Chronic Diseases in Canada

Volume 27, Number 1, 2006

Public Health Agency of Canada
Agence de santé publique du Canada

Canada

Table of Contents

1 **Spatio-temporal distribution of hypothyroidism in Quebec**
Fabien Gagnon, Marie-France Langlois, Isabelle Michaud, Suzanne Gingras, Jean-François Duchesne and Benoît Lévesque

9 **The epidemiology of self-reported fibromyalgia in Canada**
J Dayre McNally, Doug A Matheson and Volodko S Bakowsky

17 **A population-based analysis of health behaviours, chronic diseases and associated costs**
Arto Ohinmaa, Donald Schopflocher, Philip Jacobs, Sandor Demeter, Anderson Chuck, Kamran Golmohammadi and Scott W Klarenbach

25 **Multiple exposures to smoking, alcohol, physical inactivity and overweight: Prevalences according to the Canadian Community Health Survey Cycle 1.1**
Julia E Klein-Geltink, Bernard CK Choi and Richard N Fry

34 **Letters**
Chronic or non-communicable?

Status Reports

36 **Two to three percent of infants are born with a congenital anomaly, but who's counting? A national survey of congenital anomalies surveillance in Canada**
Dana Paquette, R Brian Lowry and Reg Sauvé

39 **Easy access to chronic disease surveillance information: The NCD Surveillance Infobase**

40 **Calendar of Events**

41 **2005 Peer Reviewers**

42 **Indexes to Volume 26**

Information for Authors
(on inside back cover)

Chronic Diseases in Canada

a publication of the Public Health Agency of Canada

Chronic Diseases in Canada (CDIC) is a quarterly scientific journal focussing on current evidence relevant to the control and prevention of chronic (i.e. non-communicable) diseases and injuries in Canada. Since 1980 the journal has published a unique blend of peer-reviewed feature articles by authors from the public and private sectors and which may include research from such fields as epidemiology, public/community health, biostatistics, the behavioural sciences, and health services or economics. Only feature articles are peer reviewed. Authors retain responsibility for the content of their articles; the opinions expressed are not necessarily those of the CDIC editorial committee nor of the Public Health Agency of Canada.

Subscription is free upon request.

When notifying us of a change of address, please enclose your address label.

Chronic Diseases in Canada
Public Health Agency of Canada
130 Colonnade Road
Address Locator: 6501G
Ottawa, Ontario K1A 0K9

Fax: (613) 941-3605
E-mail: cdic-mcc@phac-aspc.gc.ca

Indexed in Index Medicus/MEDLINE, PAIS (Public Affairs Information Service) and EMBASE, the Excerpta Medica database.

This publication is also available online at http://www.phac-aspc.gc.ca/publicat/cdic-mcc/index.html

Published by authority of the Minister of Health

ISSN 0228-8699

Spatio-temporal distribution of hypothyroidism in Quebec

Fabien Gagnon, Marie-France Langlois, Isabelle Michaud, Suzanne Gingras, Jean-François Duchesne and Benoît Lévesque

Abstract

This study estimates the incidence and prevalence of hypothyroidism in Quebec, based on a data bank produced by the Régie de l'assurance maladie du Québec (RAMQ) on the use of thyroid hormones by persons insured under RAMQ's public drug insurance plan between 1992 and 2001. In 2001, the prevalence of thyroid hormone use in women and men respectively was 10.8 and 2.9 percent. Prevalence increases with age, reaching, among those aged 65 and over, 21.9 percent in women and 8.0 percent in men in 2001. Incidence is highest in women between the ages of 45 and 64 and in men aged 65 and over. Age-related incidence is relatively stable in women but tends to increase in men. On a regional and local basis (by Centre local de services communautaires [CLSC]), incidence rates up to 2.4 times higher than anticipated on the basis of provincial incidence rates were observed.

Key words: *distribution by age, distribution by sex, hypothyroidism, incidence, prevalence, Quebec, spatial distribution, temporal trend*

Introduction

Thyroid hormones, which act at the genome level, perform many different functions within many different systems. In addition to being essential to neurological and intellectual development at the fetal stage and in childhood, these hormones are also essential to normal growth. They also have an effect on the heart by accelerating cardiac rate and contractility. Thyroid hormones influence the respiratory centres, alter intestinal motility and increase bone remodelling as well as protein uptake by the muscles. Finally, these hormones influence the metabolism of carbohydrates and lipids.[1]

Hypothyroidism is defined as a clinical syndrome resulting from thyroid hormone deficiency. However, because thyroid hormones are implicated in numerous functions, the signs and symptoms of hypothyroidism can often be rather general and difficult to characterize. The symptomatology of this endocrine disease is generally subtle and insidious, at least in the early stages. Consequently, hypothyroidism may manifest as a variety of stigmas, including hoarseness, psychomotor slowing, intolerance to cold, hair loss, skin coarsening and dryness, weight gain, bradycardia and constipation. Certain signs, such as myxoedema and slowing of the relaxation phase in tendon reflexes, are more specific but not always present.[1] The condition can also cause morbid complications in a wide variety of other conditions. For example, even mild, sub-clinical hypothyroidism is associated with a partially reversible rise in low-density lipoprotein (LDL) cholesterol.[2] This can have clinically important consequences, as demonstrated in cohort studies that point to a possible link between sub-clinical hypothyroidism and cardiovascular disease.[3,4] Hypothyroidism thus represents a far from negligible source of morbidity, both from an individual and a population standpoint.

Management of this chronic condition consists of lifelong treatment with levothyroxine, as well as medical monitoring. Even when the disease is stable, adjustments in therapy may be required in a variety of situations (pregnancy, aging, particularly in patients suffering from coronary disease), or as a result of poor drug compliance.[1] According to the classification established by the *Régie de l'assurance maladie du Québec* (RAMQ), sodium levothyroxine (Synthroid®) is the medication most frequently prescribed by Quebec physicians after acetylsalicylic acid (Aspirin®).[5]

Recognized risk factors for hypothyroidism include genetic predisposition, excessive consumption of iodine or, conversely, iodine deficiency, as well as certain iatrogenic causes (radioiodide, surgery) and drug-related causes (lithium, amiodarone, anticonvulsant drugs).[1] A large number of chemical products can interfere with thyroid gland functioning and, possibly, the action of thyroid hormones.[6] However, there is still considerable uncertainty regarding the clinical impact of such disturbances, given the paucity of studies on human subjects.[7] Accordingly, the purpose of this study is to provide guidance for etiological research in this area.

Author References

Fabien Gagnon, CHUL-Centre de recherche du CHUQ, Unité de recherche en santé publique; Université de Sherbrooke, Faculté de médecine
Marie-France Langlois, Université de Sherbrooke, Faculté de médecine; Centre de recherche clinique du CHUS, Axe de physiopathologie endocrinienne
Isabelle Michaud, Université de Sherbrooke, Faculté de médecine
Suzanne Gingras, Benoît Lévesque, CHUL-Centre de recherche du CHUQ, Unité de recherche en santé publique; Institut national de santé publique du Québec
Jean-François Duchesne, CHUL-Centre de recherche du CHUQ, Unité de recherche en santé publique
Correspondence: Fabien Gagnon, 300 King Street East, Suite 300, Sherbrooke, Québec J1G 1B1; fax: (819) 566-2903; e-mail: fgagnon.rr05@ssss.gouv.qc.ca

Method

Study population and period

The study population is that of Quebeckers who were insured under the Régie de l'assurance maladie du Québec's (RAMQ) public drug insurance plan during the period of 1992 to 2001 inclusively. Prior to 1997, only persons aged 65 and over, as well as income security recipients and aboriginal persons, were insured under this plan. In 1997, coverage under the public plan was extended to all persons under the age of 65 who were not covered under a private drug plan. These persons are referred to as "participants." Users of thyroid hormone replacement products are defined as those given a prescription for sodium levothyroxine (Synthroid® or Eltroxin®) or sodium liothyronine (Cytomel®). Excluded from this study are users of thyroid hormone replacement products who also take lithium, a drug that can induce hypothyroidism.[1]

The first year of the study period, 1992, encompasses a combination of new and old cases. It was therefore selected as the base level for identifying new users of thyroid hormone replacement products as of 1993. Moreover, since "participants" were added to the population covered by the public insurance plan in 1997, data from that year can only be used to establish a new base level for subsequent years and to identify new users as of 1998. For persons under the age of 65, the study period was divided into two periods: 1993 to 1996 and 1998 to 2001. However, for persons aged 65 and older who were covered by the plan without interruption, the entire period of 1993 to 2001 was used.

Variables

Since the data bank of RAMQ assigned an anonymous identification number to every user of thyroid hormone replacement products, we were able to gain access to the following data: age or date of birth, sex, *Centre local de services communautaires* (CLSC) area and administrative region of residence, and product name. Lithium use status was also available for each subject (except for the year 1992).

For each year from 1997 to 2001, three different records (one for income security recipients, one for persons aged 65 and over, and another for public drug insurance plan participants) provided the total number of persons (in person-years) who were insured under the plan, by age and sex, in the various health and social service regions of Quebec. For years prior to 1997, population data for income security recipients, as well as for persons aged 65 and over, by region, sex and age, were not available and were therefore estimated based on the data relating to 1997 and 1998. This estimate was based on the supposition that the change in the size of the insured population that occurred between 1997 and 1998 was comparable to the changes that occurred in earlier years, based on region, sex and age.

An additional record dealt with the total number of persons insured, in 2002, under the public drug insurance plan for each area served by a CLSC, by age and sex. These population data were applied to the 1998–2001 period, according to CLSC area, age and sex.

Data processing and statistical analysis

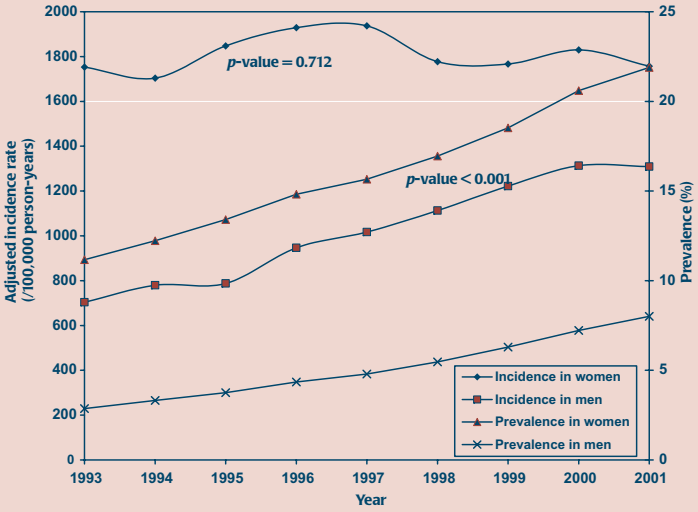
In the course of this study, prevalence, as well as crude and age-standardized incidence rates (direct standardization) were

TABLE 1
Incidence and prevalence of thyroid hormone use in Quebec from 1993 to 1996, in seniors and social assistance recipients

			Incidence			Prevalence	
Sex	Year	Eligible population (PY)[a]	Number of new cases	Crude rate (/100,000)	Adjusted rate (/100,000)	Number of cases	Prevalence (%)
Women	1993	962,170	12,302	1,278.57	1,384.44	65,722	6.83
	1994	945,939	12,608	1,332.86	1,472.39	73,562	7.78
	1995	929,708	13,498	1,451.85	1,550.84	81,726	8.79
	1996	913,477	14,255	1,560.52	1,648.89	91,435	10.01
	1993–1996	3,751,294	52,663	1,403.86	1,511.75	106,792	11.39
	p-trend value[b] < 0.001						
Men	1993	772,894	3,013	389.83	390.33	11,200	1.45
	1994	756,046	3,331	440.58	420.70	13,194	1.75
	1995	739,198	3,504	474.03	448.95	15,211	2.06
	1996	722,350	4,135	572.44	515.00	17,921	2.48
	1993–1996	2,990,488	13,983	467.59	443.49	22,285	2.98
	p-trend value[b] < 0.001						

[a] person-years
[b] calculated for adjusted incidence rates

FIGURE 1
Annual prevalence and age-adjusted incidence rates of thyroid hormone use in Quebec from 1993 to 2001 in persons aged 65 and over



used to describe the use of thyroid hormones. The weighting system employed was based on the five-year age group structure of the Quebec population insured by RAMQ, via the summation of male and female population sizes during the period extending from 1998 to 2001.

The age-standardized rate ratio (SRR)—the standardized incidence rate of a given area over the provincial rate—was the measure used to compare rates. The *p*-value associated with the SRR provided a means of determining whether differences were statistically significant.[8] Rate variation coefficients were also presented in order to measure the rates.

In order for an SRR to be considered significantly different (by 1), both clinically and statistically, three elements had to be present: the gap in relation to the province had to be sufficiently large (a difference of at least 33 percent); rates had to be stable (a variance coefficient of no more than 16.5 percent); and, of course, the difference had to be statistically significant (p-value ≤ 0.001).

The importance attributed to a gap is always partly subjective. For this reason, it was decided that the knowledge acquired concerning geographic variations in cardiovascular disease (CVD) would be used to provide objective benchmarks. Like hypothyroidism, CVD is a multifactorial chronic disease. There are significant CVD mortality gaps among industrialized countries. Since we knew that the rate of CVD mortality in Japan was 67 percent lower than in Canada,[9] we felt that we were justified in assuming that a gap should be at least equivalent to half of this value (that is, 33 percent) before variations in exposure to certain potential risk factors should be considered. Moreover, the statistical power of this study is unassailable, given the large population sizes that were used in our calculations. It is important to underscore, however, that this considerable statistical power may result in rejection of the null hypothesis for very small differences. In order to offset this phenomenon, the threshold of statistical significance was set at $\alpha = 0.1\%$ ($p \leq 0.001$).

For each of the two study periods, provincial incidence rates and prevalence were calculated by year and according to the following age groups: < 15 years, 15 to 44 years, 45 to 64 years and ≥ 65 years. Since the population aged 65 and over was insured by RAMQ during the period from 1992 to 2001 inclusively, annual rates for this age group were calculated for each study year, beginning with 1993. Regional incidence rates and prevalence were calculated for the period of 1998 to 2001, by year and by age group. Rates for the entire period were also calculated for each of the 167 CLSC areas in Quebec. However, rates by region and by CLSC area were not calculated for the 1993–1996 period since there remained considerable uncertainty regarding insured population estimates for this period. All results are stratified by sex.

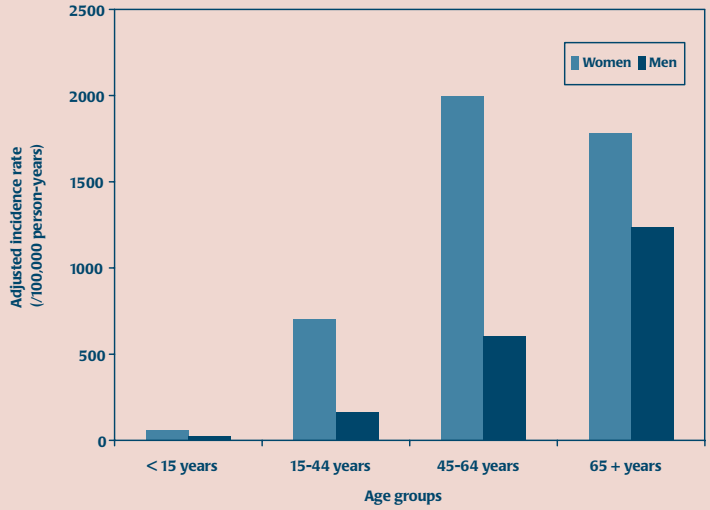
In order to determine the presence of a temporal trend, in the form of an increase or decrease in annual provincial or regional incidence rates during the period under study, linear rate modelling was employed. The threshold of statistical significance for these temporal trends was also set at 0.1% ($p \leq 0.001$).

Results

Table 1 presents incidence and prevalence of thyroid hormone use by seniors and social assistance recipients for the period of 1993 to 1996, while Table 2 presents incidence and prevalence of use for all persons covered under the public drug insurance plan during the 1998–2001 period. In 2001, 1,705,570 women and 1,454,208 men (in person-years) were covered by the public drug insurance plan. For the 1998–2001 period as a whole, the adjusted incidence rate was 1,192/100,000 person-years (PY) for women and 541/100,000 PY for men. Among women, the incidence rate tends to increase over time during the first study period of 1993 to 1996 ($p < 0.001$), but shows a downward trend during the second period of 1998 to 2001 ($p < 0.001$). In the case of men, the incidence rate tends to increase during both of the periods under study ($p < 0.001$). The overall incidence rate in women was 3.4 times higher than that of men for the 1993–1996 period, and 2.2 times higher in 1998–2001. In 2001, 10.8 percent of women insured under the public drug insurance plan were taking thyroid hormone replacement products, a proportion that falls to 2.9% for men.

Figure 1 presents annual rates of thyroid hormone use in persons aged 65 and over from 1993 to 2001. In women, the incidence rate is fairly stable over time ($p = 0.712$), whereas in men the rate increases ($p < 0.001$). In 2001, the prevalence of

FIGURE 2
Adjusted incidence rates of thyroid hormone use in Quebec, by age and sex, from 1998 to 2001, in persons registered with the public drug insurance plan



thyroid hormone use in women and men in this age group was 21.9 percent and 8.0 percent, respectively.

Figure 2 illustrates variations in the incidence of thyroid hormone use for different age groups during the 1998–2001 period. The highest incidence in women is found in the 45-to-64 age group (1,998/100,000 PY). In men, the highest incidence rate is found in the 65-and-over age group (1,239/100,000 PY).

Incidence and prevalence of thyroid hormone use, by administrative region during the 1998–2001 period, are presented in Table 3. For women, Chaudière-Appalaches (age-standardized rate ratio [SRR] = 1.426) is the only region in which the incidence rate is significantly higher than the provincial rate, based on the criteria selected. For men, two regions show an incidence rate that is significantly higher than the provincial rate, namely Chaudière-Appalaches (SRR = 1.778) and Lower St. Lawrence (SRR = 1.491). Based on the selected criteria, no region shows an incidence rate for either sex that is significantly lower than the provincial rate. The highest prevalence obtained by age group were in persons aged 65 and over residing in the Chaudière-Appalaches region, where 30.6 percent of women and 16.4 percent of men in this group were thyroid hormone users (data not presented).

During the 1998–2001 period, annual incidence rates for women showed a downward trend in Saguenay-Lac-Saint-Jean, Montreal-Centre, Outaouais, Chaudière-Appalaches and Lanaudière, and an upward trend in Montérégie ($p < 0.001$). Among men, a downward variation was observed only in the Lanaudière region, while rates increased in Mauricie-Centre-du-Québec, Estrie, Abitibi-Témiscamingue, Gaspésie-Îles-de-la-Madeleine and Montérégie.

Two additional figures (not published here for technical reasons but available by request) show the geographical distribution, for men and women respectively, of the SRRs calculated for the 1998-2001 period, by *Centre local de services communautaires* (CLSC) area. Based on the selected criteria, women in 17 CLSC areas show an incidence rate of thyroid hormone use that is significantly higher than the provincial rate; incidence rates for men were significantly higher than the provincial rate in 22 CLSC areas. CLSC areas with incidence rates exceeding the provincial rate for both women and men were observed in the following regions: Chaudière-Appalaches (6 in 10 CLSC areas for women and 9 in 10 areas for men); Lower St. Lawrence (3 in 9 CLSC areas for women and 6 in 9 areas for men) and North Shore (3 in 8 CLSC areas for women and 1 in 8 areas for men). CLSC rates up to 2.0 and 2.4 times the expected rate were observed in women and men respectively (in Chaudière-Appalaches).

Moreover, for women and men respectively, 16 and 19 CLSC areas had incidence rates of thyroid hormone use that were significantly lower than the provincial rate, based on the selected criteria. The regions with the largest proportion of CLSCs with incidence rates lower than the provincial rate were Saguenay-Lac-Saint-Jean (3 in 7 CLSC areas for women and 2 in 7 areas for men), Montreal-Centre (2 in 35 CLSC areas for women and 6 in 35 areas for men), the Laurentians (2 in 7 CLSC areas for women and 3 in 7 areas for men), and Montérégie (4 in 19 CLSC areas for women and 5 in 19 areas for men). CLSC rates as low as 0.62 and 0.54 times the expected rate were observed for women and men respectively (in Montérégie).

Discussion

In locales where iodine intake levels are adequate, the usual prevalence of hypothyroidism is roughly one percent.[10] For example, a survey conducted with 2,779 adults in the municipality of Whickham, England, showed that the prevalence of hypothyroidism was 1.4 percent in women and less than 0.1 percent in men.[11] The prevalence of thyroid hormone use measured in 2001 for the purposes of this study—namely 10.8 percent for women and 2.9 percent for men—suggest that hypothyroidism is far more common than first suspected. In fact, these prevalences would appear to be more reflective of the prevalence of sub-clinical hypothyroidism, a condition defined as the presence of a high concentration of thyreostimulin (or thyroid-stimulating hormone [TSH], which is produced by the pituitary gland to stimulate the thyroid), and normal concentrations of thyroid hormones. Indeed, investigations comprising biological measurements have demonstrated prevalences of sub-clinical hypothyroidism of eight percent in women and three percent in men.[12] Our own results suggest that the majority of sub-clinical hypothyroidism cases are probably being treated in Quebec (although this practice is not unanimously supported by

TABLE 2
Incidence and prevalence of thyroid hormone use in Quebec from 1998 to 2001, in persons registered with the public drug insurance plan

Sex	Year	Eligible population (PY)[a]	Incidence: Number of new cases	Incidence: Crude rate (/100,000)	Incidence: Adjusted rate (/100,000)	Prevalence: Number of cases	Prevalence: Prevalence (%)
Women	1998	1,672,977	21,073	1,259.61	1,223.87	145,987	8.73
	1999	1,695,650	20,888	1,231.86	1,192.64	158,908	9.37
	2000	1,693,898	20,993	1,239.33	1,195.26	171,587	10.13
	2001	1,705,570	20,661	1,211.38	1,159.28	183,429	10.75
	1998-2001	6,768,095	83,615	1,235.43	1,191.83	211,956	12.53
	p-trend value[b] < 0.001						
Men	1998	1,406,844	6,299	447.74	492.25	29,003	2.06
	1999	1,429,296	7,002	489.89	538.71	33,533	2.35
	2000	1,440,160	7,397	513.62	566.41	38,069	2.64
	2001	1,454,208	7,547	518.98	565.69	42,677	2.93
	1998–2001	5,730,508	28,245	492.89	540.96	51,680	3.61
	p-trend value[b] < 0.001						

[a] person-years
[b] calculated for adjusted incidence rates

the medical community[13,14]), or perhaps that the prevalence of clinical hypothyroidism is actually greater here than elsewhere.

It is important to note that among the thyroid hormones considered in this study, sodium liothyronine (Cytomel®) is not specific to the treatment of hypothyroidism: This hormone can also be used to treat refractory depression or to prepare patients for certain nuclear medicine tests.[1] However, our data bank shows that this drug was taken by only 0.38 percent of those who used thyroid hormones for the first time during the 1998–2001 period. Moreover, the large proportion of seniors in our study population necessarily results in an overestimation of prevalence, since age adjustments are made only for incidence. Still, the prevalences calculated with respect to persons aged 65 and over are comparable to those estimated during the same period in seniors for *The Canadian Study of Health and Aging*. In that study, which was carried out between February 1991 and May 1992, the proportion of persons aged 65 and over who were using thyroid hormone replacement products was 8.8 percent for men and women combined (compared to 11.2 percent for women and 2.9 percent for men in the same group in our own 1993 study).[15]

As for incidence, the rates of thyroid hormone use observed here (1,192/100,000 PY in women and 541/100,000 PY in men for the 1998–2001 period) are distinctly higher than those measured for hypothyroidism in the Whickham cohort follow-up (410/100,000 PY in women and 60/100,000 PY in men, at the end of a follow-up period of twenty years).[16] Also noteworthy is the fact that case definitions are comparable, since the identification of new cases in the Whickham cohort follow-up was based on the treatment decisions of physicians. It may be that the treatment of sub-clinical hypothyroidism is more selective in England. What is more, the two populations are quite different: The first comprises persons aged 65 and over, as well as all social assistance recipients, while the second is derived from a random sample.

