease, adjusted for age and sex, overall and by rurality (metropolitan[a] or non-metropolitan[b] areas), Quebec, January 2006–December 2007

Health indicators[a]	Total			Metropolitan areas			Non-metropolitan areas		
	Proportion, % (range[b])	CV[c] (as %)	RR[d] (95% CI)	Proportion, % (range[b])	CV[c] (as %)	RR[d] (95% CI)	Proportion, % (range[b])	CV[c] (as %)	RR[d] (95% CI)
Prevalence of hypertension in primary prevention of CVD	5.9 (5.3–6.4)	5.4	1.14 (1.12–1.17)	6.0 (5.2–7.4)	8.9	1.18 (1.14–1.21)	5.7 (5.3–6.4)	4.8	1.04 (0.96–1.12)
Death	5.5 (4.5–7.2)	11.3	1.58 (1.41–1.77)	5.1 (4.4–7.1)	12.6	1.62 (1.43–1.84)	6.1 (4.4–7.8)	11.8	1.22 (0.86–1.73)
Cardiovascular event	5.1 (4.0–6.2)	11.4	1.46 (1.29–1.65)	4.6 (4.0–5.6)	9.3	1.41 (1.23–1.62)	6.1 (3.8–6.9)	11.5	1.67 (1.08–2.59)
All-cause hospitalization	33.4 (30.1–37.0)	4.8	1.18 (1.13–1.23)	31.6 (29.0–34.1)	3.6	1.15 (1.10–1.20)	37.2 (30.5–40.0)	5.4	1.01 (0.90–1.14)
Number of consultations									
General practitioner (≥1)	98.1 (96.1–98.7)	0.5	1.01 (1.01–1.01)	98.0 (97.3–98.5)	0.3	1.01 (1.01–1.01)	98.3 (95.5–99.1)	0.8	1.02 (1.00–1.04)
Specialist (≥1)	39.4 (36.5–45.7)	5.8	0.86 (0.83–0.89)	41.4 (38.1–46.1)	3.9	0.89 (0.86–0.92)	35.3 (33.6–39.8)	4.5	0.92 (0.82–1.03)
Cardiologist (≥1)	24.5 (20.3–29.4)	9.2	0.82 (0.78–0.86)	26.8 (24.2–29.8)	4.6	0.90 (0.86–0.95)	19.5 (17.5–23.8)	7.8	0.86 (0.72–1.03)
Internist (≥1)	16.2 (14.3–18.0)	5.7	1.00 (0.94–1.06)	15.6 (13.9–17.3)	5.9	0.92 (0.86–0.99)	17.4 (15.1–20.1)	7.7	1.08 (0.89–1.31)
Emergency departments (≥1)	45.8 (37.7–51.7)	8.4	1.37 (1.33–1.41)	42.7 (37.1–48.3)	6.1	1.30 (1.25–1.35)	52.5 (43.3–58.4)	7.0	1.27 (1.15–1.40)
Frequent users									
Outpatient clinics (≥42)	23.1 (21.2–25.6)	5.4	1.09 (1.04–1.15)	23.2 (20.9–25.4)	5.2	1.09 (1.03–1.15)	22.8 (20.1–27.9)	9.1	1.13 (0.96–1.34)
General practitioners (≥22)	25.5 (21.2–28.2)	8.4	1.31 (1.25–1.38)	24.2 (20.7–27.6)	8.5	1.30 (1.23–1.37)	28.2 (21.5–32.3)	8.1	1.37 (1.15–1.64)
Specialists (≥4)	18.7 (15.6–24.5)	11.2	0.75 (0.71–0.79)	20.6 (18.3–24.8)	6.7	0.81 (0.76–0.86)	14.6 (13.3–19.4)	9.5	0.80 (0.66–0.97)
Emergency departments (≥4)	24.5 (20.1–29.6)	10.4	1.47 (1.40–1.55)	23.1 (19.6–27.9)	9.1	1.42 (1.34–1.50)	27.5 (22.6–33.2)	10.3	1.34 (1.14–1.57)
Antihypertensive	95.7 (94.7–96.3)	0.5	1.01 (1.00–1.02)	95.5 (94.6–96.2)	0.4	1.01 (1.00–1.02)	96.0 (93.1–96.9)	0.9	1.00 (0.98–1.03)
ACEI/ARB	74.3 (72.9–75.6)	1.0	0.99 (0.97–1.01)	74.2 (72.8–77.0)	1.4	0.98 (0.96–1.00)	74.5 (68.0–76.0)	2.4	1.09 (1.01–1.18)
Diuretic	64.2 (62.6–66.5)	1.1	0.99 (0.96–1.02)	65.1 (62.4–68.4)	2.1	1.02 (0.99–1.05)	62.6 (59.6–65.5)	2.7	0.99 (0.90–1.09)
Calcium channel blocker	46.6 (42.5–49.4)	4.0	1.16 (1.12–1.21)	45.8 (41.9–48.8)	4.1	1.15 (1.10–1.20)	48.2 (45.0–51.2)	3.1	1.10 (0.97–1.24)
Beta blocker	34.8 (33.8–36.3)	1.6	1.02 (0.97–1.07)	34.0 (32.8–35.6)	2.0	1.01 (0.96–1.07)	36.2 (34.3–44.5)	5.6	0.94 (0.81–1.09)

Abbreviations: ACEI, angiotensin-converting enzyme inhibitor; ARB, angiotensin receptor blocker II; CI, confidence interval; CV, coefficient of variation; Q, quintile; RR, relative risk.

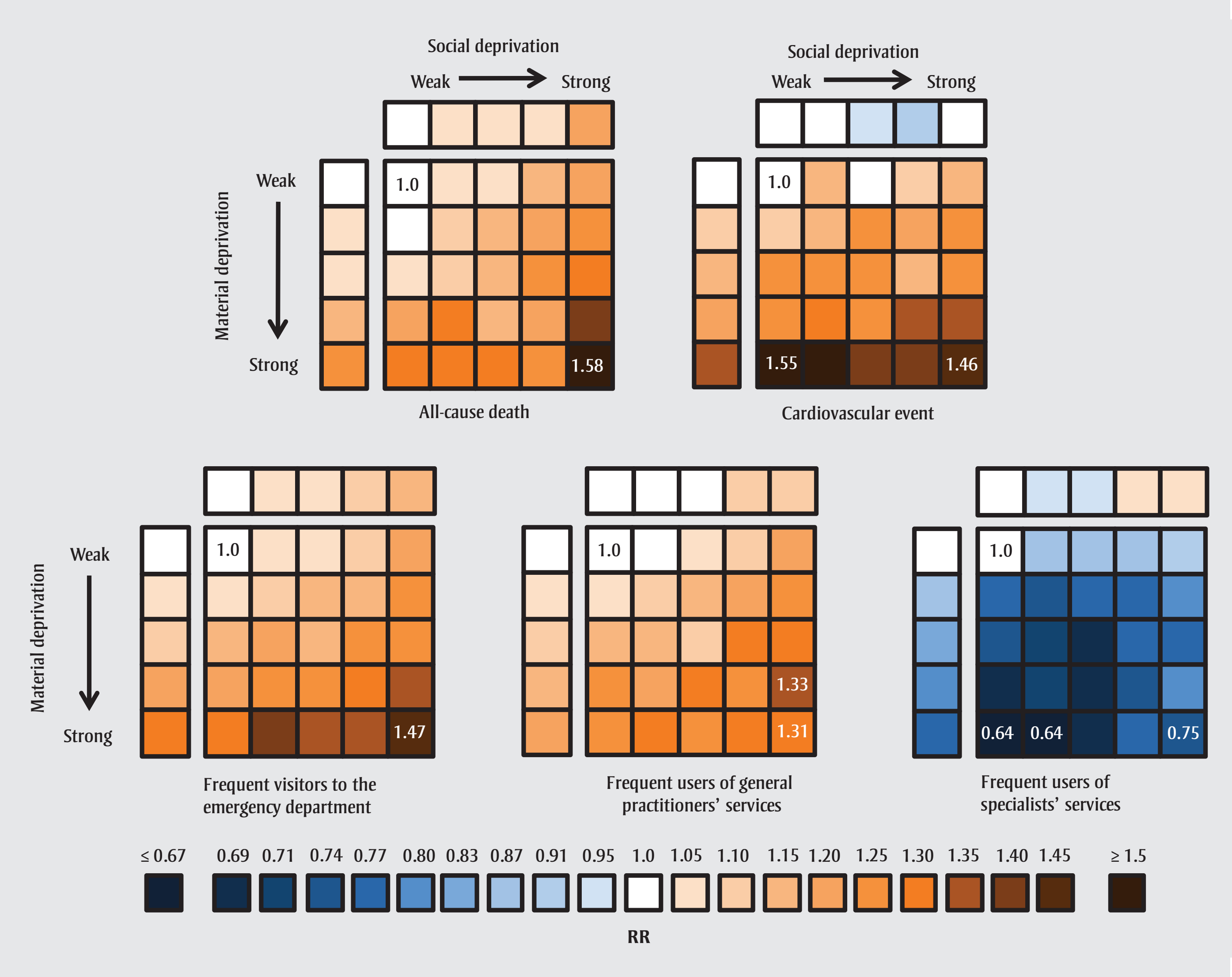
[a] Calculated in the 2 years following the reference date.

[b] Overall proportion (%) and range (minimum – maximum) of the proportions adjusted for age and sex according to the 25 values obtained by combining the material and social deprivation quintiles (Q1 × Q1 to Q5 × Q5).

[c] The coefficient of variation (CV) is the standard deviation divided by the mean of the 25 values.

[d] The relative risk (RR) is the ratio of the adjusted proportion for the people in the most materially and socially deprived areas (quintiles t) over that calculated for the people in the least materially and socially deprived areas (quintiles 1). It is accompanied by its 95% CI.

FIGURE 3
Health inequalities of patients with hypertension, by neighbourhood deprivation: relative risks



Abbreviation: RR, relative risk.

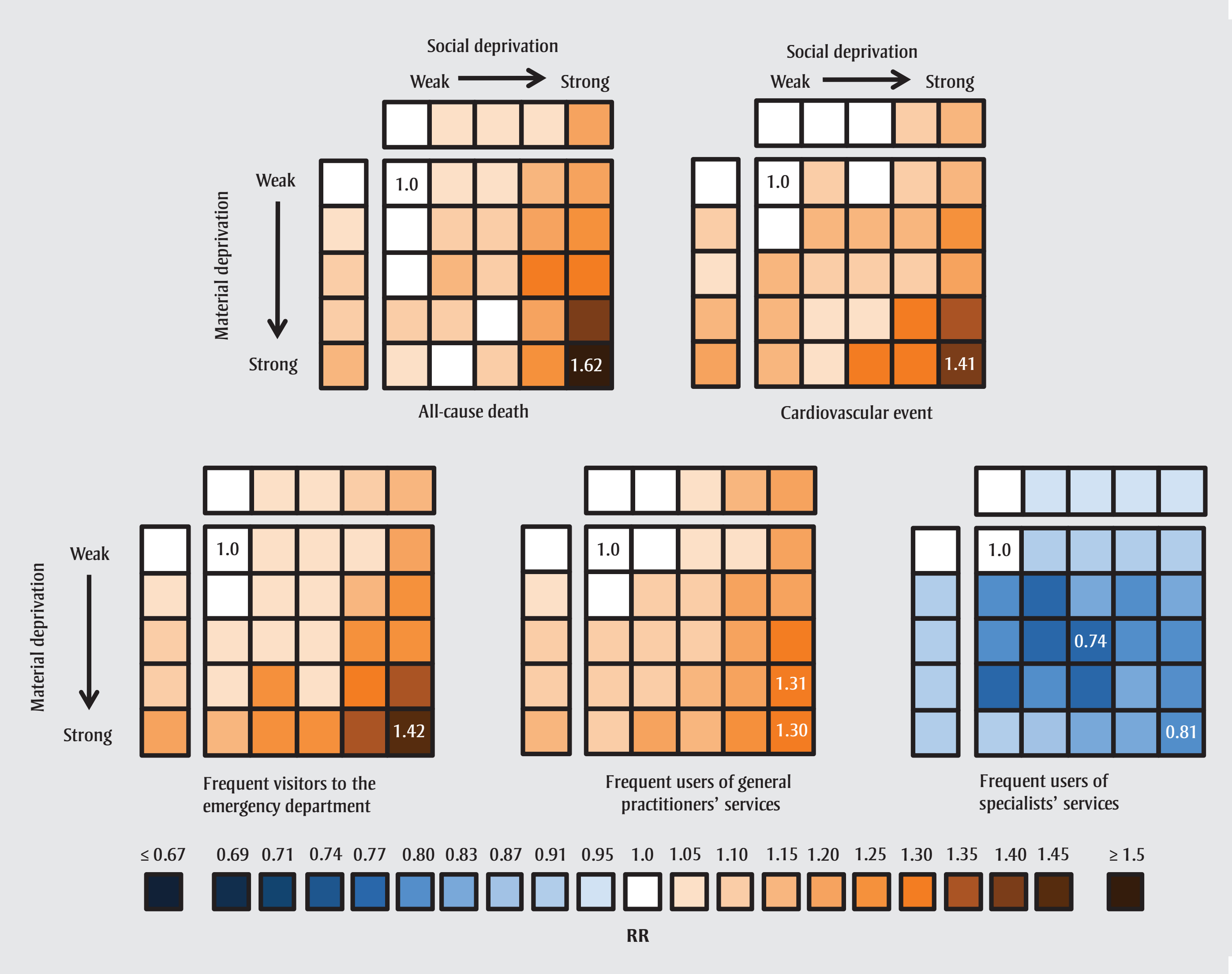
Note: The RR in an area is the proportion adjusted for age and sex in that area divided by the proportion adjusted for age and sex in the most materially and socially advantaged area.

frequently. We also saw that the proportion of frequent users of specialty services was larger in the most advantaged areas. These variations were also present in the analyses stratified by metropolitan and non-metropolitan area. The lack of variation (or the small variation) seen in the use of antihypertensives may point to the favourable impact of the provincial policy of universal access to drugs.

In short, a large proportion of patients with hypertension who have no history of CVD and live in materially and socially deprived areas experience more serious consequences than those living in advantaged areas, even though they receive equivalent pharmacotherapy.

In our study, the prevalence of hypertension in CVD primary prevention is estimated at 5.9% over the 2 years studied (2006–2007). Our estimate is much lower than the prevalence of hypertension calculated by the INSPQ[10] for the same period (20.3%) or the prevalence estimated by Lix et al.[32] for 2002–2003 (10.0%). However, the populations studied differed: we included only patients with hypertension without a history of CVD, thus reducing the cohort by nearly 38% (Figure 1). In addition, we used just one diagnostic code (ICD-9: 401 and ICD-10: I10) in our study to identify hypertension cases, as did Lix et al.,[32] while the INSPQ expanded the hypertension codes to include those related to other pathologies (heart disease, renal disease, hypertensive heart and renal disease, and secondary hypertension [ICD-9: 402-405 and ICD-10: I11-I13 and I15]). Finally, the algorithm we used to identify hypertension cases (3 diagnoses in 1 year or 1 hospitalization) was more specific than those used by the INSPQ (2 diagnoses in 2 years or 1 hospitalization) and by Lix et al.[32] (2 diagnoses in 1 year or 1 hospitalization).

FIGURE 4
Health inequalities of patients with hypertension, by neighbourhood deprivation in metropolitan areas: relative risks



Abbreviation: RR, relative risk.

Note: The RR in an area is the proportion adjusted for age and sex in that area divided by the proportion adjusted for age and sex in the most materially and socially advantaged area.

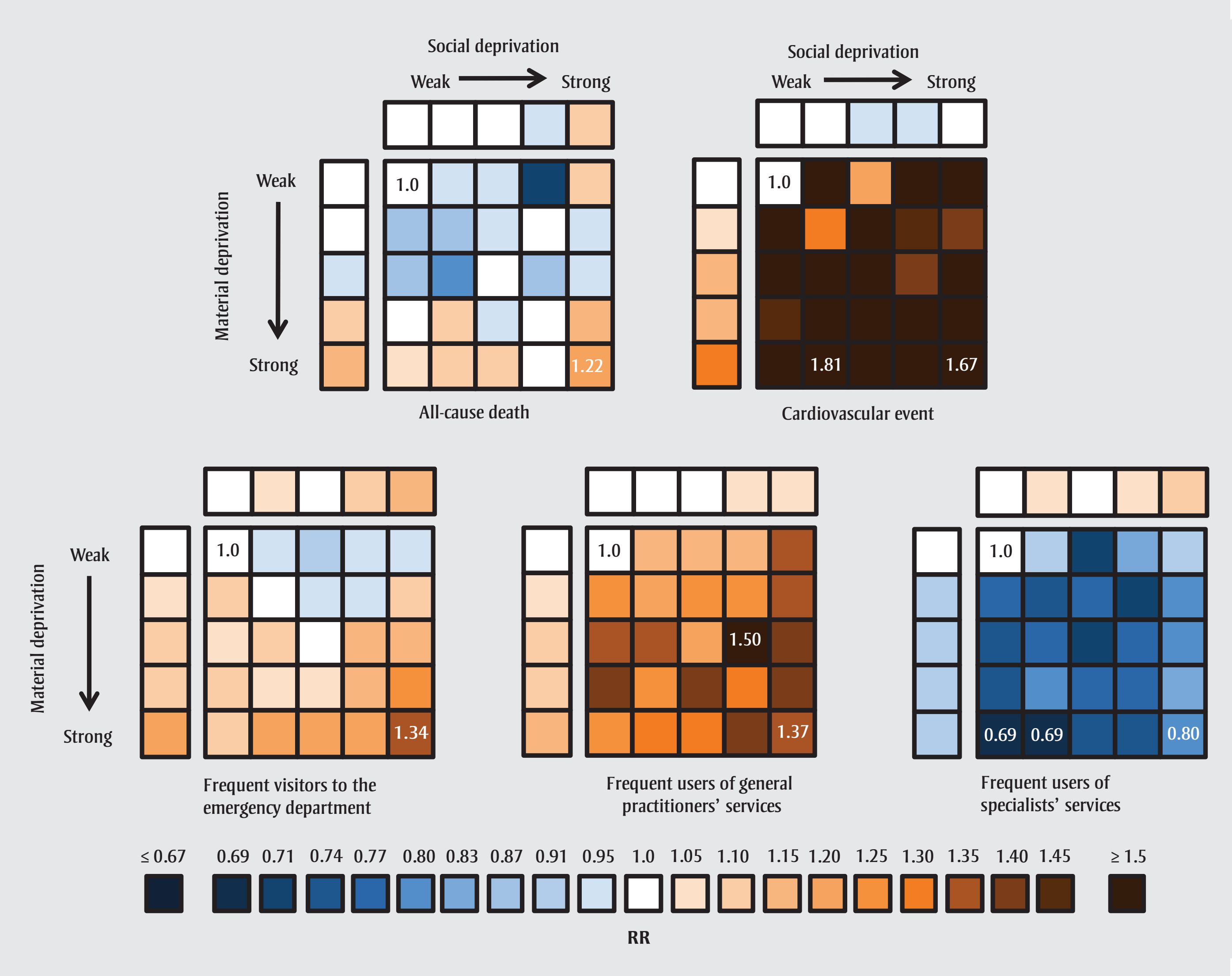
We should also point out that 60% of the cohort were women. Women use health services more frequently than do men[45-47] and are therefore more likely to be diagnosed with hypertension and to be detected by our selection algorithm. In addition, we excluded all patients who had been diagnosed with CVD, which occurs in men more frequently than in women.[48-49]

The gradient in the rates of prevalence of hypertension in primary prevention of CVD according to the neighbourhood level of deprivation is evident and reflects, in good part, a real difference in the age and sex distribution in those areas (Figure 2). This is illustrated by a significant decrease in the gradient between the adjusted and unadjusted results. However, our results for prevalence differ from those published by the INSPQ, where there was a gradient in the hypertension incidence rates from the least materially deprived to the most materially deprived for women only, with an inverse gradient for social deprivation for both sexes.[50]

Many studies have looked at the link between deprivation and certain health indicators. The health indicators related specifically to hypertension include incidence,[10] prevalence,[51-53] treatments[54] and hypertension care appropriateness.[55] Hammouche et al.[55] proved that study participants with hypertension living in deprived areas in the United Kingdom received care that was at least as good, if not better, than did those living in advantaged areas. The absence of a link between deprivation and the use of antihypertensives in our study is consistent with the results of Hammouche et al.[55] but not with those of Pears et al.[54] in Scotland. This absence of a correlation between the use of certain drugs and deprivation was also observed for a cohort of patients with schizophrenia

FIGURE 5

Health inequalities of patients with hypertension, by neighbourhood deprivation in non-metropolitan areas: relative risks



Abbreviation: RR, relative risk.

Note: The RR in an area is the proportion adjusted for age and sex in that area divided by the proportion adjusted for age and sex in the most materially and socially advantaged area.

who took antipsychotic drugs,[56] and this may point to the effectiveness of the provincial policy of universal access to drugs.

Strengths and limitations

The greatest strength of our study is that we analysed the entire population of Quebec with a hypertension diagnosis but no known CVD diagnosis. In addition, we compared a large range of health indicators according to 25 area types, ranging from the most materially and socially advantaged to the most materially and socially deprived. However, this study has a number of limitations. First, as we said earlier, the algorithm used is very specific, but not very sensitive, with the result that actual prevalence is underestimated. Nevertheless, we believe that this inclusion bias makes the analyses more robust with regard to the other health indicators because our cohort has very few false positives. In addition, a large number of people with hypertension are not diagnosed[11] and are therefore not taken into account in our cohort; this is also the case for patients who saw only doctors who work on an hourly rate—for example, in a local community service centre. In 2006–2007, as many as 12% of general practitioners worked in a local community service centre.[57]

Second, because the results for drugs relate to only 70% of the cohort we studied (183 156 patients out of 276 793 covered by the provincial drug insurance plan), our results should not be generalized to the overall population with hypertension (selection bias). Further, people aged under 65 years who are socioeconomically deprived are overrepresented in this subpopulation. For this age category, the RAMQ covers all social assistance recipients and all people not covered by a private drug insurance plan.

Conclusion

This study demonstrates the existence of significant variations for a number of health indicators among patients with hypertension in primary prevention of CVD according to their neighbourhood material and social deprivation. Some of the indicators, such as deaths from all causes and the incidence of cardiovascular events, can lead to a risk increase of up to 58% in the most deprived areas, compared with the least deprived, even though there is little or no variation in the use of antihypertensives and the patients in the most deprived areas seem to receive equally good primary care. In a context in which the burden of chronic disease is growing, such health inequalities have major public health implications. This study again shows the importance of taking socioeconomic status into account when planning interventions to prevent CVDs and their consequences. A better understanding of the processes underlying the social inequalities of health in relation to areas of residence is an essential area of public health research.

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References

1. Ezzati M, Lopez AD, Rodgers A, et al. Selected major risk factors and global and regional burden of disease. Lancet. 2002;360: 1347–60.
2. Lim SS, Vos T, Flaxman AD, et al. A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 1990–2010: a systematic analysis for the global burden of disease study 2010. Lancet. 2012;380:2224–60.
3. Cloutier L, Morris D, Bruneau J, McLean D. World Health Organization celebrates World Health Day, April 7, 2013 – focusing on hypertension. Can J Cardiovasc Nurs. 2013;23(2):9-11.
4. Kearney PM, Whelton M, Reynolds K, Muntner P, Whelton PK, He J. Global burden of hypertension: analysis of worldwide data. Lancet. 2005;365:217-23.
5. Danaei G, Finucane MM, Lin JK, et al. National, regional, and global trends in systolic blood pressure since 1980: systematic analysis of health examination surveys and epidemiological studies with 786 country-years and 5·4 million participants. Lancet. 2011;377(9765):568-77.
6. Leenen FH, Dumais J, McInnis NH, et al. Results of the Ontario survey on the prevalence and control of hypertension. CMAJ. 2008;178(11):1441-9.
7. Statistics Canada. Canadian Health Measures Survey: blood pressure in adults [Internet]. Ottawa (ON): Statistics Canada; 2010 Feb 17 [cited 2014 Jul 7]. Available at: http://www.statcan.gc.ca/daily-quotidien/100217/dq100217b-eng.htm
8. Joffres M, Falaschetti E, Gillespie C, et al. Hypertension prevalence, awareness, treatment and control in national surveys from England, the USA and Canada, and correlation with stroke and ischaemic heart disease mortality: a cross-sectional study. BMJ Open. 2013;3(8):e003423.
9. Blais C, Rochette L. Surveillance de l'hypertension au Québec: incidence, prévalence et mortalité. Québec (QC): Institut national de sante publique du Québec; 2011. Available from: http://www.inspq.qc.ca/pdf/publications/1059_HypertensionArterielle.pdf
10. Robitaille C, Dai S, Waters C, et al. Diagnosed hypertension in Canada: incidence, prevalence and associated mortality. CMAJ. 2012;184(1):E49-56.
11. Chow CK, Teo KK, Rangarajan S, et al. Prevalence, awareness, treatment, and control of hypertension in rural and urban communities in high-, middle-, and low-income countries. JAMA. 2013;310(9):959-68.
12. World Health Organization. Health impact assessment (HIA): the determinants of health [Internet]. Geneva (CH): World Health Organization; [cited 2014 Jul 7]. Available at: http://www.who.int/hia/evidence/doh/en/
13. Raphael D, editor. Social determinants of health: Canadian perspectives. Toronto (ON): Canadian Scholars' Press; 2004.
14. Shah CP. Public health and preventive medicine in Canada (5th ed.). Toronto: Elsevier Canada; 2003.
15. Starfield B. Primary Care: Balancing health needs, services, and technology. New York: Oxford University Press; 1998.
16. Wilkinson R, Marmot M, editors. Social determinants of health. The solid facts (2nd ed.). Copenhagen: World Health Organization; 2003.
17. Sallis JF, Glantz K. Physical activity and food environments: solutions to the obesity epidemic. Milbank Q. 2009;87:123-54.
18. Lemstra M, Neudorf C, Opondo J. Health disparity by neighbourhood income. Can J Public Health. 2006;97:435-9.
19. Krieger J, Higgins DL. Housing and health: time again for public health action. Am J Public Health. 2002;92:758-68.
20. Lynch JW, Smith GD, Kaplan GA, House JS. Income inequality and mortality: importance to health of individual income, psychosocial environment, or material conditions. BMJ. 2000;320:1200-4.
21. Wood D. Effect of child and family poverty on child health in the United States. Pediatrics. 2003;112:707-11.
22. Gidlow C, Cochrane T, Davey RC, Smith G, Fairburn J. Relative importance of physical and social aspects of perceived neighbourhood environment for self-reported health. Prev Med. 2010;51:157-63.
23. Lee DS, Chiu M, Manuel DG, et al. Trends in risk factors for cardiovascular disease in Canada: temporal, socio-demographic and geographic factors. CMAJ. 2009;181(3-4): E55-66.

24. Aubé-Maurice J, Rochette L, Blais C. Divergent associations between incident hypertension and deprivation based on different sources of case identification. Chronic Dis Inj Can. 2012;32(3):136-46.

25. Campbell NR, McAlister FA, Quan H; Hypertension Outcomes Research Task Force. Monitoring and evaluating efforts to control hypertension in Canada: why, how, and what it tells us needs to be done about current care gaps. Can J Cardiol. 2013;29(5):564-70.

26. Régie de l'Assurance Maladie du Québec (RAMQ). Banques de données: vue d'ensemble [Internet]. Québec (QC): RAMQ; [cited 2014 Jul 7]. Available at: http://www.ramq.gouv.qc.ca/fr/donnees-statistiques/Pages/donnees-statistiques.aspx

27. Ministère de la Santé et des Services sociaux du Québec. Cadre normatif Med-Écho – Mise à jour 2011 [Internet]. Québec (QC): MSSS; 2011[cited 2014 Apr]. Available at: http://msssa4.msss.gouv.qc.ca/fr/document/publication.nsf/0/581d207c3ed564a7852574bf005283de?OpenDocument

28. Statistics Canada. Postal code conversion file (PCCF), reference guide: July 2009 postal codes [Internet]. Ottawa (ON): Statistics Canada; 2010. [Statistics Canada, Catalogue No.: 92-153-G]. Available from: www.statcan.gc.ca/pub/92-153-g/92-153-g2010001-eng.pdf

29. Gamache P, Pampalon R, Hamel D. Guide méthodologique : l'indice de défavorisation matérielle et sociale : en bref. Québec (QC): Institut national de santé publique du Québec; 2010. Available from: http://www2.inspq.qc.ca/santescope/documents/Guide_Metho_Indice_defavo_Sept_2010.pdf

30. Statistics Canada. Age (123) and sex (3) for the population of Canada, provinces, territories, census divisions, census subdivisions and dissemination areas, 2006 census – 100% data. Ottawa (ON): Statistics Canada; 2007. [Statistics Canada, Catalogue No.: 97-551-X2006006].

31. Kadhim-Saleh A, Green M, Williamson T, Hunter D, Birtwhistle R. Validation of the diagnostic algorithms for 5 chronic conditions in the Canadian Primary Care Sentinel Surveillance Network (CPCSSN): a Kingston Practice-based Research Network (PBRN) report. J Am Board Fam Med. 2013;26(2): 159-67.

32. Lix L, Yogendran M, Burchill C, et al. Defining and validating chronic diseases: an administrative data approach. Winnipeg (MB): Manitoba Centre for Health Policy; 2006.

33. Hux JE, Ivis F, Flintoft V, Bica A. Diabetes in Ontario: determination of prevalence and incidence using a validated administrative data algorithm. Diabetes Care. 2002;25(3): 512-6.

34. Naessens JM, Baird MA, Van Houten HK, et al. Predicting persistently high primary care use. Ann Fam Med. 2005;3(4):324-30.

35. Stanton MW, Rutherford MK. The high concentration of US health care expenditures. Rockville (MD): Agency for Healthcare Research and Quality; 2005. (Research in Action 19, AHRQ no. 06-0060).

36. Statistics Canada. Statistical Area Classification (SAC) [Internet]. Ottawa (ON): Statistics Canada; [modified 2013 May 13; cited 2013 Jul]. Available at: http://www.statcan.gc.ca/pub/92-195-x/2011001/other-autre/sac-css/sac-css-eng.htm

37. Du Plessis V, Beshiri R, Bollman RD, Clemenson H. Definitions of rural. Rural and Small Town Canada Analysis Bulletin. 2001; 3:1-17. Available at: http://www.statcan.gc.ca/pub/21-006-x/21-006-x2001003-eng.pdf

38. Pampalon R, Raymond G. A deprivation index for health and welfare planning in Quebec. Chronic Dis Can. 2000;21(3):104-13.

39. Pampalon R, Hamel D, Gamache P. Recent changes in the geography of social disparities in premature mortality in Quebec. Soc Sci Med. 2008;67:1269-81.

40. Martinez J, Pampalon R, Hamel D. Deprivation and stroke mortality in Quebec. Chronic Dis Can. 2003;24(2-3):57-64.

41. Pampalon R, Raymond G. Indice de défavorisation matérielle et sociale : son application au secteur de la santé et du bien-être. Santé, société et solidarité. 2003;1:191-208.

42. Philibert M, Pampalon R, Hamel D, Thouez JP, Loiselle CG. Material and social deprivation and health and social services utilisation in Quebec: a local-scale evaluation system. Soc Sci Med. 2007;64:1651-64.

43. Carr-Hill RA, Rice N, Roland M. Socioeconomic determinants of rates of consultation in general practice based on fourth national morbidity survey of general practices. BMJ. 1996;312(7037):1008-12.

44. Menec VH, Sirski M, Attawar D. Does continuity of care matter in a universally insured population? Health Serv Res. 2005; 40(2):389-400.

45. Mustard CA, Kaufert P, Kozyrskyj A, Mayer T. Sex differences in the use of health care services. N Engl J Med. 1998;338(23):1678-83.

46. Bertakis KD, Azari R, Helms LJ, Callahan EJ, Robbins JA. Gender differences in the utilization of health care services. J Fam Pract. 2000;49(2):147-52.

47. Redondo-Sendino A, Guallar-Castillón P, Banegas JR, Rodríguez-Artalejo F. Gender differences in the utilization of health-care services among the older adult population of Spain. BMC Public Health. 2006;16(6):155.

48. Public Health Agency of Canada. Tracking heart disease and stroke in Canada 2009. Ottawa (ON): PHAC; 2009.

49. Heart and Stroke Foundation of Canada; Canadian Cardiovascular Society; Health Canada. The growing burden of heart disease and stroke in Canada 2003. Ottawa (ON): Heart and Stroke Foundation of Canada; 2003.

50. Aubé-Maurice J, Rochette L, Blais C. Relation entre la défavorisation et l'incidence de l'hypertension artérielle chez les individus de 20 ans et plus au Québec en 2006-2007. Québec (QC): Institut national de santé publique du Québec; 2010.

51. Matheson FI, White HL, Moineddin R, Dunn JR, Glazier RH. Neighbourhood chronic stress and gender inequalities in hypertension among Canadian adults: a multilevel analysis. J Epidemiol Community Health. 2010;64(8):705-13.

52. Bell AC, Adair LS, Popkin BM. Understanding the role of mediating risk factors and proxy effects in the association between socioeconomic status and untreated hypertension. Soc Sci Med. 2004;59(2):275-83.

53. Hawkley LC, Masi CM, Berry JD, Cacioppo JT. Loneliness is a unique predictor of age-related differences in systolic blood pressure. Psychol Aging 2006;21(1):152-64.

54. Pears E, Hannaford PC, Taylor MW. Gender, age and deprivation differences in the primary care management of hypertension in Scotland: a cross-sectional database study. Fam Pract. 2003;20(1):22-31.

55. Hammouche S, Holland R, Steel N. Does quality of care for hypertension in primary care vary with postcode area deprivation? An observational study. BMC Health Serv Res. 2011;11:297.

56. Brouwers FM, Courteau J, Grégoire JP, et al. The adequacy of pharmaceutical treatment of schizophrenia in Quebec varies with age, but is not influenced by sex or neighbourhood deprivation. Can J Psychiatry. 2013;58(8): 456-65.

57. Paré I, Ricard J. Le profil de pratique des médecins omnipraticiens québécois 2006-2007. Westmount (QC): Fédération des médecins omnipraticiens du Québec (FMOQ); 2007.

Active and safe transportation of elementary-school students: comparative analysis of the risks of injury associated with children travelling by car, walking and cycling between home and school

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Abstract

Introduction: Elementary school active transportation programs aim to address physical inactivity in children by prompting a modal shift from travel by car to walking or cycling among children living a distance from school conducive to walking or cycling. The objectives of this study are to evaluate the risk of injury related to walking, cycling and travelling by car between home and school among elementary-school students in the Montréal area and to evaluate the impact on number of injuries of a modal shift from travel by car to walking or cycling.

Methods: The risk of injury was estimated for the 2003–2007 period by calculating the average annual rate of injury in children aged 5 to 12 years walking, cycling or being driven in a car, per 100 million kms travelled during the normal hours of travel between home and school. The impact of a modal shift from travel by car was evaluated for children living a distance from school conducive to walking and cycling (under 1.6 km), that is, the targets of active transportation programs. This evaluation was done using the regional rate of injury calculated for each travel mode.

Results: Between 2003 and 2007, an average of 168 children aged 5 to 12 years were injured each year while walking (n = 64), cycling (n = 28) and being driven in a car (n = 76) during the normal hours of travel between home and school in the Montréal area. The rate of injury was 69 children injured per 100 million kms for travel by car (reference group), 314 pedestrians (relative risk [RR] = 4.6; 95% confidence interval [CI]: 4.3–5.1) and 1519 cyclists (RR = 22.2; 95% CI: 14.3–30.0). A shift of 20% in the distance travelled by car to walking by children living less than 1.6 km from their school is estimated to result in an increase of 2.2% (n = 3.7) in the number of children injured each year in the area. In the case of a shift to cycling, the number of resulting injuries is estimated to be 24.4, an increase of 14.5%.

Conclusion: The risk of injury among elementary-school students during the normal hours of travel between home and school is higher for walking and cycling than for travel by car, and cyclists are at greater risk of injury than pedestrians. A modal shift from travel by car would increase the number of children injured in the area (minor injuries, for the most part) if no action were taken to reduce the risk of injury to pedestrians and cyclists.

Keywords: *active transportation, elementary school, injury, pedestrians, cyclists, travel, trips, risks*

Introduction

Over the past few years, many industrialized countries have initiated programs to promote active transportation among school-age children, one of the best known being the Safe Routes to School[1] program. In Quebec, promotion of active transportation among elementary-school students mainly takes the form of implementing the Mon école à pied, à vélo[2] program. Overall, the main objective of these programs is to reduce physical inactivity, as well as the associated health problems, among children by prompting a shift from travelling to school by car to walking or cycling. This type of program usually leads to a shift of 20% or less away from travel by car in the targeted clientele.[3]

Road safety is an important aspect of the programs that promote active transportation among elementary-school students. Children of this age do not always have the cognitive and psychomotor skills required to walk or cycle safely.[4] Also, unsafe roads are one of the main reasons parents give for preferring that their children be driven to and from school.[5-7]

A study in the United States showed that children aged 5 to 13 years who walk or cycle to school are at greater risk of injury than those who are driven by car.[8] A study conducted in New Zealand revealed the same trends.[9] The results of these studies suggest that a modal shift as a result of programs to promote active transportation could lead to an increase in the number of child pedestrians or cyclists injured, but

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such an effect has not been scientifically documented.

The objective of this study is to evaluate the risk of injury related to walking, cycling and travelling by car between home and school for elementary-school students in the Montréal area, as well as to evaluate the impact on the number of children injured of a modal shift from travel by car to walking or cycling between home and school in this area. The Montréal area is of special interest for this type of evaluation because active transportation can be easily promoted in this urban setting, as about half of the elementary-school age children in Quebec live here. In addition, Montréal is one of the areas for which data on travel by children between home and school are available.

Methods

The study population comprises children aged 5 to 12 years living in the area covered by the 2003 Montréal-area Origin–Destination Survey, the most recent survey of this type and in this area at the time of our study. The Montréal area covers 5500 km^2 and 88 municipalities, including Montréal, Longueuil and Laval. In 2003, 52.3% of all Quebec children aged 5 to 12 years lived in this area.[10]

Risk of injury

Risk of injury was estimated for the 2003–2007 period by calculating the average annual rate of injury among children aged 5 to 12 years who were pedestrians, cyclists or occupants of a car, per 100 million kms travelled during the normal hours of travel between home and school while school was in session. Here, the term ''car'' is used to denote the motor vehicle normally used by caregivers to transport children between home and school. This term includes cars, pickup trucks and sport utility vehicles. Excluded are buses, heavy trucks, commercial vehicles and all-terrain vehicles.

Data sources

We obtained data on the number of injured (the numerator of the rate) from Road Vehicle Accident Reports completed and filed by police officers.[11] This file includes data on all Quebec pedestrians, cyclists or occupants of a motor vehicle injured in a collision involving a motor vehicle travelling on a public roadway. The victims are classified according to the severity of their injuries (i.e. fatal, serious or minor) on the basis of the data recorded by the police officers. The data on kilometres travelled by type of travel (denominator of the rate) are from the Origin–Destination Survey in the Montréal area in 2003.[12] That survey, carried out from 2 September, 2003, to 20 December, 2003, was of a representative sample of households in any of the 88 municipalities in the area covered by the survey. The households were randomly sampled from all the geographical strata in this area (and not one municipality after another) for the entire duration of the survey, to ensure good distribution, by survey period and according to their composition (household with a child or not). The data were gathered on a weekday, except Monday, by means of a telephone interview of an adult member of the sampled household. The interviewee was questioned about all the travel done by each member of their household in the day before the interview. The data gathered described, among other things, the mode of transportation used (e.g. walking, bicycle or motor vehicle) and the distance travelled each trip (as the crow flies, i.e. the length of a straight line drawn between the point of departure and the point of arrival).

Numerator of the rate of injury

We determined the number of accident victims (pedestrians, cyclists or car occupants, aged 5 to 12 years, injured while travelling between home and school while school was in session) in the area covered by the survey through the municipal code of the place where the injury-causing accident occurred. This information is included in each Road Vehicle Accident Report. The normal hours of travel by children between home and school were defined as 7:00 a.m. to 8:59 a.m., 11:00 a.m. to 12:59 a.m., and 3:00 p.m. to 4:29 p.m. The third time slot ends at 4:29 p.m., rather than 6:00 p.m., to exclude those children injured after their return home, while playing on the street, for example. School was considered to have been in session for 200 days a year; this excludes the period of summer vacation (June 24 to August 31), the festive season (December 24 to January 2), all Saturdays and Sundays, and local statutory holidays (Good Friday, Easter Monday, Labour Day, Thanksgiving and Patriots' Day). Children injured as occupants of a car were identified using the category ''injured in a car or pickup truck'' in the Road Vehicle Accident Report; this category includes cars, light trucks and sport utility vehicles.

Denominator of the rate of injury

We determined the number of kilometres travelled by estimating the total number of kilometres travelled in one year by all children 5 to 12 years old in the area selected for the survey, during the normal hours of travel between home and school while school was in session. This estimate was obtained by calculating the number of kilometres travelled in a day on foot, on a bicycle or in a car by the children aged 5 to 12 who participated in the survey (the sample), during the normal hours of travel between home and school while school was in session. Travel by car was identified using the category ''passenger cars''; this category includes cars, pickup trucks and sport utility vehicles (as for the numerator). In some cases, the distance travelled in one trip was an extreme value (i.e. unusually big value). To minimize the impact of these extreme values on the total number of kilometres travelled, travel on foot for more than 4 km was adjusted down to 4 km, travel by bicycle for more than 8 km was adjusted down to 8 km and travel by car for more than 50 km was adjusted down to 50 km. A total of 13 extreme values were adjusted for travel on foot, 14 for travel by bicycle and 22 for travel by car, accounting for 0.15%, 4.3% and 0.26%, respectively, of all travel on foot, by bicycle and by car. Then, because Origin–Destination Surveys provide data on travel that takes place in a single day of the week, the data on kilometres travelled calculated for the sample were multiplied by 200 to obtain values for a 200-day period (as for the numerator). Finally, a survey weight was applied in order to infer the total number of kilometres travelled, estimated through the sample, to the entire population of children 5 to 12 years old living in the area of the survey.

Relative risk

We calculated the relative risk (RR) of injury during the normal hours of travel between home and school by comparing the rate of injury when travelling on foot and by bicycle to the rate of injury for occupants of a car. The calculation of the standard errors of the estimates for the number of kilometres travelled takes into account weighting as well as the design effects due to the complex sampling in Origin–Destination Surveys. For example, trips by children aged 5 to 12 years from the same household or the same neighbourhood cannot be considered independent and form observation clusters. Using specialized software (SUDAAN)[13] and specifying the parameters of the sample design, it was possible to correct the standard errors of the population estimates and, consequently, the rate ratios. The confidence intervals can thus be determined with a significance level of 95% both for injury rates and for relative risk.

Impact of modal shift

We evaluated the impact of a modal shift from travel by car to travel on foot or by bicycle on the number of children injured during the normal hours of travel between home and school on the basis of the injury rate related to each travel mode. We considered only children travelling by car between home and school who lived less than 1.6 km from school (reasonable walking and cycling distance), that is, the target clientele of the programs that promote active transportation among elementary-school children. In 2003, the number of Montréal-area children aged 5 to 12 years who met these two conditions was estimated at 68 900, and this accounted for 57.5% of all children travelling by car between home and school in this area. In 2003, these 68 900 children travelled 8 815 400 km by car to and from school. The impact of a modal shift from travel by car on the number of children injured was evaluated by assuming that 10%, 20%, 30%, 40% and 50% of the kilometres travelled by these children would be travelled on foot or by bicycle, rather than in a car. We evaluated the impact by comparing the number of children likely to be injured as pedestrians, cyclists or occupants of a car while travelling the number of kilometres associated with each of these 5 shift scenarios (a 10% shift corresponded to 881 540 kms). The potential number of children injured as pedestrians, cyclists or occupants of a car was estimated using the corresponding injury rates between 2003 and 2007. For this estimate, we assumed that the modal shift from travel by car would be entirely either to travel on foot or to travel by bicycle. The observed gap for a given shift scenario between the number of children injured as pedestrians and as occupants of a car was expressed as the number of additional injured children and as a percentage of the average number of children injured during the normal hours of travel between home and school annually. The same procedure was followed for the scenarios involving a shift from travel by car to travel by bicycle.

Results

Number of children injured

Between 2003 and 2007, a total of 957 children aged 5 to 12 years were injured while walking, cycling or being driven in a motor vehicle (including car but also heavy trucks and other types of road vehicles) in the Montréal area, equivalent to 46.8% (957/2044) of all cases in Quebec (Figure 1). Of these 957 children, 178 (18.6%) were injured during the normal hours of travel between home and school while school was in session; those injured included 64 pedestrians, 28 cyclists and 76 occupants of cars, pickup trucks and sport utility vehicles. In most cases, the injuries were minor (89.1% of the pedestrians, 97.1% of the cyclists and 97.6% of the occupants of a car – data not shown).

Modal shares and kilometres travelled

In 2003, a total of 12 799 children aged 5 to 12 years participated in the Origin–Destination Survey in the Montréal area (Table 1). These children (the sample) made 22 819 trips between home and school on a ordinary weekday, including 29.6% in a car, 32.5% on foot and 1.4% by bicycle. (The remaining travel was mainly by school bus.) Almost all (98.1%) of the travel on foot and 86.1% of the travel by bicycle involved distances shorter than 1.6 kms to school, compared with 57.5% of the travel by car. After taking weighting into account, we estimated about 332 700 children aged 5 to 12 years travelled between home and school in the Montréal area in 2003 (the population). Overall, these children were associated with 588 800 trips, including 29.2% by car, 33.8% on foot and 1.3% by bicycle.

Table 2 shows the data for the sample by survey month: 53.9% of travel by any mode (94.2% by bicycle) was done in September and October, and 46.1% (5.8% by bicycle) in November and December. Table 3 shows the distances travelled in a year for each travel mode by the population (column: distance travelled).

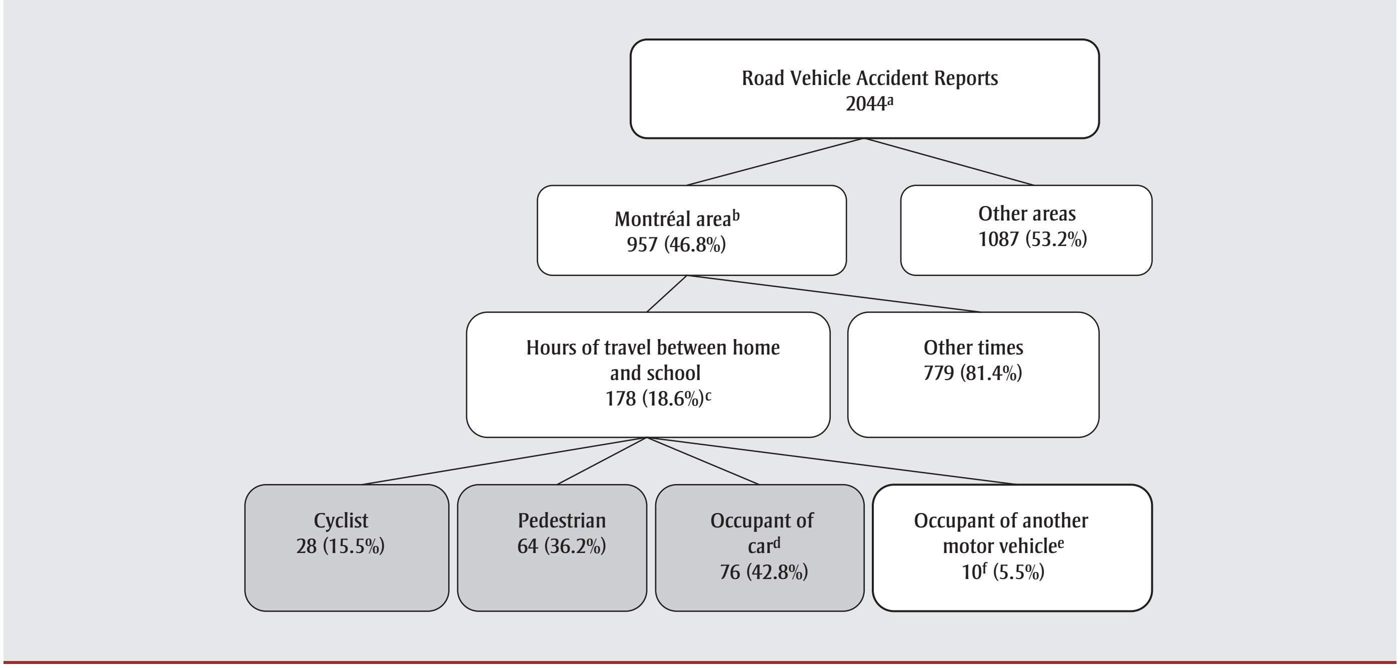
Risk of injury

Between 2003 and 2007, the average annual rate of injury among children aged 5 to 12 years old during the normal hours of travel between home and school in the Montréal area was 69 injured children per 100 million kms travelled by car (including pickup trucks and sport utility vehicles), compared with 314 for travel on foot and 1519 for travel by bicycle (Table 3). During this period, the relative risk of injury was higher for travel on foot (RR = 4.6; 95% CI: 4.3–5.1) and by bicycle (RR = 22.2; 95% CI: 14.3–30.0) than for travel by car (reference group). The risk of injury related to travel by bicycle was significantly higher than that related to travel on foot. Similar trends were observed for children aged 5 to 8 years as for those aged 9 to 12 years.

