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r	revised
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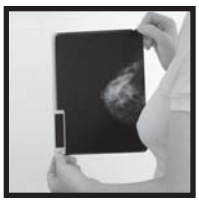


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An update on mammography use in Canada

by Margot Shields and Kathryn Wilkins

Abstract

Background
This article updates mammography use by Canadian women aged 50 to 69, and reports trends from 1990 to 2008 among the provinces. Characteristics of non-users are examined.

Data sources and methods
Data from the 2008 Canadian Community Health Survey (CCHS) were used to update mammography use and to examine factors associated with non-use. Historical estimates were produced using the 2000/2001, 2003 and 2005 CCHS, the 1994/1995, 1996/1997 and 1998/1999 National Population Health Survey and the 1990 Health Promotion Survey. Frequency estimates, cross-tabulations and logistic regression analysis were used.

Results
In 2008, 72% of women aged 50 to 69 reported having had a mammogram in the past two years, up from 40% in 1990. The increase occurred from 1990 to 2000/2001; rates then stabilized. Between 1990 and 2000/2001, the difference in participation between women in the highest and lowest income quintiles gradually narrowed—from a 26- to a 12-percentage-point difference. In 2008, the disparity widened to 18 percentage points. Non-use was high in British Columbia, Prince Edward Island and Nunavut. Non-use was associated with being an immigrant, living in a lower income household, not having a regular doctor and smoking.

Interpretation
Despite widespread availability of screening programs, women in certain segments of the population are not receiving regular mammograms.

Keywords
breast cancer, cancer screening, mass screening, trends

Authors
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Breast cancer is the most common cancer among women, and will be diagnosed in an estimated 22,700 Canadian women in 2009. A woman's probability of developing breast cancer over her lifetime is 1 in 9.[1] The probability of dying from the disease is much smaller—1 in 28. The relative five-year survival for women with breast cancer is 87%—meaning that compared with women with similar characteristics but without breast cancer, those with breast cancer are 87% as likely to survive five years after diagnosis.[2]

The most important known risk factors are a family history of the disease, age and dense breast tissue—all of which are clearly beyond the control of the individual.[3,4] Although most evidence linking modifiable behaviours with breast cancer is weak, a recently published report concluded that there is a causal link between smoking and breast cancer incidence.[5]

While the benefits of breast screening are still being debated, evidence suggests that organized mammography programs contribute to reductions in breast cancer mortality, particularly among women aged 50 to 69.[6,7] Current Canadian guidelines recommend that women in this age group have a mammogram every two years.[8] Women in their 40s and those aged 70 or older are advised to talk to their doctor about the benefits of mammography.

By 1998, organized mammography screening programs existed in every province, in addition to facilities for diagnostic mammograms, which have long been available.[9] Organized breast cancer screening programs were introduced in Yukon in 1990 and in the Northwest Territories in 2003. As of 2009, Nunavut does not have an organized screening program.

All provincial/territorial screening programs offer a biennial mammogram to women aged 50 to 69 with no previous diagnosis of breast cancer. In some provinces, annual mammograms are available. As well, some jurisdictions

offer screening to women in their 40s and to those older than 69, but a physician's referral may be required.[9]

Probably because of improved case-finding as screening participation increased, incidence rates of breast cancer rose during the 1990s, but have been fairly stable since about 2000 (Figure 1). The death rate from female breast cancer began falling in the early 1990s—perhaps partly owing to earlier detection through screening. Between 1990 and 2009, the age-standardized mortality rate declined by 30%.[1]

Since 1988, when the first provincial program was launched in British Columbia, the number of women participating in organized mammography screening increased rapidly from 4,000 to 895,000 in 2004.[9] However, the use of mammography has not been uniform throughout the population.

Earlier studies based on data collected from Canadian women in the mid-1990s found that factors such as a lower level of education, residing in a rural area, not having a regular medical doctor, and being an immigrant were associated with lower levels of mammography use.[10-12] Now more than a decade later, when organized screening programs are well established and nearly universally available, it is even more important to identify barriers to use and groups among whom mammography use might be sub-optimal.

The aim of this study is to provide an update on mammography use by women aged 50 to 69 in Canada, and to report trends from 1990 to 2008 among the provinces. Estimates include not only mammograms conducted for screening, but also those for diagnostic purposes. Based on data from the 2008 Canadian Community Health Survey, characteristics of non-users are examined, including socio-demographic factors, contact with a medical doctor, and health-related risks. Barriers associated with non-use of mammography are reported.

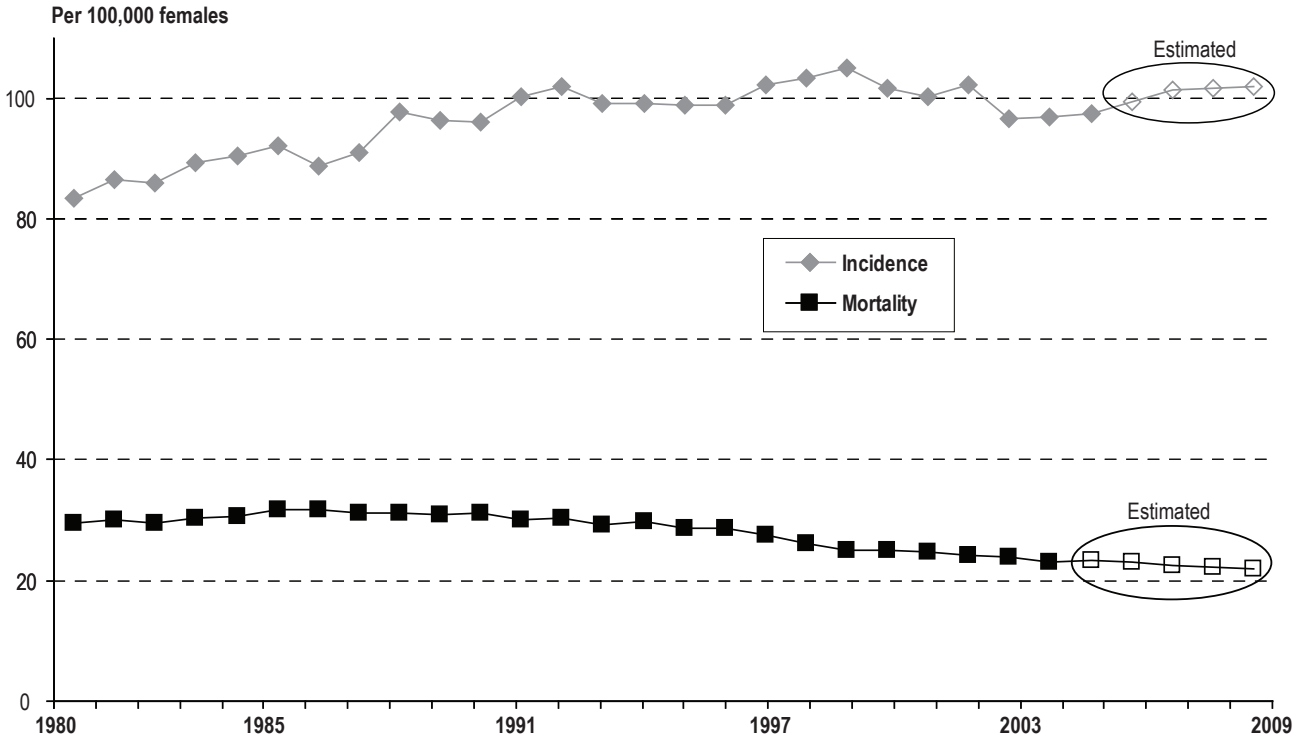
Throughout this article, the term "mammography user" refers to a woman who reported that she had undergone a mammogram within the past two years—the interval recommended in the Canadian Cancer Society guidelines; a "non-user" is one who had not had a mammogram within that period.

Methods

Data source

Data from the 2008 Canadian Community Health Survey (CCHS) were used to

Figure 1
Age-standardized† incidence and mortality rates of breast cancer, females, Canada, 1980 to 2009



† standardized to 1991 Canadian population
Note: Estimated data used for incidence in 2006 to 2009 and for mortality in 2005 to 2009.
Source: Reference 1.

estimate mammography use and to examine factors associated with being a non-user. The CCHS is cross-sectional, and covers the non-institutionalized household population aged 12 or older in all provinces and territories, except members of the regular Canadian Forces and residents of Indian reserves, Canadian Forces bases (military and civilian), and some remote areas. In 2008, the overall response rate was 75.2% (66,013 persons in the interviewed sample). A description of the CCHS methodology is available in a published report[13] and on Statistics Canada's website (www.statcan.gc.ca).

Historical estimates of mammography use are based on data from the 1990 Health Promotion Survey; the National Population Health Survey of 1994/1995, 1996/1997, and 1998/1999; and the CCHS of 2000/2001, 2003 and 2005.

Measures

Mammogram

The following questions were asked of female CCHS respondents aged 35 or older: "Have you ever had a mammogram, that is, a breast x-ray?" (Yes/No); "Why did you have it?" (open-ended; multiple responses accepted); and "When was the last time?" (Less than 1 year ago / 1 year to less than 2 years ago / 2 years to less than 3 years ago / 3 years to less than 5 years ago / 5 or more years ago).

Because of its lack of specificity, the question asking the reasons for having had a mammogram could be taken to refer to any that the respondent had ever had. Therefore, mammograms in the past two years cannot be identified as screening or diagnostic (to investigate a potential breast problem).

In the surveys used for estimates in the years before 2008, the questions about ever having a mammogram and the time of the last one were the same as in the 2008 CCHS. However, the question about reasons for having had a mammogram differed across surveys, and in some cases, it was not asked. As a result, this analysis focuses on mammography within the past two years, and necessarily includes both screening and diagnostic mammograms; women with a history of, or a current, breast problem are included.

Household income

Household income groups were derived based on a modified version of the equivalence score method, which adjusts household income by household size. This method was developed at Statistics Canada[14] and uses a weight factor based on the "40/30" rule. For each 2008 CCHS respondent, a household weight factor was calculated based on household size. The first household member was assigned a weight of 1; the second member, a weight of 0.4; and the third and all subsequent members, a weight of 0.3. The household weight factor was then calculated as the sum of these weights. For example, for a five-member household, it would be 2.3 (1 + 0.4 + 0.3 + 0.3 + 0.3). Household income was then divided by the household weight factor to derive income adjusted for household size. Using the entire weighted 2008 CCHS data file, the adjusted household incomes were grouped into quintiles (five groups, each containing one-fifth of the Canadian population). The same procedure was used to derive household income quintiles for all historical files used in the analysis.

Leisure-time physical activity

Three levels of leisure-time physical activity were derived, based on information from CCHS respondents about participation in physical activities in the three months before their interview. Levels were defined in terms of activity-specific kilocalorie expenditure per kilogram per day (KKD): active (3 or more KKD), moderate (1.5 to 2.9 KKD), and inactive (less than 1.5 KKD).

Level of day-to-day stress

Levels of day-to-day stress were estimated based on responses to the question, "Thinking about the amount of stress in your life, would you say that most days are: not at all stressful? not very stressful? a bit stressful? quit a bit stressful? extremely stressful?" The first two categories were defined as low stress; the third as medium stress; and the last two as high stress.

Sense of community belonging

To measure sense of community belonging, CCHS respondents were asked, "How would you describe your sense of belonging to your local community? Would you say it is: very strong? somewhat strong? somewhat weak? very weak?" In this analyis, sense of community belonging was used as an indicator of social support.

Analytical techniques

Frequency estimates were produced to describe the characteristics of the study population, based on weighted data to represent the female household population aged 50 to 69 in 2008. Cross-tabulations and multiple logistic regression modelling were used to examine factors associated with being a non-user of mammography. The variables included in the analysis were based on findings in the literature and availability in the CCHS.

It has been proposed that individuals with low socio-economic status are less likely to participate in cancer screening because of psychosocial factors such as lower levels of social support and higher levels of stress.[15] To explore this possibility, stress and community belonging were included in the bivariate analysis. Because neither factor was associated with non-use of mammography, they were not retained in the multivariate analysis. For the same reason, body mass index (BMI) was not retained in the multivariate analysis.

To reduce the potential for multicollinearity in the multivariate analysis, associations among the independent variables were examined. Education was excluded from the regression model because of its strong association with income. Country of birth was excluded because of its association with immigrant status.

To account for the survey design effects of the CCHS, standard errors, coefficients of variation, and 95% confidence intervals were estimated using the bootstrap technique.[16,17]

Differences between estimates were tested for statistical significance, which was established at the level of $p < 0.05$ (two-tailed).

Historical estimates of mammography use were based on data weighted to represent the female population aged 50 to 69 in the time period in which the data were collected. Because the age distribution of women in the 50-to-69 age group has shifted over time, historical rates were recalculated to standardize to the 2008 population, using 5-year age groupings. In each case, the crude and age-standardized rates were within one percentage point of each other (data not shown); therefore, only the crude percentages are presented.

Results

Characteristics of study population

The 2008 CCHS sample of 11,441 female respondents aged 50 to 69 was weighted to represent 3.8 million women in this age range (Table 1). The majority (71%) were married. Two-thirds lived in a Census Metropolitan Area. One-quarter were immigrants—19% had lived in Canada for 20 or more years; 4% for 10 to 19 years; and the remaining 2% for 0 to 9 years. Immigrants were predominantly from Europe and Asia. .

Around four-fifths (82%) reported that they had a regular medical doctor and had been in contact with a general practitioner or family doctor during the past year. Another 10% had a regular doctor, but had no contact in the past year. The remaining 8% reported that they did not have a regular doctor, although half of them (4%) had contacted a general practitioner or family doctor in the past year.

More than half (55%) of the women were postsecondary graduates. Excellent or very good health was reported by 54% of the women; only 16% reported fair or poor health

Trends in mammography use

In 1990, fewer than half (40%) of women aged 50 to 69 reported that they had had

Table 1
Selected characteristics of study sample,[†] female household population aged 50 to 69, Canada, 2008

Variable	Sample size	Estimated number (weighted) '000	Estimated percentage[‡] (weighted)
Total	**11,441**	**3,829**	**100.0**
Age group			
50 to 54	2,932	1,202	31.4
55 to 59	3,207	1,079	28.2
60 to 64	2,978	875	22.9
65 to 69	2,324	673	17.6
Marital status			
Married/Common-law	7,059	2,708	70.8
Widowed	1,346	295	7.7
Divorced/Separated	2,009	556	14.6
Never married	998	263	6.9
Missing	29	...	...
Resides in Census Metropolitan Area			
Yes	4,967	2,531	66.1
No	6,474	1,299	33.9
Place of birth			
North America	9,694	2,862	76.2
Europe	978	411	11.0
Asia	338	320	8.5
Other	235	163	4.3
Missing	196	...	...
Years since immigration			
0 to 9	85	69[E]	1.9[E]
10 to 19	183	166	4.4
20 or more	1,383	698	18.6
Non-immigrant	9,581	2,814	75.1
Missing	209	...	...
Household income quintile			
1 (lowest)	2,259	624	19.6
2	2,131	653	20.5
3	1,897	656	20.6
4	1,613	564	17.7
5 (highest)	1,688	692	21.7
Missing	1,853	...	...
Education			
Less than secondary graduation	2,330	706	18.9
Secondary graduation	2,753	974	26.1
Postsecondary graduation	6,090	2,057	55.0
Missing	268	...	...
Has regular MD?—Contacted GP/family doctor in past year?			
Yes—Yes	9,266	3,147	82.2
Yes—No	1,211	378	9.9
No—Yes	481	157	4.1
No—No	474	146	3.8
Missing	9	...	...
Self-perceived general health			
Excellent/Very good	5,985	2,050	53.6
Good	3,546	1,178	30.8
Fair/Poor	1,890	594	15.5
Missing	20	...	...

[†] excludes 174 respondents with missing value for mammogram in past two years
[‡] records with missing values excluded from denominators
[E] use with caution (coefficient of variation 16.6% to 33.3%)
... not applicable
Source: 2008 Canadian Community Health Survey.

Table 2
Percentage reporting mammogram in past two years, by province, household income quintile and education, female household population aged 50 to 69, Canada excluding territories, 1990 to 2008

	1990	1994/1995	1996/1997	1998/1999	2000/2001	2003	2005	2008	Percentage-point change (2008 minus 1990)
	Percentage								
Canada	**40.5***	**56.9***	**63.1***	**66.2***	**72.7**	**72.4**	**72.0**	**72.5**	**32.0**
Province (year organized screening program began†)									
Newfoundland and Labrador (1996)	18.9*E	33.4*	43.3*	48.2*	64.1	66.6	69.9	71.4	52.6
Prince Edward Island (1998)	44.9*	67.0	67.2	62.5	71.2	70.7	64.8	61.0*	16.1
Nova Scotia (1991)	33.6*	42.8*	53.3*	56.1*	71.1	66.1	72.7	69.0	35.5
New Brunswick (1995)	28.6*E	49.0*	66.8	72.3	73.1	75.6	75.0	74.0	45.4
Quebec (1998)	39.8*	48.5*	56.9*	58.4*	74.2	72.8	74.0	73.9	34.1
Ontario (1990)	43.7*	59.6*	66.9*	68.2*	73.6	72.4	73.1	73.2	29.6
Manitoba (1995)	36.1*	42.9*	59.3*	65.2	71.1	72.6	66.7	71.0	34.9
Saskatchewan (1990)	21.1*E	71.4	66.1*	80.7	76.4	75.0	70.1*	73.6	52.4
Alberta (1990)	43.4*	70.5	63.1*	69.7	70.9	74.2	71.7	74.0	30.6
British Columbia (1988)	44.4*	67.8	70.4	75.8	69.0	72.0	67.1	67.9	23.5
Household income quintile									
1 (lowest)	32.7*	49.5*	52.8*	56.8*	66.4	63.7	66.5	60.7*	28.0
2	39.2*	46.2*	61.1*	66.2	69.2	71.8	71.0	71.0	31.8
3	43.4*	58.1*	61.3*	67.8*	75.4	74.6	75.2	77.5	34.1
4	44.7*	61.1*	68.1*	72.3	77.5	75.8	73.4*	77.0	32.3
5 (highest)	58.5*	68.5*	71.5*	71.7	78.4	77.8	75.7	79.1	20.6
Education									
Less than secondary graduation	36.2*	48.8*	57.7*	62.7*	68.4	67.0	68.3	63.9*	27.8
Secondary graduation or some postsecondary	43.3*	58.5*	64.8*	65.8*	72.4	73.0	72.7	74.5	31.2
Postsecondary graduation	46.0*	67.1*	67.2*	70.4*	76.4	75.5	73.3*	74.5	28.4

* significantly different from estimate for 2000/2001 (shaded) ($p < 0.05$)
† see reference 8
E use with caution (coefficient of variation 16.6% to 33.3%)
Sources: 2000/2001 to 2008 Canadian Community Health Survey; 1994/1995 to 1998/1999 National Population Health Survey; 1990 Health Promotion Survey.

a mammogram in the past two years; by 2008, the rate was 72% (Table 2). All of the increase occurred from 1990 to 2000/2001, after which the percentage stabilized.

In 1988, British Columbia implemented the first formal breast screening program, followed in 1990 by Ontario, Saskatchewan and Alberta. By 1998, programs were in place in all 10 provinces—accounting for the sharp increase in mammography use between 1990 and 2000/2001.[9]

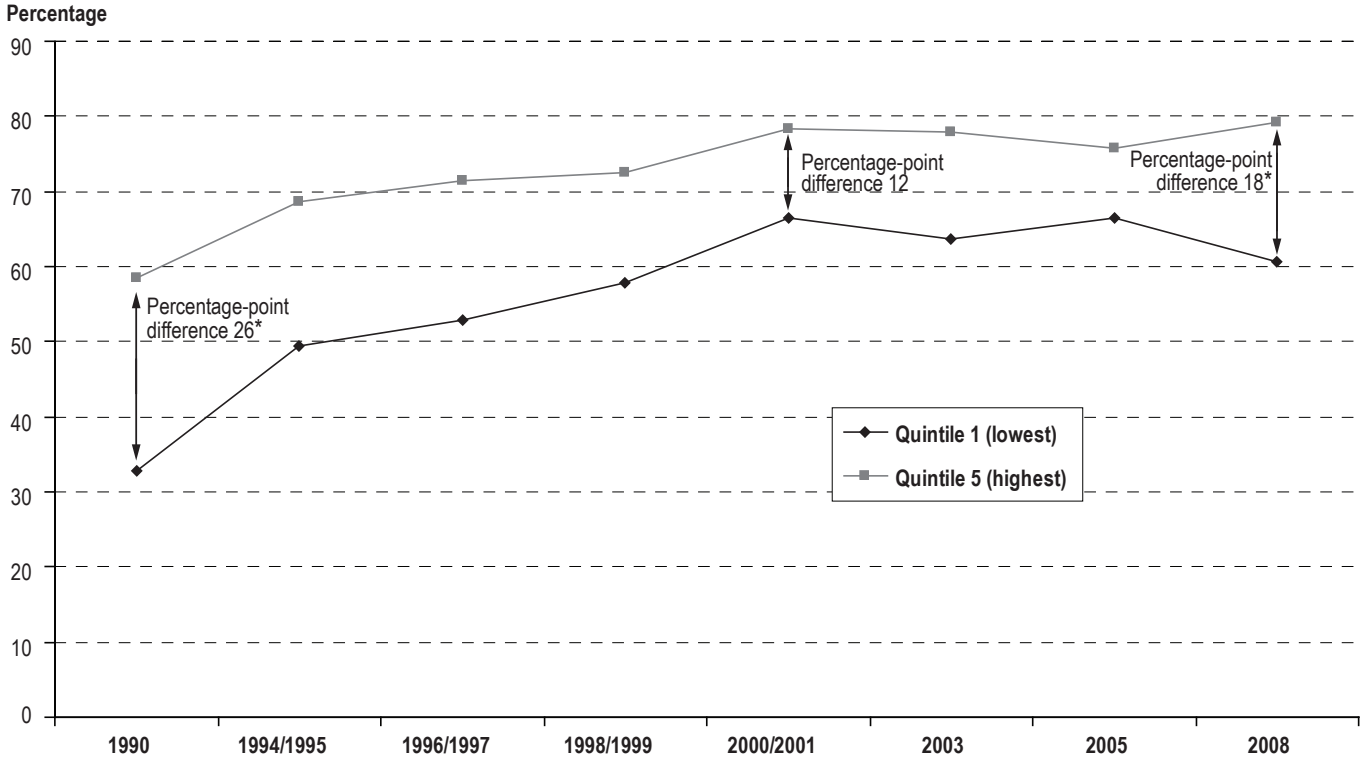
Before 2000/2001, mammography use varied substantially among the 10 provinces (Appendix Table A). In British Columbia, relatively high percentages of women reported mammography use, while in Newfoundland and Labrador and in Quebec, rates were lower, reflecting the later initiation of screening programs.[9] Disparities among the provinces were particularly wide in 1994/1995, with rates ranging from a low of 33% in Newfoundland and Labrador to a high of 71% in Saskatchewan, a difference of 38 percentage points. In 2000/2001, by which time all provinces had screening programs, the range had narrowed to 12 percentage points, and it remained about the same in subsequent years.

Lower income—Less use

In 1990, the percentage of women reporting mammography use was much higher in the highest household income quintile (58.5%) than in the lowest quintile (32.7%)—a 26-percentage-point difference (Figure 2). By 2000/2001, the difference had narrowed to 12 percentage points. However, in 2008, the gap widened to 18 percentage points, largely because of a decline in mammography use by women in the lowest income quintile. That year, 61% of women in the lowest income quintile reported mammography use, down from 67% in 2005 (Table 2). A similar decrease in 2008 was observed among women with less than secondary graduation.

Before the widespread implementation of screening programs, differences in mammography use between women in the middle and upper income categories were more pronounced. In 1990, 1994/1995 and 1996/1997, women in the middle income quintile had reduced odds of reporting mammography use, compared with those in the highest income quintile (Appendix Table B). Since 1998/1999, the odds that women in the middle quintile would use mammography have been similar to those of women in the highest quintile. By contrast, women in the lowest income quintile have had consistently lower odds of mammography use since 1990.

Figure 2
Percentage reporting mammogram in past two years, by highest and lowest household income quintile, female household population aged 50 to 69, Canada excluding territories, 1990 to 2008



* significantly larger than difference for 2000/2001 ($p < 0.05$)
Sources: 2000/2001 to 2008 Canadian Community Health Survey; 1994/1995 to 1998/1999 National Population Health Survey; 1990 Health Promotion Survey.

Who hasn't had a mammogram?

Although mammography screening programs are widely available across Canada, 28% of women aged 50 to 69 reported in 2008 that they had not had a mammogram in the past two years (Table 3).

Women aged 50 to 54 were more likely to be non-users than were those aged 55 or older. The lower rate in the younger age group reflects the inclusion of 50-year-olds, who had had less time in the age range for which mammography is nationally recommended. When the percentage was recalculated for women aged 51 to 54, 28% were non-users—similar to the percentage of non-users in older age groups (data not shown).

Compared with women who were married or living common-law, those who were widowed, divorced, separated or never married were more likely to be non-users.

Women living outside a Census Metropolitan Area (CMA) were slightly, but significantly, more likely to be non-users (29%) than were CMA residents (27%).

In 2008, residents of Prince Edward Island and British Columbia were somewhat more likely to be non-users, compared with women living elsewhere. The percentage of non-users was particularly high in Nunavut (68%) where no organized mammography screening program has been developed.

Over half (57%) of recent immigrants —those in Canada for less than 10 years—were non-users, compared with 26% of Canadian-born women. Although this difference is substantial, recent immigrants aged 50 to 69 comprise just 2% of the female population in this age group. The likelihood of being a non-user was higher among those born in Asia (34%) or Europe (32%), compared with women born in Canada or the United States (26%).