Age-related increases in incidence rates and prevalence of hypothyroidism are a well-known phenomenon.[17] However, it is impossible to determine whether the temporal variations observed in the rates measured here (particularly the marked increase observed in men aged 65 and over between 1993 and 2001) reflect a real or apparent increase in disease. Such temporal trends may reflect changes in the population's consultation habits as much as changes in medical practices (level of medical assessment, thyroid hormone assay methods, interpretation of laboratory results, etc.). One thing is certain: The same phenomenon has been observed elsewhere in the world. According to a general population study conducted in Spain, the prevalence of thyroid hormone use in that country increased by 164 percent between 1992 and 2000.[18]

One of the primary problems encountered in epidemiological studies of thyroid disease relates to the definitions used.[10] The diagnosis of hypothyroidism is based on the measurement of TSH. The secretion of thyroid hormones by the thyroid gland is in fact a response to a negative feedback mechanism: If there is thyroid insufficiency, the level of TSH increases.[1] TSH is therefore a marker of thyroid activity. Different generations of tests have been used to measure TSH. The detection limit of first-generation tests was somewhere between 5 and 10 BIU/L. Most

TABLE 3
Incidence and prevalence of thyroid hormone use, by Quebec region, from 1998 to 2001, in persons registered with the public drug insurance plan

		Incidence				Prevalence	
Sex	Region	Adjusted rate (/100,000)	SRR	P-value	CV (%)	Number of cases	Prevalence (%)
Women	01 Lower St. Lawrence	1,495.18	1.255	0.0000	1.71	8,362	15.02
	02 Saguenay – Lac-Saint-Jean	1,246.55	1.046	0.0112	1.74	8,619	13.43
	03 Quebec City	1,139.78	0.956	0.0003	1.19	19,845	13.81
	04 Mauricie et Centre-du-Québec	1,011.72	0.849	0.0000	1.38	14,849	12.14
	05 Estrie	1,273.41	1.068	0.0001	1.67	8,999	13.31
	06 Montreal-Centre	1,054.83	0.885	0.0000	0.70	54,285	11.28
	07 Outaouais	1,281.48	1.075	0.0001	1.82	7,163	11.43
	08 Abitibi-Témiscamingue	1,018.39	0.854	0.0000	2.69	4,427	12.74
	09 North Shore	1,491.30	1.251	0.0000	3.02	2,573	13.53
	11 Gaspésie – Îles-de-la-Madeleine	1,097.58	0.921	0.0027	2.72	3,416	10.90
	12 Chaudière-Appalaches	1,699.91	1.426	0.0000	1.27	14,985	17.38
	13 Laval	1,312.69	1.101	0.0000	1.57	9,750	13.29
	14 Lanaudière	1,437.23	1.206	0.0000	1.47	10,359	12.64
	15 Laurentides	1,050.59	0.881	0.0000	1.55	11,302	11.20
	16 Montérégie	1,227.85	1.030	0.0014	0.87	32,625	12.41
	10-17-18 Nord-du-Québec, Nunavik, Terres-Cries-de-la-Baie-James	1,286.58	1.079	0.3042	7.44	397	9.49
	Province	1,191.83	1	–	0.35	211,956	12.53
Men	01 Lower St. Lawrence	806.42	1.491	0.0000	2.61	2,545	5.19
	02 Saguenay – Lac-Saint-Jean	607.30	1.123	0.0001	2.95	2,125	3.86
	03 Quebec City	540.43	0.999	0.9641	2.07	4,793	4.14
	04 Mauricie et Centre-du-Québec	484.42	0.895	0.0000	2.31	3,776	3.68
	05 Estrie	586.07	1.083	0.0054	2.81	2,342	4.12
	06 Montreal-Centre	441.69	0.816	0.0000	1.27	11,782	2.96
	07 Outaouais	552.49	1.021	0.5388	3.38	1,678	3.06
	08 Abitibi-Témiscamingue	583.49	1.079	0.0682	4.11	1,282	4.08
	09 North Shore	652.87	1.207	0.0003	5.19	720	4.19
	11 Gaspésie – Îles-de-la-Madeleine	472.60	0.874	0.0036	4.59	883	3.07
	12 Chaudière-Appalaches	961.82	1.778	0.0000	1.92	4,702	6.33
	13 Laval	546.30	1.010	0.7410	2.91	2,233	3.63
	14 Lanaudière	613.55	1.134	0.0000	2.67	2,576	3.54
	15 Laurentides	458.44	0.847	0.0000	2.76	2,770	3.12
	16 Montérégie	507.78	0.939	0.0002	1.59	7,374	3.32
	10-17-18 Nord-du-Québec, Nunavik, Terres-Cries-de-la-Baie-James	530.72	0.981	0.8834	13.01	99	2.53
	Province	540.96	1	–	0.60	51,680	3.61

laboratories in Quebec now use second-generation tests, which have a detection limit of approximately 0.1 BIU/L.[19] The changeover to more sensitive tests occurred in the mid-1980s.[19] Therefore, it is unlikely that this transition accounts for the observed trend, as it occurred well before the period covered by the present study.

Moreover, the upper limit of the reference interval for TSH has regularly declined over the past two decades. Long set at 10 BIU/L,[19,20] this limit had fallen to anywhere between 0.4 BIU/L and 6.0 BIU/L by 1992.[19,21] Although it occurred just before the study period, this change in the interpretation of laboratory results may have been introduced gradually and may therefore explain part of the rate increases observed, at least during the first study period (1993–1996). Following the introduction of new guidelines in 2002 by the National Academy of Clinical Biochemistry in the U.S., the upper limit of the reference interval was again reduced.[19] However, that change took place after the period covered by the present study.

This study does not provide an explanation for the disparities and geographic clustering observed in regional and local rates of thyroid hormone use. Given that auto-immune forms represent the primary cause of hypothyroidism in regions where iodine intake levels are adequate,[1,10] increased susceptibility determined by genetic factors inevitably presents itself as a possible explanation. Exposure to certain environmental factors may also play an etiological role, even in auto-immune forms.[22] Pesticides, halocarbons, phenolic compounds and phthalates are the synthetic compounds most frequently studied for their toxic effects on thyroid function.[7] It has not been possible, within the framework of this study, to identify the proportion of users who began taking thyroid hormones following treatment for hyperthyroidism (iodine 131, subtotal thyrodectomy, antithyroid drugs). As many as one third of all cases of hypothyroidism may in fact have an iatrogenic origin.[10] Thus, it is possible that part of the geographic variations observed in rates of hypothyroidism may be due to variations in the occurrence of hyperthyroidism, or to variations in the modalities used to treat this disease. In order to avoid confounding effects, users of thyroid hormone replacement products who were also taking lithium for the treatment of manic-depressive psychosis were excluded from the study, since lithium can induce hypothyroidism.[1] Family history is considered to be the most powerful risk factor for mood disorders and bipolar disorder in particular.[23]

It is important to interpret results prudently. In certain situations, the use of extrapolations to estimate eligible populations may have resulted in inaccurate rate calculations. What is more, even though the public drug insurance plan now covers close to half of the Quebec population (46 percent of women and 41 percent of men in 2001[24]), differences exist between the population insured under this plan and that covered by private insurers. Finally, it is important to understand that two participants covered for only six months under the public plan, as a result of having access to private coverage during the rest of the year, were not counted in this study as two persons covered under the plan in that year, but as a single person-year. A variation of this phenomenon on a regional basis could represent a source of bias in terms of geographic analysis, particularly in situations where differences in types of employment or in employment stability result in more frequent movement between the public plan and private insurance plans. Still, such bias would be limited to working-age population groups, since all seniors are covered under the public plan. However, incidence rates for seniors could also be over estimated in regions that have a large proportion of persons covered by a private plan prior to age 65. Among the latter, all thyroid hormone users who acquire coverage under the public plan upon reaching age 65 will incorrectly be identified as new cases. Nonetheless, it is interesting to note that age-standardized rate ratio (SRR) calculations by age group reveal that in regions where excesses were observed, these excesses manifested themselves in all age groups, beginning at age 15.

Only population surveys that comprise biological measurements would provide a means of determining whether the temporal trends that were measured here reflect an actual or merely apparent increase in disease. It will also be necessary to determine whether regional and local disparities can be explained by variations in thyroid patient management practices. In the event that geographic variations in medical practices are not present, the investigation of regional excesses should be pushed further, in the form of etiological studies.

Acknowledgements

The authors wish to thank the Human Health intervention component of the federal-provincial St. Lawrence Action Plan Vision 2000 for financially supporting the production of the data bank required to complete this study. We also wish to thank Danielle Labrie Pelletier and France Bourque of the information production and dissemination department of the Régie *de l'assurance maladie du Québec* (RAMQ) for the establishment of the data bank, as well as Health Canada's Safe Environments Programme for its financial support of the mapping of results, and Anne-Marie Lalonde for her contribution to the mapping. The thyroid research being carried out by Dr. Marie-France Langlois is funded in part by a Junior 2 Clinical Research Scholar Award provided by the *Fonds de la recherche en santé du Québec*.

References

1. Greenspan FS. The thyroid gland. In: Greenspan FS, Gardner D, editors. Basic & clinical endocrinology. McGraw-Hill; 2004; 215–94.

2. Danese MD, Ladenson PW, Meinert CL, Powe NR. Effect of thyroxine therapy on serum lipoproteins in patients with mild thyroid failure: A quantitative review of the literature. J Clin Endocrinol Metab. 2000;85: 2993–3001.

3. Hak AE, Pols APH, Visser TJ, Drexhage HA, Hofman A, Witteman JCM. Subclinical hypothyroidism is an independent risk factor for atherosclerosis and myocardial infarction in elderly women: The Rotterdam study. Ann Intern Med. 2000;132:270–8.

4. Imaizumi M, Akahoshi M, Ichimaru S, Nakashima E, Hida A, Soda M, Usa T, Ashizawa K, Yokoyama N, Maeda R, Nagataki S, Egushi K. Risk for ischemic heart disease and all-cause mortality in subclinical hypothyroidism. J Clin Endocrinol Metab. 2004;89:3365–70.

5. Les dix médicaments les plus cofteux et les plus souvent prescrits en 2003. L'actualité médicale. June 9, 2004;10.

6. Zoeller RT, Dowling ALS, Herzig CTA, Iannacone EA, Gauger KJ, Bansal R. Thyroid hormone, brain development, and the environment. Environ Health Perspect. 2002; 110:355–61.

7. Brucker-Davis F. Effects of environmental synthetic chemicals on thyroid function. Thyroid. 1998;8:827–56.

8. Bouyer J, Hémon D, Cordier S, Derriennic F, Stücker I, Stengel B, Clavel J. Épidémiologie : Principes et méthodes quantitatives. Paris: Les Éditions INSERM;1993.

9. Levi F, Lucchini F, Negri E, La Vecchia C. Trends in mortality from cardiovascular and cerebrovascular diseases in Europe and other areas of the world. Heart. 2002;88: 119–24.

10. Vanderpump MPJ, Turnbridge WM. The epifemiology of thyroid diseases. In: Braverman LE, Utiger RD, editors. The thyroid: A fundamental and clinical text. 8th ed. Philadelphia: Lippincott Williams & Wilkins; 2000;467–73.

11. Tunbridge WMG, Evered DC, Hall R, Appleton D, Brewis M, Clark F, et al. The spectrum of thyroid disease in a community: The Whickham Survey. Clin Endocrinol. 1977;7:481–93.

12. Vanderpump MP, Tunbridge WM. Epidemiology and prevention of clinical and subclinical hypothyroidism. Thyroid. 2002; 12:839–47.

13. Vanderpump M. Subclinical hypothyroidism: The case against treatment. Trends Endocrinol Metab. 2003;14:262–66.

14. Surks MI, Ortiz E, Daniels GH, Sawin CT, Col NF, Cobin RH, Franklyn JA, Hershman JM, Burman KD, Denke MA, Gorman C, Cooper RS, Weissman NJ. Subclinical thyroid disease: Scientific review and guidelines for diagnosis and management. JAMA. 2004; 291(2):228–38.

15. Krueger PD, Raina P, Braun EA, Patterson C, Chambers LW. Prevalence and risk factors of hypothyroidism: Findings from the Canadian study of health and aging. Canadian Journal on Aging. 2001;20:127–35.

16. Vanderpump MPJ, Tunbridge WMG, French JM, Appleton D, Bates F, Clark F, et al. The incidence of thyroid disorders in the community: A twenty-year follow-up of the Whickham Survey. 1995;43:55–68.

17. USPSTF. Screening for thyroid disease, Chapter 20. Guide to clinical preventive services: Report of the U.S. Preventive Services Task Force. 2nd ed. Williams and Wilkins. 1996;209–18.

18. Diaz Madero A, Lopez Ferreras A. Estimate of the prevalence of hypothyroidism in Castilla y Leon and its progress from 1992 to 2000 through the consumption of thyroid hormones [in Spanish]. Rev Esp Salud Publica. 2001;75:345–52.

19. Baloch Z, Carayon P, Conte-Devolx B, Demers LM, Feldt-Rasmussen U, Henry JF, LiVosli VA, Niccoli-Sire P, John R, Ruf J, Smyth PP, Spencer CA, Stockigt JR. Guidelines Committee, National Academy of Clinical Biochemistry. Laboratory medicine practice guidelines. Laboratory support for the diagnosis and monitoring of thyroid disease. Thyroid. 2003;13:3–126.

20. Sox C H, Jr, editor. Thyroid function. Common diagnostic tests: Use and interpretation. Philadelphia, PA: American College of Physicians; 1990;151.

21. Wallach, J. Serum thyroid-stimulating hormone (TSH;thyrotropin). Interpretation of diagnostic tests: A synopsis of laboratory medicine. Boston: Little, Brown; 1992;448.

22. Brix TH, Kyvik KO, Hegedus L. A population-based study of chronic autoimmune hypothyroidism in Danish twins. J Clin Endocrinol Metab. 2000;85:536–9.

23. Merikangas KR, Low NC. The epidemiology of mood disorders [Abstract]. Curr Psychiatry Rep. 2004;6:411–21.

24. Statistics Canada. 2001 Census of Canada: Profile – Quebec. URL: http://www12.statcan.ca/english/census01/products/standard/prprofile/prprofile.cfm?G=24. Accessed: October 2004.

The epidemiology of self-reported fibromyalgia in Canada

J Dayre McNally, Doug A Matheson and Volodko S Bakowsky

Abstract

Fibromyalgia (FM) is a poorly understood condition characterized by chronic diffuse musculoskeletal pain. This study describes the self-reported epidemiology of FM in Canada using data collected from the Canadian Community Health Survey, Cycle 1.1 (2000). FM prevalence rates with corresponding 95 percent confidence intervals were calculated. The Canadian prevalence rate was 1.1 percent with a female-to-male ratio of six to one. In women, rates increased with age up to 65 years, declining thereafter. Data collected on-age-at-diagnosis is presented and demonstrates a surprising number of newly diagnosed FM cases among people in their 20s and 30s, signifying that FM is a problem for people of all ages. The association with FM and a number of sub-populations was also investigated. With respect to geography and environment, the FM prevalence rate in women was shown to be approximately two percent in all Canadian regions except Quebec, where it was 1.1 percent. Further analysis by language suggested that geographical and cultural differences might best explain this observation. Finally, an association with a number of behavioral and socioeconomic determinants of health, including weight, is presented.

Key words: *Canada, epidemiology, fibromyalgia, prevalence*

Introduction

Fibromyalgia (FM) is a controversial rheumatologic disorder of uncertain etiology and pathogenesis, characterized by chronic widespread non-articular musculoskeletal pain. The classification criterion most commonly used to define cases, both clinically and in research, is the 1990 American College of Rheumatology (ACR) definition.[1] This definition requires the presence of chronic widespread pain of at least three months duration and the presence of at least 11 of 18 possible tender points on clinical exam. In addition to pain, FM patients often report disturbing physical and psychological symptoms including altered sleep patterns, fatigue, cognitive problems and mood disturbances. Some have argued that these latter features should also be included in the diagnostic criteria.[2–4]

Although many aspects of FM, such as pathophysiology and treatment, are controversial, the substantial impact on patient quality of life and the socioeconomic costs of this disorder are without debate. Numerous studies have shown that FM affects not only physical health, but also emotional and mental health, leading to restrictions in daily living and leisure activities.[3,5,6] FM is often accompanied by a considerable degree of work disability, an increased likelihood of receiving financial support and consistently higher health resource utilization.[7–10] If previously reported values for FM prevalence are correct, (one to two percent of the general population) approximately 500,000 Canadians suffer from FM, with an estimated cost of 350 million dollars to the Canadian health care system.[11] Given the large impact that FM has at both the individual and population levels, further descriptive epidemiology of the disorder would be helpful.

The widespread acceptance of FM as a diagnostic entity over the past decade has created a scenario where large-scale epidemiological studies using self-reporting are now possible. For example, two European-based epidemiological studies focusing on rheumatology, and including results on FM, have recently been published, using self-reporting data.[12,13] Our study used data collected by Statistics Canada in a national health survey, the 2000/2001 Canadian Community Health Survey (CCHS), Cycle 1.1, to carry out the first Canadian-based large-scale descriptive epidemiological study on FM. More specifically, the prevalence of FM and its association with a number of socioeconomic, demographic and behavioural determinants of health were investigated.

In addition to providing more current data, a FM study utilizing the CCHS data provides numerous advantages over existing European and North American studies. To date, only small-scale studies have been carried out in North America, and, although of undisputed value, the results obtained are difficult to extrapolate to the national level. These types of studies are invariably carried out on relatively homogenous populations and can be influenced by the health care dynamics within the area.[14,15] In particular, small-scale studies may suffer from a referral bias as they are generally carried out in tertiary care centers where patients are not typical of the general community. The CCHS

Author References

J Dayre McNally, Department of Medicine, Dalhousie University, Halifax, Nova Scotia, Canada
Doug A Matheson, Emergence Consulting, Manotick, Ontario, Canada
Volodko S Bakowsky, Department of Medicine, QEII Health Sciences Centre and Dalhousie University, Halifax, Nova Scotia, Canada
Correspondence: Volodko S Bakowsky, QEII Health Sciences Centre, Nova Scotia Rehabilitation Centre, Room 245, 1341 Summer Street, Halifax, Nova Scotia, Canada B3H 4K4; fax: (902) 473-7019; e-mail: volodko.bakowsky@cdha.nshealth.ca

survey design and sample size reduces these biases. As well, the large size has allowed for the estimation of prevalence in a variety of subgroups—calculations not possible with the smaller North American studies and not performed with the larger European studies.

Methods

CCHS overview

The present analysis is based on the cross-sectional data from Cycle 1.1 of the CCHS, conducted by Statistics Canada and carried out over a 12-to-14-month period beginning in 2000. The survey's design and execution have been detailed elsewhere.[16] Briefly, the CCHS uses the area frame designed for the Canadian Labour Force Survey as its primary sampling frame. A multistage stratified cluster design was used to draw a representative sample of dwellings, totaling 131,535 individual Canadians. The target population included household residents in all ten provinces, excluding households on Indian reserves or Crown land, Canadian military bases and some remote areas. Selection of individual respondents was designed to target individuals aged 12 or older with an over-representation of those between 12 and 19 and those over the age of 65. In 82 percent of the households one person was randomly selected for an in-depth interview, and in the remaining 18 percent two persons were selected. If the selected individual was unavailable after repeated attempts, another member of the household was asked to provide a proxy interview.

Study population

As part of the interview, it was explained to the participants that the survey was focused on certain chronic health conditions. These were described as "'long-term conditions" that had lasted or were expected to last six months or longer and that had been diagnosed by a health professional. Those respondents who answered affirmatively to the survey question CC_Q041 ("Remember, we're interested in conditions diagnosed by a health professional. Do you have fibromyalgia?") were recorded as having FM. Those individuals who self-reported having FM were also asked to provide the age at which they were diagnosed (survey question CC_Q042).

CCHS variables

The CCHS included numerous questions related to health status, various determinants of health, and health service utilization. Following the identification of the study population, the associations between FM and a variety of additional characteristics were investigated. The socio-demographic variables included in the analysis were gender; geographic location (Atlantic Canada, Quebec, Ontario, the Prairie provinces, and British Columbia); urban (census districts with a population density greater than 400 inhabitants per square kilometer) versus rural; immigrant status; Francophone status; and age.

In addition, various determinants of health, including education, income, weight, smoking and alcohol consumption, were investigated and the variables were grouped as follows: To control for age and sex, men and women were analyzed separately, and only those between the ages of 35 and 65 were used for the analysis. The association between weight and FM was assessed using Body Mass Index (BMI). Smoking history was categorized as daily; occasional but former daily; occasional; nonsmoker but former daily; nonsmoker but former occasional; or never smoked. Alcohol consumption was categorized as regular, occasional or former drinkers, as well as a group who had never consumed alcohol. Subjects were also grouped into four categories based on the level of education attained: post-secondary education; some level of post-secondary education; completion of secondary education; or completion of less than secondary school graduation. Income was assessed using data provided by CCHS that grouped the sample into quartiles (lowest, lower middle, upper middle and highest income) based on absolute income levels.

Statistical analysis

Prevalence rates were calculated among the various subgroups described above. The Rao-Wu bootstrap re-sampling technique was used to calculate the corresponding 95 percent confidence interval for the point estimates. This technique corrects for the sampling error built into the CCHS complex survey design caused by stratification, multiple selection stages and the unequalled probabilities of respondent selection.[17,18] More specifically, the Rao-Wu bootstrap method estimates the sample variance by re-sampling from within the sample frame. The statistical analyses were conducted using SPSS software (release 11.1) and SPSS macros available through the Statistics Canada remote access service. Statistics Canada protects the validity of the data provided and in certain instances, when the number of observations is small and the output returns a high coefficient of variation (CV), results are withheld. More specifically, when the CV is greater than 33.3, the estimate of variance is considered meaningless and the point estimate ignored as it is deemed too unreliable to publish. Additionally, when the CV was calculated between 16 and 33.3, the point estimate and confidence intervals are retained, but the results should be interpreted cautiously as the estimated variance used for deriving the confidence interval may not be reliable.

Results

Demographic studies

Based on the CCHS data, 1.1 percent (95% CI: 1.0–1.2) of the Canadian population self-reported having health professionally diagnosed FM. Analysis by gender shows that FM is a disorder predominantly affecting women (1.8%; 95% CI: 1.7–2.0) with a prevalence six times higher than that observed in men (0.3%; 95% CI: 0.2–0.4). The FM prevalence, and corresponding confidence intervals for a number of population characteristics including age, immigrant status and geographical location, are shown in Table 1.

The prevalence of FM in women is initially low in those younger than 25 years of age (0.2%; 95% CI: 0.1–0.4) and then increases until reaching a maximum in the 55 to 64 age grouping (4.2%; 95% CI: 3.6–4.8), before declining in the elderly. The prevalence was constant in men over the age of

TABLE 1
Prevalence and 95% confidence intervals of self-reported, health professionally diagnosed FM in men and women according to individual characteristics. The Canadian Community Health Survey, Cycle 1.1 (2000)

	Men		Women	
	Percentage	CI	Percentage	CI
Age group				
< 25	[a]		0.23	0.10–0.36
25–34	[a]		0.79	0.58–1.00
35–44	0.46	0.27–0.65	1.79	1.47–2.11
45–54	0.58	0.35–0.80	3.26	2.78–3.74
55–64	0.47	0.22–0.72	4.21	3.58–4.84
> 65	0.42	0.22–0.63	1.75	1.49–2.06
Area				
Rural	0.31	0.20–0.41[b]	2.03	1.75–2.31
Urban	0.33	0.25–0.42	1.79	1.63–1.94
Immigrant status				
Born in Canada	0.28	0.22–0.35	1.93	1.78–2.08
Immigrant	0.49	0.24–0.74[b]	1.46	1.17–1.75
Region				
Atlantic provinces	0.27	0.15–0.39[b]	2.11	1.78–2.44
Quebec	0.21	0.11–0.30[b]	1.12	0.82–1.40
Ontario	0.39	0.24–0.53[b]	1.94	1.70–2.18
Prairie provinces	0.43	0.21–0.66[b]	2.13	1.82–2.44
British Columbia	0.27	0.14–0.41[b]	2.29	1.92–2.66
Overall prevalence	0.33	0.26–0.40	1.83	1.69–1.96

[a] Insufficient observations to calculate the point prevalence; coefficient of variation is greater than 33.
[b] Coefficient of variation is between 16 and 33.

35, but was too low to be estimated accurately in men under the age of 35. The combination of a gender preference and a high prevalence in the age group making up the largest portion of the population result in almost 65 percent of all reported FM cases being in women between the ages of 35 and 65.

Age-at-diagnosis observations

A number of interesting observations were made using the data collected on age at diagnosis (data on men were excluded due to the small number of cases). First, a comparison of the respondent's current age with age at diagnosis showed a disproportionately high number of women diagnosed in the years corresponding to the introduction of the ACR FM definition. Grouping the data into five-year intervals shows that there were an estimated 47,000 new FM cases in the last five years, 88,000 cases five to ten years ago (i.e. immediately following the introduction of the ACR definition) and 56,000 cases ten to fifteen years ago. A transient rise in the number of new cases per annum is common following both the general acceptance of a new disease entity and the introduction of either a new (more sensitive) diagnostic test or set of diagnostic criteria. An assessment of those cases diagnosed in the five years preceding data collection showed that only six percent of the newly diagnosed FM cases occurred in the group over the age of 60, while 27 percent occurred in those under the age of 35.