Impact of a modal shift

A modal shift of 10% in the ratio of kilometres travelled by car to those travelled on foot among children living less than 1.6 km from school led to 1.8 more injured children a year in the Montréal area, an increase of 1.1% (1.8/168.2) in the average annual number of

FIGURE 1
Process of identification of children aged 5–12 years injured during the normal hours of travel between home and school (average annual number), Montréal area, 2003–2007



[a] Average annual number of children aged 5–12 years injured as pedestrians, cyclists or occupants of a motor vehicle as a result of a collision involving a road vehicle on a public roadway, Quebec, 2003–2007.

[b] Area covered by the 2003 Origin–Destination Survey on the basis of the municipal code.

[c] Distribution of the injured children in the Montréal area during the normal hours of travel between home and school (7 a.m. to 8:59 a.m., 11:00 a.m. to 12:59 p.m., and 3 p.m. to 4:29 p.m.) while school was in session (200 days).

[d] Children injured as an occupant of a car, minivan, pickup truck or sport utility vehicle.

[e] Children injured as an occupant of another type of motor vehicle (school bus, heavy truck, etc.).

[f] Of these 10 injured children, 6 were injured as occupants of a school bus.

TABLE 1
Characteristics of the sample[a] and the population studied by travel mode

Travel mode	Sample[a]				Estimated population[b]		
	Sample, n	Trips			Number,[c] n	Trips[d]	
		n	%	< 1.6 km[e], %		n	%
Car[f]	4661	6752	29.6	57.5	119 700	172 000	29.2
Walking	3867	7413	32.5	98.1	104 900	199 000	33.8
Cycling	156	325	1.4	86.1	3700	7500	1.3
Other (school bus)	5176 (4637)	8329 (7114)	36.5 (31.2)	40.8 (42.3)	131 400 (113 400)	210 000 (184 500)	35.7 (31.3)
Total[g]	12 799	22 819	100.0	65.6	332 700	588 800	100.0

Source: Montréal-area 2003 Origin–Destination Survey.[12]

[a] Children aged 5–12 years who participated in the Origin–Destination Survey and travel by these participants in one day between home and school.

[b] Number of elementary-school students aged 5–12 years in the Montréal area and travel by these students in one day between home and school.

[c] After weighting for population.

[d] After weighting for travel.

[e] Trips shorter than 1.6 km between home and school.

[f] The type of motor vehicle normally used by caregivers to transport children between home and school, i.e. cars, pickup trucks and sport utility vehicles and not buses, heavy trucks, commercial vehicles and all-terrain vehicles.

[g] The totals for the number of children do not correspond to the sum of the number of children on the basis of travel mode because a given child may use more than one travel mode a day.

TABLE 2
Distribution of the sample[a] by survey month, all travel modes and cycling, Montréal area, 2003

Survey month	Sample[a]		Trips[b]			
	All modes		All modes		Cycling	
	n	%	n	%	n	%
September	2727	21.3	5017	22.0	155	47.7
October	4087	31.9	7277	31.9	151	46.5
November	3332	26.0	5975	26.2	17	5.2
December	2653	20.7	4550	19.9	2	0.6
Total	12 799	100.0	22 819	100.0	325	100.0

Source: Montréal area 2003 Origin–Destination Survey.[12]

[a] Children aged 5–12 years who participated in the Origin–Destination Survey.

[b] Travel by 5–12 year-old participants in the Origin–Destination Survey in one day between home and school.

children injured in this area during travel between home and school on foot, by bicycle and by car in 2003–2007 (Table 4). This increase was 2.2%, 3.3%, 4.3% and 5.5%, respectively, for shifts of 20%, 30%, 40% and 50% (Figure 2). With a shift of 10% in the kilometres travelled by car to those travelled by bicycle, 12.2 more children were injured a year, an increase of 7.3% (12.2/168.2) in the average annual number of children injured in the Montréal area during the normal hours of travel between home and school for 2003–2007. This increase was 14.5%, 21.7%, 29.0% and 36.2%, respectively, for shifts of 20%, 30%, 40% and 50% (Figure 2).

Discussion

Between 2003 and 2007, an average of 168 children aged 5 to 12 years were injured each year while walking (n = 64), cycling (n = 28) and being driven in a car (n = 76) during the normal hours of travel between home and school in the Montréal area. This represents nearly one injured child per school day. In more than 90% of the cases, the injuries were minor.

The average annual rate of injury per 100 million kms travelled was 69 children in the case of occupants of a car, 314 in the case of pedestrians and 1519 in the case of cyclists. These results suggest that children travelling on foot (RR = 4.6) or by bicycle (RR = 22.2) are at greater risk of injury than those travelling by car (reference group), and that the risk of injury associated with travel by bicycle is greater than that associated with travel on foot. The same trends were observed for both age groups studied. The results of additional analyses of the Québec and Trois-Rivières areas show the same trends (data available on request). A United States study in 1991–1999 found similar trends,[8] with the relative risk (calculated based on the rates for children injured per 100 million kms travelled) of injury associated with travel by car for children aged 5 to 10 years 9.4 times higher for travel on foot and 34 times higher for travel by bicycle. The same trends were observed in a 2003–2005 New Zealand study;[9] the relative risk of injury among children aged 5 to 17 years was 2.2 times higher for travel on foot and 14.6 times higher for travel by bicycle than for travel by car (RRs calculated based on the rates of children injured per million hours of travel). To our knowledge, these two studies are the only ones that have evaluated the risk of injury associated with travel by elementary-school children between home and school while school was in session, with control for exposure (kilometres travelled or hours of travel).

The impact of a modal shift in the ratio of kilometres travelled by car to those travelled on foot or by bicycle on the number of children injured was evaluated for 5 scenarios involving shifts ranging from 10% to 50%. A shift of 20% from travel by car to travel on foot for children living less than 1.6 km from school led to 3.7 more injured children a year, an increase of 2.2% in the average annual number of children injured in this area during the normal hours of travel between home and school. Where the 20% shift

TABLE 3
Estimated risk of injury for children aged 5–12 years travelling between home and school, by age and travel mode, Montréal area, 2003–2007

Age, years	Travel modes	Average annual number of children injured, n	Distance travelled, 1000, km	Rates per 100 million, km	95% CI	RR	95% CI
5–8	Car	36.8	56 705	65	(60–71)	1 (ref.)	—
	Walking	24.0	6 607	321	(298–347)	4.9	(4.7–5.9)
	Cycling	6.6	294	2244	(1451–4957)	34.6	(15.4–53.8)
9–12	Car	39.4	54 409	72	(67–79)	1 (ref.)	—
	Walking	40.4	12 028	311	(294–330)	4.3	(3.8–4.7)
	Cycling	21.0	1 523	1379	(991–2266)	19.0	(11.4–26.7)
5–12	Car	76.2	111 114	69	(64–73)	1 (ref.)	—
	Walking	64.4	18 634	314	(300–330)	4.6	(4.3–5.1)
	Cycling	27.6	1 817	1519	(1129–2319)	22.2	(14.3–30.0)

Abbreviations: CI, confidence interval; ref., reference; RR, relative risk.

TABLE 4
Effect of 5 scenarios for shifts in distance travelled between home and school by car to walking or cycling on the average annual number of children aged 5–12 years injured, Montréal area, 2003–2007

Scenarios for shift in kilometres travelled[a]		Estimated average annual number of children injured related to each shift scenario, by travel mode[b]			Effect of shift on average annual number of children injured in the area[c]			
					Car to walking		Car to cycling	
Proportion of shift	Number of km	Car	Walking	Cycling	Number	(%)	Number	(%)
10%	881 540	0.60	2.44	12.79	+ 1.8	(+ 1.1)	+ 12.2	(+ 7.3)
20%	1 763 080	1.21	4.88	25.57	+ 3.7	(+ 2.2)	+ 24.4	(+ 14.5)
30%	2 644 620	1.81	7.33	38.36	+ 5.5	(+ 3.3)	+ 36.5	(+ 21.7)
40%	3 526 160	2.42	9.77	51.14	+ 7.3	(+ 4.3)	+ 48.7	(+ 29.0)
50%	4 407 700	3.03	12.21	63.93	+ 9.2	(+ 5.5)	+ 60.9	(+ 36.2)

[a] The shift scenarios for kilometres travelled are for children living less than 1.6 km from school.

[b] The estimates of the average annual number of children injured were arrived at by using the regional injury rate per 100 million kms travelled for travel by car (69), walking (314) and cycling (1519). See Table 3.

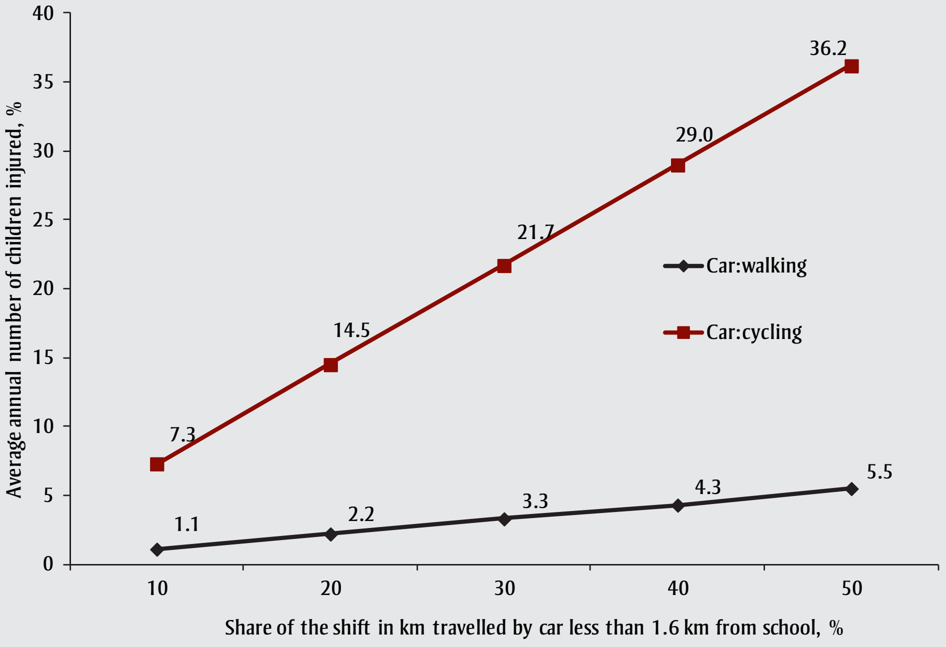
[c] The effect of the modal shift is calculated for all children injured in the Montréal area.

was to travel by bicycle, 24.4 more children were injured, an increase of 14.5%. To our knowledge, this type of evaluation has not been previously examined, so we cannot compare results.

Strengths and limitations of the study

These analyses took into consideration all children aged 5 to 12 years included in the Road Vehicle Accident Reports completed in 2003 to 2007 (numerator) and all those who participated in the 2003 Montréal-area Origin–Destination Survey (denominator). The rate of injury was evaluated by controlling for the number of kilometres travelled, allowing for comparison of the number of children injured as pedestrians, cyclists or occupants of a car for a given distance travelled. The total number of kilometres travelled during the normal hours of travel between home and school while school was in session was estimated by multiplying the distance travelled in one day by the number of school days (200). The time of data collection during the year is likely to influence the mode of travel chosen. In that regard, we know that the survey looked at half the children in September and October and half in November and December. We can assume that the interviews conducted in September and October provide informa-

FIGURE 2
Effect of 5 scenarios for shifts in distance travelled by car by children living less than 1.6 km from school to travel by walking or cycling on the average number of children aged 5–12 years injured during the normal hours of travel between home and school (as %), Montréal area, 2003–2007



tion on children's exposure during the months of the school year when the weather is milder and therefore more conducive to walking and cycling (September, October, April, May and June), while interviews in November and December provide information on children's exposure during the months when the outdoors temperatures are less comfortable for walking and cycling (November, December, January, February and March). The distribution of the travel by survey month reflects this: most of the travel by bicycle was in September and October, with only a few such trips in November and December. Note that although this estimate of kilometres travelled is during the survey year (2003), we assumed it to be a good indicator of the children's exposure for the entire period studied (2003 to 2007) because it would be unlikely that the modal share for travel on foot, by bicycle and by car changed significantly from year to year during this period. The fact that the kilometres travelled are based on the distance as the crow flies (length of a straight line drawn between the home and the school) is a limitation of this study: this distance would generally be shorter than that actually travelled. Another limitation of the study is that the Road Vehicle Accident Reports are not exhaustive for injuries caused in a collision with a motor vehicle and do not include injuries that do not involve a motor vehicle.[14-17]

The impact of a modal shift from travel by car to active transportation (walking and cycling) on the number of children injured was evaluated for children living less than 1.6 km from their school. This evaluation was done using the regional (Montréal area) rates of injury because the data available in the Road Vehicle Accident Reports do not allow for distributing the numerator (number of injured children) on the basis of the actual distance to the school. That is, it is impossible to calculate the specific rate of injury of children living less than 1.6 km from a given school. For this reason, we assumed that the rate of injury at the regional level is similar to the rate of injury of children living less than 1.6 km from their school. This assumption is fairly plausible for pedestrians and cyclists: 98.1% of the travel on foot and 86.1% of the travel by bicycle in the Montréal area is done for distances less than 1.6 km from the school. However, it is more difficult to assume this to be the case for children travelling by car because the share of the travel done within this perimeter is smaller (57.5%). In addition, the regional rate (which is, in fact, an average rate) can be used to evaluate the impact of a modal shift only on the regional level (average impact), but the impact may vary from one neighbourhood to another owing to variation in the risk of injury (spatial variation). Finally, note that the impact of a modal shift was evaluated without taking into account the fact that the risk of injury for pedestrians and cyclists could decrease due to the reduction in the number of vehicles on the roads as a result of the transfer. However, the analysis of the available data suggests that this impact would be marginal: a 20% shift from travel by motor vehicle for children living less than 1.6 km from school would be associated with a reduction of 13 780 motor vehicles (20% × 68 900 children), only a very small percentage of the total number of motor vehicles in the area.

Conclusion

Few studies have evaluated the risk of injury for elementary-school students travelling between home and school, and this study is the first of its kind in Quebec. In addition, to the best of our knowledge, this is the first time that a study has evaluated the impact of a modal shift from travel by car to active transportation (walking and cycling) on the number of injured children.

Overall, our results suggest that programs promoting active transportation among elementary-school students in the Montréal area could, by prompting a shift from travelling by car to walking or cycling, lead to an increase in the number of children injured (although for the most part the injuries would be minor) if no action were taken to increase safety among pedestrians and cyclists. This type of program usually prompts a shift of 20% or less from travel by car among children living a distance from school conducive to walking or cycling.[3] The impact on numbers of injuries of such a shift would be greater in the case of a complete shift to cycling, but that scenario is unlikely because that mode of travel is less popular than walking.

A number of measures can make travel on foot or by bicycle between home and school safer:[18] adjustment of the road environment (e.g. speed bumps, reduction of road width, curb extensions and pedestrian signals); making school crossing guards available; having adults accompany children to and from school; wearing bicycle helmets and taking road safety courses. However, making the road environment safer should always be the priority, because this has been proven to be effective or promising[19] and because, once in place, the protective effect of a safer road environment is always present, regardless of the child's age, sex or socioeconomic environment. Such measures have the potential to counter the impact of the modal shift resulting from programs promoting active transportation among elementary-school children because they protect new pedestrians and cyclists as well as those children who were walking or cycling to school before the program was implemented (the latter remain the most numerous). The inclusion of safety measures in these programs is important not only to protect children but also to promote active transportation, because lack of road safety is one of the main reasons given by parents for preferring travel by motor vehicle over active travel modes.

References

1. Osborne P. Safe routes for children: what they want and what works. Children, youth and environments. 2005;15(1):234-9.

2. Vélo Québec. Mon école à pied, à vélo, mode d'emploi. Montréal (QC): Vélo Québec; 2008.

3. Chillon P, Eveson KR, Vaughn A, Ward DS. A systematic review of interventions for promoting active transportation to school. Int J Behav Nutr Phys Act. 2011;8:10.

4. Schieber RA, Thompson NJ. Developmental risk factors for childhood pedestrian injuries. Inj Prev. 1996;2:228-36.

5. Cloutier MS. Connaissance, croyance et représentation du risque routier piéton chez les parents d'enfants du primaire: implication pour les politiques de promotion des transports actifs. DIRE. 2008;Fall:21-6.

6. Lewis P. Le transport actif et le système scolaire à Montréal et à Trois-Rivières. Analyse du système d'acteurs concernés par le transport actif des élèves des écoles primaires au Québec. Duranceau A, editor. Montréal (QC): Groupe de recherche Ville et Mobilité; 2008.

7. Centers for Disease Control and Prevention. Barriers to children walking to or from school–United States, 2004. MMWR Morb Mortal Wkly Rep. 2005;54:949-52.

8. Transportation Research Board. The relative risks of school travel: a national perspective and guidance for local community risk assessment. Washington (DC): Transportation Research Board; 2002. (Special report 269).

9. Schofield GM, Gionotti S, Badland HM, Hinckson EA. The incidence of injuries traveling to and from school by travel mode. Prev Med. 2008;46(1):74-6.

10. Agence Métropolitaine du Transport. Enquête Origine-Destination 2003: la mobilité des personnes dans la région de Montréal. Montréal (QC): Agence Métropolitaine du Transport; 2005.

11. Société de l'assurance automobile du Québec (SAAQ). Jeunes victimes âgées entre 5 et 12 ans blessées en période scolaire ou hors période scolaire: 2003-2007 (special compilation). Québec (QC): SAAQ; 2008.

12. Ministère des transports du Québec. Part modale des déplacements effectués par les enfants âgés de 5 à 12 ans, entre la maison et l'école, durant la période scolaire: régions de Montréal (1996 et 2003), Québec (1991 et 2006), Sherbrooke (1992 et 2003) et Trois-Rivières (2000). Québec (QC): MTQ, Service de la modélisation des systèmes de transport; 2009.

13. Research Triangle Institute. SUDAAN Language Manual, volumes 1 and 2, Release 11. Research Triangle Park (NC): Research Triangle Institute; 2012.

14. Kopjar B, Wickizer TM. Cycling to school–a significant health risk? Inj Prev. 1995;1:238-41.

15. Public Health Agency of Canada. Canadian Hospitals Injury Reporting and Prevention Program: Injuries associated with bicycles – 2006, ages 1 year and older). Ottawa (ON): Public Health Agency of Canada, Health Surveillance and Epidemiology Division; 2008.

16. Agran PF, Castillo DN, Winn DG. Limitations of data compiled from police reports on pediatric pedestrian and bicycle motor vehicle events. Accid Anal Prev. 1990;22:361-70.

17. Dhillon PK, Lightstone AS, Peek-Asa C, Kraus JF. Assessment of hospital and police ascertainment of automobile versus childhood pedestrian and bicyclist collisions. Accid Anal Prev. 2001;33: 529-37.

18. Burigusa G, Lavoie M, Maurice P, Hamel D, Duranceau A. Sécurité des élèves du primaire lors des déplacements à pied et à vélo entre la maison et l'école au Québec. Québec (QC): Institut national de santé publique du Québec; 2011. Available from: http://www.inspq.qc.ca/pdf/publications/1243_SecuriteElevesDeplacementsMaisonEcole.pdf

19. Retting RA, Ferguson SA, McCartt AT. A review of evidence-based traffic engineering measures designed to reduce pedestrian-motor vehicle crashes. Am J Public Health. 2003;93:1456-1463.

Developing injury indicators for First Nations and Inuit children and youth in Canada: a modified Delphi approach

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Abstract

Introduction: The purpose of this research was to take the initial step in developing valid indicators that reflect the injury issues facing First Nations and Inuit children and youth in Canada.

Methods: Using a modified-Delphi process, relevant expert and community stakeholders rated each indicator on its perceived *usefulness* and ability to *prompt action* to reduce injury among children and youth in indigenous communities. The Delphi process included 5 phases and resulted in a refined set of 27 indicators.

Results: Indicators related to motorized vehicle collisions, mortality and hospitalization rates were rated the most *useful* and most likely to *prompt action*. These were followed by indicators for community injury prevention training and response systems, violent and inflicted injury, burns and falls, and suicide.

Conclusion: The results suggest that a broad-based modified-Delphi process is a practical and appropriate method, within the OCAP™ (Ownership, Control, Access and Possession) principles, for developing a proposed set of indicators for injury prevention activity focused on First Nations and Inuit children and youth. Following additional work to validate and populate the indicators, it is anticipated that communities will utilize them to monitor injury and prompt decisions and action to reduce injuries among children and youth.

Keywords: *First Nations, Inuit, indigenous populations, injury indicators, modified-Delphi technique, surveillance*

Introduction

Injury has been recognized as an important health problem, one that strikes particularly hard at the most vulnerable people—children, youth, seniors and indigenous populations.[1] Injury is the leading cause of death among Canadian children, youth and young adults—a situation particularly important to indigenous First Nations and Inuit communities as more than 50% of their populations are under 25 years of age.

Injury is by far the greatest source of potential years of life lost (PYLL) among First Nations[*] populations. At almost 3.5 times the national average, injury accounts for 26% of deaths among First Nations, compared with 6% of deaths overall in Canada.[2,3] The injury rates among indigenous teens are almost 4 times greater than those of non-indigenous Canadians, and First Nations male and female youth are, respectively, 5 to 7 times more likely to die of suicide than their peers in other populations.[1,4] Hospitalization rates due to injury are also significantly higher (twice the rate) for children and youth living in areas with a high percentage of indigenous residents compared to those living in areas with a low percentage of indigenous residents.[5]

To begin to address these injury disparities, respectful approaches that are collaborative, sustainable and culturally sensitive and that reflect the unique identities of First Nations and Inuit peoples are recommended.[2,6] In 2004, the Canadian Child and Youth Health Coalition listed injury prevention/trauma as one of the theme areas to establish Canadian infant, child and youth health indicators.[7] Despite this, Canada had fallen behind comparable countries in many of the key health indicators for children and youth.[8] A 5-year injury prevention strategic plan indicated the need to identify injury prevention programs and strategies within Inuit communities and establish an integrated surveillance system to measure injury trends.[9] And, while the First Nations Regional Longitudinal Health Survey gathers valuable individual and community information in Canada, some of which is

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[*] According to Aboriginal Affairs and Northern Development Canada, the term "First Nations peoples" refers to the indigenous Indian peoples in Canada. The Inuit are an indigenous people who live mainly in Nunavut, Northwest Territories, Northern Quebec and Northern Labrador.

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focused on injury, no systematic gathering of comprehensive injury information currently takes place across the country for First Nations children and youth.

The purpose of this research was to take the initial step to develop valid indicators reflective of the injury issues facing First Nations and Inuit children and youth in Canada. The research builds upon the initial work of the Canadian Injury Indicators Development Team, a group of national injury prevention researchers, practitioners and policy makers who established national injury indicators for Canadian children and youth.[10] Cryer[11,p.3-1] defined an injury indicator as ''…a summary measure which denotes or reflects, directly or indirectly, variations and trends in injury, or injury-related or an injury control-related phenomenon.'' The specific aims of our present study were 1) to develop a strong collaborative working group of individuals and agencies representing indigenous peoples, and 2) to develop and specify a suite of valid indicators that can provide a baseline for First Nations and Inuit communities to document, analyze and report child and youth injury data. Once the indicators are populated with data, the resulting information can be used to support community injury prevention decision-making and action planning. Tracked over time, these indicators can show how a community or group's injury profile has changed.[12]

An indicator is valid when it measures what it is presumed to measure.[13] The indicators in this study were developed based upon the work of the International Collaborative Effort on Injury Statistics (ICE)[11] in 2001 and subsequent work by Cryer et al.[14] that outlined criteria for indicator validity. These criteria suggest that an ideal indicator for injury cases should

- have a case definition based on diagnosis—on anatomical or physiological damage;
- focus on serious injury;
- have, as far as possible, unbiased case ascertainment;
- be derived from data that are representative of the target population;
- be based on existing data systems (or it should be practical to develop new data systems that would feed into it); and
- be fully specified in writing.

Methods

In early 2007, the First Nations and Inuit Health Branch, Health Canada invited the Canadian Injury Indicators Team to begin a 3-year project to develop injury indicators for First Nations and Inuit children and youth. In Canada, First Nations and Inuit peoples are represented by many local, regional and national indigenous agencies as well as the federal government departments whose responsibility it is to ensure the provision of health and social programs, including initiatives to reduce injury.

From the outset, the process and methods of this project sought to balance scientific rigour and a community-oriented approach consistent with the OCAP^{TM} principles underlying the collection of indigenous peoples' data and information in Canada. That is, the data are **O**wned, **C**ontrolled, **A**ccessed and **P**ossessed by the indigenous community.[15] Briefly, the process attempted to ensure a practical approach to injury indicator development.

The First Nations and Inuit Health Branch, Health Canada identified relevant participants in this research and therefore included representatives from the Assembly of First Nations, Inuit Tapiriit Kanatami, Royal Canadian Mounted Police, Indian and Northern Affairs Canada, the SMARTRISK Foundation, Children's Hospital of Eastern Ontario, Plan-It-Safe Program, Katenies Research and Management Services, Statistics Canada, Nunatsiavut Department of Health and Social Development and Pauktuutit Inuit Women of Canada. Twenty-one participants from these agencies came together to plan the project and commence the process; together they formed the First Nations and Inuit Child and Youth Injury Indicators Project Working Group.

A multi-phase modified-Delphi research design was adapted from the methods described by Lindsay et al.[16] and applied to the development of injury indicators for First Nations and Inuit children and youth. The choice of each indicator was based on limited available data and information describing the burden of injury on First Nations and Inuit children and youth, previous prevention research and best practices and ongoing input from expert Working Group members and their respective networks.

Phase I: Literature review

Phase I included a review of the relevant literature, with the goal of identifying any previously established valid and evidence-based First Nations and Inuit child and youth injury indicators. Research analysts at the First Nations and Inuit Health Branch, Health Canada conducted the literature review based upon the methodology used by Pike et al.[10] using the following databases for the period 1985 to 2007, inclusive: Medline, Ovid, Transport, Transportation Research Information Services, Sportdiscus, Cumulative Index to Nursing and Allied Health Literature, Embase, Psychinfo, Healthstar and Hispanic American Periodicals Index. The search also included indigenous agency and government websites and program report listings as a means of accessing relevant grey literature. The research analysts identified and summarized a total of 10 studies from the peer-reviewed and grey literature (list available from the authors upon request). The review of literature revealed an initial list of 48 injury indicators.

Phase II: Establishing important injury categories and ranking injury indicators

Of the 21-member Working Group, 19 were able to meet and agree on 4 areas in which to group child and youth injury indicators relevant to First Nations and Inuit communities: workplace, home and public safety; transport; sport and recreation; and inflicted injury / violence (including self-inflicted injury). Using their expertise, personal experience and knowledge of the research, the group discussed the most common injuries within each area and a way to potentially measure and monitor those injuries. As a result, 4 types of indicators were defined and described: outcome, risk and protective factors, program and policy.

The group then divided into small groups based on the 4 injury areas and reviewed the 48 indicators suggested by the literature review, adding additional indicators where deemed appropriate. Following full review and discussion, each small group presented their list of indicators to the large group. All in all, the list included 170 indicators.

With the goal of reducing the number of indicators while retaining those considered important and reflective of the community child and youth injury issues, the Working Group undertook another exercise to prioritize the indicators. In this exercise, the list of indicators was posted on flip charts. Participants were each given 55 paper adhesive dots (approximately one-third the number of the posted indicators) and instructed to position these beside those indicators they considered the most important. All indicators that were marked with 10 or more dots (representing an initial indication of importance) were retained and the remainder rejected. This N/3 technique of prioritizing[17] resulted in a list of 62 indicators that were regrouped by the participants from the original 4 into 7 broad injury categories: all injury areas; animal bites and hypothermia / frostbite; violent/inflicted injury; burns and falls; drowning; suicide; and motorized vehicle collisions.

The criteria used to inform priority setting included choosing injury indicators that 1) reflected a significant burden to First Nations and Inuit peoples, their families and the health care system, and 2) could be acted upon through prevention initiatives. Further, the participants were provided the International Collaborative Effort Injury Indicators Group (ICEIInG) criteria for indicator validity to inform their decision-making.

The subsequent step was to review and further refine the list of 62 indicators. Working Group members were asked to consult with their constituent groups and, for each indicator, recommend whether to ''keep'' or ''let go'' of it or whether they were ''unsure'' based upon 3 criterion questions: 1) Is this indicator important in your community? 2) Would this indicator help you to track injuries in your community? 3) Does this indicator give you sufficient information to take action to prevent injuries among children and youth in your community?

We reviewed the responses and retained those indicators that a majority of the Working Group had recommended keeping. Indicators that received a majority of ''let go'' responses were dropped. (No indicators received a majority vote of ''unsure.'') During this phase of the process and as a result of discussion among themselves, Working Group members proposed 2 additional indicators, which were circulated and judged to be important enough to keep: *the percentage of children/youth enrolled in ''learn to swim'' programs* and *percentage of violent offenders participating in restorative justice programs* were included as additional potential indicators, resulting in a list of 36 injury indicators at this stage.

Phase III: Regional feedback

Further input was sought from potential users at the community level. Investigators attended regional meetings and engaged First Nations and Inuit injury prevention practitioners and decision makers. At each meeting, the project was explained and participants were asked for their feedback on the list of 36 child and youth injury indicators.

Feedback on each injury indicator was obtained from a number of regional organizations in Alberta, Manitoba, Ontario, Quebec and Nunatsiavuut: the Manitoba Community Wellness Working Group, the Assembly of First Nations Regional Injury Prevention Working Group, the First Nations Early Childhood Circle (representatives from Saskatchewan Aboriginal Head Start Initiative and Federation of Saskatchewan Indian Nations), Chiefs of Ontario and the National Inuit Council on Health.

In this phase of the process, regional agency representatives identified 7 additional indicators judged to be important in understanding and preventing child and youth injury in their communities. As a consequence, the list of potential injury indicators increased from 36 to 43.

Phase IV: Specification of indicators

We created a standard template for indicator specification (see Table 1) and developed draft specifications for the 43 indicators based upon the format for previous reports from Australia,[18] New Zealand,[19] Europe[20] and Canada.[21] The Working Group then met to discuss, revise and refine the indicators and their specifications, and an additional round of review and further feedback was accomplished via email. Nine members of the Working Group responded[†] and recommended that several indicators be dropped due to the lack of available data and the difficulty and cost associated with generating new data collection systems to populate those indicators. Phase IV resulted in a further refined list of 33 candidate injury indicators (see Table 2).

TABLE 1
Template for the specification of child and youth injury indicators

Indicator
Definition
Definition of relevant terms
Justification for this indicator
Operational definition of a case
Method of calculation
Numerator
Denominator
Data sources, availability and quality/years represented
Units of measurement
Guide for use
Scope of indicator
Specification of data needed
Limitations
How to use this indicator

Phase V: Finalizing injury indicators

Following the specification of all 33 indicators, the Working Group met for the last time in December 2008 with 13 members attending. Each indicator was rated for perceived *usefulness* and *ability to prompt action* to reduce injuries among First Nations and Inuit children and youth using a 9-point scale, with 1 being low (not useful, not actionable) and 9 being high (very useful, very actionable). This resulted in 7 indicators being judged as neither useful nor actionable (and therefore not meeting the criteria for validity), either because of lack of data and/or resources availability, and

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[†] It is likely there were so few responses due to the length of the document and the time required to review it and/or satisfaction with the list of indicators and specifications.

TABLE 2
Ratings of usefulness and ability to prompt action of First Nations and Inuit child and youth injury indicators

Indicator domain/area	Indicator	Usefulness mean (SD) rating [1-9]	Prompt action mean (SD) rating [1-9]
Across all injury areas	Mortality rate: number of deaths per 10 000 children and youth due to each type of injury	9.00 (0.0)	8.11 (1.5)
	Hospitalization rate: number of hospitalizations per 10 000 children and youth due to each type of injury	8.56 (0.9)	7.67 (1.5)
	Number and proportion of self-reported alcohol, solvent and substance use among First Nations children and youth (based on RHS data)	6.63 (1.8)	6.44 (2.1)
	Number of communities that have culturally appropriate alcohol / drug programs available for community members	4.88 (2.2)	5.00 (2.4)
	Number of self-governing features that exist in the community	6.78 (2.7)	6.11 (3.0)
	Potential years of life lost (PYLL) due to injury among children and youth[a]	n/a	n/a
Community injury prevention training/ response systems	Proportion of community members who complete injury prevention training	7.11 (1.3)	6.33 (1.4)
	Presence of a community emergency preparedness plan (i.e. flooding, fires, blizzards, earthquakes, etc.)	7.78 (1.2)	7.44 (1.1)
	Availability of fire and ambulance services in a community within a defined response time	7.56 (1.2)	6.56 (1.9)
Animal bites	Rate of injuries due to animal bites and maulings per 10 000 children and youth in a community	8.44 (0.9)	7.67 (1.9)
	Number and proportion of communities with Animal Control Services	7.25 (1.3)	6.50 (2.2)
Hypothermia/Frostbite	Rate of hypothermia or frostbite per 10 000 children and youth	7.25 (1.4)	5.63 (2.2)
Violent/inflicted injury	Number and proportion of police calls and charges related to violent injury per 10 000 children and youth	8.33 (0.9)	7.56 (0.4)
	Self-reported rate of inflicted injury (violence and abuse) per 10 000 children and youth (not including self-inflicted injuries)	7.78 (1.1)	7.00 (1.3)
	Number and proportion of violent offenders participating in restorative justice programs	5.00 (3.2)	5.00 (3.0)
Burns and falls	Number and proportion of homes in a community with working smoke detectors, tested fire extinguishers and carbon monoxide detectors	8.33 (0.5)	8.11 (0.8)
	Number and proportion of self-reported burns among children and youth as well as the self-reported circumstantial details of each case	7.13 (2.4)	6.38 (2.4)
	Place where falls among children and youth happen (this refers to self-reported falls to children and youth within the previous 12 months)	8.44 (0.7)	7.33 (1.4)
Drowning	Number and proportion of communities with Emergency Response Teams	7.11 (1.5)	6.78 (1.5)
	Number and proportion of communities with access to water safety education/programs	7.89 (1.3)	7.22 (0.8)
	Enforcement of laws related to water	5.13 (2.5)	4.63 (2.2)
	Number and proportion of children and youth who drown each year, including type of body of water and circumstances	8.56 (0.7)	7.33 (1.0)
	Number and proportion of children and youth enrolled in ‘‘learn to swim’’ programs in a specific year	7.67 (1.0)	6.50 (1.2)
Suicide	Number of communities with mental health and wellness promotion programs	6.50 (2.8)	6.86 (2.3)
	Rate of self-reported poor mental health among children and youth	7.89 (0.8)	6.56 (1.9)
	Rate of suicide attempts/self-harm and completed suicides per 10 000 children and youth	8.78 (0.4)	7.44 (1.0)
	Rate of calls to suicide prevention crisis telephone services, by geographical region	7.67 (1.0)	7.22 (0.8)

Continued on the following page

TABLE 2 (continued)
Ratings of usefulness and ability to prompt action of First Nations and Inuit child and youth injury indicators

Indicator domain/area	Indicator	Usefulness mean (SD) rating [1-9]	Prompt action mean (SD) rating [1-9]
Motorized vehicle collisions	Rate of motorized vehicle collisions involving children and youth, by type of vehicle and crash circumstances	8.78 (0.4)	8.00 (1.0)
	Number and proportion of seriously injured children and youth occupants who were unrestrained (not wearing a seatbelt) in a motor vehicle collision	8.67 (0.5)	8.22 (1.4)
	Number and proportion of youth who enrolled in and completed driver education courses—skills for car, snowmobile, boat and ATV drivers	8.22 (0.7)	7.22 (1.0)
	Proportion of motor vehicles demonstrating proper use of child vehicle restraints (car seats) and booster seats by community	8.78 (0.4)	8.33 (1.0)
	Age and sex of drivers and occupants involved in motor vehicle crashes by vehicle type (car, van, truck, ATV, snowmobile) and road user (driver, passenger, pedestrian, cyclist)	8.33 (0.9)	7.67 (1.4)
	Presence of legislation of minimum age to drive an ATV. Number of provinces and territories with legislation of minimum age to drive an ATV	7.13 (2.2)	6.00 (2.7)
	Number and proportion of seriously injured or killed children and youth not wearing a helmet while riding ATVs, snowmobiles and/or bicycles by community	8.67 (0.5)	8.11 (0.9)

Abbreviations: ATV, all-terrain vehicle; PYLL, potential years of life lost; RHS, First Nations Regional Longitudinal Health Survey; SD, standard deviation.

Note: The dark grey shaded areas represent indicators that received low ratings and were subsequently dropped.

[a] All members of the expert group were unanimous in their agreement to include PYLL as a useful indicator and did not rate it.

were dropped (see the shaded indicators in Table 2). The process concluded with the Working Group endorsing a final list of 27 injury indicators for First Nations and Inuit children and youth.

Immediately following the rating process, the group unanimously agreed to re-insert PYLL due to injury, which had been listed at the review of literature stage, although they did not rate it.

Results

The modified-Delphi method resulted in a proposed list of 27 injury indicators. Indicators related to motorized vehicle collisions, mortality rates and the number of children and youth hospitalized due to each injury type ranked highest in terms of *usefulness* and ability to *prompt action*. These were followed by community injury prevention training and response systems, violent and inflicted injury, burns and falls, and suicide although some were rated somewhat lower in terms of their ability to *prompt action*.

Discussion

This modified-Delphi approach represents the first step in the indicator development process that resulted in a final proposed set of 27 First Nations and Inuit child and youth injury-related indicators that can be used to inform injury prevention in Canada's indigenous peoples. While there was some variation in the degree to which experts rated the *usefulness* and likelihood to *prompt action* of each indicator, there was general consistency and agreement. The high scores given to the injury indicators suggest that they capture the needs of those working to prevent injuries among First Nations and Inuit children and youth.

While the indicators were developed to apply to First Nations and Inuit children and youth, some indicators are applicable to any children and youth living in rural or remote communities, and others apply to all children and youth.

Strengths and limitations

There are some limitations to this work, which are important to highlight here.

First, there is a paucity of published literature related to indigenous child and youth injury prevention to inform the decision-making around the indicator selection.

Second, the modified-Delphi process technique used is subjective and based upon participant expertise and experience. While efforts to be objective in generating and prioritizing indicators were made within the process, the results depend upon the opinions of the participating experts. Participants were advised of the criteria for indicator validity, but it is not known how much that influenced their choice of indicators. It is possible that the results would be different had a different group of experts participated. However, the experts chosen were those deemed most relevant to the process because they were knowledgeable about the field and the best representatives of their agencies and constituents.

A further limitation is the current and continuing lack of the data necessary to populate the indicators. Some indicators had no data available, and may not have in the foreseeable future. However, data for many of the indicators are available from the First Nations Regional Longitudinal Health Survey, and some communities (e.g. 10 bands of the Secwepemc Nation in British Columbia) collect health and injury data that can populate the indicators. In addition, we anticipate that, with time, more communities will gather their own data and information of local interest and relevance to child and youth injury prevention. This approach is consistent with the OCAP™ principles.[15]

Conclusion

Using a systematic, interdisciplinary modified-Delphi method, which involved direct input and leadership from First Nations and Inuit experts, this study resulted in a proposed list of 27 useful and actionable injury indicators to guide First Nations and Inuit community injury prevention initiatives focused on children and youth.

While several of the indicators are in line with those developed for non-indigenous Canadian children and youth,[10] differences do exist. Most important, the current indicators are specific to injury among First Nations and Inuit children and youth, reflecting local circumstances and conditions important to injury risk and prevention in indigenous communities, some of which are small, rural and remote. For example, the First Nations and Inuit indicators included those that relate to community injury prevention training and response systems, animal bites, drowning, hypothermia and frostbite, which were considered less important for non-indigenous populations.

Further research and collaboration by the Working Group with indigenous communities will demonstrate the utility of the indicators in furthering injury prevention. Work will continue to identify the necessary appropriate data and information to populate the indicators. It is anticipated that the research team will work with communities to gather the necessary data and information to populate the indicators, including helping develop consistent definitions of causes of injury and injury severity. Ultimately, indigenous health authorities and communities can use the information to plan, implement and evaluate programs and initiatives to prevent injury among children and youth, consistent with the OCAP^{TM} principles underlying research among Canadian indigenous communities.

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References

1. SMARTRISK. Ending Canada's invisible epidemic: a strategy for injury prevention. Toronto (ON): SMARTRISK; 2005.

2. Banerji A; Canadian Paediatric Society; First Nations, Inuit and Métis Health Committee. Preventing unintentional injuries in Children and Youth in Canada. Paediatr Child Health. 2012;17(7):393-4.

3. Health Canada. A statistical profile on the health of First Nations in Canada: Health services utilization in Western Canada, 2000 [Internet]. Ottawa (ON): Health Canada; 2009 [cited 2012 Apr 15]. Available from: http://www.hc-sc.gc.ca/fniah-spnia/pubs/aborig-autoch/2009-stats-profil-vol2/index-eng.php

4. Harrop AR, Brant RF, Ghali WA, Macarthur C. Injury mortality rates in Native and non-Native children: a population-based study. Public Health Rep. 2007;122(3):339-46.

5. Oliver LN, Kohen DE. Unintentional injury hospitalizations among children and youth in areas with a high percentage of Aboriginal identity residents: 2001/2002 to 2005/2006. Health Rep. 2012;23(3):7-15. [Statistics Canada, Catalogue No.: 82-003-XPE].

6. Anderson M, Smylie J, Anderson I, Sinclair R, Crengle S. First Nations, Métis, and Inuit health indicators in Canada: a background paper for the project ''Action Oriented Indicators of Health and Health Systems Development for Indigenous Peoples in Australia, Canada, and New Zealand'' [Internet]. 2006 [cited 2013 Apr 15]. Available from: http://www.med.uottawa.ca/SIM/data/Images/Aboriginal_health_indicators.pdf

7. Canadian Child and Youth Coalition. Our work: health indicators: child & youth health indicator program [Internet]. London (ON): CCYHC; 2008 [cited 2013 Apr 12]. Available from: http://www.ccyhc.org/work_indicators_about.html

8. Leitch K. Reaching for the top: a report by the advisor on healthy children & youth. Ottawa (ON): Government of Canada; 2007.

9. Pauktuutit. Inuit Five-Year Injury Prevention Strategic Plan 2010-1015. Ottawa (ON): Pauktuutit Inuit Women of Canada; 2010.

10. Pike I, Piedt S, Warda L, et al. Developing injury indicators for Canadian children and youth: a modified-Delphi approach. Inj Prev. 2010;16:154-60.

11. Cryer C. ICE Injury Indicators Group (ICEIInG) – progress report, aspirations, goals and strategy development. In: International Collaborative Effort on Injury Statistics, Volume IV. Washington (DC): NCHS, CDC, US Department of Health and Human Services; 2003. Available from: http://www.cdc.gov/nchs/data/ice/iceproceedings.pdf

12. First Nations Centre. Understanding health indicators. Ottawa (ON): National Aboriginal Health Organization; 2007.

13. Guilford JP, Fruchter D. Fundamental statistics in psychology and education, 5th edition. New York: McGraw-Hill; 1973.

14. Cryer C, Langley JD, Jarvis SN, Mackenzie SG, Stephenson SC, Heywood P. Injury outcome indicators: the development of a validation tool. Inj Prev. 2005;11:53-7.

15. First Nations Information Governance Centre. The First Nations principles of OCAP™ [Internet]. Akwesasne (ON): FNIGC; 2013 [cited 2013 Aug 19]. Available from: www.fnigc.ca/ocap.html

16. Lindsay P, Schull M, Bronskill S, Anderson G. The development of indicators to measure the quality of clinical care in emergency departments following a modified-delphi approach. Acad Emerg Med. 2002;9: 1131-39.

17. Andersen A. A process guidebook: tools and techniques for effective facilitation. Chicago (IL): Arthur Andersen & Co; 1991.

18. Harrison JE, Steenkamp M. Technical review and documentation of current NHPA injury indicators and data sources. Injury Research and Statistics Series Number 14. Adelaide (AU): AIHW; 2002. AIHW Catalogue No.: INJCAT 47.

19. Cryer C, Langley J, Stephenson S. Developing valid injury outcome indicators: a report for the New Zealand Injury Prevention Strategy. Dunedin (NZ): Injury Prevention Research Unit, Department of Preventive and Social Medicine, University of Otago; 2004.

20. Pencheon D. The good indicators guide: understanding how to choose and use indicators. Coventry (UK): NHS Institute for Innovation and Improvement; 2008.

21. Canadian Institute of Health Information. Pan-Canadian primary health care indicators. Report 1, Volume 1: Pan-Canadian Primary Health Care Indicator Development Project [Internet]. Ottawa (ON): Canadian Institute for Health Information; 2006 [cited 2013 Apr 19]. Available from: https://secure.cihi.ca/free_products/PHC_Indicator_Report_1_Volume_1_Final_E.pdf

Chronic disease and chronic disease risk factors among First Nations, Inuit and Métis populations of northern Canada

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Abstract

Introduction: Aboriginal populations in northern Canada are experiencing rapid changes in their environments, which may negatively impact on health status. The purpose of our study was to compare chronic conditions and risk factors in northern Aboriginal populations, including First Nations (FN), Inuit and Métis populations, and northern non-Aboriginal populations.

Methods: Data were from the Canadian Community Health Survey for the period from 2005 to 2008. Weighted multiple logistic regression models tested the association between ethnic groups and health outcomes. Model covariates were age, sex, territory of residence, education and income. Odds ratios (ORs) are reported and a bootstrap method calculated 95% confidence intervals (CIs) and *p* values.

Results: Odds of having at least one chronic condition was significantly lower for the Inuit (OR = 0.59; 95% CI: 0.43–0.81) than for non-Aboriginal population, but similar among FN, Métis and non-Aboriginal populations. Prevalence of many risk factors was significantly different for Inuit, FN and Métis populations.

Conclusion: Aboriginal populations in Canada's north have heterogeneous health status. Continued chronic disease and risk factor surveillance will be important to monitor changes over time and to evaluate the impact of public health interventions.

