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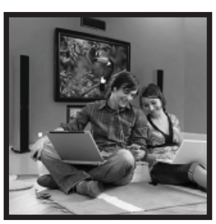
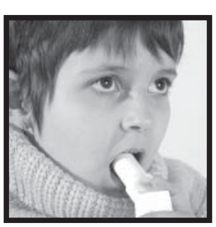




Methodological insights

Correlates of medication error in hospitals

Kathryn Wilkins and Margot Shields

Abstract

Objectives

This article examines associations between medication error and selected factors in the workplace of hospital-employed registered nurses (RNs) in Canada.

Data sources and methods

Data are from the 2005 National Survey of the Work and Health of Nurses, and were weighted to be representative of all RNs in Canada who deliver direct care to hospital patients. Correlates of medication error were considered in bivariate and multivariate analyses. Multiple logistic regression modeling was used to examine medication error in relation to work organization and workplace environment, while controlling for personal factors, including nurses' general and mental health, job dissatisfaction, education, years of experience in nursing, and clinical area of employment.

Results

Nearly one-fifth (19%) of hospital RNs reported that medication error involving patients in their care had occurred "occasionally" or "frequently" in the past year. In the fully adjusted multivariate model, medication error was positively associated with usually working overtime, role overload, perceived staffing or resource inadequacy, low co-worker support, and low job security. Usually working a 12-hour shift, compared with shorter shifts, was negatively associated with medication error.

Keywords

Drug administration, hospitals, nursing care, resource allocation, workload, workplace

Authors

Kathryn Wilkins (Kathryn.Wilkins@statcan.ca; 613-951-1769) and Margot Shields (Margot.Shields@statcan.ca; 613-951-4177) are with the Health Information and Research Division at Statistics Canada in Ottawa, Ontario, K1A 0T6.

Accumulating evidence from Canada and elsewhere indicates that, during their hospital stay, an appreciable number of patients experience adverse events, such as medication error, injurious falls, nosocomial infection, and other "medical misadventures."[1,2] A recent Canadian study reported that medication- or fluid-related error was second only to surgical error as the most common type of such incidents.[1]

Most studies of medication error have been based on data gathered from clinical records, which are well known to yield incomplete information. Partly because of fear of reprisal, very few incidents—probably only the 5% or so that are considered potentially life-threatening—are noted in patients' charts.[3-6] Therefore, from a review of clinical records, it is not possible to assess the true frequency of medication error, nor to identify the circumstances that contribute to such error.

Nurses, who typically administer medications to patients in clinical settings, are the usual focus of investigations of medication error. In fact, a key feature of nurses' training is that any failure to administer the "right drug in the right dose at the right time to the right patient by the right route" is the nurse's responsibility, even if it results from compliance with an inappropriate order written by a physician, a pharmacist's dispensing error, or a patient's inability to swallow. The expectation is that the nurse will clarify ambiguous orders; have the requisite knowledge and strength of character to question orders that are inappropriate; double- and triple-check the medication, dosage and identity of the patient; administer the medication at the right time and through the correct route; and closely monitor the patient.

Increasingly, however, the literature reflects a shift in focus away from the individual nurse as the "cause" of medication error to a consideration of the broader context. There is growing awareness that a complex interplay of circumstances in the clinical environment, rather than simply an individual's carelessness, contributes to the risk of error.[2,7-10]

Although the results are mixed, several studies suggest that links exist between medication error and systemic organizational factors. These include nurse staffing adequacy, hours worked per week, overtime, staffing mix (professional versus unregulated), and other factors reflecting how the work system is designed.[5,11-13]

Evidence of links between stress in the clinical workplace and medication error is also emerging. For example, a recent study of nurses in Alberta and Ontario found that patient safety outcomes—including medication error and other adverse events—were associated with emotional exhaustion ('burnout') in nurses, which in turn was related to staffing inadequacy, poor nurse-physician relations, and other "worklife" factors.[14]

When their confidentiality is protected, nurses can be an excellent source of information about the occurrence of and the conditions that give rise to medication errors. For instance, an American study that asked nurses to keep anonymous logbooks over a 23-day period found that 30% of them recorded at least one medication error. Nurses mentioned heavy workloads, complexity of the patients' needs, interruptions, and poor communication among health care providers as reasons for the errors.[15,16]

The 2005 National Survey of the Work and Health of Nurses (NSWHN) is a rich source of information reported anonymously by nurses across Canada. NSWHN data were collected by telephone under the strict protection of respondent confidentiality. These data offer an opportunity to study nurses' perceptions of patient safety—in this case, the frequency of medication error— in relation to factors reflecting the way in which their work is organized, as well as to those reflecting the interpersonal environment.

The objective of this study is to examine associations between medication error and work organization and workplace environment, while controlling for the possible influence of personal and health-related characteristics. The theoretical perspective was guided by the literature on determinants of nursing care outcomes in general, and adverse events in particular.[6,14,17-23] The conceptual model was based on a modified version of Donabedian's structure-process-outcome framework.[17]

The selection of variables for this analysis was influenced by their availability in the NSWHN. "Structure" was represented by variables concerning work organization: usually working overtime (paid or unpaid), a shift other than days, 12-hour shifts, more than 40 hours per week (at all jobs combined), having a part-time job, and clinical area of usual employment. "Process" was represented by variables having to do with the workplace environment, including nurse-physician working relations, perceived workload, perceived adequacy of staffing and resources, and work stress. Work stress factors were low co-worker support, low supervisor support, low job security, and high physical demands. "Outcome" was nurse-reported medication error. Personal characteristics that were controlled for in multivariate analysis were level of nursing education, years of experience as a nurse, job dissatisfaction, and general and mental health.

Methods

Data source

The data for this study are from the National Survey of the Work and Health of Nurses (NSWHN), a comprehensive survey of employed, regulated Canadian nurses (registered nurses, licensed practical nurses, and registered psychiatric nurses) conducted by Statistics Canada in partnership with the Canadian Institute for Health Information and Health Canada.[24] The purpose was to collect information from nurses in all provinces and territories about their work environment, workload, perceived quality of patient care, and their physical and mental health. The content of the survey was determined under the guidance of an expert advisory committee, with the intention of providing data for analysis focusing on links between the nursing practice environment and various nurse and patient outcomes.

The NSWHN sample was selected at random from membership lists provided to Statistics Canada by all 26 provincial and territorial nursing organizations and regulating bodies across Canada. Data collection took place from October 2005 to January 2006. The survey was administered by telephone; a typical interview lasted 30 minutes.

Of the 24,443 nurses initially selected for the sample, 21,307 were successfully contacted, and of these, 1,015 were out-of-scope—meaning that they were not employed in nursing at the time of the survey. Another 1,616 (7.6% of the 21,307 who were contacted) refused to participate. Complete responses were obtained from 18,676 nurses, for a response rate of 79.8%. Of these, 4,379 were registered nurses providing direct care to hospital patients; the analysis was based on weighted data from these respondents.

Definitions

The NSWHN collected information on the occurrence and frequency of *medication error* using the question: "The next questions are about possible incidents involving you or the patients you directly care for. In the past 12 months, how often would you say: A patient received the wrong medication or dose? never? / rarely? / occasionally? / frequently?" Responses were grouped into two categories: never or rarely, and occasionally or frequently.

Type of care provided was ascertained by asking, "Do you work in direct or non-direct patient care?" According to their responses, nurses were categorized as providing direct or indirect care; those who provided both were categorized as providing direct care.

For nurses with more than one nursing job, the "main job" was defined as the one at which the most hours were usually worked per week at the time of the interview. However, for respondents selected from the registration lists of Yukon Territory, Northwest Territories and Nunavut, the main job was defined as their job in the North, even if they had a second job outside the North at which they worked more hours during the year. (Of the estimated 1,400 nurses identified as employed in a Northern territory, 30% provided only short-term relief work there.)

Full-time status of the main job was established by asking respondents if they worked full- or part-time.

Usual shift for the main job was determined with the question, "Do you usually work days, evenings or nights?" Four response categories (days, evenings, nights and mixed shifts) were available to interviewers, but they read only the first three to respondents.

To determine length of shift, nurses were asked, "Do you usually work . . . an 8-hour shift, a 12-hour shift, some other shift or various shifts?" Those who responded "some other shift," were asked to specify the number of hours they usually worked per shift. Nurses were classified as working a *12-hour shift* if their response to the first question was a 12-hour shift, or if their response to the subsequent question indicated that their usual shift was more than 12 hours.

Overtime (time worked beyond what is scheduled) at the main job was determined with the questions, "How many hours of paid overtime do you usually work per week?" and "How many hours of unpaid overtime do you usually work per week?" Respondents who usually worked any number of hours of paid and/or unpaid overtime were defined as usually working overtime.

Number of jobs at the time of the survey was determined by asking about nursing jobs other than the main job, as well as jobs or businesses outside nursing.

Total hours worked at all jobs combined was derived by summing the total hours worked at the main job and the total hours at all other jobs.

Role overload (quantitative) is an index designed to measure the perceived appropriateness of the amount of work to be done in the time available; its reliability has been shown in previous assessments to be moderate (0.56),[25,26] although the Cronbach's alpha for this scale in Canadian nurses was 0.79.[24] Respondents were asked to rate their level of agreement on a five-point scale (strongly agree– score 4, agree – score 3, neither agree nor disagree – score 2, disagree – score 1, strongly disagree – score 0) with five statements:

- "I often have to arrive early or stay late to get my work done."
- "I often have to work through my breaks to complete my assigned workload."
- "It often seems like I have too much work for one person to do."
- "I am given enough time to do what is expected of me in my job." (Reverse scored.)
- "I have too much to do, to do everything well."

A total role overload score (with a possible range of 0 to 20) was calculated by summing the scores for the five items, with higher scores indicating more role overload. Cut-points were determined to divide the weighted distribution of scores into quartiles: first quartile – less than 9; second quartile – 9 to 12; third quartile – 13 to 15; fourth quartile – over 15. Of the total 4,379 nurses in the sample used for this analysis, 31 had missing information for role overload. A dummy variable for missing role overload was created in order to maximize the number of records that were included in multivariate analysis.

The Nursing Work Index (NWI) is a set of measures developed to study the nursing practice environment.[27] Two subscales of the NWI were used for this study: Staffing and Resource Adequacy and Nurse-Physician Working Relations. Satisfactory reliability and validity statistics for these subscales have been reported.[24,28,29] Response options were based on a four-point Likert-type scale: strongly agree – score 0, somewhat agree – score 1, somewhat disagree – score 2, strongly disagree – score 3.

The following statements comprise the *Staffing and Resource Adequacy* Subscale:

- "Adequate support services allow me to spend time with my patients."
- "There is enough time and opportunity to discuss patient care."
- "There are enough nurses on staff to provide quality patient care."
- "There is enough staff to get the work done."

A total score (with a possible range of 0 to 12) was calculated by summing the scores for the four items, with higher scores indicating greater perceived inadequacy. To maximize the number of respondents, one "not applicable" or "not stated" response was accepted. A score was calculated based on the items with responses and then adjusted to compensate for the item without a response.[24] Cut-points were determined to divide the weighted distribution of scores into quartiles: first quartile – 0 to 3; second quartile – 4 to 5; third quartile – 6 to 8; fourth quartile – 9 to 12.

Three statements were used to measure *nurse-physician working relations*:

- "Physicians and nurses have good working relations."
- "There is a lot of team work between nurses and physicians."
- "There is collaboration between nurses and physicians."

A total nurse-physician working relations score (with a possible range of 0 to 9) was calculated by summing the scores for the three items, with higher scores indicating worse relations. To maximize the number of respondents for whom scores were calculated, one "not applicable" or "not stated" response was accepted. A score was calculated based on the items with responses and then adjusted to compensate for the item without a response.[24] The weighted distribution of the scores was divided into quartiles: first quartile – 0; second quartile – 1 to 2; third quartile – 3; fourth quartile – 4 to 9.

Two statements were used to measure *co-worker support*:

- "You were exposed to hostility or conflict from the people you work with."
- "The people you work with were helpful in getting the job done."

Response options were: strongly agree, agree, neither agree nor disagree, disagree, or strongly disagree. Respondents were classified as having low co-worker support if they indicated "strongly agree" or "agree" in response to the first item, or "disagree" or "strongly disagree" in response to the second.

Supervisor support was measured with the item, "Your supervisor is helpful in getting the job done." Respondents were classified as having low supervisor support if they indicated "disagree" or "strongly disagree."

Job security was measured with the item, "Your job security was good." Respondents were classified as having low job security if they indicated "disagree" or "strongly disagree."

Physical demands of the job were measured with the item, "Your job required a lot of physical effort." Respondents were classified as having high physical demands if they indicated "agree" or "strongly agree."

Number of *years in nursing* was dichotomized as five or fewer, and more than five.

Levels of *general health* and *mental health* were assessed by asking, "In general, would you say your health is: excellent? / very good? / good? / fair? / poor?" and "In general, would you say your mental health is: excellent? / very good? / good? / fair? / poor?" Responses were categorized into two groups: excellent, very good or good; and fair or poor.

Job dissatisfaction was assessed by asking, "On the whole, how satisfied are you with this job . . . very satisfied, somewhat satisfied, somewhat dissatisfied, very dissatisfied?" Respondents who indicated that they were "somewhat" or "very" dissatisfied were classified as being dissatisfied with their job.

Analytical techniques

The NSWHN data were weighted to be representative of all regulated nurses across Canada. For this analysis, weighted data for hospital-employed Registered Nurses whose work involved providing direct care were used. Frequency estimates were produced to examine characteristics of the study population, and bivariate estimates were used to examine the likelihood of occasional or frequent medication error in relation to selected variables. Logistic regression modeling was used to study medication error in relation to work organization and workplace environment, while controlling for personal characteristics and clinical setting of employment. The selection of independent variables for inclusion in the model was guided by the literature and examination of bivariate relationships. To account for survey design effects, the bootstrap technique was used to estimate variance on estimates, on differences between proportions, and confidence intervals around odds ratios.[30-32]

Results

Personal characteristics

In 2005, registered nurses (RNs) delivering direct patient care in hospitals numbered 143,000 (Table 1).

Table 1
Selected characteristics of registered nurses providing direct care to hospital patients, Canada, 2005

	Estimated number	%
Total	**143,000**	**100**
Sex, education, experience, job satisfaction		
Female	134,900	94.3
Male	8,100	5.7
Average number of years worked as a nurse (SD)	17.0(10.6)	...
Bachelor's degree in nursing or higher	37,600	26.4
Dissatisfied with job	18,500	12.9
Health		
Fair or poor general health	9,300	6.5
Fair or poor mental health	8,100	5.7
Work organization		
Full-time job	87,000	61.1
Usually works day shift	45,600	31.9
Usually works 12-hour shift	60,900	45.2
Usually works overtime (main job)	96,500	68.2
Has more than one job	24,800	17.4
Usually works 40 or more hours per week (all jobs combined)	53,000	38.2
Work stress		
Low co-worker support	65,800	46.3
Low supervisor support	40,600	28.7
Low job security	9,100	6.4
Physically demanding job	110,200	77.7

... not applicable
Source: 2005 National Survey of the Work and Health of Nurses.

They averaged 17 years of employment as a nurse. Just over one-quarter (26%) had a baccalaureate degree (or higher) in nursing. Only 6% were men.

Hospital RNs were in good health. Only around 6% reported their general health to be "fair" or "poor," and a similarly low proportion reported their mental health to be in these categories.

Work organization

Nearly one-quarter (23%) of hospital RNs worked in medical or surgical wards (data not shown). About 13% were in maternity or newborn care units; 11% in the Emergency Room, and another 11% in the operating theatre or recovery room. Just under one in ten was in a critical care unit, and 7% reported working in several clinical areas. One in 20 worked in a psychiatric unit, and nearly the same proportion worked in ambulatory (outpatient) care. The remainder were distributed in lower proportions among oncology, geriatrics, pediatrics, rehabilitation, and palliative care.

The majority (61%) of hospital RNs had a full-time job. Reflecting the around-the-clock demands of delivering patient care, more than two-thirds usually worked hours other than the day shift (evenings, nights or mixed shifts). Twelve-hour shifts were common—reported by 45%. Over two-thirds of hospital nurses usually worked overtime (paid or unpaid) at their main job, and well over one-third (38%) reported more than 40 hours per week at all jobs combined.

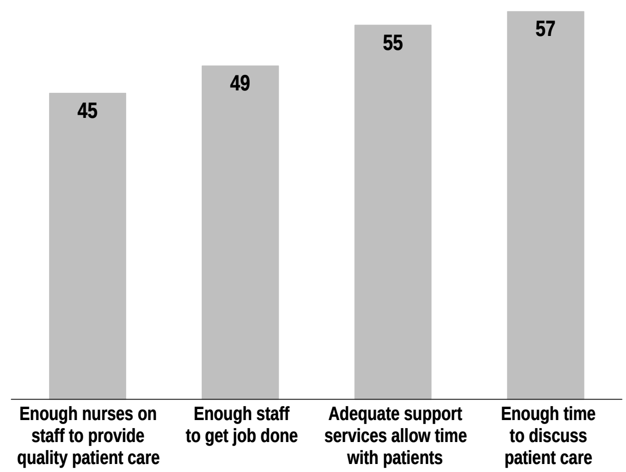
Workplace environment

Although the *Staffing and Resource Adequacy Subscale* is based on the total score of all four of its elements, response frequencies to the individual items are more informative. Less than half of hospital RNs agreed with the statements, "There are enough nurses on staff to provide quality patient care," and "There is enough staff to get the work done" (Figure 1). Just over half reported that support services and time to discuss patient care were adequate.

In strikingly large proportions, hospital RNs reported favourable working relations with physicians. Fully 89% agreed with the statement, "There is collaboration between nurses and physicians" (data not shown). Nearly as many (87%) agreed that "Physicians and nurses have good working relations," and 82% agreed that "There is a lot of team work between nurses and physicians."

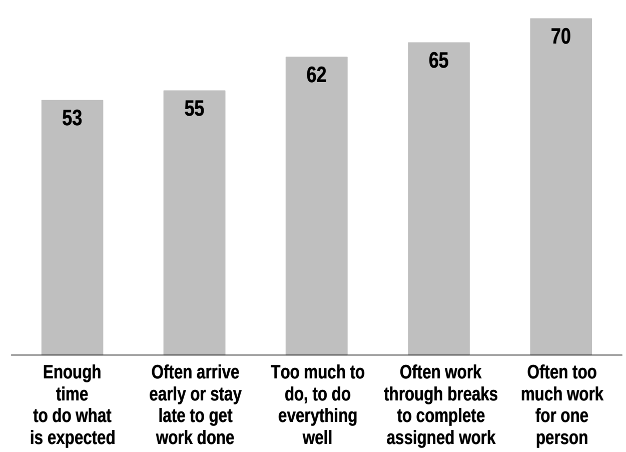
The majority of nurses felt overburdened by the amount of work they were assigned (Figure 2). Over two-thirds agreed with the statement, "It often seems like I have too much work for one person to

Figure 1
Percentage agreeing with items on Staffing and Resource Adequacy Subscale, registered nurses providing direct care to hospital patients, Canada, 2005



Source: 2005 National Survey of the Work and Health of Nurses.

Figure 2
Percentage agreeing with items on Role Overload Scale, registered nurses providing direct care to hospital patients, Canada, 2005



Source: 2005 National Survey of the Work and Health of Nurses.

do," and 62% concurred with the statement, "I have too much to do, to do everything well."

Nurses' means of coping with their workload were assessed in the items, "I often have to work through my breaks to complete my assigned workload" (65% agreed), and "I often have to arrive early or stay late to get my work done" (55%). Somewhat surprisingly, though, over half (53%) agreed with the statement, "I am given enough time to do what is expected of me in my job."

Hospital RNs reported that they were subject to work stress in varying degrees, depending on the stressor (Table 1). Nursing in Canada's hospitals is highly unionized,[24] which likely accounts for the very high proportion (94%) who reported good job security. As expected, most (78%) hospital RNs reported their jobs to be quite physically demanding. Nearly three in ten (29%) did not agree that their supervisor was "helpful in getting the job done," and an even higher percentage (46%) were classified as having low support from co-workers.

Correlates of medication error

Almost one-fifth (19%) of hospital RNs acknowledged that over the previous year, medication error involving patients who were in their care had occurred "occasionally" or "frequently" (Table 2).

Medication error was significantly related to overtime and shift length. Of nurses who usually worked overtime, 22% reported medication error, compared with 14% of those not working overtime. By contrast, among nurses who reported that they usually worked 12-hour shifts, the likelihood of medication error was slightly but significantly *lower* than for those who worked shorter shifts (18% versus 22%). For the other organizational factors studied—working more than 40 hours per week, full-time versus part-time employment, and usually working shifts other than days—no relationships with medication error were observed.

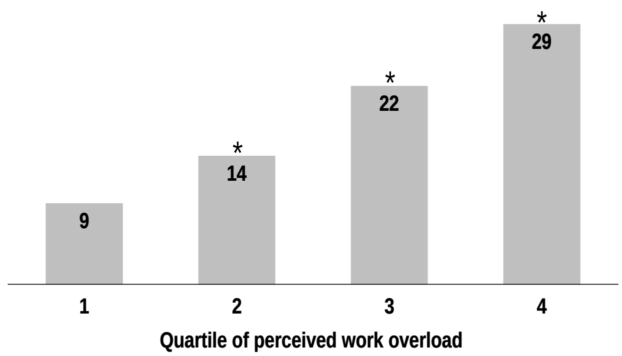
Medication error was related to nurses' perceived "role overload." In fact, the data suggested a gradient between the likelihood of error and the level of role overload (Table 2, Figure 3). Perceived adequacy of staffing and resources was similarly

Table 2
Percentage reporting occasional or frequent medication error in past year, by selected characteristics, registered nurses providing direct care to hospital patients, Canada, 2005

	%
Total	**19.4**
Work organization	
Overtime (main job)	
Does not usually work overtime†	13.7
Usually works overtime	21.8*
Hours per week (all jobs combined)	
Usually works 40 hours or more per week†	18.7
Usually works less than 40 hours per week	20.5
Number of jobs	
One†	20.0
More than one	16.3
Type of job	
Full-time†	20.2
Part-time	18.0
Shift usually worked	
Days	20.2
Other than days†	19.0
Length of shift	
Less than 12 hours†	21.7
12 hours	18.1*
Workplace environment	
Role Overload Index	
First quartile (lowest)	9.0
Second quartile	14.3‡
Third quartile	22.1‡
Fourth quartile (highest)	29.0‡
Staffing and Resource Adequacy Subscale	
First quartile (most adequate)	9.2
Second quartile	13.5‡
Third quartile	19.8‡
Fourth quartile (least adequate)	31.6‡
Nurse-Physician Working Relations Subscale	
First quartile (most favourable)	12.1
Second quartile	18.6‡
Third quartile	20.2‡
Fourth quartile (least favourable)	26.6‡
Work stress	
Lower co-worker support	24.0*
Higher co-worker support†	15.3
Lower supervisor support	21.1
Higher supervisor support†	18.7
Lower job security	31.6*
Higher job security†	18.5
Higher physical demands	20.0
Lower physical demands†	16.8
Personal characteristics	
Job dissatisfaction	
Dissatisfied	27.9*
Not dissatisfied†	18.1
General health	
Good, very good or excellent†	19.2
Fair or poor	21.0
Mental health	
Good, very good or excellent†	18.9
Fair or poor	26.7
Nursing education	
Bachelor's degree or higher†	20.4
Other than bachelor's degree	19.1
Years of experience in nursing	
More than 5†	19.8
5 or fewer	17.6

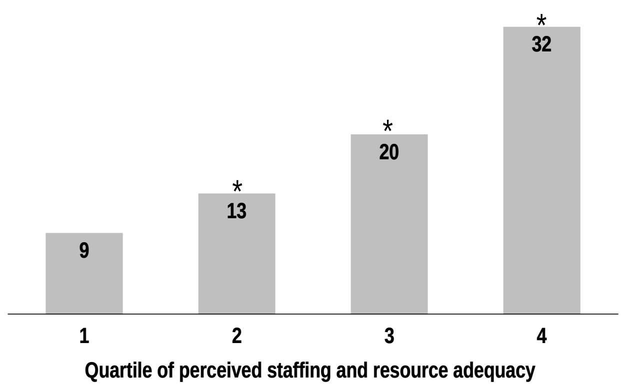
† reference category
* significantly different from estimate for reference category ($p < 0.05$)
‡ significantly different from estimate for previous quartile ($p < 0.05$)
Source: 2005 National Survey of the Work and Health of Nurses.