Using the Statistics Canada definition of urban areas, no difference in the self-reported prevalence was evident between rural and urban sub-groups for either men or women (Table 1). When disease prevalence was calculated (among women between 35 and 65) for different geographical regions, Quebec and Ontario were the only areas with point estimates below two percent. The Quebec value (1.1%; 95% CI: 0.8–1.4) was nearly half the value of all other Canadian regions—a statistically significant result.

Considering the relatively low prevalence of FM in Quebec, the leading French-speaking province in Canada, a more in-depth analysis according to language and province of residence was performed. Figure 1 shows the prevalence for francophone women between the ages of 35 and 65, based on whether they reside in Quebec or elsewhere. The graphs show that francophone women living outside of Quebec have a FM prevalence similar to the rest of the country (Figure 1A), while those who live within Quebec have a significantly decreased likelihood of reporting FM. Figure 1C shows that there is no overall difference in FM prevalence between the English and French speaking populations living outside of Quebec.

Table 1 also lists the self-reported prevalence for native-born Canadians and for immigrants. While the estimated prevalence for men was similar between the two groups, immigrant women appear to have a significantly lower prevalence (1.5%; 95% CI: 1.2–1.8) than native-born women (1.9%; 95% CI: 1.8–2.1). The self-reported prevalence of FM among immigrant women and Canadian-born women was compared for four different groups of women over the age of 35 (Table 2). The data shows that the condition is less prevalent among immigrant women in all three age groups under 65, reaching statistical significance in the 45-to-54 and 55-to-64 age groups. No difference in prevalence rates was observed for the age group representing those females over the age of 65.

Socioeconomic results

To evaluate the link between socioeconomic status and FM, we determined the prevalence of FM according to education and

income level in women between 35 and 65 (Table 3). Women in the lowest income quartile were more likely (3.4%; 95% CI: 2.8–4.1) than women from the highest (2.2%; 95% CI: 1.8–2.6) to report a diagnosis of FM. Similarly, men (no age restrictions) from the poorest households were more likely (1.2%; 95% CI: 0.5–1.8) to report FM compared to the wealthiest group (0.3%; 95% CI: 0.2–0.4). For education, the only statistically significant difference among the four groups was between women who had completed a post-secondary education (2.0%; 95% CI: 1.8–2.3) and those who had not completed their secondary school studies (1.5%; 95% CI: 1.3–1.8). No such trend was evident for men.

TABLE 2
Prevalence and 95% confidence intervals of self-reported, health professionally diagnosed FM in immigrant and Canadian-born women by age. The Canadian Community Health Survey, Cycle 1.1 (2000)

Age group	Canadian-born women		Immigrant women		Ratio of immigrant to Canadian born
	Percentage	CI	Percentage	CI	
< 25	0.18	0.10–0.35[b]	[a]		N/A
5–34	0.87	0.63–1.11	[a]		N/A
35–44	2.03	1.67–2.40	0.93	0.45–1.91[b]	0.46
45–54	3.60	3.02–4.18	2.20	1.39–2.01[b]	0.61
55–64	4.81	4.04–5.58	2.57	1.61–3.54[b]	0.53
> 65	1.71	1.34–2.07	1.86	1.23–2.50[b]	1.09

[a] Insufficient observations to calculate the point prevalence; coefficient of variation is greater than 33.
[b] Coefficient of variation is between 16 and 33.

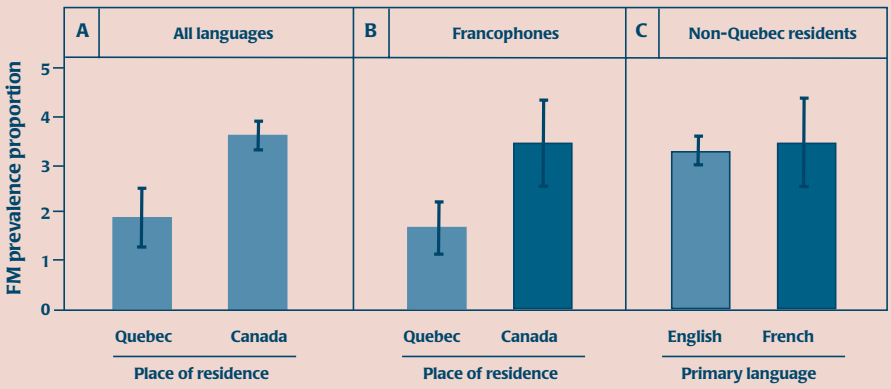
Behavioural determinants of health

To examine the association between weight and FM, the respondents were divided into four groups according to body mass index (BMI). The results for men show a similar prevalence in all 4 BMI categories (Table 4). In women, there was a clear trend towards higher self-reported FM with rising levels of BMI. Those with a BMI of greater than 30 were almost twice as likely to self-report when compared to the group with a BMI less than 24.

To consider the effect of smoking, respondents between the ages of 35 and 65 were grouped into one of six categories, ranging from daily smoker to having never smoked. No difference in self-reporting was apparent between any of the groups for men. However, the results suggested that women who had never smoked were less likely (2.0%; 95% CI: 1.7-2.4) to report having FM when compared to women with any level of smoking history (data not shown). While these data were inconclusive for women with moderate smoking histories, those who were daily (3.3%; 95% CI: 2.8–3.8) or formerly daily smokers (3.5%; 95% CI: 2.9–4.1) were clearly more likely to report suffering from FM.

The relationship between frequency of alcohol consumption and FM prevalence was analyzed by grouping respondents according to drinking frequency. In women, the results indicate that prevalence is lower among those having never consumed alcohol (1.6%; 95% CI: 1.0–2.0) when compared with any of the other groupings (data not shown). In addition, the data also suggest that the prevalence of FM among both women and men who currently consume alcohol is lower when there is more frequent consumption (regular consumption: 2.4%; 95% CI: 2.09–2.80 versus occasional consumption: 3.3%; 95% CI: 2.8–3.7).

FIGURE 1
Comparison of FM prevlaence and 95% confidence intervals by language and province of residence for women between the ages of 30 and 65. The Canadian Community Health Survey, Cycle 1.1 (2000)



Discussion

Employing self-reporting of major illness and health events is the most practical method of assessing disease status in large population studies. Self-reporting of diagnosis has been criticized by some because of misclassification concerns, resulting in potential under or overestimation of disease prevalence and societal burden. However, numerous studies assessing the agreement between self- and physician-reported diagnoses have demonstrated a satisfactory accuracy with respect to both sensitivity and specificity for the majority of disease states, including the rheumatic conditions rheumatoid arthritis and osteoarthritis.[19,20] Currently, the only

data that call into question the validity of self-reporting for FM were published in a study that used a combination of telephone interviewing and physical exam screening to estimate prevalence.[8] The study's authors state that because only 30 percent of those they ultimately classified as having FM were previously aware of their condition, the true FM prevalence is three times higher than what is commonly estimated using self-reporting. Curiously, however, the study fails to advocate for or even discuss the importance of identifying this group of previously unrecognized FM sufferers. What makes the absence of this discussion interesting is that the authors proceed to address and answer this very question within the same article. For example, when the health status of the previously diagnosed group is compared to that of the undiagnosed group, the undiagnosed are shown to have significantly better self-perceived health and less work disability than do the diagnosed. Furthermore, the authors found no deterioration in perceived health over time in either group.[8] Considering that numerous other studies have demonstrated FM to be a chronic, non-degenerative, non-progressive disorder lacking adequate treatment (and preventative measures), the corollary would be a low likelihood of those previously undiagnosed to consult a medical practitioner about their condition and, ultimately, receive an FM diagnosis. We would therefore be comfortable in stating that this evidently healthier group of individuals might be missing from our estimate of prevalence.[21–23] Moreover, if the prevalence is indeed higher than that predicted by the present work, as well as by other studies, further research on FM and its effects becomes even more important.

A number of the findings in this study confirm the results of work in other countries, suggesting that the identified Canadian FM population may be similar to those described in other, often ACR-criteria-based, previous studies. First, the estimated Canadian FM prevalence rates of 0.3 percent for men and 1.8 percent for women are consistent with the results from epidemiological studies conducted in the last several years.[12–15] These findings suggest that prevalence appears to be similar across developed countries. Second, the present work shows an increasing prevalence of FM in women up to until late middle age, followed by a marked decrease in the elderly population.[13,15,24]

The CCHS age-at-diagnosis data allowed for some previously unrecognized and interesting observations to be made regarding the natural history of the disease. Presently, most of the FM literature describes FM as a disorder predominantly affecting late-middle-aged women. This conclusion is not surprising given the almost five-fold difference in prevalence between the 30-to-34 and the 55-to-59 age groups. However, CCHS age-at-diagnosis data shows that this does not mean that women under 35 are not afflicted with the disease, as demonstrated by the fact that almost 30 percent of cases diagnosed in the five years preceding data collection occurred in those under the age of 35. Unexpectedly, the same analysis showed an almost negligible number of new FM cases (< 6%) in those over the age of 60. These findings show that FM is not just a problem for those in their late middle and senior years, but can afflict women of all ages. From these data, it could be suggested that it is the chronic, unremitting nature of the disorder that leads to the high prevalence in late middle age. More age-at-diagnosis data should become available following the completion of further CCHS cycles.

The present study describes significantly lower self-reporting among the Quebec sub-population. Previous studies of other medical conditions have demonstrated that prevalence can vary by Canadian region for other conditions. For example, research on both sinusitis and chronic pain revealed that Quebec has the lowest Canadian rate for each.[25,26] The authors of these two studies conclude that the observed differences are best explained by environmental, rather than cultural or genetic phenomena, due to the finding that rates of chronic pain among non-francophones in Quebec were the same as those among Quebec francophones, while rates for francophones outside Quebec tended to be the same as those for non-francophones in the same province of residence.[26] Given the parallel between FM and chronic widespread pain, and the comparable findings that were noted for FM in this study, we could draw similar conclusions. However, it is less than clear what the previous studies' authors imply by "environment". Environmental phenomena, in this research context, could correspond to either geography or local culture. For example, it is possible that francophones residing in other areas of Canada, as well as anglophones residing in Quebec, have been to some degree assimilated into the local culture. For this reason, although the results suggest

TABLE 3
Prevalence and 95% confidence intervals of self-reported, health professionally diagnosed FM in men and women according to income and education. The Canadian Community Health Survey, Cycle 1.1 (2000)

	Men		Women	
	Percentage	CI	Percentage	CI
Income				
Lowest quartile income	1.15	0.51–1.80 [a]	3.43	2.75–4.11
Second quartile income	0.61	0.32–0.90 [a]	2.48	2.11–2.85
Third quartile income	0.46	0.27–0.65 [a]	2.67	2.27–3.07
Highest quartile income	0.29	0.15–0.43 [a]	2.21	1.79–2.63
Education				
Less than secondary	0.34	0.21–0.48	1.53	1.30–1.77
Secondary graduate	0.27	0.12–0.41	1.93	1.59–2.27
Some post secondary	0.34	0.19–0.49	1.59	1.21–1.97
Post-secondary graduate	0.34	0.23–0.46	2.04	1.81–2.26

[a] Coefficient of variation (CV) between 16 and 33

TABLE 4
Prevalence and 95% confidence intervals of self-reported, health professionally diagnosed FM in men and women according to Body Mass Index (BMI)[a]. The Canadian Community Health Survey, Cycle 1.1 (2000)

	Men		Women	
BMI Grouping	Percentage	CI	Percentage	CI
Underweight BMI < 24	0.39	0.23–0.56[b]	2.16	1.81–2.51
Average 24 < BMI < 27	0.58	0.33–0.83[b]	2.78	2.29–3.28
Overweight 27 < BMI < 30	0.47	0.17–0.76[b]	3.65	2.84–4.46
Obese BMI > 30	0.55	0.35–0.76[b]	4.10	3.42–4.75

[a] Body Mass Index of an individual is calculated as the weight (kg) divided by the square of the height (meters).
[b] Coefficient of variation (CV) between 16 and 33.

geography as an important factor, the role of cultural influences cannot be excluded.

Sub-group analyses showed that immigrant women are less likely to report having FM. Again, multiple potential explanations exist, including decreased genetic susceptibility, different geographical or cultural exposures, and even the landing of relatively healthier women screened by the immigrant health examination. Interestingly, analysis of immigrants and Canadian-born women by age demonstrated a potential convergence of FM prevalence later in life, possibly following years of exposure to the same and as yet unidentified conditions as Canadian-born women. These conditions might be geographical in nature, though one cannot disregard the gradual assimilation into local cultures, as mentioned above, as an alternative explanation for the convergence.

Further complicating the question of the roles of environment and geography in the etiology of FM are our results showing no difference in prevalence between urban and rural respondents. One previous study, carried out in Pakistan, demonstrated higher prevalence in rural areas for numerous rheumatic diseases, including FM.[27] Here, the observation was attributed to a socioeconomic effect, since more affluent urban areas demonstrated prevalence rates lower than those from underprivileged rural regions. In Canada, it is possible that the lack of a difference between urban and rural area prevalence is due to comparable standards of living between these two settings. Nonetheless, this finding of similar prevalence rates in Canada is somewhat problematic as it calls into question the often suggested role of exposure to environmental pollutants, usually associated with urban living, in the etiology of FM.

Regarding our analyses of the socioeconomic factors of education and income, the findings not surprisingly indicate that the prevalence of FM declines with increasing income, consistent with what has been observed in other studies.[27–29] It is interesting to note that the prevalence of FM does not appear to be inversely related to education, despite the fact that education is usually strongly correlated with increased income. An attractive, but yet unproven explanation could be that lower income is not a predisposing condition for FM, but rather a result of developing the disorder. An additional, less straightforward explanation for these associations would be that high education and low income represent markers for other co-existing or correlating population characteristics, including emotional processes, which could be more common among individuals with FM.

The results of the BMI, alcohol and smoking investigation raise both some interesting issues and present some unclear findings (Table 4). To our knowledge, this study demonstrates the first clear association between BMI and FM. A number of potential explanations for this association exist. First, increasing weight could predispose an individual to developing FM. For example, obesity may lead to a relative hormonal imbalance, similar to what occurs with central obesity and glucose intolerance, predisposing to disease.[30] Alternatively, reduced physical activity, not uncommon among FM sufferers, may result in weight gain. Alcohol and smoking have been linked to the development of numerous disease entities.[31,32] Despite the lack of a clear dose-response relationship, the results of this study suggest that those who abstain from smoking and drinking are less likely to report having FM. Moreover, the observed paradoxical decrease in FM prevalence among the regular alcohol consumption group compared to those with more occasional consumption might be explained by an aversion or low tolerance to alcohol. With the exception of studies reporting more musculoskeletal and chronic pain among smokers, and more pain and functional disability in FM patients who smoke, our study provides some of the first evidence suggesting an association between tobacco use and FM.[33–35] Finally, considering the potentially higher stress and anxiety levels in individuals with FM, there is a possibility that the observed relationships between FM and drinking, smoking and overeating represent coping mechanisms.

Conclusion

Large scale population studies on self-reported diseases can be used to answer public health questions. In this study, we use data from a large national health survey to carry out a large-scale, Canadian-based, descriptive epidemiological study on FM. The CCHS's large sample size and broad collection of descriptive variables allowed for the analysis of a variety of sub-groups, which was not possible in previous and smaller North-American-based studies. The heterogeneity of the respondents should reduce biases intrinsic to studies carried out on smaller homogenous populations, which use diagnoses made by a discrete and often limited number of researchers. Despite these advantages, it must be recognized that prevalence values and associations based on self-reported cross-sectional data show correlations without evidence of cause and effect. For this reason, some of the findings presented here require verification and further investigation. For example, our results

note an association between various determinants of health, including smoking, body mass index and FM. It is not known whether these variables are risk factors, a result of the condition, or are merely correlated with other factors such as socioeconomic status. In addition, further exploration of the difference between FM prevalence in Quebec and that in the rest of Canada, and whether this simply represents differences in diagnosis or reporting would be important. If the associations identified in this study are determined to represent true risk factors, it would open the way for the development of preventative health measures.

Acknowledgements

The authors wish to acknowledge the assistance of Statistics Canada, which not only made available the data from the CCHS (Cycle 1.1), but also provided the statistical routines for the Rao-Wu bootstrap analysis. The authors also wish to thank Loren Matheson for her thoughtful consideration of the manuscript.

References

1. Wolfe F, Smythe HA, Yunus MB, Bennett RM, Bombardier C, Goldenberg DL, et al. The American College of Rheumatology 1990 criteria for the classification of fibromyalgia. Report of the multicenter criteria committee. Arthritis Rheum. 1990;33(2):160–72.
2. White KP, Harth M. Classification, epidemiology, and natural history of fibromyalgia. Curr Pain Headache Rep. 2001;5(4):320–9.
3. Tuzun EH, Albayrak G, Eker L, Sozay S, Daskapan A. A comparison study of quality of life in women with fibromyalgia and myofascial pain syndrome. Disabil Rehabil. 2004;26(4):198–202.
4. Noller V, Sprott H. Prospective epidemiological observations on the course of the disease in fibromyalgia patients. J Negat Results Biomed. 2003;2(1):4.
5. Wolfe F, Hawley DJ. Measurement of the quality of life in rheumatic disorders using the EuroQol. Br J Rheumatol. 1997;36(7): 786–93.
6. Kaplan RM, Schmidt SM, Cronan TA. Quality of well being in patients with fibromyalgia. J Rheumatol. 2000;27(3): 785–9.
7. Henriksson C, Liedberg G. Factors of importance for work disability in women with fibromyalgia. J Rheumatol. 2000;27(5): 1271–6.
8. White KP, Nielson WR, Harth M, Ostbye T, Speechley M. Does the label "fibromyalgia" alter health status, function, and health service utilization? A prospective, within group comparison in a community cohort of adults with chronic widespread pain. Arthritis Rheum. 2002;47(3):260–5.
9. Wolfe F, Anderson J, Harkness D, Bennett RM, Caro XJ, Goldenberg DL, et al. Work and disability status of persons with fibromyalgia. J Rheumatol. 1997;24(6): 1171–8.
10. Penrod JR, Bernatsky S, Adam V, Baron M, Dayan N, Dobkin PL. Health services costs and their determinants in women with fibromyalgia. J Rheumatol. 2004;31(7): 1391–8.
11. White KP, Speechley M, Harth M, Ostbye T. The London Fibromyalgia Epidemiology Study: Direct health care costs of fibromyalgia syndrome in London, Canada. J Rheumatol. 1999;26(4):885–9.
12. Picavet HS, Hazes JM. Prevalence of self reported musculoskeletal diseases is high. Ann Rheum Dis. 2003;62(7):644–50.
13. Carmona L, Ballina J, Gabriel R, Laffon A. The burden of musculoskeletal diseases in the general population of Spain: results from a national survey. Ann Rheum Dis. 2001; 60(11):1040–5.
14. Wolfe F, Ross K, Anderson J, Russell IJ, Hebert L. The prevalence and characteristics of fibromyalgia in the general population. Arthritis Rheum. 1995;38(1):19–28.
15. White KP, Speechley M, Harth M, Ostbye T. The London Fibromyalgia Epidemiology Study: the prevalence of fibromyalgia syndrome in London, Ontario. J Rheumatol. 1999;26(7):1570–6.
16. Beland Y. Statistics Canada health reports 2002;13(3):9–13.
17. Rao J, Wu C. Resampling interference with complex survey data. J Am Stat Assoc. 1998;83:231–41.
18. Rao J, Wu C, Yue K. Some recent work on resampling methods for complex surveys. Surv Methodol. 1992;18:209–17.
19. Bergmann MM, Byers T, Freedman DS, Mokdad A. Validity of self-reported diagnoses leading to hospitalization: a comparison of self-reports with hospital records in a prospective study of American adults. Am J Epidemiol. 1998;147(10):969–77.
20. Haapanen N, Miilunpalo S, Pasanen M, Oja P, Vuori I. Agreement between questionnaire data and medical records of chronic diseases in middle aged and elderly Finnish men and women. Am J Epidemiol. 1997;145(8): 762–9.
21. Baumgartner E, Finckh A, Cedraschi C, Vischer TL. A six year prospective study of a cohort of patients with fibromyalgia. Ann Rheum Dis. 2002;61(7):644–5.
22. Mengshoel AM, Haugen M. Health status in fibromyalgia: A follow-up study. J Rheumatol. 2001;28(9):2085–9.
23. Wolfe F, Anderson J, Harkness D, Bennett RM, Caro XJ, Goldenberg DL, et al. A prospective, longitudinal, multicenter study of service utilization and costs in fibromyalgia. Arthritis Rheum. 1997;40(9):1560–70.
24. Forseth KO, Gran JT. The prevalence of fibromyalgia among women aged 20–49 years in Arendal, Norway. Scand J Rheumatol. 1992;21(2):74–8.
25. Chen Y, Dales R, Lin M. The epidemiology of chronic rhinosinusitis in Canadians. Laryngoscope. 2003;113(7):1199–205.
26. Wang PP, Badley EM. Consistent low prevalence of arthritis in Quebec: Findings from a provincial variation study in Canada based on several Canadian population health surveys. J Rheumatol. 2003;30(1):126–31.
27. Farooqi A, Gibson T. Prevalence of the major rheumatic disorders in the adult population of north Pakistan. Br J Rheumatol. 1998; 37(5):491–5.
28. Reeder BA, Liu L, Horlick L. Sociodemographic variation in the prevalence of cardiovascular disease. Can J Cardiol. 1996; 12(3):271–7.
29. Valat JP, Goupille P, Vedere V. Low back pain: Risk factors for chronicity. Rev Rhum Engl Ed. 1997;64(3):189–94.

30. Vega GL. Obesity and the metabolic syndrome. Minerva Endocrinol. 2004;29(2): 47–54.

31. Bartecchi CE, MacKenzie TD, Schrier RW. The human costs of tobacco use (1). N Engl J Med. 1994;330(13):907–12.

32. Rehm J, Gmel G, Sempos CT, Trevisan M. Alcohol related morbidity and mortality. Alcohol Res Health. 2003;27(1):39–51.

33. Andersson H, Ejlertsson G, Leden I. Widespread musculoskeletal chronic pain associated with smoking. An epidemiological study in a general rural population. Scand J Rehabil Med. 1998;30(3):185–91.

34. Eriksen WB, Brage S, Bruusgaard D. Does smoking aggravate musculoskeletal pain? Scand J Rheumatol. 1997;26(1):49–54.

35. Yunus MB, Arslan S, Aldag JC. Relationship between fibromyalgia features and smoking. Scand J Rheumatol. 2002;31(5):301–5.

A population-based analysis of health behaviours, chronic diseases and associated costs

Arto Ohinmaa, Donald Schopflocher, Philip Jacobs, Sandor Demeter, Anderson Chuck, Kamran Golmohammadi and Scott W Klarenbach

Abstract

Health behaviours influence the future incidence of certain common chronic diseases and thus have an impact on health status and utilization of health care services and costs. We analyzed person-level data of the Albertan adult population from the Canadian Community Health Survey, Cycle 1.1 (2000) to determine health care costs associated with specific health behaviours (smoking, sub-optimal diet, physical inactivity) and chronic disease states (heart disease, diabetes, COPD). We found that 74.7 percent of the population exhibited one or more risk behaviours, while 10.5 percent had one or more of the chronic diseases of interest. Greater health care utilization and costs were noted in groups exhibiting risk behaviour and chronic disease states. Approximately 31 percent of health care costs in Alberta were attributable to people having one or more of the three chronic diseases. Our findings of higher health care costs incurred by those exhibiting unhealthy behaviour prior to development of disease, as well as by those with multiple co-existent diseases, are important indicators to guide future prevention and treatment strategies of chronic illness.

Key words: *Canada, chronic illnesses, health behaviour, health economics, health survey, population surveillance, risk behaviour, WHO*

Introduction

A recent World Health Organization[1] (WHO) document has called for a unified and global strategy towards the prevention of specific chronic diseases, namely chronic obstructive pulmonary disease (COPD), diabetes mellitus, heart disease, and lung and colorectal cancer. The development of these diseases has been linked to a common set of risk behaviours (tobacco use, sub-optimal nutrition and diet, and inadequate physical inactivity), and they are therefore preventable to some degree. Their prevalence is rapidly increasing, and they have been recognized as incurring a significant economic cost for society.[2,3] While some investigators have conducted detailed costing studies of specific chronic conditions[4–6] and risk factors,[7,8] the WHO vision indicates that we need a more comprehensive view of "disease" costs. Such a vision would incorporate a wide spectrum of the population, including not only those with the disorders of interest, but also those at risk of future development of the disease. Further, it is increasingly recognized that diagnoses which occur in combinations will have cumulative impacts on costs,[9–11] and thus it may not be appropriate to focus only on one disease entity.

Currently, only blunt conceptual tools are available to deal with global or population-level resource issues. In Canada, as in many other countries, a "top down" methodology (or collective approach) to study health care costs has been developed by Health Canada,[2] which is based on service provider information, not on information obtained from individuals comprising the population of interest. The Health Canada approach omits several important but as yet undeveloped areas where global burden analysis needs to be extended, including the measurement of out-of-pocket costs and the analysis of risk factors and disease co-morbidities. The relationship between health care costs and personal risk factors, in particular, cannot be addressed at the population level using previously employed top-down methodologies. Population health surveys are instruments that can potentially be harnessed to explore these important issues, though they have not yet been exploited to conduct population-level economic analyses.