Keywords: *Aboriginal, First Nations, Inuit, Métis, chronic disease, northern Canada*

Introduction

Aboriginal populations in Canada's north comprise three distinct groups, First Nations (FN), Inuit and Métis, each with their own histories, lifeways and relationships with the Government of Canada. Canada's northern territories, the Yukon, Northwest Territories (NWT) and Nunavut, have the largest proportion of Aboriginal people of any region in Canada. Overall, 40% of northern Canadians living in the territories are Aboriginal, compared to only 4% of the total Canadian population.[1] In Nunavut, 85% of the population is Aboriginal, over 90% of whom are Inuit. In the NWT, 50% of the population is Aboriginal (FN, 61%; Inuit, 20%; Métis, 17%) and in the Yukon, 25% of the population is Aboriginal (FN, 83%; Métis, 11%; Inuit, 4%).[*]

In the past half century, the Aboriginal populations of northern Canada have undergone a significant health transition characterized by a decline in infectious diseases and an increase in chronic conditions such as diabetes, obesity, heart disease and respiratory illnesses. This is paralleled by an increase in social problems such as violence, accidents and substance abuse.[2] These phenomena are strongly interrelated through the effects of colonization and the subsequent changes in both physical and social environments.[3]

The epidemiological transition is proceeding at a different pace for Aboriginal peoples in southern and northern Canada. As Lix et al.[4] described, the burden of chronic diseases and risk factors for chronic diseases is high in the south and emerging in the north. Chronic disease and risk factor surveillance is important among populations undergoing rapid changes in health and can help in developing interventions. It is important for FN, Inuit and Métis governing bodies to understand and act upon issues that affect their people specifically because each of these Aboriginal groups represent distinct groups with unique relationships to the federal, provincial and local governments. Therefore, Aboriginal groups require data that are relevant to their own people, regardless of jurisdiction.

To date there has been scant research comparing chronic disease and risk and protective factor prevalence in the three Aboriginal populations in northern Canada. The purpose of our research was 1) to describe and compare the prevalence of chronic conditions and risk factors among the FN, Inuit, and Métis populations and 2) to compare these populations to northern non-Aboriginal populations.

Methods

Data source

We used data from cycles 3.1 (2005/2006) and 4.1 (2007/2008) of the Canadian Community Health Survey (CCHS) for this

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[*] The proportions do not sum 100 because those who identified with more than one ethnic group have been excluded.

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research. The CCHS is a national survey conducted by Statistics Canada that contains questions about health care status, determinants of health and health system use for 136 health regions in Canada. The CCHS covers approximately 98% of the entire Canadian population aged 12 years or older. People living on Indian reserves and other government-owned land and in institutions as well as full-time members of the Canadian Forces are excluded from the survey. In Yukon and Nunavut, Aboriginal people do not live on reserve, nor do over 99% of the people in NWT.[5] In Nunavut, the CCHS only collects information from the 10 largest communities; therefore 71% of the population of this territory is covered by the survey.[6] Data from the two CCHS cycles were combined to allow adequate sample size to investigate multiple chronic diseases and risk factors.

Sample sizes for cycles 3.1 and 4.1 of the CCHS were 132 947 and 131 959, respectively. Response rates for cycle 3.1 were 78.9% for the total Canadian sample, 81.6% for Yukon, 81.7% for NWT and 87.7% for Nunavut. In cycle 4.1, response rates were 76.4% for total Canadian sample, 83.0% for Yukon, 85.0% for NWT and 85.4% for Nunavut. Included in this study are all respondents to cycle 3.1 or cycle 4.1 aged 20 years and older who reported Yukon, NWT or Nunavut as their region of residence. Therefore, the non-Aboriginal comparison population is also northern.

Our research was approved by the University of Manitoba Health Research Ethics Board. Statistics Canada approved access to the data; analyses were conducted within the secure environment of the Statistics Canada Research Data Centre located at the University of Manitoba.

Study measures

In each cycle of the CCHS, respondents were asked if they self-identified with one of the three constitutionally recognized Aboriginal groups. Those who identified with more than one ethnic group were assigned to the FN group. Given the small sample size, we did not want to exclude any individuals. Respondents who selected an ethnic group other than the three Aboriginal groups were defined as non-Aboriginal. Therefore, the ethnic categories for this study are FN, Inuit, Métis and non-Aboriginal.

In addition to age and sex, respondents were characterized by total household income and highest level of education. Education was categorized as less than secondary, secondary and post-secondary. Respondents were asked to provide an estimate of total household income from all sources, before taxes and deductions, in the past 12 months; total household income was assigned to one of four categories: $0 to $29 999, $30 000 to $59 999, $60 000 to $99 999, and $100 000 or more.

Respondents were asked about long-term chronic health conditions that were expected to last, or had already lasted 6 months or more and been diagnosed by a health care professional. Multiple chronic conditions are included in this analysis: arthritis/rheumatism, asthma, bowel disorders, cancer, diabetes, emphysema/chronic obstructive pulmonary disease (COPD), heart disease, high blood pressure and stroke. Dichotomous variables (i.e. presence/absence) were created for each condition. In addition, a single variable was created for an individual's overall level of morbidity. Specifically, the presence of at least one of the following chronic conditions was used to create a binary morbidity variable: arthritis/rheumatism, asthma, high blood pressure, diabetes, heart disease, cancer, stroke, chronic bronchitis, emphysema, COPD, bowel disorders, anxiety disorder, mood disorder, migraine headaches, dementia, stomach or intestinal ulcers, urinary incontinence and back problems.

We also investigated a number of risk and protective factors including alcohol consumption, cigarette smoking, body mass index (BMI) and leisure-time and regular physical activity. Risk factors included as part of the optional module in the CCHS were excluded. We categorized alcohol consumption as follows: non-drinker; occasional ($<$ 1 drink/month in the past 12 months); regular ($\geq$ 1 drink/month in the past 12 months); and heavy ($\geq$ 5 drinks on at least one occasion in the past 12 months).[7] Possible responses on the frequency of cigarette smoking were daily, occasionally or non-smoker. Dichotomous variables (yes/no) were created for each category; for example, odds ratio for daily smoking are reported as compared to non-smokers. Variables were dichotomized to improve interpretation and also minimize the effect of small cell sizes as we cross-tabulated with the explanatory variables. We determined the chronic conditions and risk factors to select based on availability in the dataset as well as theoretical considerations; many of the chronic conditions have already been implicated in the epidemiological transition that is emerging in the north.[4,8] All of the risk factors were related to multiple chronic conditions, are inter-related and/or are markers of broader community and structural factors. For example, alcohol use is associated with heart disease, blood pressure, anxiety disorders, mood disorders and bowel disorders.[9-11] Smoking is associated with asthma, chronic bronchitis, diabetes, heart disease and high blood pressure.[12] Overweight and obesity are associated with arthritis, asthma, diabetes, heart disease, high blood pressure, bowel disorders, anxiety disorders and mood disorders.[13,14]

BMI was calculated from self-reported height and weight data.[15] Overweight was defined as BMI of 25.00 to 29.99 kg/m^2 and obesity as BMI of 30.0 kg/m^2 or higher.[16]

Respondents were asked to report the frequency of all physical activities not related to work lasting over 15 minutes for the 3-month period before the date of the interview. Average monthly frequency was then calculated. Physical activity level was categorized as follows: regular ($\geq$ 12 occasions/month); occasional (4–11 occasions/month); and infrequent ($<$ 4 occasions/month). Dichotomous variables (yes/no) were formed for each category of physical activity. Levels of leisure-time physical activity were derived based on each respondent's total daily energy expenditure during leisure-time physical activities[17] and was defined as active ($\geq$ 3.0 kcal/kg/day), moderate (1.5–2.99 kcal/kg/day) or inactive (0–1.49 kcal/kg/day). Leisure-time physical activities included walking, running, cycling, swimming, home exercise, exercise classes, fishing and gardening and also playing team sports such as ice hockey, basketball, volleyball and soccer. Each category of leisure-time physical activities was dichotomized (yes/no).

Finally, we investigated an overall measure of health. Respondents were asked to rate their own health with 5 options ranging from excellent to poor. Subsequently, we combined the 5 categories of self-rated health into 2: excellent, very good and good in one, and fair and poor in the other. (For further information on self-rated health in indigenous populations, see Bombak and Bruce SG.[18])

Data analysis

Data from the two cycles were combined using a pooled estimate method.[19] Descriptive analyses of the total number of respondents and their sociodemographic characteristics were conducted in an unweighted analysis. Crude prevalence of the selected chronic diseases, risk factors and self-rated health were calculated with 95% confidence intervals (CIs) using the sampling weights, which ensures that the estimates are representative of the study population.

Weighted multiple logistic regression analyses were used to test the association between ethnicity and each of the measures of chronic disease, health risk and self-rated health. In addition to ethnic group, the covariates included age group (20–34 years, 35–54 years, 55+ years), sex, territory of residence, education level and total household income. The reference categories were the 55+ years age group, male sex, non-Aboriginal ethnicity for analyses that included all ethnic groups and FN for within-Aboriginal group analyses, NWT residence, less than secondary education and lowest income category ($0–$29 999).

We used a bootstrap method to calculate 95% CIs for the crude prevalence estimates and adjusted odds ratios (AORs).[20,21] The bootstrap method randomly samples, with replacement from the original set of observations, to obtain a sampling distribution for a population parameter. We conducted all analyses with a SAS[22] macro developed by methodologists at Statistics Canada; it was based on a total of 500 samples, as recommended by the software developers.

Results

Table 1 shows the sociodemographic characteristics of the study population. Missing data were minimal (< 1%). FN and Inuit populations were younger than the non-Aboriginal population; 59% and 74% of FN and Inuit, respectively, were aged less than 45 years compared to 50% of the non-Aboriginal population. The age structure of the Métis population is similar to the non-Aboriginal population. Educational attainment is lower among Aboriginal populations compared to the non-Aboriginal population. Annual income is also lower for FN and Inuit populations compared to the Métis and non-Aboriginal populations.

Crude prevalence and AORs for the chronic conditions and risk factors are shown in Tables 2 and 3, respectively; the non-Aboriginal population is the reference group for the regression models. The AOR for at least one chronic condition was significantly lower for Inuit than for non-Aboriginal population, but similar among FN, Métis and non-Aboriginal populations. The most common chronic conditions for all populations were arthritis and high blood pressure. The AOR for diabetes was significantly lower among the Inuit than among the non-Aboriginal population. Other chronic diseases such as asthma, bowel disorders (e.g. Crohn's disease, ulcerative colitis or irritable bowel syndrome) and mood disorders (e.g. depression) were also significantly less likely among the Inuit than among the non-Aboriginal population. Odds of reporting an anxiety disorder are significantly higher among the Métis than the non-Aboriginal

TABLE 1
Sociodemographic characteristics of northern Canadian population, ≥ 20 years, 2005 and 2008

Characteristics		First Nations		Métis		Inuit		Non-Aboriginal	
		n	%	n	%	n	%	n	%
Sex	Male	363	43.9	97	44.9	452	48.5	1486	49.6
	Female	468	56.3	119	55.1	480	51.5	1511	50.4
Age group, years	20–34	282	33.9	67	31.0	444	47.6	851	28.4
	35–44	204	24.6	58	26.9	245	26.3	649	21.7
	45–54	147	17.7	55	25.5	113	12.1	727	24.3
	≥ 55	198	23.8	36	16.7	130	14.0	770	25.7
Education	< Secondary	374	45.0	49	22.7	428	45.9	281	9.4
	Secondary school graduation	74	8.9	26	12.0	68	7.3	325	10.8
	Post-secondary education	377	45.4	141	65.3	429	46.0	2379	79.4
Total household income, $	0–29 999	277	33.3	32	14.8	304	32.6	345	11.5
	30 000–59 999	166	20.0	40	18.5	193	20.7	520	17.4
	60 000–99 999	127	15.3	46	21.3	147	15.8	801	26.7
	>100 000	107	12.9	74	34.3	122	13.1	1095	36.5
Total sample (N)		**831**	**16.6**	**216**	**4.3**	**932**	**18.6**	**2997**	**59.8**

TABLE 2
Crude prevalence (%) of chronic diseases and risk/protective factors by ethnic group, 2005 and 2008

	Prevalence, % (95% CI)			
	First Nations	Métis	Inuit	Non-Aboriginal
Chronic disease				
At least 1 chronic condition	51.88 (46.83–56.93)	52.66 (43.36–61.96)	34.64 (29.96–39.33)	50.60 (47.58–53.61)
Arthritis	12.43 (9.46–15.39)	14.03 (8.92–19.14)	11.02 (8.11–13.92)	13.98 (12.44–15.52)
Asthma	6.43 (3.86–8.99)	7.90 (4.09–11.71)	3.51 (1.78–5.23)	8.38 (7.09–9.67)
Chronic bronchitis	2.06 (1.03–3.10)	3.07 (0.00–6.39)	0.92 (0.16–1.68)	1.28 (0.71–1.85)
Diabetes	5.22 (3.51–6.93)	5.67 (1.13–10.20)	1.02 (0.41–1.62)	4.10 (3.21–4.99)
Heart disease	3.31 (1.69–4.92)	3.94 (0.75–7.14)	2.14 (0.85–3.42)	2.73 (1.97–3.50)
High blood pressure	13.45 (10.32–16.58)	12.88 (7.16–18.61)	7.76 (5.97–9.56)	12.82 (11.26–14.39)
Anxiety disorder	3.66 (2.26–5.06)	6.58 (3.43–9.74)	2.63 (0.69–4.57)	3.65 (2.68–4.62)
Bowel disorder	3.43 (1.47–5.39)	4.55 (0.81–8.28)	0.80 (0.00–1.70)	4.18 (3.13–5.23)
Mood disorder	5.46 (3.74–7.19)	5.62 (1.56–9.69)	3.05 (1.56–4.54)	6.88 (5.42–8.34)
Risk/protective factor				
Binge drinking[a]	72.83 (68.19–77.47)	64.81 (55.07–74.55)	68.82 (64.73–72.90)	54.45 (51.42–57.48)
Regular drinking[b]	54.84 (49.14–60.53)	67.95 (60.54–75.36)	45.15 (37.47–52.84)	67.48 (64.42–70.55)
Daily smoker	45.13 (40.97–49.28)	33.07 (24.77–41.37)	63.62 (59.21–68.03)	22.84 (20.33–25.35)
Overweight[c]	29.04 (25.58–32.51)	31.52 (22.19–40.85)	26.75 (23.48–30.01)	33.52 (31.25–35.79)
Obesity[d]	23.55 (18.54–28.56)	28.28 (20.43–36.12)	24.27 (20.48–28.06)	21.05 (19.06–23.03)
Active during leisure time[e]	19.37 (14.54–24.21)	18.83 (12.94–24.73)	18.48 (14.73–22.24)	23.34 (20.77–25.90)
Regular physical activity[f]	55.38 (49.30–61.47)	57.08 (49.15–65.00)	47.52 (42.57–52.47)	65.35 (62.72–67.98)
Self-perceived health[g]	82.64 (79.49–85.79)	88.51 (82.20–94.82)	82.98 (79.83–86.13)	91.05 (89.42–92.68)

Abbreviations: BMI, body mass index; CI, confidence interval.

[a] ≥ 5 drinks on at least one occasion in the past 12 months.

[b] ≥ 1 drink/month in the past 12 months.

[c] BMI 25.00–29.99 kg/m^2.

[d] BMI ≥ 30.0 kg/m^2.

[e] ≥ 3.0 kcal/kg/day.

[f] ≥ 12 occasions/month.

[g] 3 categories of self-rated health in one category: excellent, very good and good.

population. The odds of reporting a chronic illness were not significantly different between northern FN and non-Aboriginal respondents.

The prevalence of many chronic disease risk factors, however, was significantly higher among Aboriginal than non-Aboriginal population. Some of these results are highlighted in Figure 1. Compared to non-Aboriginal respondents, larger proportions of FN, Inuit and Métis respondents reported binge drinking. Odds of binge drinking among FN and Inuit respondents were about twice that of non-Aboriginal respondents. The prevalence of daily smoking was also higher among all Aboriginal populations than the non-Aboriginal population, and ranged from 64% for the Inuit to 23% for the non-Aboriginal population. The AOR of daily smoking was 3.5 times higher for the Inuit, twice as high for FN and 1.5 times higher for the Métis.

About 30% of all respondents were overweight, and prevalence of obesity ranged from 24% to 28% for FN, Inuit and Métis respondents to 21% for non-Aboriginal respondents. The AOR of obesity for the Métis is 1.51 times that of the non-Aboriginal population. The percentage of FN, Inuit and Métis respondents reporting regular physical activity and leisure-time physical activity is lower than for non-Aboriginal respondents. A high proportion of all respondents reported their health as either excellent, very good or good, from 83% for FN and Inuit respondents, to 91% for non-Aboriginal respondents. However, the AOR of reporting excellent, very good and good health was significantly lower for Inuit than for non-Aboriginal populations.

AORs for the chronic conditions and risk factors in the three Aboriginal groups are shown in Table 4; the FN population is the reference group. Odds of diabetes and bowel disorders were significantly lower among the Inuit than among the FN population. In terms of risk factors, the AORs of being a regular drinker or of being overweight were significantly lower for Inuit than for FN populations. The odds of being a regular drinker are significantly higher for the Métis than the FN population. No other differences in odds of

TABLE 3
Adjusted odds ratios for major chronic disease and risk/protective factors by ethnic group, 2005 and 2008

	AOR (95% CI)		
	First Nations	Métis	Inuit
Chronic disease			
At least 1 chronic condition	0.95 (0.72–1.27)	1.09 (0.72–1.66)	0.59 (0.43–0.81)[a]
Arthritis	0.70 (0.48–1.03)	1.06 (0.67–1.68)	0.90 (0.56–1.46)
Asthma	0.69 (0.42–1.13)	0.92 (0.50–1.68)	0.48 (0.24–0.96)[a]
Chronic bronchitis	1.00 (0.41–2.49)	2.24 (0.20–24.74)	0.68 (0.11–4.40)
Diabetes	1.26 (0.75–2.13)	1.58 (0.64–3.90)	0.36 (0.14–0.88)[a]
Heart disease	0.91 (0.48–1.72)	1.81 (0.55–5.92)	1.06 (0.45–2.49)
High blood pressure	1.12 (0.74–1.69)	1.22 (0.68–2.21)	0.77 (0.51–1.17)
Anxiety disorder	1.02 (0.61–1.68)	2.07 (1.07–4.03)[a]	0.75 (0.32–1.79)
Bowel disorder	0.63 (0.33–1.22)	1.03 (0.41–2.56)	0.15 (0.05–0.41)[a]
Mood disorder	0.66 (0.42–1.03)	0.76 (0.32–1.78)	0.37 (0.19–0.72)[a]
Risk factor			
Binge drinking[b]	2.19 (1.58–3.04)[a]	1.46 (0.91–2.34)	1.85 (1.23–2.78)[a]
Regular drinking[c]	0.77 (0.57–1.03)	1.12 (0.74–1.68)	0.46 (0.31–0.67)[a]
Daily smoker	2.09 (1.60–2.74)[a]	1.54 (1.07–2.21)[a]	3.48 (2.43–4.98)[a]
Overweight[d]	0.94 (0.73–1.21)	0.89 (0.55–1.44)	0.79 (0.58–1.07)
Obese[e]	1.36 (0.98–1.89)	1.51 (1.03–2.19)[a]	1.37 (0.93–2.03)
Leisure physical activity: active[f]	0.96 (0.68–1.37)	0.88 (0.56–1.39)	0.82 (0.59–1.12)
Regular physical activity[g]	0.93 (0.69–1.25)	0.84 (0.59–1.18)	0.76 (0.55–1.05)
Self-perceived health[h]	0.72 (0.52–0.99)	0.84 (0.41–1.71)	0.55 (0.34–0.88)[a]

Abbreviations: AOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval.

Notes: AORs are adjusted for age, sex, region, income and education.

The reference group is the non-Aboriginal population.

[a] Denotes an estimate that is statistically significant at the 5% level of significance.

[b] $\geq$ 5 drinks on at least one occasion in the past 12 months.

[c] $\geq$ 1 drink/month in the past 12 months.

[d] BMI = 25.00–29.99 kg/m^2.

[e] BMI $\geq$ 30.0 kg/m^2.

[f] $\geq$ 3.0 kcal/kg/day.

[g] $\geq$ 12 occasions/month.

[h] 3 categories of self-rated health in 1 category: excellent, very good and good.

chronic conditions, risk factors or self-rated health were found among the Aboriginal groups.

Discussion

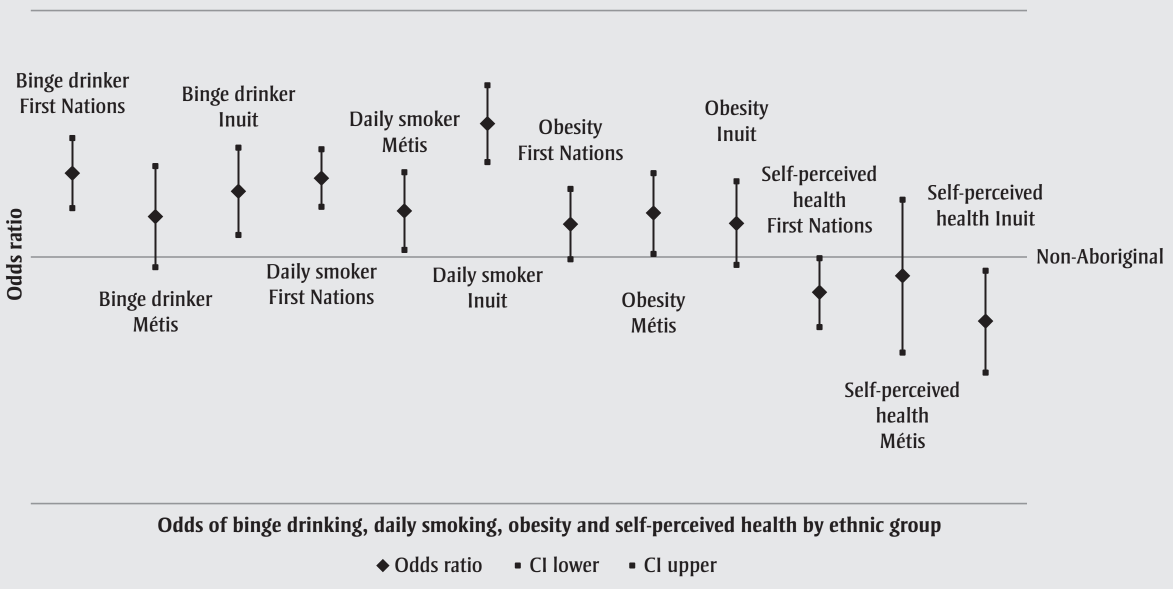
Variability in chronic disease and risk factor prevalence was found among FN, Inuit and Métis residents of northern Canada. Most research and chronic disease surveillance reports for northern Canada have, to date, combined the three ethnic groups into one—Aboriginal—group. However, the three groups have different histories, cultural backgrounds and lifeways, all of which may have influenced the differences in outcomes and will affect interventions to address them.

Among the Inuit, prevalence of chronic disease was lower than among the northern FN and Métis populations. This is consistent with previous findings related to diabetes,[23,24] although inter-ethnic differences regarding other chronic diseases have not been investigated. Lix et al. previously reported on the prevalence of chronic disease and risk factors for southern Aboriginal people (i.e. residents of the 10 Canadian provinces) using 2005/2006 CCHS data.[4] Compared to Aboriginal populations in southern Canada, the prevalence of arthritis, asthma, heart disease, diabetes and high blood pressure is lower among the Inuit. Prevalence of chronic disease risk factors is more variable. The Inuit were similar to northern FN and Métis on most of the risk factors investigated in this research. However, compared to southern Aboriginal populations, the Inuit have lower prevalence of overweight and regular drinking but similar levels of obesity and higher prevalence of binge drinking and daily smoking.[4]

We previously also reported on chronic disease and risk factor prevalence among northern Aboriginal and non-Aboriginal populations by territory of residence (i.e. NWT, Yukon and Nunavut).[8] The prevalence of most chronic disorders among the Inuit has not increased and risk factor prevalence has stayed the same or increased, compared to Aboriginal data for Nunavut. Specifically, prevalence of overweight and obesity has not changed, but daily smoking, regular drinking and binge drinking have increased.[8]

That the prevalence of chronic disease among the Inuit remains the lowest for all Aboriginal people in Canada and has generally not increased since 2000 is positive. This may be attributable to greater adherence to traditional lifestyles including dietary patterns among this group. However, the literature also suggests the beginning of a shift to western diets.[25] On the other hand, the increasing prevalence of risk factors among the Inuit is worrying. The risk factors that are increasing are linked to major chronic diseases such as cancer[26] and heart disease[27] and social problems like violence, accidents, injuries, addictions, and family and community dysfunction.[28] This finding, together with other reported adverse changes in the health transition,[29,30] suggests that some chronic conditions could be on the rise. Communities, clinicians and policy makers must work together to address the increasing risk factors and develop interventions aimed at risk factor reduction.

FIGURE 1
Odds of selected risk factors and self-perceived health among northern Aboriginal groups compared to the northern non-Aboriginal population



Abbreviation: CI, confidence interval.

Among northern FN residents, prevalence of arthritis, asthma and heart disease is lower than among southern Aboriginal people, of diabetes is about the same, and of high blood pressure is greater.[4] The picture for chronic disease risk factors is also variable. Compared to southern Aboriginal residents, FN residents in northern Canada have similar prevalence of overweight, obesity and regular drinking but higher prevalence of binge drinking and daily smoking.[4] The chronic disease and risk factor picture for northern FN people is of concern because it has been seen before among FN people in southern Canada; chronic diseases and risk factors among Aboriginal people of southern Canada are sources of excess morbidity, decreased quality of life and premature mortality.

Finally, prevalence of arthritis, asthma and heart disease among the Métis of northern Canada is lower than among Métis of southern Canada.[31-33] Compared to southern Aboriginal Canadians, the prevalence of overweight is similar, daily smoking is lower, but obesity, regular drinking and binge drinking are higher. Similar to the Inuit and northern FN, the risk factor profile of the Métis is of concern because of cardiometabolic morbidity, social consequences and premature mortality.

It will be important for northern Aboriginal communities and organizations to work with government agencies and health care professionals to decrease the risk profile if they hope to avert the epidemic of cardiometabolic conditions witnessed among Aboriginal people in southern Canada. However, the environment in the north may be more challenging because community resources are fewer, food more expensive and the effects of climate change greater.[34,35]

Strengths and limitations

This study is subject to limitations. CCHS data are based on self-report; this may result in underestimates of chronic disease and risk factors such as BMI, smoking and drinking. Further, commonly used cut-points of BMI for obesity and overweight may not be appropriate for all Aboriginal populations.[36] Respondents may also overestimate their overall levels of physical activity. Dietary data, although relevant to chronic disease, could not be included because these data were collected as part of an optional module of the CCHS. CCHS data apply only to Aboriginal people living off-reserve and therefore miss the entire segment of those living on-reserve. However, FN, Inuit and Métis populations in the Yukon and Nunavut do not live on reserve; nor do over 99% of the FN people in NWT.[5] As such, our sample is a good representation of Aboriginal people in northern Canada. There are, however, limitations of the identification of Aboriginal people in the CCHS.[37] Pooling cycles of the CCHS, specifically the issue of re-sampling the same individuals and sample dependence is also a limitation. Lastly, the large number of comparisons may contribute to a greater likelihood of significant chance findings.

Notwithstanding these limitations, this research represents an important contribution on the health of Aboriginal peoples in Canada's north. This research is the first to compare northern FN, Inuit and Métis on chronic disease and risk factor prevalence. We found significant differences in disease and risk factors among these three Aboriginal groups. Ethnic-specific data are important to Aboriginal political organizations, government policy makers, clinicians and communities because they offer the chance to set priorities for interventions. While some

TABLE 4
Adjusted odds ratios for major chronic disease and risk/protective factors by ethnic group, 2005 and 2008

	AOR (95% CI)	
	Métis	Inuit
Chronic disease		
At least 1 chronic condition	1.19 (0.74–1.91)	0.64 (0.39–1.06)
Arthritis	1.58 (0.87–2.88)	1.54 (0.73–3.28)
Asthma	1.34 (0.66–2.70)	1.19 (0.44–3.18)
Chronic bronchitis	2.04 (0.18–23.01)	0.67 (0.06–7.58)
Diabetes	1.22 (0.53–2.80)	0.33 (0.13–0.82)[a]
Heart disease	2.22 (0.69–7.08)	1.07 (0.37–3.10)
High blood pressure	1.16 (0.59–2.26)	0.95 (0.51–1.78)
Anxiety disorder	2.07 (0.98–4.37)	0.60 (0.26–1.41)
Bowel disorder	1.91 (0.64–5.68)	0.27 (0.07–0.97)[a]
Mood disorder	1.06 (0.43–2.60)	0.94 (0.30–3.02)
Risk/protective factor		
Binge drinking[b]	0.78 (0.47–1.30)	1.73 (0.91–3.31)
Regular drinking[c]	1.58 (1.09–2.31)[a]	0.56 (0.32–0.97)[a]
Daily smoker	0.69 (0.45–1.04)	1.49 (0.91–2.45)
Overweight[d]	0.94 (0.57–1.54)	0.57 (0.36–0.92)[a]
Obesity[e]	1.03 (0.61–1.75)	1.79 (0.98–3.27)
Active during leisure time[f]	0.88 (0.50–1.56)	0.56 (0.29–1.09)
Regular physical activity[g]	0.96 (0.63–1.45)	0.68 (0.41–1.13)
Self-perceived health[h]	1.18 (0.60–2.33)	0.64 (0.36–1.13)

Abbreviations: AOR, adjusted odds ratio; BMI, body mass index; CI, confidence interval.

Notes: AORs are adjusted for age, sex, region, income and education.

The reference group is the First Nations population.

[a] Denotes an estimate that is statistically significant at the 5% level of significance.

[b] $\geq$ 5 drinks on at least one occasion in the past 12 months.

[c] $\geq$ 1 drink/month in the past 12 months.

[d] BMI = 25.00–29.99 kg/m^2.

[e] BMI $\geq$ 30.0 kg/m^2.

[f] $\geq$ 3.0 kcal/kg/day.

[g] $\geq$ 12 occasions/month.

[h] 3 categories of self-rated health in 1 category: excellent, very good and good.

results are heartening, the risk factor profile among all three northern Aboriginal populations is of concern. Continued chronic disease and risk factor surveillance will be important to monitor continued changes over time and to evaluate the impact of public health interventions.

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References

1. Statistics Canada. Canadian Community Health Survey cycle 3.1: public user microdata file user guide. Ottawa (ON): Statistics Canada; 2006.
2. Bjerregaard P, Young TK, Dewailly E, Ebbesson SOE. Indigenous health in the Arctic: an overview of the circumpolar Inuit population. Scand J Public Health. 2004;32:390-5.
3. Waldram JB, Herring A, Young TK. Aboriginal Health in Canada: Historical, Cultural and Epidemiological Perspectives. Toronto (ON): University of Toronto Press; 2006.
4. Lix LM, Bruce S, Sarkar J, Young TK. Risk factors and chronic conditions among Aboriginal and non-Aboriginal populations. Health Rep. 2009;20(4):21-9.
5. Northwest Territories Bureau of Statistics. Hay River Reserve- Statistical Profile [Internet]. Yellowknife (NWT): Northwest Territories Bureau of Statistics; [updated 2010; accessed 2011 Feb 17]. Available from: http://www.statsnwt.ca/community-data/infrastructure/Hay_River_Reserve.html
6. Statistics Canada. Canadian Community Health Survey - Annual Component (CCHS): detailed information for 2008 [Internet]. Ottawa (ON): Statistics Canada; [modified: 2009 Jun 24; cited 2011 Feb 26]. Available from: http://www.statcan.gc.ca/cgi-bin/imdb/p2SV.pl?Function=getSurvey&SurvId=3226&SurvVer=1&InstaId=15282&InstaVer=5&SDDS=3226&lang=en&db=imdb&adm=8&dis=2
7. Reynolds DL, Chambers LW, DeVillaer MR. Measuring alcohol abuse in the community: consumption, binge-drinking, and alcohol-related consequences (‘‘alcoholism’’). Can J Public Health. 1992;83:441-7.
8. Sarkar J, Lix LM, Bruce S, Young TK. Ethnic and regional differences in prevalence and correlates of chronic diseases and risk factors in northern Canada. Prev Chronic Dis. 2010;7(1):A13.
9. Marmot M, Brunner E. Alcohol and cardiovascular disease: the status of the U shaped curve. BMJ. 1991;303:565-8.
10. Milani RM, Parrott AC, Turner JJ, Fox HC. Gender differences in self-reported anxiety, depression, and somatization among ecstasy/MDMA polydrug users, alcohol/tobacco users, and nondrug users. Addict Behav. 2004;29:965-71.
11. Longstreth GF, Wolde-Tsadik G. Irritable bowel-type symptoms in HMO examinees. Digest Dis Sci. 1993;38(9):1581-9.

12. Tverdal A, Thelle D, Stensvold I, Leren P, Bjartveit K. Mortality in relation to smoking history: 13 years' follow-up of 68,000 Norwegian men and women 35-49 years. J Clin Epidemiol. 1993;46(5):475-87.

13. Scott KM, Bruffaerts R, Tsang A, et al. Depression-anxiety relationships with chronic physical conditions: results from the World Mental Health surveys. J Affect Disorders. 2007;103:113-20.

14. Wyatt SB, Winters KP, Dubbert PM. Overweight and obesity: prevalence, consequences, and causes of a growing public health problem. Am J Med Sci. 2006;331(4): 166-74.

15. Statistics Canada. Canadian Community Health Survey cycle 4.1: user guide 2007-2008 microdata files. Ottawa (ON): Statistics Canada; 2009.

16. Health CanadaCanadian guidelines for body weight classification in adults. Ottawa (ON): Health Canada, Office of Nutrition Policy and Promotion; 2003.

17. Rao JN, Wu CF, Yue K. Some recent work on resampling methods for complex surveys. Survey Methodol. 1996;18:209-17.

18. Bombak AE, Bruce SG. Self-rated health and ethnicity: focus on indigenous populations. Int J Circumpolar Health. 2012;71:18538.

19. Thomas S, Wannell B. Combining cycles of the Canadian community health survey. Health Rep. 2009;20(1):53-8.

20. Rust KF, Rao J. Variance estimation for complex surveys using replication techniques. Stat Methods Med Res. 1996;5:283-310.

21. Yeo D, Mantel H, Liu TP. Bootstrap variance estimation for the national population health survey. Proceedings of the Annual Meeting of the American Statistical Association, Survey Research Methods Section. Baltimore (MD): American Statistical Association; 1999.

22. SAS Institute I. SAS/STAT user's guide. Version 9.2. Cary (NC): SAS Institute; 2009.

23. Young TK, Szathmary EJ, Evers S, Wheatley B. Geographical distribution of diabetes among the native population of Canada: a national survey. Soc Sci Med. 1990;31:129-39.

24. Young TK, Schraer CD, Shubnikoff EV, Szathmary EJ, Nikitin YP. Prevalence of diagnosed diabetes in circumpolar indigenous populations. Int J Epidemiol. 1992;21: 730-6.

25. Sharma S, Hopping BN, Roache C, Sheehy T. Nutrient intakes, major food sources and dietary inadequacies of Inuit adults living in three remote communities in Nunavut, Canada. J Hum Nutr Diet. 2013;26:578-86.

26. Roberts DL, Dive C, Renehan AG. Biological mechanisms linking obesity and cancer risk: new perspectives. Ann Rev Med. 2010; 61:301-16.

27. Hubert HB, Feinleib M, McNamara PM, Castelli WP. Obesity as an independent risk factor for cardiovascular disease: A 26-year follow-up of participants in the Framingham Heart Study. Circulation. 1983;67(5):968-77.

28. Rehm J, Mathers C, Popova S, Thavorncharoensap M, Teerawattananon Y, Patra J. Global burden of disease and injury and economic cost attributable to alcohol use and alcohol-use disorders. Lancet. 2009;373: 2223-33.

29. Riva M, Plusquellec P, Juster RP, et al. Household crowding is associated with higher allostatic load among the Inuit. J Epidemiol Commun Health. 2014;68(4):363-9. DOI:10.1136/jech-2013-203270.

30. Kral M. ''The weight on our shoulders is too much, and we are falling'': suicide among Inuit male youth in Nunavut, Canada. Med Anthropol Q. 2013;27(1):63-83.

31. Martens P, Bartlett J, Burland E, et al. Profile of Metis health status and healthcare utilization in Manitoba: a population-based study. Winnipeg (MB): Manitoba Centre for Health Policy; 2010.

32. Janz T, Seto T, Turner A. Aboriginal peoples survey, 2006: an overview of the health of the Métis population [Internet]. Ottawa (ON): Statistics Canada; 2009 [cited: 2013 Dec 9]. Available from: http://www.statcan.gc.ca/pub/89-637-x/89-637-x2009004-eng.htm

33. Bruce S. Prevalence and determinants of diabetes mellitus among the Metis of western Canada. Am J Hum Biol. 2000;12(4): 542-51.

34. Wakegijig J, Osborne G, Statham S, Issaluk MD. Collaborating toward improving food security in Nunavut. Int J Circumpolar Health. 2013;72:21201.

35. Willox AC, Harper SL, Ford JD, et al. Climate change and mental health: an exploratory case study from Rigolet, Nunatsiavut, Canada. Clim Change. 2013;121:255-70.

36. Lear SA, Humphries KH, Kohli S, Birmingham CL. The use of BMI and waist circumference as surrogates of body fat differs by ethnicity. Obesity. 2007;15(11): 2817-24.

37. Chan WW, Ng C, Young TK. How we identify and count Aboriginal people – does it make a difference in estimating their disease burden? Chronic Dis Inj Can. 2013;33(4):277-80.

Multimorbidity disease clusters in Aboriginal and non-Aboriginal Caucasian populations in Canada

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Abstract

Introduction: Patterns of multimorbidity, the co-occurrence of two or more chronic diseases, may not be constant across populations. Our study objectives were to compare prevalence estimates of multimorbidity in the Aboriginal population in Canada and a matched non-Aboriginal Caucasian population and identify the chronic diseases that cluster in these groups.

Methods: We used data from the 2005 Canadian Community Health Survey (CCHS) to identify adult (≥ 18 years) respondents who self-identified as Aboriginal or non-Aboriginal Caucasian origin and reported having 2 or more of the 15 most prevalent chronic conditions measured in the CCHS. Aboriginal respondents who met these criteria were matched on sex and age to non-Aboriginal Caucasian respondents. Analyses were stratified by age (18–54 years and ≥ 55 years). Prevalence was estimated using survey weights. Latent class analysis (LCA) was used to identify disease clusters.

Results: A total of 1642 Aboriginal respondents were matched to the same number of non-Aboriginal Caucasian respondents. Overall, 38.9% (95% CI: 36.5%–41.3%) of Aboriginal respondents had two or more chronic conditions compared to 30.7% (95% CI: 28.9%–32.6%) of non-Aboriginal respondents. Comparisons of LCA results revealed that three or four clusters provided the best fit to the data. There were similarities in the diseases that tended to co-occur amongst older groups in both populations, but differences existed between the populations amongst the younger groups.

Conclusion: We found a small group of younger Aboriginal respondents who had complex co-occurring chronic diseases; these individuals may especially benefit from disease management programs.

Keywords: *Aboriginal, chronic disease, latent class analysis, prevalence*

Introduction

Multimorbidity, the co-occurrence of two or more chronic diseases where one is not necessarily more central than the others,[1] is associated with increased health care utilization and decreased quality of life.[2-4] Unlike comorbidity, where there is an index (i.e. primary) condition of interest, multimorbidity has no index condition. Prevalence of multimorbidity is known to vary with risk factors such as gender,[1] age,[2] socioeconomic status,[5,6] and ethnicity.[7] Countries with socioculturally diverse populations may therefore face unique challenges in providing care for multimorbidity.[8]

Identifying co-occurring chronic diseases can contribute to improved care management strategies for multimorbid patients in risk groups. While some studies have taken the approach of reporting on the prevalence of specific combinations of diseases, a number of studies have used clustering techniques, such as cluster analysis, to examine patterns of multimorbidity.[9-13] Latent class analysis (LCA), a technique that can be used to identify groups of related diseases (i.e. latent classes) has, to the best of our knowledge, not been applied to examine patterns of multimorbidity in different populations, although it has been used in other studies of chronic diseases.[14] LCA is recommended over conventional clustering methods because it uses probability-based classification methods and provides various diagnostic tests that can be useful in determining the optimal number of classes.[15]

Few studies have explored the prevalence of co-occurring chronic diseases in different risk groups within the population. Schafer et al.[9] compared chronic disease clusters in senior male and female German populations and found three disease clusters in both groups but differences in the chronic disease cluster compositions. For example, women in one cluster showed relatively more pre-terminal conditions such as chronic ischemic heart disease and renal insufficiency.

Prevalence of chronic diseases has been increasing in the Aboriginal population (which comprises First Nations, Métis and Inuit peoples).[16] The potential for increasing rates of multimorbidity is of concern. However, to date no studies have examined prevalence rates in this population, or whether the chronic diseases that tend to cluster differ between Aboriginal and

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non-Aboriginal populations. For example, diabetes prevalence, which is increasing more rapidly in Aboriginal than in non-Aboriginal populations in Canada,[17] might result in clusters of associated co-occurring conditions such as renal disease and cardiovascular disease.

Our objectives were (1) to estimate prevalence of multimorbidity among the Aboriginal population in Canada and compare this prevalence to the estimate for a matched non-Aboriginal Caucasian population, and (2) to compare the clusters of chronic diseases that co-occur in these two groups across two age groups.

Methods

Study population and variables

Study data were from the 2005 Canadian Community Health Survey (CCHS) Cycle 3.1, conducted by Statistics Canada.[18] The CCHS is a cross-sectional, population-based survey intended to provide information on health determinants, health status and health care system utilization for 122 health regions in Canada. The survey was conducted every 2 years from 2001 to 2005 and annually since 2007. Cycle 3.1 was selected for this study because, when compared to Cycle 4.1, it has a sufficiently large number of Aboriginal respondents to enable use of LCA techniques in the analyses for younger and older age groups. The target population for the CCHS Cycle 3.1 was individuals aged 12 years or older living in private dwellings in Canada's provinces and territories. The CCHS adopts a multistage, stratified cluster design to select eligible individuals and their households (n = 132 221; response rate = 92.9%). Excluded from the CCHS are institutionalized individuals, residents of First Nations reserves and full-time members of the Canadian Forces.

The study inclusion criteria were (1) 18 years of age or older, to focus on the adult population, (2) self-identification as either an Aboriginal person or a non-Aboriginal Caucasian, and (3) reporting at least 2 of the 15 most prevalent chronic diseases in the CCHS Cycle 3.1. We identified the Aboriginal population based on the derived variable provided in CCHS Cycle 3.1, which combines information from two variations of one question. The question used prior to June 2005 has the following preamble: ''People living in Canada come from many different cultural and racial backgrounds.'' We identified respondents as Aboriginal if they responded ''yes'' to the question that followed: ''Are you Aboriginal (North American Indian, Métis, Inuit)?'' As of June 2005, the question used to identify Aboriginal respondents was changed to ''Are you an Aboriginal person, that is, North American Indian, Métis or Inuit?'' The non-Aboriginal Caucasian population was identified based on a similarly constructed derived variable provided in CCHS Cycle 3.1.[19]

We undertook a one-to-one match between the Aboriginal respondents who met the study inclusion criteria and their non-Aboriginal Caucasian counterparts using sex and age (in 5-year bands) as the matching criteria. Each Aboriginal respondent was successfully matched to a non-Aboriginal Caucasian respondent. In cases where there were more than one qualified non-Aboriginal Caucasian respondents for a match to an Aboriginal respondent, the matched pair was selected at random. One-to-many matching would be advantageous if there was a substantially lower prevalence of one or more chronic conditions in the non-Aboriginal Caucasian population in order to ensure adequate precision of these prevalence estimates. However, there were no substantial differences in prevalence between the two groups in our study. Although discarding individuals in the matching process to achieve a one-to-one match will result in a smaller sample size, this does not necessarily lead to increases in the sampling variance of estimates. Matching generally improves balance in the covariate distribution, which can decrease the variance of estimators.[20] Matching was undertaken to ensure comparability of the groups on 2 demographic variables, which are known to be associated with chronic disease prevalence (age and sex). The respondents were subsequently stratified into a younger age group (i.e. 18 to 54 years) and older age group (i.e. 55 years or older). The purpose of this stratification was to explore the differences, if any, in disease clustering between younger and older age groups in each population.

Only those health conditions that had at least 5% prevalence in both the Aboriginal and matched non-Aboriginal Caucasian populations, based on weighted prevalence estimates, were selected for investigating chronic disease clusters. The CCHS questions about chronic disease are prefaced with the following preamble ''Now I'd like to ask about certain chronic health conditions which you may have. We are interested in 'long-term conditions' which are expected to last or have already lasted 6 months or more and that have been diagnosed by a health professional.'' Respondents were then asked by the interviewer if they had the identified disease(s).[19] We coded the responses relating to each disease as yes or no. All other responses (i.e. not sure, no response) were treated as missing values. The 15 chronic diseases included in this study were asthma, arthritis or rheumatism, anxiety or mental disorders, back problems, bowel disease, cataracts, diabetes, emphysema or bronchitis or chronic obstructive pulmonary disease (COPD), food allergies, heart disease, high blood pressure, incontinence, migraine, thyroid conditions, and ulcers. Multimorbidity was defined as the presence of two or more of these conditions.

Statistical analysis

Aboriginal and matched non-Aboriginal Caucasian respondents were described on age, sex and prevalence of each of the 15 above-mentioned chronic diseases. Multimorbidity prevalence was estimated along with 95% confidence intervals (CIs). For the Aboriginal population, the numerator of the prevalence estimate was the number of Aboriginal respondents who met the study inclusion criteria and the denominator was the total number of Aboriginal respondents aged 18 years or older. For the non-Aboriginal Caucasian population, the numerator was the number of matched non-Aboriginal Caucasian respondents who met the study inclusion criteria and the denominator was the total number of non-Aboriginal Caucasian respondents aged 18 years or older who met the matching criteria. Prevalence estimates were expressed as percentages.

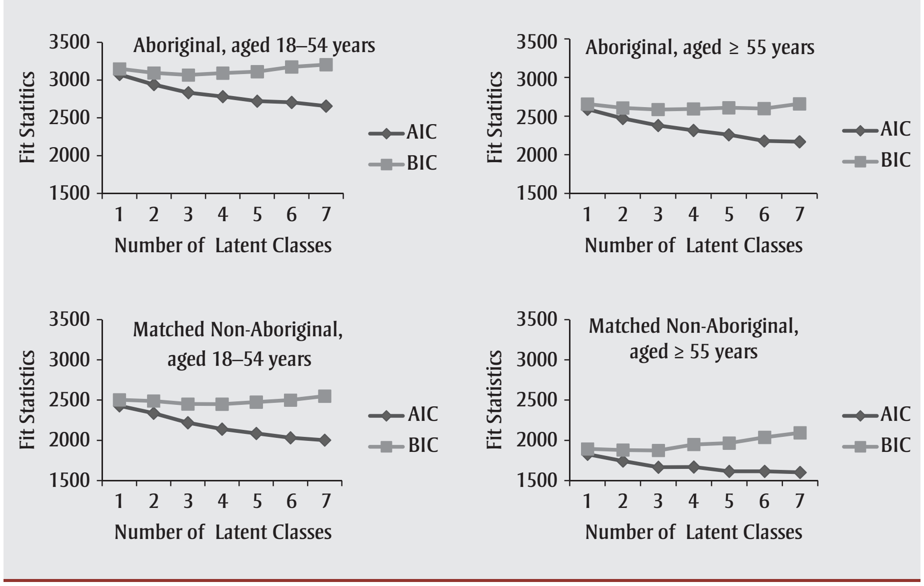
LCA was applied separately to the data for the younger and older Aboriginal and matched non-Aboriginal Caucasian respondents. LCA assumes that each individual in the study belongs to one of a set of mutually exclusive and exhaustive classes.[21] We calculated class membership probabilities, which are estimates of the proportion of respondents belonging to each latent class, and item response probabilities (presence of a disease) conditional on class membership, which are estimates of the prevalence of the chronic diseases for each of the latent classes.[21] These item response probabilities are used to characterize latent classes in a similar way to the use of factor loadings to characterize factors in factor analysis. We interpreted item response probabilities of 0.4 or greater as indicative of an association between the item and the corresponding latent class, which is consistent with previous factor analysis studies about multimorbidity patterns that have used factor loading cut-offs of 0.4.[22]

We fitted models to the data using between two and seven classes, to determine the optimal number of classes. The Akaike Information Criterion (AIC)[23] and the Bayesian-Schwarz Information Criterion (BIC),[24] which are penalized measures of the likelihood function, were used to guide the selection of the final number of classes (Figure 1).[25] A smaller AIC and BIC for a particular model suggests that it is preferable on the basis of the trade-off between fit and parsimony.