Figure 3
Percentage reporting occasional or frequent medication error, by quartile of perceived work overload, registered nurses providing direct care to hospital patients, Canada, 2005



* significantly higher than estimate for previous quartile (p < 0.05)
Source: 2005 National Survey of the Work and Health of Nurses.

Figure 4
Percentage reporting occasional or frequent medication error, by quartile of perceived staffing and resource adequacy, registered nurses providing direct care to hospital patients, Canada, 2005



* significantly higher than estimate for previous quartile (p < 0.05)
Source: 2005 National Survey of the Work and Health of Nurses.

related to the likelihood of medication error (Figure 4).

The quality of working relations between nurses and physicians was also associated with medication error (Table 2). Only 12% of the RNs in the quartile in which working relations were most favourable reported medication error. This contrasted sharply with the value of 27% reported by those in the worst quartile of nurse-physician working relations.

Associations emerged between work stress and medication error. Nurses with low support from their co-workers were significantly more likely to report medication error, compared with those with more support. However, no significant association with supervisor support was observed. Low job security was significantly related to medication error: 32% of nurses with low job security reported medication error, compared with 19% of those with better job security.

The likelihood of medication error was not significantly related to level of nursing education, number of years as a nurse, or general health. The data suggested an association with mental health: 19% of hospital RNs who rated their mental health as "excellent," "very good" or "good" reported medication error, compared with 27% of those with a rating of "fair" or "poor." However, because of the small sample size for those in the "fair/poor" category, the difference fell short of statistical significance (p=0.075).

Multivariate analysis

Multivariate analysis was undertaken to examine associations of medication error with indicators of work organization and workplace environment, while controlling for the influences of the nurse's personal characteristics. Of the work organization factors studied, the associations with medication error that were observed in bivariate analysis persisted for usually working overtime (positively related) and working 12-hour shifts (negatively related) (Table 3). Of the workplace environment factors examined, statistically significant associations with medication error persisted for adequacy of staffing and resources, role overload, nurse-physician working relations, job security, and co-worker support. As well, for staffing and resource adequacy, role overload and nurse-physician working relations, the suggested gradient in the relationship with medication error persisted.

Discussion

This study, based on a sample representative of all registered nurses providing direct care in Canadian hospitals, provides new information on nurses' perceptions of medication error and factors

Table 3
Adjusted odds ratios relating selected characteristics to occasional or frequent medication error, registered nurses providing direct care to hospital patients, Canada, 2005

	Adjusted odds ratio	95% confidence interval
Overtime (main job)		
Does not usually work overtime†	1.0	...
Usually works overtime	1.4*	1.0 to 1.8
Hours per week (all jobs combined)		
Usually works 40 hours or more per week†	1.0	...
Usually works less than 40 hours per week	1.0	0.7 to 1.3
Number of jobs		
One†	1.0	...
More than one	0.9	0.6 to 1.2
Type of job		
Full-time†	1.1	0.9 to 1.5
Part-time	1.0	...
Shift usually worked		
Days	1.1	0.8 to 1.6
Other than days†	1.0	...
Length of shift		
Less than 12 hours†	1.0	...
12 hours	0.7*	0.5 to 0.9
Role Overload Index		
First quartile (lowest)†	1.0	...
Second quartile	1.3	0.8 to 2.1
Third quartile	1.7*	1.1 to 2.7
Fourth quartile (highest)	1.9*	1.2 to 3.0
Staffing and Resource Adequacy Subscale		
First quartile (most adequate)†	1.0	...
Second quartile	1.2	0.8 to 2.0
Third quartile	1.7*	1.1 to 2.7
Fourth quartile (least adequate)	2.7*	1.6 to 4.4
Nurse-Physician Working Relations Subscale		
First quartile (most favourable)†	1.0	...
Second quartile	1.5*	1.0 to 2.1
Third quartile	1.5*	1.1 to 2.1
Fourth quartile (least favourable)	1.6*	1.1 to 2.3
Work stress		
Lower co-worker support	1.4*	1.1 to 1.8
Higher co-worker support†	1.0	...
Lower supervisor support	0.9	0.7 to 1.1
Higher supervisor support†	1.0	...
Lower job security	1.7*	1.1 to 2.7
Higher job security†	1.0	...
Higher physical demands	1.1	0.8 to 1.5
Lower physical demands†	1.0	...
Job dissatisfaction		
Dissatisfied	1.0	0.7 to 1.5
Not dissatisfied†	1.0	...
General health		
Good, very good or excellent†	1.0	...
Fair or poor	0.7	0.4 to 1.2
Mental health		
Good, very good or excellent†	1.0	...
Fair or poor	1.3	0.8 to 2.3
Nursing education		
Bachelor's degree or higher†	1.1	0.9 to 1.5
Other than bachelor's degree	1.0	...
Years of experience in nursing		
More than 5†	1.4*	1.0 to 1.9
5 or fewer	1.0	...

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
... not applicable
Note: Based on data from 3,667 respondents. Variables for clinical area of usual employment and missing role overload were included in the model; their odds ratios are not shown.
Source: 2005 National Survey of the Work and Health of Nurses.

associated with it. Nearly one-fifth of nurses reported that patients in their care during the previous year had experienced medication error occasionally or frequently. The large size of the sample used for the analysis and the high response rate to the NSWHN enhance the strength of these findings.

Consistent with previous research,[33] usually working overtime was associated with medication error. This is an important finding, because working overtime is potentially remediable. Moreover, the potentially negative influence of overtime is not limited to medication error—a recent study of patient outcomes in an intensive care unit reported associations between overtime and a variety of adverse outcomes.[34]

Although overtime was the only work organization variable positively related to medication error in this analysis, it is likely that workplace environment variables that were linked to medication error (perceived role overload and staffing/resource inadequacy) also stem from organizational characteristics.[14] This suggests that "structure" and "process" variables interact. Similarly, low co-worker support, which was significantly related to medication error, could result from inadequate staffing. Nurses working at full capacity to care for their own patients may be less able or willing to lend a hand to co-workers. Poor job security was another work stress factor linked to medication error. However, its overall impact is less than that of other factors because of the small percentage of nurses affected.

While usually working overtime was related to increased odds of medication error, the odds of error in association with working 12-hour shifts were actually 30% lower than the odds for shorter shifts. This suggests that the distinction between scheduled and unscheduled time worked (time that is planned in advance versus time that is unanticipated) may be more important than the number of hours worked. The importance of the modestly protective association between 12-hour shifts and medication error is underscored by the fact that 45% of RNs providing direct care in Canadian hospitals work 12-hour shifts.

Why is this study important?

- Medication error is a potentially life-threatening, yet relatively common occurrence in hospitals.
- This study is based on the first nationally representative sample of Canadian hospital nurses, the people who typically administer medications to patients.

What else is known on this topic?

- Previous research suggests that work-related factors such as overtime, work stress and staffing inadequacy are linked to a variety of adverse patient care outcomes.

What does this study add?

- The National Survey of the Work and Health of Nurses provides information reported in confidence by nurses; such information is unavailable from any other source, including clinical records or administrative data.
- This study identifies numerous factors related to medication error in Canadian hospitals: usually working overtime, feeling overloaded, perceiving that staffing or resources are inadequate, poor nurse-physician relations, low co-worker support, and low job security.

Previous research on shift length has yielded mixed findings. Some studies have found shifts of 12.5 hours' duration to be associated with negative effects on various aspects of nursing performance.[11,33,35] By contrast, others report improvements in nurse-patient communication, continuity of care and job satisfaction with the implementation of 12-hour shifts.[23,36,37] Because these studies analysed a variety of performance indicators, and because sampling strategies and response rates differed markedly from those of the NSWHN, it is difficult to compare the NSWHN findings with those of other research to date.

The strong associations between medication error and perceived staffing and resource inadequacy and work overload corroborate those of other studies.[5,13,14,38] Although methodological differences limit comparability, the overall consistency of findings is compelling.

An advantage of research based on the NSWHN rather than on administrative data is that for the survey, nurses would probably have been less reluctant to report the occurrence of medication error. As well, study of the correlates of medication error is enhanced by the array of information in the NSWHN about workplace conditions.

Limitations

Interpretation of the findings from the NSWHN is limited by the cross-sectional nature of the data. Because information was collected at one point in time, the temporal sequence between the dependent and independent variables cannot be established, and causality cannot be inferred. As well, both the dependent and independent variables were derived from nurses' self-reports, most of which were subjective. No validation of the data against objective sources was undertaken. The accuracy of reports of medication error, as well as independent variables such as the frequency of overtime, may have been influenced by recall bias. Such bias could also affect the observed strength of the association between variables—if, for example, the likelihood of reporting occasional or frequent medication error was correlated with that of reporting frequent overtime.[19]

Some factors that may have influenced the observed associations with medication error could not be taken into account because the requisite information was not available. For example, the professional staffing mix (the ratio of registered nurses to licensed practical nurses and auxiliary staff) has been shown to be associated with patient outcomes,[12] but could not be considered in this analysis. Similarly, no adjustment could be made for hospital size or administration system (for example, functional versus primary nursing).[26,39] As well, information on patient characteristics that may have influenced the likelihood of medication error was not available.

Associations between variables may have been affected by differences in the reference periods of the independent variables and the dependent variable. Nurses were asked about the frequency of medication error over the past year, but all other variables used in this analysis referred to the time of the interview. It is possible that nurses who had changed jobs within the year could have reported medication errors that had occurred in a setting to which their current job-related variables did not pertain.

Finally, small sample sizes precluded reporting of medication error by clinical area of employment.

Conclusion

In the view of many Canadian nurses, the restructuring of hospitals and downsizing of the nursing work force that has taken place since the early 1990s has had a major impact on the nursing work environment, and in turn, on the quality of patient care.[14,40-42] Findings from the NSWHN highlight relationships between risks to patient care and certain aspects of hospital nurses' work organization and the workplace environment. Usually working overtime, feeling overloaded, an environment where working relations between physicians and nurses are poor or where staffing and resources are inadequate, and lack of help from co-workers were all linked to medication error. It is hoped that this research will inform initiatives aimed at reducing risks to patient safety in Canadian hospitals.

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Sedentary behaviour and obesity

Margot Shields and Mark S. Tremblay

Abstract

Objectives

This article examines sedentary behaviours (television viewing, computer use and reading) in relation to obesity among Canadian adults aged 20 to 64 years.

Methods

The analysis is based on 42,612 respondents from the 2007 Canadian Community Health Survey. Cross-tabulations were used to compare the prevalence of obesity by time engaged in sedentary behaviours. Multiple logistic regression models were used to determine if associations between sedentary behaviours and obesity were independent of the effects of socio-demographic variables, leisure-time physical activity and diet.

Results

Approximately one-quarter of men (25%) and women (24%) who reported watching television 21 or more hours per week were classified as obese. The prevalence of obesity was substantially lower for those who averaged 5 or fewer hours of television per week (14% of men and 11% of women). When examined in multivariate models controlling for leisure-time physical activity and diet, the associations between time spent watching television and obesity persisted for both sexes. Frequent computer users (11 or more hours per week) of both sexes had increased odds of obesity, compared with those who used computers for 5 or fewer hours per week. Time spent reading was not related to obesity.

Keywords

body mass index, computer use, diet, health behaviour, leisure-time physical activity, reading, television

Authors

Margot Shields (613-951-4177; Margot.Shields@statcan.ca) is with the Health Information and Research Division and Mark S. Tremblay (613-951-4385; Mark.Tremblay@statcan.ca) is with the Physical Health Measures Division at Statistics Canada, Ottawa, Ontario, K1A 0T6 and the Healthy Active Living and Obesity Research Group at the Children's Hospital of Eastern Ontario Research Institute, Ottawa, Ontario, K1H 8L1.

Over the past 25 years, the prevalence of obesity in Canada has increased substantially among people of all ages.[1,2] Understanding the causes of this trend is critical for the establishment of effective population-level interventions.

Increases in energy intake and decreases in energy expenditure are obvious candidates as contributors to the rise in obesity. However, empirical evidence establishing either factor as instrumental in causing the increase in obesity is equivocal. Findings from survey data indicate that average caloric consumption among Canadians has not risen since the early 1970s, and in some population groups, consumption has declined.[3] Most survey data tracking physical activity have been limited to leisure-time physical activity, which has increased modestly since the mid-1980s.[4,5] However, leisure-time physical activity is only one small component of total waking-time activity. The counterintuitive trends for energy intake and leisure-time physical activity and those observed for obesity indicate the importance of identifying and examining other behavioural correlates of obesity.

A relatively new area of obesity research is the study of sedentary behaviours. It has been suggested that sedentary behaviours should be examined as a construct distinct from physical activity.[6] To date, the most widely studied sedentary behaviour in relation to excess weight has been television viewing. For children and adolescents, most research has found a link between the number of hours of television viewing and being overweight or obese,[7-22] but some studies have yielded inconsistent results.[23-25] A recent review of the literature concluded that although time spent watching television has been consistently linked to overweight among children and adolescents, the association is weak and unlikely to be clinically relevant.[26] This conclusion however, has been refuted by other researchers.[17,27]

Far less attention has focused on associations between television viewing and obesity among adults, and relationships with other sedentary behaviours have rarely been examined.

This article examines associations between leisure-time sedentary behaviours and obesity among a large sample of Canadian adults aged 20 to 64 years. The sedentary behaviours considered are television viewing, computer use and reading. For those associations that emerged, a second goal was to determine if they were mediated by leisure-time physical activity and nutrition (as measured by fruit and vegetable consumption).

Methods

Data source

Data are from the 2007 Canadian Community Health Survey (CCHS), a general health survey that covers the household population aged 12 years or older. The CCHS excludes residents of Indian reserves, institutions and some remote areas; full-time members of the Canadian Forces; and all residents (military and civilian) of military bases. Interviews were conducted from January through December 2007; 62% of the interviews were by telephone, and the remaining 38%, in person. The overall response rate was 78%, yielding a sample of 65,946 respondents. More information about the CCHS is available in a published report[28] and on Statistics Canada's Web site (www.statcan.ca).

This study was based on the population aged 20 to 64 years. Since body mass index is not calculated for pregnant women, they were excluded from the study. Approximately 2% of records were dropped because of non-response to the questions on sedentary behaviours. The final analysis file consisted of 42,612 respondents: 19,811 men and 22,801 women.

Analytical techniques

Frequency estimates were produced to describe the characteristics of the study population based on data weighted to represent the Canadian population aged 20 to 64 years in 2007. Cross-tabulations were used to show associations between sedentary behaviours and obesity.

Logistic regression models were used to examine sedentary behaviours in relation to three outcomes: obesity, leisure-time physical activity, and fruit and vegetable consumption. These models controlled for the effects of potential confounding variables (age, marital status, education, household income, urban/rural residence, and immigrant status). For each of the three outcomes, separate models were fitted for men and women since some studies have found that associations between sedentary behaviours and these outcomes differ between the sexes.[22,29]

In a final set of logistic regression models (one for each sex), obesity was examined in relation to sedentary behaviours using leisure-time physical activity and fruit and vegetable consumption as control variables. The purpose was to explore the possibility that these variables act as mediators in the association between sedentary behaviours and obesity. Evidence of mediation would be indicated by attenuated associations between sedentary behaviours and obesity.

All analyses were based on weighted data. To account for the survey design effect of the CCHS, standard errors, coefficients of variation and 95% confidence intervals were estimated using the bootstrap technique.[30,31] Differences between estimates were tested for statistical significance, which was established at the level of $p < 0.05$.

Definitions

The 2007 CCHS asked Canadian adults about the time they spent engaging in three *sedentary behaviours*. They were asked to report the number of hours in a typical week over the past three months they spent watching television (including videos), using a computer (including playing computer games and using the Internet), and reading. Respondents were instructed to report **leisure-time hours only and to exclude time spent on these activities at work or school**. For each behaviour, respondents reported their weekly hours in eight categories: none, less than 1, 1 to 2, 3 to 5, 6 to 10, 11 to 14, 15 to 20, or more than 20. For this analysis, these response categories were collapsed to: 5 or fewer, 6 to 10, 11 to 14, 15 to 20, or 21 or more hours for television viewing. Because of smaller sample counts in the higher categories for computer use and reading, the top category was defined as 11 or more hours.

Body mass index (BMI) is a measure of weight adjusted for height, calculated by dividing weight in kilograms by height in metres squared. CCHS respondents whose BMI was 30.0 kg/m^2 or more were classified as obese, based on Canadian guidelines,[32] which are in line with those of the World Health Organization.[33] BMI was based on CCHS respondents' self-reported height and weight.

Daily fruit and vegetable consumption in the CCHS was assessed with questions from the Behavioral Risk Factor Surveillance System in the United States.[34] Respondents were asked how frequently they consumed fruit, fruit juice, green salad, potatoes (excluding French fries and potato chips), carrots, and other vegetables. Based on responses to these questions, respondents were classified as consuming fruit and vegetables: less than 3 times, 3 to less than 5 times, or 5 or more times per day.

To measure *leisure-time physical activity*, respondents were asked about the frequency and duration of their participation in a variety of activities over the previous three months. Leisure-time physical activity level was based on total energy expenditure (EE) during leisure time. EE was calculated from the reported frequency and duration of all of a respondent's leisure-time physical activities and the metabolic energy demand (MET value) of each activity, which was independently established.[35] Time spent walking or bicycling to work/school was included in the calculation. The number of times respondents participated in each activity over the past three months was multiplied by four to produce an annual estimate, and average EE per day was calculated as:

$$EE = \sum(Ni*Di*METi / 365 \text{ days})$$ where

Ni = number of occasions of activity i in a year,
Di = average duration in hours of activity i, and
METi = a constant value for the metabolic energy cost of activity i.

The sum of the average daily energy expenditure of all activities was used to classify respondents as:

- *Active* – Using 3 or more kilocalories per kilogram of body weight per day; for example, walking an hour a day or jogging 20 minutes a day.
- *Moderately active* – Using 1.5 to less than 3 kilocalories per kilogram of body weight per day; for example, walking 30 to 60 minutes a day, or taking an hour-long exercise class three times a week.
- *Inactive* – Using less than 1.5 kilocalories per kilogram of body weight per day; for example, walking less than half an hour each day.

Based on their highest level of *education*, respondents aged 25 to 64 years were grouped into four categories: postsecondary graduation, some postsecondary, secondary graduation, and less than secondary graduation. The same categories were used for those aged 20 to 24 years, but education was based on the highest level of education in the household.

Household income groups were derived by calculating the ratio between total household income from all sources in the previous 12 months and Statistics Canada's low-income cutoff (LICO) specific to the number of people in the household, the size of the community, and the survey year. These adjusted income ratios were grouped into quintiles (five groups, each containing one-fifth of Canadians).

Immigrants were defined as those who were born outside of Canada and were not Canadian citizens by birth. Immigrant respondents were categorized into three groups according to length of residence in Canada: 0 to 9 years, 10 to 19 years, and 20 or more years.

To determine *health-related activity limitations*, respondents were asked: "Do you have any difficulty hearing, seeing, communicating, walking, climbing stairs, bending, learning or doing any similar activities?" As well, a series of questions about limitations in various settings was asked: "Does a long-term physical condition or mental condition or health problem reduce the amount or the kind of activity you can do: at home, at work, or at school or other activities (for example, transportation or leisure)?" The response categories were "often," sometimes" or "never." Respondents were classified as having a *health-related activity limitation* if they replied "often" or "sometimes" to at least one item.

Results

Characteristics of study population

The total sample of 42,612 respondents (19,811 men and 22,801 women) was weighted to represent 19.6 million Canadians (9.8 million men and 9.8 million women) aged 20 to 64 years. Of the three sedentary behaviours studied, television viewing was the most popular. Approximately one-quarter of both sexes (27% of men and 24% of women) reported watching television for 15 or more hours per week (an average of more than 2 hours per day), and 16% of men and 15% of women reported 21 or more hours per week (an average of at least 3 hours per day) (Table 1). Frequent computer use (11 or more hours per week) was reported by 18% of men and 14% of women. Just 9% of men reported reading 11 or more hours per week. Reading was more common among women, with 15% reporting 11 or more hours per week.

Correlations among sedentary behaviours were low. Among men, correlations were 0.00 between television viewing and computer use, 0.07 between television viewing and reading, and 0.13 between computer use and reading. Among women, the corresponding correlations were 0.08, 0.12, and 0.12.

The prevalence of obesity, based on self-reported height and weight, was 18% among men and 16% among women. Approximately half of men (47%) and women (50%) were categorized as being inactive in leisure-time. Infrequent consumption of fruit and vegetables (less than three times per day) was reported by 29% of men and 18% of women.

Table 1
Prevalence of sedentary behaviours, obesity, physical activity level, and fruit and vegetable consumption, by sex, household population aged 20 to 64 years, Canada, 2007

	Men		Women	
	%	95% confidence interval	%	95% confidence interval
Television viewing (hours per week)				
5 or fewer	29.4	28.4 to 30.3	33.0	32.0 to 34.0
6 to 10	28.2	27.1 to 29.2	25.6	24.8 to 26.5
11 to 14	15.9	15.2 to 16.7	17.1	16.3 to 17.8
15 to 20	10.3	9.7 to 10.9	8.9	8.3 to 9.4
21 or more	16.2	15.4 to 17.0	15.4	14.8 to 16.1
Computer use (hours per week)				
5 or fewer	64.0	62.9 to 65.1	71.8	70.8 to 72.7
6 to 10	17.7	16.9 to 18.5	14.7	13.9 to 15.4
11 or more	18.3	17.5 to 19.1	13.6	12.9 to 14.3
Reading (hours per week)				
5 or fewer	71.1	70.1 to 72.0	62.2	61.3 to 63.2
6 to 10	19.7	18.8 to 20.5	22.7	21.8 to 23.5
11 or more	9.3	8.7 to 9.9	15.1	14.4 to 15.8
Obese (body mass index ≥ 30 kg/m²)	18.4	17.6 to 19.2	15.9	15.2 to 16.6
Leisure-time physical activity level†				
Active (3 or more KKD)	27.7	26.7 to 28.6	23.2	22.4 to 24.1
Moderately active (1.5 to 2.9 KKD)	25.7	24.8 to 26.7	26.4	25.5 to 27.3
Inactive (less than 1.5 KKD)	46.6	45.5 to 47.7	50.4	49.3 to 51.4
Daily fruit and vegetable consumption				
Less than 3 times	28.7	27.7 to 29.7	17.8	17.1 to 18.6
3 to less than 5 times	36.5	35.5 to 37.5	32.4	31.5 to 33.4
5 or more times	34.8	33.8 to 35.9	49.8	48.8 to 50.7

† includes time spent walking or bicycling to work/school
Note: KKD is kilocalories per kilogram per day.
Source: 2007 Canadian Community Health Survey.