Low socio-economic status (SES) was associated with higher non-use: 39% among women in the lowest household income quintile, compared with 21% among those in the highest quintile. Among women with less than secondary graduation, 36% were non-users, compared with 26% among those with at least secondary graduation.

Recent contact with a doctor was strongly associated with mammography use. While 23% of those who had a regular medical doctor and had contacted a general practitioner or family doctor in the past year were non-users, the figure was 71% for women without a regular

Table 3
Percentage not reporting mammogram in past two years, by selected characteristics, female household population aged 50 to 69, Canada, 2008

	Percentage	95% confidence interval from	to
Total	**27.5**	**26.1**	**28.9**
Age group			
50 to 54	32.8*	29.9	35.6
55 to 59	25.1	22.3	27.9
60 to 64	23.8	21.3	26.3
65 to 69†	26.9	23.8	30.0
Marital status			
Married/Common-law†	25.8	24.1	27.5
Widowed	32.6*	27.0	38.1
Divorced/Separated	30.9*	26.9	34.9
Never married	32.8*	28.2	37.4
Resides in Census Metropolitan Area			
Yes	26.7*	24.8	28.6
No†	29.2	27.7	30.8
Province/Territory			
Newfoundland and Labrador	28.6	22.1	35.0
Prince Edward Island	39.0*	30.5	47.4
Nova Scotia	31.0	25.4	36.5
New Brunswick	26.0	21.1	31.0
Quebec	26.1	22.9	29.3
Ontario	26.8	24.3	29.3
Manitoba	29.0	23.5	34.4
Saskatchewan	26.4	21.6	31.2
Alberta	26.0	21.6	30.5
British Columbia	32.1*	28.1	36.1
Yukon	33.8E	21.0	46.5
Northwest Territories	31.6E	17.1	46.0
Nunavut	67.8*E	41.5	94.1
Place of birth			
North America†	25.9	24.5	27.3
Europe	32.4*	27.9	36.9
Asia	34.4*	26.7	42.1
Other	29.0E	18.5	39.6
Years since immigration			
0 to 9	57.4*	40.1	74.8
10 to 19	34.9	24.1	45.7
20 or more	29.0	25.1	32.9
Non-immigrant†	25.8	24.4	27.2
Household income quintile			
1 (lowest)	39.3*	35.3	43.3
2	29.0*	25.7	32.3
3	22.6	19.3	25.8
4	23.0	19.7	26.4
5 (highest)†	20.9	17.8	24.1
Education			
Less than secondary graduation	36.1*	32.6	39.7
Secondary graduation	25.5	22.9	28.2
Postsecondary graduation†	25.5	23.7	27.3
Has regular MD?—Contacted GP/family doctor in past year?			
Yes—Yes†	22.8	21.3	24.2
Yes—No	45.3*	40.2	50.3
No—Yes	40.5*	31.5	49.5
No—No	70.7*	63.5	78.0
Self-perceived general health			
Excellent/Very good†	25.7	23.8	27.6
Good	29.7*	27.2	32.3
Fair/Poor	28.9	25.5	32.4
Level of day-to-day stress			
Low†	27.3	24.9	29.6
Medium	27.9	25.8	30.1
High	27.1	24.1	30.0
Sense of community belonging			
Very/Somewhat strong†	26.8	25.0	28.5
Very/Somewhat weak	29.0	26.5	31.5
Smoking status			
Daily smoker	39.8*	36.5	43.1
Occasional smoker	30.2	21.8	38.5
Non-smoker†	25.1	23.6	26.7
Leisure-time physical activity			
Active/Moderately active (1.5 or more KKD)†	25.5	23.6	27.3
Inactive (less than 1.5 KKD)	29.3*	27.2	31.3
BMI category			
Underweight (less than 18.5)	30.4	20.7	40.2
Normal weight (18.5 to less than 25)†	27.5	25.2	29.8
Overweight (25.0 to less than 30)	26.4	23.9	28.8
Obese class I (30.0 to less than 35)	27.3	23.7	30.9
Obese class II (35.0 to less than 40)	24.2	18.9	29.5
Obese class III (40.0 or more)	32.9	24.2	41.7

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
KKD: kilocalories per kilogram per day
Note: For province/territory, the reference category is the other provinces/territories combined.
Source: 2008 Canadian Community Health Survey.

doctor and who reported no doctor contact over the past year.

Among the small percentage of women (8%) without a regular doctor, mammography use by usual source of care was estimated. Approximately half of women who usually sought care at an appointment or walk-in clinic, and 58% of those who usually go to a Centre local de services communautaires or a community health centre, were non-users (data not shown). Among women with no usual source of care, 78% were non-users.

Women who rated their health as good were slightly more likely to be non-users (30%) than were those who rated their health as excellent or very good (26%).

Neither perceived stress nor having a sense of community belonging was associated with being a non-user.

Of the three health risk factors considered, smoking and physical inactivity were correlated with non-use of mammography; no association with weight was observed. Daily smokers were substantially more likely to be non-users (40%) than were non-smokers (25%). Women who were inactive in their leisure time were slightly more likely to be non-users (29%) than were those who were active or moderately active (25%).

Factors associated with being a non-user of mammography were examined in a multivariate logistic model (Table 4). When other variables were controlled for, residing in a CMA, low household income, not having a regular doctor, and being a smoker remained significantly associated with non-use. On the other hand, associations with marital status, province/territory, self-perceived health and leisure-time physical activity level did not persist.

Reasons for not having a mammogram

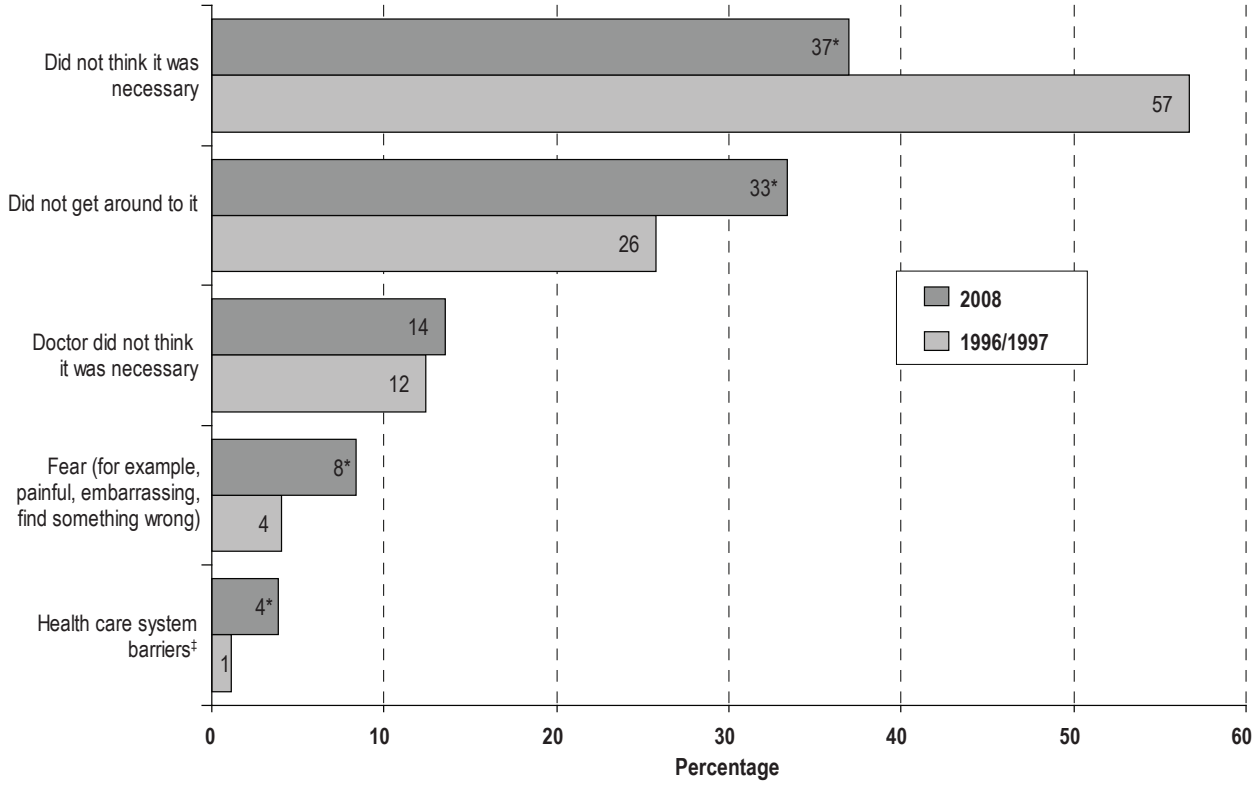
In the 2008 CCHS, women who reported that they had not had a mammogram in the past two years were asked why not. The most common reason, reported by 37% of non-users, was that they did not think it was necessary (Figure 3). A substantially

Table 4
Odds ratios relating selected characteristics to not reporting mammogram in past two years, female household population aged 50 to 69, Canada, 2008

	Unadjusted odds ratio	95% confidence interval		Adjusted odds ratio	95% confidence interval	
		from	to		from	to
Age group						
50 to 54	1.3*	1.1	1.6	1.4*	1.1	1.8
55 to 59	0.9	0.7	1.1	0.9	0.7	1.2
60 to 64	0.8	0.7	1.1	0.9	0.7	1.1
65 to 69†	1.0	…	…	1.0	…	…
Marital status						
Married/Common-law†	1.0	…	…	1.0	…	…
Widowed	1.4*	1.1	1.8	1.1	0.9	1.5
Divorced/Separated	1.3*	1.0	1.6	1.1	0.9	1.5
Never married	1.4*	1.1	1.8	1.1	0.8	1.4
Resides in Census Metropolitan Area						
Yes	0.9*	0.8	1.0	0.9*	0.8	1.0
No†	1.0	…	…	1.0	…	…
Province/Territory						
Newfoundland and Labrador	1.1	0.8	1.5	0.9	0.7	1.3
Prince Edward Island	1.7*	1.2	2.6	1.4	0.9	2.2
Nova Scotia	1.2	0.9	1.6	1.2	0.9	1.7
New Brunswick	1.0	0.7	1.3	0.9	0.6	1.2
Quebec	1.0	0.8	1.2	0.8	0.6	1.0
Ontario†	1.0	…	…	1.0	…	…
Manitoba	1.1	0.8	1.5	1.0	0.7	1.5
Saskatchewan	1.0	0.7	1.3	0.9	0.7	1.3
Alberta	1.0	0.7	1.3	0.9	0.7	1.2
British Columbia	1.3*	1.0	1.6	1.2	0.9	1.5
Yukon	1.4	0.8	2.5	1.2	0.6	2.4
Northwest Territories	1.3	0.6	2.5	0.6	0.2	1.3
Nunavut	5.7*	1.7	19.3	2.5	0.5	14.0
Years since immigration						
0 to 9	3.9*	1.9	7.8	3.7*	1.8	7.7
10 to 19	1.5	0.9	2.5	1.7	1.0	2.8
20 or more	1.2	1.0	1.4	1.3*	1.1	1.7
Non-immigrant†	1.0	…	…	1.0	…	…
Household income quintile						
1 (lowest)	2.5*	1.9	3.2	2.1*	1.6	2.9
2	1.5*	1.2	2.0	1.4*	1.1	1.9
3	1.1	0.8	1.5	1.1	0.8	1.4
4	1.1	0.9	1.5	1.1	0.8	1.4
5 (highest)†	1.0	…	…	1.0	…	…
Has regular MD?—Contacted GP/family doctor in past year?						
Yes—Yes†	1.0	…	…	1.0	…	…
Yes—No	2.8*	2.3	3.5	2.9*	2.3	3.7
No—Yes	2.3*	1.6	3.4	2.3*	1.6	3.5
No—No	8.2*	5.7	11.8	9.0*	6.0	13.5
Self-perceived general health						
Excellent/Very good†	1.0	…	…	1.0	…	…
Good	1.2*	1.0	1.4	1.1	0.9	1.3
Fair/Poor	1.2	1.0	1.4	1.0	0.8	1.3
Smoking status						
Daily smoker	2.0*	1.7	2.3	1.7*	1.5	2.1
Occasional smoker	1.3	0.9	1.9	1.2	0.8	1.9
Non-smoker†	1.0	…	…	1.0	…	…
Leisure-time physical activity level						
Active/Moderately active (1.5 or more KKD)†	1.0	…	…	1.0	…	…
Inactive (less than 1.5 KKD)	1.2*	1.1	1.4	1.1	0.9	1.3

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
…not applicable
KKD: kilocalories per kilogram per day
Source: 2008 Canadian Community Health Survey.

Figure 3
Most frequently reported reasons for not having mammogram in past two years, female household population aged 50 to 69,† Canada, 1996/1997 and 2008



† based on population who did not report mammogram in past two years
‡ includes not available at time required, not available in area, and waiting time too long
* significantly different from estimate for 1996/1997 ($p < 0.05$)
Note: Respondents could report more than one reason.
Sources: 2008 Canadian Community Health Survey, 1996/1997 National Population Health Survey.

higher proportion (57%) of non-users had offered the same explanation in response to a similar question in the 1996/1997 NPHS. One-third (33%) of non-users in 2008 reported that they "had not gotten around to it"—up from 26% in 1996/1997. The percentages of non-users who reported that the doctor did not think it was necessary were similar in 2008 and 1996/1997, at 14% and 12%, respectively. In 2008, relatively few non-users mentioned fear or health care system barriers (8% and 4%, respectively), but these reasons had been reported even less frequently in 1996/1997.

Supplementary analysis focusing on non-users revealed an association between low SES and the belief that having a mammogram was unnecessary. Women in the lowest household income quintile and those with less than secondary graduation were more likely than those in higher income quintiles and with more education to report that they did not think a mammogram was necessary (data not shown). As well, 39% of daily smokers reported that they did not believe that mammography was necessary, compared with 30% of non-smokers.

Discussion

Since the implementation of breast screening programs in the late 1980s and the 1990s, mammography use among Canadian women has increased substantially. However, in 2008, more than one quarter of women aged 50 to 69 reported that they had not had a mammogram in the past two years—the interval recommended by the Canadian Cancer Society. The main factors associated with non-use were low SES, being an immigrant, not having a regular medical doctor, not having contacted a general practitioner or family doctor in the past year, and being a smoker.

The major strengths of the current study include the large, representative sample of Canadian women upon which it is based, and the up-to-date information it provides on factors associated with being a non-user of mammography—despite the nearly universal availability of breast screening programs.

What is already known on this subject?

- Evidence suggests that mammography contributes to reductions in mortality from breast cancer.
- Since the first provincial breast screening program was launched in 1988, rapidly increasing numbers of women have used mammography.
- Data collected in the mid-1990s indicate that use of mammography was not uniform throughout the population.

What does this study add?

- In 2008, 72% of women reported having mammography in the past two years—up from 40% in 1990.
- Mammography use peaked in 2000/2001.
- Before 2000/2001, rates differed markedly among the provinces; since then, provincial rates have become more similar.
- Mammography use in 2008 was less common at lower levels of income and education, and among immigrants, smokers, and those without a regular doctor.
- From 2005 to 2008, use of mammography declined among women at the lowest income level.

In the United States, the American Cancer Society[18] recommends an annual mammogram starting at age 40; in Canada, the recommendation is a biennial mammogram beginning at age 50. While the screening protocol in the United States calls for more frequent mammography that also begins at an earlier age, it is important to remember that not all women in that country have health care insurance. Despite these differences, in 2005, the most recent year for which comparable data are available, the percentages of women aged 50 to 69 who reported a mammogram in the past two years was similar: 72.5% in the United States[19] and 72.0% in Canada.

A slightly higher proportion of American than Canadian women were using mammography in 1994 and 2002/2003.[20,21] Similar to Canada, use of mammography in the United States increased dramatically between 1987 and 2000. However, in contrast to the stabilization of the mammography rate in Canada since 2000, the percentage of American women reporting they had had a mammogram in the past two years declined slightly between 2000 and 2005.[22]

The finding that low SES is associated with being a non-user of mammography is consistent with the results of earlier studies conducted in Canada and other countries.[10,11,20,23-26] Two models have been proposed to explain differences in cancer screening by SES. The psychosocial model proposes that low SES individuals are less likely to engage in health-protective behaviours including cancer screening because they experience more stress and receive less social support than do those at higher SES levels.[15] According to the cognitive model, beliefs about the risk of disease and the benefits of screening explain reduced levels of screening among low SES individuals. Findings from the CCHS data did not support the psychosocial model: stress and community belonging (used as a proxy for social support) were not associated with mammography use. Some support for the cognitive model emerged from supplementary analysis indicating that for non-users, reporting that mammography was unnecessary was significantly associated with both low income and low education.

A notable finding from this study was the decline in mammography use by low SES women as of 2008. This underscores an opportunity for informing women at all SES levels about the importance of regular mammograms.

Consistent with findings from the 2008 CCHS, reports of lower use of mammography among recent immigrants and women born in Asia have been published previously.[12,23,26,27] Lower use in these groups may reflect cultural sensitivities and differing attitudes about the mammogram procedure and its usefulness.

A fairly consistent report in the literature is that mammography use is associated with other preventive health behaviours such as regular exercise, being a non-smoker and contact with physicians.[25,26,28,29] This study found that women who were physically inactive in their leisure time and women who smoke were more likely to be non-users of mammography. It has been hypothesized that women who are unable or unwilling to quit smoking are generally less concerned about other health-promoting behaviours such as cancer screening.[26] A previous study found that although smokers and non-smokers were equally likely to receive a recommendation for a mammogram from their primary care physician, smokers were less likely to follow through. Furthermore, smokers were less likely to feel that mammography was necessary or beneficial,[30] a finding that was somewhat supported by the CCHS data. The low use of mammography among smokers is particularly relevant in light of a recently published review suggesting a causal link between smoking and breast cancer incidence.[5]

Having a usual source of care, recent contact with a physician, and receiving a recommendation from a physician have been found to be salient predictors of mammography use.[23,26,27,31] The strong association between mammography use and contact with doctors in this study supports the previous research and emphasizes the importance of the doctor's role in promoting the use of mammography.

Limitations

This analysis examines mammography use over the past two years and includes both screening and diagnostic mammograms. The extent to which trends in use and the characteristics

associated with being a non-user would differ if the analysis could be restricted to screening mammograms is unknown. It is likely that the vast majority of mammograms reported in 2008 were for screening. When asked why they had (ever) had a mammogram, 91% of 2008 CCHS respondents indicated reasons that were consistent with screening, and only 13% gave reasons consistent with diagnostic purposes.

Estimates of mammography use in the past two years are based on self-reported data, and responses were not validated against clinical records. A recent meta-analysis examined the accuracy of self-reported mammography.[32] Sensitivity (the percentage of women who reported having had a mammogram among those whose medical records showed that they had actually had one) was estimated to be 0.95. Specificity, however, was somewhat low (0.61), meaning that among women whose medical records indicated that they had not had a mammogram, 61% identified themselves as non-users; the remaining 39% incorrectly reported that they had had a mammogram. Over-reporting results partly from a phenomenon known as telescoping—that is, the date of the last mammogram is reported as being more recent than it actually was.[33] Social desirability bias may also result in over-reporting. As a result, it is likely that estimates of mammography use in this analysis are somewhat inflated.

The CCHS did not include a question about whether a doctor had recommended a mammogram. Previous research has indicated that advice from a physician is even more important than SES as a predictor of mammogram use.[31,32] Had it been possible to include such a variable in the multivariate analysis, the associations observed between other independent variables and non-use might have been attenuated.

Health behaviours such as participation in cancer screening are often examined using the theoretical framework proposed in the Health Belief Model.[34] According to this model, the likelihood of undergoing mammography is driven by subjective factors such as perceived susceptibility to and danger of breast cancer, and perceived benefits of and deterrents to mammography. The Health Belief Model is consistent with the argument proposed in the cognitive model that low SES individuals are less likely to engage in health-promoting behaviours because of lack of knowledge. An extensive analysis of mammography use by the components proposed in these models was not possible because of their unavailability in the CCHS, although some examination of the barriers to mammography was carried out by examining reasons for not having had a mammogram.

Conclusion

Mammography is one of the few steps a woman can take to reduce her risk of mortality from breast cancer. In 2008, 72% of Canadian women aged 50 to 69 had had a mammogram in the past two years—a figure that had remained unchanged from 2000/2001 when mammography screening programs were nearly universally available. Since 2000/2001, mammography use has been fairly similar across provinces. However, use is lower in identifiable sub-groups, namely, women with low SES, immigrants, smokers, and those without a regular doctor. ■

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Appendix

Table A
Percentage reporting mammogram in past two years, by province, female household population aged 50 to 69, Canada excluding territories, 1990 to 2008

	1990	1994/ 1995	1996/ 1997	1998/ 1999	2000/ 2001	2003	2005	2008
	Percentage							
Canada	**40.5**	**56.9**	**63.1**	**66.2**	**72.7**	**72.4**	**72.0**	**72.5**
Province (year organized screening program began†)								
Newfoundland and Labrador (1996)	18.9[E]L	33.4L	43.3L	48.2L	64.1L	66.6L	69.9	71.4
Prince Edward Island (1998)	44.9	67.0	67.2	62.5	71.2	70.7	64.8L	61.0L
Nova Scotia (1991)	33.6	42.8L	53.3	56.1L	71.1	66.1L	72.7	69.0
New Brunswick (1995)	28.6[E]L	49.0	66.8	72.3	73.1	75.6	75.0	74.0
Quebec (1998)	39.8	48.5L	56.9L	58.4L	74.2	72.8	74.0H	73.9
Ontario (1990)	43.7	59.6	66.9H	68.2	73.6	72.4	73.1	73.2
Manitoba (1995)	36.1	42.9L	59.3	65.2	71.1	72.6	66.7L	71.0
Saskatchewan (1990)	21.1[E]L	71.4H	66.1	80.7H	76.4H	75.0	70.1	73.6
Alberta (1990)	43.4	70.5H	63.1	69.7	70.9	74.2	71.7	74.0
British Columbia (1988)	44.4	67.8H	70.4H	75.8H	69.0L	72.0	67.1L	67.9L
Highest province minus lowest province	**26.1**	**38.0**	**27.1**	**32.5**	**12.3**	**9.5**	**10.2**	**13.0**

L significantly lower than estimate for other provinces combined ($p < 0.05$)
H significantly higher than estimate for other provinces combined ($p < 0.05$)
[E] use with caution (coefficient of variation 16.6% to 33.3%)
† see reference 8
Sources: 2000/2001 to 2008 Canadian Community Health Survey; 1994/1995 to 1998/1999 National Population Health Survey; 1990 Health Promotion Survey.

Table B
Unadjusted odds ratios relating household income quintile to reporting mammogram in past two years, female household population aged 50 to 69, Canada excluding territories, 1990 to 2008

	1990	1994/ 1995	1996/ 1997	1998/ 1999	2000/ 2001	2003	2005	2008
	Unadjusted odds ratio							
Household income quintile								
1 (lowest)	0.3L	0.5L	0.4L	0.5L	0.5L	0.5L	0.6L	0.4L
2	0.5L	0.4L	0.6L	0.8	0.6L	0.7L	0.8L	0.6L
3	0.5L	0.6L	0.6L	0.8	0.8	0.8	1.0	0.9
4	0.6L	0.7	0.8	1.0	0.9	0.9	0.9	0.9
5 (highest)†	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0

† reference category
L significantly lower than estimate for reference category ($p < 0.05$)
Sources: 2000/2001 to 2008 Canadian Community Health Survey; 1994/1995 to 1998/1999 National Population Health Survey; 1990 Health Promotion Survey.


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Colorectal cancer testing in Canada–2008

by Kathryn Wilkins and Margot Shields

Abstract

Objectives
This article provides estimates of the reported level of colorectal cancer (CRC) testing in the Canadian population aged 50 or older in 2008.

Data sources and methods
The data are from the 2008 Canadian Community Health Survey. With weighted data, the percentage of people who had undergone CRC testing (fecal occult blood test in the past two years or endoscopy within the past five years) was estimated. Bivariate and multivariate analyses were used to examine testing status in relation to personal, socio-economic and other health-related characteristics.

Results
In 2008, an estimated 40% of Canadians aged 50 or older reported that they had had CRC testing. The percentage ranged from 28% in Quebec to 53% in Manitoba. Testing was associated with being 65 or older, higher income, having a regular doctor, being a non-smoker, and being physically active.

Interpretation
Organized CRC screening was limited in 2008, but may account for some of the differences in participation among the provinces.

Keywords
colonoscopy, colorectal neoplasms, endoscopy, fecal occult blood test, mass screening, sigmoidoscopy

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As a group, cancers of the colon and rectum constitute the third most common cancer in Canadian adults.[1] An estimated 22,000 new cases will be diagnosed in 2009–about one in eight of all new cancers that year. Approximately 94% of colorectal cancers (CRC) are diagnosed in people aged 50 or older. CRC is also important as a cause of death; in 2009, it will lead to the deaths of an estimated 9,100 Canadians, making it the second-leading cancer-related cause of death. Since 1990, age-standardized mortality rates have fallen somewhat in both sexes.[1]

Accumulating evidence indicates that the fecal occult blood test (FOBT) reduces the CRC mortality rate.[2-6] If approximately 70% of Canadians aged 50 to 74 had a biennial FOBT, followed up by colonoscopy for positive FOBTs, the CRC mortality rate could be reduced by an estimated 15% to 17%.[5,7] Detailed information on the strengths and limitations of FOBT and endoscopy is available in a previous report.[8]

Several Canadian organizations have issued colorectal screening recommendations over the past few years (Text Box 1). Although details differ slightly, a common, fundamental recommendation is that people aged 50 or older who are at average risk of CRC (that is, without bowel disease or a family history of CRC) should have an FOBT at least biennially. Colonoscopy is the usually recommended follow-up procedure of a positive FOBT.