Measurement invariance was tested between the Aboriginal and matched non-Aboriginal respondents. This was done by first fitting a model in which the parameters of the item responses were freely estimated for both groups. A second model was then fitted to the data in which parameters were constrained to be equal across groups. The difference in the likelihood ratio statistics for the two nested models, G^2, asymptotically follows a χ^2 distribution. The degrees of freedom (*df*) for this difference statistic is equal to the difference in degrees of freedom between the two nested models. If the null hypothesis of measurement invariance is retained, then the identified classes are assumed to be the same for both groups; if the null hypothesis is rejected, then it is recommended that separate classes be estimated for the two groups.[21] The tests were conducted separately for the younger and older populations. In each case, only the optimal model(s) based on the fit statistics and model interpretability results were selected for testing measurement invariance.

The analysis was implemented using PROC LCA version 1.3.0 [26] in SAS version 9.3.[27] All analyses were conducted using full sample weights. Permission to access the data was granted by Statistics Canada.

FIGURE 1
Akaike Information Criteria and Bayesian-Schwarz Information Criteria values for latent class analysis models in Aboriginal and matched non-Aboriginal Caucasian CCHS respondents



Abbreviations: AIC, Akaike Information Criteria; BIC, Bayesian-Schwarz Information Criteria; CCHS, Canadian Community Health Survey.

Results

A total of 1642 Aboriginal respondents (weighted n = 198 955) who met the study inclusion criteria were matched to an equal number of non-Aboriginal Caucasian respondents (weighted n = 169 149). Table 1 shows the age-stratified Aboriginal and matched non-Aboriginal Caucasian cohorts. The mean age (standard deviation [SD]) of the younger (18–54 years) Aboriginal cohort was 37.4 (17.8) years, and 39.4% were male. The mean (SD) age of the older (≥ 55 years) Aboriginal cohort was 64.8 (10.8) years, and 41.9% of them were male. The age and sex distribution of the non-Aboriginal study cohort were similar to those of the Aboriginal study cohort because of the matching process.

In both the younger and older age groups, the mean number of chronic conditions was higher for the Aboriginal than for the non-Aboriginal respondents. Back problems were the most prevalent condition in both the younger Aboriginal (55.8%) and non-Aboriginal study cohorts (50.8%). For the older age group, arthritis/rheumatism was the most prevalent condition in both the Aboriginal (63.4%) and non-Aboriginal (64.5%) study cohorts.

Overall, multimorbidity prevalence was 38.9% (95% CI: 36.5%–41.3%) in the Aboriginal population compared with 30.7% (95% CI: 28.9%–32.6%) in the non-Aboriginal population. The prevalence of multimorbidity was higher in the older Aboriginal group (64.0%; 95% CI: 58.7%–69.2%) than the non-Aboriginal group (58.3%; 95% CI: 53.7%–63.0%). Similarly, multimorbidity prevalence was higher in the younger Aboriginal (33.7%; 95% CI: 31.1%–36.2%) than the non-

TABLE 1
Demographic and chronic disease characteristics of Aboriginal and matched non-Aboriginal Caucasian CCHS respondents by age groups

Variable	Aboriginal (Weighted n = 198 955, Unweighted n = 1642)		Matched Non-Aboriginal Caucasian (Weighted n = 169 149, Unweighted n = 1642)	
	18–54 Years (Weighted n = 142 206, Unweighted n = 1034)	≥ 55 Years (Weighted n = 56 749, Unweighted n = 608)	18–54 Years (Weighted n = 121 627, Unweighted n = 1016)	≥ 55 Years (Weighted n = 47 522, Unweighted n = 626)
Mean (SD) age, years	37.4 (17.8)	64.8 (10.8)	37.3 (14.0)	64.7 (9.8)
Sex, %				
Male	39.4	41.9	43.2	42.6
Female	60.6	58.1	56.8	57.4
Number of chronic diseases				
Mean (SD)	3.1 (1.9)	3.4 (2.5)	2.7 (1.3)	3.2 (1.5)
Median	2.2	2.5	2.0	2.4
Individual chronic diseases, % (95% CI)				
Anxiety/Mental disorders	33.5 (29.0–38.0)	14.0 (9.9–18.1)	25.2 (21.7–28.6)	13.8 (10.2–17.5)
Arthritis/Rheumatism	36.9 (32.2–41.5)	63.4 (56.2–70.6)	32.0 (28.0–36.0)	64.5 (59.4–69.5)
Asthma	25.4 (21.4–29.5)	16.8 (12.1–21.7)	24.6 (21.0–28.2)	11.0 (7.8–14.2)
Back problems	55.8 (51.1–60.6)	39.3 (32.2–46.4)	50.8 (46.6–55.1)	36.5 (31.3–41.7)
Bowel disease	12.8 (9.8–15.7)	8.1 (4.5–11.6)	14.6 (11.9–17.3)	12.3 (9.3–15.4)
Cataracts	3.8 (1.6–6.1)	18.6 (13.5–23.7)	0.9 (0.4–1.5)	13.6 (10.6–16.6)
Diabetes	7.6 (5.3–10.0)	27.0 (21.6–32.4)	5.7 (4.0–7.4)	25.3 (20.9–29.7)
Emphysema/Bronchitis/COPD	13.7 (10.6–16.8)	17.1 (11.2–22.9)	9.4 (6.6–12.1)	9.6 (6.9–12.3)
Food allergy	23.4 (19.2–27.6)	13.7 (9.3–18.2)	18.5 (15.2–21.8)	7.2 (5.0–9.5)
Heart disease	6.3 (4.2–8.5)	22.0 (16.9–27.0)	4.1 (2.6–5.5)	23.0 (18.5–27.5)
High blood pressure	21.8 (18.0–25.7)	50.1 (43.1–57.0)	20.8 (17.2–24.3)	64.4 (59.3–69.5)
Incontinence	7.3 (5.1–9.6)	11.3 (7.6–15.0)	3.9 (2.2–5.5)	9.0 (6.5–11.6)
Migraine	37.5 (33.0–41.9)	17.7 (10.8–24.5)	40.0 (35.6–44.3)	7.1 (4.7–9.5)
Thyroid condition	10.7 (7.3–14.1)	17.5 (12.6–22.4)	11.9 (9.2–14.6)	16.6 (12.8–20.4)
Ulcers	15.1 (11.7–18.6)	12.4 (7.7–17.1)	10.9 (8.4–13.4)	6.5 (4.4–8.7)

Abbreviations: CCHS, Canadian Community Health Survey; COPD, chronic obstructive pulmonary disease.

Note: Small differences in the sex and age distribution between the Aboriginal and matched non-Aboriginal Caucasian respondents were as a result of applying survey weights.

Aboriginal groups (25.7%; 95% CI: 23.6%–27.7%) (data not shown).

The LCA model fit results are summarized in Figure 1. While AIC values decreased with an increase in the number of latent classes in both populations and for the two age groups, this was not the case for the BIC, which began to increase (indicating poorer fit) after three classes in both age groups in the Aboriginal population, and in the older age group of the non-Aboriginal population. The BIC values began to increase after four classes in the younger non-Aboriginal group. Consequently, we chose to compare the three-class and four-class model solutions for both groups.

Among the younger respondents, the test of measurement invariance between Aboriginal and non-Aboriginal respondents resulted in G^2 = 192.6 (df = 45) for the 3-class model (p < .0001) and G^2 = 224.0 (df = 60) for the 4-class model (p < .0001). For the older respondents, the test for measurement invariance between Aboriginals and non-Aboriginals resulted in G^2 = 189.6 (df = 45) for the 3-class model (p < .0001) and G^2 = 182.3 (df = 60) for the 4-class model (p < .0001). These results suggest that measurement non-invariance exists in the data, and therefore LCA model parameters were estimated separately for Aboriginal and non-Aboriginal respondents in each age group.

Characteristics of the three-class model

Table 2 shows the class membership percentages and item response probabilities for three classes. The first latent class constituted less than 12% of younger respondents in both populations (5.8% for Aboriginal and 11.9% for non-Aboriginal respondents). The second class accounted for almost one-fifth (18.3%) of younger Aboriginal respondents. In the younger matched non-Aboriginal group, the second class accounted for more than one-quarter (27.6%) of respondents. More than half (52.7%) of the older Aboriginal respondents belonged to the second class compared to only 39.8% of the older non-Aboriginal Caucasian respondents.

Younger group

For the three-class model in the younger Aboriginal population, the first class had high item-response probabilities on eight of the chronic diseases, while the second

TABLE 2
Item response probabilities for three classes of chronic diseases in Aboriginal and matched non-Aboriginal Caucasian CCHS respondents by age groups

Chronic disease	18–54 Years					
	Aboriginal			Matched Non-Aboriginal Caucasian		
	Class 1 (5.8%)	Class 2 (18.3%)	Class 3 (75.9%)	Class 1 (11.9%)	Class 2 (27.6%)	Class 3 (60.5%)
Anxiety/Mental disorders	**0.678**	0.189	0.344	0.230	0.168	0.294
Arthritis/Rheumatism	**0.632**	0.312	0.362	0.158	0.292	0.364
Asthma	**0.510**	0.063	0.281	**1.000**	0.183	0.127
Back problems	**0.600**	0.376	**0.599**	0.267	0.356	**0.626**
Bowel disease	0.189	0.080	0.135	0.144	0.062	0.184
Cataract	0.256	0.000	0.031	0.003	0.015	0.008
Diabetes	0.244	0.158	0.045	0.023	0.135	0.028
Emphysema/Bronchitis/COPD	**0.541**	0.008	0.138	0.203	0.058	0.089
Food allergy	0.181	0.167	0.254	0.356	0.096	0.192
Heart disease	0.436	0.080	0.031	0.000	0.128	0.009
High blood pressure	**0.645**	**0.989**	0.000	0.000	**0.751**	0.000
Incontinence	0.268	0.036	0.068	0.000	0.024	0.053
Migraine	**0.608**	0.248	0.387	0.055	0.290	**0.518**
Thyroid condition	0.116	0.070	0.115	0.050	0.110	0.137
Ulcers	**0.515**	0.078	0.142	0.053	0.124	0.114
Chronic disease	**≥ 55 Years**					
	Aboriginal			**Matched Non-Aboriginal Caucasian**		
	Class 1 (14.7%)	**Class 2 (52.7%)**	**Class 3 (32.6%)**	**Class 1 (31.4%)**	**Class 2 (39.8%)**	**Class 3 (28.8%)**
Anxiety/Mental disorders	0.328	0.084	0.146	0.126	0.082	0.230
Arthritis/Rheumatism	**0.931**	**0.591**	**0.575**	**0.734**	**0.546**	**0.683**
Asthma	**0.780**	0.056	0.076	0.188	0.095	0.045
Back problems	**0.608**	0.233	**0.555**	0.310	0.212	**0.636**
Bowel disease	0.190	0.025	0.122	0.225	0.000	0.183
Cataract	0.121	0.194	0.202	0.290	0.113	0.000
Diabetes	0.398	**0.401**	0.000	0.256	**0.434**	0.000
Emphysema/Bronchitis/COPD	**0.508**	0.085	0.157	0.307	0.000	0.000
Food allergy	0.156	0.102	0.186	0.103	0.022	0.109
Heart disease	0.246	0.297	0.084	0.353	0.223	0.105
High blood pressure	**0.549**	**0.751**	0.076	**0.539**	**0.886**	**0.423**
Incontinence	0.200	0.085	0.120	0.212	0.023	0.051
Migraine	0.306	0.081	0.273	0.081	0.024	0.126
Thyroid condition	0.284	0.155	0.160	0.144	0.088	0.297
Ulcers	0.187	0.031	0.246	0.067	0.047	0.088

Abbreviations: CCHS, Canadian Community Health Survey; COPD, chronic obstructive pulmonary disease.

Note: Bold values represent diseases with item response probabilities of 0.400 or greater.

class had high item-response probabilities for high blood pressure, and the third class had high item-response probabilities for back problems. Among the younger non-Aboriginal respondents, the first and second classes had high item-response probabilities for asthma and high blood pressure, respectively. The third class had high probabilities for both back problems and migraine.

Older group

For the three-class model in the older Aboriginal population, the first class had high probabilities on five of the chronic diseases, while the second class had high probabilities for arthritis/rheumatism, diabetes and high blood pressure. The third class had high probabilities for arthritis/rheumatism and back problems. Arthritis/rheumatism and high blood pressure had the highest item response probabilities in the first class among the older non-Aboriginal respondents. The conditions that had high item-response probabilities in the second class of the older Aboriginal respondents were the same for older non-Aboriginal respondents (arthritis/rheumatism, diabetes and high blood pressure). The conditions with the highest probabilities in the third class for older non-Aboriginal respondents were arthritis/rheumatism, back problems and high blood pressure. Overall, the 3-class LCA model results reveal that more chronic conditions tended to cluster together in the older age group in both Aboriginal and non-Aboriginal populations than in the younger age groups of both populations.

Characteristics of the four-class model

Younger group

The differences observed between the younger Aboriginal and non-Aboriginal age groups in the three-class model persisted in the four-class model (Table 3). In the Aboriginal group, the size of the first latent class remained small (6.0%) and the same diseases had high item-response probabilities. The second class comprised one-fifth of respondents (21%) and had a high item-response probability for high blood pressure. The third class, which comprised almost two-thirds (62.4%) of the respondents, had a high item-response probability for back problems. The fourth class had high item-response probabilities for both back problems and ulcers. The first class in the non-Aboriginal respondents was also small (13.1%) and had a high item-response probability for asthma. The second and third classes in these respondents had high blood pressure and migraine as the only conditions with high probabilities, respectively.

TABLE 3
Item response probabilities for four classes of chronic diseases in Aboriginal and matched non-Aboriginal Caucasian CCHS respondents by age groups

Chronic disease	18–54 Years							
	Aboriginal				Matched Non-Aboriginal Caucasian			
	Class 1 (6.0%)	Class 2 (21.0%)	Class 3 (62.4%)	Class 4 (11.6%)	Class 1 (13.1%)	Class 2 (20.7%)	Class 3 (39.4%)	Class 4 (26.8%)
Anxiety/Mental disorders	**0.659**	0.207	0.372	0.203	0.238	0.158	0.329	0.216
Arthritis/Rheumatism	**0.695**	0.389	0.376	0.129	0.176	0.278	0.342	0.389
Asthma	**0.620**	0.071	0.329	0.000	**1.000**	0.188	0.104	0.132
Back problems	**0.568**	0.275	**0.594**	**0.881**	0.235	0.354	0.347	**0.999**
Bowel disease	0.236	0.075	0.143	0.089	0.147	0.059	0.265	0.037
Cataract	0.246	0.026	0.029	0.000	0.003	0.014	0.016	0.000
Diabetes	0.309	0.206	0.015	0.052	0.021	0.108	0.081	0.000
Emphysema/Bronchitis/COPD	**0.493**	0.005	0.133	0.216	0.191	0.059	0.072	0.104
Food allergy	0.258	0.214	0.283	0.000	0.336	0.086	0.203	0.162
Heart disease	0.379	0.122	0.008	0.087	0.006	0.090	0.053	0.000
High blood pressure	**0.544**	**0.723**	0.000	0.293	0.000	**1.000**	0.000	0.000
Incontinence	0.324	0.044	0.073	0.000	0.000	0.023	0.073	0.019
Migraine	**0.667**	0.268	0.396	0.304	0.107	0.279	**0.509**	**0.475**
Thyroid condition	0.135	0.109	0.124	0.000	0.044	0.075	0.247	0.000
Ulcers	**0.496**	0.000	0.107	**0.481**	0.059	0.121	0.151	0.063

Chronic disease	≥ 55 Years							
	Aboriginal				Matched Non-Aboriginal Caucasian			
	Class 1 (17.6%)	Class 2 (51.5%)	Class 3 (27.0%)	Class 4 (3.9%)	Class 1 (9.3%)	Class 2 (19.6%)	Class 3 (53.0%)	Class 4 (18.1%)
Anxiety/Mental disorders	0.301	0.084	0.121	0.285	0.258	0.058	0.059	0.395
Arthritis/Rheumatism	**0.934**	**0.574**	**0.651**	0.000	**0.909**	**0.434**	**0.683**	**0.624**
Asthma	**0.664**	0.058	0.082	0.000	0.213	0.063	0.134	0.038
Back problems	**0.610**	0.227	**0.525**	**0.695**	**0.421**	0.174	0.375	**0.513**
Bowel disease	0.174	0.021	0.144	0.000	**0.426**	0.000	0.091	0.194
Cataract	0.139	0.212	0.102	**0.640**	0.388	0.165	0.128	0.000
Diabetes	0.367	0.399	0.000	0.000	**0.617**	**1.000**	0.000	0.000
Emphysema/Bronchitis/COPD	**0.524**	0.085	0.007	**0.839**	**0.412**	0.004	0.108	0.000
Food allergy	0.131	0.101	0.229	0.000	0.186	0.012	0.060	0.114
Heart disease	0.232	0.295	0.099	0.007	**0.489**	0.195	0.276	0.000
High blood pressure	**0.506**	**0.758**	0.082	0.000	**0.609**	**0.782**	**0.662**	**0.460**
Incontinence	0.223	0.090	0.053	0.349	0.265	0.037	0.097	0.039
Migraine	0.303	0.079	0.304	0.000	0.173	0.005	0.045	0.165
Thyroid condition	0.282	0.153	0.173	0.000	0.279	0.060	0.087	**0.453**
Ulcers	0.170	0.033	0.208	**0.533**	0.016	0.062	0.061	0.105

Abbreviations: CCHS, Canadian Community Health Survey; COPD, chronic obstructive pulmonary disease.

Note: Bold values represent diseases with item response probabilities of 0.400 or greater.

Older group

In the four-class model for the older Aboriginal respondents (Table 3), the first class comprised slightly less than one-fifth of the sample (17.6%) and had high item-response probabilities on 5 of the 15 chronic conditions. The second class had high probabilities for arthritis/rheumatism and blood pressure, while the third had high probabilities for arthritis/rheumatism and back problems. The fourth class, which comprised the smallest percentage of members in the group (3.9%), had high item-response probabilities for four chronic conditions (back problems, cataracts, emphysema and ulcers). Among the non-Aboriginal respondents in the older age group, the first class (9.3%) had seven chronic conditions with high item-response probabilities while subsequent classes had fewer conditions with high probabilities. However, there were similarities in the disease clusters in both Aboriginal and non-Aboriginal populations.

Discussion

This is the first nationally representative study to compare the prevalence of multimorbidity and investigate co-occurring chronic diseases patterns in Aboriginal and matched non-Aboriginal Caucasian populations. Our results reveal that the Aboriginal population had higher overall prevalence of multimorbidity as well as higher prevalence for most of the investigated chronic diseases.

We identified a small group of younger Aboriginal respondents in the three-class model (5.8%) and four-class model (6.0%) with high prevalence of multiple chronic conditions. A cluster with similar characteristics was not evident among younger non-Aboriginal Caucasian respondents. Other disease clusters identified in the younger age group in both populations had just one or two highly prevalent conditions in the three- and four-class models.

Unlike the younger age group, the chronic disease clusters in the older age group for the three-class and four-class models were frequently comprised of three or more conditions, and there were some similarities in the latent classes identified in the Aboriginal and non-Aboriginal populations. For instance, in the three-class model, arthritis/rheumatism, diabetes and high blood pressure had the highest probabilities of co-occurrence in both populations.

Some of the chronic disease clusters identified in our study were similar to those identified in previous research. A study conducted on a sample of working-age Australians identified six chronic disease clusters.[22] They found that arthritis, back/neck problems, migraine and other chronic pain conditions tended to co-occur. This is similar to our results: we found that arthritis/rheumatism and back problems tended to co-occur. We also found a disease cluster made up of arthritis/rheumatism, back problems, bowel disease, diabetes, heart disease, high blood pressure, and emphysema/bronchitis/COPD in the older non-Aboriginal Caucasian population. The Australian study[22] found similar conditions (i.e. cardiovascular disease, diabetes, fatigue, high blood pressure, high cholesterol, arthritis) in one cluster.

Limitations

First Nations living on reserve comprise a significant portion of the total Aboriginal population but were not included in this study; therefore the results are representative of only the off-reserve Aboriginal population of Canada. The data are from a cross-sectional survey and therefore provide a snapshot of multimorbidity at one point in time; diseases that cluster may change over time. Although we matched the Aboriginal and non-Aboriginal Caucasian respondents on two important demographic variables (i.e. age and sex), the two populations may still differ in terms of socioeconomic characteristics, which may also be associated with multimorbidity. Residual confounding may therefore account for some of the differences in disease clustering between the two populations. There may be differences in access to health care services between Aboriginal and non-Aboriginal populations, which may result in under-reporting of diagnosed chronic diseases. This under-reporting may be more likely to affect the Aboriginal population.

Further, surveys are prone to self-reporting bias due to failure to accurately recall previously diagnosed conditions and the social undesirability of certain health conditions.

Further research could investigate whether individuals within different chronic disease clusters have different patterns of health care utilization, including utilization of emergency, acute, primary, and supportive care. Such findings will be useful in ascertaining the clinical relevance and cost implications of different patterns of multimorbidity.

Conclusion

Our findings emphasize the dynamics of co-occurring chronic diseases in Aboriginal and non-Aboriginal Caucasian populations in Canada. The Aboriginal population had higher prevalence of multimorbidity than an age-and-sex-matched non-Aboriginal Caucasian population. Although there were some similarities in the diseases that tended to co-occur in the older Aboriginal and non-Aboriginal Caucasian populations, differences existed in the younger age group. Understanding the differences in diseases that are likely to co-occur in different populations can help in developing tailored prevention and management strategies.

We found a small group of the younger Aboriginal respondents who had complex co-occurring chronic diseases. This group in particular may benefit from disease prevention and management programs.

Contributors

JPK, LML and SS contributed substantially to the conception and design, acquisition, analysis and interpretation of data and the final approval of the version to be published. JPK and LML were responsible for drafting the article or revising it critically for intellectual content.

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References

1. Van den Akker M, Buntinx F, Metsemakers JF, Roos S, Knottnerus JA. Multimorbidity in general practice: prevalence, incidence, and determinants of co-occurring chronic and recurrent diseases. J Clin Epidemiol. 1998;51:367-75.
2. McGann PE. Comorbidity in heart failure in the elderly. Clin Geriatr Med. 2001;16: 631-48.
3. Patrick L, Knoefel F, Gaskowski P, Rexroth D. Medical comorbidity and rehabilitation efficiency in geriatric inpatients. J Am Geriatr Soc. 2001;49:1471-7.
4. Wolff JL, Starfield B, Anderson G. Prevalence, expenditure, and complications of multiple chronic conditions in elderly. Arch Inter Med. 2002;162:2269-76.
5. Orueta JF, Nuno-Solinis R, Garcia-Alvarez A, Alonso-Moran E. Prevalence of multimorbidity according to the deprivation level among the elderly in the Basque country. BMC Public Health. 2013;13:918.
6. Tucker-Seeley RD, Li Y, Sorensen G, Subramanian SV. Lifecourse socioeconomic circumstances and multimorbidity among older adults. BMC Public Health. 2011;11:313.
7. Mathur R, Hull SA, Badrick E, Robson J. Cardiovascular multimorbidity: the effect of ethnicity on prevalence and risk factor management. Br J Gen Pract. 2011;61:e262-70.
8. Shadmi E. Multimorbidity and equity in health. Int J Equity Health. 2013;12:59.
9. Schafer I, von Leitner EC, Schon G, et al. Multimorbidity patterns in the elderly: a new approach of disease clustering identifies complex interrelations between chronic conditions. Plos ONE. 2010;5(12):e15941.
10. Prados-Torres A, Poblador-Plou B, Calderon-Larranaga A, et al. Multimorbidity patterns in primary care: Interactions among chronic diseases using factor analysis. Plos ONE. 2012;7(2):e32190.
11. Cornell JE, Pugh JA, Williams JW, et al. Multimorbidity clusters: Clustering binary data from a large administrative medical database. Appl Multivar Res. 2008;12:163-82.
12. Marengoni A, Rizzuto D, Wang HX, Winblad B, Fratiglioni L. Patterns of chronic multimorbidity in the elderly population. J Am Geriatr Soc. 2009;57:225-30.
13. Newcomer SR, Steiner JF, Bayliss EA. Identifying subgroups of complex patients with cluster analysis. Am J Manag Care. 2011;17(8):e324-32.
14. Kaldor J, Clayton D. Latent class analysis in chronic disease epidemiology. Stat Med. 1985;4(3):327-35.
15. Magidson J, Vermunt JK. Latent class models for clustering: a comparison with K-means. Can J Market Res. 2002;20:37-44
16. Deering KN, Lix LM, Bruce S, Young TK. Chronic diseases and risk factors in Canada's northern populations: longitudinal and geographic comparisons. Can J Public Health. 2009;100(1):14-7.
17. Diabetes in Canada: facts and figures from a public health perspective [Internet]. Ottawa (ON): Public Health Agency of Canada; 2011 [cited 2014 Jan 11]. Available at: http://www.phac-aspc.gc.ca/cd-mc/publications/diabetes-diabete/facts-figures-faits-chiffres-2011/index-eng.php?utm_source = Stakeholders&utm_medium = email_eng&utm_campaign = DiabetesReport2011
18. Statistics Canada. Canadian Community Health Survey. Detailed information for 2005 (Cycle 3.1) [Internet]. Ottawa (ON): Statistics Canada; 2005 [cited 2013 Dec 30]. Available at: http://www23.statcan.gc.ca/imdb/p2SV.pl?Function = getSurvey&SurvId = 1630&InstaId = 22642&SDDS = 3226
19. Statistics Canada. Canadian Community Health Survey, Cycle 3.1. Final Questionnaire [Internet]. Ottawa (ON): Statistics Canada; 2005 [cited 2013 Dec 30]. Available at: http://www23.statcan.gc.ca/imdb-bmdi/instrument/3226_Q1_V3-eng.pdf
20. Stuart EA. Matching methods for causal inference: a review and a look forward. Stat Sci. 2010;25(1):1-21.
21. Lanza ST, Collins LM. A new SAS procedure for latent transition analysis: Transitions in dating and sexual risk behaviour. Dev Psychol. 2008;44(2):446-56.
22. Holden L, Scuffham PA, Hilton MF, Muspratt A, Ng SK, Whiteford HA. Patterns of multimorbidity in working Australians. Popul Health Metrics. 2011;9:15.
23. Akaike H. A new look at the statistical model identification. IEEE Trans Autom. 1974;19:716-23.
24. Schwartz G. Estimating the dimension of a model. Ann Statist. 1978; 6:461-4.
25. Lanza ST, Collins LM, Lemmon DR, et al. Proc LCA: a SAS procedure for latent class analysis. Struct Equ Modeling. 2007;14(4): 671-94.
26. PROC LCA & PROC LTA (Version 1.2.7) [Software]. Penn State: The Methodology Center, PA; 2011 [cited 2013 July 20]. Available at: http://methodology.psu.edu
27. SAS Institute Inc. SAS/STAT user's guide. Cary, NC: SAS Institute Inc; 2004.

Quebec Integrated Chronic Disease Surveillance System (QICDSS), an innovative approach

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Abstract

Introduction: With the growing burden of chronic diseases, surveillance will play an essential role in improving their prevention and control. The Institut national de santé publique du Québec has developed an innovative chronic disease surveillance system, the Quebec Integrated Chronic Disease Surveillance System (QICDSS). We discuss the primary features, strengths and limitations of this system in this report.

Methodology: The QICDSS was created by linking five health administrative databases. Updated annually, it currently covers the period from January 1, 1996, to March 31, 2012. The operational model comprises three steps: (1) extraction and linkage of health administrative data according to specific selection criteria; (2) analysis (validation of case definitions essentially) and production of surveillance measures; and (3) data interpretation, submission and dissemination of information. The QICDSS allows the surveillance of the following chronic diseases: diabetes, cardiovascular diseases, respiratory diseases, osteoporosis, osteoarticular diseases, mental disorders, Alzheimer's disease and related disorders. The system also lends itself to the analysis of multimorbidity and polypharmacy.

Results: For 2011–2012, the QICDSS contained information on 7 995 963 Quebecers with an average age of 40.8 years. Of these, 95.3% met at least one selection criterion allowing the application of case definitions for chronic disease surveillance. The actual proportion varied with age, from 90.1% for those aged 19 years or less to 99.3% for those aged 65 years or over.

Conclusion: The QICDSS provides a way of producing population-based data on the chronic disease burden, health services and prescription drug uses. The system facilitates the integrated study of several diseases in combination, an approach rarely implemented until now in the context of population surveillance. The QICDSS possesses all the essential features of a surveillance system and supports the dissemination of information to public health decision-makers for future actions.

Keywords: *surveillance, chronic diseases, health administrative databases, surveillance model, public health*

Introduction

According to the World Health Organization[1] and the United Nations,[2] the chronic disease burden is increasing and will continue to grow. Strategies for preventing and controlling chronic diseases are necessary to address this burden, and the development of surveillance plays a fundamental role.[3] Surveillance data contribute to identifying population subgroups affected by chronic diseases (or at high risk of developing such diseases) and help to determine their needs. Surveillance data can also guide the implementation of prevention programs and facilitate the planning of health care services and orient public health priorities.

Chronic diseases warrant enhanced surveillance[4] in Quebec because the aging population in this province entails a heavy burden on the health care system. This is especially true for the most prevalent, disabling, or early death associated chronic conditions such as diabetes, cardiovascular diseases, respiratory diseases, osteoarticular diseases, osteoporosis, mental disorders, Alzheimer's disease and related disorders. To tackle this issue, the Ministère de la Santé et des Services sociaux (MSSS) du Québec has mandated the Institut national de santé publique du Québec (INSPQ) with the task of overseeing chronic disease surveillance in the province using health administrative data.

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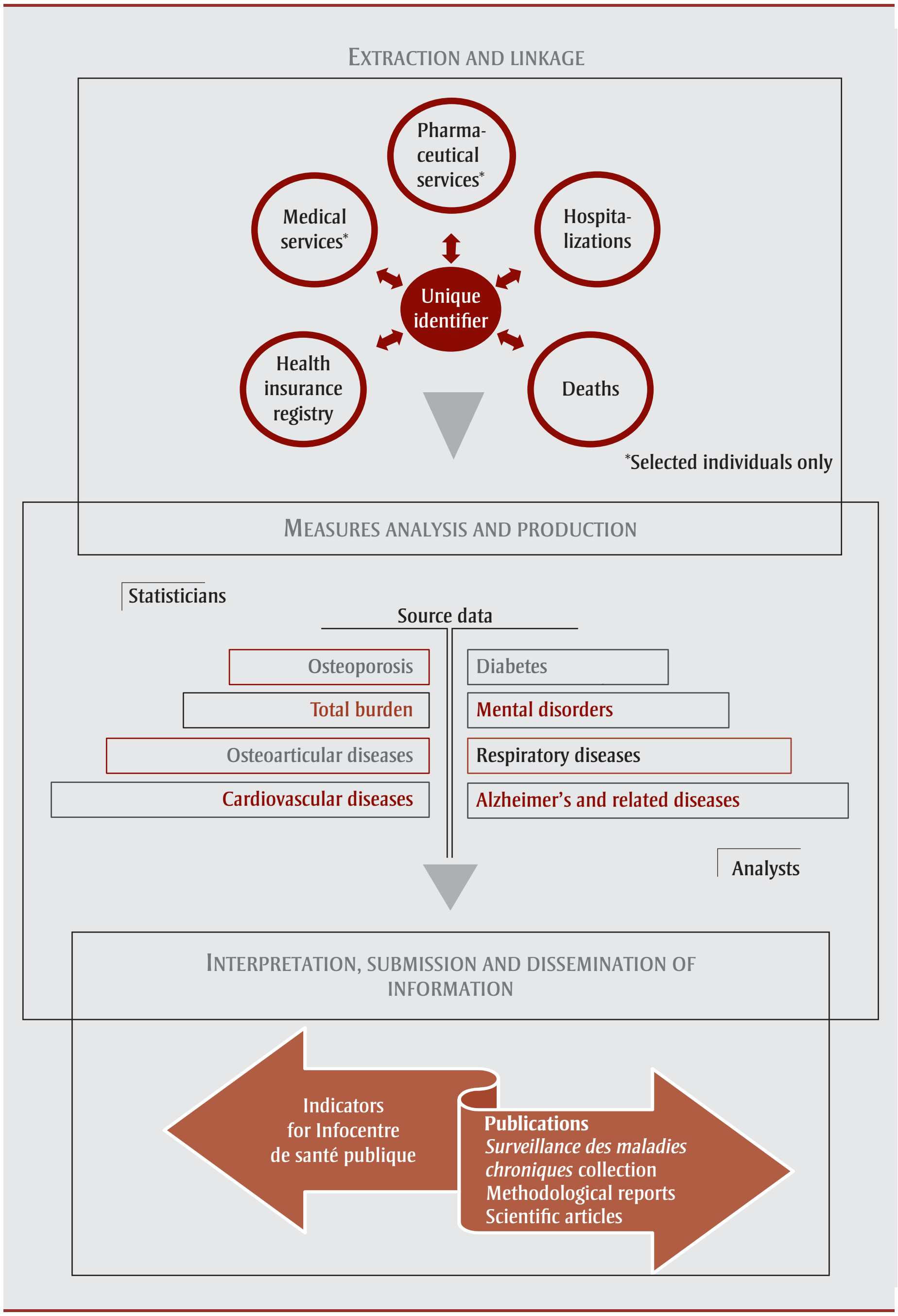
In a universal health care system like the one in Quebec, health data collected for administrative purposes constitute a valuable source of information for chronic disease surveillance.[5] Such data allow the calculation of accurate and reliable measures,[6,7] continuously and systematically. Furthermore, linking several databases makes it possible to study various health-related outcomes, including the use of health care resources. Data mining is practical, relatively simple, accessible and cost effective. As the databases are population-based, biases associated with sample-based studies (particularly selection, recall and non-response biases) are minimized.[8,9] However, since these types of databases are designed for administrative purposes, their use in epidemiological surveillance requires the application of rigorous quality standards.

This is why the INSPQ created the Quebec Integrated Chronic Disease Surveillance System (QICDSS). In this paper, we look at the system's content, strengths, limitations and potential uses. An integrated approach was deemed necessary to address both traditional surveillance objectives for individual diseases but also newer approaches such as the combination of several diseases. Like the other provinces and territories in Canada, Quebec participated in the National Diabetes Surveillance System (NDSS), a system created to address information gaps about prevalence and consequences of diabetes in Canada.[10-12] Quebec has been able to apply NDSS methodology for the surveillance of other chronic diseases, particularly within the Canadian Chronic Disease Surveillance System (CCDSS).

FIGURE 1
QICDSS Operational Model



Abbreviation: QICDSS, Quebec Integrated Chronic Disease Surveillance System.

Methods

Data sources

The QICDSS data are extracted from five linked health administrative databases that are updated annually. As illustrated in the upper part of Figure 1, these data sources are the health insurance registry (Fichier d'inscription des personnes assurées [FIPA]), the hospitalization database (MED-ÉCHO - Maintenance et exploitation des données pour l'étude de la clientèle hospitalière), the vital statistics death database, the physician claims database, and the pharmaceutical services database (for persons aged 65 and older). Of the many variables in these databases, only those relevant to chronic disease surveillance have been integrated into the QICDSS. The health insurance number (HIN) constitutes the key for linking data. The data available in fall 2013 covered the period of January 1, 1996, to March 31, 2012, with the exception of the death database (up to December 31, 2009).

- The health insurance registry, which is administered by the Régie de l'assurance maladie du Québec (RAMQ),[13] contains demographic and geographic records on people who have a valid and active HIN, as well as data about their eligibility and admissibility to the province's public health and drug insurance plans.

- The hospitalization database (MED-ÉCHO) contains information on inpatient discharges from Quebec hospitals that provide general or specialized care. The data cover acute care and day surgeries and relate 1) to the hospital stay itself (location, duration, patient origin and destination); 2) diagnoses (at admission, primary diagnosis, secondary diagnoses, and cause-of-death diagnosis); 3) services (described according to location [room], medical specialty or diagnosis); 4) intensive care; and 5) interventions (therapeutic, diagnostic, surgical and obstetric). Diagnostic codes are based on the *International Classification of Diseases, 9th Revision* (ICD-9) up to March 31, 2006, and the Canadian enhancement of the tenth revision (ICD-10-CA) thereafter. ICD-10-CA lists as much as 25 secondary diagnoses, versus 15 in ICD-9. Intervention codes are based on the Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures (CCP), in conjunction with ICD-9, and the Canadian Classification of Health Interventions (CCI), in conjunction with ICD-10-CA. The number of interventions in the CCP is 10, while the CCI has 20. Medical registrars are responsible for encoding the data provided by physicians.
- The vital statistics death database records all deaths of Quebecers, including those that occur outside the province. The records are submitted by physicians who report deaths or by coroners, and include the date, primary cause of death and, since January 1, 2000, up to 10 contributing causes. Before that date, only one additional cause could be entered for deaths attributable to an external cause. Cause-of-death codes are based on the ICD, with January 1, 2000, being the transition date from ICD-9 to ICD-10 codes.
- The physician claims database collects data related to fee-for-service billings, that is, the payment claims that health professionals submit to the RAMQ. Each record includes the code associated with the service rendered and optionally, in 91% of claims submitted between 1996–1997 and 2011–2012, the most relevant ICD-9 diagnostic code. Also included are data on health professionals themselves (treating or referring professionals) and the location where the service was provided.
- The pharmaceutical services database centralizes prescription drug claims submitted under the public drug insurance plan. Data related to private insurance plans (which cover a significant portion of the Quebec population) are not included. This database covers over 90% of people aged 65 years or older as Quebec senior citizens are automatically covered (data on seniors covered by a private plan or living in long-term care facilities are not included). The records include prescription drugs information (drug code, dose, number of renewals, duration of treatment, etc.) and health professionals information (prescriber's class and specialty).

Since these databases contain little socioeconomic information, the QICDSS incorporates the material and social deprivation index, an ecological substitute of the socioeconomic status developed by the INSPQ.[14] Combining six indicators from the Canadian census at the dissemination area (DA) level (the smallest geographical unit for which census data are produced), this index is attributed to each individual through a correspondence file linking DAs and six-character postal codes in the FIPA. The six indicators are 1) the proportion of people who do not have a high-school diploma; 2) the employment-to-population ratio; 3) the average personal income; 4) the proportion of widowed, separated or divorced people; 5) the proportion of people living alone; and 6) the proportion of single-parent families. The first three of these indicators relate to the material dimension of the deprivation index, while the rest relate to the social dimension.[14]

Operational model

The QICDSS operational model (Figure 1) is structured around three steps linked to one of the three components of surveillance systems: data extraction and linkage, measures analysis and production, and interpretation and dissemination of information. Since a description of this model has been published elsewhere,[15] we will only include a brief description here.

Extraction and linkage of health administrative data

The INSPQ receives, for the selected variables, anonymous unique identifiers and complete individual information for the entire Quebec population for three of the databases (FIPA, hospitalizations and deaths). Due to access-to-information restrictions, individual information from the other two databases is limited to people who are at risk for at least one of the chronic diseases studied. These people are identified using selection criteria that relate to diagnostics, medical acts, hospital procedures and pharmaceutical codes. In order to obtain historical data, selection criteria about those at risk are also applied when extracting data from the mortality and hospitalization databases. The diagnostic or cause-of-death codes list used for the patient selection is presented in Table 1. The pharmaceutical, medical act and hospital intervention codes are available upon request.

At INSPQ, some criteria are applied to the FIPA to create the QICDSS insurance registry: data of an individual inscribed in the FIPA for the year under consideration are preserved if the eligibility and admissibility criteria of this individual are met for at least one day during the year in question (that is to say that his HIN is in effect). Periods of ineligibility are associated with death, emigration, the transition period prior to immigration, or an absence of more than six months from the province. Also excluded are periods of inadmissibility during which a person does not have an active health insurance card. However, in order to obtain population counts that approximate official demographic data, the admissibility criterion is not applied to women aged 18 to 25 years and to men aged 18 to 29 years, as many people in these age groups do not renew their health insurance card. We should emphasize that most of the Quebec population is included in the FIPA registry. Therefore, this registry can be used as a population-counting tool, as its data are similar to the official demographic data published by the Institut de la statistique du Québec.[16]

TABLE 1
List of diagnostic or cause-of-death codes used to select individuals potentially affected by a chronic disease in QICDSS

Disease	ICD-9	ICD-10-CA/ICD-10
Diabetes	250; 648.0; 648.8; 790.2	E10–E14; O24; O99.8; R73
Cardiovascular diseases and associated risk factors	272, 278, 305.0, 305.1, 357.5, 362, 362.11, 362.3, 390–459, 514, 518.4, 584.5, 584.9, 585, 586.9, 745–747, 785–786, 788.5, 797–799, 989.84, V158.2, V451	E66, E78, F10, F17, G45, G62.1, H34, I00–I99, J81, M30.3, N17, N18–N19, Q20–Q28, R00–R09, R34, R54, R57, R96–R98, T65.2, Z50.2, Z71.4, Z72.0, Z99.2
Respiratory diseases	490–493, 496, 460–462, 464–466, 480–486	J20, J45–J46, J40–J44, J00–02, J04–06, J12–18, J21–22
Osteoporosis	733, 805–814, 818–825, 827–829, 905, 731	M80–M81, S12, S22, S32, S42, S52, S62, S72, S82, S92, T02, T08, T10, T12, T14, T911–T912, T921–T922, T931–T932, T940, M88
Osteoarticular diseases	710–729, 274, 446, 696	M00–M99
Mental disorders, Alzheimer's disease and related disorders	046, 290–319, 331, 332, 797	F00–F99, A81, B24, G10, G20, G30, G31, G35

Abbreviations: ICD-9, International Classification of Diseases, 9th Revision; ICD-10, International Statistical Classification of Diseases, 10th Revision; ICD-10-CA, Canadian Enhancement of the International Statistical Classification of Diseases, 10th Revision; QICDSS, Quebec Integrated Chronic Disease Surveillance System.

Note: The total burden includes all these diseases.

The process of creating the QICDSS and data access both meet stringent standards of security and privacy. Government bodies in legal possession of the databases (RAMQ and MSSS), the public health ethics committee and the Commission d'accès à l'information du Québec evaluated and approved the creation process. The data are stored on a secure server at the INSPQ. Access to data is logged and is limited to authorized personnel of the Chronic Disease and Injury Surveillance Unit according to different levels of access.

Measures analysis and production

People with chronic diseases are identified using case definitions specific to each disease. Validation studies are essential in order to select case definitions that will minimize classification errors. Table 2 shows a few examples of case definitions applied to the QICDSS databases and their respective validation studies.[17-21]

Thanks to its extensive coverage of the Quebec population, the QICDSS data can be used to describe the scope of chronic diseases at the provincial and regional levels according to various determinants (age, sex, deprivation), as well as to analyze trends and make projections. An integrated approach facilitates the development of new indicators for disease outcomes (excess mortality, rate of complications); it also enables comparisons of hospital services use between people who suffer from a chronic disease and those who do not, and helps the analysis of disease continuums and care trajectories. In addition to conventional surveillance measures, the QICDSS can also produce innovative ones, such as multimorbidity and polypharmacy measures.

Interpretation, submission and dissemination of information

Data interpretation and knowledge transfer are essential components of surveillance.[5,22] QICDSS dissemination modes include the transmission of aggregate data to various public health stakeholders (particularly the regional public health authorities) through the secure Internet site of the Infocentre de santé publique du Québec, the transmission of summary aggregated data to the Public Health Agency of Canada through CCDSS, and the publication of various documents (for example, thematic series, such as the *Surveillance des maladies chroniques* collection, methodological reports and scientific articles).

Results

The first QICDSS data transmission to the INSPQ, conducted in 2010, covered the period from January 1, 1996, to March 31, 2009. Since then, the system has been updated annually, every summer. Thus, in the fall of 2013, the QICDSS' coverage extended until March 31, 2012.

Table 3 shows various characteristics of the population of the QICDSS insurance registry. In fiscal year 2011–2012, 99.1% (n = 7 995 963) of the Quebec population[16] was eligible and admissible to the RAMQ health insurance (average age 40.8 years). The proportion of the population aged 65 years and older was 16.0%. This proportion increased between 2001–2002 and 2011–2012. More than half of the people in this age group were women (56.2%) and 89.9% were enrolled in the drug insurance plan. Close to half of all Quebecers lived in the Montréal Census Metropolitan Area (48.2%). The rural population is the only population segment that has tended to decrease slightly over time. Between 2.5% (2001–2002) and 1.3% (2011–2012) of the population was not associated with any geographical area due to a missing or erroneous postal code. While the proportion of people enrolled in the drug insurance plan decreased slightly between 2001–2002 and 2011–2012, their actual number increased.

People potentially affected by at least one of the studied chronic diseases were selected from the various health administrative databases according to several criteria. Table 4 shows the number and proportion of individuals who met at least one selection criterion, by age and year. A large proportion of the population can be found in the QICDSS, particularly in older age groups, given the higher prevalence of many chronic diseases in these age groups and the selection criteria that were applied. In 2001–2002, 97.9% of people listed in the registry met at least one criterion, a proportion that rose to 99.7%

TABLE 2
Examples of case definitions used in the QICDSS

Disease	Age, years	Case definition	Diagnostic codes		Intervention codes	Validation studies
			ICD-9	ICD-10-CA		
Ischemic heart diseases	≥ 20	Two diagnoses of ischemic heart diseases in the physician claims database within a one-year period (365 days) OR one diagnosis (primary or secondary) OR one intervention code for ischemic heart diseases in the MED-ÉCHO database	410–414	I20–I25	CCP[a] 48.02, 48.03, 48.11–48.19 CCI[b] 1.IJ.50, 1.IJ.57.GQ, 1.IJ.54, 1.IJ.76	Tu et al., 2010[19]
Diabetes, hypertension	≥ 1 (diabetes), ≥ 20 (hypertension)	Two diagnoses of diabetes (or hypertension) in the physician claims database within a two-year period (730 days) OR one diagnosis (primary or secondary) of diabetes (or hypertension) in the MED-ÉCHO database *Exclusion of gestational diabetes (or hypertension) cases*[43]	250 (diabetes) 401–405 (hypertension)	E10–E14 (diabetes) I10–I15 (hypertension)		Ouhoummane et al., 2010[44] Hux et al., 2002[17] Quan et al., 2009[20] Tu et al., 2007[21]
Osteoporotic fractures	≥ 50	One medical act in the physician claims database corresponding to an open reduction, a closed reduction, or immobilization of a fracture OR one medical act corresponding to a primary visit or an orthopedic consultation with a diagnosis of fracture plus at least one other medical consultation with a diagnosis of fracture at the same site within a 4-month period		See reference[18]		Jean et al., 2012[18]

Abbreviations: CCI, Canadian Classification of Health Interventions; CCP, Canadian Classification of Diagnostic, Therapeutic and Surgical Procedures; ICD-9, International Classification of Diseases, 9th Revision; ICD-10-CA, Canadian Enhancement of the International Statistical Classification of Diseases, 10th Revision; QICDSS, Quebec Integrated Chronic Disease Surveillance System.

[a] CCP is associated with ICD-9 in the hospitalization database prior to April 1, 2006.