Associations with obesity

Television viewing was associated with obesity for both sexes. Among men, the prevalence of obesity rose from 14% of those who averaged 5 or fewer hours per week to 25% of those averaging 21 or more hours a week (Table 2). Similar results emerged for women, with the prevalence of obesity rising from 11% of those reporting 5 or fewer hours to 24% of those reporting 21 or more hours per

Table 2
Prevalence of obesity by sex and sedentary behaviours, household population aged 20 to 64 years, Canada, 2007

Sedentary behaviours (hours per week)	Obese (body mass index ≥ 30 kg/m²) Men %	Men 95% confidence interval	Women %	Women 95% confidence interval
Television viewing				
5 or fewer†	13.7	12.3 to 15.0	11.3	10.3 to 12.4
6 to 10	17.3*	15.6 to 18.9	15.4*	14.0 to 16.8
11 to 14	18.7*	16.6 to 20.8	16.2*	14.5 to 18.0
15 to 20	23.5*	20.7 to 26.4	20.6*	18.0 to 23.2
21 or more	25.0*	23.1 to 27.0	23.6*	21.8 to 25.4
Computer use				
5 or fewer†	18.4	17.4 to 19.3	15.3	14.5 to 16.1
6 to 10	19.6	17.3 to 21.9	16.9	14.9 to 18.8
11 or more	17.2	15.3 to 19.0	18.2*	16.0 to 20.4
Reading				
5 or fewer†	18.3	17.3 to 19.2	15.2	14.2 to 16.1
6 to 10	18.5	16.6 to 20.4	16.3	14.7 to 17.8
11 or more	18.6	16.2 to 20.9	18.4*	16.7 to 20.1

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
Source: 2007 Canadian Community Health Survey.

Table 3
Adjusted odds ratios relating sedentary behaviours to obesity, by sex, household population aged 20 to 64 years, Canada, 2007

Sedentary behaviours (hours per week)	Obese (body mass index ≥ 30 kg/m²) Men Adjusted odds ratio	Men 95% confidence interval	Women Adjusted odds ratio	Women 95% confidence interval
Television viewing				
5 or fewer†	1.0	...	1.0	...
6 to 10	1.2*	1.0 to 1.5	1.4*	1.2 to 1.6
11 to 14	1.3*	1.1 to 1.6	1.4*	1.1 to 1.6
15 to 20	1.8*	1.5 to 2.2	1.7*	1.4 to 2.1
21 or more	1.8*	1.6 to 2.2	1.8*	1.6 to 2.2
Computer use				
5 or fewer†	1.0	...	1.0	...
6 to 10	1.2*	1.0 to 1.4	1.3*	1.1 to 1.5
11 or more	1.2*	1.0 to 1.4	1.3*	1.1 to 1.6
Reading				
5 or fewer†	1.0	...	1.0	...
6 to 10	1.0	0.9 to 1.2	1.0	0.9 to 1.2
11 or more	1.0	0.9 to 1.2	1.1	0.9 to 1.3

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
... not applicable
Notes: Adjusted for age group, marital status, education, household income, population size of place of residence, and immigrant status. See Appendix Table A for results of full model.
Source: 2007 Canadian Community Health Survey.

week. These associations persisted when examined in multivariate models that controlled for the potentially confounding effects of age, marital status, education, household income, urban/rural residence, and immigrant status (Table 3).

In the bivariate analysis, leisure-time computer use was not significantly associated with obesity among men. Among women, those using computers 11 or more hours per week were slightly more likely to be obese than were those who averaged 5 or fewer hours per week (18% versus 15%). However, computer use is most common among younger individuals,[36] who are also less likely to be obese. As a result, when examined in multivariate models controlling for age and other socio-demographic characteristics, stronger associations between computer use and obesity emerged. For both sexes, those who used computers for at least 6 hours per week had increased odds of being obese (20% higher odds for men and 30% higher odds for women), compared with those who averaged 5 or fewer hours.

Reading was not associated with obesity among men. Among women, those who reported reading 11 or more hours per week were slightly more likely to be obese than were those who averaged 5 or fewer hours (18% versus 15%). But reading is more common among older women, who are also more likely to be obese. Consequently, in the multivariate model, the association between obesity and hours spent reading did not persist among women. Since reading was not associated with obesity in the multivariate analyses for either sex, it was not retained in subsequent analyses.

Poor diet and low levels of physical activity are commonly thought to act as mediators in the relationship between television viewing and obesity. In this study, positive associations were observed between hours devoted to television and to computer use, and infrequent leisure-time physical activity and low consumption of fruit and vegetables (Appendix Tables B and C). Nonetheless, associations between obesity and television viewing remained significant in models that controlled for these potentially mediating variables, and attenuation of the odds ratios was minimal (Table 4). The association between obesity and frequent computer use also persisted for both sexes.

Table 4
Adjusted odds ratios relating television viewing, computer use, physical activity level, and fruit and vegetable consumption to obesity, by sex, household population aged 20 to 64 years, Canada, 2007

	Obese (body mass index ≥ 30 kg/m²)			
	Men		Women	
	Adjusted odds ratio	95% confidence interval	Adjusted odds ratio	95% confidence interval
Television viewing (hours per week)				
5 or fewer†	1.0	...	1.0	...
6 to 10	1.2*	1.0 to 1.5	1.4*	1.2 to 1.6
11 to 14	1.3*	1.1 to 1.6	1.3*	1.1 to 1.6
15 to 20	1.8*	1.4 to 2.1	1.6*	1.3 to 2.0
21 or more	1.8*	1.5 to 2.1	1.7*	1.4 to 2.0
Computer use (hours per week)				
5 or fewer†	1.0	...	1.0	...
6 to 10	1.2*	1.1 to 1.5	1.3*	1.1 to 1.5
11 or more	1.2*	1.0 to 1.4	1.4*	1.1 to 1.6
Leisure-time physical activity level‡				
Active (3 or more KKD)†	1.0	...	1.0	...
Moderately active (1.5 to 2.9 KKD)	1.2*	1.0 to 1.4	1.5*	1.2 to 1.7
Inactive (Less than 1.5 KKD)	1.4*	1.2 to 1.7	2.3*	2.0 to 2.7
Daily fruit and vegetable consumption				
Less than 3 times	1.0	0.9 to 1.3	1.0	0.9 to 1.2
3 to less than 5 times	1.0	0.9 to 1.2	0.9	0.8 to 1.1
5 or more times†	1.0	...	1.0	...

† reference category
‡ includes time spent walking or bicycling to work/school
* significantly different from estimate for reference category ($p < 0.05$)
... not applicable
Notes: Adjusted for age group, marital status, education, household income, population size of place of residence, immigrant status, and variables in this table. KKD is kilocalories per kilogram per day.
Source: 2007 Canadian Community Health Survey.

Since television viewing and computer use may vary over the course of the year, the season in which the CCHS interview was conducted was added as a control variable, but the odds ratios relating television viewing and computer use to obesity remained virtually the same as those in Table 4 (data not shown).

In a final set of models, health-related activity limitation was added as a control variable. Again, the odds ratios relating television viewing and computer use to obesity were essentially the same as those in Table 4 (data not shown).

Discussion

To our knowledge, this is the first study based on a nationally representative data set to examine associations between sedentary behaviours and obesity among Canadian adults. The findings provide strong evidence of a positive association between time spent watching television and obesity among both men and women. When examined in multivariate models, modest associations emerged between computer use and obesity for both sexes, but reading was not associated with obesity for either sex.

Most studies examining sedentary behaviours in relation to obesity have measured associations between television viewing and overweight among children and adolescents. Reviews of the literature conclude that evidence from both cross-sectional and prospective studies of children and youth support a positive association between hours of television viewing and excess weight, but the effects are generally small.[26,37,38] Studies examining associations between television viewing and obesity among adults are relatively scarce and have usually been based on small-scale surveys or specific population sub-groups or occupations. However, the findings of these studies[9,39-50] are generally consistent with those reported here.

The mechanisms most commonly proposed to explain the link between television viewing and obesity are reduced leisure-time physical activity and increased energy intake.[51] Television viewing is hypothesized to supplant physical activity and/or increase caloric intake through snacking in response to the numerous cues in advertisements for energy-dense foods of poor nutritional content.[52-54] This study provides some support for both mechanisms. Men and women who were frequent television viewers were more likely to be inactive in their leisure time. Low consumption of fruit and vegetables, which is correlated with a diet high in fat,[55] was also associated with high levels of television viewing. However, when obesity was examined in models controlling for these potentially mediating factors, attenuations in associations between obesity and television viewing were minimal. Other studies of adults have also found television viewing to be

What is already known on this subject?

- Numerous studies have examined associations between sedentary behaviours and obesity among children and adolescents. Results provide evidence of a positive association between television viewing and excess weight, but the effects have generally been small.
- Studies of adults have been relatively rare and have usually been based on small-scale surveys or specific population sub-groups and occupations.

What does this study add?

- Among Canadian men and women, the odds of being obese increased as weekly hours of television viewing rose. Furthermore, associations between time spent watching television and obesity were independent of leisure-time physical activity and diet.
- When the effects of age and other potential confounding variables were controlled, a modest association was observed between frequent computer use and obesity among men and women.
- Reading was not associated with obesity for either sex.

associated with obesity, independent of physical activity and dietary intake.[9,40,44,48]

A third possible explanation of the link between television time and obesity is the low metabolic rate associated with television viewing.[51] The metabolic energy demand (MET value) required for watching television is 1.0, only slightly above the MET value for sleeping (0.9).[35] Household chores such as vacuuming (3.5 METS), wall painting and papering (3.0 METS) and putting away groceries (2.5 METS) and sedentary behaviours such as playing the piano (2.5 METS), sitting writing (1.8 METS), typing (1.8 METS), playing cards or board games (1.5 METS) and sitting reading (1.3 METS) all have higher MET values than television viewing. This underscores the importance of accurately measuring physical activity[56] in all domains of life (including both structured and unstructured activities during leisure and non-leisure time) to understand the potential mediating role of other activities in the association between television viewing and obesity.

Limitations

The self-reported nature of these data is an important limitation of this analysis. Measures of sedentary behaviours, obesity, leisure-time physical activity, and fruit and vegetables consumption are all based on self-reports, which are likely subject to social desirability and recall biases. In particular, it is well established that the use of self-reported height and weight data results in lower estimates of the prevalence of obesity, compared with measured data.[57,58] The extent to which self-reported data affected the associations between sedentary behaviours and obesity in this study is unknown. However, other studies of associations between television viewing and measured indicators of obesity in adults have found similar results to those reported here.[29,39,44-46,49]

Single-item measures for sedentary behaviours lack content validity and likely yield only crude estimates of these behaviours.[59] In fact, a comparison with another data source suggests that the estimates of frequent television viewing in this study are low.[36]

The results of this analysis might have been different had it been possible to use better measures of dietary habits, such as total calories consumed or percentage of calories from fat.

The cross-sectional nature of the CCHS precludes inferences about the temporal ordering of events or causality. It is possible that health-related activity limitations that are often associated with obesity result in obese individuals increasing their television viewing. Nonetheless, the inclusion of activity limitation as a control variable in the regression analysis did not alter associations between television viewing and obesity. Furthermore, evidence from prospective studies of adults shows that television viewing is associated with new cases of obesity and weight gain,[40,48,49] and a decrease in television viewing is associated with weight loss.[41] The test for the mediating role of physical activity and diet in this analysis should be considered exploratory; a proper assessment of mediation would require longitudinal data.

Conclusion

Projections suggest that the steady gains in life expectancy that were realized during the 20th century will begin to diminish unless effective population-level interventions to combat obesity are implemented.[60] Intervention studies specifically targeted at reducing television viewing have yielded encouraging results in reducing obesity levels among children and adolescents.[51,61] Furthermore, some evidence indicates that recommendations aimed at reducing sedentary behaviours may be more effective than those targeted at promoting physical activity.[62] Studies have found that sedentary behaviours, particularly television viewing, adopted in childhood track into adulthood, and some even suggest that sedentary behaviours track more strongly than physical activity.[18,23,63,64] In light of the evidence of a positive association between adult obesity and time spent watching television, intervention programs aimed at reducing television viewing among both children and adults may assist in reducing the prevalence of obesity among adults in the future.

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Table A
Adjusted odds ratios relating sedentary behaviours and selected socio-demographic characteristics to obesity, by sex, household population aged 20 to 64 years, Canada, 2007

	Obese (body mass index ≥ 30 kg/m²)			
	Men		Women	
	Adjusted odds ratio	95% confidence interval	Adjusted odds ratio	95% confidence interval
Television viewing (hours per week)				
5 or fewer†	1.0	...	1.0	...
6 to 10	1.2*	1.0 to 1.5	1.4*	1.2 to 1.6
11 to 14	1.3*	1.1 to 1.6	1.4*	1.1 to 1.6
15 to 20	1.8*	1.5 to 2.2	1.7*	1.4 to 2.1
21 or more	1.8*	1.6 to 2.2	1.8*	1.6 to 2.2
Computer use (hours per week)				
5 or fewer†	1.0	...	1.0	...
6 to 10	1.2*	1.0 to 1.4	1.3*	1.1 to 1.5
11 or more	1.2*	1.0 to 1.4	1.3*	1.1 to 1.6
Reading (hours per week)				
5 or fewer†	1.0	...	1.0	...
6 to 10	1.0	0.9 to 1.2	1.0	0.9 to 1.2
11 or more	1.0	0.9 to 1.2	1.1	0.9 to 1.3
Age group (years)				
20 to 24	0.8	0.6 to 1.1	0.5*	0.4 to 0.6
25 to 34	0.9	0.8 to 1.1	0.7*	0.6 to 0.8
35 to 44	1.1	1.0 to 1.3	0.9	0.7 to 1.0
45 to 54†	1.0	...	1.0	...
55 to 64	1.1	0.9 to 1.3	1.0	0.9 to 1.2
Marital status				
Married/Common-law†	1.0	...	1.0	...
Divorced/Separated/Widowed	0.8*	0.6 to 0.9	1.0	0.9 to 1.2
Never married	0.6*	0.5 to 0.7	1.0	0.8 to 1.1
Education				
Less than secondary graduation	1.2	1.0 to 1.4	1.5*	1.2 to 1.7
Secondary graduation	1.1	0.9 to 1.3	1.1	1.0 to 1.3
Some postsecondary	1.1	0.9 to 1.4	1.2	1.0 to 1.5
Postsecondary graduation†	1.0	...	1.0	...
Household income quintile				
1 (lowest)	1.0	0.8 to 1.3	1.2	1.0 to 1.5
2	1.0	0.8 to 1.2	1.0	0.8 to 1.2
3†	1.0	...	1.0	...
4	1.0	0.8 to 1.2	0.7*	0.6 to 0.9
5 (highest)	1.0	0.8 to 1.2	0.6*	0.5 to 0.8
Urban/Rural residence				
Rural†	1.0	...	1.0	...
Urban: population less than 30,000	1.0	0.8 to 1.1	1.1	0.9 to 1.2
Urban: population 30,000 to 99,999	0.8*	0.7 to 1.0	0.9	0.7 to 1.0
Urban: population 100,000 to 499,999	1.0	0.9 to 1.2	0.8*	0.7 to 1.0
Urban: population 500,000 or more	0.7*	0.6 to 0.8	0.7*	0.6 to 0.8
Immigrant status				
Immigrant: 0 to 9 years in Canada	0.5*	0.3 to 0.7	0.5*	0.3 to 0.7
Immigrant: 10 to 19 years in Canada	0.5*	0.3 to 0.7	0.4*	0.3 to 0.6
Immigrant: 20 or more years in Canada	0.6*	0.5 to 0.8	0.7*	0.6 to 0.9
Canadian-born†	1.0	...	1.0	...

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
... not applicable
Source: 2007 Canadian Community Health Survey.

Table B
Adjusted odds ratios relating television viewing and computer use to physical inactivity, by sex, household population aged 20 to 64 years, Canada, 2007

	Physically inactive (less than 1.5 kilocalories per kilogram per day)			
	Men		Women	
	Adjusted odds ratio	95% confidence interval	Adjusted odds ratio	95% confidence interval
Television viewing (hours per week)				
5 or fewer†	1.0	...	1.0	...
6 to 10	1.1	1.0 to 1.2	1.2*	1.1 to 1.4
11 to 14	1.0	0.8 to 1.1	1.3*	1.1 to 1.5
15 to 20	1.4*	1.1 to 1.6	1.6*	1.4 to 1.9
21 or more	1.3*	1.1 to 1.5	1.9*	1.7 to 2.2
Computer use (hours per week)				
5 or fewer†	1.0	...	1.0	...
6 to 10	1.0	0.8 to 1.1	0.9	0.8 to 1.1
11 or more	1.1*	1.0 to 1.3	1.1	0.9 to 1.2

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
... not applicable
Note: Adjusted for age group, marital status, education, household income, population size of place of residence, and immigrant status.
Source: 2007 Canadian Community Health Survey.

Table C
Adjusted odds ratios relating television viewing and computer use to infrequent consumption of fruit and vegetables, by sex, household population aged 20 to 64 years, Canada, 2007

	Consume fruit and vegetables less than 3 times per day			
	Men		Women	
	Adjusted odds ratio	95% confidence interval	Adjusted odds ratio	95% confidence interval
Television viewing (hours per week)				
5 or fewer†	1.0	...	1.0	...
6 to 10	1.0	0.9 to 1.2	1.2*	1.0 to 1.4
11 to 14	1.2	1.0 to 1.3	1.3*	1.1 to 1.6
15 to 20	1.6*	1.3 to 1.9	1.3*	1.1 to 1.6
21 or more	1.7*	1.5 to 2.0	1.9*	1.7 to 2.3
Computer use (hours per week)				
5 or fewer†	1.0	...	1.0	...
6 to 10	1.0	0.9 to 1.2	1.0	0.8 to 1.1
11 or more	1.3*	1.1 to 1.5	1.5*	1.3 to 1.7

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
... not applicable
Note: Adjusted for age group, marital status, education, household income, population size of place of residence, and immigrant status.
Source: 2007 Canadian Community Health Survey.

Screen time among Canadian adults: A profile

by Margot Shields and Mark S. Tremblay

Keywords: computer use, health behaviour, sedentary behaviour, television

Substantial increases in the prevalence of obesity over the past 25 years underscore the importance of identifying and understanding behaviour correlates of obesity. A recent study of adults based on data from the 2007 Canadian Community Health Survey (CCHS) found evidence that screen time (time spent viewing television and using computers) was positively associated with obesity, inactive leisure time and a poor diet.[1] In that study, associations between screen time and obesity were independent of the effects of leisure-time physical activity and diet. Smaller-scale surveys, often based on specific sub-groups and occupations,[2] have yielded similar results.

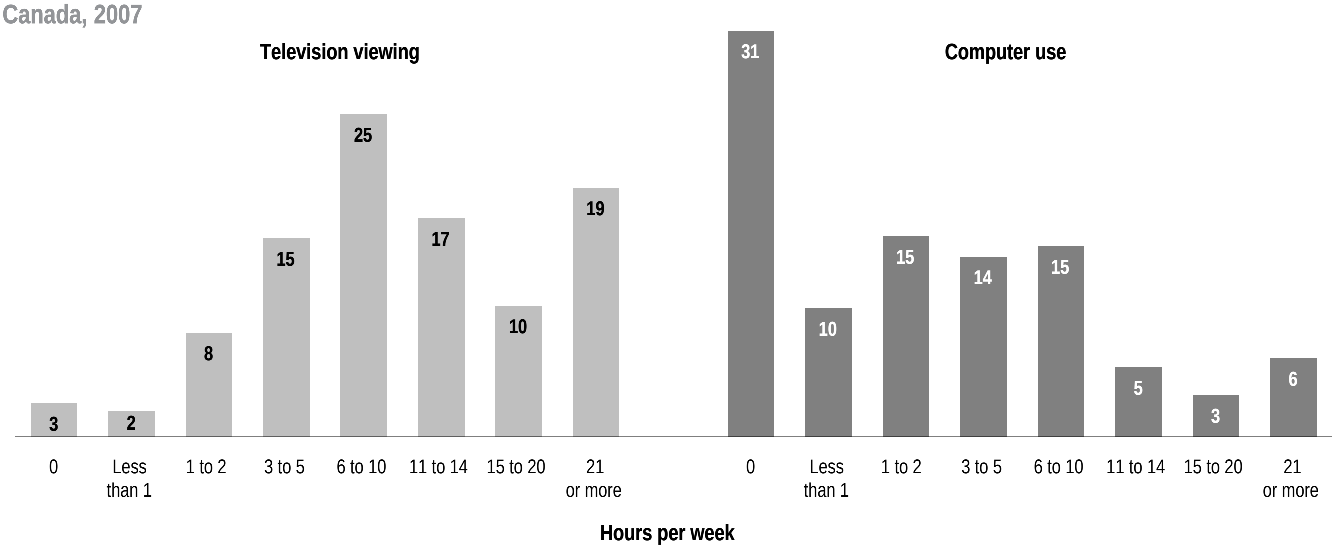
These findings highlight the importance of considering screen time as a distinct construct in the development of interventions to reduce obesity. An important first step is to gain a better understanding of the characteristics of people who report the most screen time.

Using data from the 2007 CCHS, this article profiles Canadian adults who, according to their self-reports, were frequent television viewers and leisure-time computer users. Frequent television viewing was defined as 15 or more hours per week, and frequent computer use as 11 or more hours per week. Trends in television viewing are examined with data from Statistics Canada's General Social Survey.[3]

Frequent television viewing more common

In 2007, a substantial proportion of Canadian adults were frequent television viewers (Figure 1). Close

Figure 1
Percentage distribution of hours per week viewing television and using computers, household population aged 20 years or older, Canada, 2007



Source: 2007 Canadian Community Health Survey.

to three in 10 (29%) reported that they averaged 15 or more hours per week (over 2 hours per day) watching television, and 19% reported 21 or more hours per week (an average of at least 3 hours per day).

Frequent leisure-time computer use was less common. Approximately 15% of adults averaged 11 or more hours per week. Only 6% reported 21 or more hours per week, and close to one-third (31%) reported no leisure-time computer use.

One adult in 20 (5%) was both a frequent television viewer and a frequent computer user. The correlation between time spent watching television and using the computer was not significant (correlation coefficient=0.01).

Less television time

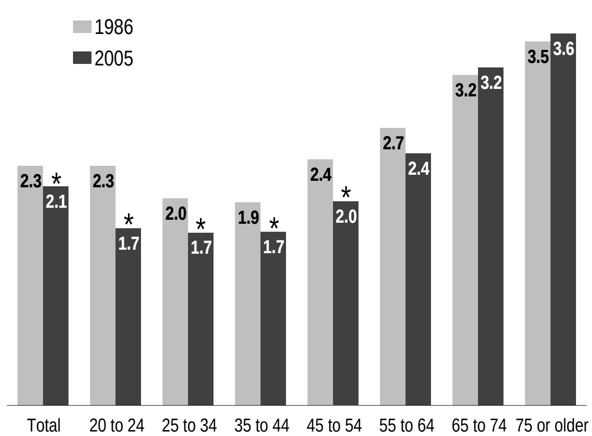
Estimates from Statistics Canada's General Social Survey[3] indicate small declines in time spent watching television since the mid-1980s: from an average of 2.3 hours per day in 1986 to 2.1 hours per day in 2005 (Figure 2). Men's average daily viewing fell from 2.6 to 2.3 hours, a somewhat greater decline than for women, among whom viewing time fell from 2.1 to 2.0 hours (data not shown).

The largest drop in television viewing time—more than half an hour per day—was among 20- to 24-year-olds (Figure 2). Declines were more modest among people aged 25 to 54 years. And among those aged 55 years or older, changes since the mid-1980s were not significant.

The downturn in television viewing parallelled the introduction and rapid proliferation of home computers. By 2006, 75% of Canadian households had a home computer, up from 40% in 1997. During the same period, home access to the Internet increased from 17% to 68% of households.[4]

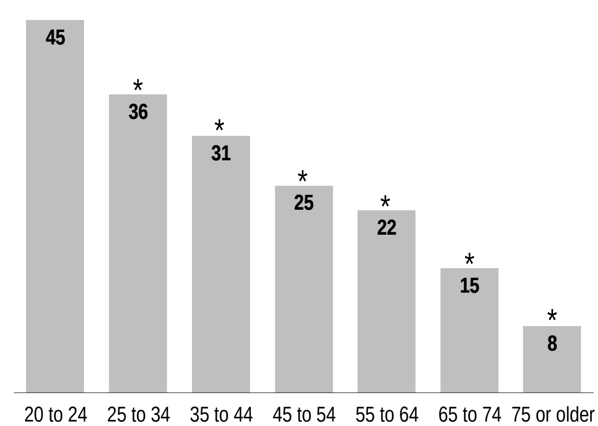
Data from the 2007 CCHS suggest that among younger age groups computer use may be replacing television as the screen time activity of choice (Figure 3). Close to half (45%) of all the screen hours reported by 20- to 24-year-olds were spent on a computer rather than watching television. Even middle-aged adults (45 to 54 years) spent one-quarter of their screen time using a computer.