Organized screening programs, such as those for breast cancer, are aimed at all people in specific target groups; the opportunity for screening does not depend entirely on physician contact.[9,10] In most parts of Canada, CRC screening is currently offered by physicians to patients individually and opportunistically, rather than through population-based organized screening programs. Barriers to implementing organized CRC screening programs may include: uncertainty about the cost-effectiveness of mass screening; the high percentage of false-positive results of FOBT;

concerns about resource availability for follow-up of positive FOBT results or treatment of newly diagnosed cases; potential to miss cancers; and patient non-compliance.[2,8,11-16]

In 2007, Ontario initiated a province-wide organized CRC screening program; Manitoba launched the pilot phase of such a program in the Winnipeg and Assiniboine Regional Health Authorities; and Alberta issued new CRC screening clinical practice guidelines together with a public and professional educational campaign.[17-19] In all three provinces, biennial FOBT is recommended for people of average risk of CRC. Ontario's guidelines include those aged 50 or older, while Manitoba and Alberta target people aged 50 to 74.

Previous research related to CRC screening in Canada has been limited; population-based data have been collected only for specific provinces or sub-provincial regions.[20-23] From these data it was not possible to estimate the extent to which Canadians across the country were participating in CRC screening.

Some findings from the previous Canadian data are consistent with those from studies in the United States. These included positive associations with income and with having a regular physician.[21,24-26]

Nationwide information on CRC testing was collected for the first time by the 2008 Canadian Community Health Survey (CCHS). Using the data from that survey, this study provides estimates of up-to-date CRC testing for any purpose (screening or diagnosis) in Canadians aged 50 or older. Up-to-date testing is defined as an FOBT in the past two years, or a colonoscopy or sigmoidoscopy in the past five years.

Personal characteristics, socio-demographic factors and other health-related risk factors are examined in relation to CRC testing status. Differences by province are presented for 2008, and where possible, estimates based on the 2003 and 2005 CCHS are also provided.

Text Box 1
Recommendations and guidelines on colorectal cancer screening for asymptomatic persons of average risk

Organization (year recommendations/ guidelines issued)	Recommendations/Guidelines
Canadian Task Force on Preventive Health Care (2001)[27]	• Good evidence to include annual or biennial FOBT in periodic health examination of people older than 50. • Fair evidence to include flexible sigmoidoscopy.
National Committee on Colorectal Cancer Screening (2002)[28]	• Biennial (at least) FOBT for people aged 50 to 74. • Follow-up of positive FOBT by colonoscopy, with options of barium enema and flexible sigmoidoscopy, where appropriate.
Canadian Association of Gastroenterology and the Canadian Digestive Health Foundation (2004)[29]	• Biennial FOBT for people aged 50 or older. • Follow-up of positive FOBT with colonoscopy. • Flexible sigmoidoscopy every five years, or • flexible sigmoidoscopy combined with FOBT every five years, or • double contrast barium enema every five years, or • colonoscopy every 10 years.
Canadian Cancer Society (2008)[30]	• Biennial (at least) FOBT for people aged 50 or older. • Follow-up of positive FOBT with colonoscopy, or double contrast barium enema and flexible sigmoidoscopy.

Methods

Data source

The data are from the 2003, 2005 and 2008 Canadian Community Health Survey (CCHS). Along with information on personal, socio-economic and other health-related characteristics, data on CRC testing (FOBT and endoscopy) were collected.

The CCHS is cross-sectional and covers the non-institutionalized household population aged 12 or older in all provinces and territories, except members of the regular Canadian Forces and residents of Indian reserves, Canadian Forces bases (military and civilian) and some remote areas. In 2008, the overall response rate was 75.2% (sample size 66,013); in 2005, it was 78.9% (sample size 132,947); and in 2003, 80.6% (sample size 135,573). A technical description of the CCHS methodology is available in a published report.[31]

The 2008 data were collected from January to December. This analysis was limited to people aged 50 or older, 62% of whom were interviewed by telephone, and the remaining 38%, in person. Of a total of 32,298 respondents in this age range, 30,835 provided information on their experience with FOBT, colonoscopy or sigmoidoscopy and thus comprised the study sample.

Measures

Colorectal investigation

FOBT: "An FOBT is a test to check for blood in your stool, where you have a bowel movement and use a stick to smear a small sample on a special card. Have you ever had this test?" (Yes/No) "When was the last time?" (Less than 1 year ago/1 year to less than 2 years ago/2

years to less than 3 years ago/3 years to less than 5 years ago/5 years to less than 10 years ago/10 or more years ago).

Endoscopy: "A colonoscopy or sigmoidoscopy is when a tube is inserted into the rectum to view the bowel for early signs of cancer and other health problems. Have you ever had either of these exams?" (Yes/No) "When was the last time?" (Less than 1 year ago/1 year to less than 2 years ago/2 years to less than 3 years ago/3 years to less than 5 years ago/5 years to less than 10 years ago/10 or more years ago).

Three measures of colorectal testing were used for this study: FOBT in the past two years; endoscopy (colonoscopy or sigmoidoscopy) in the past five years; and either FOBT in the past two years or endoscopy in the past five years. A respondent who reported FOBT and also endoscopy was counted as having had each procedure. For the combination variable, a respondent reporting both FOBT and endoscopy was counted once.

Census Metropolitan Area

As defined by Statistics Canada, a Census Metropolitan Area (CMA) is formed by one or more adjacent municipalities centred on a large urban area. To be included in the CMA, municipalities must have a high degree of integration with the central urban area, as measured by commuting flows derived from census place of work data.[32]

Household income

Household income groups were derived by calculating the ratio between total household income from all sources in the 12 months before the 2008 CCHS interview and Statistics Canada's low-income cut-off specific to the number of people in the household, the size of the community, and the survey year. Using the entire weighted 2008 CCHS data file, the adjusted income ratios were grouped into quintiles (five groups, each containing one-fifth of the Canadian household population).

Leisure-time physical activity

Three levels of leisure-time physical activity were used, based on information from respondents on their participation in physical activities in the three months before their interview. Levels were defined in terms of activity-specific kilocalorie expenditure per kilogram per day (KKD): active (3 or more KKD), moderate (1.5 to 2.9 KKD), and inactive (less than 1.5 KKD).

Body mass index

Body mass index (BMI) is a measure of weight adjusted for height. It is calculated by dividing weight in kilograms by height in metres squared. The CCHS collected self-reports of height and weight, from which BMI was calculated for each respondent. BMI was categorized as:

- Underweight: less than 18.5
- Normal: 18.5 to less than 25.0
- Overweight: 25.0 to less than 30.0
- Obese class I: 30.0 to less than 35.0
- Obese class II: 35.0 to less than 40.0
- Obese class III: equal to or greater than 40.0

Analytical techniques

Based on data weighted to be representative of the Canadian household population aged 50 or older in 2008, frequencies and cross-tabulations were produced. Logistic regression was used to estimate unadjusted odds ratios for each independent variable in relation to having undergone CRC testing (FOBT in the past two years or endoscopy in the past five years). Multiple logistic regression modeling was used to assess changes in the associations observed in the unadjusted analysis when the influence of selected independent variables was controlled for. These variables included socio-demographic characteristics, having (and contacting) a regular medical doctor, self-perceived health, and health-related risk factors. Variance was estimated using the bootstrap technique to account for the complex design of the survey.[33,34]

Results

The weighted analysis sample represented 10.2 million people aged 50 or older living in households in 2008 (Table 1). An estimated 62% of them were aged 50 to 64, and 71% were married or living in common-law relationships. Nearly two-thirds (66%) resided in Census Metropolitan Areas (CMAs). One in four (26%) had been born outside Canada, and 5% had immigrated less than 20 years ago. Relatively few people aged 50 or older (8%) reported that they did not have a regular medical doctor. Almost one in five (19%) said that their general health was fair or poor.

In 2008, an estimated 40% of Canadians aged 50 or older reported that they had had CRC testing—that is, a FOBT in the past two years or sigmoidoscopy or colonoscopy in the past five years (Table 2). The likelihood of testing was not significantly different between the sexes. Higher proportions of people aged 65 or older had been tested, compared with those aged 50 to 64. The percentage tested was higher among those who were married, and among those living in a CMA. Immigrants who had been in Canada less than 20 years were less likely than people born in Canada to have had CRC testing. People in households with income in the two lower quintiles were less likely to have been tested than were those in higher-income households.

The likelihood of CRC testing was highest (44%) among people with a regular medical doctor whom they had consulted in the past year. Percentages were lower for those with a regular doctor but whom they had not consulted in the past year (29%), and those without a regular doctor but who had consulted a doctor (21%). People without a regular doctor and who had not consulted a doctor in the past year were the least likely to have had CRC testing (10%). A higher proportion of people who perceived their general health to be fair or poor had had CRC testing, compared with those in better health.

Among the small percentage (8%) of people who did not have a regular doctor,

Table 1
Selected characteristics of study sample, household population aged 50 or older, Canada, 2008

	Sample size	Estimated number ('000)	Percentage
Total	**30,835**	**10,172**	**100.0**
Sex			
Male	13,171	4,853	47.7
Female	17,664	5,319	52.3
Age group			
50 to 64	16,506	6,269	61.6
65 to 74	7,667	2,278	22.4
75 or older	6,662	1,625	16.0
Marital status			
Married/Common-law	17,703	7,154	70.5
Widowed	6,083	1,209	11.9
Divorced/Separated	4,292	1,119	11.0
Never married	2,681	671	6.6
Missing	76	...	...
Resides in Census Metropolitan Area (CMA)			
Yes	13,445	6,714	66.0
No	17,390	3,459	34.0
Place of birth			
North America	25,473	7,436	75.0
Europe	3,326	1,310	13.2
Africa	180	149	1.5
Asia	772	735	7.4
Other	382	286	2.9
Missing	702	...	...
Years since immigration			
0 to 9	174	172	1.7
10 to 19	394	358	3.6
20 or more	4,323	2,019	20.4
Non-immigrant	25,206	7,352	74.3
Missing	738	...	...
Household income quintile			
1 (lowest)	6,254	1,842	21.8
2	5,591	1,802	21.3
3	4,679	1,589	18.8
4	4,277	1,536	18.1
5 (highest)	4,442	1,695	20.0
Missing	5,592	...	...
Has regular MD?—Contacted GP/family doctor in past year?			
Yes—Yes	24,817	8,239	81.1
Yes—No	3,359	1,073	10.6
No—Yes	1,225	411	4.0
No—No	1,397	438	4.3
Missing	37	...	...
Self-perceived general health			
Excellent/Very good	14,270	4,883	48.1
Good	10,252	3,388	33.4
Fair/Poor	6,239	1,882	18.5
Missing	74	...	...

... not applicable
Note: Excludes 1,463 respondents with missing value for colorectal cancer screening.
Sources: 2008 Canadian Community Health Survey.

the likelihood of having CRC testing was estimated according to where they usually go for health care. The percentage who reported that they had been tested was 29% for those who usually seek care at a community health clinic or Centre Local de Services Communautaires (CLSC), 27% for those who go to an appointment clinic, and 15% for those who use a walk-in clinic (data not shown).

The likelihood of CRC testing differed by the presence of health risk factors. Daily smokers were much less likely to have been tested than were non-smokers, and physically inactive people were less likely than were those who were more active. Compared with people whose self-reported height and weight placed them in the normal range of the body mass index (BMI), those in BMI obese class I were more likely to have undergone CRC testing. People classified as underweight or obese class III were less likely to have participated in CRC testing than were those of normal BMI.

Most of the associations with CRC testing observed in the bivariate analyses (Table 2; unadjusted odds ratios in Table 3) persisted in a multiple logistic regression model (Table 3, adjusted odds ratios).

Geographic differences in the percentage of people who had had CRC testing were substantial, ranging from 28% in Quebec to 53% in Manitoba (Figure 1). In general, the likelihood of testing was lower in provinces east of Ontario and in the territories than elsewhere, and markedly higher in Manitoba and Ontario.

Geographic variations were also observed in the percentages of people who had undergone each type of CRC investigation. FOBT in the past two years was less likely among residents of Quebec and the Atlantic provinces, and more likely in Ontario and Manitoba—ranging from 10% in Quebec to 42% in Manitoba (Appendix Table A). Less variation across jurisdictions was observed for endoscopy in the past five years, which ranged from 11% in Yukon to 30% in Ontario. In Quebec, Newfoundland and Labrador, and New

Table 2
Percentage reporting having fecal occult blood test in past two years or colonoscopy or sigmoidoscopy in past five years, by selected characteristics, household population aged 50 or older, Canada, 2008

		95% confidence interval	
	Percentage	from	to
Total	**39.8**	**38.8**	**40.8**
Sex			
Male	40.2	38.8	41.6
Female†	39.5	38.2	40.7
Age group			
50 to 64†	36.5	35.2	37.8
65 to 74	48.6*	47.0	50.3
75 or older	40.2*	38.2	42.1
Marital status			
Married/Common-law†	41.3	40.2	42.5
Widowed	37.0*	34.9	39.2
Divorced/Separated	37.1*	34.3	39.9
Never married	32.8*	29.7	35.8
Resides in Census Metropolitan Area			
Yes†	40.4*	39.0	41.7
No	38.7	37.6	39.7
Place of birth			
North America†	40.1	39.1	41.1
Europe	44.3*	41.7	46.9
Africa	46.2	34.9	57.5
Asia	29.6*	24.5	34.6
Other	37.5	28.7	46.4
Years since immigration			
0 to 9	22.2*E	12.1	32.3
10 to 19	32.2*	24.9	39.5
20 or more	42.8	40.0	45.5
Non-immigrant†	39.9	39.0	40.9
Household income quintile			
1 (lowest)	35.1*	33.0	37.2
2	38.4*	36.2	40.6
3†	42.4	40.0	44.8
4	42.1	39.7	44.6
5 (highest)	43.3	40.7	45.8
Has regular MD?—Contacted GP/family doctor in past year?			
Yes—Yes	43.7*	42.6	44.8
Yes—No	29.3*	26.5	32.1
No—Yes	21.0*	17.0	24.9
No—No†	9.5	6.7	12.3
Self-perceived general health			
Excellent/Very good†	39.5	38.1	40.9
Good	38.1	36.4	39.8
Fair/Poor	43.6*	41.4	45.9
Smoking status			
Daily smoker	30.1*	27.9	32.3
Occasional smoker	37.5	30.9	44.0
Non-smoker†	41.6	40.5	42.7
Leisure-time physical activity level			
Active (3 or more KKD)†	44.0	41.8	46.1
Moderately active (1.5 to 2.9 KKD)	43.4	41.6	45.3
Inactive (less than 1.5 KKD)	36.6*	35.3	37.9
BMI category			
Underweight (less than 18.5)	32.2*	25.7	38.6
Normal weight (18.5 to less than 25.0)†	39.0	37.5	40.6
Overweight (25.0 to less than 30.0)	40.5	38.9	42.0
Obese class I (30.0 to less than 35.0)	42.7*	40.0	45.4
Obese class II (35.0 to less than 40.0)	43.0	38.1	47.8
Obese class III (40.0 or more)	32.5*	26.7	38.3

† reference category
* significantly different from reference category ($p < 0.05$)
E use with caution (coefficient of variation 16.6% to 33.3%)
KKD: kilocalories per kilogram per day
Source: 2008 Canadian Community Health Survey.

Brunswick, higher percentages of people had undergone endoscopy in the past five years than had participated in FOBT in the past two years; in Manitoba, British Columbia and Yukon, the opposite was true.

Comparisons over time showed that in Newfoundland and Labrador, New Brunswick and Ontario, the percentage of people reporting having had an FOBT in the past two years and the proportion having had endoscopy in the past five years increased significantly from 2005 to 2008 (Appendix Table B). Between 2003 and 2008, the percentages tested increased significantly in British Columbia. Data for years before 2008 were unavailable for Quebec, Manitoba, Saskatchewan and Alberta. For Nunavut, sample sizes were too small to produce reliable estimates.

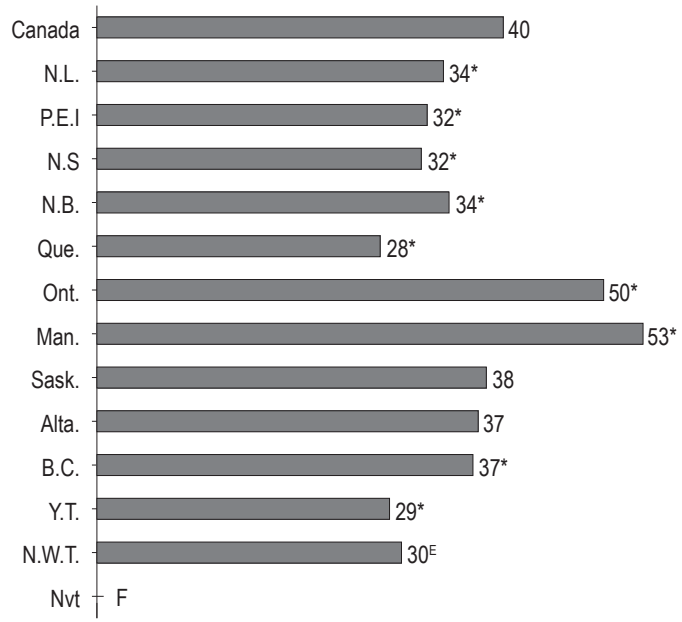
Discussion

This study provides the first national estimates of the percentage of Canadians reporting CRC testing—defined as FOBT in the past two years or endoscopy in the past five years. As of 2008, 40% of people aged 50 or older, the age range in which the incidence of CRC increases rapidly, reported up-to-date testing.

It was not possible to limit the analysis to people at average risk of CRC (see *Limitations*). As a result of the inclusion of people at higher risk, who would likely be undergoing CRC testing more frequently than is recommended for those of average risk, the estimated percentage of the population having CRC testing is probably slightly higher than the estimate for screening in the average-risk population would be.

A study based on administrative records in Ontario covering the six-year period 1995 through 2000 found that 20.5% of 50- to 59-year-olds without a previous history of CRC, other bowel disease, or large bowel investigation (FOBT, barium enema, sigmoidoscopy or colonoscopy) were screened (by FOBT, barium enema, or endoscopy) for CRC.[20] This figure is substantially lower than the finding from the CCHS

Figure 1
Percentage reporting having fecal occult blood test in past two years or colonoscopy or sigmoidoscopy in past five years, by province/territory, household population aged 50 or older, Canada, 2008



* significantly different from estimate for other provinces/territories combined
E use with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be published (coefficient of variation greater then 33.3%)
Note: See Appendix Table A for 95% confidence intervals.
Source: 2008 Canadian Community Health Survey.

that 38% of the Ontario population aged 50 or older reported CRC testing in 2005. Several factors may have contributed to the higher estimate from the CCHS data: use of the age group 50 or older rather than 50 to 59, use of self-reported data, inclusion of higher-than-average risk persons, and perhaps, a true increase in the percentage of the population tested as of 2005 versus the percentage tested from 1995 to 2000.

The 2008 data collection year is timely for two reasons: a sufficient interval had elapsed for physicians to have implemented screening guidelines published in the early 2000s into clinical practice, and it closely follows the 2007 launch of province-wide organized screening in Ontario and the pilot initiative in Manitoba. The relatively high levels of testing in Manitoba and Ontario may partially be due to the early results of organized screening. The wide provincial variations in CRC testing contrast with rates of participation in mammography, which have become more uniform since the establishment of organized breast cancer screening programs in all provinces.[35]

A distinct advantage of the CCHS is its large sample size, which supports estimates in sub-populations, as well as comparisons of utilization patterns of specific types of CRC testing among the provinces and territories. For example, in Quebec, the percentage of people reporting testing by endoscopy was approximately twice the percentage reporting FOBT; in Manitoba, the reverse was true. Such differences may reflect province-specific preferences for certain testing modalities, the availability of facilities and specialists, or the early effects of population screening initiatives.[13]

Inconsistencies in the protocols guiding CRC screening make comparisons between the United States and Canada difficult. Nonetheless, participation in the United States may be higher than in Canada. According to data for 2006, the percentage of people who reported FOBT in the past (single) year or endoscopy in the past ten years surpassed 50% in every state and 60% in 21 states.[36]

Numerous studies have noted that the proportion of Americans without health insurance who participate in CRC screening is particularly low—a barrier that Canadians do not face.[37,38] But despite universal access to health care services, Canadians in lower-income categories were less likely than those in higher-income categories to report current CRC testing in 2008—consistent with observations from earlier research in Canada and the United States.[21,24,26,27]

In most parts of Canada, CRC testing is available only with a physician's referral or requisition. Therefore, the strong, positive association with having and consulting a medical doctor was expected, and has been previously observed.[21,22,26,39] The CCHS did not ask respondents if their physician had recommended CRC testing, a factor that has also repeatedly been strongly related to current testing.[34,37-43]

Associations between socio-demographic characteristics and CRC testing have also emerged in previous research. Consistent with the finding in the present study, a positive relationship between older age and the likelihood of CRC testing has been reported.[34,42,43] As well, the finding from the CCHS data that urban area of residence was positively related to CRC testing is consistent with American studies.[37,38] Previously reported associations with marital status are less consistent.[39,42] Little evidence exists related to immigrant status in association with CRC testing, although a lower likelihood of CRC testing in people born outside Canada has been reported.[21]

Relatively few studies have examined associations between health-related risk factors and CRC screening, although the positive association between level of physical activity and CRC testing is corroborated by previous Canadian research.[21] The negative relationship

Table 3
Odds ratios relating selected characteristics to reporting fecal occult blood test in past two years or colonoscopy or sigmoidoscopy in past five years, household population aged 50 or older, Canada, 2008

	Unadjusted odds ratio	95% confidence interval		Adjusted odds ratio	95% confidence interval	
		from	to		from	to
Sex						
Male	1.0	1.0	1.1	1.0	0.9	1.1
Female†	1.0	…	…	1.0	…	…
Age group						
50 to 64†	1.0	…	…	1.0	…	…
65 to 74	1.6*	1.5	1.8	1.6*	1.5	1.8
75 or older	1.2*	1.1	1.3	1.2*	1.1	1.4
Marital status						
Married/Common-law†	1.0	…	…	1.0	…	…
Widowed	0.8*	0.8	0.9	0.8*	0.7	0.9
Divorced/Separated	0.8*	0.7	1.0	1.0	0.9	1.2
Never married	0.7*	0.6	0.8	0.9	0.8	1.1
Resides in Census Metropolitan Area						
Yes	1.1	1.0	1.2	1.0	0.9	1.1
No†	1.0	…	…	1.0	…	…
Province/Territory						
Newfoundland and Labrador	0.8*	0.6	0.9	0.8	0.7	1.0
Prince Edward Island	0.7*	0.6	0.9	0.8	0.6	1.0
Nova Scotia	0.7*	0.6	0.8	0.7*	0.5	0.8
New Brunswick	0.8*	0.7	0.9	0.8*	0.7	0.9
Quebec	0.5*	0.4	0.5	0.5*	0.5	0.6
Ontario	1.9*	1.8	2.1	2.0*	1.8	2.2
Manitoba	1.8*	1.5	2.1	1.9*	1.6	2.2
Saskatchewan	0.9	0.8	1.1	1.0	0.9	1.1
Alberta	0.9	0.8	1.0	0.9	0.8	1.0
British Columbia	0.9*	0.8	1.0	0.8*	0.7	0.9
Yukon	0.6*	0.4	0.9	0.7	0.4	1.0
Northwest Territories	0.6	0.3	1.2	1.6	0.7	3.7
Nunavut	0.3*	0.1	0.8	1.3	0.6	2.8
Year since immigration						
0 to 9	0.4*	0.2	0.8	0.4*	0.2	0.7
10 to 19	0.7*	0.5	1.0	0.6	0.4	0.8
20 or more	1.1	1.0	1.3	0.9	0.8	1.0
Non-immigrant†	1.0	…	…	1.0	…	…
Household income quintile						
1 (lowest)	0.7*	0.6	0.8	0.8*	0.7	0.9
2	0.8*	0.7	1.0	0.8*	0.7	1.0
3†	1.0	…	…	1.0	…	…
4	1.0	0.9	1.1	1.0	0.8	1.1
5 (highest)	1.0	0.9	1.2	1.0	0.9	1.2
Has regular MD?—Contacted GP/ family doctor in past year?						
Yes—Yes	7.4*	5.3	10.4	5.7*	4.0	8.1
Yes—No	3.9*	2.8	5.6	3.0*	2.1	4.4
No—Yes	2.5*	1.7	3.8	2.4*	1.5	3.7
No—No†	1.0	…	…	1.0	…	…
Self-perceived general health						
Excellent/Very good†	1.0	…	…	1.0	…	…
Good	0.9	0.9	1.0	1.0	0.9	1.1
Fair/Poor	1.2*	1.1	1.3	1.3*	1.1	1.5
Smoking status						
Daily smoker	0.6*	0.5	0.7	0.7*	0.6	0.8
Occasional smoker	0.8	0.6	1.1	0.9	0.7	1.2
Non-smoker†	1.0	…	…	1.0	…	…
Leisure-time physical activity level						
Active (3 or more KKD)†	1.0	…	…	1.0	…	…
Moderately active (1.5 to 2.9 KKD)	1.0	0.9	1.1	1.0	0.8	1.1
Inactive (Less than 1.5 KKD)	0.7*	0.7	0.8	0.7*	0.7	0.8
BMI category						
Underweight (less than 18.5)	0.7	0.5	1.0	0.8	0.6	1.2
Normal weight (18.5 to less than 25.0)†	1.0	…	…	1.0	…	…
Overweight (25.0 to less than 30.0)	1.1	1.0	1.2	1.0	0.9	1.1
Obese class I (30.0 to less than 35.0)	1.2*	1.0	1.3	1.1	1.0	1.3
Obese class II (35.0 to less than 40.00)	1.2	1.0	1.4	1.1	0.9	1.4
Obese class III (40.0 or more)	0.8*	0.6	1.0	0.7*	0.5	0.9

† reference category
* significantly different from reference category ($p < 0.05$)
… not applicable
KKD: kilocalories per kilogram per day
Note: For province/territory, reference group is combined other provinces/territories.
Source: 2008 Canadian Community Health Survey.

between smoking and CRC testing has been reported in Canada and the United States,[21,34,39,41] although some inconsistent results have been noted.[42] Evidence of an association between BMI and CRC testing is limited, but the negative association for people in obese class III is consistent with research findings based on medical records in the United States.[44]

Limitations

The study sample was representative of the household population aged 50 or older. Because not all respondents were asked about personal diagnosis or family history of bowel cancer, it was not possible to differentiate those at average risk from those at higher risk, as is common in other studies.[20-24]

The data were self-reported; no independent verification of the information reported by respondents was undertaken. Validity studies comparing patient-reported with physician-recorded FOBT and endoscopy indicate a tendency to overreport these procedures, which results in overestimates of their prevalence.[45,46] It is thus likely that estimates of CRC testing are inflated to some extent.