[b] CCI is associated with ICD-10-CA in the hospitalization database.

among those aged 65 years or older. In 2011–2012, 95.3% of the people in the registry met at least one criterion. This slight decrease relative to 2001–2002 may be attributable to a shorter follow-up period, which reduces the likelihood of meeting at least one selection criterion, particularly among younger people (90.1% among those aged 19 years or less). It is important to note that people who meet selection criteria are potentially at risk but not all of them necessarily have a chronic disease. For example, for the surveillance of cardiovascular disease, selection criteria identified 6 164 006 people (77.1%) in 2011–2012. In fact, for that year, 1 483 168 people aged 20 years and older (23.8% crude prevalence) met the case definition of hypertension presented in Table 2, which allows the evaluation of the burden of this problematic in terms of incidence and prevalence.

Discussion

Surveillance is a fundamental step in measuring the evolution of the health status of the population. In Quebec, data collection of health events has evolved and currently consists of three steps: data collection itself, analysis and interpretation, and the timely dissemination of information to decision-makers who oversee disease prevention and control. Quebec's most relevant data sources for the purposes of chronic disease surveillance are health administrative databases. They are updated systematically; they can also be linked and they require little effort or additional cost.

The QICDSS constitutes an inestimable source of information on Quebec's chronic disease burden as it covers all health care services used by the population, from medical consultations to deaths, via hospitalizations and drug use. The system enables up-to-date chronic disease surveillance and takes into account their co-occurrence and the organization of health care services, extremely important aspects in an aging population. In short, the QICDSS data addresses a growing need for information on populations that are vulnerable to chronic diseases.[23-24] With data available from 1996 and yearly updates, the system facilitates the analysis of health care services use,[25] trend studies and projections for different population cohorts.[26,27] The information derived from the QICDSS contributes to a better understanding of the continuum of disease prevention, progression, treatment and outcomes (impact of public health programs, use of health care services, treatment compliance, etc.), leading to a more efficient planning of public health resources and interventions.

TABLE 3
Characteristics of the population eligible and admissible to the RAMQ (QICDSS insurance registry), by year and sex

Characteristics	2001–2002			2006–2007			2011–2012		
	Total, n (%)	Men, n (%)	Women, n (%)	Total, n (%)	Men, n (%)	Women, n (%)	Total, n (%)	Men, n (%)	Women, n (%)
Totals, N	7 462 734	3 671 680	3 791 054	7 693 005	3 788 475	3 904 530	7 995 963	3 944 033	4 051 930
Age, years									
0–19	1 809 881 (24.2)	924 135 (25.2)	885 746 (23.4)	1 769 931 (23.0)	903 109 (23.8)	866 822 (22.2)	1 774 008 (22.2)	904 998 (22.9)	869 010 (21.4)
20–34	1 489 603 (20.0)	757 321 (20.6)	732 282 (19.3)	1 513 723 (19.7)	768 269 (20.3)	745 454 (19.1)	1 570 545 (19.6)	794 491 (20.1)	776 054 (19.2)
35–49	1 867 632 (25.0)	935 077 (25.5)	932 555 (24.6)	1 781 591 (23.2)	893 773 (23.6)	887 818 (22.7)	1 644 967 (20.6)	827 610 (21.0)	817 357 (20.2)
50–64	1 314 602 (17.6)	648 868 (17.7)	665 734 (17.6)	1 539 363 (20.0)	761 368 (20.1)	777 995 (19.9)	1 730 025 (21.6)	857 495 (21.7)	872 530 (21.5)
65–74	550 633 (7.4)	252 505 (6.9)	298 128 (7.9)	583 269 (7.6)	273 945 (7.2)	309 324 (7.9)	702 847 (8.8)	336 325 (8.5)	366 522 (9.0)
≥ 75	430 383 (5.8)	153 774 (4.2)	276 609 (7.3)	505 128 (6.6)	188 011 (5.0)	317 117 (8.1)	573 571 (7.2)	223 114 (5.7)	350 457 (8.6)
≥ 20	5 652 853 (75.7)	2 747 545 (74.8)	2 905 308 (76.6)	5 923 074 (77.0)	2 885 366 (76.2)	3 037 708 (77.8)	6 221 955 (77.8)	3 039 035 (77.1)	3 182 920 (78.6)
≥ 65	981 016 (13.1)	406 279 (11.1)	574 737 (15.2)	1 088 397 (14.1)	461 956 (12.2)	626 441 (16.0)	1 276 418 (16.0)	559 439 (14.2)	716 979 (17.7)
Area of residence									
Metropolitan Montréal area	3 494 352 (46.8)	1 703 296 (46.4)	1 791 056 (47.2)	3 697 988 (48.1)	1 805 106 (47.6)	1 892 882 (48.5)	3 854 436 (48.2)	1 882 226 (47.7)	1 972 210 (48.7)
Other metropolitan area	1 355 600 (18.2)	657 155 (17.9)	698 445 (18.4)	1 487 679 (19.3)	723 752 (19.1)	763 927 (19.6)	1 553 851 (19.4)	758 107 (19.2)	795 744 (19.6)
Medium-size city	849 668 (11.4)	415 180 (11.3)	434 488 (11.5)	919 989 (12.0)	451 586 (11.9)	468 403 (12.0)	943 244 (11.8)	462 976 (11.7)	480 268 (11.9)
Rural area	1 579 561 (21.2)	799 839 (21.8)	779 722 (20.6)	1 512 145 (19.6)	767 632 (20.3)	744 513 (19.1)	1 539 409 (19.3)	782 331 (19.8)	757 078 (18.7)
Not determined	183 553 (2.5)	96 210 (2.6)	87 343 (2.3)	75 204 (1.0)	40 399 (1.1)	34 805 (0.9)	105 023 (1.3)	58 393 (1.5)	46 630 (1.1)
Population enrolled in drug plan (≥ 65 years)[a]	896 015 (91.3)	371 076 (91.3)	524 939 (91.3)	981 267 (90.2)	414 220 (89.7)	567 047 (90.5)	1 147 415 (89.9)	499 499 (89.3)	647 916 (90.4)

Abbreviations: RAMQ, Régie de l'assurance maladie du Québec; QICDSS, Quebec Integrated Chronic Disease Surveillance System.

[a] People enrolled for at least one day in the year in question.

Essential features and strengths of the QICDSS

The QICDSS meets all five basic requirements of a public health surveillance system:[5,22,28] 1) simplicity and flexibility, 2) acceptability, 3) sensitivity and positive predictive value, 4) representativeness, and 5) timeliness.

- Since human and material resources are limited, the secondary use of health administrative data is relatively simple and economical. The annual addition of new selection codes and potential cases ensures that QICDSS remains flexible. However, this flexibility is limited by certain legal constraints. Furthermore, the system is not able to quickly respond to health care organizational changes or to the addition of diseases or data sources (e.g. database on family medicine groups).
- The acceptability of the QICDSS is excellent. Organizations responsible for these health administrative databases agree that they are used for surveillance purposes. Decision-makers are already using the information from the system and recognize its relevance. Moreover, regional surveillance stakeholders who make extensive use of the QICDSS information wish to play an active role in system activities.
- Validity measures, such as sensitivity and positive predictive value, vary from one disease to the next and are dependent on case definitions. When surveillance covers an entire population, the goal is to achieve a balance between these two validity measures for every disease and every case definition.
- The QICDSS also stands out in terms of representativeness, as it links several data sources within a universal health care system. This extensive coverage allows extrapolating the information to the entire population, describing socio-demographic, economic and geographical characteristics and minimizing many selection biases. The QICDSS's ability to link different data sources also increases the quality and usefulness of the information it generates.
- Timeliness is not as critical a factor in chronic disease surveillance as in other

TABLE 4
Number and proportion of people who meet at least one QICDSS selection criterion,[a] by year and age

Characteristics	2001–2002		2006–2007		2011–2012	
	Total (insurance registry), n	≥ 1 selection criterion, n (%)	Total (insurance registry), n	≥ 1 selection criterion, n (%)	Total (insurance registry), n	≥ 1 selection criterion, n (%)
Totals	7 462 734	7 307 855 (97.9)	7 693 005	7 511 892 (97.6)	7 995 963	7 617 930 (95.3)
Age, years						
0–19	1 809 881	1 764 479 (97.5)	1 769 931	1 710 415 (96.6)	1 774 008	1 599 191 (90.1)
20–34	1 489 603	1 435 025 (96.3)	1 513 723	1 453 093 (96.0)	1 570 545	1 464 750 (93.3)
35–49	1 867 632	1 830 421 (98.0)	1 781 591	1 744 230 (97.9)	1 644 967	1 586 085 (96.4)
50–64	1 314 602	1 299 876 (98.9)	1 539 363	1 519 958 (98.7)	1 730 025	1 700 141 (98.3)
≥ 65	981 016	978 054 (99.7)	1 088 397	1 084 196 (99.6)	1 276 418	1 267 763 (99.3)

Abbreviation: QICDSS, Quebec Integrated Chronic Disease Surveillance System.

[a] People who meet diagnostic, pharmaceutical, therapeutic (acts or treatments) or cause-of-death criteria associated with the chronic diseases studied in the QICDSS (see Table 1).

surveillance systems (e.g. infectious disease surveillance). Nevertheless, because it is updated annually, the QICDSS is able to produce timely incidence measures and thereby facilitates intervention within a reasonable timeframe.

In short, the QICDSS possesses all of the attributes required for a surveillance system and, as it is based on health services use within the context of a universal health care system, it meets the fundamental principle of surveillance, namely the presence of a functional health care system.[5]

Among other QICDSS's strengths, let us emphasize that access to source data (gross data) enables quality control at the different stages of data processing and analysis. Although the RAMQ is itself responsible for applying some of the selection, extraction and linkage criteria, and also for encrypting HINs, the INSPQ still receives data in the form of individual records. Furthermore, the addition of a deprivation index makes the QICDSS an important source of information on the impacts of social inequalities in health.[23,24] The system also allows the INSPQ to produce aggregate chronic disease surveillance measures for Quebec that can be harmonized with those of other Canadian provinces and territories participating in the CCDSS, an initiative coordinated by the Public Health Agency of Canada. Finally, the fact that data are collected for administrative purposes can be advantageous from a quality standpoint, particularly in the case of pharmaceutical services data. According to Tamblyn et al.,[29] this type of data is accurate and remarkably complete, since claimants know they may not receive payment if they provide incorrect or incomplete information when submitting their claims.

Comparison of QICDSS with other surveillance systems

The QICDSS compares favourably with other surveillance systems deployed worldwide. In the United States, the Institute of Medicine developed a nationwide framework for surveillance of cardiovascular and chronic lung diseases that severely criticized the lack of a national surveillance system capable of disseminating timely information to decision-makers.[30] Indeed, although American data sources include, among others, population surveys (such as the National Health and Nutrition Examination Survey [NHANES]), registries for specific diseases, population cohort data (such as the Framingham and Rochester cohorts[31]) and insurance claims data, none of these data sources could be linked in order to establish a national profile or produce incidence information until recently. The National Center for Health Statistics now links several population surveys with death certificates, Medicare and Medicaid services data, historical social security data and other data sources.[32] Australia bases much of its surveillance activities on survey data, most notably the Australian Bureau of Statistics National Health Survey (NHS).[33] The United Kingdom's population surveillance strategy also rests on the integration and processing of new data sources, such as acute and chronic disease registries and behavioural follow-up data (smoking, diet, exercise, etc.).[34] Given its flexibility, the QICDSS could easily incorporate this type of information. In fact, other Canadian provinces, such as Ontario[35] and Manitoba,[36] have access to linked health administrative databases but also incorporate survey data into their surveillance systems.

Limitations of QICDSS

The primary limitation of the QICDSS has to do with the nature of the data sources it uses. Since health administrative databases are designed to meet administrative needs, databases[37] and case definitions[17-19] need to be validated before using them for epidemiological purposes. Furthermore, even if validation studies demonstrate the quality of the selected case definitions, only health care services users and people who receive a diagnosis are included in the analysis, which leads to an underestimation of the actual magnitude of diseases. For example, a person might not know that he or she had a myocardial infarction and never consulted a physician, so this will not be counted in the QICDSS.[38]

Moreover, certain data are absent from the QICDSS. For example, medical services of Canadian Armed Forces members are paid by the federal government.[39] Similarly, services that Quebec citizens receive in other provinces from physicians not enrolled in the RAMQ are not included in the QICDSS at this time. However, work is currently underway to integrate that missing information, which would minimize the underestimations of the services received, particularly in the border regions (the Outaouais region, for example). Information on long-term care is also not included in the QICDSS and data on pharmaceutical services is limited to people aged 65 years or older.

Finally, some physicians in Quebec are not remunerated on a fee-for-service basis, which leads to an underestimation of services rendered and makes QICDSS a less sensitive tool.[39] Other forms of physician remuneration include salary-based compensation, fixed amount compensation (e.g. per-patient management fees for general practitioners), sessional compensation (or per diem) and, since September 1, 1999, blended compensation (a combination of fee-for-service and sessional compensation). In 2010–2011, these other forms of compensation accounted for 24% of physicians' remuneration, versus 16% in 1999–2000. The growing popularity of blended compensation since its introduction for specialists in 1999 accounts for much of this change: the sessional part of the blended compensation now accounts for 11.6% of all clinical payments to physicians, while salary-based compensation accounts for only 1.9%.[40] Although proportions of forms of remuneration (other than fee-for-service) have been increasing, the number of medical services provided on a fee-for-service basis increased by 8.8% between 2001 and 2007, following an 18-year low in 2001. The consequences of alternative forms of remuneration are felt most keenly in remote areas. Improving surveillance for these population groups requires alternative data sources or surveys. In the Aboriginal communities of Terres-Cries-de-la-Baie-James, for example, where all general practitioners are compensated under alternative arrangements, a data linkage pilot project with the Cree Diabetes Information System (CDIS) revealed that QICDSS identifies only 60% of the diabetes cases in the region, with an average lag time of 2.3 years after the incidence date of the disease. As this data linkage initiative provided a means of compensating for the lack of information on other modes of remuneration, ongoing linkage of these two systems is under consideration. As for the presence of the private sector in Quebec's health care system, it remains marginal and primarily affects the fee-for-service database and the pharmaceutical services database (in the case of people aged under 65 years).

Finally, each chronic disease definition in the QICDSS has its limitations, thus complicating the study of multimorbidity. Moreover, health administrative databases generally do not disclose disease severity, nor do they provide a way of confirming diagnoses through clinical information. Health administrative databases also contain little information on chronic disease risk factors and no information on laboratory results or chronic disease lifestyle risk factors (diet, physical activity, smoking, alcohol consumption). However, the hospitalization database is an excellent source of information for certain risk factors and comorbidities since secondary diagnoses and diagnoses that contribute to hospital admission and length of stay are included (25 possibilities since April 1, 2006).

Conclusion

The chronic disease burden will continue to grow and will become more complex as the population ages and life expectancy rises. Chronic disease surveillance needs to be improved in order to identify both at-risk and affected populations, and to track the evolution of chronic diseases and the issues associated with them. The QICDSS is clearly the most appropriate way to realize chronic disease surveillance in Quebec. It maximizes the use of existing information systems, is economical, and provides reliable population data. It contains, with respect to the 2011–2012 period, individual, hospital, medical, socioeconomic, and cause-of-death data on close to 8 million Quebecers of all ages and from all regions. Thus, it allows a thorough study of the chronic disease burden. In addition, the QICDSS is consistent with the integrated model of chronic disease care prevention and control,[41] whereas surveillance not only looks at each disease separately, but also considers the co-occurrence of diseases and its complications.

We therefore conclude that the QICDSS fully meets the objectives of an efficient, integrated surveillance system. It is flexible and can be enhanced and enriched as needs arise[42]. Indeed, incorporating data on chronic disease risk factors and lifestyle factors into the system will be considered. Also planned are linkages with other health administrative databases (including births and stillbirths), with health surveys and with information systems such as the Cree Diabetes Information System. This capacity to evolve makes QICDSS a truly innovative and responsive system. Note finally that QICDSS should be evaluated regularly in order to maintain its scientific rigour and ensure that the surveillance conducted with this system is efficient and useful for public health decision-making and action.

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References

1. World Health Organization. Preventing chronic diseases: a vital investment. Geneva (CH): WHO; 2005.

2. United Nations. Political declaration of the high-level meeting of the General Assembly on the Prevention and Control of Non-communicable Diseases. New York (NY): United Nations; 2012. Available at: http://www.who.int/nmh/events/un_ncd_summit2011/political_declaration_en.pdf

3. Health Canada. Chronic disease surveillance in Canada: a background paper. Ottawa (ON): Health Canada; 2003.

4. Ministère de la Santé et des Services sociaux du Québec (MSSS), Institut national de santé publique du Québec (INSPQ). Plan ministériel de surveillance multithématique, Thème 1, Habitudes de vie, comportements et maladies chroniques, Volet 1: Maladies chroniques. Québec (QC): MSSS/INSPQ; 2010.

5. Kone Pefoyo AJ, Rivard M, Laurier C. Importance de la surveillance en santé publique et utilité des données administratives. Rev Epidemiol Sante Publique. 2009;57(2):99-111.

6. Roos LL Jr., Roos NP, Cageorge SM, Nicol JP. How good are the data? Reliability of one health care data bank. Med Care. 1982; 20(3):266-76.

7. Roos LL, Gupta S, Soodeen RA, Jebamani L. Data quality in an information-rich environment: Canada as an example. Can J Aging. 2005;24 Suppl 1:153-70.

8. Benchimol EI, Manuel DG, To T, Griffiths AM, Rabeneck L, Guttmann A. Development and use of reporting guidelines for assessing the quality of validation studies of health administrative data. J Clin Epidemiol. 2011;64(8):821-9.

9. Wilchesky M, Tamblyn RM, Huang A. Validation of diagnostic codes within medical services claims. J Clin Epidemiol. 2004; 57(2):131-41.

10. Émond V. Prévalence du diabète au Québec et dans ses régions: premières estimations d'après les fichiers administratifs. Québec (QC): Institut national de santé publique du Québec; 2002.

11. Patt A. Marshalling the troops: advocating for the needs of people with diabetes. Can J Diabetes. 2005;29(3):180.

12. Clottey C, Mo F, LeBrun B, Mickelson P, Niles J, Robbins G. The development of the National Diabetes Surveillance System (NDSS) in Canada. Chronic Dis Can. 2001; 22(2):67-9.

13. Régie de l'assurance maladie du Québec. Données et statistiques: Données sur demande: Fichier d'inscription des personnes assurées [Internet]. Québec (QC): RAMQ; [2013; cited 2013 Dec 20]. Available from: http://www.ramq.gouv.qc.ca/fr/donnees-statistiques/sur-demande/donnees-regie

14. Pampalon R, Hamel D, Gamache P, Raymond G. A deprivation index for health planning in Canada. Chronic Dis Can. 2009;29(4):178-91.

15. Saint-Laurent D, Blais C, Jean S, Sirois C, Rochette L, Émond V. Le modèle québécois de surveillance des maladies chroniques basé sur l'utilisation des données médico-administratives jumelées. Bulletin épidémiologique hebdomadaire. 2013; Numéro hors-série:4-8.

16. Institut de la statistique du Québec (ISQ). Banque de données de statistiques officielles sur le Québec. Population et démographie [Internet]. Québec (QC): ISQ; [cited 2013 Dec 4, 2013]. Available from: http://www.bdso.gouv.qc.ca

17. Hux JE, Ivis F, Flintoft V, Bica A. Diabetes in Ontario: determination of prevalence and incidence using a validated administrative data algorithm. Diabetes Care. 2002;25(3): 512-6.

18. Jean S, Candas B, Belzile E, et al. Algorithms can be used to identify fragility fracture cases in physician-claims databases. Osteoporos Int. 2012;23(2):483-501.

19. Tu K, Mitiku T, Lee DS, Guo H, Tu JV. Validation of physician billing and hospitalization data to identify patients with ischemic heart disease using data from the Electronic Medical Record Administrative Data Linked Database (EMRALD). Can J Cardiol. 2010;26(7):e225-8.

20. Quan H, Khan N, Hemmelgarn BR, et al. Validation of a case definition to define hypertension using administrative data. Hypertension. 2009;54(6):1423-8.

21. Tu K, Campbell NRC, Chen ZL, Cauch-Dudek KJ, McAlister FA. Accuracy of administrative databases in identifying patients with hypertension. Open Med. 2007;1(1):e18-26.

22. Lee LM, Teutsch SM, Thacker SB, St. Louis ME. Principles and practice of public health surveillance. New York (NY): Oxford University Press; 2010.

23. Blais C, Hamel D, Rinfret S. Impact of socioeconomic deprivation and area of residence on access to coronary revascularization and mortality after a first acute myocardial infarction in Quebec. Can J Cardiol. 2012;28(2):169-77.

24. Aube-Maurice J, Rochette L, Blais C. Divergent associations between incident hypertension and deprivation based on different sources of case of identification. Chronic Dis Inj Can. 2012;32(3):121-30.

25. Jean S, Bessette L, Belzile EL, et al. Direct medical resource utilization associated with osteoporosis-related nonvertebral fractures in postmenopausal women. J Bone Miner Res. 2013;28(2):360-71.

26. Robitaille C, Dai S, Waters C, et al. Diagnosed hypertension in Canada: incidence, prevalence and associated mortality. CMAJ. 2012;184(1):e49-56.

27. Robitaille C, Bancej C, Dai S, et al. Surveillance of ischemic heart disease should include physician billing claims: population-based evidence from administrative health data across seven Canadian provinces. BMC Cardiovasc Disord. 2013;13(1):88.

28. German RR, Lee LM, Horan JM, Milstein RL, Pertowski CA, Waller MN. Updated guidelines for evaluating public health surveillance systems: recommendations from the Guidelines Working Group. MMWR Recomm Rep. 2001;50(RR-13):1-35.

29. Tamblyn R, Lavoie G, Petrella L, Monette J. The use of prescription claims databases in pharmacoepidemiological research: the accuracy and comprehensiveness of the prescription claims database in Quebec. J Clin Epidemiol. 1995;48(8):999-1009.

30. Institute of Medicine. A nationwide framework for surveillance of cardiovascular and chronic lung diseases. Washington (DC): The National Academies Press; 2011.

31. St Sauver JL, Grossardt BR, Yawn BP, et al. Data resource profile: the Rochester Epidemiology Project (REP) medical records-linkage system. Int J Epidemiol. 2012;41(6):1614-24.

32. Centers for Disease Control and Prevention. NCHS Data Linkage Activities [Internet]. Atlanta (GA): Centers for Disease Control and Prevention; 2014 [cited 2014 March 31]. Available from: http://www.cdc.gov/nchs/data_access/data_linkage_activities.htm

33. Australian Institute of Health and Welfare. Key indicators of progress for chronic disease and associated determinants: data report. Canberra (AU): Australian Institute of Health and Welfare; 2011.

34. Department of Health. Public health surveillance: towards a public health surveillance strategy for England. London (UK): Department of Health; 2012.

35. Paul C. Creating and using CCHS files to link survey responses to health service utilization data – Ontario's experience. Paper presented at Explaining the miracle! Statistics and analysis in public health. 15th conference of the Association of Public Health Epidemiologists in Ontario (APEO); 2007 Oct 14-16; Ottawa, ON.

36. Lix L, Yogendran M, Burchill C, et al. Defining and validating chronic diseases: an administrative data approach. Winnipeg (MB): Manitoba Centre for Health Policy; 2006.

37. Lambert L, Blais C, Hamel D, et al. Evaluation of care and surveillance of cardiovascular disease: can we trust medico-administrative hospital data? Can J Cardiol. 2012;28(2):162-8.

38. de Torbal A, Boersma E, Kors JA, et al. Incidence of recognized and unrecognized myocardial infarction in men and women aged 55 and older: the Rotterdam Study. Eur Heart J. 2006;27(6):729-36.

39. Ministère de la Santé et des Services sociaux du Québec (MSSS). Regards sur le système de santé et de services sociaux du Québec. Québec (QC): MSSS; 2009.

40. Canadian Institute for Health Information. National Physician Database, 2010-2011 – Data Release. Ottawa (ON): CIHI; 2013.

41. Pineault R, Provost S, Hamel M, Couture A, Levesque JF. The influence of primary health care organizational models on patients' experience of care in different chronic disease situations. Chronic Dis Inj Can. 2011;31(3):109-20.

42. Choi BCK. Perspectives on epidemiologic surveillance in the 21st century. Chronic Dis Can. 1998;19(4):145-51.

43. Blais C, Rochette L, Hamel D, Poirier P. Prevalence, incidence, awareness and control of hypertension in the Province of Quebec: perspective from administrative and survey data. Can J Public Health. 2014;105(1):e79-85.

44. Ouhoummane N. Impact du diabète sur la mortalité à la suite d'une hospitalisation pour un premier infarctus aigu du myocarde au Québec [thesis]. Québec (QC): Université Laval; 2010.

Awakening professionals' critical awareness of health literacy issues within a francophone linguistic-minority population in Ontario

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Abstract

Introduction: We carried out a qualitative evaluation of immediate learning and attitudinal change among health care and social services professionals who attended a workshop promoting critical reflection about health literacy among linguistic-minority Franco-Ontarians.

Methods: The study involved 41 francophone health care and social services professionals. The workshop facilitator used evocative objects to elicit reflection on health literacy. Data sources were audio-recordings of group discussions and feedback forms completed by participants.

Results: The study found that the workshop awakened participants' awareness of health literacy and stimulated them to promote health literacy in their professional practice. The workshop also broadened participants' vision of health literacy as a social determinant of health that interacts synergistically with culture, age, immigration status, social support, and socioeconomic status.

Conclusion: Professionals expressed their awakened awareness of health literacy as collective accountability. This corroborates our claim that critical pedagogy applied to in-service education effectively stimulates professionals' awareness of their potential to change their practice and work environment.

Keywords: *evaluation study, francophone linguistic minority, minority health, training activities*

Introduction

Health literacy (HL) is considered to be a stronger social determinant of health than age, gender, education, race, employment or socioeconomic status.[1] Clients' knowledge of chronic disease self-management can be predicted by their HL.[2] Self-management requires building capacity to care for oneself and increase one's autonomy. These steps are most likely achieved through participatory learning, a methodology used in health education programs to inform health care professionals about asthma, hypertension, AIDS, tuberculosis and other chronic diseases.[3-5] In Canada, participatory learning has been used to strengthen self-management by building HL,[6] which is difficult to do when health information is presented in a language other than one's first language.[7]

In this article, we address 1) the attitudes toward HL of francophone professionals born in Canada and elsewhere who live as linguistic minority in Ontario, and 2) the HL issues these professionals report facing when working with francophone clients.

We define ''francophone'' as having French as first language[8] and being able to use it conversationally.[9] Being a francophone linguistic minority encompasses ethnolinguistic identity, social identity and the affective meaning of these identities.[10]

After Quebec, Ontario has the second-highest proportion of francophone immigrants in Canada; 10.3% of these francophone immigrants are ethno-cultural minorities and of these, 86% live in linguistic-minority situations.[11,12] Ontario also has a high proportion of senior ''native'' francophones with low levels of general literacy.[13] Although there is no specific information on francophone health care professionals in Ontario, Canadian health care professionals generally lack awareness of the nature, significance and impact of HL[14] on their linguistic-minority clients. We present findings from an evaluation study of a workshop held with francophone health and social services professionals. The goal of the workshop was to identify and appraise professionals' knowledge of HL among their francophone linguistic minority clients and to promote HL best practices by addressing clients' health needs and willingness to be accountable for their health.

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Background

A surprisingly high proportion of Canadian adults—42% of working-age adults (16 to 65 years) and 56% of francophones—find it difficult to understand the content of written material in their mother tongue.[13] Such a lack of comprehension decreases HL and affects health care costs[15,16] because the motivation to adhere to health promotion principles requires the ability to assess health information.[17] The link between HL and disparities in access to health care among linguistic-minority Canadian francophones remains relatively unexplored.[18] The literature on HL in this population is also scarce as are evaluations of HL interventions or professional in-service education about HL. Our evaluation study addresses this knowledge gap.

Multiple definitions of HL are rooted both in the perspective of social determinants of health and disease self-management.[19] As a social determinant of health, HL is lifelong, socially constructed knowledge[7] that encompasses reading, writing, listening, speaking, numeracy and critical thinking—which are all deeply influenced by language and culture.[20] HL acts synergistically with other social determinants of health (e.g. access to health care, age, culture, location, education, income) to influence health status. HL also forms the basis for health beliefs, health decisions or lifestyle choices[21] and how people navigate complex health care systems. Poor or inadequate HL therefore tends to contribute to inequities of access to health care.[22]

From the perspective of disease self-management, HL is a set of measurable cognitive skills (e.g. writing, reading, counting) that enable a conceptual understanding of health, adequate use of health services, safe decision-making and adherence to medical treatments and regimens.[23] HL measurements can predict approximate health behaviours, health outcomes, health-promoting behaviours and health care system inequities[24] as well as visits to the emergency department and high health care costs related to poor understanding of health information and disease management in general.[25,26] High HL is also associated with satisfaction with health services, optimism about care and trust in health care systems and professionals.[27]

In this study, we used the social determinants of health definition of HL, intertwined with tenets of health communication[28] and critical literacy.[15] Within such a combined perspective, HL comprises multidimensional processes of social learning (e.g. accumulation of family, school, social, cultural and professional assets) that incorporate health-related values, beliefs, fears and behaviours. The roots of HL include (1) health culture and health knowledge, (2) the type of health education to which a person is exposed, (3) practice in searching, reading, decoding and communicating health information, (4) ability to use numerical health information to solve health problems, and (5) applying other forms of literacy to interpret the world.[7] HL is understood within a perspective of synergism among other determinants that goes beyond the individual's will and skills to self-manage her/his health conditions.

Literature review

Ideas about critical literacy as an avenue to helping people make social change, such as Freire's[29] approach of critical awareness in education, have guided evaluation studies of practice-renewal workshops for health care and social services professionals. Freire's approach helps professionals' reflect on their work and their agency within their political, socioeconomic and professional contexts.[3] Reported outcomes of those studies include a commitment to facilitating clients' empowerment, improved understanding of clients and more reflection on challenges in communication.[30] Concepts of critical awareness, empowerment, emancipation and participatory learning as related to professionals and clients have guided health-promotion initiatives for the last 3 decades.[31,32] It is noteworthy that, despite enhanced HL being an expected outcome of health promotion initiatives, these concepts are neither synonymous nor interchangeable.

Conceptual framework

In his philosophy of education, Freire defines ''critical consciousness''[29,33] as the process of recognizing one's own world and one's place in this world, and taking part in transforming it.[34] Critical consciousness is a means for reflection within the process of action-reflection-action. Sharing critical dialogue with others in the learning process co-creates new knowledge. Freire postulates that the awareness raised from learning may motivate learners to identify for themselves the most appropriate means to solve problems they face in their lives. In other words, learners' understanding of how their social reality affects learning helps them recognize the need to defy existing oppressive conditions, consider alternatives and then set learning goals related to personal educational outcomes.[33,35]

Freire's approach guided the design and development as well as the evaluation of our HL workshop for francophone professionals. Freire's concept of critical consciousness[36] was particularly well suited to this workshop because the francophone participants were all aware of the status-based historical oppression of their linguistic minority in Canada. The silence about this oppression led to the loss of cultural, social, community and ethnic identity among linguistic-minority francophones, along with non-francophones' perception that the French language belongs to a historically colonized, minority population.[37]

Methods

Research questions

We conducted an evaluation study of the workshop ''Placing Health Literacy at the Core of Your Practice'' with francophone health and social services professionals to disseminate empirical information on HL and elicit reflection on HL among their clients.

The following questions guided the evaluation study:

- How did the workshop expand the participants' visions of HL?

- Which attitudes, skills, motivations or intended behaviours did the workshop influence?
- Can changes in participants' understanding of their clients and service provision be attributed to the workshop?

The health literacy awakening workshop

The aim of the workshop ''Placing Health Literacy at the Core of Your Practice'' was to update professionals' knowledge of HL and make them aware of 2 major problems associated with HL and the health of francophones: 1) the dearth of knowledge in the literature and among francophone professionals about social determinants of health and the specific needs of francophone linguistic minorities,[10] and 2) low awareness of HL among Canadian health care and social service professionals.[14] We used a constructivist approach in which social dialogue leads to learning based on self-reflection about the learner's own social constructions[38] as well as how knowledge enables people to pursue goals in multiple contexts.[39]

Because this was an awareness-awakening workshop, participants' knowledge was not measured before and after the workshop. Evidence of learning emerged from individual self-reflection and group discussions.[31] The workshop was held in the three Ontario cities where the majority of francophone health and social service professionals live: Sudbury (in December 2008), Toronto (in January 2009) and Ottawa (in February 2009). The 6-hour workshop was offered once in each city, and the number of participants ranged from 9 to 18.

Empirical information presented in the workshop included Canadian statistics on literacy levels and research findings on HL published by the Canadian Council of Learning[22] and available on their website,[40] from Health Consortium for Francophone Populations,[41] and from the Canadian Public Health Association and its associated researchers.[6,14] The workshop required participants to work with evocative objects (e.g. photographs, drawings or objects) that sustained the dialectical dialogue between the workshop facilitator and the participants[42] and that were used to 1) recall experiences and known social realities and recognize learners' own ideas, 2) create analogies to guide learners' self-reflection on their practice to help them transform it, and 3) encourage learners to reflect on their own experiences and decide on how to act on them. To ensure consistency among the workshop presentations, the facilitator (MZ) chose and brought the same evocative objects to all 3 workshops.

Table 1 describes the workshop components. These used Freire's[29] concept of action–reflection–action, evocative objects and critical dialogue.

Recruitment of workshop attendees and study participants

To produce an in-depth understanding of the workshop's immediate outcomes, we collected detailed information about our participants through a qualitative evaluation study.[43] Ethics approval to conduct the study was obtained from York University Research Ethics Board. Where participants consented, we audio-recorded their accounts.

Workshop participants comprised francophone professionals born in Burkina Faso, Haiti, Lebanon, Morocco and Canada who worked in the social service and health sectors (including project managers), policy making and public advocacy. Students in the health and social disciplines also

TABLE 1
Description of the workshop ''Place Health Literacy at the Core of your Practice''

Facilitator's presentation topics	Exercise 1	Exercise 2	Evaluation
Statistical data on literacy and HL, using local data about workshop location Overview of scientific evidence on HL Review of HL conceptual definitions Discussion of the many HL definitions Interactive exercise comparing functional skills of generally literate and illiterate[a] individuals Discussion of social determinants of health related to low HL among francophone linguistic-minority Interactive discussion about participants' comprehension of presentation, incorporating their personal and professional experiences	Goal: Promote application and comprehension of HL concept through metaphors/analogies Create discussion groups Distribute evocative objects to each participant Individually reflect on the presentation, HL, concept and ideas evoked by objects Participants individually presented on metaphors and analogies evoked by objects Facilitator concluded exercise by synthesizing participants' presentations	Goal: Provoke critical reflection about essential competencies for HL within the professional context to awaken professionals' consciousness of HL Discussion in groups about essential competencies to incorporate HL into practice and the support needed at organization and community level to improve professionals' knowledge and competencies of HL Short presentation by each group about support needs they identified Facilitator concluded exercise by synthesizing groups' key ideas	Distribution of form asking for: Evaluation of workshop's contribution to participants' learning of HL Awareness of francophone linguistic-minority difficulties in receiving services in French Awareness of importance of linguistically/culturally appropriate health and social services Requested suggestions for future workshop

Abbreviation: HL, health literacy.

Note: We opted to present a detailed description of the workshop, intending to inform readers about the use of evocative objects according to Freire's pedagogical method,[29] as well as to allow its replication.

[a] The term ''illiterate'' implies that the person is totally lacking in any literacy skills. It was used in the comparative exercise to allow participants to understand that reasoning aspect of literacy does not depend on reading skills.

participated in the workshop (see Table 2).

All 44 workshop participants were Rifssso members and were recruited (by CF) through that organization's listserve. We did not use any criteria to select participants, and the sample size was determined by the number of people who applied to join the study at the beginning of the workshop. As a result, it was not possible to have an even distribution among the participants' areas of practice.

A team member (CF) explained the benefits and risks of participating in the evaluation and the participants' right to stop the audio-recording. A question period followed, and the participants were then invited to review and sign the consent forms. Of the 44 workshop participants, 41 agreed to participate in the evaluation study (see Table 2). When those workshop participants who did not agree to take part in the evaluation study spoke, audio-recording was paused.

Data collection and analysis

A total of 17 recorded hours were transcribed verbatim. In addition, the participants were asked to complete feedback forms that asked how the workshop had contributed to their knowledge of HL and their awareness of HL-related problems encountered by their clients. Verbatim transcripts and feedback forms underwent manual content analysis[44] using the following process:

1) reading all transcripts;
2) grouping descriptive and explanatory ideas;
3) creating clusters of meaning composed of words and sentences;
4) identifying dichotomies within the categories (e.g. positive/negative, favourable/unfavourable);
5) organizing evidence of the impact of learning about HL into 3 conceptual categories:
    - expanded knowledge,
    - changes in attitude, and
    - anticipated changes in professional practice;
6) identifying features of the following emergent themes:
    - acknowledging the various dimensions of HL (prevention, self-management of health, right to access services, equity in services, language as a social determinant of health),
    - broadened vision of health (environment, education, economy, gender, social network, age), and
    - awakening critical awareness (HL levels among francophones, life in linguistic-minority situations);
7) rereading the transcripts while applying the themes;
8) analyzing associations between themes; and
9) re-analyzing the transcripts to identify whether HL consciousness was awakened.

TABLE 2
Distribution of "Place Health Literacy at the Core of your Practice" workshop attendees, by city and professional sector

City	Sector[a]	Profession and scope of activity	N
Sudbury	Health	Registered nurses, physiotherapy faculty, dietician, senior community health, community organizers, community developer	7
	Social services	Social worker	1
	Education	Social sciences college faculty	1
	Subtotal		9
Toronto	Health	Health educators, nursing undergraduate student, project manager, psychologist, consultant	6
	Social services	Social workers, community workers, policy maker, anthropologist, communication professionals, project coordinators, accountant	10
	Education	Social sciences college faculty	1
	Subtotal		17
Ottawa	Health	Midwife, nursing students, physician, project manager, public advocate, project coordinators, registered nurses	14
	Social services	Social sciences college student	1
	Education	High school teacher, nursing university faculty, school administrator	3
	Subtotal		18
Total			44

Abbreviation: Rifssso, Regroupement des intervenants francophones en santé et en services sociaux de l'Ontario.

[a] These sectors are most likely representative of Rifssso members' areas of professional activity.

MZ, LS and NW, who are fluent in French but not native speakers, analyzed the data. Afterwards, four francophone professionals who live in linguistic-minority situations in Ontario verified the findings. As natural experts, CM and CF confirmed the original interpretation of the findings.[45] Two other francophone professionals with experience in the health and education sectors also reviewed an early draft of the manuscript. Original quotes were translated into English for this paper by LS, and the translation's accuracy was confirmed by the francophone co-authors.

Results

At registration, only 3 workshop participants knew about HL. After the facilitator's presentation, most of the evaluation study participants reported that this was the first time they had heard about HL in the context of health and social services and HL's significance to their clients:

> It's the first time that I hear about health literacy. The extent to which this literacy is present in our daily work and to which it is important that we understand it, in order to help the Canadian senior population, is remarkable. [Sudbury participant]

When the facilitator used the Canadian Council on Learning's online interactive map of Ontario[46] to show literacy and reading levels, the participants immediately related to this their clients' HL reality. Afterwards, they discussed how low literacy interferes with their efforts to enhance their clients' HL if they mainly have printed materials to use.

Participants' preliminary ideas about health literacy

The personal and professional stories that the workshop participants shared during Exercise 1 (see Table 1) demonstrated their expanding awareness of the consequences of low HL. Access to health information was a key issue in group discussions. Four interlinked ideas emerged: (1) how HL influences whether or how clients understand health information; (2) the importance of listening to clients; (3) the necessity of professionals producing simple, clear health information; and (4) the need for professionals to delve below the superficial presentation of health information.

Evocative objects inspired various ideas. A bottle of nail polish, for example, evoked society's standards for women's health, nail care, body image, the cost of manicures and being at times forced to choose between paying for food and beauty products; a baby bottle evoked the risk of milk contamination from poor-quality plastic as well as infants' poor oral hygiene; a can of tuna evoked reading difficulties due to the small font on cans and misinterpretation of nutritional information. (For other examples, see Table 3.)

Participants' reflections on health literacy and experiences with disease

The participants reflected on how poorly clients with low HL understand the probability, a concept that is often used in explaining diagnostic and prognostic information. Lack of health educational material responsive to HL issues and help in decoding health information aggravates the effect of clients' low numerical literacy. As a result, clients prefer less stress-provoking health information, for example, that the probability of *not* developing cancer is 95% rather than that there is a 5% probability of developing cancer. Numerical literacy is needed to interpret health information that, for example, requires clients to keep track of the fats, carbohydrates and calories in their diet. The participants also pointed out that clients need technological and computer literacy to handle medical machines and electronic medical supplies.

Some participants noted that their francophone clients strategically navigate health information in their second language by using medical jargon to disguise their lack of ability to decode English-language health information. Their ability to use medical jargon would protect them from professionals questioning their understanding of health information. Other participants reflected on the difficulties faced by francophone immigrants to Ontario who may not be able to read and write in French. They may also be unable to use the telephone system to seek urgent medical help or to access primary health care services. Being less familiar than non-immigrants with the concept of preventing disease as it is applied in Canada, they may misunderstand disease-prevention initiatives. The participants suggested that the HL issues could be addressed by switching from disease-prevention health information that focuses on the probability of developing diseases to health-promotion information that focuses on ways to stay healthy.

TABLE 3
Ideas generated by evocative objects used in the "Place Health Literacy at the Core of your Practice" workshop exercises

Conceptual categories	Evocative object	Ideas flowing from objects
Expanded knowledge	Pacifier	"Remove their [clients'] pacifiers…information can pass through…when clients are different…we remove them [pacifiers]…so we can understand." (Ottawa participant)
	Bart Simpson's "No Problem" lunchbox	"Clients come with their 'no problemo' but are sick…all of their baggage in the box… it'll fill itself as we help to explain what the person has." (Toronto participant)
Changes in professional practice	Bonsai tree	"We look for information…roots in the ground…try to make the trunk…must reignite one's awareness constantly…make something good…using the ancient with the new." (Sudbury participant)
	Microphone	"We're not listening enough to our clients…we talk too much…we must learn their needs to have an impact…we must listen." (Toronto participant)
Changes in attitudes	Octopus	"Multidimensional aspect…adapting oneself to all kinds of people…more arms, more chances to reconnect one's message." (Ottawa participant)
	Pink princess shoe	"Cultural aspect to health literacy…necessary to adapt one's message to cultures." (Toronto participant)

Note: This table presents examples of thoughts from different participants' perspectives. The information in the table is not intended to indicate consensual meaning of the evocative objects.

Organizational barriers to incorporating health literacy in practice

During Exercise 2, the participants shared stories that revealed both the organizational barriers (e.g., necessarily fast pace of client consultations combined with professional usual use of medical jargon) and the ways they could apply HL in their practice. The participants agreed that professional language needs to be appropriate to the organizational setting and the literacy levels of clients and that communication styles need to be adapted to clients' cultures and literacy levels. The participants considered medical jargon in particular as a cause of inhibiting adherence, compliance and self-management as well as a barrier to clients using their own words to describe their symptoms. One participant remarked,

> …because, if ever a doctor or any health professional, you try to explain to someone, as she said, the concept [it] took four hours [for us] to understand. And you try explaining it to [a client] in two minutes using very technical terms. [Sudbury participant]

The participants discussed the importance of talking to their clients in their first language. For example, some senior clients grew up speaking French at home and studying in both French and English and may prefer to speak French and read English. This discrepancy may be an issue in organizations that provide printed health information materials in only one language or that claim to provide bilingual services but verbally communicate only in English.

Better communication with clients was seen as a key strategy for improving the clinical and cultural appropriateness of professional efforts to enhance clients' HL. Some communication techniques (e.g. speaking slowly, repeating information and using simpler sentences) were defined as crucial to sustaining health knowledge among those clients who were unable to access services in French.

The participants also considered the organizational structure and culture within the health care system, particularly the lack of time and flexibility, as limiting the application of HL in professional practice. Specifically, there is not always enough time to explain concepts and address clients' nonverbal cues and complex social contexts. A Sudbury participant explained, ''We find that it is very, very important to listen carefully to the language that people use—the verbal, the nonverbal—watch for little signs, how they speak. We should also find ways to increase our knowledge of our clientele.'' Another (Ottawa) participant suggested addressing time constraints by developing plans with clients and other professionals to change approaches to health information, care and service provision: ''We need to anticipate and plan and take time with clients because we said that we are often limited. [For example,] if you go to your family doctor, you have eight minutes only.''

Although the participants thought about ways to incorporate HL at individual and community-practice levels, they perceived fewer opportunities to do so at the organizational level, possibly because of budgetary constraints and decision makers' priorities. The feedback forms indicated a gain in 3 kinds of awareness about HL: as a concept, as a social determinant of health and as an individual, community and organizational support to improve health. Many participants wanted more workshops and opportunities to share knowledge with other professionals so as to expand their knowledge about and competencies in HL. Some requested in-service education on how to better reflect francophone cultural diversity in health and social services:

> We need workshops that include cultural competencies. It is a big problem for those in our community, because the francophone community is very large. People come from all over, but they come with cultural differences. [Toronto participant]

Analysis of evaluation study findings

Freire's[29] and Ekebergh's[47] common ideas about learning about one's world and one's place in it through conscious self-reflection were the key inspirations for the analysis and interpretation of the workshop evaluation data. Both Freire and Ekebergh claim that distancing oneself from everyday experiences and critically reflecting on one's reality heightens critical consciousness. The workshop participants reflected on their experiential knowledge of francophone Canadians' struggles to access health information and services in French, and how HL influences both. The evocative objects that the facilitator gave to each participant and which prompted discussions about personal and professional experiences sparked these reflections. The participants discussed how delivery of health information affects clients' understanding and how clients apply health information to their self-care and self-management of their diseases. Our analysis of workshop evaluation data revealed three phenomena: (1) participants' broadened vision of HL, (2) changes in participants' attitudes to HL, and (3) pondering changes in professional practice.

Participants' broadened vision of health literacy

The workshop participants valued their experiential knowledge and new knowledge equally. They also shared an understanding of power relations among professionals and between professionals and clients. The participants developed their vision of HL from its physical and mental dimensions to broader social and political dimensions. As they began to empathize with the experiences of low health literate clients, they acknowledged the stigma associated with poor comprehension of health information and the difficulty of making health decisions without understanding medical jargon or treatment options and consequences. In addition, clients can react emotionally and psychosocially when medical jargon is used to convey information to them, which can interfere with their understanding and ability to adhere to instructions and make decisions.[48] Sharing ideas and experiences allowed the participants to become aware of how HL intersects with other social determinants of health and how these influence access to health and social services.[48] This broadened vision of HL, rooted in decoding the world and reflecting on it, may help to further promote it:[49,50]

> This workshop has allowed me to understand the concept, the notion of health literacy, and has brought me to connect it to the other social aspects. [I understand that] literacy also embraces the cultural background and social constructions relating to disease and health care. [Ottawa participant]

Changes in participants' attitudes to health literacy

The group discussions revealed that the participants' attitudes to HL changed as a result of the workshop. Participants recognized that low HL among francophone clients was, in fact, a systemic problem that extended beyond the lack of availability of services in French and that important legal, ethical and administrative issues should be recognized and discussed in all social and health agencies that serve their clientele. The participants affirmed their intention to advocate for clients' rights to services and health information in French and to identify language-based service inequities. These intentions came from the better understanding of challenges that low health literate clients face with regard to all levels of care. In identifying barriers to client decision-making (e.g. lack of information, predictive skills, ability to understand risk), participants acknowledged their share of the responsibility to educate and support clients with respect to disease prevention and management while recognizing the influence of HL on clients' understanding:

> I understand that the issue is larger than I thought, that it extends beyond reading and that it can be harmful to the health of individuals. [Toronto participant]

Self-reflection provoked more awareness (see Tables 3 and 4) of clients' right to services and health information in French within participants' own professional contexts and elsewhere. As difficult as they found it to recall professional knowledge prompted by the evocative objects, they realized the efficacy of these simple and playful objects in challenging their awareness. The objects evoked analogies and metaphors rich in meaning. As a result of this increased awareness about difficulties in communication, the participants identified time constraints, limited budgets, professional jargon, complex written materials and high service demands as ongoing challenges to client-centered care. Lack of time to fully explain concepts and treatment regimens was considered the main barrier to effective health communication. A greater awareness of the HL challenges faced by linguistic minorities motivated the participants to change their practice to incorporate plain language and allocate more time for listening to their clients.