Figure 2
Mean hours per day viewing television, by age group, household population aged 20 years or older, Canada excluding territories, 1986 and 2005



* significantly lower than estimate for 1986
Sources: 1986 and 2005 General Social Survey.

Figure 3
Percentage of total weekly screen-time hours spent using computers, by age group, household population aged 20 years or older, Canada, 2007



* significantly lower than estimate for previous category ($p < 0.05$)
Source: 2007 Canadian Community Health Survey.

Among seniors, television viewing remained, by far, the preferred screen time activity.

Overall, men devoted 29% of their total screen time to computers, compared with 26% among women (data not shown).

Frequent television viewers

The likelihood of being a frequent television viewer rose steadily with age from 20% at ages 20 to 24 years to 52% at age 75 years or older (Table 1). Compared with those who were married, never-married individuals were somewhat more likely to be frequent television viewers.

Negative associations with socio-economic status were evident. Close to half (47%) of people with less than secondary graduation were frequent television viewers, compared with 24% of postsecondary graduates. As well, 39% of people in the lowest household income quintile were frequent viewers, compared with 22% of those in the highest income quintile.

Residents of highly populated urban areas (500,000 or more) were somewhat less likely to be frequent television viewers (26%) than were people in rural areas (31%). However, the figure was slightly higher (35%) among those in areas with populations of 30,000 to under 100,000. Only 19% of recent immigrants were frequent viewers, compared with 30% of the Canadian-born.

Among people of working age, employment status was strongly associated with television viewing. Only 21% of full-time workers were frequent viewers, compared with 37% of those who were not employed.

When examined in a multivariate model, these associations between socio-demographic characteristics and frequent television viewing generally persisted (Table 1).

While men and women were equally likely to be frequent television viewers, differences were evident for certain sub-populations (Appendix Table A). Notably, among people of working age who were not employed, women were less likely than men to be frequent television viewers: 34% versus 45%.

Table 1
Prevalence of and adjusted odds ratios for viewing television 15 or more hours per week, by selected characteristics, household population aged 20 years or older, Canada, 2007

	View television 15 or more hours per week			
	%	95% confidence interval	Adjusted odds ratio	95% confidence interval
Total	29.2	28.6 to 29.8	...	...
Sex				
Male	29.5	28.6 to 30.3	1.1*	1.1 to 1.2
Female†	28.9	28.1 to 29.7	1.0	...
Age group				
20 to 24	20.0*	18.1 to 22.0	0.6*	0.5 to 0.7
25 to 34	22.4*	21.0 to 23.8	0.8*	0.7 to 0.9
35 to 44	21.5*	20.3 to 22.7	0.8*	0.7 to 0.9
45 to 54†	26.1	24.8 to 27.4	1.0	...
55 to 64	36.1*	34.6 to 37.5	1.6*	1.4 to 1.7
65 to 74	46.9*	45.1 to 48.7	2.1*	1.9 to 2.4
75 or older	52.1*	50.4 to 53.9	2.4*	2.1 to 2.6
Marital status (aged 25 to 54 years)				
Married/Common-law†	22.3	21.4 to 23.2	1.0	...
Divorced/Separated/Widowed	24.6	22.4 to 26.9	1.0	0.9 to 1.1
Never married	26.9*	25.4 to 28.5	1.1*	1.0 to 1.2
Education				
Less than secondary graduation	47.4*	45.9 to 48.8	1.8*	1.7 to 1.9
Secondary graduation	33.8*	32.2 to 35.3	1.4*	1.3 to 1.5
Some postsecondary	30.6*	28.1 to 33.1	1.3*	1.1 to 1.5
Postsecondary graduation†	23.6	22.9 to 24.4	1.0	...
Household income quintile				
1 (lowest)	39.2*	37.7 to 40.7	1.4*	1.3 to 1.6
2	31.5*	30.1 to 32.9	1.1	1.0 to 1.2
3†	28.1	26.7 to 29.4	1.0	...
4	25.1*	23.8 to 26.4	0.9*	0.8 to 1.0
5 (highest)	22.1*	20.8 to 23.4	0.8*	0.7 to 0.9
Urban/Rural status				
Rural†	31.0	29.9 to 32.1	1.0	...
Urban: population less than 30,000	32.2	30.7 to 33.7	1.1	1.0 to 1.2
Urban: population 30,000 to 99,999	35.2*	33.2 to 37.2	1.2*	1.1 to 1.3
Urban: population 100,000 to 499,999	32.0	30.7 to 33.3	1.1*	1.0 to 1.2
Urban: population 500,000 or more	26.1*	25.1 to 27.1	0.9*	0.8 to 1.0
Immigrant status				
Immigrant: 0 to 9 years in Canada	18.9*	16.1 to 21.7	0.7*	0.6 to 0.9
Immigrant: 10 to 19 years in Canada	24.4*	21.4 to 27.4	0.9	0.7 to 1.1
Immigrant: 20 or more years in Canada	31.5	29.6 to 33.4	0.8*	0.8 to 0.9
Canadian-born†	30.1	29.4 to 30.8	1.0	...
Employment status (aged 25 to 54 years)				
Employment full-time	20.8*	20.0 to 21.6	0.5*	0.4 to 0.5
Employment part-time	24.4*	21.8 to 27.0	0.6*	0.5 to 0.7
Not employed†	37.4	35.2 to 39.5	1.0	...

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
... not applicable
Notes: The odds ratios for employment status are based on a model including all variables in the table for the population aged 25 to 54 years. All other odds ratios are based on a model for the population aged 20 years or older and exclude employment status.
Source: 2007 Canadian Community Health Survey.

The data

The data are from the 2007 Canadian Community Health Survey (CCHS), which covers the household population aged 12 years or older. Residents of Indian reserves, institutions and some remote areas; full-time members of the Canadian Forces; and all residents (military and civilian) of Canadian Forces bases were excluded. Interviews were conducted from January through December, 2007. The overall response rate was 78%, yielding a sample of 65,946 respondents. More information about the CCHS is available in a published report[5] and on Statistics Canada's Web site (www.statcan.ca).

This study was based on the population aged 20 years or older and represents 57,367 respondents who answered the question on television viewing, and 57,617 respondents who answered the question on leisure-time computer use.

All estimates were weighted to be representative of the household population aged 20 years or older in 2007. Cross-tabulations and logistic regression analysis were used to study associations between socio-demographic characteristics and self-reported screen time. To account for the survey design effect, standard errors, coefficients of variation and 95% confidence intervals were estimated using the bootstrap technique.[6,7] Differences between estimates were tested for statistical significance, which was established at $p < 0.05$.

Screen time was assessed by asking CCHS respondents the number of hours in a typical week over the past three months they spent watching television (including videos) and using a computer (including playing computer games and using the Internet). Respondents were instructed to report **leisure-time hours only** and to exclude time spent on these activities at work or school. For each behaviour, respondents reported their weekly hours in one of eight categories: none, less than 1 hour, 1 to 2 hours, 3 to 5 hours, 6 to 10 hours, 11 to 14 hours, 15 to 20 hours, or more than 20 hours. No guidelines have been proposed for adults, but the Canadian Paediatric Society recommends a maximum of two hours of television per day for children.[8] Among adults, a variety of cut-points have been used in the literature to define frequent viewing. For this analysis, those who reported 15 or more hours per week were defined as frequent television viewers, and those who reported 11 or more hours of leisure-time computer use were defined as frequent computer users. To calculate the proportion of total screen time devoted to computers, continuous measures were derived for television viewing and computer use by assigning the midpoint of each response category (0, 0.5, 1.5, 4, 8, 12.5, 17.5, or 25 hours for the highest category).

Based on their highest level of education, respondents aged 25 years or older were grouped into four categories: postsecondary graduation, some postsecondary, secondary graduation, and less than secondary graduation. The same categories were used for those aged 20 to 24 years, but for these respondents, education was based on the highest level in the household.

Household income groups were derived by calculating the ratio between the total household income from all sources in the previous 12 months and Statistics Canada's low-income cutoff (LICO) specific to the number of people in the household, the size of the community, and the survey year. These adjusted income ratios were grouped into quintiles (five groups, each containing one-fifth of Canadians).

Trends in television viewing are from the General Social Survey (GSS) (1986 and 2005), which used a one-day time use diary to collect information on time spent on a wide variety of activities.[3]

CCHS estimates of screen time are based on self-reported data, which are subject to social desirability and recall biases. Single-item measures for the assessment of sedentary behaviours lack content validity and likely yield only crude estimates.[9] Comparisons with GSS data suggest that television viewing time is underestimated in the CCHS; according to 2005 data from the GSS, the prevalence of frequent television viewing (15 or more hours per week) was 39%, substantially above the estimate of 29% from the 2007 CCHS.

Characteristics of frequent computer users

Men were more likely than women to report frequent leisure-time computer use (17% versus 12%) (Table 2). Frequent computer use fell with age from 30% among 20- to 24-year-olds to 6% among seniors aged 75 years or older. Frequent computer use was much more common among people who were never married (24%) than among those who were married (13%).

Only 7% of people with less than secondary graduation were frequent computer users, compared with 17% of postsecondary graduates. On the other hand, proportions were similar across all household income levels.

Table 2
Prevalence of and adjusted odds ratios for using computers 11 or more hours per week, by selected characteristics, household population aged 20 years or older, Canada, 2007

	Use computers 11 or more hours per week			
	%	95% confidence interval	Adjusted odds ratio	95% confidence interval
Total	**14.8**	**14.3 to 15.3**	...	...
Sex				
Male	17.4*	16.7 to 18.1	1.5*	1.4 to 1.6
Female†	12.3	11.7 to 12.9	1.0	...
Age group				
20 to 24	29.9*	27.6 to 32.3	2.1*	1.8 to 2.5
25 to 34	21.1*	19.8 to 22.4	1.7*	1.5 to 1.9
35 to 44	13.8*	12.8 to 14.8	1.1	1.0 to 1.3
45 to 54†	11.3	10.3 to 12.3	1.0	...
55 to 64	10.6	9.7 to 11.5	1.0	0.9 to 1.2
65 to 74	11.2	10.2 to 12.3	1.3*	1.1 to 1.5
75 or older	5.9*	5.1 to 6.8	0.7*	0.6 to 0.8
Marital status (aged 25 to 54 years)				
Married/Common-law†	12.9	12.2 to 13.6	1.0	...
Divorced/Separated/Widowed	14.1	12.3 to 15.9	1.1*	1.0 to 1.3
Never married	23.9*	22.2 to 25.6	1.7*	1.5 to 1.9
Education				
Less than secondary graduation	6.8*	6.1 to 7.5	0.5*	0.4 to 0.5
Secondary graduation	11.7*	10.6 to 12.8	0.7*	0.6 to 0.8
Some postsecondary	18.1	16.3 to 19.9	1.0	0.9 to 1.2
Postsecondary graduation†	17.1	16.4 to 17.7	1.0	...
Household income quintile				
1 (lowest)	15.7	14.6 to 16.9	1.2*	1.0 to 1.3
2	15.3	14.0 to 16.5	1.1	1.0 to 1.3
3†	14.0	13.0 to 15.1	1.0	...
4	15.9	14.7 to 17.0	1.1	1.0 to 1.3
5 (highest)	14.1	12.9 to 15.3	1.0	0.9 to 1.2
Urban/Rural status				
Rural†	10.1	9.3 to 10.8	1.0	...
Urban: population less than 30,000	12.4*	11.5 to 13.3	1.2*	1.1 to 1.4
Urban: population 30,000 to 99,999	15.0*	13.8 to 16.2	1.4*	1.2 to 1.6
Urban: population 100,000 to 499,999	15.7*	14.8 to 16.7	1.4*	1.3 to 1.6
Urban: population 500,000 or more	16.6*	15.8 to 17.4	1.4*	1.2 to 1.5
Immigrant status				
Immigrant: 0 to 9 years in Canada	27.7*	24.9 to 30.5	2.0*	1.7 to 2.3
Immigrant: 10 to 19 years in Canada	21.1*	18.0 to 24.3	1.5*	1.2 to 1.8
Immigrant: 20 or more years in Canada	10.5*	9.3 to 11.8	0.9	0.8 to 1.0
Canadian-born†	14.1	13.6 to 14.6	1.0	...
Employment status (aged 25 to 54 years)				
Employment full-time	13.8*	13.1 to 14.5	0.5*	0.4 to 0.5
Employment part-time	16.6*	14.1 to 19.1	0.7*	0.6 to 0.9
Not employed†	22.5	20.5 to 24.4	1.0	...

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
... not applicable
Notes: The odds ratios for employment status are based on a model including all variables in the table for the population aged 25 to 54 years. All other odds ratios are based on a model for the population aged 20 years or older and exclude employment status.
Source: 2007 Canadian Community Health Survey.

Residents of urban areas were more likely to be frequent computer users than were those in rural areas. The percentages ranged from 10% among rural residents to 17% among residents of urban areas with a population of 500,000 or more.

Recent immigrants were far more likely than those who were Canadian-born to be frequent computer users (28% versus 14%).

Among the working-age population, those who were not employed were appreciably more likely to be high leisure-time computer users (23%) than were full-time workers (14%).

When examined in a multivariate model, these associations between socio-demographic characteristics and frequent leisure-time computer use generally persisted.

Regional differences

Across the provinces, the proportion of adults who were frequent television viewers varied from the national level (29%). Frequent viewing was somewhat higher in New Brunswick (32%) and Quebec (31%) and somewhat lower in Alberta (26%) and British Columbia (27%) (Appendix Table B). As well, 44% of Nunavut residents were frequent television viewers.

Compared with the proportion for Canada (15%), high leisure-time computer use was slightly more common in Ontario (16%), British Columbia (18%) and Nunavut (20%,) and slightly less common in Newfoundland and Labrador (11%), Quebec (12%), Manitoba (13%) and Saskatchewan (12%) (Appendix Table C).

A major strength of the CCHS is its large sample size. As a result, it was possible to produce estimates of frequent television viewing and computer use for health regions (Appendix Tables B and C).

Conclusion

In 2007, 29% of Canadian adults were classified as frequent television viewers, and 15% as frequent leisure-time computer users. Differences in socio-demographic characteristics were apparent, often in opposite directions for the two screen-time activities. Younger ages and higher levels of education were negatively associated with frequent television viewing, but positively associated with frequent computer use. Recent immigrants were less likely than people born in Canada to be frequent television viewers, but more likely to be frequent computer users. Among the working-age population, those employed full-time were less likely to be frequent viewers of television or frequent leisure-time computer users than were people who were not employed.

Margot Shields (613-951-4177; Margot.Shields@statcan.ca) is with the Health Information and Research Division and Mark S. Tremblay (613-951-4385; Mark.Tremblay@statcan.ca) is with the Physical Health Measures Division at Statistics Canada, Ottawa, Ontario, K1A 0T6 and the Healthy Active Living and Obesity Research Group at the Children's Hospital of Eastern Ontario Research Institute, Ottawa, Ontario, K1H 8L1.

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Table A
Percentage reporting frequent screen time, by sex and selected characteristics, household population aged 20 years or older, Canada, 2007

	View television 15 or more hours per week		Use computers 11 or more hours per week	
	Men	Women	Men	Women
	%		%	
Total	**29.5**	**28.9**	**17.4**	**12.3‡**
Age group				
20 to 24	19.8*	20.3*	33.4*	26.4*‡
25 to 34	23.4*	21.4*	25.3*	16.8*‡
35 to 44	24.0	19.1*‡	16.0*	11.7‡
45 to 54†	27.4	24.8	12.7	9.9‡
55 to 64	36.6*	35.5*	11.5	9.8‡
65 to 74	44.6*	49.1*‡	14.0	8.7‡
75 or older	50.2*	53.4*	9.1*	3.8*‡
Marital status (age 25 to 54 years)				
Married/Common-law†	23.5	21.0‡	14.9	10.9‡
Divorced/Separated/Widowed	28.0	22.5‡	15.7	13.1
Never married	28.7*	24.7*‡	27.3*	19.6*‡
Education				
Less than secondary graduation	45.4*	49.2*‡	7.3*	6.3*
Secondary graduation	33.6*	33.9*	14.0*	9.8*‡
Some postsecondary	29.9*	31.2*	19.3	17.0
Postsecondary graduation†	25.1	22.2‡	20.3	13.9‡
Household income quintile				
1 (lowest)	40.3*	38.6*	18.1	14.2‡
2	31.4	31.5*	18.2	12.6‡
3†	29.3	26.8	16.5	11.5‡
4	26.4	23.7‡	19.0	12.3‡
5 (highest)	24.1*	19.4*‡	16.3	11.3‡
Urban/Rural status				
Rural†	31.1	30.8	10.8	9.3
Urban: population less than 30,000	33.2	31.3	12.7	12.1*
Urban: population 30,000 to 99,999	34.2	36.1*	16.9*	13.3*‡
Urban: population 100,000 to 499,999	31.5	32.5	18.2*	13.3*‡
Urban: population 500,000 or more	26.8*	25.5*	20.6*	12.9*‡
Immigrant status				
Immigrant: 0 to 9 years in Canada	15.3*	22.0*‡	30.3*	25.3*
Immigrant: 10 to 19 years in Canada	25.1	23.8*	29.1*	13.8‡
Immigrant: 20 or more years in Canada	32.0	31.1	13.3*	7.9*‡
Canadian-born†	30.6	29.6	16.4	11.9‡
Employment status (age 25 to 54 years)				
Employment full-time	22.6*	18.4*‡	16.4*	10.5*‡
Employment part-time	31.2*	22.7*‡	30.3	13.1*‡
Not employed†	44.7	33.9‡	27.6	20.0‡

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
‡ significantly different from estimate for men ($p < 0.05$)
... not applicable
Source: 2007 Canadian Community Health Survey.

Table B

Percentage viewing television 15 or more hours per week, by province/territory and health region, household population aged 20 years or older, Canada, 2007

	Region code	%	95% confidence interval	Significantly higher or lower (p < 0.05) than: Canada	Province or Territory
Canada		**29.2**	**28.6 to 29.8**	**...**	**...**
Newfoundland and Labrador	**10**	**31.6**	**28.6 to 34.6**	**Same**	**...**
Eastern Regional Integrated Health Authority	1011	30.2	26.0 to 34.5	Same	Same
Central Regional Integrated Health Authority	1012	37.0	32.5 to 41.6	Higher	Higher
Western Regional Integrated Health Authority	1013	31.4	23.4 to 39.4	Same	Same
Labrador-Grenfell Regional Integrated Health Authority	1014	28.9	22.8 to 34.9	Same	Same
Prince Edward Island	**11**	**29.0**	**25.9 to 32.1**	**Same**	**...**
Kings County	1101	41.2	28.9 to 53.5	Same	Higher
Queens County	1102	24.3	20.7 to 28.0	Lower	Lower
Prince County	1103	31.5	26.5 to 36.5	Same	Same
Nova Scotia	**12**	**31.3**	**28.8 to 33.7**	**Same**	**...**
Zone 1	1201	37.0	31.2 to 42.8	Higher	Higher
Zone 2	1202	30.5	23.1 to 37.9	Same	Same
Zone 3	1203	32.9	27.4 to 38.5	Same	Same
Zone 4	1204	36.3	29.6 to 43.1	Higher	Same
Zone 5	1205	42.3	35.6 to 48.9	Higher	Higher
Zone 6	1206	24.7	20.4 to 29.0	Lower	Lower
New Brunswick	**13**	**32.4**	**30.1 to 34.8**	**Higher**	**...**
Region 1	1301	35.3	30.2 to 40.4	Higher	Same
Region 2	1302	25.4	20.2 to 30.6	Same	Lower
Region 3	1303	31.5	26.3 to 36.7	Same	Same
Region 4	1304	33.7	27.2 to 40.2	Same	Same
Region 5	1305	48.3	40.5 to 56.0	Higher	Higher
Region 6	1306	32.9	28.1 to 37.6	Same	Same
Region 7	1307	39.2	32.7 to 45.7	Higher	Higher
Quebec	**24**	**31.1**	**29.8 to 32.4**	**Higher**	**...**
Région du Bas-Saint-Laurent	2401	29.2	25.3 to 33.2	Same	Same
Région du Saguenay - Lac-Saint-Jean	2402	38.1	31.7 to 44.5	Higher	Higher
Région de la Capitale Nationale	2403	36.1	31.6 to 40.5	Higher	Higher
Région de la Mauricie et du Centre-du-Québec	2404	39.1	32.6 to 45.6	Higher	Higher
Région de l'Estrie	2405	37.3	32.0 to 42.6	Higher	Higher
Région de Montréal	2406	29.0	25.9 to 32.2	Same	Same
Région de l'Outaouais	2407	33.1	28.0 to 38.1	Same	Same
Région de l'Abitibi-Témiscamingue	2408	38.4	33.1 to 43.8	Higher	Higher
Région de la Côte-Nord	2409	37.1	30.0 to 44.2	Higher	Same
Région du Nord-du-Québec	2410	25.0	19.9 to 30.1	Same	Lower
Région de la Gaspésie - Îles-de-la-Madeleine	2411	36.8	31.2 to 42.4	Higher	Higher
Région de la Chaudière-Appalaches	2412	24.3	20.3 to 28.3	Lower	Lower
Région de Laval	2413	24.9	21.1 to 28.7	Lower	Lower
Région de Lanaudière	2414	28.6	24.3 to 32.8	Same	Same
Région des Laurentides	2415	32.4	27.4 to 37.5	Same	Same
Région de la Montérégie	2416	28.3	24.4 to 32.1	Same	Same
Ontario	**35**	**29.1**	**28.1 to 30.1**	**Same**	**...**
District of Algoma Health Unit	3526	36.3	31.1 to 41.5	Higher	Higher
Brant County Health Unit	3527	39.3	33.0 to 45.5	Higher	Higher
Durham Regional Health Unit	3530	30.6	25.7 to 35.5	Same	Same
Elgin-St Thomas Health Unit	3531	31.8	23.6 to 40.0	Same	Same
Grey Bruce Health Unit	3533	36.7	30.7 to 42.7	Higher	Higher
Haldimand-Norfolk Health Unit	3534	34.3	27.1 to 41.6	Same	Same
Haliburton, Kawartha, Pine Ridge District Health Unit	3535	38.5	32.0 to 45.1	Higher	Higher
Halton Regional Health Unit	3536	24.8	20.2 to 29.3	Same	Same
City of Hamilton Health Unit	3537	30.4	25.9 to 34.8	Same	Same
Hastings and Prince Edward Counties Health Unit	3538	43.9	36.2 to 51.5	Higher	Higher
Huron County Health Unit	3539	37.4	31.0 to 43.8	Higher	Higher
Chatham-Kent Health Unit	3540	38.6	31.3 to 46.0	Higher	Higher

Table B

Percentage viewing television 15 or more hours per week, by province/territory and health region, household population aged 20 years or older, Canada, 2007 continued