The degree to which associations between CRC testing and other variables may be affected by reporting error is

What is already known on this subject?

- Just over 90% of colorectal cancers (CRC) are diagnosed in people aged 50 or older.
- Evidence suggests that population screening for colorectal cancer reduces its mortality rate.
- To date, only Ontario has an organized, province-wide screening program; preliminary steps for programs are under way in other provinces.

What does this study add?

- In 2008, an estimated 40% of Canadians aged 50 or older reported up-to-date colorectal cancer testing—that is, a fecal occult blood test in the past two years or endoscopy in the past five years.
- Differences among the provinces and territories in the percentage of the population tested were large.
- The likelihood of CRC testing was greater among people who lived in higher-income households, had a regular doctor, did not smoke, and were active in their leisure time.

unknown. In particular, the accuracy of information about socially sensitive characteristics such as body weight (or perhaps even CRC testing) may be affected.

Data were not collected on all factors that may influence compliance with CRC testing, so they could not be taken into account in the analysis. Subjective factors that have been observed to affect health-related decisions and preventive behaviours have been catalogued under the Health Belief Model. These include perceived susceptibility, perceived seriousness of the condition to be prevented, and perceived benefits of, and barriers to, preventive action.[47,48] In the specific context of CRC testing, the perception of a procedure as unpleasant, invasive or dangerous may hinder compliance.

Conclusion

This study provides new information on current levels of CRC testing in the Canadian population. The data show considerable differences in participation among the provinces and territories. The analysis also indicates that participation in CRC testing varies depending on contact with a physician, and identifiable socio-economic and behavioural characteristics. Continued monitoring of CRC testing in conjunction with CRC incidence and mortality will provide further useful information. ■

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Appendix

Table A
Percentage reporting having colorectal cancer testing, by type of test and province/territory, household population aged 50 or older, Canada, 2008

	Fecal occult blood test (FOBT) in past two years			Colonoscopy or sigmoidoscopy in past five years			FOBT in past two years or colonoscopy or sigmoidoscopy in past five years		
		95% confidence interval			95% confidence interval			95% confidence interval	
Province/Territory	Percentage	from	to	Percentage	from	to	Percentage	from	to
Canada	**22.7**	**21.9**	**23.6**	**24.4†**	**23.6**	**25.3**	**39.8**	**38.8**	**40.8**
Newfoundland and Labrador	15.6*	12.8	18.4	24.8†	21.2	28.3	33.9*	30.0	37.8
Prince Edward Island	18.0*	14.1	21.9	21.3	16.4	26.2	32.3*	27.1	37.5
Nova Scotia	16.3*	13.3	19.3	19.4*	16.8	22.0	31.8*	28.2	35.4
New Brunswick	16.4*	14.1	18.6	24.1†	21.3	27.0	34.5*	31.2	37.8
Quebec	9.7*	8.5	11.0	21.6*†	19.9	23.3	27.7*	25.9	29.5
Ontario	30.5*	28.9	32.2	29.8*	28.2	31.4	49.6*	47.8	51.5
Manitoba	41.9*	38.0	45.7	22.4†	19.2	25.5	53.5*	49.8	57.2
Saskatchewan	22.3	19.6	25.0	23.6	20.9	26.3	38.1	35.1	41.2
Alberta	23.0	20.4	25.5	20.3*	17.9	22.7	37.3	34.5	40.2
British Columbia	23.8	21.8	25.7	19.4*†	17.4	21.4	36.8*	34.6	39.1
Yukon	24.6	17.2	31.9	10.9*†E	5.8	16.1	28.7*	21.0	36.3
Northwest Territories	18.5E	7.7	29.3	F	F	F	29.8E	16.8	42.9
Nunavut	12.0*E	5.4	18.6	F	F	F	F	F	F

* significantly different from estimate for other provinces/territories combined ($p < 0.05$)
† significantly different from estimate for FOBT ($p < 0.05$)
E use with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be published (coefficient of variation greater than 33.3%)
Source: 2008 Canadian Community Health Survey.

Table B
Percentage reporting having colorectal cancer testing, by type of test, household population aged 50 or older, selected provinces/territories, Canada, 2003, 2005 and 2008

	Fecal occult blood test (FOBT) in past two years			Colonoscopy or sigmoidoscopy in past five years			FOBT in past two years or colonoscopy or sigmoidoscopy in past five years		
	2003	2005	2008	2003	2005	2008	2003	2005	2008
	Percentage			Percentage			Percentage		
Province/Territory									
Newfoundland and Labrador	9.3	10.8	15.6*	18.8	20.4	24.8*	23.8	26.6	33.9*
Prince Edward Island	..	17.8	18.0	..	22.2	21.3	..	33.7	32.3
Nova Scotia	..	12.7	16.3	..	18.2	19.4	..	27.1	31.8*
New Brunswick	..	12.7	16.4*	..	20.1	24.1*	..	27.6	34.5*
Ontario	..	20.7	30.5*	..	24.2	29.8*	..	37.9	49.6*
British Columbia	16.4	..	23.8*	14.7	…	19.4*	26.6	..	36.8*
Yukon	..	18.1E	24.6	..	13.3E	10.9E	..	27.0	28.7
Northwest Territories	..	17.0E	18.5E	..	22.3E	F	..	30.6	29.8E

* significantly different from estimate for previous time period ($p < 0.05$)
E use with caution (coefficient of variation 16.6% to 33.3%)
.. not available
Sources: 2003, 2005 and 2008 Canadian Community Health Survey.

Smoking cessation: intentions, attempts and techniques

by Scott T. Leatherdale and Margot Shields

Abstract

Background
A better understanding of characteristics associated with intentions to quit smoking and quit attempts and of the use of various aids is required to develop effective cessation strategies.

Data and methods
Data from the 2006 Canadian Tobacco Use Monitoring Survey were used to examine intentions to quit smoking, quit attempts, use of cessation aids, and receipt of cessation advice from health professionals.

Results
One-third of Canadian smokers aged 15 or older reported intentions to quit within the next 30 days, and almost half had tried to quit in the past year. The number of cigarettes smoked per day was associated with intending to quit and quit attempts. The intention to quit was strongly associated with the number of past quit attempts. Half of current smokers who had seen a doctor in the past year had been advised to reduce or quit smoking.

Keywords
health personnel, nicotine dependence, nicotine replacement therapy, pharmaceutical aid, quit attempts, smoking quit methods, tobacco, tobacco use cessation

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Despite the serious health risks, a considerable number of Canadians continue to smoke.[1] However, the vast majority of smokers regret having started.[2] Many are interested in quitting and have tried to do so,[1,3] but most cessation attempts are unsuccessful.[1,4] A better understanding of smokers' intentions and quit attempts may further the development of effective cessation strategies.

Intentions indicate how much effort people are willing to exert to accomplish a goal.[5] Smokers with strong intentions to quit might be expected to have more success than those with weak intentions.[5] It is, therefore, important to understand characteristics associated with intending to quit smoking. Research has shown that smokers are not as likely to intend to quit if they have less education[6] or if they are heavier smokers.[7] As well, female smokers are less likely than male smokers to intend to quit.[6] The frequency of smoking is also important—non-daily smokers more often report intentions to quit than do daily smokers.[8] And smokers are more apt to want to quit if they have previously tried to do so.[4]

Once smokers decide they want to quit, the next step is to actually try. Factors shown to be positively associated with trying to quit smoking include being a young adult,[9] being a non-daily[8] or lighter smoker,[7] and receiving cessation advice from a health care provider.[10,11] On the other hand, smokers who switch to "light" cigarettes as a harm reduction strategy are less apt to quit.[12] Quit attempts do not appear to be related to the presence of children in the home,[13] and the evidence pertaining to quit attempts and education is mixed.[4,6]

Although most smokers try to quit at least once,[3,4] the majority will relapse. Relapse is more likely if smokers do not use a formal cessation method such as nicotine replacement therapy,[14-16] or if they switch to a lower-tar cigarette before quitting.[12,17] Smokers with higher levels of education are less likely to relapse than those with less education.[17,18]

Given the need for current Canadian information about intentions to quit

smoking, quit attempts and relapse, this study uses data from the 2006 Canadian Tobacco Use Monitoring Survey to examine: 1) factors associated with intentions to quit smoking; 2) factors associated with one or more quit attempts; 3) smokers' reasons for relapse; 4) their use of cessation aids and strategies; and 5) their receipt of cessation advice from health professionals.

Methods

Data source

The Canadian Tobacco Use Monitoring Survey is a nationally representative survey designed to monitor trends in smoking prevalence.[19] The survey covers the population aged 15 or older in Canada, excluding residents of Yukon, Nunavut and the Northwest Territories and full-time residents of institutions.

Using computer-assisted telephone interviews, Statistics Canada collected data from 21,976 individuals from February through December 2006. The overall response rate was 69.9%. Only direct reports from selected respondents were allowed (proxy reports were not accepted). The sampling design was a two-phase stratified random sample of telephone numbers. The two-phase design was used to increase the representation of people in the 15 to 19 and 20 to 24 age groups. In the first phase, households were selected using Random Digit Dialing; in the second phase, one or two individuals (or none) were selected based on household composition. Survey weights were used to account for probabilities of selection and to adjust for non-response between provinces and groups. A full description of the sampling design is available.[19]

Measures

Smokers were identified based on the question, "At the present time, do you smoke cigarettes every day, occasionally or not at all?" Respondents who said they smoked every day or occasionally were defined as current smokers. Among current smokers, daily smokers were defined as those who reported smoking daily, and occasional smokers, those who reported smoking occasionally. Current smokers were asked about intentions to quit smoking in the next 30 days, quit attempts in the past year, number of cigarettes smoked per day, strength of cigarettes usually smoked, use of pharmaceutical cessation aids, reasons for not using cessation aids, other cessation strategies, reasons for relapse, and cessation advice received from health professionals. Information was also collected about age, sex, marital status, education, and the presence of children younger than 15 in the home.

Analytical techniques

Descriptive analyses of the demographic characteristics of all current smokers were examined. Cigarettes per day, number of quit attempts, strength of cigarettes and demographic characteristics were cross-tabulated by intentions to quit in the next 30 days and by quit attempts in the past year. Two logistic regression models were then fitted to examine associations between those characteristics and the likelihood of intending to quit and of having made a quit attempt in the past year. Among current smokers who had tried to quit in the past year, reasons for relapse, use of pharmaceutical cessation aids, reasons for not using such aids, and other cessation strategies were examined by sex and age. Finally, for all current smokers, the receipt of cessation advice from health professionals was examined by sex and age. Data were weighted on sex, age and province, after adjustments for non-response and multiple telephone lines in the household. To account for the survey design effects, standard errors were estimated with the bootstrap technique. The statistical package SAS 9.1 was used for all analyses.[20] Sample sizes for all variables in the analyses are shown in Appendix Table A.

Table 1
Prevalence of current smoking, by selected characteristics, household population aged 15 or older, Canada excluding territories, 2006

		95% confidence interval	
	Percentage	from	to
Total	**18.6**	**17.6**	**19.6**
Sex			
Males	20.3*	18.8	21.8
Females†	17.0	15.7	18.2
Age group			
15 to 19	14.8*	13.3	16.4
20 to 24	27.3*	25.2	29.4
25 to 34	23.9*	20.7	27.0
35 to 44†	19.8	17.4	22.2
45 to 54	22.0	19.7	24.3
55 or older	11.1*	9.7	12.5
Marital status (aged 25 or older)			
Married/Common-law†	16.0	14.6	17.4
Widowed/Divorced/Separated	20.7*	18.1	23.4
Never married	26.5*	23.1	29.9
Education (aged 25 or older)			
Less than secondary graduation†	22.4	19.2	25.6
Secondary graduation	22.0	20.0	23.9
Postsecondary graduation	13.9*	12.3	15.4

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
Source: 2006 Canadian Tobacco Use Monitoring Survey.

Results

One in five

In 2006, almost one in five Canadians (19%) aged 15 or older was a current smoker (Table 1). Males were more likely than females to be smokers (20% versus 17%). The prevalence of smoking was high among 20- to 24-year-olds (27%) and low among those aged 55 or older (11%). Smoking prevalence was higher among people who had never been married (27%) than among those who were married or in a common-law relationship (16%). Postsecondary graduates were less likely than people who had graduated from secondary school to be current smokers (14% versus 22%).

Intentions to quit

One-third of current smokers reported that they intended to quit in the next 30 days (Table 2). The intention to quit was negatively associated with the number of cigarettes smoked per day and positively associated with the number of quit attempts made in the past year. The percentage intending to quit were highest among smokers of ultra/extra light, mild cigarettes.

One or more quit attempts in past year

Almost half of current smokers (48%) reported that they had tried to quit at least once in the past year (Table 3). The likelihood of having made a quit attempt declined at older ages. Fully 62% of smokers aged 20 to 24 had tried to quit, compared with 32% of those aged 55 or older. The number of times smokers had tried to quit was also related to age: 15- to 19-year-olds averaged 2.5 quit attempts, compared with 1.0 attempts for those aged 55 or older (data not shown).

Frequency of smoking was related to quit attempts. Compared with smokers who consumed 10 to 24 cigarettes a day, those who consumed 1 to 9 were more likely, and those who consumed at least 25 less likely, to report at least one quit attempt.

Table 2
Percentage of and adjusted odds ratios for smokers considering quitting within next 30 days, by selected characteristics, household population aged 15 or older, Canada excluding territories, 2006

	Considering quitting in next 30 days					
		95% confidence interval			95% confidence interval	
	Percentage	from	to	Adjusted odds ratio	from	to
Total	**32.5**	**29.5**	**35.4**	**...**	**...**	**...**
Sex						
Males	33.9	30.0	37.9	1.3	0.9	1.8
Females†	30.8	26.5	35.2	1.0	...	...
Age group						
15 to 19	34.5	28.8	40.2	0.8	0.4	1.3
20 to 24	32.8	28.4	37.1	0.7	0.5	1.2
25 to 34	37.2	29.3	45.1	1.1	0.6	1.8
35 to 44†	30.0	23.0	37.0	1.0	...	...
45 to 54	31.9	25.7	38.1	1.2	0.7	1.8
55 or older	29.2	22.2	36.2	1.6	0.9	2.9
Marital status (aged 25 or older)						
Married/Common-law†	32.4	27.7	37.1	1.0	...	...
Widowed/Divorced/Separated	36.2	27.8	44.6	1.4	0.9	2.2
Never married	31.5	24.0	39.0	1.1	0.7	1.6
Education (aged 25 or older)						
Less than secondary graduation†	26.5	19.3	33.7	1.0	...	...
Secondary graduation	31.0	25.9	36.1	1.2	0.8	1.8
Postsecondary graduation	37.6*	31.4	43.9	1.4	0.9	2.3
Children younger than 15 in household						
Yes	34.1	28.5	39.6	1.0	0.7	1.4
No†	31.7	28.5	35.0	1.0	...	...
Cigarettes per day						
Occasional smoker	52.8*	46.9	58.7	4.1*	2.8	6.0
1 to 9	34.7*	28.1	41.4	1.4	0.9	2.0
10 to 24†	25.2	21.2	29.2	1.0	...	...
25 or more	20.0E	13.4	26.7	0.9	0.5	1.4
Number of quit attempts in past year lasting at least 24 hours						
0†	17.2	13.9	20.4	1.0	...	...
1	35.3*	27.5	43.1	3.0*	2.0	4.6
2	46.6*	37.2	55.9	4.5*	2.8	7.3
3	54.8*	45.5	64.1	6.7*	4.2	10.9
4 or more	62.1*	55.1	69.1	8.9*	6.0	13.3
Strength of cigarettes						
Ultra or extra light	43.7*	33.9	53.5	1.4	0.9	2.3
Light	30.8	25.9	35.6	0.9	0.7	1.4
Ultra or extra mild	36.2E	21.2	51.1	1.3	0.6	2.6
Mild	38.7	27.0	50.3	1.6	0.9	3.0
Regular†	28.7	24.7	32.6	1.0	...	...

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
... not applicable
E use with caution (coefficient of variation 16.6% to 33.3%)
Note: Odds ratios adjusted for province and all other variables in table.
Source: 2006 Canadian Tobacco Use Monitoring Survey.

Cessation aids and strategies

Reducing consumption was the most common cessation strategy used by current smokers who had tried to quit in the past two years (69%) (Table 4). About half (48%) of smokers who had tried to quit used at least one pharmaceutical aid: 32% used the

nicotine patch; 21%, nicotine gum; and 14%, other pharmaceutical-based cessation aids. Use of cessation aids was less common among younger smokers.

Reasons most often reported for not using cessation aids were doubt that the products work (21%), cost (18%), and concern about possible side effects (16%). Higher percentages of females than males expressed concern about side effects.

Reasons for relapse

Among current smokers who had tried to quit in the past year, the most common reasons for relapsing were stress or the need to relax (34%) and addiction or habit (25%) (Table 4). A higher percentage of females than males reported stress or the need to relax (39% versus 29%).

Advice from health professionals

Although most current smokers had seen one or more health professionals in the past year, many reported not being advised to reduce or quit smoking (Table 5). For instance, 76% of current smokers had seen a doctor, but 50% of this group reported that a doctor had advised them to reduce or quit smoking. The likelihood of smokers' reporting that a doctor had advised them to quit rose with age from 38% of those aged 15 to 24 to 59% of those aged 45 or older.

Among those who had been advised to reduce or quit smoking, the percentage receiving cessation advice ranged from a 25% from a dentist to 76% from a pharmacist. Smokers aged 15 to 24 were less likely to report that a doctor had provided them with cessation information (41%) than were smokers aged 45 or older (60%).

Table 3
Percentage of and adjusted odds ratios for smokers making one or more quit attempts in past year lasting at least 24 hours, by selected characteristics, household population aged 15 or older, Canada excluding territories, 2006

	One or more quit attempts in past year					
		95% confidence interval			95% confidence interval	
	Percentage	from	to	Adjusted odds ratio	from	to
Total	**48.4**	**45.4**	**51.3**	...	...	...
Sex						
Males	48.5	44.4	52.5	1.1	0.9	1.5
Females†	48.3	44.2	52.3	1.0	...	...
Age group						
15 to 19	58.2*	52.4	64.0	2.0*	1.2	3.1
20 to 24	61.6*	57.3	65.8	2.0*	1.4	2.8
25 to 34	57.5*	49.9	65.2	1.4	0.9	2.2
35 to 44†	46.3	39.5	53.1	1.0	...	...
45 to 54	44.1	38.1	50.2	1.0	0.7	1.4
55 or older	31.7*	25.1	38.2	0.5*	0.3	0.7
Marital status (aged 25 or older)						
Married/Common-law†	46.1	41.3	50.8	1.0	...	...
Widowed/Divorced/Separated	49.0	41.1	56.9	1.5*	1.0	2.3
Never married	45.3	37.8	52.9	0.9	0.6	1.2
Education (aged 25 or older)						
Less than secondary graduation†	43.4	34.8	52.0	1.0	...	...
Secondary graduation	45.4	40.3	50.5	1.0	0.7	1.4
Postsecondary graduation	48.7	43.0	54.3	1.1	0.7	1.6
Children younger than 15 in household						
Yes	52.7	46.8	58.6	1.1	0.8	1.5
No†	46.3	43.0	49.7	1.0	...	...
Cigarettes per day						
Occasional smoker	51.0	45.2	56.8	1.0	0.7	1.4
1 to 9	57.0*	49.6	64.4	1.5*	1.0	2.1
10 to 24†	48.0	43.4	52.6	1.0	...	...
25 or more	34.0*	26.8	41.2	0.6*	0.4	1.0
Strength of cigarettes						
Ultra or extra light	54.1	44.7	63.5	1.2	0.8	1.9
Light	48.7	43.4	54.0	1.0	0.7	1.3
Ultra or extra mild	48.1	33.7	62.6	1.1	0.6	2.1
Mild	41.9	30.1	53.6	0.8	0.5	1.4
Regular†	48.1	44.1	52.1	1.0	...	...

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
... not applicable
Note: Odds ratios adjusted for province and all other variables in table.
Source: 2006 Canadian Tobacco Use Monitoring Survey.

Discussion

This study shows that in 2006, close to a third of smokers intended to quit in the immediate future, and about half of them had tried to do so in the past year. Among those who had tried to quit, pharmaceutical cessation aids were not widely used. Of the smokers who had contacted a doctor in the past year, half reported that they had been advised to reduce or quit smoking.

Findings indicate that cigarette strength was significantly associated with intentions to quit. For instance, smokers of ultra or extra light cigarettes were more likely to report intentions to quit than were those who smoked regular cigarettes. This is consistent with Borland et al.[3] who reported that although few smokers actually agree that smoking *light* cigarettes will make quitting easier, those intending to quit are more apt to smoke *light* cigarettes. However, evidence of the benefits of switching to light cigarettes as a

Table 4
Selected characteristics of current smokers who made at least one quit attempt, household population aged 15 or older, Canada excluding territories, 2006

		Sex		Age group		
	Total	Men	Women†	15 to 24	25 to 44	45 or older†
			Percentage			
Cessation aids used in past 2 years‡§						
Nicotine patch	32.1	29.2	35.4	15.5*	34.0	40.7
Nicotine gum	21.2	23.9	18.3	17.0*	21.2	24.1
Other pharmaceutical-based cessation aids	13.8	12.7	15.0	2.7*E	13.0*	22.4
At least one of these aids	47.7	46.3	49.2	28.4*	49.4	58.3
Reasons for not using cessation aids§						
Do not believe products work	21.4	23.7	18.7	18.8*	17.4*E	30.9
Cost	18.3	14.9E	22.3	18.4*	23.1*E	10.4E
Concern about possible side effects	16.2	10.1*	23.4	10.1	23.4*E	11.7E
Not enough information about products	8.7	8.4E	9.0E	11.2*	9.3E	4.8E
Other cessation strategies§						
Deal with friend/family member to quit together	29.3	25.9*	33.2	39.9*	30.4*	20.8
Reduced consumption	69.0	69.2	68.8	74.3	65.1	70.7
Main reason for beginning to smoke again††						
Stress/Need to relax/calm down	33.6	28.6*	39.2	30.2	32.3	37.9
Addiction/Habit	25.2	26.4	23.9	20.2*	25.1	29.1
Family/Friends smoke	12.4	11.9E	12.9	16.6*	14.9*E	5.7E
Going out more (bars/parties)	5.4	6.7E	4.0E	10.0	6.1*E	F
Boredom	2.7E	3.2E	2.1E	F	F	3.4E
Other reason	11.1	10.0E	12.4E	8.6	11.4E	12.6E
No reason	9.6	13.2*	5.6E	11.1*	8.3E	10.3E

† reference category
‡ multiple responses permitted
§ based on smokers who made at least one quit attempt in past two years
†† based on smokers who made at least one quit attempt in past year
* significantly different from estimate for reference category ($p < 0.05$)
E use with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be published
Source: 2006 Canadian Tobacco Use Monitoring Survey.

Table 5
Percentage of current smokers receiving advice from selected health professionals, household population aged 15 or older, Canada excluding territories, 2006

		Sex		Age group		
	Total	Men	Women†	15 to 24	25 to 44	45 or older†
			Percentage			
Doctor						
Saw in past 12 months	76.3	69.7*	83.8	69.0*	75.8	80.4
Advised to reduce/quit smoking‡	50.3	52.6	48.2	38.2*	47.1*	58.6
Provided information on cessation aids§	53.6	56.9	50.2	41.2*	50.3	59.5
Dentist/Dental hygienist						
Saw in past 12 months	59.3	53.7*	65.7	64.0*	59.8	56.5
Advised to reduce/quit smoking‡	33.8	39.4*	28.6	30.0	37.9	31.2
Provided information on cessation aids§	24.5	30.0*	17.3E	26.8	21.9E	26.9E
Pharmacist						
Saw in past 12 months	45.8	37.3*	55.6	38.0*	44.6	50.9
Advised to reduce/quit smoking‡	14.2	17.8*	11.5	16.3	14.0E	13.6
Provided information on cessation aids§	76.4	74.5	78.7	63.2*	77.3	81.3

† reference category
‡ among those who saw the health professional in past 12 months
§ among those advised to reduce/quit smoking
* significantly different from estimate for reference category ($p < 0.05$)
E use with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be published
Source: 2006 Canadian Tobacco Use Monitoring Survey.