Pondering changes in professional practice

The workshop gave the participants opportunities to brainstorm about tools, competencies and strategies for promoting HL in their practice. Their disciplinary and cultural diversity may have enhanced the strength and validity of the strategies suggested as many were based on experience. Developing strategies and identifying tools demonstrated the participants' mastery of new resources for learning about and promoting HL. For example, community organizations are now using Twitter to promote HL and reinforce clients' understanding of basic health information. In addition, government agencies are giving more attention to cultural diversity in their Twitter-posted messages.[51]

The participants were able to call on their experiences as francophone professionals to critically evaluate research evidence related to HL and translate it in ways relevant to their practice. They even used their learning about HL to suggest new strategies that could improve services (see Table 5). Targeted scientific evidence should be considered when developing innovative interventions for low health literate people.[52] Particular attention should be paid to clients' preferred means of communication (e.g. photo-novellas, videos). An approach that targeted clients' cultural preferences for health communication proved to be effective in reaching Canadian immigrants with asthma.[53]

The organizational environment that the participants described inadequately supports HL interventions; therefore, changes in professional practice require increased access to material and professional resources as organizational support, as recommended by DeWalt et al.[54] Primary health care organizations should adopt quality improvement programs to implement HL interventions, ''[…] promote services in French and promote health literacy, therefore develop this sensitivity and cultural competence, make it possible for staff to go on training, focus on the clients and find out what they need.'' [Ottawa participant]

Anticipated changes in practice were expressed in plans of action because the participants realized they possessed the experiential knowledge needed to promote and bring about such changes. By mastering the learning process they experienced, the participants may be able to replicate it with their clientele. Their own experience of decoding the potential meanings in each evocative object put them in a position similar to that of a client attempting to decode health information, thus raising their awareness of clients' struggles. This decoding, a primary aspect of HL, may influence how participants redesign their approach to educating clients in preventing and managing injuries and chronic diseases. The workshop awakened the participants' awareness of HL among linguistic-minority francophones and mobilized them to want to change their professional practice (see Table 5) as well as advocate for organizational change.

Discussion

Our literature review found no studies that reported on using evocative objects to have professionals reflect on learners' cultural worlds and lived experiences.[31]

TABLE 4
''Place Health Literacy at the Core of your Practice'' workshop participants' thoughts on health literacy

Expanded knowledge about HL	Changed attitudes toward HL	Anticipated changes in professional practice to incorporate HL
Interpreted blocks in clients' decision making caused by lack of information, analytical and predictive skills Understanding importance of using simple language in communications with clients	Acknowledging that communication with francophone clients may require a more individual, slower pace Acknowledging that a critical way of teaching is necessary, one that respects clients' willingness and ability to comprehend and safely apply health information Intending to transmit health-related information in ways that respect clients' cultural diversity	Mastering new resources for self-learning about HL Acquiring instrumental knowledge to change communication approaches Envisioning new strategies to mobilize francophone communities and improve their HL Planning to enhance professional–client communication through two-way listening

Abbreviation: HL, health literacy.

TABLE 5
Recommendations for incorporating health literacy into practice

Target population	Workshop[a] participants' and authors' recommendations
Professionals	Make clientele aware of the concept of HL
	Network to encourage dialogue among community practitioners about HL
	Share information to increase collective awareness of available HL resources and possible interventions
Managers	Foster organizational change to support professionals in adapting to their clients' new social realities and in identifying HL needs at individual, community, and organizational levels
	Create organizational vision to address HL issues in linguistic minorities
Researchers	Design innovative methodologies to study emergent social issues interlinked with HL, using expertise of professionals in direct contact with clientele
	Identify organizational barriers to incorporating HL in professional practice
	Explore opportunities to involve clients in decision-making and organizational change
	Design participatory action research that includes those who organize and deliver health and social services, as well as clients, in francophone minority communities
	Evaluate long-term impacts of similar workshops
Educators	Strategize to demystify abstract, complex concepts for professionals
	Create communication tools to link theory and practice
	Help professionals gain understanding, through participatory learning, of theory underlying practice
	Promote activities to enhance knowledge about barriers to accessing information about health and social services at client, professional, organizational, and system levels
	Offer similar workshops with francophone postsecondary students in health and social sciences, giving them skills to advocate for better access to services for francophone linguistic minority

Abbreviation: HL, health literacy.

[a] Placing Health Literacy at the Core of Your Practice.

Most studies of participatory-learning methods for training health care professionals do not provide details about the pedagogical theories and philosophies that underpin their methods. As a result, it is difficult to compare our findings with those of other studies. However, the literature does identify some learning strategies such as group discussion and interaction and role playing.[55] Some studies also report on multidisciplinary community-services training that aims to integrate professional communication and collaboration among students in the health sciences and social services.[56] Despite that the importance of language proficiency in clients' fully benefiting from health care and social services is recognized, this issue has been inadequately examined in the context of professional training. One example is a study by Sullivan et al[30] of a series of 4 workshops to build professionals' capacity to communicate with a multilingual clientele where the main method used was group discussion. Another study applied Freire's educational principles through theatre, stories and pictures[57] to educate community health workers about community organization and mobilization.[58] Overall, the lack of information in several studies on workshop development does not allow further discussion of the appropriateness of other educational approaches to in-service education.

The findings of our evaluation study corroborate existing literature on systemic barriers faced by francophone professionals in responding to health and social conditions within francophone linguistic-minority populations.[59] In short, few organizations have mandates or formal mechanisms to directly address HL in their services.[60] For most social service and health organizations, providing services (if any) for francophones remains the responsibility of anglophone stakeholders and decision makers.[61] Health care professionals may assume that clients understand their advice because few clients request services in French.[61] However, improving clients' HL education alone cannot eliminate communication barriers[62] if professionals are not also educated[63] in promoting the HL of linguistic minorities.

The workshop participants identified strategies to improve how they would disseminate health information. First, they suggested diversifying their pedagogy by using audio-visual materials, particularly for seniors. Second, they highlighted the importance of building stronger relationships with their clients and improving oral communication. Third, the participants considered HL to be a public health issue because it affects clients' ability to understand risks, manage their health conditions and engage in preventative and screening behaviours. This insight corroborates other research that argues that HL and general literacy, including the ability to understand risk and probability, are required to participate in public health initiatives.[7] The participants emphasized the need for plain language communication, which is recommended best practice.[40,62,64] Although they acknowledged the need for improved communication and education materials, the majority of participants realized that collaborating with clients to develop solutions was unfeasible within the constraints of their work environment and the operations.

Fourth, the participants suggested in-service education to improve professionals' competency at addressing HL in their practices. As their competency improves, professionals may be more inclined to make sure that their clients understand health information and may be more likely to tailor education materials to low-literacy clients.[65]

Finally, the participants learned that HL acts synergistically with language (including accents) and culture (including health beliefs, age, immigration status, social support, education and socioeconomic status). As a result, they identified a need for in-service education on cultural competencies and delivery of culturally relevant services that would promote professionals' involvement in developing, delivering and evaluating services.[66]

Equally necessary is cross-cultural health-communication education for health educators and consumers alike.[67] However, confirming the findings of Herndon et al.[24] participants disclosed that lack of time was a major organizational barrier to promoting HL.

Continuing to build awareness of HL matters if we are to increase professionals' ability to support their clients' HL.[63] All health care professionals, including physicians and medical students, need more HL education.[63] Nurses and nursing students, who typically teach clients but are less likely than physicians to assess clients' HL,[68] need to be trained in simple ways to assess HL in primary health care.[19,69] Since clients' HL can hardly be improved with continued use of printed health information in languages they have difficulty reading, non-print formats should be considered for low-literacy clients.[55,70]

Study limitations

Our evaluation study has several limitations. First, organizational requirements to deliver bilingual services and the professional development goals set by the workshop participants themselves may have motivated them to attend the workshop. Second, we documented only the perspective of service providers, not of clients or directors of health and social services organizations. Third, impacts of the workshop were self-reported on feedback forms collected immediately after the workshop, a format vulnerable to enthusiastic reactions that may be subsequently tempered by reflection on the usefulness of the work.

There were also several potential biases in the study. First, the participants self-identified as francophone professionals working with Franco-Ontarians, a situation that potentially sensitized them to the problems associated with HL. Second, the participants all worked in organizations mandated to serve francophones, which may have led to a sense of professional obligation to become aware of HL issues as lived by their francophone clients. Third, the researchers who worked with the verbatim transcripts were non-native French speakers, which could have led to some misinterpretations of participants' accounts. To counteract this potential problem, native French speakers transcribed the audio-recordings and francophone researchers attended the workshop and participated in data analysis. A francophone cultural insider confirmed the final interpretation of findings.

Conclusion

Our workshop participants expressed their awakened awareness of HL as a collective accountability. By stating that they were all responsible for changing their work environments and their individual and collective practice, the participants affirmed the appropriateness of Freire's[29] critical-pedagogy approach for the workshop. The collective accountability also corroborates our claim that critical pedagogy applied to in-service education effectively stimulates professionals' awareness of their potential to change their practice and work environments and to make social change. Professional development programs should support critical learning and offer meaningful tools for addressing the growing complexity of HL in multicultural and multilingual societies. These meaningful tools are ones that should make sense to professional learners. Freire[71] advises that what we use to teach be meaningful for learners. Moreover, he describes an activity that is fundamentally formative for educators: critical reflection on their current practice and their visions for the future.[71] This reflection should address educators' dreams, innovative ideas and objectives, all of which reveal the political roots of their educational undertaking. In the process of promoting HL, francophone professionals and their clients share the same social reality: living as a linguistic minority. Nevertheless, they may be unaware of the political import of this minority status for their own lives. Therefore, our use of Freire's critical-pedagogy approach was appropriate for promoting learners' autonomy in critiquing their social reality. It is their linguistic-minority status that guided our choice of philosophical approach, rather than empirical evidence from studies, which are often conducted with populations living in different cultural and linguistic settings.

Our findings may be transferable to other Canadian linguistic minorities and to organizations that provide them with health and social service policy development and to countries that lack second- or multiple-language policies.

Ontario health and social service professionals have developed expertise in working in multicultural contexts. As a result, our findings may be useful in similar practice contexts and in understanding how language, access to health and social services and other social determinants of health affect the health of linguistic minorities, including immigrants' health.[72] The findings could inform health education initiatives for immigrant groups with low French or English proficiency. As well, evocative objects could be an appealing method for teaching other population groups such as those at risk of injury (for example, youth in seasonal sports) and for stimulating professionals to design appropriate ways to promote health in chronic disease populations.

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References

1. Barrett SE, Puryear JS. Health literacy: improving quality of care in primary care settings. J Health Care Poor Underserved. 2006;17(4):690-7.

2. Gazmararian JA, Williams MV, Peel J, Baker DW. Health literacy and knowledge of chronic disease. Patient Educ Couns. 2003;51:267-75.

3. Cronin M, Connolly C. Exploring the use of experiential learning workshops and reflective practice within professional practice development for post-graduate health promotion students. Health Educ J. 2007;66(3): 286-303.

4. de Barros D, Barbieri AR, Ivo ML, et al. O contexto da formação dos agentes comunitários de saúde no Brasil. [The context of education of community health agents in Brazil]. Texto & Contexto Enfermagem. 2010;19(1):78-84 (Portuguese).

5. Chávez V, Turalba RA, Malik S. Teaching public health through a pedagogy of collegiality. Am J Public Health. 2006;96(7): 1175-80.

6. Rootman I, Gordon-El-Bihbety D, Frankish J, et al. National literacy and health research program: needs assessment and environmental scan. Ottawa (ON): Canadian Public Health Association; 2003.

7. Kaszap M, Zanchetta MS. La littératie en santé, vécue dans la simplicité mais comprise à travers la complexité : regard sur les communautés culturelles (francophones, minoritaires et multiethniques). In: Masny D, ed. Les littératies multiples : lire au 21e siècle. Ottawa: Les Presses de l'Université d'Ottawa; 2009. pp. 287-325.

8. Forgues É, Landry R. Définitions de la francophonie en situation minoritaire : analyse de différentes définitions statistiques et de leurs conséquences. Ottawa (ON): Consortium National de Formation en Santé; 2006.

9. Bouchard L, Gaboury I, Chomienne M-H, Gilbert A, Dubois L. Health in language minority situation. Healthc Policy. 2009;4: 36-42.

10. Deveau K, Landry R, Allard R. Au-delà de l'autodéfinition. Composantes distinctes de l'identité ethnolinguistique. Francophonies d'Amérique. 2005;20:79-93.

11. Office of Francophone Affairs. Profile de la communauté francophone de l'Ontario 2009 [Internet]. Toronto (ON): Office of Francophone Affairs – The Ontario Trillium Foundation; 2009 [cited 2012 Mar 10]. Available at: http://docs.files.ontario.ca/documents/410/profil-des-francophones.pdf

12. Corbeil J, Lafrenière S. Portrait of official-language minorities in Canada: Francophones in Ontario. Ottawa (ON): Statistics Canada; 2010 [Statistics Canada, Catalogue No.: 89642X].

13. Canadian Council on Learning. La littératie en santé au Canada: une question de bien-être [Internet]. Ottawa (ON): Canadian Council on Learning; 2008 Feb 20 [cited 2009 Nov 29]. Available at: http://www.ccl-cca.ca/CCL/Reports/HealthLiteracy-2.html

14. Rootman I, El-Bihbety D. A vision for a health literate Canada: report of the expert panel on health literacy. Ottawa (ON): Canadian Public Health Association; 2008.

15. Papen U. Adult literacy as social practice: more than skills. New York (NY): Routledge; 2005.

16. Schonlau M, Martin L, Haas A, Derose KP, Rudd R. Patients' literacy skills: more than just reading ability. J Health Commun. 2011;16(10):1046-54.

17. St. Clair R. Why literacy matters – understanding the effects of literacy education for adults. Leicester (UK): National Institute of Adult Continuing Education; 2010.

18. Bouchard L, Desmeules M. Minorités de langue officielle du Canada. Québec: Presses de l'Université du Québec; 2011.

19. Berkman ND, Davis TC, McCormack L. Health literacy: what is it? J Health Commun. 2010;15(Suppl.2):9-19.

20. Howard DH, Sentell T, Gazmararian JA. Impact of health literacy on socioeconomic and racial differences in health in an elderly population. J Gen Intern Med. 2006;21(8): 857-61.

21. Zanchetta MS, Poureslami IM. Health literacy within the reality of immigrants' culture and language. Can J Public Health. 2006;97(Suppl.2):S26-30.

22. Canadian Council on Learning. State of learning in Canada: no time for complacency. Ottawa (ON): Canadian Council on Learning; 2007.

23. Baker DW. The meaning and the measure of health literacy. J Gen Intern Med. 2006;21(8):878-83.

24. Herndon JB, Chaney M, Carden D. Health literacy and emergency department outcomes: a systematic review. Ann Emerg Med. 2011;57(4):334-45.

25. Perlow E. Accessibility: global gateway to health literacy. Health Promot Pract. 2010;11(1):123-31.

26. Paasche-Orlow MK, Schillinger D, Greene SM, Wagner EH. How health care systems can begin to address the challenge of limited literacy. J Gen Intern Med. 2006;21(8):884-7.

27. Volandes AE, Paasche-Orlow MK. Health literacy, health inequality and a just healthcare system. Am J Bioeth. 2007;7(11):5-10.

28. Rudd RE, Rosenfeld L, Simonds VW. Health literacy: a new area of research with links to communication. Atl J Commun. 2012;20(1): 16-30.

29. Freire P. Education for critical consciousness. New York (NY): Continuum; 1973.

30. Sullivan MF, Ferguson W, Haley HL, et al. Expert communication training for providers in community health centers. J Health Care Poor Underserved. 2011;22(4):1358-68.

31. Wallerstein N, Bernstein E. Empowerment education: Freire's ideas adapted to health education. Health Educ Q. 1988;5:379-94.

32. Wallerstein N. Powerlessness, empowerment, and health: implications for health promotion programs. Am J Health Promotion. 1992;6:197-205.

33. Freire P. Pedagogy of hope: reliving the pedagogy of the oppressed. New York (NY): Continuum; 2003.

34. Freire P. Educação como prática da liberdade [Education as practice of freedom]. 23rd ed. Rio de Janeiro (BR): Paz e Terra; 1999 (Portuguese).

35. Freire P. Educação e mudança [Education and change]. 23rd ed. Rio de Janeiro: Paz e Terra; 1999 (Portuguese).

36. Freire P. Ação cultural para a liberdade e outros escritos [Cultural action for freedom and other writings]. 10th ed. São Paulo: Paz e Terra; 2002 (Portuguese).

37. Racine L. Applying Antonio Gramsci's philosophy to postcolonial feminist social and political activism in nursing. Nurs Philos. 2009;10(3):180-90.

38. Schwandt TA. Constructivist, interpretivist approaches to human inquiry. In: Denzin NK, Lincoln YS, eds. Handbook of qualitative research. 1st ed. Thousand Oaks: Sage; 1994. pp. 118-37.

39. Tobin K, Tippins D. Constructivism as a referent for teaching and learning. In: Tobin K, ed. The practice of constructivism in science education. Hillsdale: Lawrence Erlbaum; 1993. pp. 3-22.

40. Canadian Council on Learning. Health literacy in Canada: a healthy understanding. Ottawa (ON): Canadian Council on Learning; 2008.

41. Picard L, Allaire G. Deuxième rapport sur la santé des francophones de l'Ontario [Internet]. Sudbury (ON): Institute franco-ontarien, University Laurentienne; 2005 [cited 2008 Aug 10]. Available at: http://www.sdhu.com/uploads/content/listings/rapport_sante_jan06.pdf

42. Freire P. Conscientização. Teoria e prática da libertação- Uma introdução ao pensamento de Paulo Freire [Conscientization: Theory and practice of liberation. An introduction to Paulo Freire's thoughts]. São Paulo: Centauro; 2001 (Portuguese).

43. Rossi PH, Lipsey MW, Freeman HE. Evaluation: a systematic approach. 7th ed. Thousand Oaks: Sage; 2004.

44. Bardin L. L'analyse de contenu. 2nd ed. Paris (FR): Quadrige/Presses Universitaires de France; 2007.

45. Sandelowski M. The call to experts in qualitative research. Res Nurs Health. 1998;21(5):467-71.

46. Canadian Council on Learning. Health literacy in Canada [interactive map of health literacy]. Ontario [Internet]. Ottawa (ON): Canadian Council on Learning; 2003 [cited 2008, Oct, 10]. Available at: http://www.ccl-cca.ca/cclflash/healthliteracy/map_canada_e.html

47. Ekebergh M. Lifeworld-based reflection and learning: a contribution to the reflective practice in nursing and nursing education. Reflective Practice. 2007;8(3):331-43.

48. Roter DL. Oral literacy demand of health care communication: challenges and solutions. Nurs Outlook. 2011;59(2):79-84.

49. Zanchetta M, Kaszap M, Mohamed M, et al. Construction of Francophone families' health literacy in a linguistic-minority situation. Alterstice: Revue International de la Recherche Interculturelle. 2012;2(2):47-62.

50. Wink J. Critical pedagogy: notes from the real world. 4th ed. Saddle River; 2011.

51. Park H, Rodgers S, Stemmie J. Analyzing health organizations' use of Twitter for promoting health literacy. J Health Commun. 2013;18(4):410-25.

52. Sheridan SL, Halpern DJ, Viera AJ, Berkman ND, Donahue KE, Crotty K. Interventions for individuals with low health literacy: a systematic review. J Health Commun. 2011;16(Suppl.3):30-54.

53. Poureslami I, Rootman I, Doyle-Waters MM, Nimmon L, Fitzgerald JM. Health literacy, language, and ethnicity-related factors in newcomer asthma patients to Canada: a qualitative study. J Immigr Minor Health. 2011;13(2):315-22.

54. DeWalt DA, Broucksou KA, Hawk V, et al. Developing and testing the health literacy universal precautions toolkit. Nurs Outlook. 2011;59(2):85-94.

55. Hershberger PJ, Righter EL, Zryd TW, Little DR, Whitecar PS. Implementation of a process-oriented cultural proficiency curriculum. J Health Care Poor Underserved. 2008;19(2):478-83.

56. Nandiwada DR, Dang-Vu C. Transdisciplinary health care education: training team players. J Health Care Poor Underserved. 2010;21(1):26-34.

57. Porr CJ, Mayan M, Graffigna G, Wall S, Vieira, ER. The evocative power of projective techniques for the elicitation of meaning. Int J Qual Meth. 2011;10(1):30-41.

58. Perez M, Findley SE, Mejia M, Martinez J. The impact of community health worker training and programs in NYC. J Health Care Poor Underserved. 2006;17(1 Suppl):26-43.

59. Langille D, Rainham D, Kisely S. Is francophone language status associated with differences in the health services use of rural Nova Scotians? Can J Public Health. 2012;103(1):65-8.

60. Canadian Public Health Association. Perceptions of health literacy: results of a questionnaire for practitioners, policy-makers and researchers. Ottawa (ON): Canadian Public Health Association; 2007 Jan [cited 2010 May 7]. Available at: http://www.cpha.ca/uploads/portals/h-l/questionnaire_e.pdf

61. Commissariat aux services en français de l'Ontario. Rapport annuel 2010-2011: un engagement partagé [Internet]. Toronto (ON): Commissariat aux services en français de l'Ontario; 2011 [cited 2012 Jun 5]. Available at: http://www.csf.gouv.on.ca/fr/rapport-annuel-2010-2011-un-engagement-partage

62. Sudore RL, Landefeld CS, Pérez-Stable EJ, Bibbins-Domingo K, Williams BA, Schillinger D. Unraveling the relationship between literacy, language proficiency, and patient-physician communication. Patient Educ Couns. 2009;75(3):398-402.

63. Coleman C. Teaching health care professionals about health literacy: a review of the literature. Nurs Outlook. 2011;59(2):70-8.

64. Herndon JB, Chaney M, Carden D. Health literacy and emergency department outcomes: a systematic review. Ann Emerg Med. 2011;57(4):334-45.

65. Schlichting JA, Quinn MT, Heuer LJ, Schaefer CT, Drum ML, Chin MH. Provider perceptions of limited health literacy in community health centers. Patient Educ Couns. 2007;69(1-3):114-20.

66. Gillis D, Quigley A. Antigonish, N. S.: Taking off the blindfold: seeing how literacy affects health. Antigonish (NS): St. Frances Xavier University; 2004 Jun [cited 2008 Mar 10]. Available at: http://www.nald.ca/library/research/takngoff/takngoff.pdf

67. Kreps GL, Sparks L. Meeting the health literacy needs of immigrant populations. Patient Educ Couns. 2008;71(3):328-32.

68. Macabasco-O'Connell A, Fry-Bowers EK. Knowledge and perceptions of health literacy among nursing professionals. J Health Commun. 2011;16(Suppl.3):295-307.

69. Weiss BD, Mays MZ, Martz W, et al. Quick assessment of literacy in primary care: the newest vital sign. Ann Fam Med. 2005;3(6):514-22.

70. Hasnain-Wynia R, Wolf MS. Promoting health care equity: is health literacy a missing link? Health Serv Res. 2010;45(4):897-903.

71. Freire P. Pedagogia da autonomia–Saberes necessários à prática educativa [Pedagogy of autonomy–Necessary knowledge for educational practice]. 43rd ed. São Paulo (BR): Paz e Terra; 2011 (Portuguese).

72. De Maio FG. Understanding the health transitions of immigrants to Canada: research priorities. J Health Care Poor Underserved. 2012;23(3):958-62.

Self-reported health behaviour change in adults: analysis of the Canadian Community Health Survey 4.1

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Abstract

Introduction: Knowledge of Canadians' experiences in making health behaviour changes (HBCs) in general, and among those at risk due to body mass index (BMI), would help inform health promotion / disease prevention programs. Selected self-reported HBCs in the past 12 months by BMI category were examined in this secondary analysis of the Canadian Community Health Survey 4.1. These HBCs included increased sports/exercise, weight loss and improved eating habits. Barriers to HBC were also examined.

Methods: Descriptive analyses and forward stepwise logistic regression were completed on data from respondents 18 years and older. Self-reported BMI was corrected by the method of Connor Gorber et al. (2008).

Results: Our final sample was n = 111 449. Overall, 58% of respondents had made an HBC, with increased sports/exercise as the most important HBC in 29% of the sample, followed by improved eating habits (10%) and weight loss (7%). Half (51%) experienced barriers to HBC; lack of will power was most commonly cited, followed by work and family responsibilities. Obese respondents reported HBC more frequently than normal-weight respondents (60% vs. 55%), but the prevalence of increased sports/exercise and improved eating habits was similar across BMI categories. Regression models accounted for only 6%–10% of the total variance.

Conclusion: That a majority of respondents had made at least one HBC bodes well for positively shifting population health. Additional work to further characterize the population, and to improve on population indicators, is needed to assess the impact of health promotion/disease prevention efforts. These findings provide important first population benchmarks for future work.

Keywords: *health behaviour, obesity, weight loss, diet, physical activity, population characteristics*

Introduction

With the development of the Canadian Community Health Survey (CCHS) in 2000 and the Canadian Health Measures Survey in 2009, health planners have improved their capacity to reliably assess the effects of health promotion / disease prevention efforts on the health of Canadians.[1] Among many health issues, the rise in obesity is of particular interest as an intermediate risk factor for common chronic diseases.

Prevalence of overweight is currently 34.2% and of obesity is 26% among adults aged 18 to 79 years.[2] Diet and physical activity are primary lifestyle factors that influence obesity prevalence. To date, cross-sectional health surveys have provided limited information on the prevalence of physical activity and consumption of fruits and vegetables (as an indicator of a healthy diet). A review of the summary 2009–2012 CCHS tables shows that 56.2% of Canadians aged 12 years and older engage in enough leisure time activity to be considered at least moderately active (≥ 1.5 kcal/kg/day).[2] Activity prevalence is stable; however, the percentage of Canadians consuming fruits and vegetables 5 or more times per day has decreased from 45.6% in 2009 to 40.6% in 2012.[3]

Information on population prevalence of self-reported health behaviour change (HBC) to improve diet, physical activity and body weight—the main barriers to change—and the associated sociodemographic characteristics could both inform the development of new initiatives and provide population-based data to evaluate the longer-term success of public health approaches[4,5] An opportunity to examine the prevalence of HBC became available in the CCHS Cycle 4.1 (2007) along with information on associated demographic and health variables and barriers to change.[6] The goals of this secondary analysis were to (1) examine the prevalence of self-reported HBC among adults in general and by body mass index (BMI) category, (2) determine the sociodemographic factors associated with HBC and (3) examine the prevalence of barriers to HBC by BMI category.

Methods

The CCHS Cycle 4.1 was a national, cross-sectional survey of self-reported information on health status, health care utilization and health determinants including

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HBC.[6] Data were collected from respondents in all provinces and territories, and the results are representative of 98% of the Canadian population. Further details on the survey are available online.[6]

BMI was calculated and classified according to national standards for weight classification.[7] The bias in self-reported BMI, where people underestimate their weight and overestimate their height, is well-recognized.[8] Since self-reported height and weight were used in this study, we applied previously established correction equations to the BMI estimates of overweight and obese adults but not of normal-weight adults due to the smaller reporting bias in this group.[9]

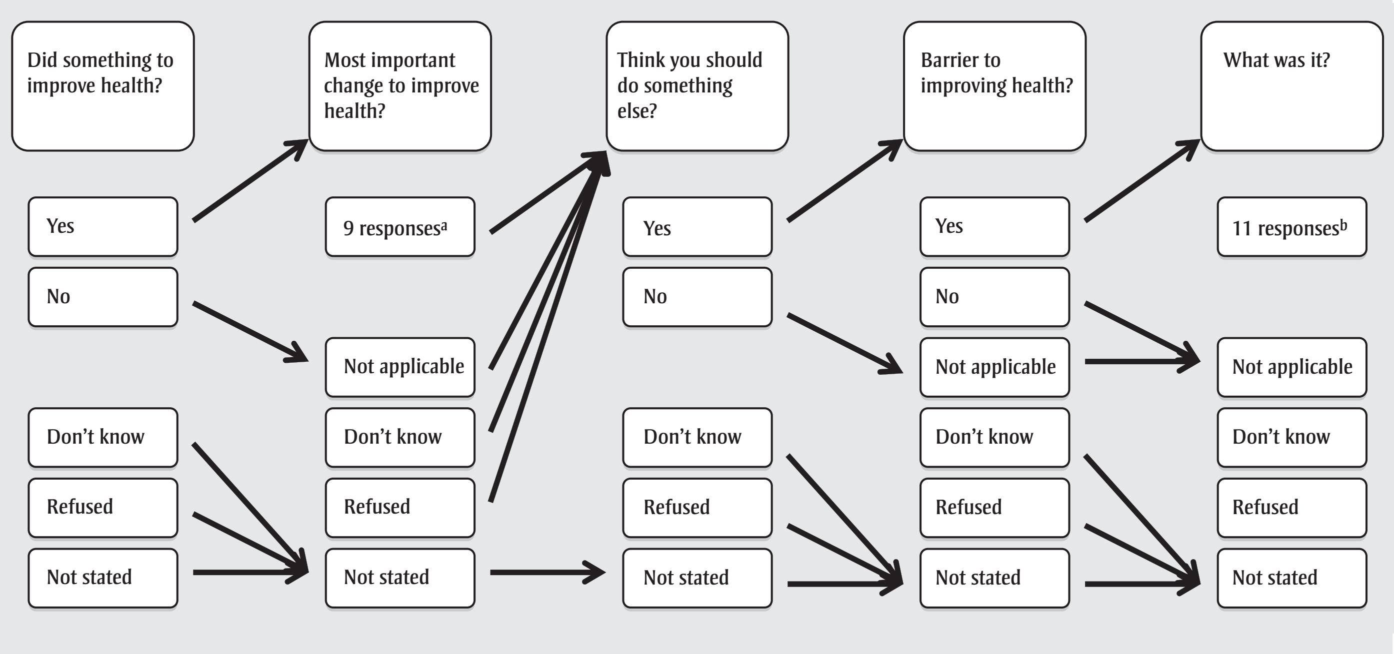
This analysis was limited to non-pregnant respondents 18 years and older who responded themselves (not by proxy) and had a BMI between 18.5 kg/m^2 and 55.0 kg/m^2 prior to correction for self-report bias. Respondents in the extreme ends of the BMI range were excluded as they face unique health challenges with respect to their body weight.

Self-reported HBC in the past year (Yes/No) was the main outcome of interest. Respondents were also asked to identify the single most important HBC made in the past year (see Figure 1 for question flow pattern). Options for types of self-reported HBC included increased sports/exercise, lost weight, improved eating habits, quit/reduced amount smoked, drank less alcohol, reduced stress level, received medical treatment, took vitamins, and undisclosed ''other.'' If a respondent used multiple HBCs simultaneously, he or she had to select the single most important change.

Respondents who indicated they felt they should do something to improve their health were asked to identify barriers to HBC and allowed to select multiple barriers. Options for barriers to HBC included lack of willpower, work schedule, family responsibilities, disability, physical condition, too stressed, too costly, problems with the weather, addiction to drugs/alcohol, not available in area, transportation problems and undisclosed ″other.″ Willpower was the colloquial term used for perceived behavioural control, which is considered an overarching, superordinate construct, consisting of 2 lower-level components, self-efficacy and controllability.[10,11]

We ran descriptive statistics (using SPSS version 19.0 [IBM Corp., Armonk, NY, US]) to determine the demographic characteristics and prevalence of HBC among normal-weight, overweight and obese respondents. When the chi-square indicated a difference in proportions, these were compared using a z-test (assuming central limit approximation applies) and adjusted for multiple comparisons using the Bonferroni adjustment. Continuous variables were examined by analysis of variance with posthoc comparison of means by Tamhane's T2, not assuming equal sample sizes or variances. Data were weighted using supplied sampling weights.[12] A subset analysis was then performed on respondents who did or did not undertake HBC and experienced barriers. Those who did not feel they needed to make additional HBCs (Figure 1) were excluded from this analysis.

FIGURE 1
Questionnaire flow diagram: health behaviour change module



[a] Responses include increased sports/exercise, lost weight, improved eating habits, quit/reduced amount smoked, drank less alcohol, reduced stress level, received medical treatment, took vitamins, and other.

[b] Responses include lack of will power, work schedule, too costly, too stressed, disability, family responsibilities, addiction to drugs or alcohol, physical condition, not available in area, transportation problems, weather problems, and other.

We used forward stepwise logistic regression to determine the variables associated with HBC in order of influence while controlling for age, sex, education and personal income. The initial regression models generated included all available variables in the CCHS that had been previously associated with weight change and physical activity in a preliminary literature review. The variables were age and sex, sociodemographic characteristics, education, income, immigration status, general health, self-reported height and weight, chronic conditions, medication use, changes made to improve health, food security, physical activity index, sedentary activity, social support and job stress. After reviewing for conceptual overlap, temporal issues and multicollinearity, we retained the most influential predictors. We created an initial regression model for HBC overall; based on those results, we then generated individual models predicting each specific HBC. Separate models were initially run for each BMI category; however, due to similarities between the models, all BMI categories were collapsed into a single grouping and BMI was included as a continuous predictor variable in the model. Model fit was assessed using Nagelkerke R^2 and the Hosmer–Lemeshow test. As the models explained little variance, no bootstrapping was conducted.

Results

Of the final sample (n = 111 449), 27% (n = 30 442) of respondents were obese, 29% (n = 31 831) overweight and 44% (n = 49 176) normal weight. See selected sociodemographic variables in Table 1.

Overall, 58% (n =64 035) of respondents said they did something to improve their health (Table 2). Increased sports/exercise was the most popular HBC among all respondents (29%; n = 31 936), followed by improved eating habits (10%) and weight loss (7%). All other HBC changes (13%) included quit/reduced smoking, drank less alcohol, reduced stress level, received medical treatment, took vitamins, and other. A higher percentage of obese respondents (60%) than normal-weight respondents (55%) did something to improve their health.

Two-thirds (68%; n = 75 717) of all respondents felt they should be doing more to improve their health. Of these, 51% (n = 38 193) met with one or more barriers to HBC (see Table 2), with lack of willpower the most commonly cited barrier (34%), followed by work schedule (28%) and family responsibilities (15%). All other barriers were reported by less than 10% of respondents. Among those who experienced barriers to HBC, obese respondents were significantly more likely than normal-weight respondents to cite lack of willpower, disability or a physical condition as a barrier to health change ($p < .05$ for all). Normal-weight respondents were significantly more likely than obese respondents to cite work, family responsibilities and cost as barriers to improving health ($p < .05$ for all) (see Figure 2).

We performed a subset analysis to determine differences in the prevalence of barriers among those who did and did not report having made a HBC. Family responsibility was a statistically significantly greater barrier ($p < .001$) among those who did not make an HBC (16%) than among those who did (15%), but this difference was small. Cost was a significantly greater barrier ($p < .001$) among those who made an HBC (6%) than those who did not (4%), but cost was not a prevalent barrier. Differences between HBC and non-HBC groups in the prevalence of barriers related to lack of willpower, work schedule, disability or physical condition were not significant.

Initial logistic regression models showed that BMI, opinion of own weight, fruit and vegetable consumption, number of consultations with medical doctor, smoking status and self-perceived general health were all important variables associated with any HBC. A significant age by smoking status interaction effect was found for all models. All models had limited power to account for the variance. The increased sports/exercise model had a Nagelkerke R^2 of 0.07, indicating a low level of variance explained by the model; the Hosmer–Lemeshow test was significant at $p = .001$, indicating a poor model fit. The model for weight loss

TABLE 1
Basic demographic characteristics by BMI classification, ≥ 18 years old, Canada, CCHS 2007

Variable	Obese n = 30 442	Overweight n = 31 831	Normal Weight n = 49 176
Male sex,[a] %	53.5	61.0	43.3
Mean (SD) age,[b] years	48.7 (15.6)	48.5 (16.4)	43.7 (17.6)
Mean (SD) BMI,[a] kg/m^2	34.3 (4.4)	27.9 (1.1)	22.4 (1.7)
Post-secondary graduate,[a] %	55.5	59.9	60.8
Mean (SD) total personal income,[a] $	41 904.9 (40 181.8)	44 135.8 (43 876.6)	37 176.5 (37 545.7)
Urban dwellers,[a] %	78.2	80.7	84.3
Canada born,[a] %	81.8	75.5	73.7
Aboriginal identity,[c] %	4.2	2.9	2.7
Caucasian,[a] %	90.0	85.2	80.5
Never smoked,[a] %	32.5	34.6	38.6
Daily consumption of fruits and vegetables < 5/day,[a] %	61.0	57.9	54.3
Opinion of own weight: overweight,[a] %	86.6	53.3	14.4
Excellent or very good self-perceived general health,[a] %	45.1	59.9	65.6
Mean (SD) number of consultations with medical doctor in past year,[c] n	4.6 (7.5)	3.7 (6.9)	3.5 (6.1)

Abbreviations: BMI, body mass index; CCHS, Canadian Community Health Survey; SD, standard deviation.

[a] Each subset of BMI classification categories differ significantly from each other at the .05 level by z-test comparison of pairs of categories. Data are adjusted for multiple comparisons by Bonferroni adjustment.

[b] Normal weight category differs significantly from other categories at the .05 level by z-test comparison of pairs of categories. Data are adjusted for multiple comparisons by Bonferroni adjustment.

[c] Obese weight category differs significantly from other categories at the .05 level by z-test comparison of pairs of categories. Data are adjusted for multiple comparisons by Bonferroni adjustment.

TABLE 2
Prevalence of health behaviour change characteristics by BMI, ≥ 18 years old, Canada, CCHS 2007

Variable	BMI classification			
	Obese n = 30 442 (%)	Overweight n = 31 831 (%)	Normal weight n = 49 176 (%)	Whole group n = 111 449 (%)
Did something to improve health				
Yes[a]	18 314 (60.2)	18 607 (58.5)	27 114 (55.2)	64 035 (57.5)
No[a]	12 092 (39.8)	13 190 (41.5)	22 006 (44.8)	47 288 (42.5)
Don't know/refused	36	35	55	126
Most significant HBC				
Not applicable[a]	12 092 (39.8)	13 190 (41.5)	22 007 (44.9)	47 289 (42.5)
Increased sports/exercise[b]	7898 (26.0)	9460 (29.8)	14 578 (29.7)	31 936 (28.7)
Lost weight[a]	3121 (10.3)	2315 (7.3)	1910 (3.9)	7346 (6.6)
Improved eating habits[a]	3156 (10.4)	3087 (9.7)	4502 (9.2)	10 745 (9.7)
Other[a,c]	4113 (13.5)	3708 (11.7)	6069 (12.3)	13 890 (12.5)
Don't know/refused	25	37	55	117
Not stated	36	34	56	126
Thinks should do something else				
Yes[a]	23 405 (77.5)	21 399 (67.7)	30 913 (63.2)	75 717 (68.4)
No[a]	6801 (22.5)	10 227 (23.3)	17 989 (36.8)	35 017 (31.6)
Don't know/refused	201	172	219	589
Not stated	36	34	56	126
Have barrier to improving health				
Yes[a]	11 885 (50.9)	10 269 (48.1)	16 039 (52.0)	38 193 (50.6)
No[a]	11 452 (49.1)	11 079 (51.9)	14 790 (48.0)	37 321 (49.4)
N/A	6801	10 227	17 989	35 017
Don't know/refused	67	51	84	201
Not stated	236	206	274	717

Abbreviations: BMI, body mass index; CCHS, Canadian Community Health Survey; HBC, health behaviour change.

[a] Each subset of BMI classification categories whose column proportions differed significantly from each other at the .05 level by z-test comparison of pairs of categories. Data are adjusted for multiple comparisons by Bonferroni adjustment.

[b] Obese category differed significantly from other categories at the .05 level by z-test comparison of pairs of categories. Data are adjusted for multiple comparisons by Bonferroni adjustment.

[c] Other includes: Quit smoking/reduced amount smoked, drank less alcohol, reduced stress level, received medical treatment, took vitamins and undisclosed other.

had a Nagelkerke R^2 of 0.10, though the Hosmer–Lemeshow test was non-significant (p = .12), indicating a good fit to the data. Similarly, the model for improved eating habits had a Nagelkerke R^2 of 0.06, with a non-significant Hosmer–Lemeshow test (p = .09).

Daily smoking was inversely associated with increased sports/exercise (odds ratio [OR] = 0.66; confidence interval [CI] = 0.63–0.70), while opinion of own weight status in the overweight range as well as of higher fruit and vegetable intake were positively associated with increased exercise (see Table 3). For the model for weight loss, opinion of own weight, BMI and increased fruits and vegetable intake were positively associated with weight loss, while smoking and self-perceived general health were not. Finally, for the model predicting improved eating habits, daily smoking was inversely associated, while opinion of weight, BMI and higher fruit and vegetable intake were also positively associated with improved eating habits, and no variables were excluded from the model.

Discussion

The fact that nearly 60% of adults reported making an HBC in the past 12 months was striking and suggests that many Canadians are both concerned about their health and willing to make positive changes. Similarly, the fact that two-thirds felt they should be doing more to improve their health suggests widespread concern. Since this was a new set of questions to be asked nationally (they had been asked in a subset in CCHS 3.1), it will be some years before comparative data will be available, either for longitudinal comparison or cross-sectionally with other surveys.

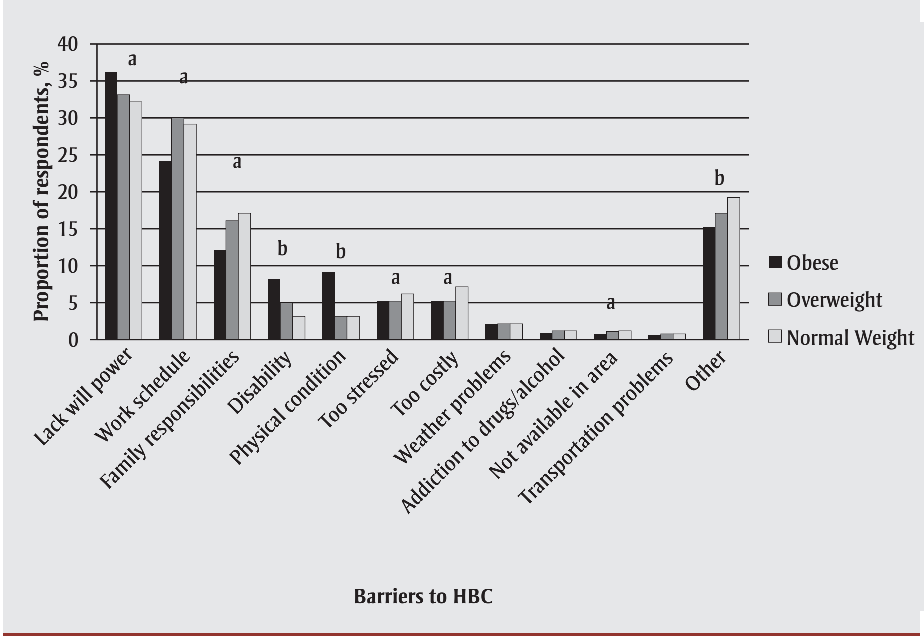
The focus on identifying the most important HBC was novel and provides new information, in contrast to other population studies that assessed a range of HBCs.[13,14] Increased sports/exercise was reported nearly 3 times as often as the next most reported HBC of improved eating habits (29% vs. 10%, respectively). This result runs counter to some other studies that have suggested that changes in physical activity may be more difficult than changes in diet among those who are overweight.[15]

Variation among studies is considerable. Newson et al.[16] looked at HBC after a chronic disease diagnosis in the National Population Health Survey cohort. Among the group who developed diabetes, who are generally advised by health care practitioners to both increase exercise and improve diet,[17] the percentage who were physically active and consumed 5 or more servings of fruits and vegetables increased by 7%; only 35 out of 487 adopted both behaviours. In contrast, among those who developed heart disease, the percentage meeting physical activity guidelines increased only 2% (from 51.6% to 53.9%), compared with an increase of 9% (from 42% to 51%) for meeting fruit and vegetable intake guidelines. Reasons for the differences are uncertain, but older subjects were less likely to make changes.[16]

Review of the exploratory logistic regression results in our study also hint at differences by health behaviour and health subgroups in the population. Various forms of cluster analysis could help further characterize groups in the population who are more likely to adopt different lifestyle changes. Overall, the high prevalence of

FIGURE 2

Comparison of reasons for experiencing barriers to health behaviour change across BMI categories



Abbreviations: BMI, body mass index; HBC, health behaviour change.

[a] Normal weight and obese BMI groups differ significantly at $p < .05$.

[b] All BMI groups differ significantly at $p < .05$.

self-reported increased exercise was encouraging.

An a priori focus of this work was to assess the overall prevalence of the main HBC associated with body weight management (diet, exercise, weight loss), comparing respondents categorized by BMI levels that have been previously established for their relationship to mortality risk (normal, overweight and obese). It was notable that weight loss as the primary HBC was relatively rare (10% of obese respondents), in line with a large body of evidence showing that weight loss is challenging. Such population-based data are important because the majority of weight loss attempts occur outside of the health care system and are not tracked in any way. While no details were asked of CCHS respondents, in a study using data from the National Health and Nutrition Examination Survey (NHANES) 1999–2004 and limited to respondents with central obesity and cardiovascular disease, 15% reported losing 5% or more of body weight.[18] A much higher percentage (38%) of obese respondents who completed an in-person interview during the 2001–2006 NHANES reported losing 5% or more of body weight.[19] Similarly, 35% of obese adults who completed the Counterweight Programme weight loss program in primary care lost 5% or more of body weight,[20] but half dropped out before completing the one-year follow-up. Additional more detailed population-based surveys are needed to determine the percentage and characteristics of Canadians who can achieve clinically relevant weight loss.

Compared with those who were normal weight, the majority of overweight and obese respondents undertook more HBC of all types and said they wanted to do more to improve their health. They also chose increased exercise as the most important HBC, as did normal-weight respondents. Given the positive health benefits of exercise for people of all weights, these results suggest a greater emphasis on exercise in health promotion efforts would be well received. Current health promotion that speaks of achieving ‘‘a healthy weight’’ could be highly discouraging to overweight and obese people, given how challenging it is to lose weight. A positive message based on exercise would be more consistent with population preferences and with emerging evidence that the physically and metabolically fit obese have decreased mortality risk of cardiovascular disease compared with the unfit.[21,22]

Assessment of prevalence of barriers was unique to the CCHS; other large surveys assessing similar concepts were not found. Half of the relevant respondents did not report any barriers to HBC. Among those who did report barriers, lack of willpower (as expected) was the most commonly cited, followed by work schedule and family responsibilities.

Willpower includes the concepts of self-efficacy and controllability, key foci of much of the health behaviour literature, as evidenced by such seminal texts as *Health Behavior and Health Education*, first published in 1990, which provided the first overview of all the major theories at that time.[23] Since then, the importance of environmental and social context in affecting individual behaviour has been increasingly recognized. Lack of time is one such barrier to HBC commonly cited in the literature.[24,25,26] Lack of time was not listed as an option in the CCHS; however, as work and family responsibilities are time-intensive tasks that reduce the time available to undertake HBC, it may be inferred that these tasks describe similar barriers. Considering overall barriers by BMI, obese respondents reported a similar prevalence of barriers as normal-weight respondents (51% vs. 52%), but the types of barriers differed somewhat, with disability and lack of willpower being more common but work and family responsibilities being less common among obese respondents. Overall, however, transportation, cost, stress and lack of availability were not endorsed as common barriers by the majority of Canadians. Such population-based data on prevalence of key barriers to HBC has implications for the design of new approaches.