	Region code	%	95% confidence interval	Significantly higher or lower (p < 0.05) than: Canada	Province or Territory
Kingston, Frontenac and Lennox and Addington Health Unit	3541	33.3	28.8 to 37.9	Same	Same
Lambton Health Unit	3542	40.4	34.1 to 46.7	Higher	Higher
Leeds, Grenville and Lanark District Health Unit	3543	36.5	31.6 to 41.3	Higher	Higher
Middlesex-London Health Unit	3544	30.6	26.0 to 35.2	Same	Same
Niagara Regional Area Health Unit	3546	34.3	29.1 to 39.5	Higher	Higher
North Bay Parry Sound District Health Unit	3547	35.1	30.0 to 40.2	Higher	Higher
Northwestern Health Unit	3549	35.3	26.4 to 44.2	Same	Same
City of Ottawa Health Unit	3551	23.0	19.4 to 26.7	Lower	Lower
Oxford County Health Unit	3552	30.7	23.9 to 37.6	Same	Same
Peel Regional Health Unit	3553	24.4	20.7 to 28.1	Lower	Lower
Perth District Health Unit	3554	26.9	20.7 to 33.2	Same	Same
Peterborough County-City Health Unit	3555	35.5	30.0 to 41.1	Higher	Higher
Porcupine Health Unit	3556	35.7	28.2 to 43.1	Same	Same
Renfrew County and District Health Unit	3557	41.5	34.4 to 48.6	Higher	Higher
Eastern Ontario Health Unit	3558	37.5	31.5 to 43.6	Higher	Higher
Simcoe Muskoka District Health Unit	3560	36.3	32.2 to 40.3	Higher	Higher
Sudbury and District Health Unit	3561	30.8	26.0 to 35.6	Same	Same
Thunder Bay District Health Unit	3562	33.6	27.9 to 39.3	Same	Same
Timiskaming Health Unit	3563	33.2	26.1 to 40.2	Same	Same
Waterloo Health Unit	3565	30.6	25.6 to 35.7	Same	Same
Wellington-Dufferin-Guelph Health Unit	3566	25.6	21.7 to 29.5	Same	Same
Windsor-Essex County Health Unit	3568	32.0	27.5 to 36.4	Same	Same
York Regional Health Unit	3570	26.9	23.1 to 30.8	Same	Same
City of Toronto Health Unit	3595	24.0	21.4 to 26.5	Lower	Lower
Manitoba	**46**	**30.7**	**28.0 to 33.4**	**Same**	**...**
Winnipeg Regional Health Authority	4610	33.3	29.1 to 37.4	Same	Higher
Brandon Regional Health Authority	4615	36.5	29.3 to 43.7	Higher	Same
North Eastman Regional Health Authority	4620	27.0	18.8 to 35.1	Same	Same
South Eastman Regional Health Authority	4625	23.0	16.9 to 29.1	Lower	Lower
Interlake Regional Health Authority	4630	31.2	25.4 to 37.0	Same	Same
Central Regional Health Authority	4640	19.6	14.8 to 24.5	Lower	Lower
Assiniboine Regional Health Authority	4645	27.3	21.5 to 33.1	Same	Same
Parkland Regional Health Authority	4660	22.1	16.2 to 28.1	Lower	Lower
Norman Regional Health Authority	4670	38.8	29.2 to 48.5	Higher	Same
Burntwood/Churchill	4685	28.7	21.5 to 35.9	Same	Same
Saskatchewan	**47**	**29.8**	**27.7 to 32.0**	**Same**	**...**
Sun Country Regional Health Authority	4701	32.9	25.6 to 40.2	Same	Same
Five Hills Regional Health Authority	4702	30.6	23.7 to 37.4	Same	Same
Cypress Regional Health Authority	4703	38.9	28.9 to 48.9	Same	Same
Regina Qu'Appelle Regional Health Authority	4704	31.6	27.1 to 36.0	Same	Same
Sunrise Regional Health Authority	4705	29.5	23.1 to 35.9	Same	Same
Saskatoon Regional Health Authority	4706	25.2	20.7 to 29.7	Same	Lower
Heartland Regional Health Authority	4707	25.3	17.4 to 33.2	Same	Same
Kelsey Trail Regional Health Authority	4708	27.2	20.7 to 33.8	Same	Same
Prince Albert Parkland Regional Health Authority	4709	38.4	30.0 to 46.8	Higher	Higher
Prairie North Regional Health Authority	4710	30.3	24.0 to 36.6	Same	Same
Mamawetan/Keewatin/Athabasca	4714	35.9	25.2 to 46.5	Same	Same
Alberta	**48**	**25.7**	**23.7 to 27.6**	**Lower**	**...**
Chinook Regional Health Authority	4821	26.2	20.0 to 32.4	Same	Same
Palliser Health Region	4822	25.9	21.0 to 30.8	Same	Same
Calgary Health Region	4823	26.2	22.4 to 29.9	Same	Same
David Thompson Regional Health Authority	4824	26.7	22.3 to 31.0	Same	Same
East Central Health	4825	25.3	21.2 to 29.4	Same	Same
Capital Health	4826	24.8	20.9 to 28.7	Lower	Same
Aspen Regional Health Authority	4827	27.3	21.7 to 32.8	Same	Same
Peace Country Health	4828	25.9	20.5 to 31.3	Same	Same
Northern Lights Health Region	4829	20.1[E]	12.0 to 28.2	Lower	Same

Table B
Percentage viewing television 15 or more hours per week, by province/territory and health region, household population aged 20 years or older, Canada, 2007 continued

	Region code	%	95% confidence interval	Significantly higher or lower (p < 0.05) than: Canada	Province or Territory
British Columbia	**59**	**26.7**	**25.3 to 28.1**	**Lower**	**...**
East Kootenay Health Service Delivery Area	5911	31.7	25.5 to 37.9	Same	Same
Kootenay-Boundary Health Service Delivery Area	5912	28.0	20.6 to 35.4	Same	Same
Okanagan Health Service Delivery Area	5913	31.5	26.7 to 36.3	Same	Higher
Thompson/Cariboo Health Service Delivery Area	5914	34.4	28.9 to 39.9	Same	Higher
Fraser East Health Service Delivery Area	5921	25.4	21.1 to 29.7	Same	Same
Fraser North Health Service Delivery Area	5922	19.7	15.8 to 23.6	Lower	Lower
Fraser South Health Service Delivery Area	5923	26.2	21.9 to 30.5	Same	Same
Richmond Health Service Delivery Area	5931	27.8	22.2 to 33.5	Same	Same
Vancouver Health Service Delivery Area	5932	23.2	19.0 to 27.4	Lower	Same
North Shore/Coast Garibaldi Health Service Delivery Area	5933	21.0	15.5 to 26.5	Lower	Lower
South Vancouver Island Health Service Delivery Area	5941	31.3	26.4 to 36.2	Same	Same
Central Vancouver Island Health Service Delivery Area	5942	32.0	26.2 to 37.8	Same	Same
North Vancouver Island Health Service Delivery Area	5943	34.8	28.5 to 41.0	Same	Higher
Northwest Health Service Delivery Area	5951	34.7	25.9 to 43.5	Same	Same
Northern Interior Health Service Delivery Area	5952	28.2	22.4 to 34.0	Same	Same
Northeast Health Service Delivery Area	5953	21.2	15.0 to 27.3	Lower	Same
Yukon Territory	**6001**	**35.4**	**28.5 to 42.3**	**Same**	**...**
Northwest Territories	**6101**	**33.2**	**27.2 to 39.3**	**Same**	**...**
Nunavut - 10 largest communities[1]	**6201**	**43.8**	**34.2 to 53.4**	**Higher**	**...**

... not applicable
E coefficient of variation between 16.6% and 33.3% (interpret with caution)
1. The Canadian Community Health Survey is administered in the 10 largest communities in Nunavut, using an alternative methodology that accommodates some of the operational difficulties inherent to remote locales. The 10 largest communities are Iqaluit, Cambridge Bay, Baker Lake, Arviat, Rankin Inlet, Kugluktuk, Pond Inlet, Cape Dorset, Pangnirtung, Igloolik.
Source: 2007 Canadian Community Health Survey.

Table C
Percentage using computers 11 or more hours per week, by province/territory and health region, household population aged 20 years or older, Canada, 2007

	Region code	%	95% confidence interval	Significantly higher or lower (p < 0.05) than: Canada	Province or Territory
Canada		**14.8**	**14.3 to 15.3**	**...**	**...**
Newfoundland and Labrador	**10**	**11.0**	**9.0 to 13.0**	**Lower**	**...**
Eastern Regional Integrated Health Authority	1011	11.5	8.4 to 14.7	Lower	Same
Central Regional Integrated Health Authority	1012	9.1[E]	5.5 to 12.6	Lower	Same
Western Regional Integrated Health Authority	1013	9.6	6.5 to 12.7	Lower	Same
Labrador-Grenfell Regional Integrated Health Authority	1014	15.1	10.6 to 19.5	Same	Same
Prince Edward Island	**11**	**13.0**	**10.7 to 15.3**	**Same**	**...**
Kings County	1101	21.7[E]	10.9 to 32.5	Same	Same
Queens County	1102	11.6	9.0 to 14.1	Lower	Same
Prince County	1103	11.5[E]	7.1 to 15.8	Same	Same
Nova Scotia	**12**	**14.7**	**12.8 to 16.7**	**Same**	**...**
Zone 1	1201	11.8[E]	7.5 to 16.1	Same	Same
Zone 2	1202	13.4	9.5 to 17.3	Same	Same
Zone 3	1203	13.3[E]	8.9 to 17.7	Same	Same
Zone 4	1204	15.7[E]	9.8 to 21.7	Same	Same
Zone 5	1205	13.0	9.4 to 16.6	Same	Same
Zone 6	1206	16.6	13.0 to 20.3	Same	Same
New Brunswick	**13**	**13.0**	**11.1 to 14.8**	**Same**	**...**
Region 1	1301	15.4	11.1 to 19.6	Same	Same
Region 2	1302	14.9	10.3 to 19.5	Same	Same
Region 3	1303	12.1[E]	8.0 to 16.1	Same	Same
Region 4	1304	8.4[E]	4.9 to 11.9	Lower	Lower
Region 5	1305	11.1[E]	5.3 to 16.8	Same	Same
Region 6	1306	9.9[E]	6.0 to 13.8	Lower	Same
Region 7	1307	10.9[E]	6.1 to 15.6	Same	Same
Quebec	**24**	**11.9**	**11.0 to 12.8**	**Lower**	**...**
Région du Bas-Saint-Laurent	2401	4.5[E]	2.6 to 6.3	Lower	Lower
Région du Saguenay - Lac-Saint-Jean	2402	11.9	8.7 to 15.2	Same	Same
Région de la Capitale Nationale	2403	15.0	11.4 to 18.7	Same	Same
Région de la Mauricie et du Centre-du-Québec	2404	12.1	8.2 to 16.0	Same	Same
Région de l'Estrie	2405	9.0[E]	6.0 to 12.1	Lower	Same
Région de Montréal	2406	17.5	15.2 to 19.9	Higher	Higher
Région de l'Outaouais	2407	10.9	7.8 to 14.0	Lower	Same
Région de l'Abitibi-Témiscamingue	2408	6.7[E]	4.2 to 9.3	Lower	Lower
Région de la Côte-Nord	2409	6.3[E]	4.2 to 8.4	Lower	Lower
Région du Nord-du-Québec	2410	7.8[E]	4.5 to 11.1	Lower	Lower
Région de la Gaspésie - Îles-de-la-Madeleine	2411	7.1[E]	4.3 to 9.9	Lower	Lower
Région de la Chaudière-Appalaches	2412	6.2[E]	4.1 to 8.3	Lower	Lower
Région de Laval	2413	10.9[E]	7.2 to 14.6	Lower	Same
Région de Lanaudière	2414	8.6[E]	5.8 to 11.4	Lower	Lower
Région des Laurentides	2415	9.7	6.6 to 12.8	Lower	Same
Région de la Montérégie	2416	9.3	7.3 to 11.3	Lower	Lower
Ontario	**35**	**16.1**	**15.3 to 17.0**	**Higher**	**...**
District of Algoma Health Unit	3526	17.1	12.9 to 21.4	Same	Same
Brant County Health Unit	3527	14.4	10.1 to 18.6	Same	Same
Durham Regional Health Unit	3530	18.3	13.8 to 22.7	Same	Same
Elgin-St Thomas Health Unit	3531	15.5	10.8 to 20.2	Same	Same
Grey Bruce Health Unit	3533	16.3	11.6 to 21.0	Same	Same
Haldimand-Norfolk Health Unit	3534	10.0[E]	5.5 to 14.5	Lower	Lower
Haliburton, Kawartha, Pine Ridge District Health Unit	3535	13.6	9.9 to 17.3	Same	Same
Halton Regional Health Unit	3536	17.4	13.1 to 21.8	Same	Same
City of Hamilton Health Unit	3537	14.7	10.7 to 18.8	Same	Same
Hastings and Prince Edward Counties Health Unit	3538	17.2[E]	11.4 to 23.1	Same	Same
Huron County Health Unit	3539	11.1[E]	7.1 to 15.1	Same	Lower
Chatham-Kent Health Unit	3540	10.9[E]	7.1 to 14.7	Lower	Lower

Table C

Percentage using computers 11 or more hours per week, by province/territory and health region, household population aged 20 years or older, Canada, 2007 continued

	Region code	%	95% confidence interval	Significantly higher or lower (p < 0.05) than: Canada	Province or Territory
Kingston, Frontenac and Lennox and Addington Health Unit	3541	22.5	17.9 to 27.2	Higher	Higher
Lambton Health Unit	3542	18.6	13.6 to 23.6	Same	Same
Leeds, Grenville and Lanark District Health Unit	3543	16.3	12.2 to 20.3	Same	Same
Middlesex-London Health Unit	3544	19.1	15.1 to 23.2	Higher	Same
Niagara Regional Area Health Unit	3546	14.4	11.4 to 17.3	Same	Same
North Bay Parry Sound District Health Unit	3547	15.1[E]	8.8 to 21.4	Same	Same
Northwestern Health Unit	3549	13.5[E]	8.4 to 18.6	Same	Same
City of Ottawa Health Unit	3551	18.9	16.0 to 21.9	Higher	Same
Oxford County Health Unit	3552	11.1[E]	6.5 to 15.8	Same	Lower
Peel Regional Health Unit	3553	16.8	13.9 to 19.6	Same	Same
Perth District Health Unit	3554	13.3[E]	8.7 to 17.9	Same	Same
Peterborough County-City Health Unit	3555	10.4[E]	6.5 to 14.3	Lower	Lower
Porcupine Health Unit	3556	14.2	10.1 to 18.4	Same	Same
Renfrew County and District Health Unit	3557	10.7[E]	6.7 to 14.8	Same	Lower
Eastern Ontario Health Unit	3558	11.6	7.9 to 15.3	Same	Lower
Simcoe Muskoka District Health Unit	3560	14.2	11.5 to 16.9	Same	Same
Sudbury and District Health Unit	3561	12.9	9.3 to 16.4	Same	Same
Thunder Bay District Health Unit	3562	13.1	9.7 to 16.5	Same	Same
Timiskaming Health Unit	3563	8.6[E]	4.8 to 12.4	Lower	Lower
Waterloo Health Unit	3565	15.3	11.7 to 18.8	Same	Same
Wellington-Dufferin-Guelph Health Unit	3566	11.0	7.8 to 14.2	Lower	Lower
Windsor-Essex County Health Unit	3568	12.9	9.5 to 16.2	Same	Same
York Regional Health Unit	3570	17.5	14.0 to 21.0	Same	Same
City of Toronto Health Unit	3595	17.2	14.8 to 19.6	Higher	Same
Manitoba	**46**	**12.6**	**10.9 to 14.3**	**Lower**	**...**
Winnipeg Regional Health Authority	4610	14.8	12.2 to 17.5	Same	Higher
Brandon Regional Health Authority	4615	13.5[E]	8.6 to 18.5	Same	Same
North Eastman Regional Health Authority	4620	6.6[E]	3.0 to 10.2	Lower	Lower
South Eastman Regional Health Authority	4625	6.6[E]	3.8 to 9.5	Lower	Lower
Interlake Regional Health Authority	4630	11.9[E]	6.1 to 17.7	Same	Same
Central Regional Health Authority	4640	10.1[E]	6.1 to 14.1	Lower	Same
Assiniboine Regional Health Authority	4645	7.1[E]	3.5 to 10.7	Lower	Lower
Parkland Regional Health Authority	4660	F	...	...	...
Norman Regional Health Authority	4670	12.9[E]	7.0 to 18.7	Same	Same
Burntwood/Churchill	4685	15.4[E]	8.6 to 22.2	Same	Same
Saskatchewan	**47**	**12.4**	**11.0 to 13.9**	**Lower**	**...**
Sun Country Regional Health Authority	4701	13.0[E]	7.9 to 18.0	Same	Same
Five Hills Regional Health Authority	4702	12.8[E]	8.5 to 17.1	Same	Same
Cypress Regional Health Authority	4703	12.5[E]	6.6 to 18.4	Same	Same
Regina Qu'Appelle Regional Health Authority	4704	16.0	12.4 to 19.7	Same	Higher
Sunrise Regional Health Authority	4705	4.3[E]	1.6 to 7.0	Lower	Lower
Saskatoon Regional Health Authority	4706	13.9	10.6 to 17.2	Same	Same
Heartland Regional Health Authority	4707	8.1[E]	4.0 to 12.1	Lower	Lower
Kelsey Trail Regional Health Authority	4708	3.7[E]	1.3 to 6.0	Lower	Lower
Prince Albert Parkland Regional Health Authority	4709	13.3[E]	7.8 to 18.8	Same	Same
Prairie North Regional Health Authority	4710	5.7[E]	2.8 to 8.6	Lower	Lower
Mamawetan/Keewatin/Athabasca	4714	7.8[E]	3.7 to 12.0	Lower	Lower
Alberta	**48**	**15.2**	**13.8 to 16.7**	**Same**	**...**
Chinook Regional Health Authority	4821	15.6	11.5 to 19.6	Same	Same
Palliser Health Region	4822	16.6	12.6 to 20.7	Same	Same
Calgary Health Region	4823	14.8	12.4 to 17.2	Same	Same
David Thompson Regional Health Authority	4824	12.8	9.2 to 16.4	Same	Same
East Central Health	4825	6.0[E]	3.6 to 8.3	Lower	Lower
Capital Health	4826	18.2	14.9 to 21.5	Higher	Higher
Aspen Regional Health Authority	4827	11.6[E]	7.7 to 15.5	Same	Same
Peace Country Health	4828	11.4	8.3 to 14.4	Lower	Lower
Northern Lights Health Region	4829	16.8[E]	11.1 to 22.4	Same	Same

Table C

Percentage using computers 11 or more hours per week, by province/territory and health region, household population aged 20 years or older, Canada, 2007 continued

	Region code	%	95% confidence interval	Significantly higher or lower ($p < 0.05$) than: Canada	Province or Territory
British Columbia	**59**	**17.6**	**16.2 to 19.0**	**Higher**	**...**
East Kootenay Health Service Delivery Area	5911	12.8[E]	6.8 to 18.8	Same	Same
Kootenay-Boundary Health Service Delivery Area	5912	11.0[E]	6.9 to 15.1	Same	Lower
Okanagan Health Service Delivery Area	5913	13.0	10.0 to 16.1	Same	Lower
Thompson/Cariboo Health Service Delivery Area	5914	14.4	10.5 to 18.2	Same	Same
Fraser East Health Service Delivery Area	5921	15.2	10.6 to 19.9	Same	Same
Fraser North Health Service Delivery Area	5922	18.0	14.5 to 21.6	Same	Same
Fraser South Health Service Delivery Area	5923	18.7	14.0 to 23.5	Same	Same
Richmond Health Service Delivery Area	5931	21.7	16.6 to 26.9	Higher	Same
Vancouver Health Service Delivery Area	5932	21.9	17.5 to 26.4	Higher	Higher
North Shore/Coast Garibaldi Health Service Delivery Area	5933	17.9	12.3 to 23.4	Same	Same
South Vancouver Island Health Service Delivery Area	5941	17.7	13.8 to 21.7	Same	Same
Central Vancouver Island Health Service Delivery Area	5942	18.7	13.5 to 23.9	Same	Same
North Vancouver Island Health Service Delivery Area	5943	13.5[E]	7.8 to 19.2	Same	Same
Northwest Health Service Delivery Area	5951	20.5[E]	12.5 to 28.6	Same	Same
Northern Interior Health Service Delivery Area	5952	11.9[E]	8.0 to 15.9	Same	Lower
Northeast Health Service Delivery Area	5953	16.3[E]	8.4 to 24.3	Same	Same
Yukon Territory	**6001**	**14.1**	**10.9 to 17.4**	**Same**	**...**
Northwest Territories	**6101**	**16.1**	**11.5 to 20.6**	**Same**	**...**
Nunavut - 10 largest communities[1]	**6201**	**20.1**	**15.6 to 24.6**	**Higher**	**...**

... not applicable
[E] coefficient of variation between 16.6% and 33.3% (interpret with caution)
F coefficient of variation greater than 33.3% (too unreliable to be published)
1. The Canadian Community Health Survey is administered in the 10 largest communities in Nunavut, using an alternative methodology that accommodates some of the operational difficulties inherent to remote locales. The 10 largest communities are Iqaluit, Cambridge Bay, Baker Lake, Arviat, Rankin Inlet, Kugluktuk, Pond Inlet, Cape Dorset, Pangnirtung, Igloolik.
Source: 2007 Canadian Community Health Survey.

Changes in the prevalence of asthma among Canadian children

by Rochelle Garner and Dafna Kohen

Asthma is one of the most common chronic conditions in childhood, and its prevalence is increasing in many countries, including Canada.[1-4] This article picks up where previous examinations of childhood asthma have left off.[4,5] Based on data from the National Longitudinal Survey of Children and Youth (NLSCY), changes in prevalence rates among children aged 0 through 11 are examined from 1994/1995 through 2000/2001, by asthma severity, and by child and family socio-demographic factors.

Prevalence increasing

In 1994/1995, 11% of Canadian children aged 0 to 11 (nearly 520,000) had been diagnosed with asthma.

Table 1
Asthma prevalence among children aged 0 to 11, Canada excluding territories, 1994/1995 to 2000/2001

	1994/ 1995	1996/ 1997	1998/ 1999	2000/ 2001	Comparison between 1994/1995 and 2000/2001 (p-value)
Population aged 0 to 11 (000s)	4,681.2	4,750.0	4,514.9	4,379.6	...
Number with asthma (000s)	518.4	575.4	583.7	586.0	...
% with asthma	11.1	12.1	12.9	13.4	<.0001
Asthma severity among children with asthma					
Low (%)	27.0	29.0	31.8	30.9	ns
Moderate (%)	32.3	31.3	32.0	33.3	ns
High (%)	40.8	39.7	36.2	35.8	.02
Asthma attack in past year among children with asthma					
Number (000s)	264.4	256.6	241.3	230.2	...
%	51.1	44.6	41.4	39.3	<.0001
Wheezing in past year					
% of 0- to 11-year-olds	17.5	17.2	18.5	18.7	ns
% of 0- to 11-year-olds with asthma	66.5	65.2	62.2	60.5	.007
Regular use of inhalants					
% of children with asthma	47.2	45.6	42.2	44.5	ns

ns = not significant
... not applicable
Note: Because of rounding, detail may not add to 100%.
Source: 1994/1995 to 2000/2001 National Longitudinal Survey of Children and Youth.

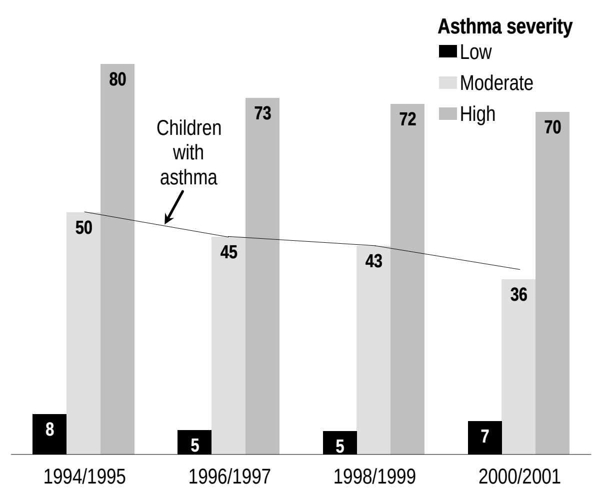
By 2000/2001, the rate had risen to more than 13% (Table 1), a statistically significant increase of nearly 70,000 children.

Among children with asthma, the proportion with high-severity symptoms dropped from 41% in 1994/1995 to 36% in 2000/2001. This is similar to a British study that found a significant increase in the prevalence of asthma diagnosis, but only for children with mild symptoms.[6]

Asthma attacks less common

Despite the increase in childhood asthma, the prevalence of asthma attacks decreased. In 1994/1995, about half (51%) of 0- to 11-year-olds with asthma were reported to have had an attack in the previous year; by 2000/2001, this proportion had dropped to 39% (Table 1).