What is already known on this subject?

- Most Canadian smokers report that they want to quit.
- Previous research has examined a variety of characteristics associated with intending to quit and cessation attempts, but the evidence is often mixed and not specific to the Canadian population.
- Most quit attempts fail.
- Smokers who try to quit are more likely to relapse if they do not use a formal cessation method.

What does this study add?

- A third of smokers reported that they intended to quit in the immediate future, and close to half had tried to do so in the previous year.
- The majority of smokers who tried to quit did not use pharmaceutical cessation aids, which increase the likelihood of success.
- Many smokers who want to quit are skeptical about the effectiveness and safety of pharmaceutical aids.
- Half the smokers who had contacted a doctor in the past year reported that they had been advised to reduce or quit smoking; among younger smokers, 38% reported that they had received such advice.

cessation strategy is mixed. While Lee and Kahende[17] found that switching to light cigarettes improved the likelihood of quitting, Tindle et al.[12] reported that cessation was less likely among smokers who switched to light cigarettes, and Hyland et al.[21] found that switching to light cigarettes did not alter the chances of success. Some research suggests that smokers may mistakenly regard switching to light cigarettes as a step toward quitting instead of using formal cessation programs or treatments.[10,22] Other research suggests that smokers may switch to light cigarettes rather than use nicotine replacement therapy because of concern about the health risks of nicotine.[23] In light of the inconclusive results in the literature, the relationship between cigarette strength and quit intentions in the present study requires further investigation. Additional research is also needed to evaluate the impact of providing information about the health consequences of using *light* cigarettes as a cessation strategy.

Like earlier studies,[14,23-25] this analysis shows that many smokers do not use pharmaceutical cessation aids. Moreover, many are skeptical about the effectiveness and safety of such products. However, previous research has found that smokers who use a formal cessation method are less likely to relapse,[13-15] compared with those who try to quit on their own.[14,15] Some who are trying to quit smoking may even be at an increased risk of relapse because they tend not to use a formal cessation aid—notably, those with lower educational attainment[22] and young adults.[11,26] Research is needed to determine if these smokers would benefit from alternative formal cessation methods, such as telephone quitlines,[26] and whether uptake of these methods would increase if recommended by health care providers.

A greater variety of formal cessation methods may also be important because, in this analysis, the majority of current smokers who had tried to quit in the past year reported that their main reason for relapsing was stress or social models rather than addiction alone. Programs focused solely on providing all smokers with nicotine replacement therapy may not address the real barriers to successful cessation. A broad range of formal cessation resources that deal with addiction and situational and psychological reasons for relapse should be evaluated for effectiveness and feasibility of implementation at the population level.

Advice from a health professional can improve cessation outcomes,[11,15] and the vast majority of smokers want additional information on how to quit.[25] Consistent with previous research,[10,11,27] many smokers reported seeing at least one health professional in the past year, and half of them reported that they had been advised to quit or to reduce the amount they smoke. However, previous research has noted variability across health professionals in whether smokers regard them as a credible resource for cessation,[28] in the amount of training they have had in smoking cessation,[27,29,30] and whether health professionals consider it their responsibility.[29] Future research could explore the effectiveness and feasibility of incorporating smoking cessation into the routine practice of different health professionals who can reach groups that may be hard to target. For instance, the present study shows that fewer than a third of smokers aged 45 or older intended to quit in the immediate future, yet 80% of them had seen a doctor in the past year. Given that tobacco-related morbidity and mortality can be reduced substantially, even among smokers who quit at age 60,[31] it is never too late for health professionals to intervene.

Consistent with other reports,[7,8,10] this study found that the frequency of smoking was related to cessation intentions and quit attempts. Occasional smokers and those who consumed fewer cigarettes were more likely to intend to quit. Heavy smokers were less likely to report a quit attempt. This suggests that it may be beneficial to target lighter

smokers, especially because they tend to be more successful in their quit attempts.[10] Current smoking cessation guidelines were developed primarily for daily smokers.[15] But as the population of non-daily smokers continues to grow,[1] there is a need to know if occasional and lighter smokers require strategies designed for their unique situation.

Although the presence of children in the home was not directly associated with quit attempts in this study, it is possible that there may be an indirect effect by motivating smokers to make their homes smoke-free. Research has shown that the strongest predictor of having a smoke-free home is the presence of children,[13] possibly because smokers wish to protect their children from second-hand smoke,[32] because they wish to set a good example,[10] or because most children report that they do not want to be exposed to smoking inside their home.[33]

Limitations

This study has a number of noteworthy limitations. The cross-sectional nature of the data from the Canadian Tobacco Use Monitoring Survey does not allow for causal inferences about associations between respondents' characteristics and cessation intentions and quit attempts. As well, longitudinal data, such as those collected by the National Population Health Survey,[34] would be required to ascertain the temporal sequence of the relationships identified in this analysis.

No data were available on risk factors such as mental health or drug and alcohol use that may be associated with smoking cessation. Nor was it possible to discover what cessation aids smokers had used in previous quit attempts. In addition, information from the survey could not be used to determine if lighter smokers simply smoked less often or were former heavy smokers who had reduced their consumption as a cessation strategy. This is an important distinction because quitting abruptly has been shown to be associated with higher long-term success rates than reduced consumption.[15] Data were not available about whether smokers would have been interested in using or had used other formal cessation aids, such as telephone quitlines and behavioural counselling.

Finally, because abstinence is a distinctly different behaviour from trying to quit, this analysis did not explore factors associated with being a former smoker.

Conclusion

A large proportion of smokers reported intentions to quit in the immediate future, and almost half of them had tried to do so in the past year. Many current smokers were unaware of or uninterested in cessation aids. Half of smokers who saw a physician were advised to cut down or quit smoking. ■

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Appendix

Appendix Table A
Unweighted sample counts, by selected characteristics, household population aged 15 or older, Canada excluding territories, 2006

	Total	Smokers
Total	**21,976**	**4,608**
Sex		
Males	10,158	2,291
Females	11,818	2,317
Age group		
15 to 19	5,761	922
20 to 24	4,589	1,377
25 to 34	1,895	502
35 to 44	2,534	611
45 to 54	2,697	624
55 or older	4,500	572
Marital status		
Married/Common-law	8,219	1,595
Widowed/Divorced/Separated	2,475	524
Never married	10,904	2,417
Not stated	378	72
Education		
Less than secondary graduation	6,563	1,331
Secondary graduation	8,762	2,138
Postsecondary graduation	6,268	1,043
Not stated	383	96
Children younger than 15 in household		
Yes	6,287	1,374
No	15,689	3,234
Smoking status		
Daily smoker	3,397	...
Occasional smoker	1,211	...
Non-smoker	17,368	...
Considering quitting within next 30 days		
Yes	...	1,435
No	...	2,792
Not stated	...	381
Cigarettes per day		
Occasional smoker	...	1,211
1 to 9	...	868
10 to 24	...	1,817
25 or more	...	481
Not stated	...	231
Number of quit attempts in past year lasting at least 24 hours		
0†	...	2,051
1	...	651
2	...	585
3	...	357
4 or more	...	814
Not stated	...	150
Strength of cigarettes		
Ultra or extra light	...	360
Light	...	1,613
Ultra or extra mild	...	177
Mild	...	256
Regular	...	2,043
Not stated	...	159

... not applicable
Source: 2006 Canadian Tobacco Use Monitoring Survey.


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Diet quality in Canada

by Didier Garriguet

Abstract

Background
In addition to recommendations about the consumption of specific foods and nutrients, a measure of overall diet quality is useful. Over the years, a number of countries, but not Canada, have developed indexes to evaluate diet quality.

Data and methods
The *American Healthy Eating Index* was adapted to conform to recommendations in Canada's Food Guide. Data from 33,664 respondents to the 2004 Canadian Community Health Survey–Nutrition were used. Usual index scores were calculated with the Software for Intake Distribution Estimation program. Multiple linear regression models were used to examine associations between index scores and various characteristics, particularly the frequency of vegetable and fruit consumption.

Results
For the population aged 2 or older, the average score on the Canadian adaptation of the Healthy Eating Index in 2004 was 58.8 out of a possible 100 points. Children aged 2 to 8 had the highest average scores (65 or more). Average scores tended to fall into early adolescence, stabilizing around 55 at ages 14 to 30. A gradual upturn thereafter brought the average score to around 60 at age 71 or older. At all ages, women's scores exceeded those of men. The frequency of vegetable and fruit consumption was linked to index scores.

Interpretation
The American *Healthy Eating Index* can be adapted to Canadian food intake recommendations. Canadian Community Health Survey questions about the frequency of vegetable and fruit consumption can be used as an approximation of diet quality.

Keywords
diet, dietary habits, eating, food intake, fruit, nutrition, nutrition surveys, vegetables

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Recommendations about what to eat, how much and what to avoid are designed to help prevent or control chronic conditions and diseases such as osteoporosis, high blood pressure, cardiovascular disease, anemia, diabetes and obesity.[1] In Canada, such recommendations come from a number of sources, notably, *Canada's Food Guide,*[2] Dietary Reference Intakes[1] (a joint Canada-US initiative) published by the Institute of Medicine, and organizations targeting specific diseases, such as the Heart and Stroke Foundation and the Canadian Diabetes Association.

Beyond specific prescriptions and proscriptions, a multidimensional measure—an index—of overall diet quality is useful. With such a measure, it is possible to evaluate the nutritional health of populations, trace trends in eating habits, compare different groups, and assess the value of qualitative indicators of eating habits.

Over the years, several diet quality indexes have been developed.[3-11] These indexes assess as many as four aspects of diet quality: adequacy, moderation, variety and balance. Adequacy is a measure of the sufficiency of intake of nutrients and foods; moderation, whether certain nutrients or foods are consumed in excess; variety, the diversity of food choices; and balance, the equilibrium of food intake.

Because nutrition recommendations in Canada and the United States are similar, the 2005 version of the American *Healthy Eating Index* can be adapted to the Canadian situation.[4] This article presents an adaptation of that index and briefly outlines results for Canada based on data from the 2004 Canadian Community Health Survey–Nutrition. The index is also used to evaluate the Canadian Community Health Survey module on vegetable and fruit consumption as an indicator of diet quality.

Methods

Data source

The data are from cycle 2.2 of the Canadian Community Health Survey.

The survey covers the household population, excluding members of the regular Canadian Forces; residents of the three territories, of certain remote areas and of institutions; and all residents (military and civilian) of Canadian Forces bases. Detailed descriptions of the survey design, sample and interview methods are available in a published report.[12] Cycle 2.2, conducted in 2004, was the first national survey of Canadians' eating habits in more than 30 years.

A 24-hour dietary recall was used to estimate food and nutrient intake. A total of 35,107 people completed an initial recall; three to ten days later, a subsample of 10,786 completed a second recall. Response rates were 76.5% and 72.8%, respectively.

This study deals with the population aged 2 or older, the age group to whom the recommendations in the 2007 publication, *Canada's Food Guide,* apply. Respondents whose food intake was null (15) or invalid (43), children younger than age 2 (1,088), women who were pregnant (175) or breastfeeding (92), and children who were being breastfed (30) were excluded. The study pertains to 33,664 people, 10,352 of whom completed the second 24-hour dietary recall.

To help respondents remember what and how much they ate and drank the previous day, interviewers used the Automated Multiple Pass Method,[13,14] which consists of five steps:

- a quick list (respondents reported all foods and drinks they had consumed);
- a series of questions about specific food categories and frequently forgotten foods;
- questions about the time and type of meal;
- a series of questions seeking more detailed information about the foods, drinks and quantities consumed; and
- a final review.

The calorie and nutrient content of the foods reported was derived from Health Canada's Canadian Nutrient File 2001b supplement.[15]

Analytical techniques

The index developed in this study was calculated for each of the two 24-hour dietary recalls. The first recall was used to estimate average index scores for given populations. With the Software for Intake Distribution Estimation (SIDE),[16,17] the two recalls were used together to estimate usual index scores and the percentage of the population scoring below 50, 50 to 80, and more than 80.

The effect of selected socio-economic, lifestyle and health, and dietary characteristics on index scores was estimated with multiple linear regression. These estimates should be considered as regression-adjusted averages, since they are based only on the first recall.

The bootstrap method, which takes account of the complex survey design,[18-20] was used to estimate confidence intervals. The significance level was set at 0.05.

Definitions

Foods (basic foods, recipes or ingredients) were classified according to the four food groups in the 1992 publication, *Canada's Food Guide to Healthy Eating for People Four Years Old and Over*[21]— vegetables and fruit, milk products, meat and alternatives, and grain products—and the "other foods" category. The 2007 classification was not available when this analysis was conducted. No food was counted twice; for example, if a recipe was classified in the "other foods" category, the recipe was used rather than the ingredients, and vice versa.

The American 2005 *Healthy Eating Index* definition of whole fruits excludes fruit juice from total fruit. The definition of whole fruits in the Canadian adaptation is the same, but also excludes vegetable juice from total vegetables and fruit. Fruit and vegetable juice correspond to the Bureau of Nutritional Sciences groups 45A, 46C, 231E and 231F.

Dark green and orange vegetables were identified based on a list published by Health Canada.[22] The category excludes legumes and some fruits that can be substituted for orange vegetables, such as apricots, cantaloupes, mangoes, nectarines, papayas and peaches.

Whole grain products were identified based on Bureau of Nutritional Sciences groups and the list published by Health Canada.[23]

Frequency of consumption of vegetables and fruit was not determined from the 24-hour recall, but from survey questions about the number of times a day respondents ate vegetables and fruit. It is the sum of the frequency with which respondents reported consuming six categories of foods: fruit juice; fruit excluding juice; green salad; potatoes (excluding fries, hash browns and chips); carrots; and other vegetables.

Two other diet quality variables are considered in the analysis: *vitamin and mineral consumption* in the 30 days before the interview (yes or no) and *frequency of adding salt at the table* (never, rarely, sometimes, often).

In addition to *age* and *sex,* the sociodemographic variables considered in the analysis are *highest level of education in the household* (less than secondary graduation, secondary graduation, some postsecondary, and postsecondary graduation), *immigrant status, Aboriginal status* and *household income.* Household income was based on total self-reported household income from all sources in the previous 12 months. The ratio between total household income and the low-income cutoff corresponding to the number of people in the household and community size was calculated. The ratios were adjusted by dividing them by the highest ratio for all respondents. The adjusted ratios were grouped into quintiles.

The lifestyle and health variables are: *smoking status,* with smokers defined as those who smoke every day or occasionally; *alcohol consumption* (yes or no) during the 12 months before the interview*; leisure-time physical activity* (inactive, moderately active, active) defined in terms of average daily energy expenditure, based on the frequency and duration of all leisure-time physical activities in which respondents participated during the three months before the interview and the metabolic energy expenditure of each activity;

and *self-reported health* (excellent, very good, good, fair, poor).

Alcohol consumption, smoking status, leisure-time physical activity and self-reported health are not available for respondents younger than 12.

A healthy eating index for Canada

The Healthy Eating Index

The *Healthy Eating Index* was developed by the United States Department of Agriculture to measure the quality of Americans' diets. The original 1995 version[5] was based on the *Dietary Guidelines for Americans* and the *Food Guide Pyramid*.[24] The *Index* was revised in 2005[4] after publication of a new version of the *Dietary Guidelines.*

The *Healthy Eating Index* assesses two aspects of diet quality: adequacy and moderation. The maximum possible score is 100 points. All components are measured continuously and are reported in relation to energy consumption (Table 1). Intake between 0 and the maximum number of points possible for each component is prorated linearly. For the sake of comparability in this analysis, amounts were converted into the equivalent of "servings" in the most recent (2007) recommendations in *Canada's Food Guide*.[2] Details on the how the components are defined and the foods included in some of the less evident components are available in a technical report.[4]

Table 1
Components of American 2005 *Healthy Eating Index*, range of scores and scoring criteria

Component	Range of scores	Scoring criteria
Adequacy*	**0 to 60 points**	
Total fruit	0 to 5 points	Minimum: 0 Maximum: 1.6 servings per 1,000 kilocalories
Whole fruit	0 to 5 points	Minimum: 0 Maximum: 0.8 servings per 1,000 kilocalories
Total vegetables	0 to 5 points	Minimum: 0 Maximum: 2.2 servings per 1,000 kilocalories
Dark green and orange vegetables and legumes	0 to 5 points	Minimum: 0 Maximum: 0.8 servings per 1,000 kilocalories
Total grains	0 to 5 points	Minimum: 0 Maximum: 3 servings per 1,000 kilocalories
Whole grains	0 to 5 points	Minimum: 0 Maximum: 1.5 servings per 1,000 kilocalories
Milk	0 to 10 points	Minimum: 0 Maximum: 1,3 servings per 1,000 kilocalories
Meat and beans	0 to 10 points	Minimum: 0 Maximum: 75 grams per 1,000 kilocalories
Oils (non-hydrogenated vegetable oil or oil in fish, nuts, seeds)	0 to 10 points	Minimum: 0 Maximum: 12 grams per 1,000 kilocalories
Moderation†	**0 to 40 points**	
Saturated fats	8 to 10 points 0 to 8 points	Minimum 7% to 10% of total energy intake 10% to maximum 15% of total energy intake
Sodium	8 to 10 points 0 to 8 points	Minimum 700 milligrams to 1,100 milligrams per 1,000 kilocalories 1,100 milligrams to maximum 2,000 milligrams per 1,000 kilocalories
Solid fats, alcohol and sugar	0 to 20 points	Minimum: 20% of total energy intake Maximum: 50% of total energy intake

* for adequacy components, 0 points for minimum or less, 5 or 10 points for maximum or more, and proportional for amounts between minimum and maximum

† for moderation components, 10 or 20 points for minimum or less, 0 points for maximum or more, and proportional for amounts between minimum and maximum

Note: Amounts recommended in the American *Healthy Eating Index* were converted into the equivalent of servings in *Canada's Food Guide*.

Source: Reference 4.

Adaptation to Canadian recommendations

Although Canadian and American dietary guidelines differ slightly (Appendix Tables B and C), the *Food Pyramid* in the United States and *Canada's Food Guide* are designed to meet generally similar recommendations. As a result, the 2005 *Healthy Eating Index* is relatively easy to adapt for Canada.

The American *Index* uses a proportional approach to energy intake—recommended intake of various types of food is expressed per 1,000 calories of total intake. (A diet averaging 2,150 calories a day for an adult is assumed.) To adapt this index for Canada, recommendations are expressed as number of servings, according to age and sex, as specified in the 2007 version of *Canada's Food Guide*.[2] As noted above, the 1992 classification of food groups was used (see *Definitions*) because it was the only one available when the analysis was conducted.

The Canadian adaptation is comprised of eight *adequacy* components (total vegetables and fruit, whole fruit, dark green and orange vegetables, total grain products, whole grains, milk and alternatives, meat and alternatives, and unsaturated fats) and three *moderation* components (measuring saturated fats, sodium, and "other food") (Table 2). For the eight adequacy components, points between 0 and the potential maximum score are assigned proportionally.

Guidelines in Canada and the United States recommend around two servings of dark green or orange vegetables a day, and the consumption of whole fruits (and vegetables) rather than juice. The Canadian threshold was set in terms of the American threshold, but is expressed as a percentage of total vegetable and fruit intake. Specifically, 0.8 servings of whole fruit or dark green and orange vegetables per 1,000 calories represents 21% (1.6 servings + 2.2 servings) of the recommended number of servings of vegetables and fruit. Some dark green

Table 2
Components of Canadian adaptation of *Healthy Eating Index*, range of scores and scoring criteria

Component	Range of scores	Scoring criteria
Adequacy†	**0 to 60 points**	
Total vegetables and fruit	0 to 10 points	Minimum: 0 Maximum: 4 to 10 servings*
Whole fruit	0 to 5 points	Minimum: 0 Maximum: 0.8 to 2.1 servings (21% of recommendation for total vegetables and fruit)*
Dark green and orange vegetables	0 to 5 points	Minimum: 0 Maximum: 0.8 to 2.1 servings (21% of recommendation for total vegetables and fruit)*
Total grain products	0 to 5 points	Minimum: 0 Maximum: 3 to 8 servings*
Whole grains	0 to 5 points	Minimum: 0 Maximum: 1.5 to 4 servings (50% of recommendation for total grain products)*
Milk and alternatives	0 to 10 points	Minimum: 0 Maximum: 2 to 4 servings*
Meat and alternatives	0 to 10 points	Minimum: 0 Maximum: 1 to 3 servings (75 to 225 grams)*
Unsaturated fats	0 to 10 points	Minimum: 0 Maximum: 30 to 45 grams*
Moderation‡	**0 to 40 points**	
Saturated fats	8 to 10 points 0 to 8 points	Minimum 7% to 10% of total energy intake 10% to maximum 15% of total energy intake
Sodium	8 to 10 points 0 to 8 points	Adequate intake to tolerable upper intake level Tolerable upper intake level to twice tolerable upper intake level
"Other food"	0 to 20 points	Minimum: 5% or less of total energy intake Maximum: 40% or more of total energy intake

* according to age and sex, as specified in *Canada's Food Guide*
† for adequacy components, 0 points for minimum or less, 5 or 10 for maximum or more, and proportional for amounts between minimum and maximum
‡ for moderation components, 10 or 20 points for minimum or less, 0 points for maximum or more, and proportional for amounts between minimum and maximum

and orange vegetables are classified differently in the two countries; for this study, the Canadian classification was used.

In both countries, it is recommended that whole grains make up half of grain products.

To adhere to the recommendations in *Canada's Food Guide*, consumption of unsaturated fats (poly- and monounsaturated) is used to calculate the oil component in Canada.

For the moderation components, consumption levels of saturated fats in the American *Healthy Eating Index* are drawn directly from the *Dietary Guidelines for Americans*. *Canada's Food Guide*, too, recommends limiting consumption of saturated fats. No modification was made to this component for the adaptation of the index in this study.

The sodium component of the American *Index* is based on Institute of Medicine recommendations and is expressed per 1,000 calories consumed per day. The thresholds were established in relation to adequate intake (1,500 milligrams a day) and the tolerable upper intake level for an adult (2,300 milligrams a day). Because the Canadian recommendations vary by age and sex, the Institute of Medicine recommendations by age and sex were used as the thresholds consumption in the Canadian adaptation. Sodium consumption below adequate intake scores 10 points; consumption equal to the tolerable upper intake level scores 8 points; consumption exceeding twice that level scores 0; and for consumption between the tolerable upper intake level and twice the the tolerable upper intake level, scores between 0 and 8 are assigned proportionally. As is the case for the American *Index*, points above the tolerable upper intake level are assigned to prevent a flooring effect, since the usual sodium intake of the majority of the population (77% to 100%, depending on age and sex) exceeds the tolerable upper intake level.[25]

The final moderation component of the index, worth 20 points, pertains to "discretionary calories," a concept in the American *Food Guide Pyramid*, but not in *Canada's Food Guide*. The American *Index* assesses this component as calories derived from solid fats, alcohol and added sugar. For the Canadian adaptation, calories from "other foods" (as defined in the 1992 *Canada Food Guide*) represent the discretionary component. The American *Index* assigns 20 points for intake below 20% of calories, 0 points for intake greater than 50% of calories, and proportional points for intake between these levels, based on the 10th and 85th percentile of the distribution of daily energy intake from these sources. Application of the same reasoning to energy intake from "other foods" for the Canadian adaptation results in an interval from 5% to 40% of daily calories (Appendix Table A).

For the original 1995 *Healthy Eating Index*, the United States Department of Agriculture classified scores into diet quality categories: more than 80 points represented a good quality diet; 50 to 80 points, a diet that required improvement; and fewer than 50 points, a poor diet. These categories were not used for the 2005 version of the *Index*. However, these intervals were applied in the current study to define low, average and high scores on the Canadian adaptation.

Validation

One of the advantages of using the American *Healthy Eating Index* as a basis for constructing a Canadian index is that its content validity and construct validity have been evaluated.[4]

Content validity is the degree to which items in a measurement tool represent the universe of content for the concept being measured—in this case, the degree to which the components of a healthy eating index embody published nutrition guidelines. The American *Healthy Eating Index* is considered to have content validity because it captures the key concepts of the *Dietary Guidelines*.

Similarly, the Canadian adaptation reflects *Canada's Food Guide*. Based on 500 simulated diets that follow the recommendations in the *Guide*,[2] maximum points would be assigned on all adequacy components. As well, scores on the moderation components would be high. Median saturated fat intake would amount to 5.8% to 9.2% of daily calories,[2] which merits scores between 8.5 and 10. Median sodium intake[2] would yield scores between 4.6 and 8.7. The 500 simulated diets leave no discretionary calories for a sedentary individual. However, according to results from the 2004 Canadian Community Health Survey—Nutrition, around 5% of unsaturated fats calories in an average diet come from "other foods," so individuals adhering to *Canada's Food Guide* would receive scores close to 20 points on that component. Thus, diets in line with the *Guide's* recommendations would score 95 or more.

Construct validity seeks to determine if theoretical and empirical support for a specific measuring device exist. The American *Healthy Eating Index* is considered to have construct validity because menus developed by nutrition experts, such as the National Heart Lung and Blood Institute's *DASH Eating Plan,*[26] Harvard's *Healthy Eating Pyramid*,[27] and the American Heart Association's *No-Fad Diet,*[28] score high. As well, the *Index* can distinguish smokers from non-smokers (groups whose diets are known to be of different quality); is independent of calorie intake; and can detect meaningful differences by limiting floor and ceiling effects.[4] Similarly, on the Canadian adaptation, *DASH*, the *Healthy Eating Pyramid* and the *No-Fad Diet* score high, and smokers' scores are significantly lower than those of non-smokers, before and after adjustment for socio-economic, lifestyle, health and other dietary characteristics.