The purpose of this paper is to estimate the cost of health services for adults in Alberta from a population-based perspective using individual-level data, with specific inquiry into the burden attributable across a broad spectrum of the population and using the WHO framework. This spectrum ranges from those with no high-risk behaviours to those with one or more risk behaviours, and then includes those with the chronic disease of interest, including single and multiple chronic illnesses.

Method

Our analysis entails the identification of individuals with risk behaviours and disease

Author References

Arto Ohinmaa, Philip Jacobs, Anderson Chuck, Department of Public Health Sciences, University of Alberta, Edmonton, Alberta, Canada
Donald Schopflocher, Health Surveillance, Alberta Health & Wellness, Government of Alberta, Canada
Sandor Demeter, Section of Nuclear Medicine, University of Manitoba, Winnipeg, Manitoba, Canada
Kamran Golmohammadi, Department of Radiology and Diagnostic Imaging, University of Alberta, Edmonton, Alberta, Canada
Scott W Klarenbach, Department of Medecine, University of Alberta, Edmonton, Alberta, Canada
Correspondence: Scott W Klarenbach, 11-107 Clinical Sciences Building, 8440-112 Street, University of Alberta, Edmonton, Alberta, Canada T6G 2G3; fax: (780) 407-7878; e-mail: scott.klarenbach@ualberta.ca

states, quantifying per-person units of health care resource utilization, and applying age-and-gender-specific costs to each unit of resources to enable determination of person-level costs. The population of interest is the non-First Nation (including off-reserve FN), non-institutionalized population of Alberta aged 20 and over in budget year 2000/1. Person-level data from the 2000–2001 Canadian Community Health Survey (CCHS), Cycle 1.1, a household survey of non-institutionalized persons in the general population conducted by Statistics Canada, was used for the analysis.[12] Respondents to this survey answered a variety of questions dealing with personal and family characteristics, health status (including mental health and presence of chronic conditions), and health care service utilization. This survey utilizes a multistage stratified cluster design and provides cross-sectional data representative of 98 percent of the Canadian population over the age of 12. It attained an 80 percent overall response rate.[13]

The population was sub-divided into groups based on the presence (or absence) of COPD, heart disease and diabetes, either in isolation or combination. Presence of disease states were obtained from individual responses to questions which asked whether the persons had been diagnosed with COPD, heart disease or diabetes by a health professional. The presence or absence of other diseases, such as arthritis or cancer, may have occurred but were not incorporated into the analysis.

Persons without any of the three reported chronic diseases were classified by risk behaviour categories: no risk behaviour, or one or any combination of smoking, inadequate nutrition and physical inactivity. Smokers were defined as those who indicated that they smoked daily or occasionally in response to the question "At the present time, do you smoke cigarettes daily, occasionally or not at all?" "Adequate nutrition" was defined as consumption of five or more servings of fruit and vegetables daily (the current Health Canada standard), which was derived from a series of questions within the survey. "Physical activity" was defined by the Physical Activity Index,[14,15] which is derived from several questions in the survey pertaining to physical activity. Those classified as "inactive" were defined as having sub-optimal physical activity (as opposed to those classified as "moderate" or "active").

The frequencies of respondents for the risk factors and chronic disease were adjusted with population-based weights to obtain population estimates. The distribution of health states among valid cases was used to redistribute a health state to those with missing information. Responses to service utilization questions provided subject-level data on the number of days in hospital, and the number of visits to family doctors and specialists over a one-year period. Per-person units of health care resource utilization was based on responses of valid cases in the CCHS. The utilization rates of multiple chronic diseases were estimated from the Canadian sample, due to the small number of people in these groups in Alberta.

Unit costs were developed for the aforementioned services using Alberta cost data. The average cost of a typical hospital day was

TABLE 1
Distribution and prevalence of risk behaviours and chronic disease by age group in Alberta (CCHS 2000–01)

	Age groups							
	20 – 45		45–64		65+		All ages	
Risk and disease[a] groups	Population[b]	Percent	Population[b]	Percent	Population[b]	Percent	Population[b]	Percent
No risk behaviors	183,001	15.30	93,542	14.33	40,898	14.34	315,036	14.77
One risk behavior	371,491	31.07	193,550	29.66	82,060	28.78	642,976	30.14
>1 risk behavior	609,657	50.99	296,029	45.36	73,595	25.81	951,454	44.60
Heart disease only	12,113	1.01	24,847	3.81	40,416	14.17	91,666	4.30
COPD only	1,433	0.12	4,970	0.76	8,255	2.90	17,764	0.83
Diabetes only	17,249	1.44	32,201	4.93	27,742	9.73	89,268	4.18
Heart and diabetes	128	0.01	5,446	0.83	8,068	2.83	17,103	0.80
Heart and COPD	651	0.05	1,208	0.19	2,355	0.83	4,991	0.23
COPD and diabetes	0	0.00	237	0.04	1,172	0.41	1,765	0.08
All 3 conditions	0	0.00	539	0.08	565	0.20	1,391	0.07
Total	**1,195,722**	**100.00**	**652,567**	**100.00**	**285,124**	**100.00**	**2,133,413**	**100.00**

[a] Chronic health conditions other than those specified may also coexist, and include asthma, fibromyalgia, arthritis, back problems, high blood pressure, migraine headaches, epilepsy, cancer, stomach or intestinal ulcers, urinary incontinence, inflammatory bowel disease, dementia, glaucoma, cataracts, thyroid disease, neurologic disease including stroke, chronic fatigue syndrome, food allergies and multiple chemical sensitivities.

[b] The final population was derived by using the distribution of health states among valid cases to redistribute the number of missing cases to a corresponding health state.

obtained from Alberta Health and Wellness (AHW), measured as the total inpatient facility) cost divided by total inpatient days, as estimated from the provincial Management Information System (MIS) data base for the budget year 2000–01.[16–18] A weighted-average, province-wide, cost-perdiem statistic ($780) was obtained from all hospitals.

Since physicians bill the provincial payment plan for services and procedures, the data from AHW was used to calculate physician-associated costs. We calculated an average physician-billing per day of hospitalization according to patient age (20–44, 45–64, 65 +). This per diem fee was added to the daily hospital facility cost for each recorded day of care. We estimated total general practitioner (GP) office billings per visit for the province by age group. The cost of diagnostic services attached to GP visits was added to this statistic, so that the total GP cost included examination and diagnostic costs.[18]

The cost of a specialist visit was also calculated by patient age. Specialist visits were divided into two groups: those which were made in specialists' offices and those which were made in hospital outpatient clinics. For the office visits, we calculated an average cost and added the costs per visit for diagnostic services. For outpatient hospital visits, we added a hospital outpatient facility fee based on the province-wide Alberta Ambulatory Care Classification System cost per visit (adjusted for age) to the physician fee to obtain a total cost per outpatient visit.[18]

We added to the CCHS estimates the costs of those who died during 2000, as these persons would not appear in the CCHS, yet would have received services. We estimated the age-specific health care cost of deaths for all persons who died in 2000, including persons with one of the three chronic conditions as the major diagnosis for death according to Alberta mortality statistics,[19] which we valued using the last six months of life cost (average lifetime during the budget year) in Manitoba.[20]

As the CCHS is based on self-reported utilization data, it may be subject to errors of recall. In order to determine the degree of error in our estimates and establish face validity, we compared the population-level costs for physician and hospital inpatient and outpatient care in Alberta, as documented by AHW budget data, to the estimated results using our methodology, and with respect to the population over 20 years of age.

Our analysis had three components. In the first component, we estimated the number of persons in each health status group, which include disease states and risk behaviour. In the second component, we estimated the hospital and physician utilization and cost per person by age category and health status. Finally, with the third component, we calculated global health care system-wide costs by health status, inclusive of mortality cases.

Results

The total non-First Nations population in Alberta aged 20 and over according to the CCHS analysis was 2.13 million. The breakdown of persons by group is shown in Table 1. Approximately 15 percent of the population in each age group exhibited none of the specific risk behaviours, while 75 percent of the population had one or more of them present. Among those without chronic disease, the proportion of subjects exhibiting risk behaviours decreased with age from 82.1 percent (20–45 years) to 54.6 percent (65 +). Those with one or more of the three chronic conditions comprised 10.5 percent of the estimated Albertan population, with disease prevalence rising with increased age.

The unit costs for physician visits and hospital days for the three age groups in Alberta are shown in Table 2. With the exception of family physician visits, fewer resources are used per visit or hospitalization day with increasing patient age, reflecting that fewer investigations and procedures are performed as age increases for any single day. (Note that hospital stays typically are longer among older persons).

The health care utilization statistics are shown in Table 3. There is a trend for higher health care utilization rates when moving across the risk behaviour spectrum in every age group. Furthermore, the number of family physician visits is approximately double for those subjects identified with a chronic condition of interest compared to those not exhibiting risk behaviours. The number of physician visits is substantially higher when more than one chronic disease is present, especially in the youngest age group. Hospitalizations increase very rapidly when moving from the no-risk behaviour population to the multiple chronic diseases category. The number of specialist visits increases gradually by age; however, the variation in the visits by health status is not large within each age group. The increasing trend of health care utilization by increased

FIGURE 1

Average annual total health care costs per person by age in different risk behaviour and chronic disease groups in Alberta, 2000–01

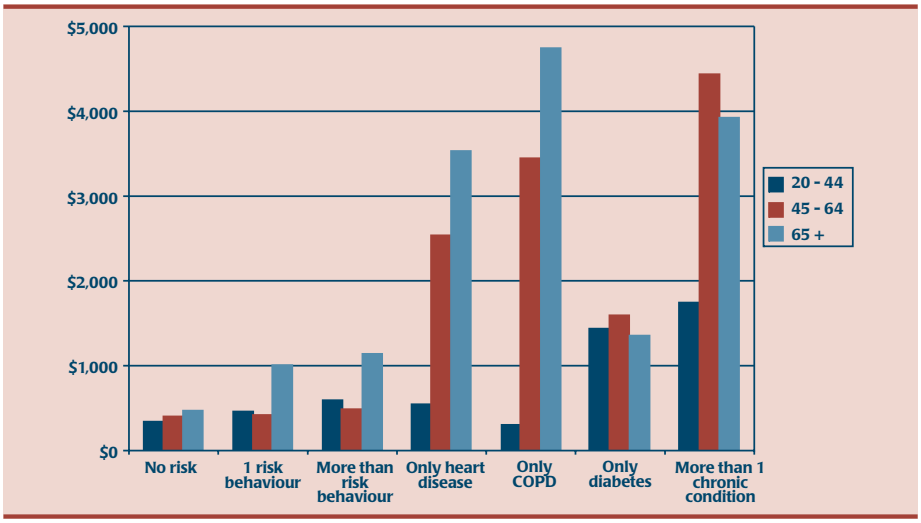
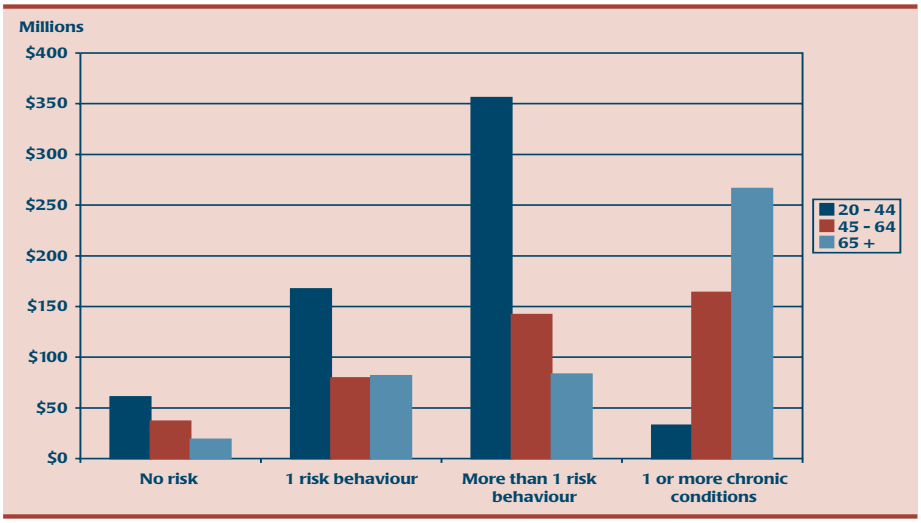


FIGURE 2
Total health care cost in different risk behaviour and combined disease groups among three age groups of adult Albertans, 2000–01 (millions of dollars)



risk behaviour and number of chronic diseases was statistically significant (95 percent CI), with a few exceptions—mainly in the specialist visit category (Table 3).

The average annual cost per person by health status is shown in Figure 1. Similar to utilization data, total annual costs increase through the risk behaviour spectrum: from no-risk behaviour to some risk behaviours, and from one chronic disease to more than one coexisting chronic illness. In those with a single disease of interest, subjects with diabetes alone incurred the lowest costs. Costs increased with increasing age for heart disease and COPD, but not diabetes mellitus alone. Examples of the increment in costs for groups with disease compared to the no-risk groups include a six-fold increase for 45 to 64 years olds and a 7.5 fold increase for those 65 years and over with heart disease. For diabetes, this increase from no risk is approximately four times for the two youngest age groups and three times for the oldest.

The total annual cost in Alberta of the identified services on a population basis was $1.49 billion (excluding the cost of deaths during the year) and was distributed by health status and age as per Figure 2. Approximately 7.8 percent of health care costs in this population were incurred by those without the aforementioned risk behaviours or disease states (14.8 percent of population), with relatively more costs incurred by younger age groups. The population that exhibited one or more risk behaviours were responsible for 61.1 percent of the health care costs, although they comprise 74.7 percent of the population. Persons with the three chronic diseases alone or in any combination accounted for 31.1 percent of total health care costs, although they comprise 10.5 percent of the adult population.

Health care costs associated with the presence of chronic disease is presented in Figure 3. While costs associated with heart disease alone represents about 14.2 percent of all health care costs, the prevalence is 4.3 percent. Similarly, diabetes alone (4.2 percent of the population) or in combination with heart disease (0.8 percent of the population) is responsible for a substantial burden of disease, while COPD has a smaller impact on total health care costs, especially in younger age groups.

Mortality-related costs in Alberta were $187 million. Of these costs about 42 percent were attributable to heart disease, two percent to diabetes and five percent to COPD. The projected cost of death in 2000–01 would increase the individual-based health care cost estimate by 12.6 percent to $1.68 billion.

In validating this costing method, we used as the gold standard the total budgeted cost estimates for hospital and physician services in Alberta. The AHW health care budget data for the adult population showed $2.06 billion, resulting in a difference of 18 percent between the two estimates.

Discussion

Combining the person-level CCHS risk behaviour and utilization data with unit cost data from Alberta for health care services, we estimated the Alberta adult population health care costs, including costs for those exhibiting specific risk behaviour characteristics and those with chronic diseases of interest. As the CCHS contains a high degree of detail with respect to risk behaviours and personal characteristics, our analysis sheds light on system-wide economic issues related to health risk behaviour and chronic disease. Our results indicate that per-person incremental costs rise within the spectrum of risk behaviours prior to the development of

TABLE 2
Average unit costs for family physician visit, specialist visit and hospitalization day by age category in Alberta, 2000–01

Age	Family physician visit[a]	Specialist visit[b]	Hospitalization day[c]
20 – 44	$32.11	$122.29	$918.78
45 – 64	$36.98	$114.20	$884.42
65 +	$33.63	$92.40	$826.80

[a] Source: Alberta Health Care Insurance Plan Payment database (AHW) for physician visits, and provincial fee schedule for laboratory services and diagnostic radiology.
[b] Source: Alberta Health Care Insurance Plan Payment database (AHW) for physician visits, Alberta Ambulatory Care Classification System outpatient facility fee (AHW) where applicable, and provincial fee schedule for laboratory services and diagnostic radiology.
[c] Source: Inpatient Database (AHW) and Management Information System data from Alberta.

TABLE 3
Average (per capita) health care utilization by age in different risk behaviour and chronic disease groups in Alberta, 2000–01

Health status	Family physician visits			Specialist visits[a]			Hospitalization days[b]		
	Mean	SD	95% CI	Mean	SD	95% CI	Mean	SD	95% CI
Age group 20-44									
No risk behavior	2.86	3.874	2.84–2.88	0.53	1.558	0.53–0.54	0.19	1.495	0.18–0.20
One risk behavior	3.20	4.959	3.18–3.22	0.58	1.721	0.58–0.59	0.30	1.927	0.29–0.31
More than 1 risk behaviour	3.52	5.243	3.51–3.54	0.63	1.931	0.62–0.63	0.43	2.564	0.42–0.44
Only heart disease	4.15	5.264	4.03–4.28	1.02	2.239	0.96–1.07	0.30	2.005	0.26–0.35
Only COPD	6.52	3.843	6.26–6.78	0.70	1.269	0.61–0.79	0.00	0.000	NA
Only diabetes	8.06	7.926	7.90–8.22	1.51	2.995	1.45–1.57	1.07	3.500	1.00–1.14
More than one disease[c]	11.89	10.473	11.68–12.44	4.18	3.890	4.10–4.26	5.15	8.781	4.96–5.33
Age group 45-64									
No risk behaviour	3.11	3.959	3.08–3.13	0.85	2.028	0.84–0.87	0.21	1.730	0.19–0.22
One risk behaviour	3.22	4.028	3.21–3.24	0.67	1.625	0.66–0.68	0.24	1.602	0.24–0.25
More than 1 risk behavior	3.62	5.446	3.60–3.64	0.56	1.744	0.56–0.57	0.32	2.191	0.31–0.33
Only heart disease	7.85	7.420	7.76–7.95	1.43	2.459	1.40–1.46	2.34	5.614	2.27–2.42
Only COPD	5.63	4.728	5.50–5.77	1.56	3.109	1.47–1.65	3.45	6.811	3.25–3.65
Only diabetes	5.93	5.012	5.87–5.99	1.13	2.246	1.10–1.15	1.40	3.958	1.35–1.44
More than one disease[c]	9.11	8.188	9.06–9.17	2.55	3.250	2.52–2.57	4.22	8.593	4.17–4.28
Age group 65+									
No risk behaviour	3.37	3.450	3.33–3.40	0.49	1.093	0.48–0.50	0.37	2.279	0.34–0.39
One risk behaviour	4.15	4.922	4.15–4.19	0.69	1.583	0.67–0.70	0.96	3.835	0.93–0.99
More than 1 risk behaviour	4.44	5.267	4.40–4.48	0.62	1,863	0.61–0.64	1.12	3.790	1.09–1.15
Only heart disease	6.86	6.035	6.80–6.93	1.35	2.089	1.33–1.37	3.83	8.650	3.74–3.92
Only COPD	8.10	8.391	7.91–8.29	1.90	2.378	1.85–1.96	5.19	8.943	4.98–5.39
Only diabetes	5.76	5.866	5.69–5.83	0.61	1.168	0.59–0.62	1.33	4.796	1.27–1.39
More than one disease[c]	8.00	6.406	7.97–8.03	1.93	2.903	1.92–1.94	4.29	8.292	4.25–4.33

Note: Means are based on the responses of valid cases (i.e. non-missing cases).

[a] Including outpatient hospital visits

[b] Excluding long-term chronic care facility stay

[c] Means are based on the responses from the entire Canadian population due to irregularities in the utilization of Albertans with more than one of the specified diseases.

the specified chronic diseases, a finding which to our knowledge has not previously been reported on a population basis. Furthermore, costs increase markedly when chronic disease occurs, especially so for those with multiple co-existing diseases.

The WHO has predicted a shift in the prevalence of chronic diseases because of the widespread prevalence of risk behaviours.[1] Our results suggest that an increase in the disease burden will have substantial economic consequences, because of both the sheer number of persons currently exhibiting unhealthy behaviours who are at risk of developing the diseases, and the significant cost implications of developing a chronic disease. While the number of persons who have chronic diseases is relatively small at present, such persons are very costly, especially so in younger age groups. The number of persons without chronic disease who exhibit high risk behaviours is very large—especially in the younger age groups though they are not yet costly (although clearly more costly than their no-risk counterparts). As such, the potential for large increases in economic burden due to chronic disease is substantial, although the proportion of subjects who will go on to develop chronic disease and at what age the disease will manifest are not known.

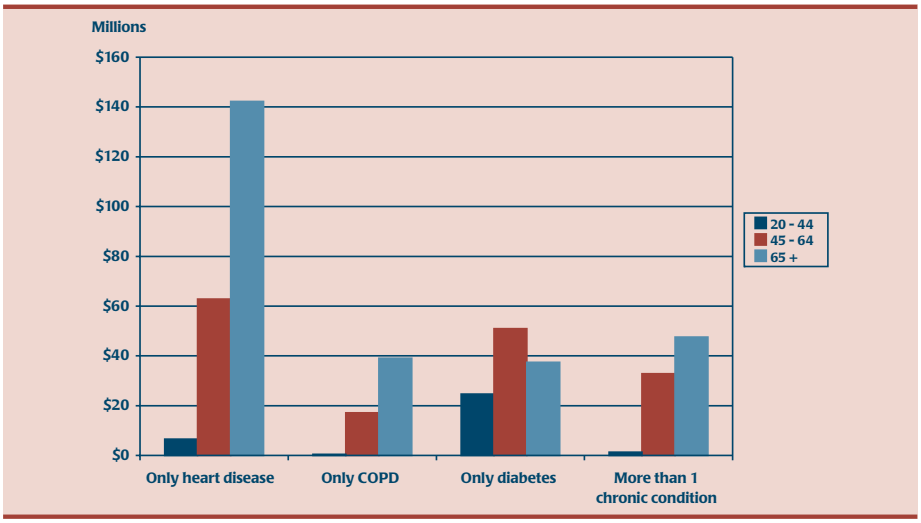
While the incremental per-person costs for those exhibiting unhealthy behaviours (without the chronic diseases in question) are relatively small, the large number of persons accounts for a large fraction of health care costs. While this health care use may be advantageous if it is addressing risk factor modification, the relatively low health care expenditure on prevention in Alberta suggests that this may not be the case.[21] The confluence of multiple risk factors may lead to opportunities to provide prevention strategies efficiently. The nature of the health care services used needs to be clarified in future studies, and opportunities for multiple simultaneous risk factor modification (similar to those provided in disease management clinics), as well as improved efficiency of health care resource use, should be promulgated.

Several limitations merit specific mention. The scope of risk behaviours considered was limited to smoking, nutrition and physical activities, and while the WHO has identified these as major modifiable risks, other genetic, environmental, and person-level risks were not included in this analysis. In addition, the self-reported nature of risk behaviours and disease states may lead to systematic error, although evidence suggests this error is likely to be small.[15,22]

Our utilization analysis is based on self-reported data, and investigators have questioned whether , as such, is subject to a recall bias.[23,24] We conducted a validity check to determine the degree of correspondence between costs as estimated by our method, and as those reported through provincial expenditure data, and found a difference of 18 percent. There may be several reasons for tthis differences. For example, First Nations persons who live on reserves were not captured. This population has an increased prevalence of chronic diseases including diabetes and respiratory disease, and incurs higher health care utilization than a matched population.[25] Approximately 3.8 percent of the Alberta population in 2000 was of First Nations status,[25] and it is estimated that 60 percent live on reserves.[26] Additionally, institutionalized adults are also excluded from the CCHS. Approximately five percent of Canadians reside in nursing homes. The vast majority of these are over the age of 65 years and on average consume more health care resources.[27] Also, persons of very low socioeconomic status who may utilize several times more health care resources than the general population may not be captured in population health surveys. When accounting for this incomplete capture of approximately seven percent of the population who are very likely to exhibit greater-than-average health care utilization, the range of error is not wide. This adds confidence and face validity to our estimates based on individual-level data, and establishes this methodology as a credible approach to population-based costing.

The estimation of the total population was done by multiplying the age- and risk/disease-category-specific rate in the CCHS by the Statistics Canada population estimate. The validity of this estimate depends on the accuracy of the sampling and the prevalence of the condition or behaviour. The sampling methodology of the CCHS has been demonstrated to be very accurate in representing the Canadian population characteristics,[28] and as such even a relatively small prevalence of some diseases in the lowest age group (20–44) is likely to lead to accurate population estimates at a global level. However, the small numbers of subjects with disease in younger age groups may increase the uncertainty of the cost estimates to a

FIGURE 3
Total health care cost in different chronic disease groups, and in their combinations, among three adult-Albertan age groups, 2000–01 (millions of dollars)



certain amount, mainly in the group with multiple chronic conditions. To minimize this risk of small numbers, we used Canada-wide health care utilization estimates in all multiple chronic disease groups. Lastly, disease classification errors in cause-of-death reporting may also lead to some inaccuracies.