Figure 1
Prevalence of past-year asthma attacks among children aged 0 to 11 with asthma, by asthma severity, Canada excluding territories, 1994/1995 to 2000/2001



Source: 1994/1995 to 2000/2001 National Longitudinal Survey of Children and Youth.

Throughout the period, the likelihood of having had an asthma attack depended on the severity of the disease (Figure 1). For example, in 2000/2001, 70% of children with high-severity asthma were reported to have had an attack in the past year, compared with fewer than 10% of those with low-severity asthma.

Treatment and use of inhalers

The decrease in asthma attacks among Canadian children may be associated with the use of medications. Two types of treatment are available: relievers and controllers (Table 2). Both types of treatment are generally administered through inhalation devices, sometimes called inhalers or puffers, although oral medication is also available.

Relievers (short-acting $ß_2$-agonists) are used on demand when a child becomes symptomatic. This may be during periods of physical exertion or when the condition is triggered by environmental stimuli such as pets, dust or tobacco smoke. For children with mild asthma requiring infrequent treatment, relievers are recommended.[7-9] More severe cases are generally treated with controllers, that is, inhaled glucocorticoids,[7-9] which are typically used daily to help control asthma and prevent attacks.[10] It was not possible to differentiate the use of these two types of medication in the NLSCY, as the question asked only if the child used inhalers or puffers for asthma, not if the medication was for relief or control of the condition.

Nearly 45% of children with asthma used inhalers on a regular basis in 2000/2001, a figure similar to that reported in 1994/1995 (Table 1). However, the use of inhalers (as asked in the NLSCY) is not the same as reporting whether a child has been prescribed an inhaler. A child may have a prescribed inhaler, but owing to better control of asthma or lower severity, may not have to use it regularly. This is particularly true for asthma relievers. In such cases, the person reporting on behalf of the child is likely to have answered “no” to questions about regular inhaler use, even though the child has a prescription for inhaled asthma medications. Therefore, it is possible that the prevalence of prescriptions is underestimated in this sample. Another possibility is that other asthma controllers or adjunct treatments may have been used, but were not captured by any of the NLSCY items.

Table 2
Asthma treatments and their use

Treatment	Examples	Use
Relievers	Inhaled short-acting $ß_2$-agonist (bronchodilators)	As needed to relieve intermittent asthma symptoms; not to exceed 3 times/week
Controllers	Inhaled or oral glucocorticosteroid (e.g., (beclomethasone diproprionate, budesonide, fluticasone propionate)	Daily; lowest dosage necessary to achieve control of symptoms
Adjunct therapy	Leukotriene-receptor agonists	May be used as alternative to higher does of inhaled glucocorticosteroids or for those who are intolerant to glucocorticosteroids
	Anti-allergic, non-steroidal agents (e.g., cromoglycate, nedocromil)	May be used in children as alternative to low-dose inhaled glucocorticosteroids
	Long-acting $ß_2$-agonists (e.g., salmetrol, formoterol, theophylline, iprotropium)	In addition to inhaled glucocorticosteroids, may be used as alternative to higher doses to achieve control

Source: Canadian Asthma Consensus Report, 1999.[8]

Boys and older children

Boys were significantly more likely than girls to have been diagnosed with asthma (Table 3). For example, in 2000/2001, 16% of boys were reported to have asthma, compared with around 11% of girls, a difference that has been observed in other studies.[11-13] Boys were also more likely than girls to have had symptoms such as wheezing or whistling in the chest (Table 4). However, among children with asthma, there was no gender difference in the rate of attacks in the past year (Table 4).

The prevalence of asthma among boys rose significantly from just under 14% to 16% between 1994/1995 and 2000/2001 (Table 3). However, the percentage of boys with asthma who had had an attack in the past year fell from 52% to 41% (Table 4). The pattern was similar for girls, but unlike boys, the percentage who had experienced wheezing or whistling in the chest increased (Table 4).

Table 3
Prevalence of asthma among children aged 0 to 11, by selected characteristics, Canada excluding territories, 1994/1995 to 2000/2001

	Prevalence of asthma				Comparison between 1994/1995 and 2000/2001 (p-value)
	1994/ 1995	1996/ 1997	1998/ 1999	2000/ 2001	
	%				
Total	**11.1**	**12.1**	**12.9**	**13.4**	**<.0001**
Sex					
Male	13.6*	14.9*	15.3*	16.1*	.002
Female†	8.4	9.2	10.4	10.5	.003
Age					
0 to 5	8.4‡	8.9‡	9.9‡	9.9‡	.003
6 to 9	13.7	15.2	15.0	15.7	ns
10 to 11	14.0	15.4	17.6	17.6	.03
Daily smoker in household					
Yes	13.0*	13.4*	14.8*	15.4*	.01
No†	9.8	11.4	12.0	12.5	.0001
Household income					
Lowest/Lower-middle	11.9	14.2*	15.3*	15.5	.04
Middle	10.8	11.0	12.5	12.2	ns
Upper-middle	10.8	13.1*	13.1	14.5	.0002
Highest†	11.2	10.0	11.9	12.4	ns
Urban/Rural					
Urban	11.2	12.3*	12.9	13.5	.0002
Rural†	10.5	10.5	12.9	12.8	.03
Region of residence					
British Columbia†	9.6	10.3	10.8	11.4	ns
Prairie provinces	10.1	10.7	11.1	11.1	ns
Ontario	11.1	13.3*	13.8*	13.6	.01
Quebec	11.3	10.9	13.3	15.1*	.002
Atlantic provinces	14.7*	16.2*	15.8*	15.5*	ns

† reference category
‡ significantly different from estimate for next-oldest age group ($p < 0.05$)
* significantly different from estimate for reference category ($p < 0.05$)
ns = no statistically significant difference between 1994/1995 and 2000/2001
Source: 1994/1995 to 2000/2001 National Longitudinal Survey of Children and Youth.

Young children were less likely than older children to have been diagnosed with asthma (Table 3). Throughout the period, the proportion of 6- to 9-year-olds who had asthma was significantly higher than the proportion of 0- to 5-year-olds.

Although the prevalence of asthma rose in all age groups between 1994/1995 and 2000/2001, the increase was significant only for 0- to 5-year-olds and 10- to 11-year-olds (Table 3). The prevalence of wheezing or whistling in the chest also increased among the youngest children (Table 4).

Relatively lower rates of asthma but higher rates of wheezing or whistling in the chest among 0- to 5-year-olds are not contradictory. Health professionals often have difficulty diagnosing asthma in very young children, who are less able to follow instructions required to complete the diagnostic lung function test. Young children (ages 0 to 5 who experience wheezing and whistling in the chest may go to be diagnosed with asthma when they are older. Conversely, asthma symptoms may resolve as the child's airways grow and develop.

Table 4
Prevalence of wheezing or whistling in chest in past year (all children aged 0 to 11) and asthma attack (children aged 0 to 11 with asthma), by selected characteristics, 1994/1995 and 2000/2001

	Prevalence of past-year wheezing or whistling in chest (all children)		Prevalence of past-year asthma attack (children with asthma)	
	1994/ 1995	2000/ 2001	1994/ 1995	2000/ 2001
	%		%	
Total	**17.5**	**18.7**	**51.1**	**39.3** §
Sex				
Male	20.1*	20.5*	52.0	40.9 §
Female†	14.7	16.8§	49.5	36.7 §
Age				
0 to 5	19.4‡	22.1‡§	56.8‡	48.3‡§
6 to 9	16.7‡	16.4	48.6	33.7 §
10 to 11	13.5	14.5	45.6	36.8
Daily smoker in household				
Yes	20.2*	20.9*	49.8	41.0 §
No†	15.8	17.7§	52.4	38.7 §
Household income				
Lowest/Lower-middle	20.4*	21.2*	52.0	41.3
Middle	16.6	17.9	52.6	32.7 §
Upper-middle	17.5	20.2*§	50.9	43.5
Highest†	15.8	16.6	47.2	38.8
Urban/Rural				
Urban	17.7	18.7	52.3*	39.6 §
Rural†	16.4	18.7§	45.2	36.8
Region of residence				
British Columbia†	15.3	14.4	52.8	43.8
Prairie provinces	16.2	16.6	52.0	44.8
Ontario	17.3	19.4*	49.9	35.6 §
Quebec	18.7*	20.5*	51.2	39.1 §
Atlantic provinces	21.3*	21.7*	51.7	42.4 §

† reference category
‡ significantly different from estimate for next-oldest age group ($p < 0.05$)
* significantly different from estimate for reference category ($p < 0.05$)
§ significant difference between 1994/1995 and 2000/2001 ($p < 0.05$)
Source: 1994/1995 to 2000/2001 National Longitudinal Survey of Children and Youth.

Among children who had been diagnosed with asthma, past-year attacks dropped significantly for those aged 0 to 5 and 6 to 9 (Table 4).

Smoking in household increases risk

Children living in households where either parent was a daily smoker were significantly more likely than children in non-smoking households to have been diagnosed with asthma (Table 3) or to have asthma-like symptoms (Table 4). However, among children with asthma, there was no difference in the rate of past-year asthma attacks between those in smoking and non-smoking households (Table 4).

Between 1994/1995 and 2000/2001, in smoking households, the prevalence of asthma among children increased (Table 3), but past-year attacks among those with asthma decreased (Table 4). Curiously, only children in non-smoking households experienced an increase in the prevalence of wheezing or whistling in the chest (Table 4). The presence of other allergenic factors in the home (pets, for instance), which was not assessed in the NLSCY, may be related to the increase in asthma-like symptoms among children in non-smoking households.

Association with income

While low income generally tends to be associated with poor health, and high income with good health, the relationship between household income and childhood asthma did not follow this pattern. In 2000/2001, the prevalence of childhood asthma did not differ significantly by household income (Table 3). Similarly, among those with asthma, the likelihood of having had an attack in the past year was not related to household income (Table 4). And while reports of wheezing or whistling in the chest were significantly high for children in lowest/lower-middle income households, this was also true for those in upper-middle income households.

From 1994/1995 to 2000/2001, the prevalence of asthma rose significantly for children in the lowest/lower-middle and upper-middle income households (Table 3). Rates of wheezing and whistling in the chest increased among children in the upper-middle income group (Table 4). Yet for children with asthma, the rate of past-year attacks fell among those in middle income households.

Regional differences

As has been found in other Canadian studies,[14] the prevalence of asthma among children did not differ between urban and rural areas. By contrast, surveys in other countries, notably the United States, have found significantly higher rates of childhood asthma in urban centres, where pollution tends to be higher and air quality poorer.[15]

However, childhood asthma rates in Canada did differ by region. Children in British Columbia and the prairie provinces (Alberta, Saskatchewan and Manitoba) had the lowest rates in every NLSCY cycle. In the other regions, rates were significantly higher, particularly in the Atlantic provinces (Nova Scotia, Newfoundland, New Brunswick and Prince Edward Island).

Other researchers who have found the same regional patterns attempted to determine if the differences in childhood asthma rates could be explained by environmental conditions such as ozone, temperature, and relative humidity.[5] But even when these factors were taken into account, children in the Atlantic provinces continued to show higher rates of asthma. Other factors that may be associated with these regional discrepancies could be indoor air conditions, acid aerosol levels, and even early immigration and settlement practices that may have contributed to a greater genetic predisposition to asthma in the Atlantic provinces.[5]

Summary

The prevalence of childhood asthma is rising, particularly among boys, among 0- to 5-year-olds and 10- to 11-year-olds, and among children in households where adults smoke. Whether the increase is due to an improvement in physicians' ability to recognize and diagnose asthma, or whether

About the data

The data for this article are from the National Longitudinal Survey of Children and Youth (NLSCY), a longitudinal survey that has been conducted biennially since 1994/1995. The target population was children who were aged 0 to 11 in 1994/1995. Beginning in 1996/1997, an additional cohort (primarily newborns and one-year-olds) was recruited to each cycle to maintain a representative sample of children aged 0 through 11.

For every household, the "person most knowledgeable" (PMK) about the child was identified to provide information about each respondent child, as well as for the entire household. In most cases, the PMK was the child's biological mother.

Data from the first four NLSCY cycles were used for this article. Cross-sectional weights were not made available in the NLSCY for the fifth and sixth cycles, which precluded their use in this analysis. Estimates were weighted to represent the Canadian population aged 0 through 11 on January 1 of each survey year. Analyses were bootstrapped to account for the complex survey design.

The prevalence of asthma among children was based on the PMK's response to the question: "Has he/she ever had asthma that was diagnosed by a health professional?" If they answered "yes," PMKs were asked if their child had had an asthma attack in the past 12 months. All PMKs, regardless of whether the child had been diagnosed with asthma, were asked: "Has he/she had wheezing or whistling in the chest at any time in the last 12 months?" and "Does he/she take any of the following prescribed medication on a regular basis: Ventolin or other inhalants?"

The NLSCY does not ask about the severity of a child's asthma per se. To obtain a proxy for asthma severity, two items were used to create a classification: past-year wheezing or whistling in the chest and regular use of inhalers. Three levels of severity in children with asthma were identified:

- Low: no wheezing or whistling in the chest in the past year and no regular use of inhalers.
- Moderate: wheezing or whistling in the chest in the past year OR regular use of inhalers.
- High: wheezing or whistling in the chest in the past year AND regular use of inhalers.

While this classification is based on measures used in other epidemiological studies,[16] as an indicator of severity, it is only a proxy and is limited in its ability to generate classes that are homogenous in the individuals they capture. Nevertheless, in other studies,[17] this measure has been associated with poor health and the presence of activity limitations.

Household income was based on the number of people in the household and total household income from all sources in the 12 months before the interview.

Household income group	People in household	Total household income
Lowest	1 to 4	Less than $10,000
	5 or more	Less than $15,000
Lower-middle	1 or 2	$10,000 to $14,999
	3 or 4	$10,000 to $19,999
	5 or more	$15,000 to $29,999
Middle	1 or 2	$15,000 to $29,999
	3 or 4	$20,000 to $39,999
	5 or more	$30,000 to $59,999
Upper-middle	1 or 2	$30,000 to $59,999
	3 or 4	$40,000 to $79,999
	5 or more	$60,000 to $79,999
Highest	1 or 2	$60,000 or more
	3 or more	$80,000 or more

For this analysis, the two lowest income groups were combined.

The use of survey data entails certain limitations. First, the analysis is constrained by the items and wording in the survey. For example, as noted above, because no single question about asthma severity was included in the NLSCY, a composite measure was derived from existing items. For this analysis, it would also have been preferable to have more detailed questions about the use of asthma medications, including type (reliever versus controller), use of adjunct therapy, and the frequency of treatment use.

Second, it was not possible to use NLSCY data post-2000/2001, because cross-sectional survey weights were not generated for more recent cycles. Nevertheless, these results update[4] information about the prevalence of childhood asthma and provide a description of trends by sociodemographic and behavioural factors.

A final limitation of this study is the inability to determine if the increase in the prevalence of asthma was due to changes in diagnostic behaviors, in patterns of prescribing medications, in behavioural symptoms, or in the prevalence of the condition itself.

the underlying causes are becoming more widespread, cannot be determined from this analysis and warrant further study.

Rochelle Garner (613-951-3977; Rochelle.Garner@statcan.ca) and Dafna Kohen (613-951-3346; Dafna.Kohen@statcan.ca) are with the Health Information and Research Division at Statistics Canada.

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Community belonging and self-perceived health by Margot Shields

Over the past 25 years, research has established a causal association between social relationships and health.[1,2] People who are socially isolated and have few ties to other individuals are more likely to suffer from poor physical and mental health and to die prematurely.

The notion of "social capital" has received increasing attention in health research. Social capital is generally defined as aspects of social organization, such as civic participation and trust in others, that facilitate cooperation among community members.[3] High levels of social capital have been linked to lower mortality rates, lower rates of crime, and positive perceptions of health.[3-7]

There is, however, some debate about whether social capital benefits the community at large or individual residents, who profit directly from feelings of connectedness to the community. A recent study suggests that the association between social capital and positive perceptions of health is important at the individual level.[7] It is hypothesized that feeling "connected" to one's community promotes health because such ties promote mutual respect, and thereby increase self-esteem. Another possibility is that interaction among community members results in the transmission of social norms related to health-promoting behaviours such as physical activity and refraining from smoking.[1,2]

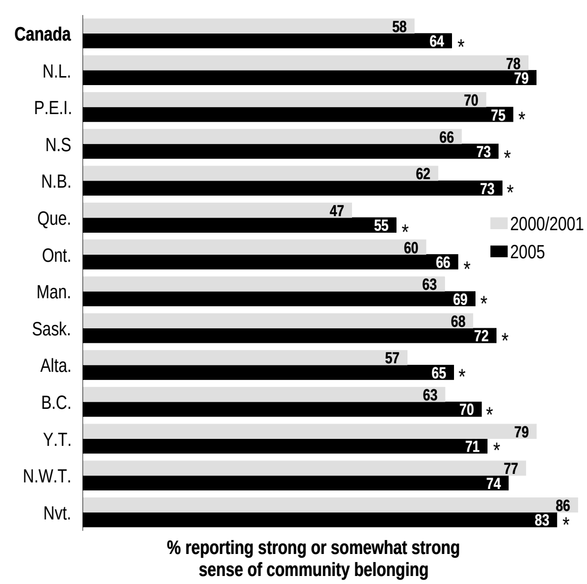
Since its inception in 2000/2001, the Canadian Community Health Survey (CCHS) has included a question on community belonging. An earlier paper, based on data from the 2000/2001 CCHS, revealed an association between individuals' sense of belonging and their general self-perceived health.[8] With data from the 2005 CCHS, this article updates that earlier work.

Comparisons are made between rates of community belonging at the provincial or territorial and health region levels. Because the 2005 CCHS contains questions about self-perceived mental health, the previous analysis can be extended by measuring associations between community belonging and mental as well as general health.

Majority feel connected

In 2005, close to two-thirds of Canadians (64%) reported a strong sense of community belonging; this included 17% who described their sense of belonging as very strong, and 47% who reported it as "somewhat strong." Just over a quarter (26%) reported a "somewhat weak" sense of community belonging; and 10%, "very weak."

Figure 1
Percentage reporting strong or somewhat strong sense of community belonging, by province or territory, household population aged 12 or older, Canada, 2000/2001 and 2005

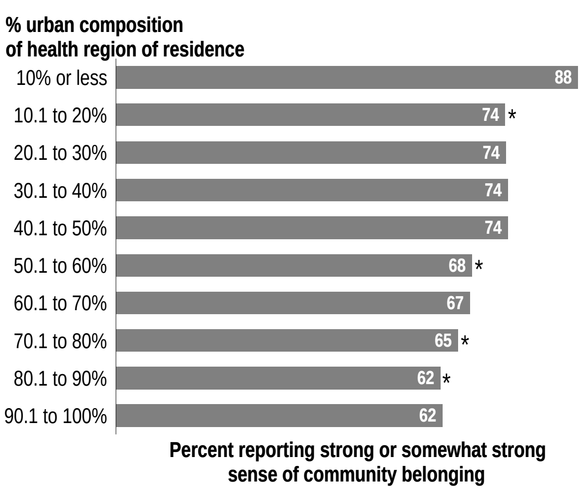


* significantly different from estimate for 2000/2001 ($p < 0.05$)
Sources: 2000/2001 and 2005 Canadian Community Health Survey.

Higher in Atlantic provinces and the territories

The likelihood of reporting a strong sense of community belonging varied across the country (Figure 1, Appendix Table A). Approximately three-quarters of the residents of the Atlantic provinces reported a strong sense of belonging, with Newfoundlanders having the highest rate among the ten provinces at 79%. Rates were also high for residents of the territories: 71% for Yukon Territory, 74% for the Northwest Territories, and 83% for Nunavut. Residents of Quebec were the least likely to feel connected, with only 55% reporting a strong sense of belonging. A previous study found that Quebecers were less likely to report a strong sense of belonging to Canada, but their sense of belonging to their province was similar to that of other Canadians.[9]

Figure 2
Percentage reporting strong or somewhat strong sense of community belonging, by percent urban composition of health region of residence, household population aged 12 or older, Canada, 2005



* significantly lower than previous estimate ($p < 0.05$)
Source: 2005 Canadian Community Health Survey.

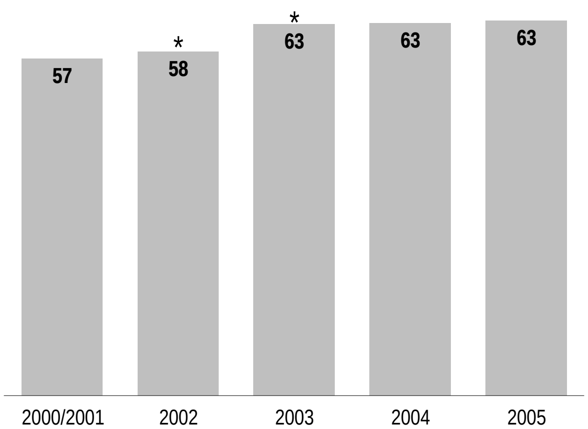
The degree to which the residents of health regions within each province felt connected to their respective communities also differed widely. Health regions made up of major urban centres tended to have the lowest rates of community belonging. For people living in predominately urban health regions (80% to 100% urban), the overall community belonging rate was 62%. In Ontario, the lowest rates were for the health regions of the City of Toronto, York, and the City of Ottawa; in Manitoba, the lowest rate was for Winnipeg; in Saskatchewan, Saskatoon; in Alberta, Calgary and the Capital health region (Edmonton); and in British Columbia, Vancouver. Conversely, rural health regions had higher rates of belonging. The figure for residents of health regions that were predominantly rural (10% or less urban) was 88% (Figure 2). The highest rate in the country was 90% in the Labrador-Grenfell health region in Newfoundland and Labrador.

Rates increasing

The question on community belonging has been included in every CCHS cycle since 2000/2001. Because some cycles included only the population aged 15 or older and some excluded the territories, trends in rates were compared for the population aged 15 or older living in the ten provinces (Figure 3). From 2000/2001 to 2002, the proportion of the population reporting a strong sense of community belonging rose slightly from 57% to 58%. By 2003, the rate had risen 5 percentage points to 63% and has remained stable since then.

Between 2000/2001 and 2005, significant increases in community belonging occurred in all provinces except Newfoundland and Labrador (Figure 1) The sharpest upturn was in New Brunswick, where the rate rose from 62% to 73%. Conversely, in the territories, rates decreased in Nunavut and Yukon Territory, and no significant change was observed for the Northwest Territories.

Figure 3
Percentage reporting strong or somewhat strong sense of community belonging, household population aged 15 or older, Canada excluding territories, 2000/2001 to 2005



* significantly different from estimate for previous period ($p < 0.05$)
Sources: 2000/2001 to 2005 Canadian Community Health Survey.

Home language and cultural group

Community belonging was related to home language (Table 1). Among people who spoke mostly English at home, 68% reported a strong sense of community belonging. The figure was considerably lower (55%) among those whose home language was French. For those who spoke some other language at home, 60% reported a strong sense of belonging.

This low rate of community belonging at the national level for people whose home language was French reflects the situation in Quebec. In Quebec, a strong sense of belonging was reported by 61% of those whose home language was English, compared with 54% of those whose home language was French (data not shown). By contrast, in the other provinces and territories, the likelihood of reporting a strong sense of belonging was similar regardless of whether the home language was English or French (68% and 67%, respectively).

Associations between community connectedness and cultural or racial group were also observed.