The American *Index* purports to be independent of calorie consumption, but calorie intake is correlated, to some extent, with scores on the Canadian adaptation. When calorie intake is included in the regression models, the coefficient differs significantly from 0 for people aged 12 or older (0.25 for each 100 kcal), but not for children (0.05 for each 100 kcal) (data not shown). However, this may be an artifact of under-reporting (see *Limitations*). In general, the ranges of values of the components of the Canadian adaptation are similar to those of the American *Index.*

Finally, principal component analysis and correlations between components showed the American *Index* to have more than one dimension. Principal component analysis of the Canadian adaptation reveals that at least four factors exist, confirming that multiple factors underlie it as well. The vegetables and fruit components and the percentage of calories coming from "other foods" have the highest correlations with the total score. Low correlations for dairy products and unsaturated fats indicate that the components measure another dimension of diet quality (Appendix Table D).

Results

Average index scores

In 2004, the average score on the Canadian adaptation of the healthy eating index was 58.8 for the total population aged 2 or older (Table 3). Almost 17% of the population scored below 50; fewer than 1% scored more than 80.

Children aged 2 to 8 had the highest index scores, averaging at least 65. Scores tended to fall in early adolescence, stablizing around 55 in the 14-to-30 age range. A gradual upturn through adulthood brought the average score to about 60 at age 71 or older. At all ages, women's index scores exceeded those of men.

Table 3
Average score on Canadian adaptation of *Healthy Eating Index* and percentage distribution of index score categories, by age group and sex, household population aged 2 or older, Canada excluding territories, 2004

			Percentage with index score:		
Age group	Sex	Average score	Less than 50	50 to 80	80 or more
Total	Both	58.8	16.6	82.9	0.5
2 or 3	Both	67.1	<3	97.5	<3
4 to 8	Both	65.4*	2.3[E]	96.5	1.2[E]
9 to 13	Boys	59.7*	8.7*[E]	91.3*	<3
	Girls	60.0*	7.9*[E]	92.1*	<3
14 to 18	Boys	54.3*	27.1*	72.9*	0
	Girls	55.6*†	25.5*	74.4*	<3
19 to 30	Men	54.0	28.9	71.1	<3
	Women	56.9†	20.0†	80.0†	<3
31 to 50	Men	56.4*	22.4	77.5	<3
	Women	60.2*†	13.0*†	86.4*†	<3
51 to 70	Men	57.7*	19.2	80.5	<3
	Women	61.3*†	10.4†	88.9†	0.7[E]
71 or older	Men	59.1	16.4	83.0	<3
	Women	62.4*†	6.8*†	92.2*†	1.1[E]

* significantly different from estimate for same sex in previous age group (p<0.05)
† significantly different from estimate for men (p<0.05)
<3 coefficient of variation more than 33.3%, but limits of confidence interval included within interval (0.0, 3.0)
[E] use with caution (coefficient of variation 16.6% to 33.3%)
Source: 2004 Canadian Community Health Survey—Nutrition.

These patterns in average index scores were reflected in the percentages of various age-sex groups scoring below 50: fewer than 3% of children aged 2 to 8, but more than 25% of 14- to 18-year-olds of both sexes and of men aged 19 to 30. At age 71 or older, 16% of men, compared with 7% of women, scored below 50.

Effect of index components

The components of the index on which Canadians' scores tended to be relatively high (thereby raising overall scores) were total grain products (3.6 out of 5), meats and alternatives (7.4 out of 10), and unsaturated fats (8.3 out of 10) (Table 4). By contrast, relatively low scores on dark green and orange vegetables, whole fruits and whole grains, and the percentage of calories derived from "other foods" lowered overall scores.

Frequency of vegetable and fruit consumption

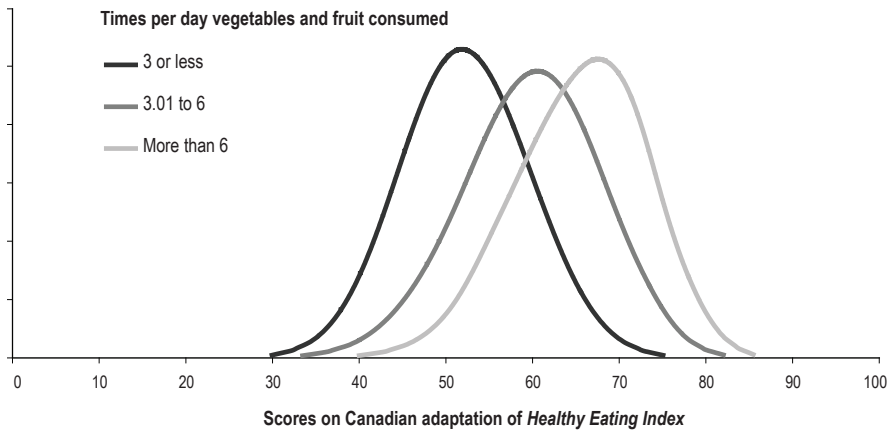
While a healthy eating index is a useful summary measure of diet quality, collecting the data necessary to construct it (through a 24-hour diet recall) is expensive and complicated. A comparison of the index scores in this analysis with other indicators of

Table 4
Average component scores on Canadian adaptation of *Healthy Eating Index*, household population aged 2 or older, Canada excluding territories, 2004

Component (maximum score possible)	Average score
Vegetables and fruit (10)	5.9
Dark green or orange vegetables (5)	1.4
Whole fruits (5)	2.4
Grain products (5)	3.6
Whole grain products (5)	1.6
Milk products (10)	5.5
Meat and alternatives (10)	7.4
Unsaturated fats (10)	8.3
Saturated fats (10)	6.5
Sodium (10)	5.6
Percentage of energy from "other foods" (20)	10.7

Source: 2004 Canadian Community Health Survey - Nutrition (first recall).

Figure 1
Distribution of scores on Canadian adaptation of *Healthy Eating Index*, by number of times per day vegetables and fruit consumed, household population aged 19 or older, Canada excluding territories, 2004



Source: 2004 Canadian Community Health Survey — Nutrition.

Table 5
Average score on Canadian adaptation of *Healthy Eating Index* and percentage scoring less than 50, by number of times per day vegetables and fruit consumed, household population aged 19 or older, Canada excluding territories, 2004

Times per day vegetables and fruit consumed	Score			Percentage scoring less than 50		
		95% confidence interval			95% confidence interval	
	Average	from	to	Percentage	from	to
0 to 1	45.5	44.0	46.9	80.9	68.3	93.5
1.01 to 2	50.2	49.4	51.0	49.1	42.8	55.4
2.01 to 3	54.5	53.7	55.3	27.1	22.7	31.5
3.01 to 4	57.9	57.1	58.6	15.9	12.7	19.1
4.01 to 5	60.5	59.8	61.2	8.9	6.6	11.2
5.01 to 6	62.2	61.1	63.3	6.9[E]	4.2	9.6
6.01 to 7	64.7	63.5	65.8	3.7[E]	1.9	5.5
7.01 to 8	64.5	63.1	66.0	F	...	...
8.01 to 9	67.6	65.1	70.1	<3	...	...
9.01 to 10	66.5	63.6	69.5	<3	...	...
10.01 or more	63.9	59.9	68.0	F	...	...
3 or less	52.2	51.7	52.8	38.6	35.2	42.0
3.01 to 6	59.8	59.3	60.3	11.7	9.9	13.4
More than 6	65.1	64.3	65.9	2.7[E]	1.5	4.0

<3 coefficient of variation more than 33.3%, but limits of confidence interval included within interval (0.0, 3.0)
[E] use with caution (coefficient of variation 16.6% to 33.3%)
F too unreliable to be published (coefficient of variation more than 33.3%)
... not applicable
Source: Canadian Community Health Survey—Nutrition, 2004.

diet quality reveals the potential utility of other less cumbersome variables as measures of diet quality—for example, the frequency of vegetable and fruit consumption.

Figure 1 shows the distribution of index scores among adults aged 19 or older by their reported frequency of consuming vegetables and fruit (3 times a day or less, 3.01 to 6 times a day, or more than 6 times a day). As the frequency of vegetable and fruit consumption rose, so did average index scores (Table 5). For example, the average score of people who reported eating vegetables and fruit 3 times a day or less was 52.2; for those who reported more than 6 times a day, the average score was 65.1. And while 39% of people who reported eating vegetables and fruit 3 times a day or less scored below 50, this was the case for fewer than 3% of those who reported eating vegetables and fruit more than 6 times a day.

Linear regressions between index scores and several dietary, socio-economic, and lifestyle and health characteristics confirm the relationship between the frequency of vegetable and fruit consumption and index values. For children aged 2 to 11, eating vegetables and fruit more than 6 times a day raised index scores by an average of 3.8 points, compared with those who reported eating vegetables and fruit 3 to 6 times a day. For children whose consumption was 3 times a day or less, scores dropped an average of 5.4 points (Table 6). The corresponding results for people aged 12 or older were an average gain of 4.5 points, and an average loss of 5.7 points (Table 7).

Among children, taking vitamin and mineral supplements raised index scores, while adding salt at the table reduced them. A low level of household education had a negative effect on children's scores, but immigrant status had a positive effect. No significant associations emerged between children's scores and sex, household income or Aboriginal status.

Among people aged 12 or older, the associations between index scores and taking vitamin and mineral supplements or adding salt at the table were similar to those among children. Alcohol consumption lowered scores of this age group by an average of 1.8 points. Self-reported health, leisure-time physical activity and smoking status were also significantly associated with index scores. And as was the case for children, immigrant status and level of household education were significant, while Aboriginal status and household income were not. However, sex and age were significantly associated with index scores of people aged 12 or older.

Table 6
Average score and linear regression coefficient of Canadian adaptation of *Healthy Eating Index*, by selected dietary and socio-economic characteristics, household population aged 2 to 11, Canada excluding territories, 2004

Characteristics	Average score		Linear regression coefficient
	Average	Standard deviation	
Intercept	...	...	64.4
Dietary			
Times per day vegetables and fruit consumed			
3 or less	58.3*	0.5	-5.4§
3.01 to 6†	64.0	0.3	...
More than 6	67.9*	0.4	3.8§
Consumption of vitamin and mineral supplements			
Yes	65.0*	0.3	1.2§
No†	63.3	0.3	...
Adds salt at table			
Never†	64.7	0.3	...
Rarely	64.0	0.4	-0.5
Occasionally	62.8*	0.6	-1.6§
Often	59.2*	1.1	-4.0§
Socio-economic			
Sex			
Boys	64.3	0.3	0.8
Girls†	63.7	0.3	...
Highest level of education in household			
Less than secondary graduation	59.5*	0.8	-3.6§
Secondary graduation	62.1*	0.6	-1.5§
Some postsecondary	63.0	0.9	-1.1
Postsecondary graduation†	64.8	0.3	...
Household income quintile			
First (lowest)	63.4*	0.5	-0.4
Second	63.0*	0.5	-1.4
Third	64.0	0.5	-0.5
Fourth	64.9	0.5	0.0
Fifth (highest)†	65.2	0.6	...
Missing	64.8	0.9	0.5
Immigrant			
Yes	66.6*	0.9	3.2§
No†	63.9	0.2	...
Aboriginal person			
Yes	60.7 *	1.1	-1.1
No†	64.0	0.2	...

† reference catgory
* significantly different from estimate for reference category (p<0.05)
§ coefficient significantly different from 0 (p<0.05)
... not applicable
Source: 2004 Canadian Community Health Survey—Nutrition.

Table 7
Average score and linear regression coefficients of Canadian adaptation of *Healthy Eating Index*, by selected dietary, socio-economic, and lifestyle and health characteristics, household population aged 12 or older, Canada excluding territories, 2004

Characteristics	Average score		Linear regression coefficient
	Average	Standard deviation	
Intercept	...	...	60.0
Dietary			
Times per day vegetables and fruit consumed			
3 or less	52.2 *	0.3	-5.7 §
3.01 to 6†	59.5	0.2	...
More than 6	64.8 *	0.4	4.5 §
Consumption of vitamin and mineral supplements			
Yes	59.9 *	0.3	1.1 §
No†	57.0	0.2	...
Adds salt at table			
Never†	59.2	0.3	...
Rarely	59.3	0.3	0.2
Occasionally	57.2 *	0.3	-1.0 §
Often	54.9 *	0.5	-2.4 §
Socio-economic			
Sex			
Male	56.4 *	0.2	-1.9 §
Female†	59.9	0.2	...
Age group			
12 and 13	59.3 *	0.5	0.0
14 to 18	55.0	0.3	-2.0 §
19 to 30†	55.4	0.4	...
31 to 50	58.3 *	0.3	2.4 §
51 to 70	59.6 *	0.3	2.8 §
71 or older	61.1 *	0.3	3.2 §
Highest level of eduction in household			
Less than secondary graduation	56.4 *	0.4	-1.8 §
Secondary graduation	56.6 *	0.5	-1.0 §
Some postsecondary	55.8 *	0.5	-1.6 §
Postsecondary graduation†	58.8	0.2	...
Household income quintile			
First (lowest)	57.0 *	0.4	0.2
Second	58.7	0.4	0.8
Third	57.9	0.4	0.4
Fourth	57.9	0.4	-0.1
Fifth (highest)†	58.8	0.4	...
Missing	58.6	0.4	0.6
Immigrant			
Yes	61.2 *	0.4	2.7 §
No†	57.3	0.2	...
Aboriginal person			
Yes	52.7 *	0.9	-1.4
No†	58.2	0.2	...
Lifestyle and health			
Smoker			
Yes	52.6 *	0.3	-4.4 §
No†	59.8	0.2	...
Alcohol consumption			
Yes	57.5 *	0.2	-1.8 §
No†	60.0	0.3	...
Level of physical activity			
Active	59.7 *	0.3	1.6 §
Moderately active	59.3 *	0.3	1.2 §
Inactive†	57.0	0.2	...
Self-reported health			
Poor/Fair	55.6 *	0.4	-1.8 §
Good/Very good/Excellent†	58.4	0.2	...

† reference catgory
* significantly different from estimate for reference category (p<0.05)
§ coefficient significantly different from 0 (p<0.05)
... not applicable
Source: 2004 Canadian Community Health Survey—Nutrition.

Discussion

Owing to the similarity between American and Canadian nutrition recommendations, the 2005 *Healthy Eating Index* can be adapted to the Canadian situation. The major difference in the adaptation presented in this study is the use of thresholds based on absolute quantities. A validation exercise similar to that conducted for the American *Index* shows that the Canadian adaptation is valid and represents multidimensional factors of diet quality.

Only a few direct comparisons between the American and Canadian indexes are possible. For saturated fat, one of the few components that can be compared, the average Canadian score is half a point more and slightly skewed toward higher values, and a larger percentage of Canadians scores 10. The sodium component is also skewed toward higher values in Canada. On the other hand, for discretionary calories, the Canadian component is skewed toward lower values, and the American component, toward higher values. Scoring is similar for the adequacy components, except for oils and unsaturated fats, with Americans scoring, on average, almost 3 points less than Canadians. However, oils and unsaturated fats are also the components on which definitions in the two countries differ the most.

A healthy eating index for Canada could have been based on a number of other indexes, but they are more difficult to adapt, largely because they contain a "variety" component. Even so, the adaptation presented in this article is just one among many possibilities. Although Health Canada's 2007 publication, *Canada's Food Guide,* was used as the source of nutrition recommendations, Health Canada was not involved in the development of this index.

While the frequency with which vegetables and fruit are consumed can differentiate diet quality, the optimal categorization remains to be established. Nonetheless, the use of 3 and 6 times a day as thresholds seems to maximize differences.

Limitations

Nutrition surveys are susceptible to under-reporting of energy intake. A recent validation of the collection instrument used by the Canadian Community Health Survey revealed that under-reporting averaged 11%,[29] and an earlier study showed under-reporting to average 10%.[30] Obese respondents were particularly likely to under-report how much they ate.

A possible way to overcome this limitation would have been to use a subsample of "plausible respondents"[31]—people whose reported calorie intake roughly corresponded to the amount they might be expected to eat, based on their age, sex, measured height, measured weight and reported leisure-time physical activity. However, the average index score of this group is only slightly higher than that of the full sample (59.5 rather than 58.1), and the coefficient for energy intake in the regression model no longer differs significantly from 0 (0.02 per 100 kcal) (data not shown). Thus, the effect of under-reporting calories consumed on the overall index score is minimal.

Another limitation of this analysis is that the results for frequency of vegetable and fruit consumption cannot be generalized to other cycles of the Canadian Community Health Survey. Compared with results for 2001 and 2007, the frequency of vegetable and fruit consumption in 2004 was 0.7 fewer occasions (data not shown). This difference may reflect the structure of the questionnaire. In 2004, the 24-hour dietary recall preceded the vegetable and fruit consumption questions, so respondents' answers to the food recall could have influenced their answers to these questions. For example, in 2004, lower percentages of people reported consuming fruit juice every day and a given number of times per week (data not shown). The effect was to shift the distribution of the frequency of vegetable and fruit consumption toward lower values. Nonetheless, the relationship between the frequency of vegetable and fruit consumption and the index is strong.

While recommendations published in 2007 in *Canada's Food Guide* were used to construct the index, the classification of foods is that of the 1992 *Canada Food Guide*, which was the only classification available when the data were analyzed. Some foods could be in different categories in the new classification.

Information about children younger than 6, which was provided by a parent, may not be accurate, particularly for meals consumed out of the parent's presence, at daycare, for example.

Finally, the physical activity variable pertains only to leisure-time activity, not to work-related activity such as manual labour, or to transportation that involves physical activity such as walking or bicycling.

Conclusion

A healthy eating index combines recommendations about various components of nutrition into a single measure of diet quality. In so doing, it transforms elements of what constitutes a "good" diet into a score that can be computed and compared.

On the index adapted from the American *Healthy Eating Index,* the average score for Canadians aged 2 or older was 58.8 out of a potential 100. One Canadian in six scored less than 50.

The results of this analysis suggest that variables other than an index based on the results of a 24-hour food recall might be used as measures of diet quality, notably, the frequency of fruit and vegetable consumption. ■

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Appendix

Table A
Cumulative percentage of daily energy intake from "other foods," by population percentile, household population aged 2 or older, Canada excluding territories, 2004

	Population percentile										
	10th	15th	20th	30th	40th	50th	60th	70th	80th	85th	90th
Percentage of daily energy intake from other foods (%)	5.0	7.1	9.1	12.7	16.3	19.9	23.7	28.5	34.2	38.1	43.2

Note: "Other foods" are defined according to 1992 Food Guide.
Source: 2004 Canadian Community Health Survey—Nutrition.

Table B
Recommended number of servings from each food group and unsaturated fat intake per day according to *Food Guide Pyramid*, by age group and sex

	Age group (years)							
	2 and 3	4 to 8	9 to 13	14 to 18	19 to 30	31 to 50	51 to 70	71 or older
Males								
Vegetables and fruit	4	6	8	10	10	10	9	9
Grain products	3	5	6	7	8	7	6	6
Milk products	2	2	3	3	3	3	3	3
Meat and alternatives	1	1.5	2	2	2.5	2	2	2
Unsaturated fats (grams)	15	17	24	29	31	29	27	27
Females								
Vegetables and fruit	4	5	7	8	9	8	7	7
Grain products	3	4	5	6	6	6	5	5
Milk products	2	2	3	3	3	3	3	3
Meat and alternatives	1	1	2	2	2	2	2	2
Unsaturated fats (grams)	15	17	22	24	27	24	22	22

Source: Reference 24.

Table C
Recommended number of servings from each food group and unsaturated fat intake per day according to *Canada's Food Guide*, by age group and sex

	Age group (years)							
	2 and 3	4 to 8	9 to 13	14 to 18	19 to 30	31 to 50	51 to 70	71 or older
Males								
Vegetables and fruit	4	5	6	8	10	8	7	7
Total grain products	3	4	6	7	8	8	7	7
Milk products	2	2	3-4	3-4	2	2	3	3
Meat and alternatives	1	1	2	3	3	3	3	3
Unsaturated fats (grams)	30	30	30	45	45	45	45	45
Females								
Vegetables and fruit	4	5	6	7	8	7	7	7
Grain products	3	4	6	6	7	6	6	6
Milk products	2	2	3-4	3-4	2	2	3	3
Meat and alternatives	1	1	1	2	2	2	2	2
Unsaturated fats (grams)	30	30	30	30	30	30	30	30

Source: Reference 2.

Table D
Correlation between components of Canadian adaptation of *Healthy Eating Index*, household population aged 2 or older, Canada excluding territories, 2004

Components	Total score†	Vegetables and fruit	Dark green or orange vegetables	Whole fruit	Grain products	Whole grain products	Milk products	Meat and alternatives	Unsaturated fats	Saturated fats	Sodium	Percentage of energy from "other foods"
Total score	1.00											
Vegetables and fruit	0.40	1.00										
Dark green or orange vegetables	0.23	0.38	1.00									
Whole fruits	0.38	0.52	0.13	1.00								
Total grain products	0.20	0.08	-0.01	0.11	1.00							
Whole grain products	0.25	0.15	0.10	0.18	0.25	1.00						
Milk products	0.01	0.08	0.02	0.08	0.24	0.05	1.00					
Meat and alternatives	0.10	0.14	0.13	0.02	0.06	0.03	0.02	1.00				
Unsaturated fats	-0.02	0.15	0.05	0.02	0.34	0.04	0.25	0.41	1.00			
Saturated fats	-0.03	0.13	0.06	0.13	0.04	0.10	-0.34	-0.06	-0.27	1.00		
Sodium	-0.27	-0.18	-0.05	-0.00	-0.39	-0.04	-0.32	-0.29	-0.50	0.18	1.00	
Percentage of energy from "other foods"	0.26	0.22	0.09	0.21	0.16	0.16	0.13	0.09	-0.13	0.01	0.06	1.00

† total score minus specified components
Source: 2004 Canadian Community Health Survey—Nutrition.

Health status, preventive behaviour and risk factors among female nurses

by Pamela A. Ratner and Richard Sawatzky

Abstract

Background
This study compares the health status, preventive behaviour and risk factors of female nurses with those of other employed postsecondary-educated women.

Data and methods
Cross-sectional data from the 2003 Canadian Community Health Survey were analyzed. Multiple logistic regression analyses were conducted to adjust for potential confounding by demographic and socio-economic characteristics.

Results
When confounding by demographic and socio-economic characteristics was taken into account, nurses were more likely than other employed postsecondary-educated women to report back problems, that most work days were "quite a bit" or "extremely" stressful, and having had flu immunizations and cervical cancer screening. They were less likely to report insufficient consumption of vegetables and fruit or heavy alcohol use.

Interpretation
Canadian nurses' occupation may account for their higher prevalence of back problems and work stress. At the same time, their occupation may motivate flu immunization, cervical cancer screening, and vegetable and fruit consumption. Some problematic aspects of nurses' health profile are similar to those of other educated women.

Keywords
health behaviour, health surveys, occupational health, preventive practices, risk factors

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Research on the health of Canadian nurses has revealed a number of areas of concern. Nurses face occupational health hazards that include exposure to infectious diseases, biological hazards and carcinogens; psychological demands; and shift work.[1-4] A study commissioned by Health Canada's Office of Nursing Policy found that registered nurses who were employed full-time had an illness- and injury-related absenteeism rate 83% higher than that of other occupational groups.[5] This level of absenteeism raises questions about nurses' health, the environments in which they work, the work they do and how it is organized, and the cost to the system in lost time—an estimated 19.6 million hours (about 11,000 full-time equivalents) in 2002.[5]

In 2005, the National Survey of the Work and Health of Nurses was conducted with a focus on their health status and working conditions. Comparisons of the survey results with the health status of employed Canadians aged 21 or older revealed an excess risk of back problems and arthritis, pain severe enough to prevent activities of daily living, and depression among nurses.[3]

By contrast, in a 2007 study of mortality and cancer risks among British Columbia nurses, Dimich-Ward et al.[4] found that, compared with the general population of women in the province, female registered nurses were at lower risk of all-cause, cardiovascular-related, and cancer mortality. And with the exception of malignant melanoma, the nurses had a lower incidence of cancer. The authors speculated that these relatively good health outcomes for nurses arose from a "healthy worker effect," and possibly, better uptake of cancer screening programs and healthy lifestyles.

Much of the research on nurses' health has analytical limitations. The occupational health information has often come from time-loss claims collected by workers' compensation boards, which are biased through underreporting.[6] And although some of these claims are made for stress-related health problems and infectious diseases, the vast majority are for physical injury. Further, they are confined to incidents reported and judged to be work-related and are typically "acute" or sudden in onset.[7] Analyses of administrative databases and registries, if comparisons with referent groups are made, do not include information about employment status, and thus, are frequently limited to comparisons with the "general public," which, as in the case of the Dimich-Ward et al. study,[4] are biased by the "healthy worker effect." This occurs because the general public includes people who are not employed owing to illness or disability; consequently, this referent group tends to have poorer overall health than people who are employed (in this case, nurses).[8] Also, when comparing nurses' health with that of other employed people, it is preferable to control for confounding factors such as differences in age, socio-economic status, place of residence and lifestyle. In the report of the 2005 National Survey of the Work and Health of Nurses, which compared nurses' health with the health of other employed people based on data from another survey, such adjustments could not be made.[2]

Several theories (for example, the Health Belief Model, the Theory of Planned Behavior, and the Precaution Adoption Process Model[9-11]) describe the predisposing, enabling and reinforcing factors that shape health behaviour, and ultimately, health status.[12] Understanding factors associated with nurses' health status and behaviour—that is, whether health deficits arise from occupational, personal or environmental factors—is important. This is particularly relevant now when the number of employed nurses is not keeping pace with population growth, the average age of the nursing workforce is rising, and concerns about retention are mounting.[13]

The purpose of this study is to compare the health status of nurses with that of other employed female postsecondary graduates, focusing on perceived health status, disease prevention, behavioural risk and protective factors, and psychosocial risk factors. This analysis overcomes some of the limitations of other studies by providing an appropriate referent group and by adjusting for important demographic and socio-economic confounders.