One of the benefits of our approach has been the ability to generate relatively complete costs for each of the components of utilization that we studied. Doctors' office visits contained both direct fees and diagnostic costs. Doctors' hospital outpatient (including emergency room) visits considered doctors' fees and facility costs. Hospital inpatient stays calculated the doctor and facility components, including overheads relating to administrative, diagnostic and support services. The comprehensiveness of our unit-cost measure is a partial explanation for the correspondence between, on one hand, costs as we calculated them, and provincially budgeted expenditures on the other.

Several components of care are not attainable with our method. The most obvious omission is outpatient drug costs, which cannot be estimated from CCHS. We were able to estimate from Alberta administrative data only the prescription drug costs of diabetes, heart disease and COPD for population over 65 years of age ($134 million). Most of these costs were related to heart disease drugs (85.5 percent), and a much smaller proportion to diabetes (9.1 percent) and COPD (5.4 percent). We also omitted home care because it is vaguely reported and its current economic impact is of small magnitude. Our analysis also does not include the indirect costs associated with lost productivity caused by disability and mortality. Indirect costs are usually included in burden of disease calculations, although methodologically they are a controversial topic due to difficulties in accurately defining and measuring the "'opportunity cost" of future lost work.[29,30] In addition, CCHS determines the long-term disability for only the 12-month period prior to the interview, thus making the estimation of future or past disability/lost-productivity costs difficult.

We have demonstrated and described in detail the gradient of increasing health care costs across the risk behaviour and chronic disease spectrum using a framework advocated by the World Health Organization. Our analyses indicate that person-level data from large, population-based health surveys can be used to accurately estimate bottom-up global health care costs, thus offering new possibilities to examine the impact on resources and costs of demographics, risk behaviours, and major chronic diseases in isolation or in combination. This information can also be used to determine the size and characteristics of the target populations of preventive interventions. Our findings using this approach demonstrate increased resource utilization by those who exhibit risk factors but who have not yet developed the diseases of interest, as well as by those with multiple co-existing chronic diseases of interest. This may have important implications for identification of persons exhibiting risk behaviours, since modification of their behaviours may provide an opportunity to attenuate resource utilization before chronic disease sets in.

Acknowledgements

We would like to thank Health Canada and Alberta Health and Wellness for their financial support of this study.

References

1. World Health Organization. Global strategy for the prevention and control of noncommunicable disease. Geneva, Switzerland: World Health Organization, A53/14;3–22–2000.
2. Health Canada. Economic burden of illness in Canada, 1998. Ottawa, Ontario: Population and Public Health Branch, Health Canada; 2002.
3. Colman R. The cost of chronic disease in Nova Scotia. Halifax: Nova Scotia, GPI Atlantic; 2002.
4. Dawson KG, Gomes D, Gerstein H, et al. The economic cost of diabetes in Canada, 1998. Diabetes Care. 2002;25(8):1303–7.
5. Chan B, Coyte P, Heick C. Economic impact of cardiovascular disease in Canada. Can J Cardiol Cardiol. 1996;12(10):1000–6.
6. National Institute of Cancer of Canada. Canadian cancer statistics 2004. Toronto, Ontario: Canadian Cancer Society; 2004.
7. Kaiserman M. The cost of smoking in Canada, 1991. Chronic Diseases in Canada 1997;18(1):1–12.
8. Katzmarzyk PT, Gledhill N, Shephard RJ. The economic burden of physical inactivity in Canada. CMAJ. 2000;163(11):1435–40.
9. Simpson SH, Corabian P, Jacobs P, et al. The cost of major co-morbidity in people with diabetes mellitus. CMAJ. 2003;168(13): 1661–7.
10. Ramsey SD, Newton K, Blough D, et al. Patient-level estimates of the cost of complications in diabetes in a managed-care population. Pharmacoeconomics. 1999;16(3):2 85–95.
11. Rapoport J, Jacobs P et al. (2004). Refining the measurement of the economic burden of chronic diseases in Canada. Chronic Dis Can. 2004;25(1):13–21.
12. Canadian Community Health Survey 2000–2001. [Database] Ottawa: Statistics Canada, 2003.
13. Statistics Canada. Canadian Community Health Survey Methodological Overview. Health Reports 2002 Mar;13(3):9–14.
14. Stephens TM, Craig CL. The well-being of Canadians: Highlights of the 1988 Campbell's Survey. Ottawa, ON: Canadia Fitness and Lifestyle Research Institute, 1993; 91–118.
15. Craig C, Russell S, and Cameron C. Reliability and validity of Canada's Physical Activity Monitor for assessing trends. Med Sci Sports Exerc. 2002 Sep;34(9):1462–7.
16. Jacobs P. A National list of provincial costs for health care: Canada 1997/8. Institute of Health Economics Working Paper, 2000
17. Jacobs P, Roos NP. Standard cost lists for health care in Canada. Issues in validity and inter-provincial consolidation. Pharmacoeconomics. 1999;15:551–60.

18. Philip Jacobs P, Scott Klarenbach S, Arto Ohinmaa A, Kamran Golmohammadi K, Sandor Demeter S, Donald Schopflocher D. Chronic diseases in Alberta: Cost of treatment and investment in prevention. Alberta Healthy Living Network. www.health-in-action.org/library/pdf/AHLN/whatsnew/Chronic_Diseases_in_AB.pdf

19. Alberta Government Services. Alberta Vital Statistics. Annual review 2000. Edmonton: Alberta, Alberta Government Services; 2001.

20. Menec V, Lix L, Steinbach C et al. Patterns of health care use and cost at the end of life. Winnipeg: Manitoba Centre for Health Policy; February 2004.

21. Jacobs P, Ohinmaa A, Golmohammadi K, Demeter S, Schopflocher D, Klarenbach S. Public investment in providing information for chronic disease prevention for adults in Alberta, 2003: A cross-sector analysis. Canadian Journal of Public Health. 2005 (in press)

22. Haapanen N, Miilunpalo S, Pasanen M, Oja P, Vuori I: Agreement between questionnaire data and medical records of chronic diseases in middle-aged and elderly Finnish men and women. Am J Epidemiol. 1997;145:762–9

23. Harlow S, Linet M. Agreement between questionnaire data and medical records. The evidence for accuracy of recall. Am J Epidemiol. 1989;129(2):233–48.

24. Linet M, Harlow S, McLaughlin J, McCaffrey L. A comparison of interview data and medical records for previous medical conditions and surgery. J Clin Epidemiol. 1989;42(12):1207–13.

25. Cardinal J, Schopflocher D, Svenson L, Morrison K, Laing L. First Nations in Alberta: A focus on health service use. Edmonton: AB, Alberta Health and Wellness, 2004 Available at: http://www.health.gov.ab.ca/resources/publications/index.html#Nations Accessed November 15, 2005

26. Alberta: First Nations Population – Summary (December, 2002). AB, Alberta Aboriginal Affairs and Northern Development, June 2003

27. Donna Dryden D. Health services utilization in the population aged 65 and older: Review of the literature. Alberta Centre for Health Services Utilization Research. March 1999. Available at: http://www.health.gov.ab.ca/key/research/01_summary.PDF (accessed Nov 24, 2005)

28. Canadian Community Health Survey (CCHS) [Statistics Canada Web site]. December 18, 2003. Available at: http://www.statcan.ca/english/concepts/health/. Accessed June 24, 2004.

29. Koopmanschap M, Rutten F. Indirect costs in economic studies: Confronting the confusion. Pharmacoeconomics. 1993;4(6):446–54.

30. Oostenbrink J, Koopmanschap M, Rutten F. Standardisation of costs: The Dutch manual for costing in economic evaluations. Pharmacoeconomics. 2002;20(7):443–54.

Multiple exposures to smoking, alcohol, physical inactivity and overweight: Prevalences according to the Canadian Community Health Survey Cycle 1.1

Julia E Klein-Geltink, Bernard CK Choi and Richard N Fry

Abstract

The objective of this study was to calculate the prevalence of multiple exposures to four modifiable risk factors (smoking, alcohol, physical inactivity and overweight) and to establish whether there are more Canadians with multiple risk factor exposures than those with singular ones. Weighted estimates of the prevalence of mutually exclusive risk factor clusters were calculated according to the Canadian Community Health Survey, Cycle 1.1 (2000). Confidence limits were estimated by bootstrap techniques. Findings indicate that 21.0 percent of Canadians have no risk factor exposures, 53.5 percent are physically inactive, 21.5 percent currently smoke, 44.8 percent are overweight, and 6.0 percent are high-risk drinkers. Compared to females, males are less physically inactive but more likely to smoke, have high alcohol intake and be overweight, across all age groups. At least one risk factor was present in 79.0 percent of Canadians and 39.0 percent have at least two coexistent exposures. The distribution of risk factor prevalences differed significantly by age, most peaking among those between age 35 and 64, with the exception of physical inactivity. Those who smoke and are physically inactive account for the highest proportion of the population with two or more coexistent risk factors. Canadians who are free of the four risk factors for chronic disease examined in this paper constitute the minority. Future studies are recommended to examine other risk factors, as well as interactions of multiple exposures in association with chronic disease.

Key words: *chronic diseases, epidemiology, multiple exposures, prevalence*

Introduction

Chronic illness represents a major disease burden to society and is to a large extent preventable.[1–3] The major chronic diseases causing death in Canada are cardiovascular disease (CVD), cancer, chronic respiratory disease (CRD) and diabetes.[4] Several of these diseases share common preventable risk factors, including smoking, high alcohol intake, physical inactivity and overweight.[1,4–8] It is incumbent upon public health professionals to determine if—and potentially to what extent—unhealthy behaviours can be modified to reduce the risk of disease.[2,3]

Much of the research relating risk factors to chronic diseases has focussed on singular independent risk factors. Yet these factors are known not to occur in isolation. Smoking, high alcohol intake, physical inactivity and overweight coexist within individuals. Dawson notes the literature has established that, within individuals, drinking is associated with long-term smoking behaviour.[9] Within-person associations between physical inactivity and overweight,[10–12] and alcohol intake and overweight are reported.[13] Similar relationships between smoking and physical inactivity,[14,15] smoking and overweight,[16–18] and alcohol intake and physical inactivity have also been found.[19]

These risk factors are also known to coexist, or cluster, with respect to disease, allowing researchers to identify those who are at an especially high risk for a disease based on risk factor profiles. Research has focussed primarily on Syndrome X, a cluster of metabolic risk factors including insulin resistance, abnormal blood fats, overweight and high blood pressure, which increase risk for CVD and diabetes.[20,21] Past studies have looked at the clustering of the major behavioural risk factors for CVD in relation to Syndrome X. Particularly, Twisk et al. found clustering with respect to CVD among Syndrome X, physical inactivity and, in males, heavy alcohol consumption.[22] Genest et al. reviewed the research on clustering of behavioural and metabolic risk factors for CVD in an effort to identify those with high-risk profiles.[23] A similar study quantified the extent of clustering in the American Indian and Alaskan Native population.[24] It was also found that as the number of risk factors increases in young people, so too does severity of asymptomatic coronary and aortic atherosclerosis.[25] Similar clustering relationships with respect to other chronic diseases have been noted.[7,26,27] One recent study quantified

Author References

Julia E Klein-Geltink, Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada; Department of Public Health Sciences, Faculty of Medicine, University of Toronto

Bernard CK Choi, Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada; Department of Public Health Sciences, Faculty of Medecine, University of Toronto; Department of Epidemiology and Community Medicine, Faculty of Medicine, University of Ottawa

Richard N Fry, Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada

Correspondence: Bernard CK Choi, Centre for Chronic Disease Prevention and Control, Public Health Agency of Canada, AL 6701A, 120 Colonnade Road, Ottawa, Ontario, Canada K1A 1B4; e-mail: Bernard_Choi@phac-aspc.gc.ca

the prevalence and clustering of cigarette smoking, risky drinking of alcoholic beverages, physical inactivity and overweight in the U.S. population based on 2001 data.[28]

Despite these reports of risk factor coexistence,[28,29] the prevalence of such coexistence and resultant impacts on risk for the major chronic diseases has not been described systematically in the Canadian population. The primary objective of this study was to estimate the prevalences[30] within the Canadian population of various clusters of risk factors of interest (smoking, high alcohol intake, physical inactivity and overweight). Our research question was to quantify what proportion of the Canadian population have multiple coexistent rather than singular independent risk factor exposures.

TABLE 1
Weighted prevalence and confidence limits of selected chronic disease risk factors in Canada, Canadian Community Health Survey, Cycle 1.1 (2000)

Risk factor	Number in sample	Number in population	Prevalence*	Lower 95% CL†	Upper 95% CL
None	23,186	4,863,489	21.0	20.7	21.4
Smoking‡	29,011	5,539,648	21.5	21.2	21.9
High alcohol intake§	7,277	1,524,372	6.0	5.8	6.2
Physical inactivity¶	61,444	12,662,515	53.5	53.0	53.9
High BMI#	58,258	11,352,881	44.8	44.3	45.2
Total	**125,574**	**25,801,718**			

* Prevalence of risk factor was calculated by weighted methods and expressed in terms of percentage of total Canadian population. Total prevalence equals more than 100% because some respondents may be counted in more than one risk factor category.
† CL = Confidence limit
‡ Smoking = current smoker; Non-smoking = never been smoker or former smoker.
§ High alcohol intake = consuming more than 14.0 drinks per week (male) or 9.0 drinks per week (female); Low alcohol intake = consuming 14.0 or less drinks per week (male) or 9.0 or less drinks per week (female)
¶ Physically inactive = having an energy expenditure level of less than 1.5 kcal/kg/day; Physically active = having an energy expenditure level of 1.5 or more
# High BMI = overweight or having a BMI of greater than or equal to 25; Low BMI = BMI of less than 25

Materials and methods

Prevalences for various risk factor clusters were estimated from the Canadian Community Health Survey (CCHS) Cycle 1.1 (2000) data file, using a methodology based on binary risk factor variables, stratified by age and sex.

Data source

The CCHS is a cross-sectional survey of health determinants, health status and health care system utilization in Canada.[31, 32] Data collection began in September 2000 and follows a two-year cycle in which health-region-level data is collected in the first year (Cycle 1.1), and provincial-level data is collected in the second (Cycle 1.2). Data from the first year, with a sample size of approximately 130,000, were used in this study. The sampling frame covered approximately 98 percent of the Canadian population over age 12. The sample included one randomly selected respondent per selected household in all provinces and territories. First Nations reserves, Canadian Forces Bases and some remote areas were excluded.

Risk factor definitions

"Smoking" was defined as a current daily smoker; "non-smoking" denoted never having smoked or being a former or current occasional smoker. Smoking status was derived from four CCHS questions, which assessed quantity of cigarettes smoked during a lifetime, the smoking status of the respondent at the present time (daily, occasional or not at all) and if the respondent had ever smoked cigarettes daily.[33]

"High alcohol intake" was defined as having more than 14 drinks per week (males) or nine drinks per week (females); "low alcohol intake" meant 14 or fewer drinks per week (males) or nine or fewer drinks per week (females). These cutoffs were based on the recommendations by Statistics Canada (2002),[34] Bondy et al.[35] and the meta-analysis findings of English et al. which indicate that weekly consumption of more than 14 drinks per week for males and nine drinks per week for females begin to link with an increased risk of overall mortality.[36] Alcohol intake was assessed using a measure for derived, continuous alcohol consumption over the previous week.[33]

"Physical inactivity" was assessed using a derived CCHS variable—energy expenditure—and was calculated using the frequency and duration of a respondent's physical activity sessions self-report as well as its metabolic equivalent (MET) value. The MET is a value of metabolic energy cost expressed as a multiple of the resting metabolic rate.[33] Expressed as kilocalories per kilogram of body weight per day (kcal/kg/day), an energy expenditure value of less than 1.5 (moderate activity) was considered physically inactive. This approach is consistent with other literature reporting the prevalence of physical inactivity in Canada.[37]

Body mass index (BMI)[30] was calculated based on weight and height variables using the equation BMI = weight (kg)/height $(m)^2$. Among adults 19 years of age and older, a BMI equal to or greater than 25 (overweight) was considered high, while a BMI less than 25 was considered low. For those 18 years and under, we used overweight cutoff levels by age and sex, as suggested by Cole et al.[38]

Risk factor cluster variables

When data were analysed with respect to the four single risk factors, each risk factor was coded binary (YES = 1, NO = 0), irrespective of the status of the other risk factors. In order to measure prevalence of risk factor clusters in the population, a total of 15 risk

TABLE 2
Weighted prevalence and 95% confidence limits of selected chronic disease risk factors in Canada, by age and sex, Canadian Community Health Survey, Cycle 1.1 (2000)

Risk factor	Age groups (years) 12–19	20–34	35–49	50–64	65+	Total
Males						
None	**49.2** (47.5, 50.9)	**18.0** (16.9, 19.1)	**12.0** (11.3, 12.7)	**11.7** (10.9, 12.6)	**18.5** (17.2, 19.9)	**18.9** (18.4, 19.4)
Smoking‡	**12.2** (11.3, 13.2)	**29.6** (28.3, 30.8)	**29.4** (28.4, 30.3)	**22.2** (21.1, 23.3)	**11.8** (10.8, 12.8)	**23.6** (23.1, 24.1)
High alcohol intake§	**3.8** (3.2, 4.5)	**11.3** (10.5, 12.1)	**7.8** (7.2, 8.4)	**7.6** (6.9, 8.4)	**4.9** (4.3, 5.6)	**7.8** (7.5, 8.1)
Physical inactivity¶	**24.7** (23.3, 26.0)	**48.0** (46.6, 49.4)	**56.0** (54.9, 57.2)	**55.5** (54.1, 56.9)	**53.1** (51.4, 54.8)	**49.6** (48.9, 50.3)
High BMI#	**25.6** (24.1, 27.1)	**45.5** (44.3, 46.8)	**59.2** (58.1, 60.3)	**64.3** (62.9, 65.6)	**54.5** (53.0, 56.1)	**51.8** (51.2, 52.4)
Total Canadian population	**1,662,580**	**3,193,934**	**3,826,542**	**2,427,992**	**1,594,367**	**12,705,415**
Females						
None	**45.0** (43.3, 46.6)	**25.2** (24.1, 26.4)	**20.2** (19.3, 21.2)	**17.0** (16.0, 18.0)	**16.6** (15.5, 17.7)	**23.1** (22.5, 23.6)
Smoking‡	**13.7** (12.7, 14.7)	**22.7** (21.7, 23.7)	**24.5** (23.5, 25.4)	**19.6** (18.6, 20.5)	**9.5** (8.8, 10.2)	**19.5** (19.0, 20.0)
High alcohol intake§	**3.4** (2.8, 3.9)	**5.2** (4.7, 5.6)	**5.1** (4.7, 5.6)	**3.7** (3.2, 4.2)	**2.7** (2.2, 3.2)	**4.3** (4.0, 4.5)
Physical inactivity¶	**38.6** (37.0, 40.2)	**54.7** (53.5, 55.9)	**58.6** (57.5, 59.6)	**59.1** (57.8, 60.3)	**68.2** (66.9, 69.5)	**57.0** (56.4, 57.5)
High BMI#	**16.4** (15.4, 17.5)	**27.7** (26.7, 28.8)	**39.5** (38.4, 40.6)	**53.3** (51.9, 54.7)	**47.9** (46.6, 49.1)	**37.8** (37.3, 38.4)
Total Canadian population	**1,580,702**	**3,107,188**	**3,897,071**	**2,457,918**	**2,053,423**	**13,096,302**

* Prevalence of risk factor was calculated by weighted methods and expressed in terms of percentage of total Canadian population.
† Confidence limit
‡ Smoking = current smoker; Non-smoking = never been smoker or former smoker.
§ High alcohol intake = consuming more than 14.0 drinks per week (male) or 9.0 drinks per week (female); Low alcohol intake = consuming 14.0 or less drinks per week (male) or 9.0 or less drinks per week (female)
¶ Physically inactive = having an energy expenditure level of less than 1.5 kcal/kg/day; Physically active = having an energy expenditure level of 1.5 or more
# High BMI = overweight or having a BMI of greater than or equal to 25; Low BMI = BMI of less than 25

factor categories (four singular risk factors, six risk factor pairs, four risk factor trios, one category with all four risk factors) were encoded based on the four risk factors under study. The group of respondents with no risk factors (i.e., smoking = NO; high alcohol intake = NO; physical inactivity = NO; high BMI = NO) was defined for analyses as the baseline comparison group, named "None". Fifteen categorical variables for the risk factor clusters were created. For example, individuals were counted in the "Smoking" category if they were smoking, but had none of the other risk factors. Individuals were counted in the "Smoking and High alcohol intake" category if they currently smoked and had high alcohol intake, but were physically active and had low BMI; otherwise, they were not counted. Finally, individuals were counted in the "Smoking, High alcohol intake, Physically inactivity and High BMI" category if they had exposure to all four risk factors; otherwise, they were not counted.

Statistical analysis

Prevalence of risk factor clusters was estimated by weighted methods appropriate for the stratified complex design of CCHS and expressed as a percentage of the total Canadian population. Its 95 percent confidence limits (CL) were estimated by bootstrap techniques.[39] Cases for whom data on any of these variables were missing were not included in the respective prevalence calculations. The Statistical Analysis System, version 8.01 for Windows (SAS Institute, Inc., Cary, North Carolina), was used for all analyses including bootstrapping. All differences discussed are statistically significant.

Results

Tables 1 and 2 show prevalences of single risk factor exposures. Here, prevalence refers to weighted prevalence of a single factor in the population, regardless of any of its co-occurrences with other factors.

Table 1 shows the weighted prevalence of the four selected risk factors expressed as percentages of the total Canadian population. Our results indicate that 21.0 percent of Canadians have no risk factor exposures, 21.5 percent currently smoke, 6.0 percent are high-risk drinkers, 53.5 percent are physically inactive, and 44.8 percent are overweight.

Table 2 shows that, across most age groups, males were found to be significantly less physically inactive, but more likely to smoke, have high alcohol intake and be overweight when compared to females. Additionally, the proportion of males with none of the four risk factors was significantly lower than that of females. Prevalence values for high-risk drinking and overweight peaked in the same age groups for both males and females.

Tables 3 to 5 show prevalences of multiple risk factor exposures. The prevalence refers to the weighted prevalence of the population, counting only those risk factors specified. For example, smoking prevalence specifically refers to the prevalence of current smokers (smoking = YES) who had low alcohol intake (high alcohol intake = NO), were physically active (physical inactivity = NO) and had low BMI (high BMI = NO). Thus, the risk factors specified in Tables 3–5 are discrete (i.e. non-overlapping).

Table 3 presents risk factor cluster prevalences as percentages of the Canadian population and their associated 95 percent confidence limits in the Canadian population. For example, 4.3 percent of Canadians (Sample N = 5,555) were current smokers who had low alcohol intake, were not physically inactive and had low BMI. Whereas 0.8 percent of Canadians (Sample N = 923) were current smokers who had high alcohol intake, but were not physically inactive and had low BMI (Table 3).