Table 1
Percentage reporting strong or somewhat strong sense of community belonging, by selected characteristics, household population aged 12 or older, Canada, 2005

	%	95% confidence interval
Total	**64.4**	**64.0 to 64.8**
Sex		
Men	64.0	63.4 to 64.6
Women†	64.7	64.2 to 65.3
Age group		
12 to 17	77.4*	76.3 to 78.4
18 to 29	54.5*	53.5 to 55.5
30 to 44†	62.1	61.2 to 62.9
45 to 64	65.4*	64.7 to 66.2
65 or older	71.6*	70.8 to 72.5
Marital status‡		
Married or common-law†	64.9	64.2 to 65.5
Widowed	63.2	59.3 to 67.1
Divorced or separated	57.3*	55.7 to 59.0
Never married	54.4*	53.1 to 55.7
Children younger than 12 in household		
Yes	66.8*	66.0 to 67.6
No†	63.6	63.1 to 64.1
Education‡		
Less than secondary graduation	61.1	59.6 to 62.6
Secondary graduation	64.6*	63.3 to 65.9
Some postsecondary	63.2	61.3 to 65.1
Postsecondary graduation†	62.2	61.6 to 62.8
Household income quintile		
1 Lowest	60.8*	59.8 to 61.8
2	64.4	63.4 to 65.4
3†	64.7	63.6 to 65.7
4	65.2	64.3 to 66.2
5 Highest	65.0	64.1 to 66.0
Home ownership		
Yes	67.1*	66.6 to 67.6
No†	55.1	54.3 to 56.0
Language spoken most often at home		
English†	68.1	67.6 to 68.5
French	55.0*	54.0 to 55.9
Other	60.1*	58.3 to 61.8
Cultural or racial group		
White†	64.8	64.4 to 65.3
South Asian	74.2*	71.3 to 77.1
Filipino	68.9	63.9 to 73.9
Aboriginal (off-reserve)	63.7	61.5 to 65.9
Black	63.7	59.9 to 67.5
Arab	62.3	56.0 to 68.6
Japanese	58.7	48.4 to 69.0
West Asian	57.1	48.3 to 65.9
Latin American	54.3*	48.4 to 60.1
Southeast Asian	51.9*	45.8 to 57.9
Chinese	51.8*	48.6 to 55.0
Korean	50.0*	39.8 to 60.3
Other or multiple racial or cultural origin	62.2	58.8 to 65.5

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
‡ based on people aged 25 to 64
Source: 2005 Canadian Community Health Survey.

The data

Estimates are based on data from the 2005 Canadian Community Health Survey (CCHS), cycle 3.1. The CCHS covers the household population aged 12 or older in all provinces and territories, except members of the regular Forces and residents of institutions, Indian reserves, Canadian Forces bases, and some remote areas. Data for cycle 3.1 were collected from January to December 2005 from a sample of 132,947 persons. The response rate was 79%. Approximately 3% of this sample were excluded from this analysis because of non-response to the question on community belonging. All estimates were weighted to be representative of the household population aged 12 or older in 2005. Differences between estimates were tested to ensure statistical significance, which was established at the 0.05 level. To account for survey design effects, standard errors and coefficients of variation were estimated using the bootstrap technique.[16-18]

To measure *sense of community belonging*, respondents to the CCHS 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?"

Self-perceived general health was assessed with the question, "In general, would you say your health is: excellent? very good? good? fair? poor?"

Self-perceived mental health was measured with the question, "In general, would you say your mental health is: excellent? very good? good? fair? poor?"

Household income was based on the number of people in the household and total household income from all sources in the 12 months before the interview. Household income groups were derived by calculating the ratio between the total household income from all sources in the previous 12 months and Statistics Canada's low-income cutoff (LICO) specific to the number of people in the household, the size of the community and the survey year. These adjusted income ratios were grouped into quintiles (five groupings, each containing one-fifth of Canadians).

Home ownership was established by asking respondents if the dwelling in which they lived was owned by a member of the household.

An *urban/rural* variable was assigned to each record based on the percent urban composition of the health region where the respondent lived. Urban areas were defined as continuously built-up areas having a population concentration of 1,000 or more and a population density of 400 or more per square kilometre based on current census population counts. The percent urban composition was calculated for each health region by dividing the population living in these urban areas by the total population of the health region.

Home language was established by asking respondents, "What language do you speak most often at home?"

To establish *cultural or racial group*, respondents were asked, "People living in Canada come from many different cultural and racial backgrounds. Are you: …." A check-list of responses was read to respondents.

Among Whites, 65% reported a strong sense of community belonging. The figure was higher for South Asians (74%), and lower for Koreans (50%), Chinese (52%), Southeast Asians (52%) and Latin Americans (54%).

Age, marital status, socio-economic characteristics

While the proportions of men and women who reported a strong sense of community belonging did not differ, rates did vary by age group. More than three-quarters (77%) of youth aged 12 to 17 reported a strong sense of belonging, but among young adults aged 18 to 29, the figure was much lower at 55%. At older ages, the rate increased steadily from 62% among those aged 30 to 44 to 72% among seniors (65 or older).

Feeling connected to the community was less common among people who were divorced or separated (57%) or never married (54%) than among those who were married or living common-law (65%). People living with young children were slightly more likely than those who did not have young children in their household to have a strong sense of belonging.

Modest associations were observed between community belonging and socio-economic status. People in the lowest household group were less likely to report a strong sense of community belonging, compared with those in the middle-income group, but there were no differences for the remaining income groups. The only association with education was that postsecondary graduates were slightly less likely to feel connected than were people who had completed only high school.

Home ownership, however, did make a difference, with 67% of owners reporting a strong sense of community belonging, compared with 55% of those who were not owners.

Relationships persist

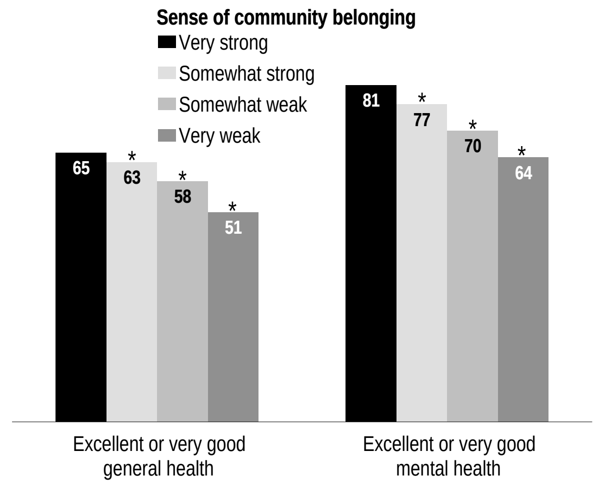
When examined in a multivariate model, these associations between community belonging and cultural and socio-demographic characteristics generally persisted (Appendix Table B). Because rates of community belonging differed by age group and the age structure of the population has shifted slightly since 2000, rates over time were recalculated to standardize to the 2005 population. The crude and age-standardized rates were virtually identical (data not shown), indicating that the increases over time were not due to changes in the age distribution of the population. As well, to ensure that geographical differences were not the result of differing age distributions, provincial and health region rates were age-standardized to the overall 2005 Canadian population. Again, the crude and adjusted rates were similar; the results of significance testing between provincial and health region rates versus the overall Canadian rate (Appendix Table B) remained virtually unchanged when based on adjusted rates.

Community belonging and health

Close to two-thirds of those who felt a very strong or somewhat strong sense of community belonging reported excellent or very good general health (Figure 4). By contrast, about half (51%) of those with a very weak sense of belonging viewed their general health favourably. These findings are particularly relevant in view of evidence that self-perceived general health is predictive of chronic disease incidence, use of medical services, recovery from illness, functional decline, and mortality.[10-15]

The likelihood of reporting excellent or very good mental health also paralleled decreases in connectedness—from 81% among those with a very

Figure 4
Percentage reporting excellent or very good health, by sense of community belonging, household population aged 12 or older, Canada, 2005



* significantly lower than previous category ($p < 0.05$)
Source: 2005 Canadian Community Health Survey.

Table 2
Adjusted odds ratios relating community belonging to excellent or very good self-perceived general and mental health, household population aged 12 or older, Canada, 2005

	Model 1 Excellent or very good self-perceived general health		Model 2 Excellent or very good self-perceived general health controlling for mental health		Model 3 Excellent or very good self-perceived mental health	
	Adjusted odds ratio‡	95% confidence interval	Adjusted odds ratio‡	95% confidence interval	Adjusted odds ratio‡	95% confidence interval
Sense of community belonging						
Very strong	1.8*	1.7 to 1.9	1.5*	1.4 to 1.7	2.2*	2.0 to 2.3
Somewhat strong	1.4*	1.3 to 1.5	1.2*	1.2 to 1.3	1.5*	1.4 to 1.6
Somewhat weak	1.1*	1.0 to 1.2	1.1	1.0 to 1.1	1.1*	1.0 to 1.2
Very weak†	1.0	...	1.0	...	1.0	...

† reference category
‡ controlled for sex, age, marital status, presence of children in household, education, household income, home ownership, language spoken most often at home, cultural or racial group, percent urban composition in health region of residence, province or territory, employment status, smoking status, number of physical chronic conditions, and mood or anxiety disorder in past year
* significantly different from estimate for reference category ($p < 0.05$)
... not applicable
Source: 2005 Canadian Community Health Survey.

strong sense of community belonging down to 64% among those whose sense of community belonging was very weak (Figure 4).

Even when other potentially confounding factors were taken into account, community belonging was strongly related to self-perceived general and mental health (Table 2). Compared with people whose sense of community belonging was weak, those with a very strong sense had close to twice the odds of reporting excellent or very good general health (Model 1), and over twice the odds of reporting excellent or very good mental health (Model 3)

When people rate their general health, psychological factors play a role in perceptions.[19] Therefore, the degree to which physical and mental factors contribute to associations between community belonging and perceptions of general health is unknown. When the relationship between community belonging and self-perceived general health was examined in a model controlling for self-perceived mental health in addition to other possible confounders, the odds ratios for community belonging diminished but were still significant (Model 2). This suggests that a sense of community belonging is associated with both physical and mental health. However, because of the cross-sectional nature of this analysis, it is not possible to determine if health exerts an influence on sense of community belonging or the other way around.

Margot Shields (613-951-4177; Margot.Shields@statcan.ca) is with the Health Information and Research Division at Statistics Canada.

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Table A

Percentage reporting strong or somewhat strong sense of community belonging, by province or territory and health region, household population aged 12 or older, Canada, 2005

	Region code	%	95% confidence interval	Significantly higher or lower (p < 0.05) than: Canada	Province or Territory
Canada		**64.4**	**64.0 to 64.8**	**...**	**...**
Newfoundland and Labrador	**1000**	**79.2**	**77.5 to 80.9**	**Higher**	**...**
Eastern Regional Integrated Health Authority	1011	74.7	72.2 to 77.3	Higher	Lower
Central Regional Integrated Health Authority	1012	86.8	83.4 to 90.1	Higher	Higher
Western Regional Integrated Health Authority	1013	81.5	77.6 to 85.4	Higher	Same
Labrador-Grenfell Regional Integrated Health Authority	1014	90.3	87.7 to 92.8	Higher	Higher
Prince Edward Island	**1100**	**75.1**	**72.4 to 77.8**	**Higher**	**...**
West Prince	1101	87.6	82.3 to 93.0	Higher	Higher
East Prince	1102	80.5	76.5 to 84.4	Higher	Higher
Queens	1103	68.9	64.0 to 73.7	Same	Lower
Kings	1104	78.4	72.7 to 84.1	Higher	Same
Nova Scotia	**1200**	**72.6**	**70.9 to 74.2**	**Higher**	**...**
Zone 1	1201	74.8	71.2 to 78.5	Higher	Same
Zone 2	1202	68.7	63.4 to 74.0	Same	Same
Zone 3	1203	72.3	67.8 to 76.8	Higher	Same
Zone 4	1204	78.9	74.7 to 83.1	Higher	Higher
Zone 5	1205	80.0	76.6 to 83.4	Higher	Higher
Zone 6	1206	68.8	65.6 to 72.0	Higher	Lower
New Brunswick	**1300**	**73.2**	**71.6 to 74.8**	**Higher**	**...**
Region 1	1301	74.9	71.6 to 78.1	Higher	Same
Region 2	1302	75.7	72.4 to 78.9	Higher	Same
Region 3	1303	70.2	66.5 to 73.9	Higher	Same
Region 4	1304	67.9	61.8 to 73.9	Same	Same
Region 5	1305	79.4	75.0 to 83.8	Higher	Higher
Region 6	1306	67.1	61.4 to 72.8	Same	Lower
Region 7	1307	81.0	75.2 to 86.7	Higher	Higher
Quebec	**2400**	**54.7**	**53.8 to 55.6**	**Lower**	**...**
Région du Bas-Saint-Laurent	2401	66.6	64.0 to 69.1	Same	Higher
Région du Saguenay - Lac-Saint-Jean	2402	60.4	56.4 to 64.4	Same	Higher
Région de la Capitale Nationale	2403	53.1	49.6 to 56.5	Lower	Same
Région de la Mauricie et du Centre-du-Québec	2404	56.0	52.3 to 59.7	Lower	Same
Région de l'Estrie	2405	56.9	53.3 to 60.6	Lower	Same
Région de Montréal	2406	55.2	53.3 to 57.0	Lower	Same
Région de l'Outaouais	2407	52.8	49.1 to 56.5	Lower	Same
Région de l'Abitibi-Témiscamingue	2408	56.2	52.2 to 60.1	Lower	Same
Région de la Côte-Nord	2409	74.0	70.7 to 77.2	Higher	Higher
Région du Nord-du-Québec	2410	74.3	69.9 to 78.7	Higher	Higher
Région de la Gaspésie - Îles-de-la-Madeleine	2411	71.8	67.9 to 75.8	Higher	Higher
Région de la Chaudière-Appalaches	2412	53.7	50.1 to 57.4	Lower	Same
Région de Laval	2413	45.2	42.6 to 47.7	Lower	Lower
Région de Lanaudière	2414	49.4	44.9 to 54.0	Lower	Lower
Région des Laurentides	2415	54.1	50.8 to 57.4	Lower	Same
Région de la Montérégie	2416	53.6	50.9 to 56.4	Lower	Same
Ontario	**3500**	**65.5**	**64.7 to 66.3**	**Higher**	**...**
District of Algoma Health Unit	3526	74.0	70.1 to 78.0	Higher	Higher
Brant County Health Unit	3527	70.6	66.8 to 74.4	Higher	Higher
Durham Regional Health Unit	3530	63.0	59.7 to 66.3	Same	Same
Elgin-St Thomas Health Unit	3531	69.4	65.2 to 73.7	Higher	Same
Grey Bruce Health Unit	3533	74.4	70.8 to 78.1	Higher	Higher
Haldimand-Norfolk Health Unit	3534	66.0	61.4 to 70.6	Same	Same
Haliburton, Kawartha, Pine Ridge District Health Unit	3535	72.2	68.4 to 76.0	Higher	Higher
Halton Regional Health Unit	3536	69.5	66.4 to 72.7	Higher	Higher
City of Hamilton Health Unit	3537	67.6	64.7 to 70.6	Higher	Same
Hastings and Prince Edward Counties Health Unit	3538	78.2	74.5 to 81.9	Higher	Higher

Table A

Percentage reporting strong or somewhat strong sense of community belonging, by province or territory and health region, household population aged 12 or older, Canada, 2005 continued

	Region code	%	95% confidence interval	Significantly higher or lower (p < 0.05) than: Canada	Province or Territory
Huron County Health Unit	3539	73.6	68.7 to 78.5	Higher	Higher
Chatham-Kent Health Unit	3540	71.5	68.1 to 75.0	Higher	Higher
Kingston, Frontenac and Lennox and Addington Health Unit	3541	69.5	65.6 to 73.5	Higher	Higher
Lambton Health Unit	3542	77.1	73.7 to 80.4	Higher	Higher
Leeds, Grenville and Lanark District Health Unit	3543	69.6	66.0 to 73.3	Higher	Higher
Middlesex-London Health Unit	3544	67.8	64.4 to 71.2	Higher	Same
Niagara Regional Area Health Unit	3546	70.9	67.7 to 74.0	Higher	Higher
North Bay Parry Sound District Health Unit	3547	71.6	67.4 to 75.8	Higher	Higher
Northwestern Health Unit	3549	73.0	68.2 to 77.8	Higher	Higher
City of Ottawa Health Unit	3551	62.2	59.6 to 64.8	Same	Lower
Oxford County Health Unit	3552	70.5	65.8 to 75.1	Higher	Higher
Peel Regional Health Unit	3553	67.8	65.5 to 70.2	Higher	Higher
Perth District Health Unit	3554	74.6	70.3 to 79.0	Higher	Higher
Peterborough County-City Health Unit	3555	75.5	71.5 to 79.4	Higher	Higher
Porcupine Health Unit	3556	74.4	70.3 to 78.6	Higher	Higher
Renfrew County and District Health Unit	3557	72.5	67.2 to 77.8	Higher	Higher
Eastern Ontario Health Unit	3558	62.5	58.2 to 66.7	Same	Same
Simcoe Muskoka District Health Unit	3560	65.1	62.0 to 68.3	Same	Same
Sudbury and District Health Unit	3561	70.8	67.4 to 74.1	Higher	Higher
Thunder Bay District Health Unit	3562	74.3	71.0 to 77.6	Higher	Higher
Timiskaming Health Unit	3563	72.8	67.8 to 77.8	Higher	Higher
Waterloo Health Unit	3565	65.8	62.8 to 68.8	Same	Same
Wellington-Dufferin-Guelph Health Unit	3566	64.1	60.6 to 67.6	Same	Same
Windsor-Essex County Health Unit	3568	67.6	64.7 to 70.5	Higher	Same
York Regional Health Unit	3570	60.9	58.1 to 63.8	Lower	Lower
City of Toronto Health Unit	3595	58.2	55.8 to 60.7	Lower	Lower
Manitoba	**4600**	**68.5**	**66.7 to 70.3**	**Higher**	**...**
Winnipeg Regional Health Authority	4610	64.6	61.9 to 67.4	Same	Lower
Brandon Regional Health Authority	4615	67.4	61.9 to 72.9	Same	Same
North Eastman Regional Health Authority	4620	70.5	65.0 to 76.1	Higher	Same
South Eastman Regional Health Authority	4625	66.2	61.3 to 71.0	Same	Same
Interlake Regional Health Authority	4630	74.2	69.1 to 79.2	Higher	Higher
Central Regional Health Authority	4640	76.4	72.8 to 80.0	Higher	Higher
Assiniboine Regional Health Authority	4645	82.0	78.2 to 85.8	Higher	Higher
Parkland Regional Health Authority	4660	81.4	76.2 to 86.5	Higher	Higher
Norman Regional Health Authority	4670	74.5	69.6 to 79.4	Higher	Higher
Burntwood/Churchill	4685	72.4	67.2 to 77.6	Higher	Same
Saskatchewan	**4700**	**72.2**	**70.7 to 73.7**	**Higher**	**...**
Sun Country Regional Health Authority	4701	80.5	75.5 to 85.6	Higher	Higher
Five Hills Regional Health Authority	4702	71.0	66.0 to 76.0	Higher	Same
Cypress Regional Health Authority	4703	84.0	80.3 to 87.8	Higher	Higher
Regina Qu'Appelle Regional Health Authority	4704	71.7	68.5 to 75.0	Higher	Same
Sunrise Regional Health Authority	4705	67.9	61.3 to 74.5	Same	Same
Saskatoon Regional Health Authority	4706	66.0	62.7 to 69.2	Same	Lower
Heartland Regional Health Authority	4707	79.3	75.2 to 83.3	Higher	Higher
Kelsey Trail Regional Health Authority	4708	79.2	74.8 to 83.7	Higher	Higher
Prince Albert Parkland Regional Health Authority	4709	75.9	71.1 to 80.6	Higher	Same
Prairie North Regional Health Authority	4710	79.2	74.6 to 83.8	Higher	Higher
Mamawetan/Keewatin/Athabasca	4714	75.0	70.4 to 79.7	Higher	Same
Alberta	**4800**	**64.8**	**63.4 to 66.1**	**Same**	**...**
Chinook Regional Health Authority	4820	76.8	72.9 to 80.7	Higher	Higher
Palliser Health Region	4821	70.5	66.9 to 74.1	Higher	Higher
Calgary Health Region	4822	60.9	58.5 to 63.3	Lower	Lower
David Thompson Regional Health Authority	4823	71.1	68.2 to 74.0	Higher	Higher
East Central Health	4824	75.1	71.6 to 78.7	Higher	Higher
Capital Health	4825	62.3	59.7 to 64.9	Same	Lower
Aspen Regional Health Authority	4826	68.9	64.9 to 73.0	Higher	Higher

Table A

Percentage reporting strong or somewhat strong sense of community belonging, by province or territory and health region, household population aged 12 or older, Canada, 2005 continued

	Region code	%	95% confidence interval	Significantly higher or lower (p < 0.05) than: Canada	Province or Territory
Peace Country Health	4827	71.5	67.3 to 75.7	Higher	Higher
Northern Lights Health Region	4828	69.3	64.1 to 74.6	Same	Same
British Columbia	**5900**	**69.6**	**68.6 to 70.6**	**Higher**	**...**
East Kootenay Health Service Delivery Area	5911	69.1	64.1 to 74.1	Same	Same
Kootenay-Boundary Health Service Delivery Area	5912	77.2	72.4 to 81.9	Higher	Higher
Okanagan Health Service Delivery Area	5913	71.0	67.2 to 74.7	Higher	Same
Thompson/Cariboo Health Service Delivery Area	5914	76.3	72.4 to 80.3	Higher	Higher
Fraser East Health Service Delivery Area	5921	70.0	66.4 to 73.7	Higher	Same
Fraser North Health Service Delivery Area	5922	66.6	63.8 to 69.3	Same	Lower
Fraser South Health Service Delivery Area	5923	68.4	65.4 to 71.4	Higher	Same
Richmond Health Service Delivery Area	5931	66.9	62.1 to 71.7	Same	Same
Vancouver Health Service Delivery Area	5932	65.5	62.5 to 68.6	Same	Lower
North Shore/Coast Garibaldi Health Service Delivery Area	5933	71.7	68.1 to 75.4	Higher	Same
South Vancouver Island Health Service Delivery Area	5941	72.6	69.8 to 75.4	Higher	Higher
Central Vancouver Island Health Service Delivery Area	5942	71.8	68.3 to 75.4	Higher	Same
North Vancouver Island Health Service Delivery Area	5943	71.5	65.3 to 77.8	Higher	Same
Northwest Health Service Delivery Area	5951	80.9	76.6 to 85.1	Higher	Higher
Northern Interior Health Service Delivery Area	5952	68.3	63.5 to 73.2	Same	Same
Northeast Health Service Delivery Area	5953	67.3	60.2 to 74.4	Same	Same
Yukon Territory	**6001**	**70.6**	**66.7 to 74.6**	**Higher**	**...**
Northwest Territories	**6101**	**74.3**	**69.3 to 79.3**	**Higher**	**...**
Nunavut	**6201**	**82.8**	**79.6 to 85.9**	**Higher**	**...**

... not applicable
Source: 2005 Canadian Community Health Survey.