Our logistic regression modelling was exploratory and aimed at identifying possible associations beyond the obvious differences by age, gender, income and education. The association between BMI and HBC has been previously observed: Verheijden et al.[27] found that obese respondents were more likely than normal-weight respondents to continue to

TABLE 3
Summary of health behaviour change regression models, ≥ 18 years old, Canada, CCHS 2007

	Increased sports/exercise		Lost weight		Improved eating habits	
	OR	95% CI	OR	95% CI	OR	95% CI
BMI (per unit increase)	—	—	1.06	1.05–1.07	1.02	1.01–1.02
Smoking status						
Never[a]	—	—	—	—	—	—
Daily	0.66	0.63–0.70	—	—	0.72	0.66–0.77
Occasional (former daily)	1.04	0.94–1.16	—	—	0.99	0.85–1.16
Always occasional	1.18	1.04–1.34	—	—	0.88	0.72–1.08
Former daily	1.13	1.08–1.19	—	—	1.14	1.06–1.22
Former occasional	1.08	1.02–1.14	—	—	1.22	1.13–1.32
Opinion of own weight[b]						
About right[a]	—	—	—	—	—	—
Overweight	1.27	1.23–1.32	1.79	1.66–1.94	1.26	1.18–1.34
Underweight	1.04	0.94–1.15	0.93	0.73–1.19	0.90	0.77–1.06
Fruit and vegetable intake[c]						
< 5 times/day[a]	—	—	—	—	—	—
5–10/day	1.28	1.23–1.33	1.42	1.33–1.52	1.45	1.37–1.53
> 10 times/day	1.33	1.22–1.45	1.55	1.34–1.81	1.86	1.65–2.08
Number of consultations with doctor[d]	1.01	1.01–1.01	1.02	1.02–1.02	1.01	1.01–1.02
Self-perceived general health[e]						
Excellent[a]	—	—	—	—	—	—
Poor/Fair	1.01	0.94–1.09	—	—	1.52	1.36–1.69
Good	1.12	1.06–1.18	—	—	1.45	1.34–1.57
Very Good	1.17	1.12–1.23	—	—	1.37	1.27–1.47

Abbreviations: BMI, body mass index; CCHS, Canadian Community Health Survey; CI, confidence interval; HBC, health behaviour change; OR, odds ratio.

[a] Referent category.

[b] This variable classifies the respondent by their self-reported opinion of their own weight.

[c] This variable classifies the respondent by the total number of times per day he/she eats fruits and vegetables, based on a food frequency recall.

[d] This variable indicates the number of times respondents have seen or talked to a family doctor or specialist in the last 12 months.

[e] This variable indicates the respondent's health status based on his/her own judgement.

participate in an HBC-promotion program, while Teixeria et al.[28] found a positive correlation between BMI and weight loss.

Smoking has often been inversely associated with HBC.[27,29,30] Higher fruit and vegetable intake has been consistently associated with better health in many epidemiological studies, so it was not surprising that people who already ate more fruits and vegetables were also more likely to make HBCs. Perception of overweight status and general health, as well as greater number of consultations with physicians were all associated with undertaking HBC, as observed in previous studies.[31] Better characterization of the subgroups who undertake HBC is needed to guide health promotion efforts. Each of these variables should be considered in more detail; they may be indirect indicators of lifestyle or other factors, which may in turn be associated with HBC. Further research is required to fully understand these relationships.

Only one previous study has examined HBC in the CCHS 4.1; Hystad and Carpiano's[32] results for overall prevalence of HBC confirmed ours. Sense of belonging in the community was the focus of their work. In our analysis, sense of belonging was included as a possible predictor in the initial regression models. Though statistically significant, sense of belonging in the community was strongly overshadowed by other variables and accounted for very little unique variance in the model. As a result, we removed it from the final model for the sake of parsimony.

Strengths and limitations

Strengths of this study include (1) a baseline estimate of the prevalence of the most important HBC activities and (2) the barriers to change by BMI category at the population level in Canada. Over time, it will be possible to better assess outcomes of health promotion efforts at the population level.

There are also significant limitations. While the HBC measures in the CCHS 4.1 provided important new information, we could not find published assessments of reliability or of the various types of validity of the questions in Statistics Canada documentation or in peer-reviewed literature. It was stated that expert advice was sought on measures;[12] thus, the current measures are a starting point. However, the conceptualization of losing weight versus exercise versus diet change as separate HBCs need more development and validation for population surveys because changes to improve both diet and physical activity are typically required to change body weight. Such work is urgently needed since surveillance of population HBC would be a potentially valuable addition to current tools used for assessing HBC. The relative merits of reporting on the most important HBC, as done in this study, versus multiple concurrent HBCs is also unknown. Similarly, further work is needed to assess the reliability and validity of self-reports of barriers to change.

Categorization of obesity status by BMI was another limitation of this and other population health surveys as it has become increasingly clear that BMI alone may be an inadequate indicator of health or mortality risk. Various strategies will be needed to address this issue, including more subsample approaches.[19,20]

Conclusion

This analysis of self-reported HBCs and barriers in the CCHS 4.1 revealed a high prevalence of HBC overall, and especially of increased exercise by a substantial minority of adults. While we were particularly interested in possible differences by obesity status, this analysis indicated the obese are very similar to the normal weight in reported HBCs. The regression analyses also identified other factors that may help further characterize the population. Further methodological development of the methods for assessing HBCs and barriers in the population are needed, but the current study has provided new information that can inform development of future HBC strategies.

References

1. Health Council of Canada. Stepping it up: moving the focus from health care in Canada to a healthier Canada. Toronto (ON): Health Council of Canada; 2010.
2. Statistics Canada. Canadian Health Measures Survey: Cycle 2 Data Tables 2009 to 2011. Ottawa (ON): Government of Canada; 2012.
3. Statistics Canada summary tables: tables by subject [Internet]. Ottawa (ON): Government of Canada; [cited 2013 Oct 3]. Available from: http://www.statcan.gc.ca/tables-tableaux/sum-som/l01/ind01/l3_2966_2968-eng.htm?hili_health77
4. Plotnikoff RC, Lippke S, Johnson ST, Hugo K, Rodgers W, Spence JC. Awareness of Canada's Physical Activity Guide to Healthy Active Living in a large community sample. Am J Health Promot. 2011;25:294-7.
5. Garcia AC, Piche LA. Perceptions and use of Canada's Food Guide to Healthy Eating by grocery shoppers in London, Ontario. Can J Diet Pract Res. 2001;62:123-7.
6. Statistics Canada. Canadian Community Health Survey – Annual Component (CCHS). Detailed information for 2007 (Cycle 4.1) [Internet]. Ottawa (ON): Government of Canada; [modified 2008 Jun 17; cited 2013 Oct 3]. Available from: http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SurvId=50653&InstaId=29539&SDDS=3226
7. Health Canada. Canadian guidelines for body weight classification in adults. Ottawa (ON): Health Canada Publications Centre; 2003.
8. Gorber SC, Tremblay MS. The bias in self-reported obesity from 1976 to 2005: a Canada-US comparison. Obesity. 2010;18(2):354-61.
9. Gorber SC, Shields M, Tremblay MS, McDowell I. The feasibility of establishing correction factors to adjust self-reported estimates of obesity. Health Rep. 2008;19(3):71-82.
10. Ajzen I. Perceived behavioral control, self-efficacy, locus of control, and the theory of planned behavior. J Appl Social Psychol. 2002;32(4):665-83.
11. Strecher VJ, DeVellis BM, Becker MH, Rosenstock IM. The role of self-efficacy in achieving health behavior change. Health Educ Q. 1986;13(1):73-92.
12. Statistics Canada. Canadian Community Health Survey (CCHS). 2007 Microdata Files User Guide; June 2008 Ottawa (ON): Government of Canada; [cited 2013 Oct 3]. Available from: http://www23.statcan.gc.ca/imdb-bmdi/document/3226_D7_T9_V4-eng.pdf
13. Prochaska JJ, Spring B, Nigg CR. Multiple health behavior change research: an introduction and overview. Prev Med. 2008;46(3):181-8.
14. Lippke S, Nigg CR, Maddock JE. Health-promoting and health-risk behaviors: theory-driven analyses of multiple health behavior change in three international samples. Int J Behav Med. 2012;19(1):1-13.
15. Bish CL, Blanck HM, Maynard LM, Serdula MK, Thompson NJ, Khan LK. Activity/participation limitation and weight loss among overweight and obese US adults: 1999 to 2002 NHANES. MedGenMed. 2007;9(3):63.
16. Newson JT, Huguet N, Ramage-Morin PL, et al. Health behaviour changes after diagnosis of chronic illness among Canadians aged 50 or older. Health Rep. 2012;23(4):49-53.
17. Canadian Diabetes Association Clinical Practice Guidelines Expert Committee. Canadian Diabetes Association 2013 Clinical Practice Guidelines for the Prevention and Management of Diabetes in Canada. Can J Diabetes. 2013;37(suppl 1):S1-S212.
18. Singh S, Somers VK, Clark MM, et al. Physician diagnosis of overweight status predicts attempted and successful weight loss in patients with cardiovascular disease and central obesity. Am Heart J. 2010;160(5):934-42.
19. Nicklas JM, Huskey KW, Davis RB, Wee CC. Successful weight loss among obese U.S. adults. Am J Prev Med. 2012;42(5):481-5.
20. Counterweight Project Team. The implementation of the Counterweight Programme in Scotland, UK. Fam Pract. 2012;29(Suppl 1):i139-44.
21. Hamer M, Stamatakis E. Metabolically healthy obesity and risk of all-cause and cardiovascular disease mortality. J Clin Endocrinol Metab. 2012;97(7):2482-8.
22. Ortega FB, Lee DC, Katzmarzyk PT, et al. The intriguing metabolically healthy but obese phenotype: cardiovascular prognosis and role of fitness. Eur Heart J. 2013;34(5):389-97.
23. Glanz K, Lewis FM, Rimer BK, editors. Health behavior and health education: theory, research and practice. San Francisco (CA): Jossey-Bass; 1990.
24. Ruelaz AR, Diefenbach P, Simon B, Lanto A, Arterburn D, Shekelle PG. Perceived barriers to weight management in primary care--perspectives of patients and providers. J Gen Intern Med. 2007;22(4):518-22.
25. Mauro M, Taylor V, Wharton S, Sharma AM. Barriers to obesity treatment. Eur J Intern Med. 2008;19(3):173-80.
26. Welch N, McNaughton SA, Hunter W, Hume C, Crawford D. Is the perception of time pressure a barrier to healthy eating and physical activity among women? Public Health Nutr. 2009;12(7):888-95.
27. Verheijden MW, Jans MP, Hildebrandt VH, Hopman-Rock M. Rates and determinants of repeated participation in a web-based behavior change program for healthy body weight and healthy lifestyle. J Med Internet Res. 2007;9(1):e1.

28. Teixeria PJ, Going SB, Sardinha LB, Lohman TG. A review of psychosocial pre-treatment predictors of weight control. Obesity Rev. 2005;6(1):43-65.

29. Van Horn L, Dolecek TA, Grandits GA, Skweres L. Adherence to dietary recommendations in the special intervention group in the Multiple Risk Factor Intervention Trial. Am J Clin Nutr. 1997;65(1 Suppl):289S-304S.

30. Stubbs J, Whybrow S, Teixeira P, et al. Problems in identifying predictors and correlates of weight loss and maintenance: implications for weight control therapies based on behaviour change. Obes Rev. 2011;12(9):688-708.

31. Yaemsiri S, Slining MM, Agarwal SK. Perceived weight status, overweight diagnosis, and weight control among US adults: The NHANES 2003-2008 study. Int J Obes. 2011;35(8):1063-70.

32. Hystad P, Carpiano RM. Sense of community-belonging and health-behaviour change in Canada. J Epidemiol Community Health. 2012;66(3):277-83.

Agreement between survey data and Régie de l'assurance maladie du Québec (RAMQ) data with respect to the diagnosis of asthma and medical services use for asthma in children

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Abstract

Introduction: The goal of this study was to assess the agreement between the results of a respiratory health survey conducted in Montréal on children aged 6 months to 12 years and the Régie de l'assurance maladie du Québec (RAMQ, Quebec health insurance board) database in terms of the diagnosis of asthma and medical services use. A secondary aim was to evaluate the effect of the survey method used (Internet-based survey or telephone survey).

Methods: We assessed whether a diagnosis of asthma was made for 7922 children. In addition, we compared the use of medical services for asthma (emergency department visits and hospitalizations) in the 12 months preceding the survey for the 402 children considered to have asthma, using 2 groups of respiratory diagnoses and 2 data linkage periods. The agreement between the 2 data sources was evaluated using the kappa statistic (κ) and sensitivity and specificity, as well as percentages of agreement, over-reporting and under-reporting with respect to health services use.

Results: Moderate agreement was found between the 2 data sources (survey and RAMQ data) in terms of the diagnosis of asthma ($\kappa = 0.54$ and $\kappa = 0.60$ depending on the definition used). Specificity was high (93% and 96%), but sensitivity varied (50% and 65%). Respondents over-reported health services use, resulting in moderate kappa values (0.49 for emergency department visits and 0.48 for hospitalizations). However, when more diagnoses were included in the definition and when the linkage period was extended (15 rather than 12 months), the kappa values increased (0.59 for emergency department visits and 0.64 for hospitalizations) and sensitivity and specificity were high. Slightly higher agreement was obtained for the Internet-based survey relative to the telephone survey.

Conclusion: The findings validate the use of survey data with respect to the diagnosis of pediatric asthma and major health services use for this disease.

Keywords: *asthma, respiratory diseases, child, health survey, validation, administrative databases*

Introduction

Questionnaire-based or telephone interview surveys are often used to obtain information on population health and health services use, particularly for chronic diseases, for example, asthma. The validity of the information gathered in surveys of this type may, however, be called into question since the data may be affected by both non-directional error (date errors, failure to understand information provided by physician, etc.) and directional error (social desirability, errors in recall, etc.). Nevertheless, the validity of survey data on health services use and on diagnoses can be assessed by comparing them to administrative health services databases.

The purpose of this study was to evaluate the concordance between a survey conducted in Montréal, Quebec, and the Régie de l'assurance maladie du Québec (RAMQ) database with respect to the diagnosis of asthma and use of medical services for asthma in children. The medical services we investigated consisted of emergency department visits and hospitalizations (for asthma) in the previous 12 months. We also assessed the effect of the survey method (Internet-based or telephone survey) on agreement. Through this research we set out to confirm the suitability of using survey data for studies on asthma, particularly pediatric asthma, as well as for studies on other chronic diseases.

The literature reports varying levels of concordance between self-reported data and administrative data with respect to chronic diseases and associated symptoms. For example, Lix et al.[1] found a low level of agreement for irritable bowel syndrome. Martin et al.[2] and Robinson et al.[3] reported high levels of agreement (along with high sensitivity and specificity) for hypertension

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and diabetes and lower levels of agreement for hypercholesterolemia. Kriegsman et al.[4] reported agreement levels ranging from low for various forms of arthritis and atherosclerosis to high for diabetes in a sample of community-based senior patients. Boyer et al.[5] found significant discrepancies between patient recall and medical records for symptoms of a form of arthritis. In effect, using survey data could lead to under- or overestimating the prevalence of chronic diseases.[4,5,6] In general, self-report data and administrative data showed better agreement for chronic diseases requiring repeated use of medical services (e.g. diabetes) and lower agreement for hard-to-diagnose diseases.[6,7]

Lix et al.[1] found moderate agreement between self-reported data and administrative data, depending on which definition of asthma was used. Similarly, a Manitoba-based study conducted by Huzel et al.[8] found moderate agreement between the prevalence (in the previous 12 months) of self-reported symptoms of asthma in adults and the data in an administrative database. A Colorado-based study of several chronic diseases found good concordance between patient survey data and medical records for asthma.[9]

In a British Columbia study, Palin et al.[10] found that individuals tend to overestimate the number of their mental health visits to health professionals. In contrast, an earlier Quebec study indicated that psychiatric patients' self-reports about health services use were generally consistent with the administrative data.[11] Tisnado et al.[9] found varying levels of agreement for a range of chronic diseases, including asthma, with respect to health services use.

Previous research comparing survey and administrative data focused on the health status of the respondents themselves. To our knowledge, none of the studies used guardians' survey responses about their children in such comparisons.

Methods

Description of survey

Data were from a cross-sectional epidemiological survey of the respiratory health of nearly 8000 residents of the Island of Montréal, Quebec, aged 6 months to 12 years.[12] The goal of the epidemiological study was to identify the factors associated with the distribution of respiratory diseases (specifically asthma, allergic rhinitis and respiratory infections) in children in order to guide preventive actions and health care decisions.[12] Participants were selected from a random list of 17 661 families obtained from RAMQ. The questionnaire was designed by drawing on a literature review on the determinants of these diseases in children and questionnaires from other studies.[13,14,15] The data were collected in 2006 using a mixed-mode survey methodology: telephone and Internet. The overall response rate was estimated to be 60%. The final sample consisted of 7964 subjects.

Definition of survey variables for comparison purposes

To confirm diagnosis of asthma, we used an affirmative answer to the survey question ''Has a doctor ever said that your child has asthma?'' The questions about the use of medical services for asthma concerned only a sub-sample of children in the survey since only those guardians who answered ''yes'' to the first question as well as to the question ''Has your child had one or more asthma attacks in the last 12 months?'' were required to fill out the corresponding part of the survey. We created 2 variables related to medical services use based on the answers to 2 subsequent survey questions—one concerning emergency department visits (''In the last 12 months, did your child have to go to emergency because of asthma?'') and another concerning hospitalizations (''In the last 12 months, did your child have to be hospitalized for at least one night because of asthma?''). Another subquestion in the survey focused on the exact number of visits. When the respondent answered ''yes'' to the main question but ''I don't know'' to the question about the number of visits, we assigned a value of ''1'' (this occurred in 3 cases for emergency visits but none for hospitalizations).

RAMQ data

In Quebec, health care is covered by the provincial health insurance board, RAMQ. For every consultation with a patient, the physician submits a billing claim to RAMQ using a specific procedure code and a diagnostic code. As a result, RAMQ data include almost all health services provided, with the exception of unbilled private health care and health care provided by physicians who are not paid on a fee-for-service basis. RAMQ provided us with information on the diagnosis, the date and place of consultation, and the physician's identification number and area of specialization for each consultation with the children in the survey (for the period from the child's birth date to the date on which the questionnaire was filled out). This information consisted of all respiratory diseases including pneumonia and bronchitis (ICD-9* codes: 460–519, 786.0, 786.2; ICD-10† codes: J00–J99, R06.0–R06.8, R05.0). The billing data were linked to medical procedures performed in a physician's office or in the emergency department or to a hospitalization. Children not registered with RAMQ were considered to never have been diagnosed with asthma.

The confidentiality of the individual-level data obtained from the health insurance board was guaranteed. Pairing of RAMQ data with survey data was authorized by the Commission d'accès à l'information du Québec.

Definition of RAMQ variables for comparison purposes

Diagnosis of asthma

Each child was assigned either negative or positive asthma status according to two

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* *International Classification of Diseases, 9th Revision*.

† *International Classification of Diseases, 10th Revision*.

definitions. Under the first definition, any child with at least one diagnosis of asthma (ICD-9 code 493; ICD-10 code J45) in the RAMQ database, whether made during a visit to a physician, during a visit to an emergency department or during a hospitalization, was considered to have asthma. If no diagnosis of asthma was made or if no visit took place, we considered the child as free of asthma. According to the second, more restrictive definition, the child had to have been diagnosed at least twice with asthma during his/her life in order to be identified as having asthma since physicians do not always mention this diagnosis to parents on the first visit.

Medical services use

We also used 2 definitions for emergency department visits and hospitalizations: a diagnosis of asthma or bronchiolitis, which can easily be confused with asthma in young children (ICD-9: 493 and 466; ICD-10: J45 and J21), and any respiratory diagnosis (ICD-9: 460–519, 786.0, 786.2 and ICD-10: J00–J99, R060, R06.8, R05.0). As the questions about emergency department visits and hospitalizations concerned the 12 months before the survey, the health service and hospitalization data extracted from the RAMQ database were from the same 12-month period. We also tested a slightly longer period, 15 months, in view of the difficulty respondents have in recalling the exact dates of consultations. Visits at doctors' offices were not retained for comparison purposes.

Linkage of the two data sources

We used different samples to compare asthma diagnoses and medical services use. For the asthma diagnosis, the data from the 2 paired sources included 7922 children, as the data related to these questions were missing for 42 of the 7964 children. The sample used for the comparison of emergency department visits and hospitalizations consisted of 402 children, based on the answers to the sub-questions in the survey (see the ''Definition of survey variables for comparison purposes'' section above).

Statistical analyses

We used the kappa statistic[16] (κ) and computed the sensitivity and specificity to evaluate the agreement between the survey data and RAMQ data for the diagnosis of asthma and medical services use. We used the scale developed by Landis and Koch[17] to assess the degree of agreement obtained with the kappa statistic.

Unlike the kappa, which is a measure of agreement that does not take into account the validity of the 2 sources, calculating sensitivity and specificity requires that one of the 2 data sources be considered a gold standard. Sensitivity indicates the percentage of correctly identified positive elements (true positives), and specificity indicates the percentage of correctly identified negative elements (true negatives). The kappa value increases in conjunction with these 2 measures. We calculated specificity and sensitivity using the RAMQ database as the gold standard. Although this database may contain errors, we assumed it is more accurate than a survey. In a study comparing RAMQ administrative data with medical records, Wilchesky et al.[18] found high specificity but lower sensitivity for the administrative data. We take this limitation into account when applying the second definition of asthma status, that is, the one requiring 2 diagnoses in the RAMQ database.

For the number of emergency department visits and the number of hospitalizations, we also assessed concordance by comparing the proportion of under-reports, over-reports and perfect agreement as a function of the diagnosis considered (asthma or any type of respiratory diagnosis) and as a function of the pairing period (12 or 15 months). Using the z-test, we also compared the agreement values (kappa coefficients, sensitivity and specificity) for the online surveys and the telephone surveys.

Although the survey data were adjusted for the response rate by sub-area as well as for the children's age and sex, the analyses were conducted on unweighted data, since the latter are used to assess the real agreement between the 2 data sources.

Results

Table 1 shows the personal and socioeconomic characteristics of the children in the 2 samples used in the comparison of asthma diagnoses and the comparison of health services use (emergency department visits and hospitalizations). The 2 samples are reasonably similar in terms of these characteristics.

Diagnosis of asthma

Table 2 shows the extent of agreement between survey data and RAMQ data

TABLE 1
Characteristics of respiratory health survey children, age 6 months to 12 years, Island of Montréal, Quebec, 2006

Characteristics of study participants and their families	Total sample (for comparison of diagnosis) (N = 7922)	Sub-sample (for comparison of health services use) (n = 402)
Average age, years (SD)	7.2 (3.3)	7.6 (2.9)
Male sex, %	51	59
Annual family income, $[a]		
First quartile	25,000–34,999	25,000–34,999
Median	55,000–74,999	55,000–74,999
Third quartile	75,000–99,999	75,000–99,999
Highest level of education achieved		
High school, %	23.8	26.5
CEGEP or university, %	76.2	73.5

Abbreviation: SD, standard deviation.

[a] Family income is divided into 7 groups: < $15,000, $15,000–$24,999, $25,000–$34,999, $35,000–$54,999, $55,000–$74,999, $75,000–$99,999, ≥ $100,000.

TABLE 2
Comparison of self-report asthma data from respiratory health survey participants, age 6 months to 12 years, with data from the RAMQ database, Island of Montréal, Quebec, 2006

	Sample (N = 7922)			κ (95% CI)	Sensitivity (%) (95% CI)	Specificity (%) (95% CI)
	Survey,[a] n	RAMQ[b,c]	n			
Total sample (N = 7922)	1280	≥ 1 diagnosis	2152	0.54 (0.52–0.57)	50.4 (48.3–52.5)	96.6 (96.1–97.1)
		≥ 2 diagnoses	1330	0.60 (0.57–0.62)	65.2 (62.6–67.7)	93.7 (93.1–94.3)

Abbreviations: ICD-9, International Classification of Diseases, 9th Revision; ICD-10, International Classification of Diseases, 10th Revision; RAMQ, Régie de l'assurance maladie du Québec.

[a] Affirmative response to the question ''Has a doctor ever said that your child has asthma?''

[b] Diagnoses made during emergency department visits or in a physician's office, or during hospitalizations.

[c] ICD-9: 493; ICD-10: J45.

for the 2 definitions used for the diagnosis of asthma. Moderate agreement was obtained (κ = 0.54) for the first definition (1 diagnosis of asthma recorded in the RAMQ database) and higher agreement (κ = 0.60) for the second definition (2 diagnoses of asthma in the database).

The diagnosis of asthma based on survey data is highly specific (> 93%) but moderately sensitive (50%–65%), which indicates, in general, that children identified in the survey as not having asthma were accordingly classified in the RAMQ database, but a certain proportion of children with asthma were not identified in the survey. Both sensitivity and kappa values increase when there are 2 diagnoses in RAMQ data, whereas specificity is slightly reduced. Sensitivity was increased (to 54.9 for one diagnosis and 70.7 for 2 diagnoses) with the same specificity (96.5 and 93.5 respectively) by the exclusion in the study of children who were taking asthma medication but had no report of an asthma diagnosis in the survey (data not shown). The prevalence rates[‡] for asthma are very similar for the second definition: 16.2% (survey) and 16.8% (RAMQ data).

The results are almost the same when children aged less than 6 years were compared with children aged 6 years and over. However, with 2 diagnoses, the kappa value is slightly higher for the older group—which is to be expected since the diagnosis is more definite in older children—but this difference is not statistically significant (z-test at the 95% level; data not shown).

Emergency department visits and hospitalizations

The results of the analyses show that the number of emergency department visits and hospitalizations of children with asthma to be generally over-reported by guardians (Table 3). The survey data show 295 emergency department visits, whereas the RAMQ database records between 122 and 240 visits (depending on the period and the diagnoses considered). Agreement improved when a 15-month period was used or when the list of diagnoses was broadened to include all respiratory diagnoses in RAMQ data (versus diagnoses of asthma and bronchiolitis only). However, the number of visits reported by guardians in the survey was 18% higher than that recorded in the RAMQ database. For hospitalizations, there is a slight trend of over-reporting by the guardians, but the proportion of over-reporting is similar to that of under-reporting when all respiratory diagnoses and the 15-month period are considered (Table 3).

The kappa value for the occurrence of one or more emergency department visits (no visits versus one or more visits) ranged

TABLE 3
Comparison of the number of emergency department visits and hospitalizations in self-report survey data with RAMQ data for children who experienced an asthma attack, Island of Montréal, Quebec, 2006

Survey, n	RAMQ		Agreement, %	Under-reporting, %	Over-reporting, %
	Definition	n			
Emergency department visits					
295	Asthma or bronchiolitis[a,b]	122	69.9	3.7	26.4
	Any respiratory diagnosis[b,c]	155	74.6	3.7	21.6
	Asthma or bronchiolitis[a,d]	188	71.6	5.5	22.9
	Any respiratory diagnosis[c,d]	240	76.9	5.5	17.7
Hospitalizations					
63	Asthma or bronchiolitis[a,b]	18	91.5	0.3	8.2
	Any respiratory diagnosis[b,c]	26	90.8	2.7	6.5
	Asthma or bronchiolitis[a,d]	49	91.8	1.0	7.2
	Any respiratory diagnosis[c,d]	66	90.8	4.0	5.2

Abbreviations: ICD-9, International Classification of Diseases, 9th Revision; ICD-10, International Classification of Diseases, 10th Revision; RAMQ, Régie de l'assurance maladie du Québec.

[a] ICD-9: 493 and 466; ICD-10: J45 and J21.

[b] In the 12 months before the survey questionnaire.

[c] ICD-9: 460–519, 786.0, 786.2; ICD-10: J00–J99, R060, R06.8, R05.0.

[d] In the 15 months before the survey questionnaire.

[‡] These prevalence rates correspond to unweighted data and therefore do not reflect the real prevalence within the population of children living in Montréal.

from 0.49 to 0.59, which is indicative of moderate agreement between the 2 data sources (Table 4). Sensitivity and specificity were good. The kappa value for one or more hospitalizations (versus no hospitalizations) suggests moderate agreement for diagnoses of asthma or bronchiolitis in the 12 months before the survey (κ = 0.48) and a substantial level of agreement for any respiratory diagnosis in the previous 15 months (κ = 0.64) (Table 4). Sensitivity and specificity were high when considering one or more hospitalization for asthma or bronchiolitis in the previous 12 months (94.1 and 92.5). For both emergency department visits and hospitalizations, sensitivity was reduced while specificity was slightly increased by broadening the inclusion criteria in the RAMQ data (Table 4).

Comparison according to survey method

The kappa values for the diagnosis of asthma were higher for the Internet-based survey than for the telephone survey: 0.56 and 0.51, respectively, for the first definition (only one diagnosis in the RAMQ database), and 0.71 and 0.65, respectively, for the second definition (2 or more diagnoses in the administrative data) (data not shown). The difference is significant at the 95% level for the first definition only. Sensitivity was also slightly higher for the Internet-based survey compared with the telephone survey (52.6% versus 48.4% for the first definition, and 67% versus 63% for the second definition); however, these differences were not statistically significant at the 95% level. Specificity values and disease prevalence were similar for the 2 survey methods.

With regard to medical services use (emergency department visits and hospitalizations), sensitivity and specificity were similar for the 2 survey methods (non-significant differences at the 95% level) (data not shown). The kappa values likewise did not differ significantly. It should be noted, however, that the small sample size for medical services use resulted in wide confidence intervals for the estimates.

Discussion

The goal of our study was to validate the results of a survey of pediatric asthma conducted in Montréal, Quebec, among the guardians of children aged 6 months to 12 years against data in the RAMQ database with respect to the diagnosis of pediatric asthma. The 2 data sources were also compared in relation to number of emergency department visits and hospitalizations in the 12 months prior to the survey using a subpopulation of children with asthma.

Diagnosis of asthma

When comparing survey data and RAMQ data, moderate concordance (κ = 0.60) was found for the diagnosis of asthma when a definition requiring 2 diagnoses in the RAMQ database was used. If the RAMQ data are taken as the gold standard, specificity is high and sensitivity is moderate. Sensitivity was partly influenced by the exclusion in the study of children who were taking asthma medication but had no report of asthma diagnosis in the survey.

Some studies have found levels of agreement between self-report data and hospitalizations and billing claims in the administrative database for diagnoses of chronic diseases range from poor to good.[3,7,8] Other studies have found good agreement with medical record databases.[2,9] Kriegsman et al.[4] showed strong concordance between patient survey data and general practitioner questionnaires for the majority of chronic disease diagnoses. For asthma specifically, the findings of our study are similar to those of other published studies that relate to adults. As mentioned earlier, Lix et al.[1] found moderate agreement (estimated with the kappa statistic) between survey data and hospitalization and prescription billing data for chronic disease diagnoses. Huzel et al.[8]

TABLE 4

Comparison of the occurrence of one or more emergency department visits or one or more hospitalizations in survey data with RAMQ data for children who had an asthma attack, Island of Montréal, Quebec, 2006

Survey (≥ 1 report), n	RAMQ		κ (95% CI)	Sensitivity, % (95% CI)	Specificity, % (95% CI)
	Definition	n			
Emergency department visits					
145	≥ 1 diagnoses of asthma or bronchiolitis[a,b]	74	0.49 (0.40–0.57)	90.5 (81.7–95.3)	76.2 (71.3–80.5)
	≥ 1 respiratory diagnoses[b,c]	101	0.56 (0.48–0.64)	84.2 (75.8–90.0)	80.1 (75.2–84.2)
	≥ 1 diagnoses of asthma or bronchiolitis[a,d]	87	0.53 (0.44–0.61)	87.4 (78.8–92.8)	78.1 (73.2–82.3)
	≥ 1 respiratory diagnoses[c,d]	122	0.59 (0.51–0.68)	79.5 (71.5–85.7)	82.9 (78.0–86.8)
Hospitalizations					
45	≥ 1 diagnoses of asthma or bronchiolitis[a,b]	17	0.48 (0.33–0.64)	94.1 (73.0–99.0)	92.5 (89.4–94.7)
	≥ 1 respiratory diagnoses[b,c]	24	0.58 (0.43–0.72)	87.5 (69.0–95.7)	93.7 (90.7–95.7)
	≥ 1 diagnoses of asthma or bronchiolitis[a,d]	23	0.55 (0.41–0.70)	87.0 (67.9–95.5)	93.4 (90.4–95.5)
	≥ 1 respiratory diagnoses[c,d]	32	0.64 (0.51–0.77)	81.3 (64.7–91.1)	94.9 (92.1–96.7)

Abbreviations: ICD-9, International Classification of Diseases, 9th Revision; ICD-10, International Classification of Diseases, 10th Revision; RAMQ, Régie de l'assurance maladie du Québec.

[a] ICD-9: 493 and 466; ICD-10: J45 and J21.

[b] In the 12 months before the survey questionnaire.

[c] ICD-9: 460–519, 786.0, 786.2; ICD-10: J00–J99, R060, R06.8, R05.0.

[d] In the 15 months before the survey questionnaire.

also found moderate agreement for the diagnosis of asthma between self-report data and physician claims in the Manitoba health insurance administrative database using the kappa statistic. The study by Tisnado et al.[9] showed good agreement (self-report data and medical records in Colorado) based on the kappa statistic as well as sensitivity and specificity.

In addition, our study showed that agreement varies with the disease definition used: the definition that required 2 diagnoses of asthma in the administrative database yielded better agreement with guardians' self-report survey data than the definition based on a single diagnosis. The reason for this can be that physicians do not always inform guardians about the first diagnosis, either because they want to wait until the next visit when the results of diagnostic tests are available or because they believe that the health problem consists of a transient bronchospasm. The prevalence of asthma is similar for the 2 data sources when the definition requiring 2 diagnoses in the RAMQ database is used. The study by Lix et al.[1] also reported variation in agreement depending on the definition used; however, the definition requiring 2 diagnoses did not result in stronger agreement between the 2 data sources in the case of asthma.

Some studies have suggested that agreement is likely to be lower for complex or difficult-to-diagnose diseases,[6,7] or in cases where the physician and patient do not have the same understanding of the definition of the disease.[1,9] The fact that asthma is a disease that is not always easy to diagnose, especially in young children, could partly explain the non-concordant cases mentioned here. Using survey data to derive estimates of diagnoses of complex diseases should therefore be more difficult.

Medical services use

The study showed that the number of emergency department visits and the number of hospitalizations based on the survey data were overestimated relative to RAMQ data. Moderate agreement was obtained with the kappa statistic when the occurrence of at least one visit was used as a criterion (rather than the exact number of visits). This also resulted in good sensitivity and specificity. Some guardians may have confused an emergency department visit with a hospitalization if their child was kept under observation for a short period of time. This would lead to overestimation of the frequency of hospitalization based on self-report data. This type of error may be negligible in a case where the degree of control over or the severity of the child's asthma is of interest, as measured by the fact that the latter needed a follow-up emergency medical visit at least once during the year.

Palin et al.[10] found over-reporting of mental health visits to a physician based on the Canadian Community Health Survey (CCHS) compared with the number of such visits recorded in the British Columbia Medical Services Plan administrative data. In our study, we found better agreement for emergency department visits and hospitalizations for asthma and bronchiolitis in children with asthma when a longer time period was used (15 months instead of 12 months). This is consistent with the findings of other studies.[3] Agreement also improved when the list of diagnoses was expanded to include all respiratory diagnoses: when a child presents with a respiratory infection, the physician may not write down the diagnosis of asthma. Palin et al.[10] found a similar trend when they broadened the definition of mental health visits to include all visits to the main general practitioner. In contrast, Robinson et al.[3] did not find an improvement when more than one diagnosis was used to define a chronic disease; however, asthma was not included in their study.

Our study showed slightly better agreement for online surveys than for telephone interviews with regard to the diagnosis of asthma based on a single diagnosis in the RAMQ database. This finding could be explained in part by the fact that respondents had more time to answer questions in the online survey.

Limitations

The main limitation of this study consists of the small sample size used for the validation of health services use. In addition, we were unable to assess agreement based on the exact number of visits. Despite that a preliminary analysis showed poor agreement based on the exact number of visits, the occurrence (versus the absence) of a visit or a hospitalization provided valuable information in terms of validating the survey.

Some uncertainty persists in relation to the use of the kappa statistic for low prevalence rates, which is the case in our study with respect to hospitalizations and emergency department visits. The kappa value may remain low even in the presence of a large proportion of concordant pairs.[19] However, in such a case, our results would be conservative.

Conclusion

Our study shows good agreement between guardian self-report data and RAMQ data in relation to pediatric asthma diagnoses. Overall, we found that the survey data over-reported the number of emergency department visits and hospitalizations in the previous 12 months. However, moderate agreement was found for the occurrence/non-occurrence of at least one visit and at least one hospitalization. A higher level of agreement, based on kappa values, occurred for emergency department visits and hospitalizations when the linkage period was increased from 12 months to 15 months and when diagnoses of respiratory infections were added to diagnoses of asthma and bronchiolitis, but is associated with a decreased sensitivity. These findings validate the use of survey data for the diagnosis of asthma in children and the use of major health services for this disease.

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References

1. Lix LM, Yogendran MS, Shaw SY, Burchill C, Metge C, Bond R. Population-based data sources for chronic disease surveillance. Chronic Dis Can. 2008;29(1):31-8.

2. Martin LM, Leff M, Calonge N, Garrett C, Nelson DE. Validation of self-reported chronic conditions and health services in a managed care population. Am J Prev Med. 2000;18(3):215-8.

3. Robinson JR, Young TK, Roos LL, Gelskey DE. Estimating the burden of diseases: comparing administrative data and self-reports. Medical Care. 1997;35(9):932-47.

4. Kriegsman DM, Penninx BW, van Eijk JT, Boeke AJ, Deeg DJ. Self-reports and general practitioner information on the presence of chronic diseases in community dwelling elderly. A study on the accuracy of patients' self-reports and on determinants of accuracy. J Clin Epidemiol. 1996;49(12):1407-17.

5. Boyer GS, Templin DW, Goring WP, et al. Discrepancies between patient recall and the medical record. Potential impact on diagnosis and clinical assessment of chronic disease. Arch Inter Med. 1995;155(17):1868-72.

6. Okura Y, Urban LH, Mahoney DW, Jacobsen SJ, Rodeheffer RJ. Agreement between self-report questionnaires and medical record data was substantial for diabetes, hypertension, myocardial infarction and stroke but not for heart failure. J Clin Epidemiol. 2004;57(10):1096-103.

7. Lix LM, Yogendran MS, Shaw SY, Targownick LE, Jones J, Bataineh O. Comparing administrative and survey data for ascertaining cases of irritable bowel syndrome: a population-based investigation. BMC Heath Services Research. 2010;10:31.

8. Huzel L, Roos LL, Anthonisen NR, Manfreda J. Diagnosing asthma: the fit between survey and administrative database. Can Respir J. 2002;9(6):407-12.

9. Tisnado DM, Adams JL, Liu H, et al. What is the concordance between the medical record and patient self-report as data source for ambulatory care? Med Care. 2006; 44:132-40.

10. Palin JL, Goldner EM, Koehoorn M, Hertzman C. Primary mental health care visits in self-reported data versus provincial adminstrative records. Health Rep. 2011; 22(2):41-7.

11. Bonin JP, Fournier L, Blais R, Perreault M, White ND. Are the responses of clients with psychiatric and addiction disorders using services for the homeless valid? Can J Psychiatry. 2007;52(12);798-802.

12. Jacques L, Plante C, Goudreau S, et al. Étude sur la santé respiratoire des enfants montréalais de 6 mois à 12 ans. Rapport synthèse régional. Montréal (QC): Agence de la santé et des services sociaux de Montréal, Direction de santé publique; 2011.

13. Worldwide variation in prevalence of symptoms of asthma, allergic rhinoconjunctivitis and atopic eczema: International Study of Asthma and Allergies in Childhood (ISAAC). Lancet. 1998;351(9111):1225-32.

14. Burney PG, Luczynska C, Chinn S, Jarvis D. The European Community Respiratory Health Survey. Eur Respir J. 1994;7:954-60.

15. Aubin J, Lavallée C, Camirand J, et al. Enquête sociale et de santé auprès des enfants et des adolescents québécois 1999. Québec (QC): Institut de la statistique du Québec; 2002.

16. Armitage P, Berry G. Statistical methods in medical research. 3rd ed. London (UK): Blackwell; 1994.

17. Landis JR, Koch GG. The measurement of observer agreement for categorical data. Biometrics. 1977;33:159-74.

18. Wilchesky M, Tamblyn RM, Huang A. Validation of diagnostic codes within medical services claims. J Clin Epidemiol. 2004;57(2):131-41.

19. Viera AJ, Garrett JM. Understanding interobserver agreement: the kappa statistic. Fam Med. 2005;37(5):360-3.

Roll-your-own tobacco use among Canadian youth: current prevalence and changes in youth smoking ''rollies'' since 2008

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Abstract

Introduction: Roll-your-own (RYO) cigarettes, or ''rollies,'' represent an affordable alternative to manufactured cigarettes, especially among youth with a lower disposable income. This study characterizes changes in the prevalence of RYO tobacco current use between 2008 and 2010 in Canadian youth and examines the sociodemographic characteristics associated with RYO use in 2010.

Methods: This study uses representative data collected from grade 9 to 12 students as part of the 2008/2009 and 2010/2011 cycles of the Canadian Youth Smoking Survey (YSS).

Results: Among current smokers, 30.5% currently use RYO cigarettes. Youth with a disposable income of more than $100 each week were less likely to be current RYO users (OR = 0.49, 95% CI: 0.34–0.71). Current RYO tobacco users were more likely to be current alcohol users (OR = 2.01, 95% CI: 1.09–3.72) or marijuana users (OR = 2.63, 95% CI: 1.73–4.01).

Conclusion: RYO cigarettes continue to provide an affordable alternative to youth smokers. Targeted school-based prevention programs that address the use of RYO cigarettes may offer additional reductions to the use of RYO cigarettes.

Keywords: *roll-your-own tobacco, adolescent, smoking, alcohol use, marijuana smoking*

Introduction

Despite substantial declines in the sale of manufactured cigarettes in recent years, the sale of more affordable tobacco products, such as roll-your-own (RYO) tobacco, has increased across the population.[1] Research suggests that most current smokers use RYO cigarettes (''rollies'') because they are less expensive.[2-4] This substitution poses significant barriers to current public health policies that attempt to discourage smoking through taxation, especially since loose tobacco for RYO cigarettes tends to be cheaper than manufactured cigarettes.[5] It is important to understand how prevalent RYO tobacco use is among youth as they are the most price-sensitive population of smokers.[6]

RYO tobacco is characterized as a hand-rolled cigarette using loose tobacco and cigarette papers that may or may not be smoked with a filter.[7] Evidence suggests that RYO cigarettes are at least as harmful as manufactured cigarettes[8-9] and contribute to the development of many cancers.[10-12] Data are limited with respect to RYO use in Canada, especially among youth populations. According to the 2002 Canadian Tobacco Use Monitoring Survey, 17% of current adult smokers over the age of 15 years reported smoking RYO cigarettes,[13] while data from the 2008/2009 Youth Smoking Survey suggest that current RYO cigarette use is more prevalent among youth populations (24%).[14]

Because most studies have concentrated on RYO tobacco use among adult smokers, there is little evidence for predictors of use among youth. A common finding is that adult smokers who use RYO cigarettes are more likely to have a lower income[7,13,15,16] and are more likely to be heavier smokers.[4,13,15] RYO users are also less likely to consider or to have made a recent quit attempt compared to manufactured cigarette users.[4,13,16] Additional sociodemographic factors associated with RYO cigarette use in adult smokers include younger age, male sex, and having many friends who smoke.[4,7,16,17]

As with the findings for adult smokers, the population of youth RYO users is more likely to be younger and male[14,17] and more likely to have less disposable income.[14] Compared to adult RYO users who favour one tobacco product over the other, youth and young adult users are also more likely to use both cigarettes and RYO tobacco.[7,16] Youth who use RYO cigarettes are also more likely to use marijuana regularly.[14] International data suggest that not only is RYO tobacco use in youth on the rise,[17] but it is also higher in youth than in any other age group.[7] Therefore, we need to further evaluate changes in the prevalence of RYO tobacco use among Canadian youth to help inform future tobacco control policies.

The purpose of this study is to characterize changes in the prevalence of RYO

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tobacco use between 2008 and 2010 among Canadian youth and to examine the sociodemographic characteristics that are associated with current use with the most recent wave of nationally representative data of Canadian youth smokers in grades 9 to 12.

Methods

This study used representative data collected as part of the 2008/2009 and 2010/2011 cycles of the Canadian Youth Smoking Survey (YSS). Detailed information on the sample design, methods and survey rates for the 2008/2009 YSS have been described elsewhere[18] and are also available online (www.yss.uwaterloo.ca). The 2010/2011 YSS collected data from 31 396 Canadian students in grades 9 to 12. The target population for the data consisted of all young Canadian residents in grades 9 to 12 attending public, private and Catholic secondary schools in 9 Canadian provinces. While New Brunswick had participated in the previous cycles of YSS, they did not participate in 2010/2011, so youth in that province were excluded from the target populations in 2010 and their student responses were removed from the 2008 data set before analysis. Youth in Yukon, Nunavut and the Northwest Territories as well as in institutions, special schools or schools on military bases or on First Nation Reserves were also excluded. The YSS was administered to students during class time and participants were not compensated. The survey design and sample weight allow for the production of population-based estimates within this manuscript.

A combination of active information–passive permission and active permission protocols were used to recruit students in the 2010/2011 YSS. Students also had the opportunity to decline participation on the day of data collection. The University of Waterloo Office of Research Ethics and appropriate School Board and Public Health Ethics committees approved all procedures, including passive consent.

To be consistent with Health Canada's definitions of smoking status for the YSS,[18] we defined current daily smokers as having smoked at least 100 cigarettes in their lifetime and at least one whole

TABLE 1
Weighted descriptive statistics for roll-your-own tobacco current use for the sample of current smokers (grades 9–12), 2010/2011 Youth Smoking Survey, Canada

Parameters	Roll-Your-Own Tobacco Current Use (N = 41 900)[a]	Chi-square
	% of students	
Sex		
Female	38.6	$\chi^2 = 9.4$; $p < .01$; $df = 1$
Male	61.4	
Grade		
9	18.0	$\chi^2 = 84.2$; $p < .001$; $df = 3$
10	29.0	
11	27.6	
12	25.5	
Region		
Atlantic[b]	11.2	$\chi^2 = 84.9$; $p < .001$; $df = 4$
Quebec	18.4[E]	
Ontario	23.7	
Prairies[c]	23.8	
British Columbia	23.0	
Ethnicity		
White	65.6	$\chi^2 = 33.8$; $p < .001$; $df = 3$
Black, Latin, Other	18.3	
Asian	3.7	
Aboriginal	12.4	
Smoking classification		
Daily smoker[d]	62.4	$\chi^2 = 112.8$; $p < .001$; $df = 1$
Occasional smoker[e]	37.6	
Number of cigarettes usually smoked each day over the last 30 days, n		
≤ 5	37.1	$\chi^2 = 155.6$; $p < .001$; $df = 2$
6–10	28.0	
≥ 11	34.9	
Attempts to quit smoking cigarettes, n		
0	37.3	$\chi^2 = 19.5$; $p < .001$; $df = 2$
1	20.8	
≥ 2	41.9	
Reasons why respondents smoke the reported brand of cigarettes[f]		
My friends smoke the same brand	14.6	$\chi^2 = 6.6$; $p < .05$; $df = 1$
This brand costs less than other brands	23.1	$\chi^2 = 0.2$; $p > .05$; $df = 1$
I like the image of this brand	6.3	$\chi^2 = 14.7$; $p < .001$; $df = 1$
I like the taste	67.2	$\chi^2 = 8.0$; $p < .01$; $df = 1$
Ever used blunt wraps		
Yes	46.7	$\chi^2 = 157.2$; $p < .001$; $df = 1$
No	53.3	
Used blunt wraps in the last 30 days		
Yes	30.7	$\chi^2 = 181.6$; $p < .001$; $df = 1$
No	69.3	

Continued on the following page

TABLE 1 (continued)
Weighted descriptive statistics for roll-your-own tobacco current use for the sample of current smokers (grades 9–12), 2010/2011 Youth Smoking Survey, Canada

Parameters	Roll-Your-Own Tobacco Current Use (N = 41 900)[a]	Chi-square
	% of students	
Number of close friends that smoke cigarettes, n		
0	3.0^E	$\chi^2 = 133.5$; $p < .001$; $df = 5$
1	2.2^E	
2	6.0	
3	6.4	
4	4.3	
≥ 5	78.6	
Amount of money respondents usually get *each week* to spend on themselves or to save, $		
0	11.2	$\chi^2 = 4.0$; $p > .05$; $df = 4$
1–20	26.2	
21–100	29.0	
> 100	24.4	
I do not know	9.1	
Alcohol use in the last 12 months		
Non-user[g]	4.1	$\chi^2 = 31.1$; $p < .001$; $df = 2$
Occasional[h]	44.8	
Current[i]	51.1	
Marijuana use in the last 12 months		
Non-user[g]	5.7	$\chi^2 = 91.7$; $p < .001$; $df = 2$
Occasional[h]	22.1	
Current[i]	72.2	

[a] Weighted sample estimate, as described in the methods.