TABLE 3
Weighted prevalence of selected chronic diseases risk factors and risk factor clusters in Canada, Canadian Community Health Survey, Cycle 1.1 (2000)

Risk factors present within individual**	Number in sample	Number in population	Prevalence*	Lower 95% CL†	Upper 95% CL
None	23,186	4,863,489	21.0	20.7	21.4
Smoking‡ (only)	5,555	1,004,329	4.3	4.2	4.5
High alcohol intake§ (only)	1,146	258,008	1.1	1.0	1.2
Physical inactivity¶ (only)	19,712	4,488,975	19.4	19.0	19.8
High BMI# (only)	18,628	3,510,975	15.2	14.9	15.5
Smoking and high alcohol intake	923	174,284	0.8	0.7	0.8
Smoking and physical inactivity	7,660	1,523,506	6.6	6.4	6.8
Smoking and high BMI	3,793	644,632	2.8	2.7	2.9
High alcohol intake and physical inactivity	669	157,492	0.7	0.6	0.8
High alcohol intake and high BMI	1,102	229,186	1.0	0.9	1.1
Physical inactivity and high BMI	22,143	4,394,103	19.0	18.7	19.4
Smoking, high alcohol intake and physical inactivity	1,019	214,517	0.9	0.9	1.0
Smoking, high alcohol intake and high BMI	543	101,418	0.4	0.4	0.5
Smoking, physical inactivity and high BMI	6,583	1,229,995	5.3	5.1	5.5
High alcohol intake, physical inactivity and high BMI	894	179,685	0.8	0.7	0.9
Smoking, high alcohol intake, physical inactivity and high BMI	730	142,894	0.6	0.6	0.7
Total	**125,574** (11,288 missing)	**25,801,718** (2,684,230 missing)	**99.9**		

* Prevalence of risk factor cluster was calculated by weighted methods and expressed in terms of percentage of total Canadian population.
** All categories are discrete and non-overlapping.
† Confidence limit
‡ Smoking = current smoker; Non-smoking = having never smoked or being a former smoker
§ High alcohol intake = consuming more than 14.0 drinks per week (male) or 9.0 drinks per week (female); Low alcohol intake = consuming 14.0 or less drinks per week (male) or 9.0 or less drinks per week (female)
¶ Physical inactivity = having an energy expenditure level of less than 1.5 kcal/kg/day; Physical activity = having an energy expenditure level of equal to or greater than 1.5
# High BMI = overweight or having a BMI of greater than or equal to 25; Low BMI = having a BMI of less than 25

From Table 3, 79.0 percent (or 100 percent minus 21.0 percent) of the population had at least one of the four risk factors, 39.0 percent had at least two, 8.1 percent had at least three and 0.6 percent had all four. The cluster with none of the risk factors accounted for the highest cluster prevalence (21.0 percent), followed by those with physical inactivity (19.4 percent); physical inactivity and overweight (19.0 percent); and

TABLE 4
Weighted prevalence and 95% confidence limits of selected chronic disease risk factors and risk factor clusters in Canadian males, by age, Canadian Community Health Survey, Cycle 1.1 (2000)

Risk factor present within individual**	Age groups (years) 12–19	20–34	35–49	50–64	65+	Total
None	**49.2** (47.5, 50.9)	**18.0** (16.9, 19.1)	**12.0** (11.3, 12.7)	**11.7** (10.9, 12.6)	**18.5** (17.2, 19.9)	**18.9** (18.4, 19.4)
Smoking‡ (only)	**5.6** (4.8, 6.3)	**5.7** (5.1, 6.3)	**4.3** (3.8, 4.7)	**3.3** (2.8, 3.8)	**2.0** (1.6, 2.4)	**4.3** (4.1, 4.6)
High alcohol intake§ (only)	1.4 (0.9, 1.8)	**2.0** (1.6, 2.4)	**0.7** (0.5, 0.9)	**0.9** (0.6, 1.1)	**0.7** (0.4, 1.0)	**1.1** (1.0, 1.3)
Physical inactivity¶ (only)	**14.6** (13.4, 15.8)	**15.6** (14.5, 16.7)	**13.2** (12.3, 14.0)	**11.7** (10.7, 12.7)	**18.0** (16.8, 19.3)	**14.3** (13.7, 14.8)
High BMI# (only)	**15.9** (14.7, 17.0)	**17.1** (16.0, 18.2)	**19.3** (18.4, 20.2)	**22.7** (21.6, 23.9)	**22.7** (21.4, 24.1)	**19.4** (18.9, 19.9)
Smoking and high alcohol intake	**1.2** (0.8, 1.5)	**2.0** (1.6, 2.4)	**0.8** (0.6, 1.0)	**0.5** (0.3, 0.7)	**0.2** (0.1, 0.4)	**1.0** (0.9, 1.1)
Smoking and physical inactivity	**2.5** (2.0, 3.0)	**8.1** (7.3, 9.0)	**7.5** (6.9, 8.2)	**5.6** (5.0, 6.3)	**3.9** (3.3, 4.5)	**6.3** (5.9, 6.6)
Smoking and high BMI	**1.6** (1.2, 2.0)	**3.8** (3.3, 4.3)	**5.0** (4.5, 5.4)	**3.2** (2.8, 3.6)	**1.3** (1.0, 1.6)	**3.5** (3.3, 3.7)
High alcohol intake and physical inactivity	**0.4** (0.2, 0.6)	**1.1** (0.8, 1.3)	**0.5** (0.3, 0.6)	**0.7** (0.5, 0.9)	**0.5** (0.3, 0.7)	**0.7** (0.6, 0.8)
High alcohol intake and high BMI	**0.5** (0.3, 0.8)	**2.2** (1.8, 2.6)	**1.4** (1.2, 1.7)	**2.0** (1.5, 2.4)	**1.3** (1.0, 1.7)	**1.6** (1.4, 1.8)
Physical inactivity and high BMI	**5.3** (4.6, 6.1)	**13.5** (12.5, 14.5)	**22.3** (21.3, 23.3)	**26.7** (25.5, 28.0)	**25.2** (23.8, 26.7)	**19.2** (18.7, 19.7)
Smoking, high alcohol intake and physical inactivity	**0.3** (0.2, 0.4)	**1.5** (1.2, 1.8)	**1.5** (1.2, 1.8)	**0.9** (0.6, 1.2)	**0.5** (0.3, 0.8)	**1.1** (1.0, 1.2)
Smoking, high alcohol intake and high BMI	**0.4** (0.3, 0.6)	**1.1** (0.9, 1.4)	**0.7** (0.5, 0.9)	**0.5** (0.3, 0.6)	**0.2** (0.0, 0.4)	**0.7** (0.6, 0.8)
Smoking, physical inactivity and high BMI	**1.0** (0.6, 1.4)	**6.0** (5.4, 6.6)	**8.3** (7.7, 8.9)	**7.2** (6.4, 7.9)	**3.0** (2.5, 3.6)	**6.0** (5.7, 6.2)
High alcohol intake, physical inactivity and high BMI	**0.1** (0.0, 0.2)	**1.2** (0.9, 1.5)	**1.4** (1.1, 1.7)	**1.4** (1.1, 1.7)	**1.4** (1.0, 1.8)	**1.2** (1.1, 1.3)
Smoking, high alcohol intake, physical inactivity and high BMI	–	**1.2** (0.9, 1.4)	**1.3** (1.1, 1.5)	**1.0** (0.8, 1.3))	**0.4** (0.2, 0.6)	**0.9** (0.8, 1.1)
Total Canadian population	**1,662,580**	**3,193,934**	**3,826,542**	**2,427,992**	**1,594,367**	**12,705,415**

* Prevalence of risk factor cluster was calculated by weighted methods and expressed in terms of percentage of total Canadian population.

** All categories are discrete and non-overlapping.

‡ Smoking = current smoker; Non-smoking = having never smoked or being a former smoker

§ High alcohol intake = consuming more than 14.0 drinks per week (male) or 9.0 drinks per week (female); Low alcohol intake = consuming 14.0 or less drinks per week (male) or 9.0 or less drinks per week (female)

¶ Physical inactivity = having an energy expenditure level of less than 1.5 kcal/kg/day; Physical activity = having an energy expenditure level of equal to or greater than 1.5

High BMI = overweight or having a BMI of greater than or equal to 25; Low BMI = having a BMI of less than 25

TABLE 5
Weighted prevalence and 95% confidence limits of selected chronic disease risk factors and risk factor clusters in Canadian females, by age, Canadian Community Health Survey, Cycle 1.1 (2000)

Risk factor present within individual**	Age groups (years) 12–19	20–34	35–49	50–64	65+	Total
None	**45.0** (43.3, 46.6)	**25.2** (24.1, 26.4)	**20.2** (19.3, 21.2)	**17.0** (16.0, 18.0)	**16.6** (15.5, 17.7)	**23.0** (22.5, 23.6)
Smoking‡ (only)	**5.3** (4.6, 6.0)	**5.8** (5.3, 6.3)	**5.0** (4.5, 5.5)	**3.2** (2.8, 3.7)	**1.6** (1.3, 2.0)	4.4 (4.1, 4.6)
High alcohol intake§ (only)	**1.1** (0.7, 1.5)	**1.5** (1.2, 1.7)	**1.1** (0.9, 1.4)	**0.8** (0.6, 1.0)	**0.8** (0.5, 1.1)	**1.1** (1.0, 1.2)
Physical inactivity¶ (only)	**25.7** (24.3, 27.1)	**28.3** (27.1, 29.5)	**23.1** (22.1, 24.1)	**17.1** (16.1, 18.2)	**27.7** (26.6, 28.9)	**24.2** (23.7, 24.7)
High BMI# (only)	**7.9** (7.1, 8.7)	**8.7** (8.1, 9.4)	**11.1** (10.5, 11.7)	**16.3** (15.3, 17.2)	**12.0** (11.2, 12.7)	**11.3** (11.0, 11.6)
Smoking and high alcohol intake	**0.6** (0.4, 0.8)	**0.9** 0.7, 1.1)	**0.6** (0.4, 0.7)	**0.3** (0.1, 0.4)	**0.1** (0.0, 0.2)	**0.5** (0.5, 0.6)
Smoking and physical inactivity	**4.9** (4.2, 5.5)	**8.4** (7.7, 9.1)	**8.3** (7.8, 8.9)	**6.4** (5.8, 7.0)	**4.0** (3.6, 4.5)	**6.9** (6.6, 7.2)
Smoking and high BMI	**1.2** (0.9, 1.5)	**2.3** (2.0, 2.7)	**2.8** (2.4, 3.1)	**2.7** (2.3, 3.2)	**0.7** (0.5, 0.9)	**2.2** (2.0, 2.3)
High alcohol intake and physical inactivity	**0.4** (0.2, 0.6)	**0.8** (0.6, 1.1)	**0.8** (0.6, 1.0)	**0.7** (0.4, 0.9)	**0.6** (0.4, 0.8)	**0.7** (0.6, 0.8)
High alcohol intake and high BMI	**0.1** (0.0, 0.2)	**0.5** (0.3, 0.6)	**0.5** (0.3, 0.6)	**0.6** (0.4, 0.8)	**0.3** (0.1, 0.4)	**0.4** (0.4, 0.5)
Physical inactivity and high BMI	**5.1** (4.4, 5.8)	**11.3** (10.5, 12.2)	**18.2** (17.3, 19.1)	**27.2** (25.9, 28.4)	**31.6** (30.3, 32.8)	**18.9** (18.4, 19.3)
Smoking, high alcohol intake and physical inactivity	**0.9** (0.6, 1.1)	**0.9** (0.7, 1.1)	**1.1** (0.8, 1.3)	**0.4** (0.2, 0.5)	**0.4** (0.2, 0.5)	**0.8** (0.7, 0.9)
Smoking, high alcohol intake and high BMI	**0.2** (0.1, 0.3)	**0.4** (0.2, 0.5)	**0.3** (0.2, 0.5)	**0.1** (0.0, 0.1)	–	**0.2** (0.2, 0.3)
Smoking, physical inactivity and high BMI	–	**4.6** (4.1, 5.1)	**6.0** (5.5, 6.6)	**6.5** (5.9, 7.1)	**2.9** (2.5, 3.4)	**4.7** (4.5, 5.0)
High alcohol intake, physical inactivity and high BMI	**0.1** (0.0, 0.2)	**0.3** (0.2, 0.4)	**0.4** (0.3, 0.6)	**0.5** (0.3, 0.6)	**0.6** (0.4, 0.8)	**0.6** (0.4, 0.8)
Smoking, high alcohol intake, physical inactivity and high BMI	**0.4** (0.1, 0.7)	**0.2** (0.1, 0.3)	**0.5** (0.4, 0.6)	**0.4** (0.2, 0.5)	**0.1** (0.0, 0.1)	**0.3** (0.3, 0.4)
Total Canadian population	**1,580,702**	**3,107,188**	**3,897,071**	**2,457,918**	**2,053,423**	**3,096,302**

* Prevalence of risk factor cluster was calculated by weighted methods and expressed in terms of percentage of total Canadian population.

** All categories are discrete and non-overlapping.

‡ Smoking = current smoker; Non-smoking = having never smoked or being a former smoker

§ High alcohol intake = consuming more than 14.0 drinks per week (male) or 9.0 drinks per week (female); Low alcohol intake = consuming 14.0 or less drinks per week (male) or 9.0 or less drinks per week (female)

¶ Physical inactivity = having an energy expenditure level of less than 1.5 kcal/kg/day; Physical activity = having an energy expenditure level of equal to or greater than 1.5

High BMI = overweight or having a BMI of greater than or equal to 25; Low BMI = having a BMI of less than 25

overweight (15.2 percent). Respondents who are physically inactive and overweight account for the highest proportion of the population with two or more coexistent risk factors.

Tables 4 and 5 show the age distribution of risk factor clusters for males and females, respectively. With the exception of the clusters for smoking (only), high-risk drinking (only), smoking and physical inactivity, high-risk drinking and physical inactivity, and physical inactivity and overweight, all cluster prevalence values (for the "all-age" comparisons) were statistically different between males and females. Further, when compared to females, the prevalence values were higher in males for all-risk factor clusters, except for the no-risk factor, smoking, physical inactivity, and smoking and physical inactivity clusters. Except for four risk factor clusters (physical inactivity; physical inactivity and overweight; high alcohol intake and overweight; and smoking, physical inactivity and overweight), prevalence values peaked in the same age groups for both males and females. Specifically, for both sexes, the prevalence for the no-risk factor cluster peaked among those aged 12 to 19. Prevalence figures for most of the clusters peaked among those aged 20 to 34 years or those 35 to 49 years of age. Exceptionally, high BMI-only peaked among those aged 50 to 64 years; the high alcohol intake, physical inactivity and high BMI cluster peaked among those over 65 years of age.

Discussion

The CCHS represents the most recent and the largest population health survey to date in Canada. The findings of this study therefore closely reflect the current risk factor situations of Canadians. It provides insights not previously available on the question of chronic disease risk factor coexistence in Canada and sets the stage for renewed clinical, policy and research directions.

Our research question was to determine whether or not Canadians have multiple rather than singular risk factor exposures. Based on our study, 40 percent of Canadians had one independent risk factor, while 39 percent had multiple coexistent risk factors, and the remaining 21 percent had none. This distribution differs somewhat from that found by Fine et al. for the U.S. population, where 9.7 percent had no risk factors, 32.6 percent had one independent risk factor and 57.7 percent had multiple coexistent risk factors.[28] This difference is mainly due to the difference in how physical inactivity and high-risk drinking are defined. Our definition for physical inactivity made use of an energy expenditure cut-point of 1.5, while Fine et al. looked at individuals who reported engaging in light/moderate physical activities for less than 30 minutes at a time for five or more times a week, or who reported engaging in vigorous physical activity for less than 20 minutes at a time for three or more times a week. Our definition for high-risk drinking used weekly consumption cutoff values of at least 15 drinks for men and at least 10 drinks for women. Fine et al. defined risky drinking for men as the average weekly consumption of more than 14 drinks, or five or more drinks per day at least twice in the last year, or four or more drinks per day for at least three times in the last year. For women it was defined as the average weekly consumption of more than seven drinks, or four or more drinks per day at least twice in the last year, or three or more drinks per day at least three times in the last year.

According to our results, males are expected to be more at risk of chronic disease outcomes than females due to increased smoking, alcohol intake and overweight. Similarly, in the U.S. population, men were found to have more risk factors than women.[28] The gender differences in health behaviours, including modifiable chronic disease risk factors, are consistent with the literature. Particularly, it has been noted that males are more likely to partake in "risky" behaviours[40] and that females are more likely to be physically inactive.[41,42]

According to our analyses, the group with none of the risk factors was the most common (21.0 percent), followed by those with physical inactivity only (19.4 percent), physical inactivity and overweight (19.0 percent), and overweight (15.2 percent). Those who are physically inactive and overweight account for the highest proportion of the population with two or more coexistent risk factors. Our findings are comparable to those found in the U.S. population, where the most common risk factor clusters were physical inactivity and overweight (26.4 percent), physically inactive (16.4 percent), overweight (11.7 percent) and the no-risk factor cluster (9.7 percent).[28] The slight differences are due to different risk factor definitions.

Although best efforts were taken to define chronic disease risk factor presence in terms of cut-points that are meaningful to chronic disease outcomes, we were reliant upon literature to inform our decisions. One particular definition at issue is that of physical inactivity. The definition used by Fine et al., while technically different from ours (therefore potentially explaining prevalence differences from the two studies) did incorporate exercise duration and intensity measures, something that the CCHS definition intended to do, although in a different way. We chose a cut-point of 1.5 kcal/kg/day, which is consistent with the definition of physical inactivity used throughout the Canadian chronic disease risk factor literature.[33, 37] In choosing this cut-point, we are assuming that the population is healthy and has no physical activity limitations. As a result, the prevalence of physical inactivity in the population would be high, especially among elderly females. However, using a standard definition such as this does allow for comparisons across populations and time periods from various Canadian studies.

Our study has certain limitations, though we employed techniques to deal with some of them. Because there were missing data, and cases with missing data were automatically excluded from prevalence calculations, weighted numbers in the population would have been underestimated. However, this was corrected in our study by programming. Cases with missing data were programmed to be excluded from both the numerator and denominator so that prevalence estimates were corrected. Because of the complexity of the sampling design, sampling error for prevalence estimates was calculated using the bootstrap re-sampling technique.[30] In the CCHS, training and use of skilled interviewers, monitoring of interviewers and use of various quality assurance protocols reduced the amount of non-sampling error.[30]

Non-response was rare as a result of the use of computer-assisted telephone interviews as the data collection instrument.[30] Lastly, the CCHS is based on self-report; thus, the true prevalences of risk factor clusters are most likely underestimated, a phenomenon known as social desirability bias.[43]

This study has described a new approach that examines multiple coexistent risk factor clusters to assess the corresponding prevalence rates in the Canadian population. Its results are important in that they quantify the level of coexistent risks in the population. The existence of multiple risk factors is known to elevate the risk for chronic disease outcome beyond that which would exist, due to the presence of a single risk factor.

The impacts of risk factor clusters on the risk for the major chronic diseases experienced by the Canadian population can now, with these data, be more accurately assessed and so further research into the coexistence of multiple chronic disease risk factors is warranted. As well, other risk factors (such as nutritional status, ethnicity and family history of disease) for other chronic disease outcomes should be studied using the methodology described in this study. Different definitions of the risk factors under study (e.g., light, moderate and heavy levels for physical activity) could be used to arrive at different prevalence figures which might allow for more accurate assessment of population attributable risks. Additionally, other demographic groups, defined on the basis of income and immigrant status, could be examined to determine which are at an especially high risk to chronic disease outcomes in Canada. Similar methodologies used across studies will allow for comparisons between populations, both nationally and internationally. Lastly, better systematic and ongoing surveillance of the risk factors for chronic disease in the Canadian population via a longitudinal database over time would allow for more definitive results.

Acknowledgments

The authors wish to thank Peter Walsh for his assistance with SAS programming; Seema Nagpal and Howard Morrison for their assistance in the conceptualization of this project; Shirley Bryan for her content expertise; Wei Luo, Lisa Pogany and Jay Onysko for their discussion input; and Monique Haan and Ineke Neutel for their editorial support.

References

1. Heart and Stroke Foundation of Canada. The changing face of heart disease and stroke in Canada. Ottawa: (Canada): Heart and Stroke Foundation of Canada; 1999.
2. Katzmarzyk PT, Gledhill N, Shephard RJ. The economic burden of physical inactivity in Canada. CMAJ. 2000;163:1435–40.
3. Birmingham CL, Muller JL, Palepu A, et al. The cost of overweight in Canada. CMAJ. 1999;160:483–8.
4. Centres for Disease Control. Chronic diseases and their risk factors: The nation's leading causes of death. 1999. Available from: http://www.cdc.gov/nccdphp/statbook/statbook.htm.
5. Choi BCK, Shi F. Risk factors for diabetes mellitus by age and sex: Results of the National Population Health Survey. Diabetologia. 2001;44:1221–31.
6. Magnus P. The real contribution of the major risk factors to the coronary epidemics: time to end the "only-50%" myth. Arch Intern Med. 2001;161:2657–60.
7. Rennard SI. COPD: Overview of definitions, epidemiology, and factors influencing its development. Chest. 1998;113:235–41S.
8. Health Canada. Cancer: What's your risk? Health Canada Magazine; 2001.
9. Dawson DA. Drinking as a risk factor for sustained smoking. Drug Alcohol Depend. 2000;59:235–49.
10. Wing RR, Hill JO. Successful weight loss maintenance. Annu Rev Nutr. 2001; 21: 323–41.
11. Grundy SM, Blackburn G, Higgins M, et al. Physical activity in the prevention and treatment of Overweight and its comorbidities. Med Sci Sports Exerc. 1999;31:S502–8.
12. Godsland IF, Leyva F, Walton C, et al. Associations of smoking, alcohol and physical activity with risk factors for coronary heart disease and diabetes in the first follow-up of the Heart Disease and Diabetes Risk Indicators in a Screened Cohort study (HDDRISC-1). J Intern Med. 1998;244: 33–41.
13. Doucet E, Tremblay A. Food intake, energy balance and body weight control. J Clin Nutr. 1997;51:846–55.
14. Stamford BA, Matter S, Fell RD, et al. Cigarette smoking, physical activity and alcohol consumption: relationship to blood lipids and lipoproteins in premenopausal females. Metabolism. 1984;7:585–90.
15. Paffenbarger RS, Hyde RT, Wing AL, et al. Physical activity, all-cause mortality and longevity of college alumni. New Engl J Med. 1986;314:605–13.
16. Williamson DF, Madans J, Anda RF, et al. Smoking cessation and severity of weight gain in a national cohort. New Engl J Med. 1991;324:739–45.
17. Klesges RC, Meyers AW, Klesges LM, et al. Smoking, body weight, and their effects on smoking behaviour: a comprehensive review of the literature. Psychol Bull. 1989;106: 204–30.
18. Flegal KM, Troiano RP, Pamuk ER, et al (1995). The influence of smoking cessation on the prevalence of overweight in the United States. New Engl J Med. 1995;33: 165–75.
19. Smothers B, Bertolucci D. Alcohol consumption and health-promoting behaviour in a U.S. household sample: leisure-time physical activity. J Stud Alcohol. 2001;62:467–76.
20. Timar O, Sestier F, Levy E. Metabolic syndrome X: A review. Can J Cardiol. 2000;16: 779–89.
21. Saito I, Folsom AR, Brancati, FL, et al. Nontraditional risk factors for coronary heart disease incidence among persons with diabetes: the atherosclerosis risk in communities (ARIC) study. Ann Intern Med. 2000; 133:81–91.

22. Twisk JWR, Kemper HCG, Van Mechelen W, et al. Clustering of risk factors for coronary heart disease: the longitudinal relationship with lifestyle. Ann Epidemiol. 2001;11: 157–65.

23. Genest J, Cohn JS. Clustering of cardiovascular risk factors: targeting high-risk individuals. Am J Cardiol. 1995;76:8A–20A.

24. Centers for Disease Control. Prevalence of selected cardiovascular disease risk factors among American Indians and Alaska Natives – United States, 1997. MMWR Morb Mortal Wkly Rep. 2000;49:461–5.

25 Berenson GS, Srinivasan SR, Bao W, et al. Association between multiple cardiovascular risk factors and atherosclerosis in children and young adults. N Engl J Med. 1998; 338:1650–6.

26. Bryant H, Murphy E, Fayers C, et al. A snapshot of cancer in Alberta 2001. Calgary (AB): Alberta Cancer Board; 2002.

27. Chang M, Hahn RA, Teutsch SM, et al. Multiple risk factors and population attributable risk for ischemic heart disease mortality in the United States, 1971–1992. J Clin Epidemiol. 2001;54:634–44.

28. Fine LJ, Philogene GS, Gramling R, et al. Prevalence of multiple chronic disease risk factors: 2001 National Health Interview Survey. Am J Prev Med. 2004; 27(2S).

29. Hahn RA, Heath GW, Chang MH. Cardiovascular disease risk factors and preventive practices among adults – United States, 1994: a behavioural risk factor atlas. MMWR Morb Mortal Wkly Rep. 1998;47(SS–5):35–69.

30. Last JM. A dictionary of epidemiology. 4th ed. New York (NY): Oxford University Press, Inc.; 2001.

31. Beland Y. Canadian Community Health Survey – Methodological overview. Health Rep. 2002;13:9–14.

32. Statistics Canada. The Canadian community health survey (CCHS). 2000. Available from: http://www.statcan.ca/english/conepts/health/cchsinfo.htm.

33. Canadian community health survey (CCHS), Cycle 1.1, Derived variable (DV) specifications. Health Statistics Division, Statistics Canada 2002.

34. Wilkins K. Moderate alcohol consumption and heart disease. Health Rep. 2002;14:9–24.

35. Bondy SJ, Rehm J, Ashley MJ, et al. Low-risk drinking guidelines: The scientific evidence. CJPH. 1999;90:264–270.

36. English, DR, Holman, CDJ, Milne, E, et al. 1995. The quantification of drug caused morbidity and mortality in Australia, 1995 edition. Canberra: Commonwealth Department of Human Services and Health.

37. Heart and Stroke Foundation of Canada. The growing burden of heart disease and stroke in Canada 2003. Ottawa (Canada): Heart and Stroke Foundation of Canada; 2003.

38. Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and overweight worldwide: international survey. BMJ. 2000;320: 1240–3.

39. Efron B, Tibshirani, RJ. An introduction to the bootstrap. NewYork (NY): Chapman and Hall; 1993.

40. Doyal L. Sex, gender, and health: The need for a new approach. BMJ. 2001;323:1061–3.

41. Meisinger C, Thorand B, Schneider A, et al. Sex Differences in Risk Factors for Incident Type 2 Diabetes Mellitus: The MONICA Augsburg Cohort Study. Arch Intern Med 2002;162:82–9.

42. Health Canada. Women's Health Surveillance Report: A multi-dimensional look at the health of Canadian women. Ottawa, Canada: Canadian Institute for Health Information, 2003.