The analysis in this article, based on the 2003 Canadian Community Health Survey, contrasts the health of female nurses with that of other postsecondary-educated women who had been employed at some time during the previous 12 months and whose occupations were not likely to have involved exposure to the hospital environment. At some point in their career, all nurses have been exposed to the hospital environment. While many may not be currently employed within a hospital setting (for example, community-based nurses, researchers, educators), all nurses were included in this study to avoid a selection bias that would result if the sample was limited to current hospital-based nurses. In fact, some nurses may have left hospital positions precisely because of relevant exposures and resulting health problems. As well, the lag time between exposure and the development of health problems may be considerable.

Data and methods

Data source

The analyses are based on cross-sectional data from cycle 2.1 of the 2003 Canadian Community Health Survey.[14] Every two years, the Canadian Community Health Survey collects data about Canadians' health status, health services use and health determinants. The survey covers 98% of household residents aged 12 or older in all provinces and territories. It excludes institutional residents; members of the regular Canadian Forces; residents of Indian reserves, Crown Lands and remote areas; and all residents (military and civilian) of Canadian Forces bases.

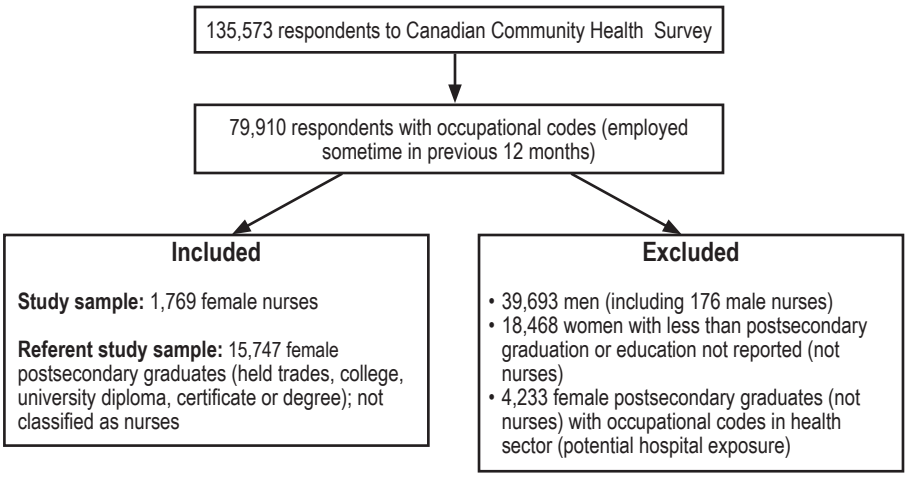
Three sampling frames were used for household selection: an area frame (48%), a list of telephone numbers (50%), and a random-digit-dialling frame (2%), which stemmed from a stratified cluster design. The 2003 sample, obtained over 11 months, consisted of 135,573 respondents for an estimated 80.7% response rate. Interviews were conducted face-to-face and by telephone. In 2.4% of cases, a proxy respondent (a knowledgeable household member) was interviewed.

Two study samples were selected from the 79,910 respondents to the 2003 Canadian Community Health Survey who were assigned occupational codes based on the 1991 Standard Occupational Classification (that is, they had been employed at least some time in the previous 12 months).[15]

The first study sample consisted of female nurses. For cycle 2.1 of the Canadian Community Health Survey, Health Canada's Office of Nursing Policy contracted to have nine supplementary questions asked of respondents who indicated that they were managers in health care, head nurses or supervisors; registered nurses; registered nursing assistants; or college or other vocational nursing instructors. They were asked, "Are you registered or licensed as a … registered nurse? Registered psychiatric nurse? Licensed practical nurse?" Those who answered affirmatively were asked about their working conditions. A total of 1,945 survey respondents (1.4%) were coded as nurses, 91.0% (1,769) of whom were women. The analysis was limited to female nurses because estimates based on the small number of male nurses would have been unreliable. According to their occupational codes, 65.2% were registered nurses; 19.2% were registered nursing assistants; 8.2% were managers in health care, head nurses or supervisors; and 7.4% were college or other vocational instructors.

The second study sample (the referent group) consisted of female postsecondary graduates (held a trade or

Figure 1
Study samples



Source: 2003 Canadian Community Health Survey.

college diploma, or university certificate or degree), 29,315 of whom were not classified as nurses. Of these, 9,335 were not assigned occupational codes (because they had not worked in the past year, refused to provide the information, or the information provided could not be coded) and were excluded from the study. To restrict the potential risk of hospital exposure to female nurses, an additional 4,233 women who were in occupations that might have been employed by hospitals or who had been assigned occupational codes in the health sector were excluded from the referent group (Appendix Tables A and B). Thus, 1,769 female nurses and 15,747 women with postsecondary credentials, representing 329,020 and 3,411,108 women, respectively, were included in the analysis (Figure 1).

Analytical techniques

Cross-tabulations were produced to examine associations between the health indicators and membership in the two study groups. Odds ratios with 95% confidence intervals were calculated to estimate the magnitude of the associations. Multiple logistic regression analyses were conducted to estimate the same associations with the addition of all covariates to adjust the odds ratios for potential confounding. Because data were missing on some items (ranging from 0% to 7.7% missing for total household income), multiple imputation, based on Rubin's procedure, was used to create five data sets with imputed values.[16,17] The five data sets were analyzed according to the procedures described above, and the results were combined following Rubin's guidelines; this approach results in statistically valid inferences that appropriately reflect the uncertainty associated with missing values.[18]

All confidence intervals were computed with the program Bootvar 3.1, developed by Statistics Canada, using the bootstrap resampling technique with 500 bootstrap weights, to take into account the complex clustered and stratified survey design effects.[19] All statistical analyses were conducted with the SAS (v. 8.2) statistical software package.[20] Significance was established as a 95% confidence interval not spanning unity. With groups the size of those studied here, a 95% confidence level, and desired power of 80%, it is possible to detect a difference in prevalence rates as small as 3.5% (corresponding to an odds ratio of 1.15). In the multivariate analyses, assuming a coefficient of multiple correlation of no more than .25 between the exposure of interest (female nurses versus other postsecondary graduates) and the covariates, there would be more than 80% power to detect an odds ratio of at least 1.20.[21]

Measurement

Self-reported general health was assessed with the question, "In general, would you say your health is..." Responses were grouped: "excellent or very good" = 0 and "good, fair or poor" = 1. *Self-reported mental health* was determined with the question: "In general, would you say your mental health is..." Responses were grouped: "excellent or very good" = 0 and "good, fair, or poor" = 1. To determine the presence of *chronic conditions,* the interviewers stated, "Now I'd like to ask about certain chronic health conditions which you may have. We are interested in 'long-term conditions' which are expected to last or have already lasted six months or more and that have been diagnosed by a health professional." Questions were asked about 30 specific conditions, along with a summary question: "Do you have any other long-term physical or mental health condition that has been diagnosed by a health professional?" The conditions examined in this analysis are: "has a chronic condition," "asthma," "arthritis or rheumatism (excluding fibromyalgia)," "back problem (excluding fibromyalgia and arthritis)" and "high blood pressure." These were the most prevalent conditions; all others affected fewer than 5% of one or both study groups.

Participation in *disease prevention* was assessed through three questions: "Have you ever had a flu shot?"; "Have you ever had a pap smear test?"; and "Have you ever had a mammogram, that is, a breast x-ray?" The last question was asked of 62.2% of participants (women younger than 35 were not asked). Responses were coded: "no" = 0 and "yes" = 1.

Behavioural risk factors were weight, physical inactivity, insufficient daily

fruit and vegetable consumption, heavy alcohol use, and current smoking. Based on self-reported height and weight, respondents' body mass index was calculated (weight in kilograms divided by height in metres squared) and classified as "*overweight or obese*" = 1, if it was 25.0 or more. Respondents were classified as *physically inactive* based on a measure of average daily energy expended during leisure time in the previous three months. They were asked if they had participated in any of more than 20 activities. Statistics Canada assigned a MET value (metabolic energy cost, expressed as a multiple of the resting metabolic rate) to each activity. Each activity has a range of potential energy expenditures; Statistics Canada applied the lowest intensity value for each one. For example, walking for exercise was assigned a MET value of 3 kilocalories per kilogram per hour, which means that the activity requires three times the amount of energy expended when resting. Daily energy expenditure was calculated as the number of times a respondent engaged in an activity over the three-month period, multiplied by the average duration of the activity (in hours), multiplied by the activity's MET value. These scores were divided by 365 to obtain daily values. A daily energy expenditure of 1.5 would result, for example, from a 30-minute walk every day.[22] Participants whose energy expenditure was less than 1.5 kcal/kg/day were classified as "inactive" = 1.[14] *Insufficient daily vegetable and fruit consumption* was derived from a series of questions about the frequency of consuming fruit juice, fruit, green salad, potatoes, carrots, and other vegetables. Those who reported consuming vegetables and fruit less than five times a day were classified as having insufficient consumption, according to the recommendation in effect at the time of the survey, the 1992 *Canada's Food Guide to Healthy Eating*.[23] *Current smokers* were defined as those who smoked cigarettes daily or occasionally. *Heavy alcohol use* was derived from the question, "How often in the past 12 months have you had 5 or more drinks on one occasion?" Those who responded "once a month" or more were classified as having heavy alcohol use.

Table 1
Demographic and socio-economic characteristics of nurses and referent group, female household population, Canada excluding territories, 2003

Characteristics	Female nurses	Referent group	χ^2 statistic (df)†	Missing before imputation
	----------Percentage----------			Percentage
Marital status				
Married/Common-law	74.8	65.7	71.2 (2)***	0.0
Widowed/Divorced/Separated	10.7	10.4		
Single	14.5	23.9		
Urban dweller				
Yes	79.7	84.4	22.5 (1)***	0.0
No	20.3	15.6		
Usual work schedule				
Regular daytime	42.1	77.2	1800.3 (4)***	0.1
Regular evening/night	14.2	4.9		
Rotating shift	34.6	6.0		
Irregular shift	6.1	9.2		
Split/On-call/Other	3.1	2.6		
Total personal income				
Less than $20,000	8.6	25.8	358.9 (3)***	7.4
$20,000 to $34,999	23.4	28.5		
$35,000 to $49,999	30.5	23.7		
$50,000 or more	37.6	22.0		
Total household income				
Less than $40,000	9.6	16.9	130.3 (3)***	7.7
$40,000 to $59,999	12.9	19.0		
$60,000 to $79,999	22.9	22.4		
$80,000 or more	54.7	41.7		
Household size				
1	10.3	10.8	0.7 (3)***	0.0
2	30.9	31.3		
3	21.3	21.4		
4 or more	37.5	36.5		
Immigrant				
Yes	14.4	20.7	35.3 (1)***	0.1

† continuity correction used for 2 * 2 tables
*** $p < 0.001$
Notes: The referent group is female postsecondary graduates employed in past year in occupations other than those in health sector or employed by hospitals. All estimates are weighted using bootstrapped sampling weights after multiple imputation for missing data.
Source: 2003 Canadian Community Health Survey.

Psychosocial risk factors were *perceived life stress* and *perceived work stress* and were derived from the questions: "Thinking about the amount of stress in your life, would you say that most days are..." and "Would you say that most days at work were..." The response options were: "not at all stressful," "not very stressful," "a bit stressful," "quite a bit stressful," and "extremely stressful." Those who responded "quite a bit stressful" or "extremely stressful" were compared with those who chose one of the other options.

Several demographic and socioeconomic factors were treated as potential confounders. The variables entered as continuous were: age in years; total usual number of hours worked per week; total personal income before taxes and other deductions from all sources in past 12 months; total household income from all sources in past 12 months; and household size. Other factors were entered as categorical variables. Three

marital status categories were used: married or common-law; widowed, divorced or separated; and single. Urban dweller was coded: yes, urban or no, rural. Usual work schedule described the hours the respondents usually worked: regular daytime schedule or shift; regular evening or night shift; rotating shift (change from days to evening to nights); irregular schedule; and split shift, on call or other. Immigrant status was coded "yes" or "no."

Results

Demographic and socio-economic characteristics

The female nurses were almost 4 years older, on average, than other employed female postsecondary graduates: 42.9 years (95% CI: 42.2-43.7) versus 39.0 years (95% CI: 38.8-39.2; Z = 9.3, p < .001), and usually worked about one hour less per week: 36.3 hours (95% CI: 35.5-37.2) versus 37.4 hours (95% CI: 37.0 – 37.7; Z = -2.2; p = .029). Compared with other employed female postsecondary graduates, the nurses were more likely to be married or in common-law relationships, rural dwellers, shift workers, and Canadian-born (not immigrants), and had higher personal and household income (Table 1).

Health status

Nurses' and other employed female postsecondary graduates' ratings of their health were similar (Table 2). Among nurses, 28.9% rated their general health as good, fair or poor, rather than excellent or very good; the corresponding figure for other employed women with postsecondary credentials was 31.1%. The percentages rating their mental health as good, fair or poor were 18.1% and 20.4%, respectively. And while the nurses were more likely to report a chronic condition (74.4% versus 69.6%), this excess risk disappeared when the confounding effects of age, work schedule, income, household size and immigrant status were taken into account. The nurses, however, were more likely to report back problems (excluding fibromyalgia and arthritis), a difference that remained statistically significant when controlling for the influence of confounders.

Disease prevention

Being a nurse was associated with engaging in preventive behaviour. A much higher percentage of nurses than other employed female postsecondary graduates had had flu shots (68.2% versus 38.8%) (Table 2), an association that persisted in the multivariate analysis (Table 3). Similarly, the nurses were more likely to have ever had a pap smear (97.4% versus 91.0%), even when potential confounders were taken into account. One in two nurses (49.8%) had had a mammogram, compared with 36.0% of the referent group, but the association was not significant in the multivariate analysis.

Behavioural risk factors

The nurses were more likely than the referent group to be classified as overweight or obese (43.9% versus 34.4%). Nurses' excess risk, however, became statistically non-significant after adjustment for age, place of residence, work schedule, income, household size and immigrant status (Table 3).

Table 2
Health status of nurses and referent group, female household population, Canada excluding territories, 2003

Characteristics	Female nurses	Referent group	Missing before imputation
	Percentage		
Self-reported health			
General health			
Excellent/Very good	71.2	68.9	0.0
Good/Fair/Poor	28.9	31.1	
Mental health			
Excellent/Very good	81.9	79.6	0.4
Good/Fair/Poor	18.1	20.4	
Chronic conditions			
At least one	74.4	69.6	0.1
Asthma	9.1	9.3	0.0
Arthritis/Rheumatism (excluding fibromyalgia)	14.2	12.1	0.1
Back problems (excluding fibromyalgia and arthritis)	24.0	20.0	0.1
High blood pressure	11.6	7.1	0.1
Disease prevention			
Ever had flu shot	68.2	38.8	0.5
Ever had pap smear	97.4	91.0	0.7
Ever had mammogram†	49.8	36.0	0.5
Behavioural risk factors			
Overweight/Obese‡	43.9	34.4	6.2
Physically inactive in leisure time§	47.2	47.3	0.4
Less than 5 servings of fruit/vegetables per day	40.1	50.2	1.9
Current smoker (daily or occasional)	18.9	19.7	0.1
Heavy alcohol use††	6.9	11.0	0.0
Psychosocial risk factors			
Perceived life stress			
Quite a bit or extremely	31.4	31.7	0.1
Perceived work stress			
Quite a bit or extremely	55.8	34.9	1.9

† asked of 62.2% of women in sample (women younger than 35 not asked)
‡ body mass index 25 or more
§ total daily energy expenditure less than 1.5 kcal/kg/day
†† five or more drinks on one occasion at least once a month
Notes: The referent group is female postsecondary graduates employed in past year in occupations other than those in health sector or employed by hospitals. All estimates are weighted using bootstrapped sampling weights after multiple imputation for missing data.
Source: 2003 Canadian Community Health Survey.

About half the women in both groups were physically inactive (47.2% of nurses versus 47.3% of other employed postsecondary graduates). Nurses were less likely to report insufficient consumption of vegetables and fruit (40.1% versus 50.2%) or heavy alcohol use (6.9% versus 11.0%), even when allowing for the influence of the covariates. The prevalence of smoking was almost the same in the two groups (about 19%).

Psychosocial risk factors

No group differences were noted in the percentages of women reporting that most days were "quite a bit" or "extremely" stressful (about 31%). However, when the question was specific to work stress, the nurses were more likely (55.8% versus 34.9%) to say that most days were "quite a bit" or "extremely" stressful, with minimal confounding by the demographic differences in the populations (Table 3).

Table 3
Unadjusted and adjusted odds ratios relating health status of nurses to that of referent group, female household population, Canada excluding territories, 2003

Characteristics	Unadjusted odds ratio	95% confidence interval		Adjusted odds ratio	95% confidence interval	
		from	to		from	to
Self-reported health						
General health						
Excellent/Very good	1.00	...	...	1.00	...	...
Good/Fair/Poor	0.90	0.75	1.07	0.86[a,e,g,h,i]	0.70	1.05
Mental health						
Excellent/Very good	1.00	...	...	1.00	...	...
Good/Fair/Poor	0.86	0.72	1.04	0.88[c,g]	0.71	1.08
Chronic conditions						
At least one†	1.27*	1.06	1.52	1.04[a,e,f,h,i]	0.86	1.27
Asthma†	0.98	0.77	1.26	0.92[d,g,i]	0.70	1.21
Arthritis/Rheumatism (excluding fibromyalgia)†	1.20	0.96	1.50	0.93[a,c,f,g,i]	0.71	1.20
Back problems (excluding fibromyalgia and arthritis)†	1.26*	1.05	1.52	1.24*[a,b,c,f,i]	1.01	1.53
High blood pressure†	1.72*	1.34	2.21	1.24[a,g]	0.93	1.65
Disease prevention						
Ever had flu shot†	3.38*	2.87	3.97	3.10*[a,c,d,f]	2.56	3.76
Ever had pap smear†	3.70*	2.44	5.61	2.24*[a,c,g,h,i]	1.43	3.50
Ever had mammogram†,††	1.76*	1.51	2.06	1.05[a,c]	0.79	1.39
Behavioural risk factors						
Overweight/Obese†,§	1.49*	1.27	1.75	1.15[a,d,e,g,h,i]	0.95	1.39
Physically inactive in leisure time†,††	0.99	0.84	1.17	1.05[c,d,e,g,h,i]	0.87	1.26
Less than 5 servings of fruit/vegetables per day†	0.67	0.57	0.78	0.69*[a,c,e]	0.58	0.83
Current smoker (daily or occasional)†	0.96	0.78	1.17	0.86[b,c,e,i]	0.66	1.11
Heavy alcohol use†,‡‡	0.59*	0.44	0.80	0.57[a,c,d,e,g,h,i]	0.40	0.80
Psychosocial risk factors						
Perceived life stress						
Quite a bit or extremely†	0.99	0.84	1.16	0.97[a,b,c,f,h]	0.81	1.16
Perceived work stress						
Quite a bit or extremely†	2.36	2.02	2.75	2.25*[b,e,f]	1.88	2.70

† reference category; reference category is "No" for all binary characteristics
* significantly different from reference category ($p < 0.05$)
‡ asked of 62.2% of women in sample (women younger than 35 not asked)
§ body mass index 25 or more
†† total daily energy expenditure less than 1.5 kcal/kg/day
‡‡ five or more drinks on one occasion at least once a month
Notes: The referent group is female postsecondary graduates employed in past year in occupations other than those in health sector or employed by hospitals. All estimates are weighted using bootstrapped sampling weights after multiple imputation for missing data. Adjusted for (a) age, (b) total usual hours worked/week, (c) marital status, (d) urban/rural dweller, (e) usual work schedule, (f) total personal income, (g) total household income from all sources, (h) household size, and (i) immigrant status.
Source: 2003 Canadian Community Health Survey.

Discussion

The present study profiles the health status of Canadian female nurses and compares it with that of other women with postsecondary credentials who were employed in non-hospital occupations. The two groups were similar with respect to their overall self-reported physical and mental health and their risks of being diagnosed with asthma, arthritis or rheumatism, and high blood pressure. However, even when differences in demographic and socio-economic characteristics were taken into account, being a nurse was associated with a greater risk of reporting back problems. The nurses were also more likely to have ever had a flu shot or a pap smear.

The prevalence of smoking and being physically inactive was similar in the two groups. The nurses, however, were significantly less likely to report insufficient vegetable and fruit consumption or heavy alcohol use. And while similar percentages of women in the two groups reported their lives to be "quite a bit" or "extremely" stressful, nurses were significantly more likely to describe their days at work as stressful.

Because of differences in the variables studied and in approaches to measurement, few comparisons can be made with the findings of the 2005 National Survey of the Work and Health of Nurses.[3] Nonetheless, the prevalence estimates for asthma, arthritis, back problems, high blood pressure, and overweight/obesity are remarkably congruent. A noteworthy exception is the prevalence of smoking among nurses: 18.9% in this analysis versus 15.8% in the National Survey of the Work and Health of Nurses.

The 2005 survey, which made comparisons with "employed Canadians

What is already known on this subject?

- Past research has suggested that Canadian nurses' illness- and injury-related absenteeism rates are considerably higher than those of other occupational groups.
- Nurses have been reported to be at risk for back problems, arthritis, pain and depression.
- Compared with the general population, nurses have been found to be at lower risk of all-cause, cardiovascular-related, and cancer mortality.
- Much of the research is limited because of underreporting, comparisons with the general public that are influenced by the "healthy worker effect," and failure to adjust for confounding factors such as age, socio-economic status and place of residence.

What does this study add?

- In some respects, female nurses' occupation appears to confer some health risks and benefits.
- Nurses are more likely than other employed female postsecondary graduates to report work stress and back pain.
- Nurses are more likely to have had flu shots and pap tests, and are less likely to report excessive alcohol consumption.
- As is true of other employed women, substantial percentages of female nurses are overweight/obese, are physically inactive, consume vegetables and fruit infrequently, and smoke.

overall," concluded that female nurses were more likely to have back problems, again, a finding consistent with the data reported in this study. However, according to the results of that survey, female nurses were more likely to have arthritis and less likely to smoke, differences that were not found in the comparison with employed female postsecondary graduates. And whereas the analysis of data from the National Survey of the Work and Health of Nurses found that nurses were more likely than employed Canadians overall to have high blood pressure, in this study, female nurses were at similar risk of high blood pressure once differences in age and income were controlled.

Limitations

The present study has some limitations. Because of the small number of male nurses in the survey sample, the analysis examined only female nurses. It is possible that the health status of male nurses is different.

The use of self-reports is typically considered error-prone. Moreover, the error associated with these data may have a differential bias because nurses' reporting patterns could be influenced by their specialized knowledge of health conditions and risks.

To facilitate the comparisons, some health indicators were collapsed into binary variables. This may have resulted in the loss of information.

Causal inferences should not be made because the temporality of the predictor and outcome variables is not known, and potential confounders that were not examined here may account for the associations between occupation and health behaviour or status.

Conclusion

Although occupation was not associated with many of the health indicators examined here, some health problems and risks were relatively more prevalent among nurses, notably, back problems and reports that work was "quite a bit" or "extremely" stressful. Like other employed female postsecondary graduates, female nurses were at risk of disease because of overweight/obesity, physical inactivity during leisure time, insufficient fruit and vegetable consumption, and smoking.

As is the case for most people, the health profile of Canadian female nurses is complex and somewhat contradictory. Some aspects of their behaviour are health-promoting, while others are of potential concern. ■

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Appendix

Table A
Occupations of other postsecondary graduates

Standard Occupational Classification code	Occupation	Number	Percentage
Total		**15,747**	**100.0**
A	Management occupations	1,353	8.6
B	Business, finance and administrative occupations	4,414	28.0
C	Natural and applied sciences and related occupations	743	4.7
D	Health occupations†	174	1.1
E	Occupations in social science, education, government service and religion	2,987	19.0
F	Occupations in art, culture, recreation and sport	969	6.2
G	Sales and service occupations	4,056	25.8
H	Trades, transport and equipment operators and related occupations	329	2.1
I	Occupations unique to primary industry	331	2.1
J	Occupations unique to processing, manufacturing and utilities	391	2.5

† veterinarians (D014), optometrists (D021), chiropractors (D022), veterinary and animal health technologists and technicians (D213), denturists (D221), dental technologists, technicians, and laboratory bench workers (D223) opticians (D231), and dental assistants (D311)

Table B
Occupations *not* included among other postsecondary graduates

Standard Occupational Classification code	Examples of occupations excluded	Number	Percentage
Total		**4,233**	**100.0**
A321	Managers in health care	36	0.9
B213, B214, B411, B513, B514, B541, B553, B572	Medical secretaries; recorders and medical transcriptionists; records and file clerks; receptionists and switchboard operators; administrative clerks	1,355	32.0
C021, C041, C048, C111, C121	Biologists and related scientists; other professional engineers; applied chemical technologists and technicians; biological technologists and technicians	87	2.1
D011-D013, D023, D031, D032, D041-D044, D211, D212, D214-D217, D219, D222, D232, D234, D235, D312, D313	Specialist physicians; general practitioners and family physicians; dentists; pharmacists; dietitians and nutritionists; audiologists and speech-language pathologists; physiotherapists; occupational therapists; medical laboratory technologists and pathologists' assistants; respiratory therapists, clinical perfusionists and cardio-pulmonary technologists; medical radiation technologists; cardiology technologists; midwives	1,624	38.4
E021-E024	Psychologists; social workers; ministers of religion	394	9.3
G012-G015, G811, G931, G933, G951, G961, G962, G981, G982	Food service supervisors; cleaning supervisors; light duty cleaners; janitors, caretakers and building superintendents; elemental medical and hospital assistants; kitchen and food service helpers; laundry occupations	737	17.4


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Developmental pathways leading to obesity in childhood

by Samar Hejazi, V. Susan Dahinten, Sheila K. Marshall and Pamela A. Ratner

Abstract

Background
Researchers have yet to provide a comprehensive explanation of the variability in the development of childhood obesity, owing in part to the dearth of longitudinal studies. Such an understanding would contribute to the improvement of approaches for the primary and secondary prevention of childhood obesity. This study identifies, in a representative sample of Canadian children, age-related patterns of overweight and obesity between toddlerhood and childhood.