[b] Atlantic region includes Newfoundland and Labrador, Prince Edward Island and Nova Scotia (as described in the methods, New Brunswick was not part of the 2010/2011 YSS sample).

[c] Prairie region includes Manitoba, Saskatchewan and Alberta.

[d] Daily smokers smoked at least 100 cigarettes in their lifetime and at least 1 whole cigarette on each of 30 days preceding the survey.

[e] Current occasional smokers had smoked at least 100 cigarettes in their lifetime and at least 1 whole cigarette during the 30 days preceding the survey but not every day.

[f] Respondents were able to select more than one answer.

[g] Non-users did not report use in the previous year.

[h] Occasional users reported monthly use.

[i] Current users reported weekly use.

[E] Moderate sampling variability; interpret with caution.

cigarette on each of 30 days preceding the survey; current occasional smokers had smoked at least 100 cigarettes in their lifetime and at least one whole cigarette during the 30 days preceding the survey but not every day. Among current smokers, we measured RYO tobacco use using one multi-item question on alternate tobacco use: ‘‘In the last 30 days, did you use any of the following? (Mark all that apply).’’ For this analysis, any respondents with all items missing had RYO tobacco current use set to missing.

The YSS also collected information on demographics, weekly spending money, and alcohol and marijuana use. One question measured a respondent’s disposable income: ‘‘About how much money do you usually get each week to spend on yourself or to save? (Remember to include all money from allowances and jobs like delivering papers…).’’ As with previous definitions,[19,20] non-drinkers did not report alcohol use in the last year, occasional drinkers reported monthly alcohol use and current drinkers reported weekly alcohol use. Similarly, non-marijuana users did not report marijuana use in the last year, occasional marijuana users reported monthly marijuana use and current marijuana users reported weekly marijuana use.

We used survey weights in the descriptive statistics to adjust for differential response rates across regions or groups. As described previously,[18] the development of the survey weight was accomplished in two stages. In the first stage, a weight (W_{1j}) was created to account for the school selection within health region and school strata (either elementary or secondary based on grade enrolment numbers). A second weight (W_{2jg}) was calculated to adjust for student non-response. The weights were then calibrated to the provincial sex and grade distribution so that the total of the survey weights by sex, grade and province would equal the actual enrolments in those groups.

We examined descriptive analyses of the sample characteristics according to year of data collection. Using the 2010 data, we then conducted one logistic regression model to examine factors associated with RYO current use. We used the statistical package SAS version 9.2 for all analyses.[21]

Results

Descriptive statistics for RYO current use

Among youth in grades 9 to 12, 30.5% who currently smoked manufactured cigarettes reported currently using RYO cigarettes, 15.3% who formerly smoked manufactured cigarettes reported currently using RYO cigarettes, and 1.0% who never smoked manufactured cigarettes reported currently using RYO cigarettes. Table 1 shows weighted results of the descriptive statistics for RYO current use in 2010 among youth in grades 9 to 12.

Figure 1 shows the proportion of students who reported currently smoking RYO cigarettes, by grade, compared across cycles of the YSS. In both 2008 and 2010, the prevalence of RYO cigarette current use is greater among grade 12 than grade 9 students. Overall, the prevalence of RYO current use decreased between 2008 and 2010 by about 5%, although this change was not significant ($\chi^2 = 1.4; p > .05; df = 1$).

In 2008 and 2010, the use of RYO cigarettes was consistently higher in the Atlantic region and British Columbia and consistently lower in Quebec and Ontario. Between 2008 and 2010, the use of RYO cigarettes decreased in British Columbia and increased in the Atlantic region and Quebec, but remained relatively stable in both Ontario and the Prairie region (see Figure 2).

Logistic regression model results for current use of RYO cigarettes

Weighted results of the regression model examining current use of RYO cigarettes among current youth smokers are summarized in Table 2. The sex differences between the odds of currently using and not currently using RYO cigarettes were not significant (OR = 1.09, 95% CI: 0.88–1.36). Students in grade 10, 11 and 12 were significantly less likely to be current RYO users compared to students in grade 9 (OR = 0.67, 95% CI: 0.48–0.95; OR = 0.53, 95% CI: 0.38–0.73; and OR = 0.29, 95% CI: 0.20–0.42, respectively). Further, current RYO users were less likely to be occasional smokers (OR = 0.47, 95% CI: 0.37–0.58), to have tried quitting cigarettes once (OR = 0.62, 95% CI: 0.47–0.83) or 2 or more times (OR = 0.61, 95% CI: 0.48–0.78), and to usually have a disposable income between $21 and $100 (OR = 0.61, 95% CI: 0.42–0.87) or more than $100 each week (OR = 0.49, 95% CI: 0.34–0.71) compared to those who were not current RYO users. In contrast, current RYO users were more likely to describe themselves as Black, Latin or other (OR = 1.54, 95% CI: 1.13–2.11), to smoke RYO cigarettes because they like the image of the brand (OR = 1.82, 95% CI: 1.11–2.99), to have ever tried using blunt wraps* (OR = 2.61, 95% CI: 2.05–3.31), to be occasional (OR = 2.69, 95% CI: 1.46–4.96) or current drinkers (OR = 2.01, 95% CI: 1.09–3.72) and to be occasional (OR = 3.09, 95% CI: 1.97–4.83)

FIGURE 1

Proportion of youth currently using roll-your-own tobacco, by grade, 2008/2009 and 2010/2011 Youth Smoking Survey, Canada

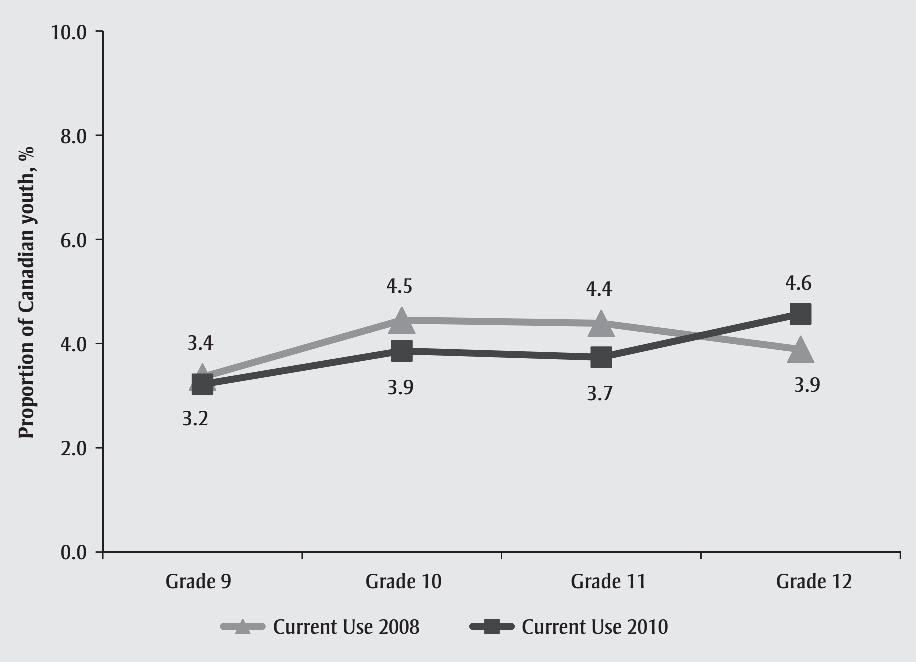
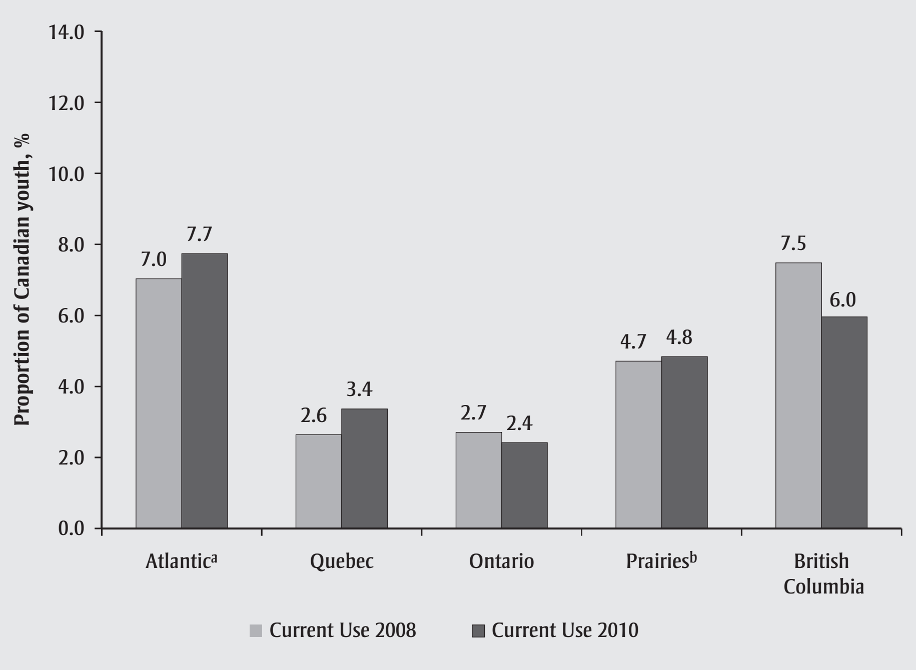


FIGURE 2

Proportion of youth currently using roll-your-own tobacco, by region, 2008/2009 and 2010/2011 Youth Smoking Survey, Canada



[a] Atlantic region includes Newfoundland and Labrador, Prince Edward Island and Nova Scotia (as described in the methods, New Brunswick was not part of the 2010/2011 YSS sample).

[b] Prairie region includes Manitoba, Saskatchewan and Alberta.

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* Cigarette rolling papers made of tobacco.

TABLE 2
Logistic regression model examining factors associated with current use of roll-your-own tobacco among current youth smokers (grades 9–12), 2010/2011 Youth Smoking Survey, Canada

Parameters		Adjusted OR[a] (95% CI) RYO current use
Sex	Female	1.00
	Male	1.09 (0.88–1.36)
Grade	9	1.00
	10	0.67 (0.48–0.95)*
	11	0.53 (0.38–0.73)***
	12	0.29 (0.20–0.42)***
Ethnicity	White	1.00
	Aboriginal	0.84 (0.60–1.18)
	Asian	0.81 (0.48–1.36)
	Black, Latin, other	1.54 (1.13–2.11)**
Smoking status	Current daily smoker[b]	1.00
	Current occasional smoker[c]	0.47 (0.37–0.58)***
Number of attempts at quitting smoking cigarettes	0	1.00
	1	0.62 (0.47–0.83)**
	≥ 2	0.61 (0.48–0.78)***
Reasons why respondents smoke the reported brand of cigarettes[d]	My friends smoke the same brand	0.77 (0.56–1.05)
	This brand costs less than other brands	1.08 (0.82–1.43)
	I like the image of this brand	1.82 (1.11–2.99)*
	I like the taste	1.14 (0.89–1.47)
Ever used blunt wraps	No	1.00
	Yes	2.61 (2.05–3.31)***
Number of close friends who smoke cigarettes, n	0	1.00
	1–2	0.57 (0.30–1.08)
	≥ 3	1.50 (0.86–2.62)
Amount of money respondents usually get *each week* to spend on themselves or to save, $	0	1.00
	1–20	0.73 (0.51–1.05)
	21–100	0.61 (0.42–0.87)**
	> 100	0.49 (0.34–0.71)***
Alcohol use in the last 12 months	Non-user[e]	1.00
	Occasional user[f]	2.69 (1.46–4.96)**
	Current user[g]	2.01 (1.09–3.72)*
Marijuana use in the last 12 months	Non-user[e]	1.00
	Occasional user[f]	3.09 (1.97–4.83)***
	Current user[g]	2.63 (1.73–4.01)***

Abbreviations: CI, confidence interval; OR, odds ratio; RYO, roll-your-own.

[a] Odds ratios controlling for region and adjusted for all other variables in the table; 1 = Currently uses RYO tobacco (n = 886), 0 = Never used RYO tobacco (n = 1466).

[b] Daily smokers smoked at least 100 cigarettes in their lifetime and at least one whole cigarette on each of 30 days preceding the survey.

[c] Current occasional smokers had smoked at least 100 cigarettes in their lifetime and at least one whole cigarette during the 30 days preceding the survey but not every day.

[d] Reference group includes those who did not respond and those who responded ''No.''

[e] Non-users did not report use in the previous year.

[f] Occasional users reported monthly use.

[g] Current users reported weekly use.

* $p < .05$.

** $p < .01$.

*** $p < .001$.

or current marijuana users (OR = 2.63, 95% CI: 1.73–4.01).

Discussion

Our data indicate that RYO tobacco use, although not as high as the current use rates for manufactured cigarettes, is not a negligible issue in Canada as almost one-third of current youth smokers (representing over 40 000 Canadian youth smokers in grades 9 to 12) were current RYO users in 2010. Comparative data between 2008 and 2010 indicate that the prevalence of current RYO cigarette use among Canadian youth has remained relatively stable, potentially mirroring stable rates of manufactured cigarette use.[22] It is clear that RYO cigarette use among youth is still an important health issue and should continue to be part of tobacco prevention and cessation programs.

Consistent with the literature, our data indicate that youth with a higher disposable income are less likely to be current RYO users. Taxation continues to be an effective method of reducing the prevalence of smoking in youth populations;[23] however, RYO cigarettes tend to be cheaper than manufactured cigarettes.[24] In 8 of 10 Canadian provinces, RYO tobacco is taxed at half the rate of manufactured cigarettes,[5] making RYO cigarettes more affordable. Therefore, we recommend that RYO tobacco taxes increase to reduce the price difference between RYO and manufactured cigarettes.[†]

Our data indicate that youth smokers who use RYO cigarettes are more likely to use marijuana, alcohol and blunt wraps, as does previous research.[25] Additional research suggests that youth who combine tobacco and marijuana into a blunt are not only more likely to become dependent on both of these substances, but they are also more likely to use other illicit drugs, such as cocaine and hallucinogens.[26] As a result, school-based prevention programs that address the use of multiple substances continue to be relevant and necessary.[27] Further, because younger youth were more likely to use RYO cigarettes compared to older youth, programs directed to youth in grades 9 and 10 may be more effective in preventing the use of RYO cigarettes. These programs should target the use of RYO cigarettes specifically, as research indicates that targeted tobacco programs are more effective than general substance abuse programs.[28] Additional evidence for the effectiveness of such a targeted approach is necessary.

Strengths and limitations

This study has several strengths. The YSS is a nationally representative survey that occurs every 2 years, providing insight to provincial differences in tobacco use in Canada and allowing researchers to monitor changes in prevalence over time. However, the cross-sectional nature of the data presents some limitations. Causal inferences with respect to variables and RYO current use cannot be made. Further, longitudinal data are required to determine if RYO cigarette current use precedes and leads to marijuana or alcohol use. These data are based on self-reported smoking behaviours; therefore the validity of responses cannot be guaranteed and there may be some bias in the estimates due to student non-response. However, self-report tobacco use measures have previously been demonstrated to be reliable and valid[29,30] and students were ensured that their responses were confidential.

Conclusions

Our data indicate that RYO tobacco use is not a negligible issue among Canadian youth. Not only are youth who smoke RYO tobacco more likely to have a lower disposable income, but they are also more likely to use blunt wraps, alcohol and marijuana. More can be done to discourage the use of this product, namely by increasing the tax applied to RYO tobacco to reduce the price disparity between manufactured cigarettes and RYO equivalents. Further, targeted school-based prevention programs that address the use of RYO cigarettes may offer additional reductions to the use of RYO cigarettes.

Acknowledgements

The Youth Smoking Survey is a product of the pan-Canadian capacity building project funded through a contribution agreement between Health Canada and the Propel Centre for Population Health Impact at the University of Waterloo. This pan-Canadian consortium included Canadian tobacco control researchers from all provinces and provided training opportunities for university students at all levels, encouraging their involvement and growth in the field of tobacco control research. Production of this paper has been made possible through a financial contribution from the Ontario Tobacco Research Unit.

References

1. Connolly GN, Alpert HR. Trends in the use of cigarettes and other tobacco products, 2000–2007. JAMA. 2008;299(22):2629-30.
2. Nosa V, Glover M, Min S, et al. The use of the ‘rollie’ in New Zealand: preference for loose tobacco among an ethnically diverse low socioeconomic urban population. N Z Med J. 2011;124(1338):25-33.
3. Wilson N, Young D, Weerasekera D, Edwards R, Thomson G, Glover M. The importance of tobacco prices to roll-your-own (RYO) smokers (national survey data): higher tax needed on RYO. N Z Med J. 2009;122(1305):92-6.
4. Young D, Wilson N, Borland R, Edwards R, Weerasekera D. Prevalence, correlates of, and reasons for using roll-your-own tobacco in a high RYO use country: findings from the ITC New Zealand Survey. Nicotine Tob Res. 2010;12(11):1089-98.
5. Ontario Tobacco Research Unit. Tobacco taxes: monitoring update. Monitoring and Evaluation Series (Vol. 16, No. 1). Toronto (ON): Ontario Tobacco Research Unit; 2010. 3 p.

[†] Effective February 12, 2014, the Federal excise duty rate applied to tobacco products (including manufactured cigarettes, fine-cut tobacco for roll-your-own cigarettes, chewing tobacco, and cigars) increased to account for changes in inflation since 2002. Although this marks a positive change in tobacco tax rates, there are still marked differences in the price of roll-your-own and manufactured cigarettes, especially across provinces.

6. Chaloupka FJ, Straif K, Leon ME. Effectiveness of tax and price policies in tobacco control. Tob Control. 2011;20(3): 235-8.

7. Li J, Grigg M, Weerasekera D, et al. Characteristics and quitting success of roll-your-own versus tailor-made cigarette smokers. N Z Med J. 2010;123(1308):64-73.

8. Laugesen M, Epton M, Frampton CM, Glover M, Lea RA. Hand-rolled cigarette smoking patterns compared with factory-made cigarette smoking in New Zealand men. BMC Public Health. 2009;9:194-9. doi: 10.1186/1471-2458-9-194.

9. Shahab L, West R, McNeill A. A comparison of exposure to carcinogens among roll-your-own and factory-made cigarette smokers. Addict Biol. 2009;14(3):315-20. doi: 10.1111/j.1369-1600.2009.00157.x.

10. Tuyns AJ, Esteve J. Pipe, commercial and hand-rolled cigarette smoking in oesophageal cancer. Int J Epidemiol. 1983;12(1):110-3.

11. Engeland A, Haldorsen T, Andersen A, Tretli S. The impact of smoking habits on lung cancer risk: 28 years' observation of 26,000 Norwegian men and women. Cancer Causes Control. 1996;7:366-76.

12. De Stefani E, Oreggia F, Rivero S, Fierro L. Hand-rolled cigarette smoking and risk of cancer of the mouth, pharynx, and larynx. Cancer. 1992;70(3):679-82.

13. Leatherdale ST, Kaiserman M, Ahmed R. The roll-your-own cigarette market in Canada: a cross-sectional exploratory study. Tob Induc Dis. 2009;5(5):1-6. doi: 10.1186/1617-9625-5-5.

14. Leatherdale ST, Burkhalter R. Roll-your-own tobacco use among Canadian youth: is it a bigger problem than we think? BMC Public Health. 2012;12:557. doi: 10.1186/1471-2458-12-557.

15. Licht AS, Hyland AJ, O'Connor RJ, et al. Socio-economic variation in price minimizing behaviors: findings from the International Tobacco Control (ITC) Four Country Survey. Int J Environ Res Public Health. 2011;8(1): 234-52.

16. Young D, Borland R, Hammond D, et al. Prevalence and attributes of roll-your-own smokers in the International Tobacco Control (ITC) Four Country Survey. Tob Control. 2006;15(Suppl 3):iii76-82.

17. Raisamo SU. Trends in roll-your-own tobacco use among adolescents in Finland, 1981-2009. Prev Med. 2011;53(6):431-2.

18. Elton-Marshall T, Leatherdale ST, Manske SR, Wong K, Ahmed R, Burkhalter R. Research methods of the Youth Smoking Survey (YSS). Chronic Dis Inj Can. 2011;32: 47-54.

19. Leatherdale ST, Burkhalter R. The substance use profile of Canadian youth: exploring the prevalence of alcohol, drug and tobacco use by gender and grade. Addict Behav. 2012;37:318-22.

20. Leatherdale ST, Rynard V. A cross-sectional examination of modifiable risk factors for chronic disease among a nationally representative sample of youth: are Canadian students graduating high school with a failing grade for health? BMC Public Health. 2013;3:569. doi: 10.1186/10.1186/1471-2458-13-569.

21. SAS Institute Inc. The SAS System for Windows: Version 9.2. Cary (NC): SAS Institute Inc.; 2008.

22. Reid JL, Hammond D, Rynard VL, Burkhalter R. Tobacco use in Canada: patterns and trends, 2014 ed. Waterloo (ON): Propel Centre for Population Health Impact, University of Waterloo; 2014.

23. Carpenter C, Cook PJ. Cigarette taxes and youth smoking: new evidence from national, state and local Youth Risk Behavior Surveys. J Health Econ. 2008;27(2):287-99.

24. Mindell JS, Whynes DK. Cigarette consumption in The Netherlands 1970–1995: does tax policy encourage the use of hand-rolling tobacco? Eur J Public Health. 2000;10(3):214-9.

25. Crawford GE. Flavoured tobacco products with marijuana names. Tob Contol. 2007; 16:70.

26. Timberlake DS. A comparison of drug use and dependence between blunt smokers and other cannabis users. Subst Use Misuse. 2009;44:401-15.

27. Leatherdale ST, Ahmed R. Alcohol, marijuana, and tobacco use among Canadian youth: do we need more multi-substance prevention programming? J Prim Prev. 2010;31:99-108.

28. Tobler NS, Roona MR, Ochshorn P, Marshall DG, Streke AV, Stackpole KM. School-based adolescent drug prevention programs: 1998 meta-analysis. J Prim Prev. 2000;20(4):275-336.

29. Fendrich M, Mackesy-Amiti ME, Johnson TP, Hubbell A, Wislar JS. Tobacco-reporting validity in an epidemiological drug-use survey. Addict Behav. 2005;30:175-81.

30. Messeri PA, Allen JA, Mowery PD, et al. Do tobacco countermarketing campaigns increase adolescent under-reporting of smoking? Addict Behav. 2007;32:1532-6.

Letter to the Editor

Tweet this article

Long-term analysis of cancer incidence, mortality and survival trends in Canada

Re: ''Cancer incidence, mortality and survival trends in Canada, 1970–2007'' by L. Kachuri, P. De, L. F. Ellison, R. Semenciw, The Advisory Committee on Canadian Cancer Statistics (Chronic Diseases and Injuries in Canada, Vol 33, No 2, March 2013, p. 69–80).

The article, ''Cancer incidence, mortality and survival trends in Canada, 1970–2007,'' analyzed long-term trends for selected cancers (prostate, breast, lung and colorectal) in Canada using data from the Canadian Cancer Registry, National Cancer Incidence and Reporting System, and the Canadian Vital Statistics Death Database. The study first examined long-term trends for all cancers, followed by the 4 most common cancers in Canada, as they have the most notable changes in incidence or mortality trends in the past decade.

The study is not put in its proper context. The authors did not justify the choice of the year range (1970–2007) for studying the long-term trend of cancer. There is a need to provide convincing reasons for the years that has been specified and why the years before 1970 have not been included in the analysis.

The authors also used several data sources for the analysis; however, it is not clear how these various data sources are linked to one another, and the authors could have clarified how the various data sources are related in one way or the other. For instance, how are the mortality data linked to the cancer incidence data that have been used in the analysis? It is not clear whether the population with the cancer incidence is the same population with the mortality rates that has been used in the analysis. This may lead to the misinterpretation of the results of the study. The authors should have explained further what criteria were used in the selection of the mortality rates indicated. It is also not clearly specified in the study whether those mortality rates were for the years 1970 to 2007. This makes it confusing for the reader to know exactly at what time periods these mortality rates cover.

Since the study was analyzing long-term trends in cancer incidence and mortality, it would have been appropriate to specify the various age categories in the analysis. For that matter, using only sex categories does not provide good trends for cancer analysis since that could have major impact on policy implication. In effect, the results of the study are limited in their interpretations since it does not take into account for other demographic variables that could have wide implications for policy.

The authors have outlined in the limitations of the study that a number of risk factors and modifiable lifestyle factors were considered in the study. A look at the results section of the study shows that no risk factors and modifiable lifestyles factors were accounted for in the study. The authors should state what risk and modifiable factors were taken into consideration in the analysis. The results of the study should therefore be interpreted with caution.

In conclusion, the paper provides a general idea about the trends and incidence of cancer in Canada by offering some policy implications. Further studies are needed to take into account other factors such as demographic and risk factors that could impact on the incidence and mortality rates of cancers in Canada.

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Authors' response

We thank Mr. Banchani for raising some important issues about our study that require further explanation. However, some aspects of surveillance research appear to have been misunderstood, so we also take this opportunity to clarify.

Our choice of year range was primarily motivated by the availability and consistency of incidence data. The national cancer registry was established in 1969 at Statistics Canada—comprising the event-oriented National Cancer Incidence Reporting System (NCIRS) and succeeded by the current patient-oriented Canadian Cancer Registry (CCR) in 1992.[1] The year 1970 was the earliest year for which we felt that national cancer incidence data were reliable for analysis. At the time of our publication, actual cancer incidence data for Canada were available up to 2007 only, which determined the latest period of observation of our analysis. The time period for the mortality rates was selected to match the year range for the incidence data, as is typical practice for surveillance studies.

The Canadian Vital Statistics Death Database,[2] which is used to derive the mortality rates presented in our publication, includes deaths (including those from cancer) for all residents who died in Canada between 1950 and 2009 (the years of data available at the time of our publication). Although not explicitly stated in the data sources of our article, all tables and figures show the year range of mortality analysis as being 1970–2007. Both the incidence and mortality databases are population-based and hence closely relate to one another. However, incidence and mortality rates for a given year will not directly relate to each other as, in general, individuals diagnosed with cancer tend to survive beyond their diagnosis year. Furthermore, some cancer deaths in the study period may relate to cases diagnosed prior to 1970. Similarly, some cases diagnosed with cancer in the study period may still be alive, may have died after 2007 or may have died from an unrelated cause. Unlike cohort studies, in which a specific group of individuals is followed over time and health outcomes are subsequently ascertained, surveillance data examine the cross-sectional incidence and mortality from disease.

The methods described in our paper specify that all ages were included in the analysis of incidence and mortality, and ages 15 to 99 years for survival analysis. Furthermore, we explain how age-adjusted rates were calculated to take into account the effect of age in cancer rates when examining trends over time. We recognize that providing an analysis stratified by age group would have enhanced our ability to examine differences by age, but such an analysis was beyond the scope of this paper. Our aim was to provide an overview of trends in cancer incidence, mortality and survival and discuss these in the context of emerging trends in major modifiable risk factors among Canadians. Select sub-group analyses, such as age-specific trends using similar datasets, can be found elsewhere.[3]

Banchani mentions that our analysis should be examined by ''other demographic variables,'' but it is not clear what this means. Population-based cancer registries do not typically collect sociodemographic variables such as education, occupation and income to allow for stratified analysis by these factors. Only recently has a linkage been made of the CCR with the Canadian census data from 1991. These linked data are expected to allow for future analyses of sociodemographic data with cancer data.

Banchani also highlights that risk factor information is not considered in our analysis. Given that our analysis was based on population rather than individual-level data, adjustment by risk factor prevalence was not possible. Instead, as is customary in most surveillance research, we related the observed trends to a discussion of risk factors for which population-based estimates could be obtained from national surveys, such as prevalence among Canadians of cigarette smoking, alcohol consumption and infectious diseases as well as measures of body mass index (BMI) and physical activity. Sex and age-specific prevalence for some of these cancer risk factors can be obtained from national health surveys such as the Canadian Community Health Survey.[4]

Surveillance studies such as ours continue to be important sources of information for cancer control and prevention as they identify important trends in cancer that can guide the need for and allocation of health care resources, evaluate the impact of population prevention activities and treatment, and help prioritize the needs of cancer survivors.

Prithwish De, Linda Kachuri,
Larry F. Ellison and Robert Semenciw

References

1. Statistics Canada. Canadian Cancer Registry (CCR) [Internet]. Ottawa (ON): Minister of Industry; [modified 2012 Oct 3; cited 2014 Jan 17]. Available at: http://www23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3207&lang=en&db=imdb&adm=8&dis=2
2. Statistics Canada. Causes of death, 2009 [Internet]. Ottawa (ON): Minister of Industry; 2012 [cited 2014 Jan 17]. [Statistics Canada, Catalogue No.: 84-208-X]. Available at: http://www.statcan.gc.ca/pub/84-208-x/84-208-x2012001-eng.htm
3. Canadian Cancer Society's Advisory Committee on Cancer Statistics. Canadian Cancer Statistics 2013. Toronto (ON): Canadian Cancer Society; 2013.
4. Statistics Canada. Canadian Community Health Survey - Annual Component (CCHS). Ottawa (ON): Statistics Canada; 2013 [cited 2014 Jan 17]. Available at: http://www.23.statcan.gc.ca/imdb/p2SV.pl?Function=getSurvey&SDDS=3226&Item_Id=144171&lang=en#a5

Chronic Disease and Injury Indicator Framework Quick Stats, Fall 2014 Edition

Surveillance and Epidemiology Division, Centre for Chronic Disease Prevention, Public Health Agency of Canada

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INDICATOR GROUP	INDICATOR MEASURE(S)	LATEST DATA[a]	DATA SOURCE (YEAR)
SOCIAL AND ENVIRONMENTAL DETERMINANTS			
Education	% of population with less than a high school education, population aged 20+ years	13.4%	CCHS (2011-2012)
Income	% of population living below low-income cut-offs, after tax, all population	8.8%	SLID (2011)
Employment	Average annual unemployment rate (% of labour force that was unemployed during reference period), population aged 15+ years	7.2%	LFS (2012)
EARLY LIFE/CHILDHOOD RISK AND PROTECTIVE FACTORS			
Birth weight	% of live births with a low birth weight	6.1%	CVS (2011)
Breastfeeding	% of women who report exclusive breastfeeding of their child for at least the first 6 months of life, women aged 15+ years	26.2%	CCHS (2011-2012)
Exposure to second-hand smoke	% of households with children aged less than 12 years regularly exposed to environmental tobacco smoke at home	3.3%	CTUMS (2012)
BEHAVIOURAL RISK AND PROTECTIVE FACTORS			
Smoking	% of population that reports being current smokers (daily and occasional), population aged 15+ years	16.1%	CTUMS (2012)
	% of population that reports being current daily smokers, population aged 15+ years	11.9%	CTUMS (2012)
Physical activity	% of children and youth that attain at least 12 000 steps daily (measured), population aged 5 to 17 years	7.0%	CANPLAY (2009-2011)
	% of population that reports being physically ‘‘active’’ or ‘‘moderately active’’ during their leisure time, population aged 20+ years	51.9%	CCHS (2011-2012)
Sedentary behaviour	% of population that reports spending more than 14 hours per week watching television or using computers during leisure time, population aged 12+ years	62.1%	CCHS (2011-2012)
Healthy eating	% of population that reports consuming fruit and vegetables at least 5 times per day, population aged 12+ years	40.3%	CCHS (2011-2012)
Unhealthy eating	% of population that reports drinking sugar-sweetened beverages daily, population aged 5 to 19 years	27.2%	CHMS (2009-2011)
Alcohol use	% of population that exceeds low risk alcohol drinking guidelines for chronic drinking, population aged 15+ years	14.4%	CADUMS (2012)
Chronic stress	% of population that reported life to be ‘‘quite a bit’’ or ‘‘extremely’’ stressful most days in the last 12 months, population aged 12+ years	22.6%	CCHS (2011-2012)
RISK CONDITIONS			
Obesity	% of population that is obese (measured), children and youth aged 5 to 17 years	11.7%	CHMS (2009-2011)
	% of population that is obese (measured), population aged 18+ years	26.2%	CHMS (2009-2011)
Elevated blood glucose	% of population that has elevated blood glucose (measured), population aged 20+ years	4.2%	CHMS (2009-2011)
Elevated blood pressure	% of population that has elevated blood pressure (measured), population aged 20+ years	7.8%	CHMS (2009-2011)
Elevated blood cholesterol	% of population that has elevated blood cholesterol (TC:HDL-C ratio [measured]), population aged 20+ years	17.3%	CHMS (2009-2011)

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DISEASE PREVENTION PRACTICES (SECONDARY PREVENTION)			
Contact with health care professional	% of population that reported consulting a family physician or general practitioner at least once in the past 12 months, population aged 12+ years	75.2%	CCHS (2012)
	% of population that reported consulting a dentist, dental hygienist or orthodontist at least once in the past 12 months, population aged 12+ years	66.0%	CCHS (2012)
Disease screening	% of women that reported having a mammogram at least once in the past 5 years, population aged 50 to 74 years	83.5%	CCHS (2012)
	% of women that reported having at least 1 Pap smear test in the past 3 years, population aged 25 to 69 years	79.7%	CCHS (2012)
	% of population that reported having at least 1 fecal occult blood test, colonoscopy and/or sigmoidoscopy in the recommended time period, population aged 50 to 74 years	51.1%	CCHS (2012)
Vaccination (influenza)	% of population living with a chronic health condition that reported having a seasonal flu shot in the past 12 months, population aged 12+ years	47.4%	CCHS (2011-2012)
HEALTH OUTCOMES/STATUS			
General health	% of population that rates their health as “very good” or “excellent,” population aged 12+ years	59.9%	CCHS (2011-2012)
	% of population that rates their mental health as “very good” or “excellent,” population aged 12+ years	72.2%	CCHS (2011-2012)
	Life expectancy at birth	82.1 years	CCDSS (2007-2009)
	Life expectancy at 65 years	20.8 years	CCDSS (2007-2009)
	Health-adjusted life expectancy at birth	71.8 years	CCDSS (2006-2008)
	Health-adjusted life expectancy at 65 years of age	15.9 years	CCDSS (2006-2008)
Morbidity – Prevalence	% of population with at least 1 major chronic disease (cancer, diabetes, cardiovascular disease, chronic obstructive pulmonary disease), population aged 20+ years	15.7%	CCHS (2011-2012)
	Prevalence of diabetes, children and youth aged 19 years or less	0.3%	CCDSS (2010-2011)[b]
	Prevalence of diabetes, population aged 20+ years	9.6%	CCDSS (2010-2011)[b]
	Prevalence of cardiovascular disease, population aged 20+ years (NEW)	6.3%	CCHS (2011-2012)
	Prevalence of stroke, population aged 20+ years	1.3%	CCHS (2011-2012)
	Prevalence of heart failure, population aged 40+ years (NEW)	3.5%	CCDSS (2010-2011)
	Prevalence of ischemic heart disease, population aged 20+ years (NEW)	8.4%	CCDSS (2010-2011)
	Prevalence of asthma, children and youth aged 19 years or less	15.7%	CCDSS (2010-2011)[b]
	Prevalence of asthma, population aged 20+ years	9.0%	CCDSS (2010-2011)[b]
	Prevalence of chronic obstructive pulmonary disease, population aged 35+ years	9.3%	CCDSS (2010-2011)[b]
	Prevalence of arthritis, population aged 20+ years	17.6%	CCHS (2011-2012)
	Prevalence of the use of health services for mental disorders, children and youth aged 19 years or less	8.3%	CCDSS (2010-2011)
	Prevalence of the use of health services for mental disorders, population aged 20+ years	15.9%	CCDSS (2010-2011)
	Prevalence of mood disorders and/or anxiety, children and youth aged 19 years or less	7.2%	CCHS (2011-2012)
	Prevalence of mood disorders and/or anxiety, population aged 20+ years	11.2%	CCHS (2011-2012)
	Prevalence of diagnosed osteoporosis, population age 40+ years	11.0%	CCDSS (2010-2011)
	% of population that has been diagnosed with cancer in the previous 10 years	2.4%	CCR (1999-2008)
	% of men that has been diagnosed with prostate cancer in the previous 10 years	1.1%	CCR (1999-2008)
	% of population that has been diagnosed with lung cancer in the previous 10 years	0.1%	CCR (1999-2008)
	% of women that has been diagnosed with breast cancer in the previous 10 years	0.9 %	CCR (1999-2008)
	% of population that has been diagnosed with colorectal cancer in the previous 10 years	0.3%	CCR (1999-2008)

Continued on the following page

HEALTH OUTCOMES/STATUS			
Morbidity – Incidence	Incidence rate of diabetes, children and youth aged 19 years or less	40.7 per 100 000	CCDSS (2010-2011)
	Incidence rate of diabetes, population aged 20+ years	803.7 per 100 000	CCDSS (2010-2011)
	Incidence rate of asthma, children and youth aged 19 years or less	1141.3 per 100 000	CCDSS (2010-2011)
	Incidence rate of asthma, population aged 20+ years	357.9 per 100 000	CCDSS (2010-2011)
	Incidence rate of chronic obstructive pulmonary disease, population aged 35+ years	909.2 per 100 000	CCDSS (2010-2011)
	Incidence rate of heart failure, population aged 40+ years (NEW)	510.6 per 100 000	CCDSS (2010-2011)
	Incidence rate of ischemic heart disease, population aged 20+ years (NEW)	630.1 per 100 000	CCDSS (2010-2011)
	Incidence rate of acute myocardial infarction, population aged 20+ years (NEW)	243.0 per 100 000	CCDSS (2010-2011)
	Annual hip fracture rate, population aged 40+ years (NEW)	147.9 per 100 000	CCDSS (2010-2011)
	Incidence rate of all cancers, all male population	438 per 100 000[d]	CCR (2010)
	Incidence rate of all cancers, all female population	368 per 100 000[d]	CCR (2010)
	Incidence rate of prostate cancer, all male population	108 per 100 000[d]	CCR (2010)
	Incidence rate of lung cancer, all male population	63 per 100 000[d]	CCR (2010)
	Incidence rate of lung cancer, all female population	47 per 100 000[d]	CCR (2010)
	Incidence rate of colorectal cancer, all male population	57 per 100 000[d]	CCR (2010)
	Incidence rate of colorectal cancer, all female population	40 per 100 000[d]	CCR (2010)
	Incidence rate of breast cancer, all female population	101 per 100 000[d]	CCR (2010)
	Incidence rate of all unintentional injuries, total population (NEW)	512.3 per 100 000	HMDB (2010-2011)
	Incidence rate of all injuries due to intentional self-harm, total population (NEW)	47.3 per 100 000	HMDB (2010-2011)
	Incidence rate of all injuries due to assault, total population (NEW)	26.0 per 100 000	HMDB (2010-2011)
Multimorbidity	% of population with multiple chronic diseases[c] (2+ of 10 chronic diseases), population aged 20+ years	14.5%	CCHS (2011-2012)
	% of population with multiple chronic diseases[c] (3+ of 10 chronic diseases), population aged 20+ years	4.9%	CCHS (2011-2012)
Disability	% of population that reports being limited in their activities ''sometimes'' or ''often'' due to disease/illness, population aged 12+ years	33.9%	CCHS (2012)
Mortality	Mortality rate due to a major chronic disease (cardiovascular diseases, all cancers, chronic respiratory disease), total population	454.3 per 100 000	CVS (2010)
	Mortality rate due to cardiovascular diseases, total population	199.1 per 100 000	CVS (2010)
	Mortality rate due to cancer, total population	211.4 per 100 000	CVS (2010)
	Mortality rate due to chronic respiratory diseases, total population	43.8 per 100 000	CVS (2010)
	Mortality rate due to all unintentional injuries, total population (NEW)	32.0 per 100 000	CVS (2010)
	Mortality rate due to homicides, total population (NEW)	1.5 per 100 000	CVS (2010)
	Mortality rate due to suicide, total population	11.6 per 100 000	CVS (2010)
	All-cause mortality rate ratios among people with and without diabetes, population aged 20+ years	2.0 rate ratio[d]	CCDSS (2010-2011)

Continued on the following page

HEALTH OUTCOMES/STATUS			
Premature mortality	Potential years of life lost due to cancer	1480.6 per 100 000	CVS (2010)
	Potential years of life lost due to cardiovascular diseases	733.1 per 100 000	CVS (2010)
	Potential years of life lost due to chronic respiratory diseases	118.8 per 100 000	CVS (2010)
	Potential years of life lost due to suicide	314.8 per 100 000	CVS (2010)
	Probability of dying (%) between ages 30 and 69 years from major chronic diseases (cardiovascular disease, cancer, chronic respiratory disease, diabetes)	11.0%	CVS (2010)
	Probability of dying (%) between ages 30 and 69 years from cardiovascular disease	3.4%	CVS (2010)
	Probability of dying (%) between ages 30 and 69 years from cancer	6.9%	CVS (2010)
	Probability of dying (%) between ages 30 and 69 years from chronic respiratory diseases	0.7%	CVS (2010)
	Probability of dying (%) between ages 30 and 69 years from diabetes	0.5%	CVS (2010)

Abbreviations: CADUMS, Canadian Alcohol and Other Drug Use Monitoring Survey; CANPLAY, Canadian Physical Activity Levels Among Youth; CCDSS, Canadian Chronic Disease Surveillance System; CCHS, Canadian Community Health Survey; CCR, Canadian Cancer Registry; CHMS, Canadian Health Measures Survey; CTUMS, Canadian Tobacco Use Monitoring Survey; CVS, Canadian Vitals Statistics; HDL-C, high-density lipoprotein cholesterol; HMBD, Hospital Morbidity Database; LFS, Labour Force Survey; SLID, Survey of Labour and Income Dynamics; TC, total cholesterol.

Note: Rates from CCDSS data do not include Alberta. Rates from CVS data do not include Quebec.

[a] All rates are crude unless otherwise stated.

[b] CCHS 2011/2012 data exist for this indicator and are available for use when disaggregating by demographic and social markers.

[c] Multimorbidity: Chronic diseases included are heart disease, stroke, cancer, asthma, chronic obstructive pulmonary disease, diabetes, arthritis, Alzheimer's or other dementia, mood disorder (depression) and anxiety.

[d] Rates are age-standardized to the 1991 Canadian population.

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For questions or comments, please contact us at: Chronic.Publications.Chronique@phac-aspc.gc.ca

Visit the Chronic Disease Indicator Framework's online tool to view additional data breakdowns: **http://infobase.phac-aspc.gc.ca/cdif**

Erratum

In the editorial ‘‘Bicycle injuries and injury prevention’’ by I. B. Pless, published in Volume 34, Number 2-3, in July 2014, a reference is incorrectly provided:

> Many of the anti-legislation papers rely heavily on one Australian study[7] for evidence that legislation decreases ridership […].

Reference number 7, which points to Olivier J, Walter SR, Grzebieta RH. Long term bicycle head injury trends for New South Wales, Australia following mandatory helmet legislation. Accid Anal Prev. 2013;50:1128-34, should in fact point to Robinson DL. Head injuries and bicycle helmet laws. Accid Anal Prev. 1996;28:463-75, and thus be numbered 8 in the text.

The editors regret this error and are grateful to Colin Clarke for bringing it to their attention.

Other PHAC publications

Researchers from the Public Health Agency of Canada also contribute to work published in other journals. Look for the following articles published in 2014:

Baillot A, **Pelletier C**, Dunbar P, Geiss L, Johnson JA, Leiter LA, et al. Profile of adults with type 2 diabetes and uptake of clinical care best practices: results from the 2011 survey on living with chronic diseases in Canada - diabetes component. Diabetes Res Clin Pract. 2014;103(1):11-9. doi:10.1016/j.diabres.2013.11.022

Blais C, **Dai S**, **Waters C**, **Robitaille C**, Smith M, Svenson LW, et al. Assessing the burden of hospitalized and community-care heart failure in Canada. Can J Cardiol. 2014;30(3):352-8. doi:10.1016/j.cjca.2013.12.013

Broten L, Aviña-Zubieta JA, Lacaille D, Joseph L, Hanly JG, Lix L, **O'Donnell S**, Barnabe C, Fortin PR, Hudson M, Jean S, Peschken C, Edworthy SM, Svenson L, Pineau CA, Clarke AE, Smith M, Bélisle P, Badley EM, Bergeron L, Bernatsky S. Systemic autoimmune rheumatic disease prevalence in Canada: updated analyses across 7 provinces. J Rheumatol. 2014;41(4):673-9. doi:10.3899/jrheum.130667

Buckley H, **Tonmyr L**, Lewig K, Jack S. Factors influencing the uptake of research evidence in child welfare: a synthesis of findings from Australia, Canada and Ireland. Child Abuse Rev. 2014;23(1):5-16. doi:10.1002/car.2262

Dai S, Wang F, Morrison H. Predictors of decreased physical activity level over time among adults. A longitudinal study. Am J Prev Med. 2014;47(2):123-30. doi:10.1016/j.amepre.2014.04.003

Dzakpasu S, Fahey J, Kirby RS, Tough SC, Chalmers B, Heaman MI, **Bartholomew S**, Biringer A, Darling EK, Lee LS, McDonald SD. Contribution of prepregnancy body mass index and gestational weight gain to caesarean birth in Canada. BMC Pregnancy Childbirth. 2014;14(1):106. doi:10.1186/1471-2393-14-106

Evans J, Chen Y, Camp PG, Bowie DM, **McRae L**. Estimating the prevalence of COPD in Canada: reported diagnosis versus measured airflow obstruction. Health Rep. 2014;25(3):3-11.

Gordon KE, **Do MT**, **Thompson W**, **McFaull S**. Concussion management by paediatricians: a national survey of Canadian paediatricians. Brain Inj. 2014;28(3):311-7. doi:10.3109/02699052.2013.862740

Willis CD, Saul JE, Bitz J, Pompu K, Best A, **Jackson B**. Improving organizational capacity to address health literacy in public health: a rapid realist review. Public Health. 2014;128(6):515-24. doi:10.1016/j.puhe.2014.01.014

Wood B, Burchell AN, Escott N, Little J, Maar M, Ogilvie G, **Severini A**, Bishop L, Morrisseau K, Zehbe I. Using community engagement to inform and implement a community-randomized controlled trial in the Anishinaabek cervical cancer screening study. Front Oncol. 2014;4:27. doi:10.3389/fonc.2014.00027

CDIC: Information for authors

Our Journal

CDIC Mandate

Chronic Diseases and Injuries in Canada (*CDIC*) is a quarterly scientific journal focussing on the prevention and control of non-communicable diseases and injuries in Canada. Its feature articles are peer reviewed. The content of articles may include research from such fields as epidemiology, health equity, public/community health, biostatistics, the behavioural sciences, and health services or economics. *CDIC* fosters communication on chronic diseases and injuries among public health practitioners, epidemiologists and researchers, health policy planners and health educators. Submissions are selected based on scientific quality, public health relevance, clarity, conciseness and technical accuracy. Although *CDIC* is a publication of the Public Health Agency of Canada (PHAC), contributions are welcomed from outside the federal government.

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