43. Choi BCK, Pak AWP. Bias, Overview. In: Armitage P, Colton T, eds. Encyclopedia of Biostatistics. Chinchester: John Wiley & Sons, 1:331–338.

Chronic or non-communicable?

Dear Editor,

Re: Choi et al.'s Situational analysis of chronic disease surveillance in Canada

In the spirit of contributing to a collegial discussion about implications for practice and surveillance, I would like to comment on the difficult question of choosing a definition of "chronic disease".

The definition cited in the above-cited status report [1] is only one of two definitions offered by McKenna, et al., in Brownson, et al.'s, *Chronic Disease Epidemiology and Control* [2]. "Disease that has a prolonged course, that does not resolve spontaneously and for which a complete cure is rarely achieved" is a standard clinical definition which could as easily refer to tuberculosis or marginal blepharitis as it could to heart disease, cancer or diabetes.

McKenna et al. offer a more specific definition in the first paragraph of the section "Definition of Chronic Disease". They write that chronic diseases "... are generally characterized by uncertain etiology, multiple risk factors, a long latency period, a prolonged course of illness, non-contagious origin, functional impairment or disability, and incurability." This definition is much more in keeping with how public health practitioners use the term and is, in my opinion, more relevant to the content and context of the status report.

Even though we are finding out more about the infectious origins of some of what we traditionally refer to as the "chronic" diseases, I feel it is still useful to make explicit the non-communicable aspect, as is exemplified in the name of the working group that co-authored the aforementioned status report. Using the broader definition is appealing semantically and it does appear more inclusive. However, it makes the scope of conditions to be addressed, their risk factors, control methods, etc., unsuitably broad. Among other things, it can make the entire focus of the risk factor reduction-end of the control spectrum (and its surveillance) very fuzzy and almost impracticable.

Christina Mills
University of Waterloo

References

1. Choi CK, Wright E, Ulrick A and the Chronic non-communicable disease surveillance infostructure sub-group, Health surveillance working group. Situational analysis of chronic disease surveillance in Canada: Results of a stakeholder interview. Chron Dis Can 2005;26(4):127-9.

2. McKenna MT, Taylor WR, Marks JS, Koplan JP. Current issues and challenges in chronic disease control. In: Brownson RC, Remington PL, Davis JR, editors. Chronic disease epidemiology and control. Second edition. Washington DC: American Public Health Association; 1998.

Dear Editor,

I would like to thank Dr. Mills for correctly pointing out the difficulty in choosing a definition for "chronic disease". At the start of the situational analysis project, we identified a large number of definitions for chronic disease, none of which was considered perfect. We finally chose one of two definitions offered by McKenna et al. because it is more concise and more correctly describes the key word "chronic". In the literature, we found that "chronic" refers to "prolonged course" and not the "long latency period".

I would also like to mention that there is currently debate on the use of the terms "chronic disease" and "non-communicable disease" to describe conditions such as cardiovascular diseases, cancers, asthma and diabetes. Some have challenged the use of the term "non-communicable", positing that these diseases are also communicable. Chronic non-communicable diseases are, in fact, transferable by virtue of their underlying risk factors.[1] Unhealthy risk behaviours such as smoking, physical inactivity and cooking style can be passed on through families, communities and populations, and are therefore "communicable".[2]

Other authors point out a current confusion in the classification system: while non-communicable disease is based on *cause*, chronic disease is based on *effect*.[3] Thus while certain chronic diseases have an infectious origin, certain communicable diseases require chronic, ongoing care.

Another issue is that the terms "chronic disease" and "non-communicable disease" may contribute to the lack of a perceived need among decision makers to pay attention to chronic diseases. These terms may not be adequately conveying the importance and urgency of chronic disease surveillance, prevention and control to public health decision makers. hronic conveys the idea of a disease being always present and, therefore, non-urgent. on-communicable conveys the idea of non-infectiousness and implies that these diseases are safe. A jurisdiction may not realize the need to dedicate scarce resources toward preventing and controlling diseases that are long term (chronic) and where causation is unclear (non-communicable).[4]

It is hoped that with further discussion among and efforts from public health researchers and practitioners, a more appropriate term will be available to describe the true nature of a group of diseases that include cardiovascular diseases, cancers, asthmas and diabetes.

Bernard CK Choi
Public Health Agency of Canada

References

1. Choi BCK, Bonita R, McQueen DV. The need for global risk factor surveillance. J Epidemiol Community Health 2001;55:370.
2. Ackland M, Choi BCK, Puska P. Rethinking the terms non-communicable disease and chronic disease. J Epidemiol Community Health 2003;57:838-39.
3. Unwin N, Epping Jordan J, Bonita R. Rethinking the terms non-communicable disease and chronic disease. (Letter). J Epidemiol Community Health 2004;58:801.
4. Ackland M, Choi BCK, Puska P. Rethinking the terms non-communicable disease and chronic disease. (Authors' reply). J Epidemiol Community Health 2004;58:801.

Status Report

Two to three percent of infants are born with a congenital anomaly, but who's counting? A national survey of congenital anomalies surveillance in Canada

Dana Paquette, R Brian Lowry and Reg Sauvé

Introduction

The thalidomide tragedy, recognized in 1962,[1] led to the development of congenital anomalies surveillance systems in many jurisdictions. Today, identifying potential teratogens is one of many important public health functions served by congenital anomalies surveillance.

Major congenital anomalies are detected in two to three percent of births every year in Canada,[2] and surveillance systems offer a way of evaluating the impact of prevention strategies (e.g., food fortification with folic acid). The systems are also useful in hypotheses generation, in describing the epidemiology of specific anomalies and in identifying infants in need of special services or programs. Existing systems have also been used for follow-up studies of survival and economic impact.[3–5]

In Canada, the Canadian Congenital Anomalies Surveillance Network (CCASN) was established in 2002 by Health Canada (now the Public Health Agency of Canada [PHAC]) under the umbrella of the Canadian Perinatal Surveillance System (CPSS). The CCASN is made up of clinicians, academics and public health professionals from across the country and its goal is to enhance the quality of surveillance data. It achieves this by advising PHAC on strategies that encourage provinces/territories to develop surveillance systems where there are none, and by maintaining and enhancing existing surveillance systems.

In December 2004, the CCASN undertook a national survey of congenital anomalies surveillance systems across the country. The goal of the survey was to gain a better understanding of existing surveillance systems and to determine how best to fulfill the CCASN's mission of supporting the development and maintenance of those that are both population based and of high quality.

Methods

A list of 37 potential respondents was compiled, which included representatives from provincial/territorial ministries of health, reproductive care programs, maternal serum screening, medical genetics programs and university departments of medical genetics. A questionnaire, based on a similar survey conducted by Miller and Kirby[6] in the United States, was modified and approved by the CCASN advisory group. The questionnaire asked respondents whether they conduct congenital anomalies surveillance, for what time periods congenital anomalies data are available, whether these data include prenatal diagnostic data, which coding/classification system is used, and how data were used in the previous year.

A survey package was mailed, which included a stamped, return envelope. Two reminders were sent following the original mailing, after two and four weeks, respectively.

TABLE 1
Suvey of congenital anomaly surveillance systems in Canada (2004). Response rate by respondent type

Respondent type	Number of questionnaires sent	Number of questionnaires received	Response rate (percentage)
Provincial/territorial ministries of health	13	12	92.3
Reproductive care programs	10	8	80.0
University departments of medical genetics	10	5	50.0
Maternal serum screening and medical genetics programs	4	3	75.0
Total	**37**	**28**	**75.7**

Author References

Dana Paquette, Public Health Agency of Canada, Ottawa, Ontario, Canada
R Brian Lowry, Department of Medical Genetics, Alberta Children's Hospital, Calgary, Alberta, Canada
Reg Sauvé, Department of Community Health Sciences, Faculty of Medicine, University of Calgary, Calgary, Alberta, Canada
Correspondence: Reg Sauvé, Department of Community Health Sciences, Faculty of Medicine, University of Calgary, 3330 Hospital Drive NW, Calgary, Alberta, Canada T2N 4N1; fax: (403) 270-7307; e-mail: rsauve@ucalgary.ca

TABLE 2
Description of congenital anomalies surveillance systems in Canada (2004)

Name of surveillance system	Earliest year of available data	Estimated number of live births covered annually	Province/ territory-wide coverage	Coding*	Captures terminations of pregnancies
Provincial ministry of health					
British Columbia Health Status Registry	1952	40,000	Yes	ICD-9/10 OMIM#	Yes (starting in 2006)
Alberta Congenital Anomalies Surveillance System	1980	37,000	Yes	BPA, ICD-9/10, OMIM #	Yes
Fetal Alcohol Spectrum Disorder Registry (Yukon)	mid-1990s	350	Yes	N/A	N/A
Reproductive care program					
British Columbia Reproductive Care Program	2000	40,000	Yes	ICD-9/10	No
Ontario Niday Perinatal Database	2004	100,000	No†	Niday definitions	No
Nova Scotia Atlee Perinatal Database and the Fetal Anomaly Database (FAD)‡	1980 (Atlee) 1992 (FAD)	9,500	Yes	FAD and Atlee definitions	Yes
Prince Edward Island Reproductive Care Program	1990	1,400	Yes	ICD-9/10	No
Maternal serum screening and medical genetics programs					
Manitoba Maternal Serum Screening Program	1985	14,000	No§	ICD-9/10	Yes
Ontario Maternal Serum Screening Program	1993	70,000	No§	ICD-9/10	Yes
Newfoundland and Labrador's Medical Genetics Program	1976	4,800	Yes	ICD-9/10	Yes

* ICD-9/10: International Classification of Diseases, ninth or tenth revision;
BPA: British Paediatric Association Classification of Diseases;
OMIM #: Online Mendelian Inheritance in Man six-digit number.

† Covers 85 percent of births.

‡ The Fetal Anomaly Database is an IWK Health Centre Department of Obstetrics and Gynaecology database and is used in combination with the Atlee Perinatal Database to report on congenital anomalies in Nova Scotia.

§ Limited to women undergoing prenatal screening. (~70 percent of pregnant women).

Results

The response rate to the survey was 76 percent (28/37). A breakdown by type of respondent is provided in Table 1.

According to the responses, ten surveillance systems in eight provinces/territories collect congenital anomalies data. Four reproductive care programs (RCPs), three maternal serum screening/medical genetics programs and three provincial/territorial ministries of health operate surveillance systems.

The surveillance systems employ multiple sources of data, with the exception of the Ontario RCP, which uses only hospital records, and Yukon's Fetal Alcohol Spectrum Disorder (FASD) registry, which relies only on physician reports.

Seven of the ten surveillance systems collect data on all major birth defects, while three are more limited in the anomalies they monitor. The Yukon registry collects data on FASD, Newfoundland and Labrador's Medical Genetics Program collects data on neural tube defects (NTDs), and the Ontario Maternal Serum Screening Program focuses on NTDs, trisomies 18 and 21 and other cytogenetic and ultrasound abnormalities. Reproductive care programs, maternal serum screening programs and the medical genetics programs gather data until discharge from hospital or shortly thereafter. This is unlike the surveillance systems run by provincial and territorial Ministries of Health (i.e., Alberta, Yukon and British Columbia), which capture data on infants up to one year of age, up to school age, and up to 19 years of age, respectively.

Respondents were asked to list the ways that they had used congenital anomalies data in

the previous year. Eight (80 percent) replied that they conducted routine statistical monitoring, five (50 percent) used the data for epidemiological studies, and three (30 percent) used the data for monitoring outbreaks and cluster investigation. Other uses of the data included identifying cases for other epidemiological studies, evaluating public health programs and identifying individuals for referral to specialized services.

Further details on the surveillance systems are presented in Table 2.

Discussion

At the time of this survey, seven provinces and one territory had congenital anomalies surveillance systems. However, variations in coding, outcomes captured and case ascertainment make it difficult to compare rates across the country.

The ability to compare numbers and rates across provinces and territories is valuable, especially in regards to congenital anomalies. When rare events are studied, the sample size must often be increased to beyond that which is captured by one province or territory. If a new teratogen appears, its effects may be more rapidly detected if comparisons can be made across several jurisdictions.

A national surveillance system, the Canadian Congenital Anomalies Surveillance System (CCASS), does exist. This is the only population-based surveillance system in Canada which provides national data on congenital anomalies. However, it has several limitations that hinder its usefulness. CCASS relies primarily on hospital separations to calculate congenital anomaly rates. This reliance on administrative databases results in issues with timeliness and representativity (i.e., prenatal diagnoses of congenital anomalies that result in a termination of pregnancy are not captured). As well, key data elements are not available, such as the gestational age of the infant.

Major congenital anomalies are a leading cause of death in infants,[2] and create a considerable emotional and economic burden for families and society.[7–8] Surveillance systems make vital contributions to our knowledge of causative factors and to the evaluation of preventive measures.

Congenital anomalies surveillance is important to public health and should be promoted within all provinces and territories. The Canadian Congenital Anomalies Surveillance Network is taking the lead by working to develop guidelines for coding, a list of suggested congenital anomalies that should be captured, and recommended data collection practices.

A review of existing case definitions has already begun and preliminary recommendations have been developed. Once finalized, these guidelines and recommendations will be distributed to provincial and territorial representatives, and posted on the CCASN Web site. (http://www.phac-aspc.gc.ca/ccasn-rcsac/index.html)

Acknowledgements

We would like to thank all of our survey respondents for providing us with the information on their congenital anomalies registries and surveillance systems.

References

1. Speirs AL. Thalidomide and congenital abnormalities. Lancet. 1962 Feb 10;1:303–305.
2. Health Canada. Canadian perinatal health report, 2003. Ottawa: Minister of Public Works and Government Services Canada, 2003.
3. Edmonds LD, Layde PM, James LM, Flynt JW, Erickson JD, Oakley GP Jr. Congenital malformations surveillance: two American systems. Int J Epidemiol. 1981 Sep;10(3):247–52.
4. Cordero JF. Registries of birth defects and genetic diseases. Pediatr Clin North Am. 1992 Feb;39(1):65–77.
5. Lechat MF, Dolk H. Registries of congenital anomalies: EUROCAT. Environ Health Perspect. 1993 Jul;101 Suppl 2:153–7.
6. Miller LA, Kirby RS. Neural tube defects surveillance: a national survey. Teratology. 2000 Jan-Feb;61(1–2):28–32.
7. Hunfeld JA, Tempels A, Passchier J, Hazebroek FW, Tibboel D. Brief report: parental burden and grief one year after the birth of a child with a congenital anomaly. J Pediatr Psychol. 1999 Dec;24(6):515–20.
8. Waitzman NJ, Romano PS, Scheffler RM. Estimates of the economic costs of birth defects. Inquiry. 1994 Summer;31(2):188–205.

Status Report

Easy access to chronic disease surveillance information: The NCD Surveillance Infobase

What is the percentage of current smokers in the Durham region of Ontario?

Which gender has a higher age-standardized hospital discharge rate for chronic, obstructive pulmonary disease in Alberta?

What is the age-standardized mortality rate for ischemic heart disease in the St. John's region relative to all the other Newfoundland and Labrador health regions?

Has the incidence trend for stomach cancer in Nova Scotia been going up or down?

If you want to find answers to these and many other surveillance questions, why not try out the NCD Infobase? The Non-Communicable Diseases (NCD) Surveillance Infobase is one of a number of Internet-based Web tools used to disseminate surveillance information at the Public Health Agency of Canada.

The Infobase profiles the epidemiology of chronic diseases in Canada— including most current rates for cancers, cardiovascular and respiratory diseases—and provides analysis by province/territory and by regional health unit. Demographic, mortality, morbidity, risk factor and related health care data are currently available. Infobase is designed with advanced Internet technology to provide users with interactive, dynamic access to an extensive database of chronic disease statistics and allows for their presentation as tables, graphs or maps. Multiple-area comparisons, morbidity and mortality time trends, birth cohort mortality trends and proportional mortality trends are just some of the options available.

The NCD Infobase evolved from its predecessor, the Global Cardiovascular Disease (CVD) Infobase. The CVD was developed seven years ago by the Ottawa Hospital as part of its role as a Canadian Collaborating Centre for Cardiovascular Disease for the World Health Organization.

The NCD Infobase is under constant development, with new data being added as they become available. Future enhancements will include facilitated user-interfaces and health-region-specific summary pages. Feedback and suggestions are welcome through the "contact us" link.

You can bookmark the NCD and CVD Web sites using the links below:

The Non-Communicable Disesase Infobase: http://www.cvdinfobase.ca/surveillance

The Global Cardiovascular Infobase: http://www.cvdinfobase.ca

Calendar of Events

16–19 May 2006 **Denver, Colorado, USA**	Centers for Chronic Disease Control and Prevention 2006 CDC Diabetes and Obesity Conference	< http://www.cdc.gov/diabetes/conferences/ >
28–31 May 2006 **Vancouver, British Columbia, Canada**	Canadian Public Health Association 97th Annual Conference	e-mail: conference@cpha.ca < http://www.cpha.ca/english/conf/conf97/97conf-e.htm >
21–22 April 2006 **Halifax, Nova Scotia, Canada**	11th Annual Atlantic Canada Cardiovascular Congress	e-mail: mary.ann.robinson@dal.ca
21–24 June 2006 **Seattle, Washington, USA**	2nd North American Congress of Epidemiology	<http://www.epicongress2006.org>
8–12 July 2006 **Washington, DC, USA**	UICC World Cancer Congress	e-mail: secretariat2006@cancer.org < http://www.2006conferences.org/u-index.php >
11-18 August 2006 **Vancouver, British Columbia, Canada**	Cancer in Women	e-mail: jbarnhart@continuingeducation.net
21–25 August 2006 **Rio de Janeiro, Brazil**	World Federation of Public Health Associations (WFPHA) 11th World Congress on Public Health	< http://www.saudecoletiva2006.com.br >
2–6 September 2006 **Paris, France**	Joint ISEE/ISEA International Conference on Environmental Epidemiology and Exposure	< http://www.paris2006.afsse.fr/ >
3–8 September 2006 **Sydney, Australia**	International Association for the Study of Obesity 10th International Conference on Obesity	< http://www.ico2006.com >
17–21 September 2006 **Geneva, Switzerland**	International Society of Paediatric Oncology 38th SIOP Congress	< http://www.siop.nl >
26–29 October 2006 **Berlin, Germany**	The World Congress on Controversies in Obesity, Diabetes and Hypertension	e-mail: codhy@codhy.com < http://www.codhy.com >
3–6 December 2006 **Winnipeg, Manitoba, Canada**	7th Canadian Immunization Conference	< http://www.phac-aspc.gc.ca/cnic-ccni/index.html >
3–7 December 2006 **Cape Town, South Africa**	International Diabetes Federation 19th World Diabetes Congress	e-mail: info@idf.org < http://www.idf2006.org >

2005 Peer Reviewers

We are extremely grateful to the following people for their enormous contribution to *Chronic Diseases in Canada* as peer reviewers in 2005.

Tye Arbuckle
Sten Ardal
Lynne Baillie
Chris Bajdik
Linda Bartlett
Ugis Bickis
Sue Bondy
Larry Chambers
Yue Chen
Mary Chipman
Bernard Choi
Linda Cook
John Cunningham
Carl D'Arcy
Philippe de Wals
Alain Demers
Linda Dodds
Sheila Dubois
David Feeny
Christine Friedenreich
Linda Geiss
Katherine Gray-Donald
Eva Grunfeld
Brian Habbick
Jill Hamilton
Nicole Hébert-Croteau
Greg Hislop
Michael Jerrett
Michel Joffres
Ken Johnson
Julia Knight
Betsy Kristjansson
Fabrice Larribe
Adrian Levy
Francine Lortie-Monette
Sora Ludwig
Lynne MacLean
Doug Manuel
Yang Mao
Loraine Marrett
Christopher Martin
Catherine McCourt
Ian McDowell
Steven McFaull
David McLean
Wayne Millar
Howard Morrison
Cameron Mustard
Stephen Newman
Robert Pampalon
Marie-Élise Parent
Mike Patterson
Stuart Peacock
Linda Pederson
Pierre Philippe
William Rickert
Will Rickett
L Dawn Satterfield
Jean Shoveller
Jack Siemiatycki
Richard Stanwick
Tom Stephens
David L. Streiner
Larry Svenson
Valerie Tarasuk
Gilles Thériault
Jean-Pierre Thouez
Jeff Whitehead
Andy Wielgosz
Cam Wild
Kathryn Wilkins
Noreen Willows
Christina Wolfson

Indexes for Volume 26, 2005

Volume 26 Contents

No 1, 2005

Influential observations in weighted analyses: Examples from the National Longitudinal Survey of Children and Youth (NLSCY) 1
IJennifer J Macnab, JJ Koval, KN Speechley, and MK Campbell

The estimation of heritability for twin data based on concordances of sex and disease 9
Hongzhuan Tan, Mark Walker, France Gagnon, and Shi Wu Wen

Breast cancer trends in Manitoba: 40 years of follow-up . . . 13
Alain A Demers, Donna Turner, Daojun Mo, and Erich V Kliewer

Smoker preference for "elastic cigarettes" in the Canadian cigarette market 20
Michael O Chaiton, Neil E Collishaw, and Aaron J Callard

Trends in mortality from diabetes mellitus in Canada, 1986–2000. 25
Jinfu Hu, Glenn Robbins, Anne-Marie Ugnat, and Chris Waters

Status Report

The Canadian Incidence Study of Reported Child Abuse and Neglect (CIS) 30
Ambika Dewan and Lil Tonmyr

Calendar of Events 32

Indexes for Volume 25, 2004 33

No 2–3, 2005

Mediterranean dietary components and body mass index in adults: The Peel Nutrition and Heart Health Survey 43
Mamdouh M Shubair, R Stephen McColl and Rhona M Hanning

Screening mammography participation and invitational strategy: The Quebec Breast Cancer Screening Program, 1998–2000. 52
Sonia Jean, Diane Major, Louise Rochette and Jacques Brisson

An observational study of sun and heat protection during Canada Day outdoor celebrations, 2003 59
ST David, U Chandran,D Paquette, D Scholten, J Wilson, E Galanis, M Becker, F Crane, R Lester, T Mersereau, E Wong and D Carr

Validity of a 12-item version of the CES-D used in the National Longitudinal Study of Children and Youth 65
Christiane Poulin, Denise Hand and Brock Boudreau

An analysis of the effect of selection bias on the association of hormone replacement therapy and breast cancer risk 73
Ilona Csizmadi, Christine M Friedenreich, Heather E Bryant and Kerry S Courneya

A comparison of measures of socioeconomic status for adolescents in a Canadian national health survey 80
Beth K Potter, Kathy N Speechley, Iris A Gutmanis, M Karen Campbell, John J Koval and Douglas Manuel

Workshop Report

Occupational cancer surveillance 90
Jennifer I Payne

2004 Peer Reviewers. 91

Calendar of Events 92

No 4, 2005

Prevalence and predictors of depression in elderly Canadians: The Canadian Study of Health and Aging 93
Truls Østbye, Betsy Kristjansson, Gerry Hill, Stephen C Newman, Rebecca N Brouwer and Ian McDowell

Measurement issues related to the evaluation and monitoring of major depression prevalence in Canada 100
Scott B Patten, Jian Li Wang, Cynthia A Beck and Colleen J Maxwell

A descriptive analysis of Canadian youth treated in emergency departments for work-related injuries 107
Tammy Lipskie and F Curtis Breslin

Acceptability of micronutrient sprinkles: A new food-based approach for delivering iron to First Nations and Inuit children in Northern Canada 114
Anna Christofides, Claudia Schauer, Waseem Sharieff and Stanley H Zlotkin

Letters

The seasonality of SIDS in Canada between 1985–1989 and 1994–1998. 121

Status Reports

Child maltreatment in different populations: Investigated cases and Canadian street youth. 124
Richard DeMarco, Michelle Wesley, Cara Bowman, Susanne Shields and Tom Wong

Situational analysis of chronic disease surveillance in Canada: Results of a stakeholder interview 127
Bernard CK Choi, Elizabeth Wright and Ulrick Auguste

Calendar of Events 130

Volume 26 Subject Index

ABORIGINAL HEALTH

Acceptability of micronutrient sprinkles: A new food-based approach for delivering iron to First Nations and Inuit children in Northern Canada. 26(4):114-120

ALTERNATIVE MEDICINE
BOOK REVIEWS
CANCER

Breast cancer trends in Manitoba: 40 years of follow-up. 26(1):13-19

Screening mammography participation and invitational strategy: The Quebec Breast Cancer Screening Program, 1998 – 2000. 26(2-3):52-58

An analysis of the effect of selection bias on the association of hormone replacement therapy and breast cancer risk. 26(2-3):73-79

Occupational cancer surveillance. 26(2-3):90-91

CEREBROVASCULAR DISEASES
DIABETES

Trends in mortality from diabetes mellitus in Canada, 1986–2000. 26(1):25-29

ECONOMIC BURDEN
ENVIRONMENTAL HEALTH

An observational study of sun and heat protection during Canada Day outdoor celebrations, 2003. 26(2-3):59-64

FOOD ISSUES

Mediterranean dietary components and body mass index in adults: The Peel Nutrition and Heart Health Survey. 26(2-3):43-51

Acceptability of micronutrient sprinkles: A new food-based approach for delivering iron to First Nations and Inuit children in Northern Canada. 26(4):114-120

GEOGRAPHIC VARIATIONS

Trends in mortality from diabetes mellitus in Canada, 1986–2000. 26(1):25-29

HEALTH SURVEYS

Influential observations in weighted analyses: Examples from the National Longitudinal Survey of Children and Youth (NLSCY). 26(1):1-8

Mediterranean dietary components and body mass index in adults: The Peel Nutrition and Heart Health Survey. 26(2-3):43-51

Validity of a 12-item version of the CES-D used in the National Longitudinal Study of Children and Youth. 26(2-3):65-72

A comparison of measures of socioeconomic status for adolescents in a Canadian national health survey. 26(2-3):80-89

Prevalence and predictors of depression in elderly Canadians: The Canadian Study of Health and Aging. 26(2-3):93-99

HEART DISEASE

Mediterranean dietary components and body mass index in adults: The Peel Nutrition and Heart Health Survey. 26(2-3):43-51

INFANT AND CHILD HEALTH

The estimation of heritability for twin data based on concordances of sex and disease. 26(1):9-12

The Canadian Incidence Study of Reported Child Abuse and Neglect (CIS). 26(1):30-31

A descriptive analysis of Canadian youth treated in emergency departments for work-related injuries. 26(4):107-113

Child maltreatment in different populations: Investigated cases and Canadian street youth. 26(4):124-126.