Data and methods
The data are from cycles 2 through 5 (1996/1997 to 2002/2003) of the National Longitudinal Survey of Children and Youth. The sample comprised children aged 24 to 35 months at baseline, who were followed biennially over six years. Group-based mixture modelling analyses (using SAS PROC TRAJ) were conducted to identify the sex-specific developmental trajectories of body mass index (BMI).

Results
Group-based modelling identified four BMI trajectories for the girls (stable normal BMI, early declining BMI, late declining BMI, and an accelerating rise to obesity) and three for the boys (stable normal BMI, transient high BMI, and a J-curve rise to obesity).

Interpretation
Identifying distinct, sex-specific BMI trajectories is valuable in understanding pathways through which a child may develop obesity. These findings have implications for further research and practice, in particular, that no single approach can be used to prevent or reduce levels of obesity.

Keywords
body mass index, child development, trajectories, health surveys, longitudinal studies

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The prevalence of childhood overweight and obesity has been increasing in Canada and globally, among boys and girls of all ages, social classes, ethnic groups and races.[1-3] Based on data from the 1998/1999 Canadian National Longitudinal Survey of Children and Youth, 19% of children aged 2 to 11 were overweight, and 18% were classified as obese.[4] The rising prevalence of obesity in children and adolescents raises concern about conditions and diseases associated with excess weight. Paediatric obesity can affect short- and long-term physical and psychosocial health, and is likely to contribute to adult-onset morbidity.[5-9]

Body mass index (BMI) is the measure used most frequently to classify weight status. Longitudinal epidemiological studies have found that after rapid growth in infancy, BMI-for-age begins to decline at about 1 year of age to a minimum around ages 5 or 6.[10-13] Thereafter, adiposity increases through adolescence. This gradual increase is described as "adiposity rebound," which reflects a normal pattern of growth.[10-13] However, certain patterns of adiposity rebound tend to be related to the development of obesity. For example, early onset of adiposity (younger than age 5) has been associated with higher BMI in adolescence[11] and with an increased risk of adult obesity.[13,14] Dietz,[11] however, suggested that BMI at the time of rebound is a stronger predictor of later BMI—children with high BMI at rebound are more likely to be overweight or obese as adults.

The few longitudinal studies that have been conducted have generally assumed that there is a continuous distribution of BMI trajectories in the population (homogenous population trajectories). This approach has limited understanding of the various pathways that lead to the development of obesity among children. Only two previous studies have explored the variation in BMI in clustered and distinct groups (heterogeneous population trajectories). Mustillo et al.[7]

identified four obesity trajectories: never obese, chronically obese, adolescent obesity, and childhood obesity (obese during childhood, but in the normal weight range during adolescence). However, the children in the study were aged 9 or older at baseline; no data were collected on earlier BMI values, so the researchers could not determine the age at which the chronically obese group developed obesity. A more recent study by Li et al.[15] identified three obesity trajectories in children aged 2 to 12: normal weight, early-onset (obese throughout the data collection period), and late-onset (became overweight after age 8). Both studies combined boys and girls in the trajectory analysis, and both used a dichotomized measure of obesity, which may have resulted in a loss of information and higher rates of misclassification.

Studying BMI trajectories is important to understanding variability in the development of childhood obesity. Such exploration helps explain the role of age, sex, and contextual factors. Hence, the primary purpose of this study was to conduct group-based mixture modelling analyses to identify distinct trajectories in the development of obesity in a representative sample of Canadian children aged 24 to 35 months at baseline, who were followed biennially over six years.

Methods

Data source and sample

The analyses were based on data from the master file of the National Longitudinal Survey of Children and Youth.[16] The study followed children aged 24 to 35 months in 1996/1997 for six years until 2002/2003 when they were aged 96 to 107 months. The National Longitudinal Survey of Children and Youth is conducted through a partnership between Statistics Canada and Human Resources and Social Development Canada. Data collection began in 1994/1995 and is repeated at two-year intervals. The survey covers topics such as children's health and cognitive well-being and their social contexts.

The target sample for this study was children aged 24 to 35 months at cycle 2 in 1996/1997. For subsequent cycles (cycles 3 to 5), only children for whom second-cycle data (baseline) were available were selected. The cohort was chosen according to the availability and consistency of other measures pertinent to the broader study objectives (for example, cycle 1 was omitted because it lacked relevant measures). To obtain reliable parameter estimates of trajectories, a minimum of three measurement time-points are needed for each case.[17] Therefore, children from the baseline cohort were retained only if they had at least three biologically plausible BMI measures over the four data collection points. As a result, the final sample was reduced from a possible 1,890 cases to 972 (490 girls and 482 boys).

Measures

Body mass index (BMI), which is weight in kilograms divided by height in metres squared (kg/m^2), is commonly used to classify children, adolescents and adults as normal weight, underweight, overweight and obese.[3] In this study, BMI was the outcome variable in the sex-specific trajectory analyses. The classification of obesity was based on cut-offs established by Cole, Bellizi and Flegal,[18] specific to the child's age and sex. This approach has been used in other studies of Canadian childhood obesity, some of which analyzed data from the National Longitudinal Survey of Children and Youth.[2,4,19,20] The children's BMI was compared with the international cut-off values for BMI for overweight and obesity by sex at ages 24 to 35 months (cycle 2), 48 to 59 months (cycle 3), 72 to 83 months (cycle 4), and 96 to 107 months (cycle 5).

BMI was calculated based on the height and weight of the child reported by the "person most knowledgeable," usually the mother. Height (without shoes) was reported in feet and inches or in metres and centimetres, and weight was reported in pounds and ounces or in kilograms and grams.

The identification of outliers is crucial in the analysis of childhood developmental characteristics. Outliers for height and weight are described as "biologically implausible values."[21] It is assumed that these outliers do not reflect actual growth, but result from inaccurate measurements, data entry errors, or inaccurate reporting by the person most knowledgeable. The outlier analysis was undertaken with a SAS® program that identified extremely low and high BMI values according to the WHO fixed exclusion ranges.[21,22] A total of 392 cases with outlier BMI values were excluded from the study, ranging from 19 cases in cycle 5 to 238 cases in cycle 2. An attrition analysis revealed that the children who were excluded because of outlier values differed significantly from those who were included—they were more likely to be from low-income homes, and the person most knowledgable tended to be younger and less-educated.

Statistical analysis

Based on Nagin's[17] approach to group-based modelling, obesity trajectories were determined by fitting a semi-parametric mixture model to the data. This strategy was used to identify groups of BMI trajectories from ages 24 to 35 months through to 96 to 107 months. With this method, it is possible to detect distinct classes of BMI change across ages, each class with a specific intercept and slope and estimated population prevalence. The model defined the shape of the trajectory of each group and the estimated percentage of the population belonging to the trajectory group. Group-based modelling assumes that the population is composed of multiple subgroups with different developmental trajectories, but membership at the individual level is unobserved. The parameters of the group-based model are estimated by maximum likelihood; the method utilizes a multi-nomial function to model the relationship between the variables.

The mixture model analysis was conducted by applying PROC TRAJ[23]

in SAS® 9.1. Estimation of trajectories was accomplished by using the censored normal model (CNORM). CNORM is typically used to model the conditional distribution of a censored variable where there is a cluster of data at the maximum or minimum values,[23] or for data that are measured on a continuous scale without censoring (for example, BMI).[17] Identifying the distinct groups of developmental trajectories involved: (a) model selection—establishing the optimal number of groups and trajectory shapes that best fit the data, based on the change in the Bayesian Information Criterion (BIC), and (b) estimation of the percentage of individuals in each group. To evaluate the alterations in model fit, the models were compared based on: (a) the change in the log-likelihood BIC, (b) the BIC-based probability approximation, and (c) the BIC log Bayes factor approximation.[17,23] To account for the complex survey design, which incorporated both clustered and stratified sampling, standardized longitudinal sample weights were applied in all analyses. For all 972 cases, the standardized weights were calculated by dividing the cycle 5 longitudinal weight provided by Statistics Canada over the average of that weight.

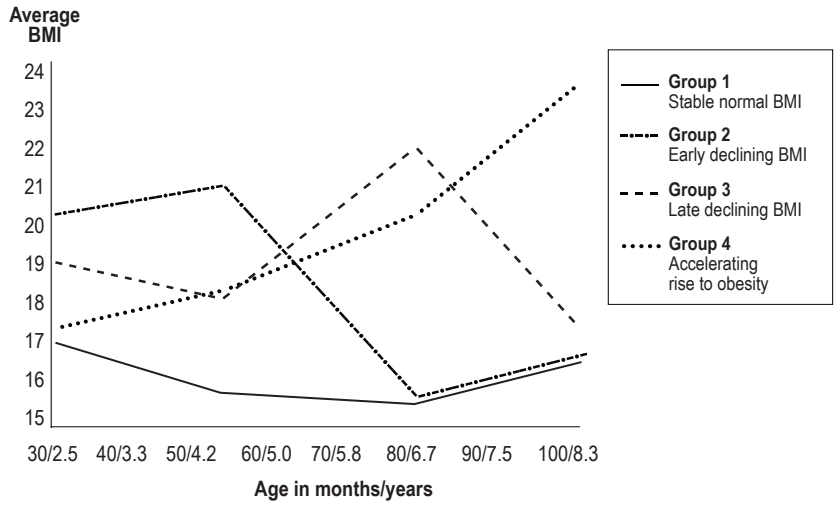
Results

Sample description

Descriptive analyses were conducted separately for the boys and girls at baseline (1996/1997) when they were aged 24 to 35 months.

For about 50% of the boys and 46% of the girls, the person most knowledgeable was a college or university graduate; 5.8% of the boys and 9.5% of the girls had a person most knowledgeable with less than secondary graduation. The majority of the children (67.8% of the boys and 60.9% of the girls) were from households where total annual income equalled or exceeded $40,000; about 5% lived in households with less than $15,000 per annum. A large majority of the boys (89%) and girls (93%) were reported to have very good or excellent health; only 2% of the boys and 1% of the girls were reported to have fair or poor health. When the person most knowledgeable was asked about the child's activity level compared with that of other children, 56% of the boys and girls were reported to be "equally active."

Figure 1
Body mass index (BMI) trajectories for girls aged 24 to 35 months at baseline, Canada, 1996/1997 to 2002/2003



Source: National Longitudinal Survey of Children and Youth, 1996/1997 to 2002/2003.

Table 1
Classification of body mass index (BMI) trajectories of girls aged 24 to 35 months at baseline, Canada, 1996/1997 to 2002/2003

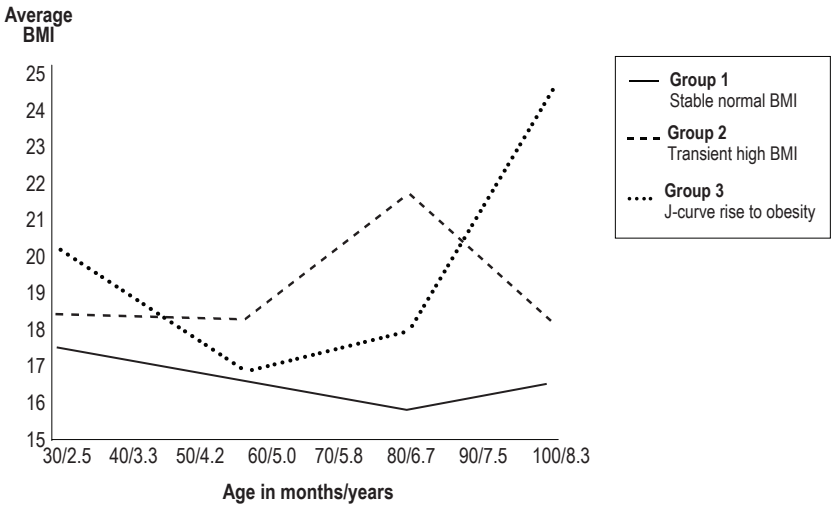
Average age in months/years (survey year)	Group 1 Stable normal	Group 2 Early-declining	Group 3 Late-declining	Group 4 Accelerating rise to obesity
30 months/2.5 years (1996/1997)	**Normal BMI** (mean BMI = 16.9; 95% confidence interval = 16.3 to 17.6)	**Obese** (mean BMI = 20.4; 95% confidence interval = 17.9 to 22.9)	**Overweight** (mean BMI = 19.1; 95% confidence interval = 17.1 to 21.1)	**Normal BMI** (mean BMI = 17.5; 95% confidence interval = 15.7 to 19.2)
53 months/4.4 years (1998/1999)	**Normal BMI** (mean BMI = 15.8; 95% confidence interval = 15.4 to 16.2)	**Obese** (mean BMI = 21.3; 95% confidence interval = 18.8 to 23.9)	**Overweight** (mean BMI = 18.5; 95% confidence interval = 14.4 to 22.6)	**Overweight** (mean BMI = 18.1; 95% confidence interval = 15.7 to 20.6)
78 months/6.5 years (2000/2001)	**Normal BMI** (mean BMI = 15.5; 95% confidence interval = 14.9 to 16.1)	**Normal BMI** (mean BMI = 15.2; 95% confidence interval = 14.0 to 16.3)	**Obese** (mean BMI = 21.3; 95% confidence interval = 18.1 to 24.4)	**Obese** (mean BMI = 20.8; 95% confidence interval = 18.7 to 22.9)
100 months/8.3 years (2002/2003)	**Normal BMI** (mean BMI =16.4; 95% confidence interval = 15.9 to 16.8)	**Normal BMI** (mean BMI = 16.6; 95% confidence interval = 15.2 to 18.0)	**Normal BMI** (mean BMI = 17.6; 95% confidence interval = 15.1 to 20.1)	**Obese** (mean BMI = 23.2; 95% confidence interval = 21.6 to 24.8)

Note: Based on cut-offs established by Cole, Bellizi and Flegal, specific to child's age and sex.
Source: National Longitudinal Survey of Children and Youth, 1996/1997 to 2002/2003.

BMI trajectory modelling results

Based on the Bayesian Information Criterion (BIC) calculations and the BIC log Bayes factor approximation, the difference in the population distribution of BMI developmental trajectories was best characterized by a four-group model

Figure 2
Body mass index (BMI) trajectories for boys aged 24 to 35 months at baseline, Canada, 1996/1997 to 2002/2003



Source: National Longitudinal Survey of Children and Youth, 1996/1997 to 2002/2003.

Table 2
Classification of body mass index (BMI) trajectories of boys aged 24 to 35 months at baseline, Canada, 1996/1997 to 2002/2003

Average age in months/years (survey year)	Group 1 Stable normal	Group 2 Transient high	Group 3 J-curve rise to obesity
30 months/2.5 years (1996/1997)	**Normal BMI** (mean BMI = 17.2; 95% confidence interval = 16.7 to 17.8)	**Normal BMI** (mean BMI = 18.0; 95% confidence interval = 16.9 to 19.0)	**Overweight** (mean BMI = 19.5; 95% confidence interval = 18.0 to 21.0)
53 months/4.4 years (1998/1999)	**Normal BMI** (mean BMI = 16.4; 95% confidence interval = 15.9 to 16.9)	**Overweight** (mean BMI = 18.5; 95% confidence interval = 17.3 to 19.7)	**Normal BMI** (mean BMI = 16.2; 95% confidence interval = 14.7 to 17.6)
78 months/6.5 years (2000/2001)	**Normal BMI** (mean BMI = 15.7; 95% confidence interval = 15.3 to 16.1)	**Obese** (mean BMI = 21.5; 95% confidence interval = 20.3 to 22.9)	**Overweight** (mean BMI = 17.8; 95% confidence interval = 16.3 to 19.4)
100 months/8.3 years (2002/2003)	**Normal BMI** (mean BMI = 16.4; 95% confidence interval = 15.9 to 17.0)	**Normal BMI** (mean BMI = 17.9; 95% confidence interval = 16.9 to 19.0))	**Obese** (mean BMI = 24.2; 95% confidence interval = 22.4 to 26.1)

Note: Based on cut-offs established by Cole, Bellizi and Flegal, specific to child's age and sex.
Source: National Longitudinal Survey of Children and Youth, 1996/1997 to 2002/2003.

for the girls' data and a three-group model for the boys' data, all with cubic (third-order polynomial) shapes. This was further supported by a comparison between the competing models based on the BIC-based probability of model correctness. For the girls' data, the four-group model had the best BIC value, and the probability of it being the correct model was 0.96. For the boys' data, a three-group solution offered the best fit to the data, and the probability of it being the correct model was 0.56. The correctness of the group membership classifications based on the maximum posterior probability assignment rule indicated strong correspondence of the models with the data. The mean group posterior probability for the girls' data ranged from 0.73 to 0.90, relatively good probabilities, while the mean group posterior probability for the boys' data ranged from 0.80 to 0.91, again, relatively strong classification probabilities.

BMI classification

BMI values in this study were compared to reference standards that take the child's age and sex into consideration. PROC TRAJ provided a predicted mean BMI by time (or child's age) for each trajectory, so it was possible to describe the changes in BMI for each of the trajectory groups by comparing the predicted BMIs with the cut-offs of Cole et al.[18] To label the various trajectories, the predicted BMI of each group at each time was first compared to the overweight cut-off value, and then, to the obesity cut-off value. Figures 1 and 2 present the BMI trajectories for the girls and the boys, respectively; Tables 1 and 2 show the classification of mean weight status at each measurement time for each trajectory.

Girls' trajectory groups

The trajectory for each group is described by the probability of BMI membership at each age. Group 1, labelled the "stable normal BMI" group, was estimated to include 64% of the population of girls in the sample. Throughout the six years, their average BMI was normal for their age and sex (Figure 1, Tables 1 and 3).

The girls in the "early declining BMI" group (Group 2) were in the obese category at the first two measurements (1996/1997 and 1998/1999), but they "rebounded" to within normal range at the third measurement (2000/2001) and remained there at the fourth (2002/2003). This group accounted for an estimated 8% of the population.

The average BMI of Group 3 was above the overweight cut-off at the first two measurements, obese at the third, and declined to within normal range at the fourth. This trajectory was labelled the "late declining BMI" group and was estimated to encompass 14% of the sampled population.

Finally, an estimated 14% of the girls' population in the sample belonged to Group 4, the "accelerating rise to obesity" group. From normal at the first

Table 3
Body mass index (BMI) trajectory group membership probabilities for girls and boys aged 24 to 35 months at baseline, Canada, 1996/1997 to 2002/2003

Sex/BMI trajectory group	Membership probability %
Girls	**100**
Group 1 (stable normal BMI)	64
Group 2 (early declining BMI)	8
Group 3 (late declining BMI)	14
Group 4 (accelerating rise to obesity)	14
Boys	**100**
Group 1 (stable normal BMI)	70
Group 2 (transient high BMI)	19
Group 3 (J-curve rise to obesity)	11

Source: National Longitudinal Survey of Children and Youth, 1996/1997 to 2002/2003

measurement, their average BMI rose to overweight at the second, and at the third, to obesity, which was sustained at the fourth.

Boys' trajectory groups

Among the boys in the sample, Group 1, the "stable normal BMI" group, accounted for an estimated 70%. Their average BMI was within the normal range throughout the six years (Figure 2, Tables 2 and 3).

The BMI of the boys in Group 2 changed continuously across the four measurements. Their average BMI was within the normal range at the first measurement; by the second, they were in the overweight range; and by the third, obese. However, at the fourth measurement, they had returned to the normal range. They were labelled the "transient high BMI" group and were estimated to encompass 19% of the sampled population.

Boys in Group 3, the "J-curve rise to obesity" group, were overweight at the first measurement, in the normal BMI range at the second, overweight at the third, and by the fourth, obese. This last group constituted 11% of the population of boys in the sample.

Discussion

A major finding of this study is the heterogeneity of BMI trajectories—differences that would not have been revealed either in conventional cross-sectional studies or in growth models. The mixed modelling approach identified four subgroups of girls and three subgroups of boys and provided average patterns of change over six years for each subgroup. It is necessary to acknowledge, however, that the results derived from applying the group-based methodology are approximations of population differences in developmental trajectories,[17] and that the BMI trajectories in this study are based on group means over a specific time period.

The longitudinal study by Li et al.[15] also explored the variation in weight status in clustered and distinct groups during early childhood, but the analysis was based on a binary dependent variable rather than a continuous measure of weight status (BMI). Two key differences in the current study are that: (1) a chronically obese or early-onset group was not found, and (2) trajectories for one cluster of boys and two clusters of girls declined from obesity during earlier years to a normal BMI by ages 8 to 9. Li et al. identified groups that were never obese or rose to obesity (early- and late-onset); they did not identify any groups among whom the likelihood of obesity declined over time. However, the trajectory they identified as late-onset obesity for the combined sample of boys and girls is similar to the J-curve rise to obesity trajectory found for some boys in this sample.

Limitations

The findings of this study should be interpreted cautiously. A major limitation is the reliability of reports of children's height and weight by the person most knowledgeable (typically, the mother), which has implications for the validity of the BMI calculations.

Few studies have assessed the accuracy of parental reporting, and the results have been inconsistent. A comparison of BMI estimates based on parental reports of children's height and weight from the 2002/2003 National Longitudinal Survey of Children and Youth with those based on measured data from the 2004 Canadian Community Health Survey revealed substantial differences, particularly for children aged 2 to 5.[24] When the parents answered for their child, overweight and obesity rates were higher, largely because the parents tended to underestimate their child's height. The author suggested that parents might report the child's last measured height, which could be inaccurate given how quickly children

What is already known on this subject?

- The prevalence of obesity among children is increasing.
- Certain patterns of adiposity rebound tend to be related to the development of obesity.
- Few longitudinal studies have explored variations in body mass index (BMI) trajectories among children, and those that have done so combined boys and girls.

What does this study add?

- Based on six-year BMI trajectories starting at ages 24 to 35 months, four subgroups of girls and three subgroups of boys were identified.
- The majority of children were in the normal BMI range throughout the six years.
- By the end of the period, 14% of the girls and 11% of the boys were in the obese BMI range.
- Another 22% of the girls and 19% of the boys had been obese at some point in the six years, but by the end of the period were in the normal range for their age and sex.
- Group-based modelling provides an alternative approach to analysing longitudinal BMI data for children.

of these ages grow. Davis and Gergen[25] and Huybrechts et al.[26] also reported that parental reports are inaccurate for classifying preschool children into BMI categories. On the other hand, Sekine et al.[27] concluded that parental reports are valid for the study of childhood obesity. Moreover, in the current study, the effects of inaccurate parental reporting may have been reduced by the omission of biologically implausible outliers. As well, children included in this study had parents with significantly higher educational attainment than did the children who were excluded, and according to Baughcum et al.,[28] limited maternal education has been associated with underestimates of children's weight problems. The methods used in this study could also have reduced the impact of inaccurate reporting by analyzing group means over time (group means are considered to be statistically more stable). And finally, the current study is not the only one to use height and weight data from the National Longitudinal Survey of Children and Youth; a number of other empirical studies have relied on these data to estimate obesity prevalence and secular and temporal trends among Canadian children.[2,20,29,30]

To some degree, the generalizability of the findings is limited. The socioeconomic characteristics of the sample on which the analysis was based differed from those of the large population from which it was drawn. This raises the possibility of the existence of other BMI trajectories that may be more prevalent among children in families with lower incomes and lower parental education.

The current study was also limited by the relatively short period—six years—for which data were available at the time of analysis. It was not possible to follow BMI trajectories into adolescence when further changes may occur. For example, using an older sample of 9- to 16-year olds, Mustillo et al.[7] identified a group that experienced obesity during childhood, but whose weight fell to normal during adolescence.

Conclusion

Group-based modelling provides an alternative approach to analysing longitudinal data. This study has advanced understanding of the various pathways by which young children may develop obesity. Knowledge of the different BMI trajectories may allow health professionals to refine their methods of addressing obesity and obesity-related health problems. For example, a normal-weight child may be overlooked as being at risk for obesity and may not receive proper assessment and counselling.

The increasing prevalence of excess weight among children makes the prevention of obesity a global health priority. Effective prevention requires a comprehensive approach in promoting and supporting healthy living. While this study has identified distinct BMI trajectories and demonstrated substantial differences between girls and boys, it is obviously only a first step. The demographic and socio-economic factors associated with these trajectories remain to be investigated. A better understanding of the risk factors associated with BMI trajectories may improve the effectiveness of programs in identifying and reaching children at the highest risk and maintaining healthful trajectories among other children. The results of such analysis will help to tailor and target programs to specific groups who are at risk of obesity, and perhaps, intervene at an early stage to alter the path of a trajectory. ■

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