The seasonality of SIDS in Canada between 1985–1989 and 1994–1998. 26(4):121-123

INJURIES

A descriptive analysis of Canadian youth treated in emergency departments for work-related injuries. 26(4):107-113

MENTAL HEALTH

Prevalence and predictors of depression in elderly Canadians: The Canadian Study of Health and Aging. 26(4):93-99

Measurement issues related to the evaluation and monitoring of major depression prevalence in Canada. 26(4):100-106

OCCUPATIONAL HEALTH

A descriptive analysis of Canadian youth treated in emergency departments for work-related injuries. 26(4):107-113

Occupational cancer surveillance. 26(2-3):90-91

POPULATION SURVEILLANCE

Trends in mortality from diabetes mellitus in Canada, 1986–2000. 26(1):25-29

The Canadian Incidence Study of Reported Child Abuse and Neglect (CIS). 26(1):30-31

Child maltreatment in different populations: Investigated cases and Canadian street youth. 26(4):124-126.

Occupational cancer surveillance. 26(2-3):90-91

Situational analysis of chronic disease surveillance in Canada: Results of a stakeholder interview. 26(4):127-129

TOBACCO ISSUES

Smoker preference for “elastic cigarettes” in the Canadian cigarette market. 26(1):20-24

TRAUMA

WOMEN’S HEALTH

Screening mammography participation and invitational strategy: The Quebec Breast Cancer Screening Program, 1998 – 2000. 26(2-3):52-58

An analysis of the effect of selection bias on the association of hormone replacement therapy and breast cancer risk. 26(2-3):73-79

Volume 26 Author Index

Auguste, Ulrick
Bernard CK Choi, Elizabeth Wright and Ulrick Auguste. Situational analysis of chronic disease surveillance in Canada: Results of a stakeholder interview. 26(4):127-129

Beck, Cynthia A
Scott B Patten, Jian Li Wang, Cynthia A Beck and Colleen J Maxwell. Measurement issues related to the evaluation and monitoring of major depression prevalence in Canada. 26(4):100-106

Becker, M
ST David, U Chandran, D Paquette, D Scholten, J Wilson, E Galanis, M Becker, F Crane, R Lester, T Mersereau, E Wong and D Carr.An observational study of sun and heat protection during Canada Day outdoor celebrations, 2003. 26(2-3):59-64

Boudreau, Brock
Christiane Poulin, Denise Hand and Brock Boudreau. Validity of a 12-item version of the CES-D used in the National Longitudinal Study of Children and Youth. 26(2-3):65-72

Bowman, Cara
Richard De Marco, Michelle Wesley, Cara Bowman, Susanne Shields and Tom Wong. Child maltreatment in different populations: Investigated cases and Canadian street youth. 26(4):124-126

Breslin, F Curtis
Shaw Amanda K, Morrison Howard I, Speechley Kathy N, Maunsell Elizabeth, Barrera Maru, Schanzer Dena, Pogany Lisa and Desmeules Marie. The Late Effects Study: Design and subject representativeness of a Canadian, multi-centre study of the late effects of childhood cancer. 25(3/4):119-26.

Bell, Neil R
Tammy Lipskie and F Curtis Breslin. A descriptive analysis of Canadian youth treated in emergency departments for work-related injuries. 26(4):107-113

Brouwer, Rebecca
Truls Østbye, Betsy Kristjansson, Gerry Hill, Stephen C Newman, Rebecca N Brouwer and Ian McDowell. Prevalence and predictors of depression in elderly Canadians: The Canadian Study of Health and Aging. 26(4):93-99

Bryant, Heather E
Ilona Csizmadi, Christine M Friedenreich, Heather E Bryant and Kerry S Courneya. An analysis of the effect of selection bias on the association of hormone replacement therapy and breast cancer risk. 26(2-3):73-79

Callard, Aaron J
Michael O Chaiton, Neil E Collishaw and Aaron J Callard. Smoker preference for “elastic cigarettes” in the Canadian cigarette market. 26(1):20-24

Campbell, MK
Jennifer J Macnab, JJ Koval, KN Speechley and MK Campbell. Influential observations in weighted analyses: Examples from the National Longitudinal Survey of Children and Youth (NLSCY). 26(1):1-8

Campbell, M Karen
Beth K Potter, Kathy N Speechley, Iris A Gutmanis, M Karen Campbell, John J Koval and Douglas Manuel. A comparison of measures of socioeconomic status for adolescents in a Canadian national health survey. 26(2-3):80-89

Carr, D
ST David, U Chandran, D Paquette, D Scholten, J Wilson, E Galanis, M Becker, F Crane, R Lester, T Mersereau, E Wong and D Carr. An observational study of sun and heat protection during Canada Day outdoor celebrations, 2003. 26(2-3):59-64

Chaiton, Michael O
Michael O Chaiton, Neil E Collishaw and Aaron J Callard. Smoker preference for “elastic cigarettes” in the Canadian cigarette market. 26(1):20-24

Collinshaw, Neil E
Michael O Chaiton, Neil E Collishaw and Aaron J Callard. Smoker preference for “elastic cigarettes” in the Canadian cigarette market. 26(1):20-24

Chandran, U
ST David, U Chandran, D Paquette, D Scholten, J Wilson, E Galanis, M Becker, F Crane, R Lester, T Mersereau, E Wong and D Carr. An observational study of sun and heat protection during Canada Day outdoor celebrations, 2003. 26(2-3):59-64

Choi, Bernard CK
Bernard CK Choi, Elizabeth Wright and Ulrick Auguste. Situational analysis of chronic disease surveillance in Canada: Results of a stakeholder interview. 26(4):127-129

Christofides, Anna
Anna Christofides, Claudia Schauer, Waseem Sharieff and Stanley H Zlotkin. Acceptability of micronutrient sprinkles: A new foodbased approach for delivering iron to First Nations and Inuit children in Northern Canada. 26(4):114-120

Courneya, Kerry S
Ilona Csizmadi, Christine M Friedenreich, Heather E Bryant and Kerry S Courneya. An analysis of the effect of selection bias on the association of hormone replacement therapy and breast cancer risk. 26(2-3):73-79

Crane, F
ST David, U Chandran, D Paquette, D Scholten, J Wilson, E Galanis, M Becker, F Crane, R Lester, T Mersereau, E Wong and D Carr. An observational study of sun and heat protection during Canada Day outdoor celebrations, 2003. 26(2-3):59-64

Csizmadi, Ilona
Ilona Csizmadi, Christine M Friedenreich, Heather E Bryant and Kerry S Courneya. An analysis of the effect of selection bias on the association of hormone replacement therapy and breast cancer risk. 26(2-3):73-79

David, ST
ST David, U Chandran, D Paquette, D Scholten, J Wilson, E Galanis, M Becker, F Crane, R Lester, T Mersereau, E Wong and D Carr. An observational study of sun and heat protection during Canada Day outdoor celebrations, 2003. 26(2-3):59-64

De Marco, Richard
Richard De Marco, Michelle Wesley, Cara Bowman, Susanne Shields and Tom Wong. Child maltreatment in different populations: Investigated cases and Canadian street youth. 26(4):124-126

Demers, Alain A
Alain A Demers, Donna Turner, Daojun Mo and Erich V Kliewer. Breast cancer trends in Manitoba: 40 years of follow-up. 26(1):13-19

Dewan, Ambika
Ambika Dewan and Lil Tonmyr. The Canadian Incidence Study of Reported Child Abuse and Neglect (CIS). 26(1):1-8:30-31

Friedenreich, Christine M
Ilona Csizmadi, Christine M Friedenreich, Heather E Bryant and Kerry S Courneya. An analysis of the effect of selection bias on the association of hormone replacement therapy and breast cancer risk. 26(2-3):73-79

Gagnon, France
Hongzhuan Tan, Mark Walker, France Gagnon and Shi Wu Wen. The estimation of heritability for twin data based on concordances of sex and disease. 26(1):9-12

Galanis, E
ST David, U Chandran, D Paquette, D Scholten, J Wilson, E Galanis, M Becker, F Crane, R Lester, T Mersereau, E Wong and D Carr. An observational study of sun and heat protection during Canada Day outdoor celebrations, 2003. 26(2-3):59-64

Gutmanis, Iris A
Beth K Potter, Kathy N Speechley, Iris A Gutmanis, M Karen Campbell, John J Koval and Douglas Manuel. A comparison of measures of socioeconomic status for adolescents in a Canadian national health survey. 26(2-3):80-89

Hand, Denise
Christiane Poulin, Denise Hand and Brock Boudreau. Validity of a 12-item version of the CES-D used in the National Longitudinal Study of Children and Youth. 26(2-3):65-72

Hunter, Duncan JW
Hunter Duncan JW, Grant Heather J, Purdue Mark PH, Spasoff Robert A, Dorland John L and Bains Nam. An epidemiology-based needs assessment for stroke services. 25(3/4):138-46.

Hanning, Rhonda M
Mamdouh M Shubair, R Stephen McColl and Rhona M Hanning. Contents

Hill, Gerry
Truls Østbye, Betsy Kristjansson, Gerry Hill, Stephen C Newman, Rebecca N Brouwer and Ian McDowell. Prevalence and predictors of depression in elderly Canadians: The Canadian Study of Health and Aging. 26(4):93-99

Hu, Jinfu
Jinfu Hu, Glenn Robbins, Anne-Marie Ugnat and Chris Waters. Trends in mortality from diabetes mellitus in Canada, 1986–2000. 26(1):25-29

Jean, Sonia
Sonia Jean, Diane Major, Louise Rochette and Jacques Brisson. Screening mammography participation and invitational strategy: The Quebec Breast Cancer Screening Program, 1998 – 2000. 26(2-3):52-58

Kliewer, Erich V
Alain A Demers, Donna Turner, Daojun Mo and Erich V Kliewer. Breast cancer trends in Manitoba: 40 years of follow-up. 26(1):13-19

Koval, John J
Beth K Potter, Kathy N Speechley, Iris A Gutmanis, M Karen Campbell, John J Koval and Douglas Manuel. A comparison of measures of socioeconomic status for adolescents in a Canadian national health survey. 26(2-3):80-89

Koval, JJ
Jennifer J Macnab, JJ Koval, KN Speechley and MK Campbell. Influential observations in weighted analyses: Examples from the National Longitudinal Survey of Children and Youth (NLSCY). 26(1):1-8

Kristjansson, Betsy
Truls Østbye, Betsy Kristjansson, Gerry Hill, Stephen C Newman, Rebecca N Brouwer and Ian McDowell. Prevalence and predictors of depression in elderly Canadians: The Canadian Study of Health and Aging. 26(4):93-99

Lester, F
ST David, U Chandran, D Paquette, D Scholten, J Wilson, E Galanis, M Becker, F Crane, R Lester, T Mersereau, E Wong and D Carr. An observational study of sun and heat protection during Canada Day outdoor celebrations, 2003. 26(2-3):59-64

Lipskie, Tammy
Tammy Lipskie and F Curtis Breslin. A descriptive analysis of Canadian youth treated in emergency departments for work-related injuries. 26(4):107-113

Macnab, Jennifer J
Jennifer J Macnab, JJ Koval, KN Speechley and MK Campbell. Influential observations in weighted analyses: Examples from the National Longitudinal Survey of Children and Youth (NLSCY). 26(1):1-8

Major, Diane
Sonia Jean, Diane Major, Louise Rochette and Jacques Brisson. Screening mammography participation and invitational strategy: The Quebec Breast Cancer Screening Program, 1998 – 2000. 26(2-3):52-58

Manuel, Douglas
Beth K Potter, Kathy N Speechley, Iris A Gutmanis, M Karen Campbell, John J Koval and Douglas Manuel. A comparison of measures of socioeconomic status for adolescents in a Canadian national health survey. 26(2-3):80-89

Maxwell, Colleen J
Scott B Patten, Jian Li Wang, Cynthia A Beck and Colleen J Maxwell. Measurement issues related to the evaluation and monitoring of major depression prevalence in Canada. 26(4):100-106

McColl, R Stephen
Mamdouh M Shubair, R Stephen McColl and Rhona M Hanning. Mediterranean dietary components and body mass index in adults: The Peel Nutrition and Heart Health Survey. 26(2-3):43-51

McDowell, Ian
Truls Østbye, Betsy Kristjansson, Gerry Hill, Stephen C Newman, Rebecca N Brouwer and Ian McDowell. Prevalence and predictors of depression in elderly Canadians: The Canadian Study of Health and Aging. 26(4):93-99

Mersereau, T
ST David, U Chandran, D Paquette, D Scholten, J Wilson, E Galanis, M Becker, F Crane, R Lester, T Mersereau, E Wong and D Carr. An observational study of sun and heat protection during Canada Day outdoor celebrations, 2003. 26(2-3):59-64

Mo, Daojun
Alain A Demers, Donna Turner, Daojun Mo and Erich V Kliewer. Breast cancer trends in Manitoba: 40 years of follow-up. 26(1):13-19

Newman, Stephen C
Truls Østbye, Betsy Kristjansson, Gerry Hill, Stephen C Newman, Rebecca N Brouwer and Ian McDowell. Prevalence and predictors of depression in elderly Canadians: The Canadian Study of Health and Aging. 26(4):93-99

Østbye, Truls
Truls Østbye, Betsy Kristjansson, Gerry Hill, Stephen C Newman, Rebecca N Brouwer and Ian McDowell. Prevalence and predictors of depression in elderly Canadians: The Canadian Study of Health and Aging. 26(4):93-99

Paquette, D
ST David, U Chandran, D Paquette, D Scholten, J Wilson, E Galanis, M Becker, F Crane, R Lester, T Mersereau, E Wong and D Carr. An observational study of sun and heat protection during Canada Day outdoor celebrations, 2003. 26(2-3):59-64

Patten, Scott B
Scott B Patten, Jian Li Wang, Cynthia A Beck and Colleen J Maxwell. Measurement issues related to the evaluation and monitoring of major depression prevalence in Canada. 26(4):100-106

Payne, Jennifer I
Jennifer I Payne. Occupational cancer surveillance. 26(2-3):90-91

Potter, Beth K
Beth K Potter, Kathy N Speechley, Iris A Gutmanis, M Karen Campbell, John J Koval and Douglas Manuel. A comparison of measures of socioeconomic status for adolescents in a Canadian national health survey. 26(2-3):80-89

Poulin, Christiane
Christiane Poulin, Denise Hand and Brock Boudreau. Validity of a 12-item version of the CES-D used in the National Longitudinal Study of Children and Youth. 26(2-3):65-72

Robbins, Glenn
Jinfu Hu, Glenn Robbins, Anne-Marie Ugnat and Chris Waters. Trends in mortality from diabetes mellitus in Canada, 1986–2000. 26(1):25-29

Rochette, Louise
Sonia Jean, Diane Major, Louise Rochette and Jacques Brisson. Screening mammography participation and invitational strategy: The Quebec Breast Cancer Screening Program, 1998 – 2000. 26(2-3):52-58

Brisson, Jacques
Sonia Jean, Diane Major, Louise Rochette and Jacques Brisson. Screening mammography participation and invitational strategy: The Quebec Breast Cancer Screening Program, 1998 – 2000. 26(2-3):52-58

Schauer, Claudia
Anna Christofides, Claudia Schauer, Waseem Sharieff and Stanley H Zlotkin. Acceptability of micronutrient sprinkles: A new foodbased approach for delivering iron to First Nations and Inuit children in Northern Canada. 26(4):114-120

Scholten, D
ST David, U Chandran, D Paquette, D Scholten, J Wilson, E Galanis, M Becker, F Crane, R Lester, T Mersereau, E Wong and D Carr. An observational study of sun and heat protection during Canada Day outdoor celebrations, 2003. 26(2-3):59-64

Sharieff, Waseem
Anna Christofides, Claudia Schauer, Waseem Sharieff and Stanley H Zlotkin. Acceptability of micronutrient sprinkles: A new foodbased approach for delivering iron to First Nations and Inuit children in Northern Canada. 26(4):114-120

Shields, Susanne
Richard De Marco, Michelle Wesley, Cara Bowman, Susanne Shields and Tom Wong. Child maltreatment in different populations: Investigated cases and Canadian street youth. 26(4):124-126

Shubair, Mamdouh M
Mamdouh M Shubair, R Stephen McColl and Rhona M Hanning. Mediterranean dietary components and body mass index in adults: The Peel Nutrition and Heart Health Survey. 26(2-3):43-51

Speechley, KN
Jennifer J Macnab, JJ Koval, KN Speechley and MK Campbell. Influential observations in weighted analyses: Examples from the National Longitudinal Survey of Children and Youth (NLSCY). 26(1):1-8

Speechley, Kathy N
Beth K Potter, Kathy N Speechley, Iris A Gutmanis, M Karen Campbell, John J Koval and Douglas Manuel. A comparison of measures of socioeconomic status for adolescents in a Canadian national health survey. 26(2-3):80-89

Tan, Hongzhuan
Hongzhuan Tan, Mark Walker, France Gagnon and Shi Wu Wen. The estimation of heritability for twin data based on concordances of sex and disease. 26(1):9-12

Tonmyr, Lil
Ambika Dewan and Lil Tonmyr. The Canadian Incidence Study of Reported Child Abuse and Neglect (CIS). 26(1):1-8:30-31

Turner, Donna
Alain A Demers, Donna Turner, Daojun Mo and Erich V Kliewer. Breast cancer trends in Manitoba: 40 years of follow-up. 26(1):13-19

Ugnat, Anne-Marie
Jinfu Hu, Glenn Robbins, Anne-Marie Ugnat and Chris Waters. Trends in mortality from diabetes mellitus in Canada, 1986–2000. 26(1):25-29

Walker, Mark
Hongzhuan Tan, Mark Walker, France Gagnon and Shi Wu Wen. The estimation of heritability for twin data based on concordances of sex and disease. 26(1):9-12

Wang, Jian Li
Scott B Patten, Jian Li Wang, Cynthia A Beck and Colleen J Maxwell. Measurement issues related to the evaluation and monitoring of major depression prevalence in Canada. 26(4):100-106

Waters, Chris
Jinfu Hu, Glenn Robbins, Anne-Marie Ugnat and Chris Waters. Trends in mortality from diabetes mellitus in Canada, 1986–2000. 26(1):25-29

Wen, Shi Wu

Hongzhuan Tan, Mark Walker, France Gagnon and Shi Wu Wen. The estimation of heritability for twin data based on concordances of sex and disease. 26(1):9-12

Wesley, Michelle

Richard De Marco, Michelle Wesley, Cara Bowman, Susanne Shields and Tom Wong. Child maltreatment in different populations: Investigated cases and Canadian street youth. 26(4):124-126

Wilson, J

ST David, U Chandran, D Paquette, D Scholten, J Wilson, E Galanis, M Becker, F Crane, R Lester, T Mersereau, E Wong and D Carr. An observational study of sun and heat protection during Canada Day outdoor celebrations, 2003. 26(2-3):59-64

Wong, Tom

Richard De Marco, Michelle Wesley, Cara Bowman, Susanne Shields and Tom Wong. Child maltreatment in different populations: Investigated cases and Canadian street youth. 26(4):124-126

Wong, E

ST David, U Chandran, D Paquette, D Scholten, J Wilson, E Galanis, M Becker, F Crane, R Lester, T Mersereau, E Wong and D Carr. An observational study of sun and heat protection during Canada Day outdoor celebrations, 2003. 26(2-3):59-64

Wright, Elizabeth

Bernard CK Choi, Elizabeth Wright and Ulrick Auguste. Situational analysis of chronic disease surveillance in Canada: Results of a stakeholder interview. 26(4):127-129

Zlotkin, Stanley H

Anna Christofides, Claudia Schauer, Waseem Sharieff and Stanley H Zlotkin.

Acceptability of micronutrient sprinkles: A new foodbased approach for delivering iron to First Nations and Inuit children in Northern Canada. 26(4):114-120

CDIC: Information for Authors

Chronic Diseases 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, public/community health, bio- statistics, the behavioural sciences, and health services or economics. CDIC endeavours to foster 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, contributions are welcomed from both the public and private sectors. Authors retain responsibility for the contents of their papers, and opinions expressed are not necessarily those of the CDIC editorial committee nor of the Public Health Agency of Canada.

Article Types

Peer-reviewed Feature Article: Maximum 4,000 words for main text body (excluding abstract, tables, figures, references) in the form of original research, surveillance reports, meta-analyses or methodological papers.

Status Report: Describe ongoing national programs, studies or information systems bearing on Canadian public health (maximum 3,000 words). Abstract not required.

Workshop/Conference Report: Summarize significant, recently held events relating to national public health (maximum 1,200 words). Abstract not required.

Cross-Canada Forum: For authors to present or exchange information and opinions on regional or national surveillance findings, programs under development or public health policy initiatives (maximum 3,000 words). Abstract not required.

Letter to the Editor: Comments on articles recently published in CDIC will be considered for publication (maximum 500 words). Abstract not required.

Book/Software Review: Usually solicited by the editors (500–1,300 words), but requests to review are welcomed. Abstract not required.

Submitting Manuscripts

Submit manuscripts to the Editor-in-Chief, *Chronic Diseases in Canada*, Public Health Agency of Canada 130 Colonnade Road, CDIC Address Locator: 6501G, Ottawa, Ontario K1A 0K9, e-mail: cdic-mcc@phac-aspc.gc.ca.

Since CDIC adheres in general (section on illustrations not applicable) to the "**Uniform Requirements for Manuscripts Submitted to Biomedical Journals**" as approved by the International Committee of Medical Journal Editors, authors should refer to this document for complete details before submitting a manuscript to CDIC (see **<www.cma.ca>** or Can Med Assoc J 1997;156(2): 270–7).

Checklist for Submitting Manuscripts

Cover letter: Signed by all authors, stating that all have seen and approved the final manuscript and have met the authorship including a full statement regarding any prior or duplicate publication or submission for publication.

First title page: Concise title; full names of all authors and institutional affiliations; name, postal and e-mail addresses, telephone and fax numbers for corresponding author; separate word counts for abstract and text.

Second title page: Title only; start page numbering here as page 1.

Abstract: Unstructured (one paragraph, no headings), maximum 175 words (100 for short reports); include 3–8 key words (preferably from the Medical Subject Headings (MeSH) of Index Medicus).

Text: Double-spaced, 1 inch (25 mm) margins, 12 point font size.

Acknowledgements: Include disclosure of financial and material support in acknowledgements; if anyone is credited in acknowledgements with substantive scientific contributions, authors should state in cover letter that they have obtained written permission.

References: In "Vancouver style" (consult a recent CDIC issue for examples); numbered in superscript in the order cited in text, tables and figures; listing up to six authors (first three and "et al." if more); without any automatic reference numbering feature used in word processing; any unpublished observations/data or personal communications used (discouraged) to be cited in the text in parentheses (authors responsible for obtaining written permission); authors are responsible for verifying accuracy of references.

Tables and Figures: Send vector graphics only. Each on a separate page and in electronic file(s) separate from the text (not imported into the text body); as self- explanatory and succinct as possible; not too numerous; numbered in the order that they are mentioned in the text; explanatory material for tables in footnotes, identified by lower-case superscript letters in alphabetical order; figures limited to graphs or flow charts/templates (no photographs), with software used specified and titles/footnotes on a separate page.

Number of copies: If submitting by mail, one complete copy, including tables and figures; one copy of any related supplementary material, and a copy of the manuscript on diskette. If submitting by e-mail to cdic-mcc@phac-aspc.gc.ca, please fax or mail the covering letter to the address on the inside front cover.