Table B

Adjusted odds of reporting strong or somewhat strong sense of community belonging, by selected characteristics, household population aged 12 or older, Canada, 2005

	Adjusted odds ratio	95% confidence interval
Sex		
Men	1.0	0.9 to 1.0
Women†	1.0	...
Age group		
12 to 17	2.3*	2.1 to 2.5
18 to 29	0.8*	0.8 to 0.9
30 to 44†	1.0	...
45 to 64	1.2*	1.2 to 1.3
65 or older	1.7*	1.6 to 1.9
Marital status		
Married or common-law†	1.0	...
Widowed	1.0	0.9 to 1.1
Divorced or separated	0.8*	0.8 to 0.9
Never married	0.9*	0.9 to 1.0
Children younger than 12 in household		
Yes	1.2*	1.2 to 1.3
No†	1.0	...
Education		
Less than secondary graduation	1.0	0.9 to 1.0
Secondary graduation	1.0	1.0 to 1.1
Some postsecondary	1.0	1.0 to 1.1
Postsecondary graduation†	1.0	...
Household income quintile		
1 Lowest	0.9*	0.9 to 1.0
2	1.0	0.9 to 1.1
3†	1.0	...
4	1.1	1.0 to 1.1
5 Highest	1.0	1.0 to 1.1
Home ownership		
Yes	1.4*	1.3 to 1.4
No†	1.0	...
Language spoken most often at home		
English†	1.0	...
French	0.7*	0.7 to 0.8
Other	0.9*	0.8 to 1.0
Cultural or racial group		
White†	1.0	...
South Asian	1.8*	1.5 to 2.1
Filipino	1.3*	1.0 to 1.6
Aboriginal (off-reserve)	0.9*	0.8 to 1.0
Black	1.2*	1.0 to 1.5
Arab	1.3	0.9 to 1.7
Japanese	0.6*	0.4 to 1.0
West Asian	0.9	0.6 to 1.4
Latin American	0.9	0.7 to 1.1
Southeast Asian	0.7*	0.5 to 0.9
Chinese	0.6*	0.5 to 0.7
Korean	0.6*	0.4 to 0.9
Other or multiple racial or cultural origin	1.0	0.8 to 1.2
Percent urban composition of health region of residence		
10% or less	2.4*	1.4 to 4.0
10.1 to 20%	1.0	0.8 to 1.3
20.1 to 30%	1.2*	1.1 to 1.4
30.1 to 40%	1.1	1.0 to 1.2
40.1 to 50%	1.1	1.0 to 1.2
50.1 to 60%†	1.0	...
60.1 to 70%	0.9*	0.9 to 1.0
70.1 to 80%	0.9*	0.8 to 0.9
80.1 to 90%	0.8*	0.8 to 0.9
90.1 to 100%	0.7*	0.7 to 0.8
Province or territory		
Newfoundland and Labrador	1.6*	1.5 to 1.9
Prince Edward Island	1.2*	1.0 to 1.4
Nova Scotia	1.2*	1.1 to 1.3
New Brunswick	1.3*	1.1 to 1.4
Quebec	0.8*	0.8 to 0.9
Ontario†	1.0	...
Manitoba	1.1	1.0 to 1.2
Saskatchewan	1.2*	1.1 to 1.3
Alberta	1.0	0.9 to 1.0
British Columbia	1.3*	1.2 to 1.4
Yukon Territory	1.1	0.9 to 1.4
Northwest Territories	1.4*	1.0 to 1.8
Nunavut	2.5*	1.8 to 3.4

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
... not applicable
Source: 2005 Canadian Community Health Survey.

Estimates of obesity based on self-report versus direct measures

Margot Shields, Sarah Connor Gorber and Mark S. Tremblay

Abstract

Objectives

Based on a representative sample of the Canadian population, this article quantifies the bias resulting from the use of self-reported rather than directly measured height, weight and body mass index (BMI).

Methods

The analysis is based on 4,567 respondents to the 2005 Canadian Community Health Survey (CCHS) who, during a face-to-face interview, provided self-reported values for height and weight and were then measured by trained interviewers.

Results

On average, males over-reported their height by 1 cm, and females, by 0.5 cm. Females under-reported their weight by an average of 2.5 kg; males, by 1.8 kg. Reporting bias in weight was strongly associated with measured BMI category. Under-reporting of weight was high among people who were overweight, and particularly high among those who were obese, compared with people of normal weight. When based on measured rather than on self-reported values, the prevalence of obesity was 9 percentage points higher among males and 6 points higher among females.

Keywords

body mass index, measurement error, misclassification, obesity, self-report, sensitivity and specificity, validity

Authors

Margot Shields (613-951-4177; Margot.Shields@statcan.ca) and Sarah Connor Gorber (613-951-1193; Sarah.Connorgorber@statcan.ca) are with the Health Information and Research Division, and Mark S. Tremblay (613-951-4385; Mark.Tremblay@statcan.ca) is with the Physical Health Measures Division at Statistics Canada, Ottawa, Ontario, K1A 0T6.

Population health surveys often base estimates of the prevalence of obesity on calculations of body mass index (BMI), which is a measure of weight in relation to height. Since the mid-1990s, Statistics Canada's two major health surveys, the Canadian Community Health Survey (CCHS) and the National Population Health Survey (NPHS), have generally relied on respondents to report their weight and height and used these data to estimate BMI.

A recent systematic review of the literature substantiated the existence of a bias associated with self-reported weight and height data.[1] Most studies have found that self-reports underestimate weight and overestimate height. Therefore, estimates of the prevalence of obesity based on self-reports tend to be lower than those based on measured data. As well, some evidence indicates that associations between obesity and morbidity differ depending on whether BMI is calculated with self-reported or measured data.[2,3]

In 2005, the CCHS collected both self-reported and measured height and weight from a subsample of respondents. Using these data, this study documents the magnitude of the bias that exists for the Canadian population when height, weight and BMI are based on self-reports rather than on physical measures. Factors associated with reporting error are examined.

Methods

Data source

Data are from the 2005 CCHS. The CCHS covers the population aged 12 years or older living in private households. It excludes residents of Indian reserves, of institutions, and of some remote areas; full-time members of the Canadian Armed Forces; and civilian residents of military bases. Interviews for the 2005 CCHS were conducted between January and December of that year. The response rate was 79%, yielding a sample of 132,947 respondents.

Three sampling frames were used to select the sample of households for the 2005 CCHS: 49% of households came from an area frame; 50% from a list frame of telephone numbers; and the remaining 1%, from a Random Digit Dialing (RDD) sampling frame. Because of cost considerations, measured height and weight were collected for only a subsample ("subsample 2") of respondents, all of whom were from the area frame. Residents of the territories were not included in this subsample.

In total, 7,376 CCHS respondents were selected for subsample 2. Measured height and weight were obtained for 4,735 of them. The main reason for non-response was refusal. Because measured height and weight were recorded for only 64% of the selected respondents in subsample 2, an adjustment was made to minimize non-response bias. A special sampling weight was created by redistributing the sampling weights of non-respondents to respondents, using response propensity classes. The variables used to create these classes were: region (British Columbia, Prairies, Ontario, Quebec, Atlantic provinces), age, sex, household size, marital status, rural/urban indicator, and quarter of collection.

Of the 4,735 respondents for whom measured height and weight were collected, 125 were excluded from this analysis because self-reported height or weight was missing, and 43 women were excluded because they were pregnant at the time of the survey. This left 4,567 respondents.

A detailed description of the CCHS methodology is available in a published report.[4]

Analytical techniques

The bias associated with using self-reported data for weight, height and BMI was estimated by calculating the difference between measured and self-reported values (measured minus self-reported). A positive difference indicates under-reporting, and a negative difference, over-reporting. Respondents whose measured minus self-reported value was five or more standard deviations from the mean were considered outliers and dropped from the analysis (28 records were dropped for weight, 30 for height, and 32 for BMI).

Because the validity of self-reported data differs between the sexes,[5-9] separate analyses were conducted for males and females. To identify factors associated with reporting bias, differences between measured and self-reported values were examined in relation to: age, household income, immigrant status, leisure-time physical activity level, and measured weight, height and BMI. Multiple linear regression models were used to determine which factors were independently associated with the bias.

Respondents were classified into BMI categories (see Definitions). The degree of misclassification that resulted from using self-reports to estimate the prevalence of the various BMI categories was assessed by calculating sensitivity and specificity. Sensitivity is the percent of true positives, and specificity, the percent of true negatives. For example, for obesity (BMI 30 kg/m^2 or more), sensitivity is the percentage of respondents classified as obese based on self-reported values among those classified as obese based on measured values; in other words, the percentage of obese respondents who reported themselves as such. Specificity is the percentage of respondents classified as not obese (BMI less than 30 kg/m^2) based on self-reported values among those who were not obese based on measured values; that is, the percentage of respondents who reported that they were not obese and among those who actually were not obese.

All estimates were weighted to represent the household population aged 12 years or older in 2005 (using the weight created to adjust for non-response to measured height and weight in subsample 2). To account for the survey design effect of the CCHS, standard errors, coefficients of variation, and 95% confidence intervals were estimated using the bootstrap technique.[10-12] Differences between estimates were tested for statistical significance, which was established at the 0.05 level.

Definitions

Self-reported height and weight were collected with the questions:

- "How tall are you without shoes on?" Categories for height in feet and inches were listed on the questionnaire, with corresponding metric values in brackets. Interviewers were instructed to round up to the closest inch for respondents who reported half-inch measures.
- "How much do you weigh?" If asked, interviewers told respondents to report weight without clothing. After reporting their weight, respondents were asked if they had reported in pounds or kilograms. Most respondents (94%) reported in pounds.

The majority of respondents (73% of males and 67% of females) reported values for their weight that ended in 0 or 5, although it would be expected that by chance only about 20% of respondents would have end-digits of 0 or 5 (10% for each value). This *end-digit preference* is another factor that was examined in relation to reporting bias.

CCHS interviewers were trained to measure the height and weight of respondents. Height was measured to the nearest 0.5 cm, and weight, to the nearest 0.1 kg. Calibrated scales (ProFit UC-321 made by Lifesource) and measuring tapes were used to ensure accuracy and consistency. The interview lasted about 50 minutes—respondents were asked their height and weight near the beginning, and measurements were taken close to the end.

Body mass index (BMI) is a measure of weight adjusted for height. In this analysis, BMI was derived from both measured and self-reported values. BMI is calculated by dividing weight in kilograms by the square of height in metres. Based on Canadian guidelines,[13] which are in line with those of the World Health Organization,[14] BMI for adults is classified into six categories:

Category	BMI kg/m^2 range
Underweight	(BMI less than 18.5)
Normal weight	(BMI 18.5 to 24.9)
Overweight	(BMI 25.0 to 29.9)
Obese class I	(BMI 30.0 to 34.9)
Obese class II	(BMI 35.0 to 39.9)
Obese class III	(BMI 40.0 or more)

For adults aged 18 or older, respondents were assigned to *height* and *weight quartiles* based on weighted distributions. Separate quartile cut-points were established for men and women.

The International Obesity TaskForce (IOTF) has recommended that overweight and obesity among children and adolescents be determined by extrapolating the adult cut-points of 25 kg/m^2 for overweight and 30 kg/m^2 for obese to create sex- and age-specific values.[15] In this analysis, 12- to 17-year-olds were classified as *normal weight, overweight* or *obese* based on these IOTF criteria; all obese adolescents were assigned to obese class I.

Immigrants were defined as those who were born outside of Canada and were not Canadian citizens by birth. Immigrant respondents were categorized into two groups according to length of residence in Canada: 0 to 10 years, and 11 or more years.

Leisure-time physical activity level was based on total energy expenditure (EE) during leisure time. EE was calculated from the reported frequency and duration of all of a respondent's leisure-time physical activities in the three months before the 2005 CCHS interview and the metabolic energy demand (MET value) of each activity, which was independently established.[16]

$EE = \sum(Ni*Di*METi / 365 \text{ days})$ where
Ni = number of occasions of activity i in a year,
Di = average duration in hours of activity i, and
METi = a constant value for the metabolic energy cost of activity i.

An EE of 3 or more kilocalories per kilogram per day (KKD) was defined as *active*; 1.5 to 2.9 KKD, *moderately active*; and less than 1.5 KKD, *inactive*.

Household income groups were derived by calculating the ratio between the total household income from all sources in the previous 12 months and Statistics Canada's' low-income cutoff (LICO) specific to the number of people in the household, the size of the community, and the survey year. These adjusted income ratios were grouped into deciles (10 groups, each containing one-tenth of Canadians). Household income was missing for 253 records (8%) on the analysis file. To maximize sample sizes, a category for missing income values was created and included in the regression analysis.

Results

Height

On average, self-reported height was 0.7 cm more than measured height (Table 1). Males over-reported their height by an average of 1 cm, compared with 0.5 cm for females.

The tendency to over-report height increased with age, particularly among seniors (Table 2). Men and women aged 65 to 79 years over-reported by 2.3 and 1.6 cm, respectively, and those aged 80 years or older, by 2.6 and 3.3 cm.

The shortest people (those whose measured height placed them in the lowest quartile of the distribution) were the least accurate: males in this group over-reported their height by an average of 2.3 cm, and females, by 1.9 cm. There was no significant difference between measured and self-reported height for males in the highest quartile (tallest), and for females in the two highest quartiles.

Over-reporting of height varied by measured BMI. For people in the normal weight category, self-reported and measured height did not differ, but those who were overweight or obese tended to over-report. Discrepancies were pronounced among people in obese class III, with males over-reporting their height by an average of 2.1 cm, and females, by 2.8 cm.

Multiple linear regression was used to identify variables associated with differences between self-reported and measured height. Measured height, measured weight and age were independently associated with differences for both sexes (Appendix Table A). In general, height was over-reported. Therefore, positive regression coefficients (for example, height) signal a reduction in this over-reporting bias, and negative coefficients (for example, weight), an increase in the bias. Associations between height discrepancies and household income, immigrant status and physical activity in the univariate analysis did not persist in the multivariate analysis.

Table 1
Mean height, weight and body mass index (BMI), by collection method and sex, household population aged 12 years or older, Canada excluding territories, 2005

		Collection method		Difference	
	Sample size	Measured	Self-reported	Measured minus self-reported	95% confidence interval
Mean height (cm)					
Both sexes	4,537	168.3	169.0*	-0.7	-0.9 to -0.6
Males	2,108	174.8	175.8*	-1.0	-1.2 to -0.8
Females	2,429	161.8	162.3*	-0.5†	-0.7 to -0.3
Mean weight (kg)					
Total	4,539	74.9	72.8*	2.1	2.0 to 2.3
Males	2,112	81.9	80.1*	1.8	1.6 to 2.0
Females	2,427	67.9	65.4*	2.5†	2.2 to 2.7
Mean BMI (kg/m^2)					
Both sexes	4,535	26.4	25.3*	1.1	1.0 to 1.1
Males	2,113	26.8	25.8*	0.9	0.8 to 1.0
Females	2,422	26.0	24.8*	1.2†	1.1 to 1.3

* significantly different from estimate for measured ($p < 0.05$)
† significantly different from estimate for males ($p < 0.05$)
Source: 2005 Canadian Community Health Survey (subsample 2).

Table 2
Mean height (cm) and mean difference between measured and self-reported height (cm), by selected characteristics, household population aged 12 years or older, Canada excluding territories, 2005

	Males					Females				
		Mean height		Mean difference			Mean height		Mean difference	
	Sample size	Measured	Self-reported	Measured minus self-reported	95% confidence interval	Sample size	Measured	Self-reported	Measured minus self-reported	95% confidence interval
Total	**2,108**	**174.8**	**175.8***	**-1.0**	**-1.2 to -0.8**	**2,429**	**161.8**	**162.3***	**-0.5**	**-0.7 to -0.3**
Age group										
12 to 24 years	435	174.0	174.4	-0.3‡	-0.7 to 0.1	435	162.8	162.6	0.3‡	-0.2 to 0.7
25 to 44 years	684	176.0	176.8*	-0.7	-1.1 to -0.4	735	163.3	163.5	-0.2	-0.5 to 0.0
45 to 64 years†	589	174.9	176.0*	-1.1	-1.5 to -0.7	673	161.9	162.3*	-0.4	-0.8 to 0.0
65 to 79 years	325	172.6	174.9*	-2.3‡	-2.9 to -1.7	426	158.0	159.6*	-1.6‡	-2.0 to -1.1
80 years or older	75	171.2	173.9*	-2.6‡	-3.7 to -1.5	160	154.7	157.9*	-3.3‡	-4.2 to -2.4
Household income decile										
1 to 3 (lowest)	582	173.3	174.5*	-1.2	-1.7 to -0.7	893	159.9	160.8*	-0.9‡	-1.3 to -0.5
4 to 7†	795	174.7	175.5*	-0.8	-1.2 to -0.4	815	162.1	162.4	-0.3	-0.6 to 0.1
8 to 10 (highest)	588	175.9	177.1*	-1.1	-1.4 to -0.8	513	163.8	164.1*	-0.3	-0.7 to 0.0
Immigrant status										
Immigrant (0 to 10 years in Canada)	90	173.9	174.8	-0.9	-1.8 to 0.0	103	159.2	159.9*	-0.7	-1.3 to 0.0
Immigrant (11 or more years in Canada)	303	172.7	174.2*	-1.5‡	-2.1 to -1.0	332	160.7	161.9*	-1.1‡	-1.8 to -0.5
Canadian-born†	1,713	175.3	176.2*	-0.9	-1.1 to -0.6	1,994	162.2	162.5*	-0.4	-0.6 to -0.1
Leisure-time physical activity level										
Active	562	174.3	175.2*	-0.9	-1.3 to -0.5	483	163.6	163.7	-0.1‡	-0.5 to 0.3
Moderate	548	175.7	176.5*	-0.9	-1.3 to -0.5	615	162.3	162.8*	-0.5	-0.9 to -0.1
Inactive†	998	174.6	175.7*	-1.1	-1.4 to -0.7	1,331	160.9	161.5*	-0.6	-0.9 to -0.4
Measured height quartile for age 18 or older (cm)										
1 (lowest)	507	166.0	168.3*	-2.3‡	-2.8 to -1.9	660	153.0	154.9*	-1.9‡	-2.3 to -1.5
2†	474	172.9	174.2*	-1.3	-1.6 to -0.9	569	159.7	160.1*	-0.5	-0.8 to -0.1
3	466	177.8	178.7*	-0.9	-1.3 to -0.6	560	164.4	164.6	-0.2	-0.5 to 0.1
4 (highest)	438	184.9	184.5	0.4‡	-0.1 to 1.0	430	171.6	171.2	0.4‡	-0.1 to 0.9
Measured BMI category (range kg/m²)										
Underweight (less than 18.5)	19	175.6	173.9	1.7	-1.0 to 4.4	62	162.4	162.9	-0.5	-1.4 to 0.5
Normal weight (18.5 to 24.9)†	750	174.9	175.0	-0.1	-0.4 to 0.2	1,133	162.7	162.7	0.0	-0.3 to 0.2
Overweight (25.0 to 29.9)	851	174.9	176.2*	-1.3‡	-1.6 to -1.0	696	161.1	161.9*	-0.8‡	-1.2 to -0.4
Obese class I (30.0 to 34.9)	382	174.4	176.2*	-1.8‡	-2.4 to -1.3	339	160.8	161.7*	-0.8‡	-1.3 to -0.4
Obese class II (35.0 to 39.9)	84	175.2	176.9*	-1.7‡	-3.0 to -0.4	129	159.7	161.1*	-1.4‡	-2.3 to -0.5
Obese class III (40.0 or more)	22	173.3	175.4*	-2.1‡	-3.9 to -0.3	70	159.5	162.3*	-2.8‡	-4.7 to -0.9

* significantly different from estimate for measured ($p < 0.05$)
† reference category
‡ significantly different from estimate for reference category ($p < 0.05$)
Source: 2005 Canadian Community Health Survey (subsample 2).

Weight

Self-reported weight was, on average, 2.1 kg less than measured weight. The bias was greater among females, who under-reported by an average of 2.5 kg, compared with 1.8 kg for males.

Females in all four measured weight quartiles under-reported their weight, with the difference rising from an average of 0.6 kg for those in the lowest quartile to 5.1 kg for those in the highest (Table 3). The self-reported and measured weight of males in the lowest quartile did not differ. Males in the remaining quartiles under-reported, with the difference rising from 1.1 kg for those in the second quartile to 4.1 kg for those in the highest.

End-digit preference (reporting a weight ending in 0 or 5) was associated with under-reporting for females, but not for males. Females with an end-digit preference tended to round their weight down, whereas males were as likely to round up as to round down.

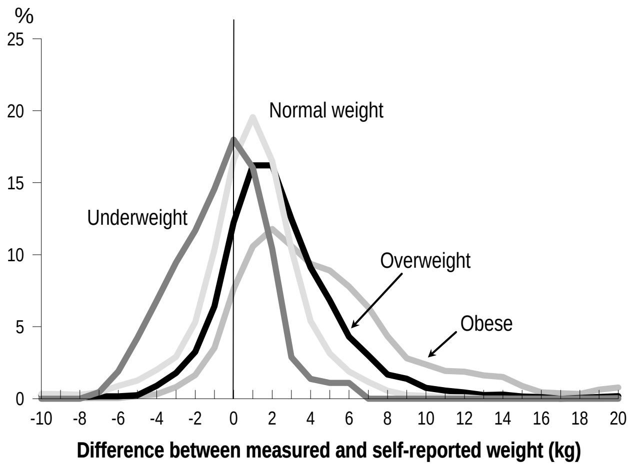
Table 3
Mean weight (kg) and mean difference between measured and self-reported weight (kg), by selected characteristics, household population aged 12 years or older, Canada excluding territories, 2005

	Males					Females				
		Mean weight		Mean difference			Mean weight		Mean difference	
	Sample size	Measured	Self-reported	Measured minus self-reported	95% confidence interval	Sample size	Measured	Self-reported	Measured minus self-reported	95% confidence interval
Total	**2,112**	**81.9**	**80.1***	**1.8**	**1.6 to 2.0**	**2,427**	**67.9**	**65.4***	**2.5**	**2.2 to 2.7**
Age group										
12 to 24 years	433	70.6	69.4*	1.2‡	0.8 to 1.6	435	60.4	58.6*	1.7‡	1.4 to 2.1
25 to 44 years	690	83.5	81.9*	1.5‡	1.1 to 1.9	730	67.9	65.6*	2.3‡	1.9 to 2.6
45 to 64 years†	589	87.2	84.8*	2.4	1.8 to 2.9	673	72.6	69.5*	3.1	2.6 to 3.6
65 to 79 years	325	84.3	81.8*	2.5	2.0 to 3.0	428	68.9	66.2*	2.7	1.8 to 3.6
80 years or older	75	75.0	74.0*	1.0‡	0.0 to 1.9	161	62.9	61.0*	1.8‡	1.1 to 2.6
Household income decile										
1 to 3 (lowest)	586	79.2	77.5*	1.7	1.2 to 2.2	898	67.5	65.2*	2.3	1.9 to 2.7
4 to 7†	795	81.4	79.7*	1.6	1.3 to 2.0	815	68.5	65.9*	2.6	2.3 to 2.9
8 to 10 (highest)	588	85.8	83.6*	2.2	1.8 to 2.6	507	68.9	66.2*	2.7	2.2 to 3.2
Immigrant status										
Immigrant (0 to 10 years in Canada)	91	76.0	75.6	0.3‡	-1.0 to 1.7	102	59.6	58.0*	1.7‡	1.0 to 2.4
Immigrant (11 or more years in Canada)	304	81.2	79.2*	1.9	1.3 to 2.5	334	68.3	65.6*	2.7	2.1 to 3.3
Canadian-born†	1,715	82.6	80.7*	1.9	1.7 to 2.2	1,991	68.4	65.9*	2.5	2.2 to 2.7
Leisure-time physical activity level										
Active	562	78.3	76.5*	1.8	1.3 to 2.2	480	65.4	62.7*	2.7	2.3 to 3.1
Moderate	549	82.2	80.4*	1.8	1.4 to 2.2	615	65.0	62.8*	2.1	1.8 to 2.5
Inactive†	1,001	83.5	81.7*	1.8	1.5 to 2.2	1,332	69.9	67.4*	2.5	2.2 to 2.8
Measured weight quartile for age18 or older (kg)										
1 (lowest)	497	66.5	66.5	0.0‡	-0.5 to 0.5	564	52.5	51.9*	0.6‡	0.4 to 0.9
2†	466	77.8	76.7*	1.1	0.6 to 1.6	550	61.6	59.9*	1.7	1.4 to 2.0
3	479	86.8	84.8*	2.0‡	1.7 to 2.4	582	71.1	68.4*	2.7‡	2.4 to 3.1
4 (highest)	450	103.5	99.4*	4.1‡	3.6 to 4.7	522	90.8	85.7*	5.1‡	4.4 to 5.8
End-digit preference for weight										
Yes	1,533	82.5	80.7*	1.8	1.6 to 2.1	1,630	69.7	66.9*	2.8‡	2.5 to 3.1
No†	579	80.2	78.4*	1.8	1.3 to 2.2	797	64.3	62.5*	1.8	1.5 to 2.0
Measured BMI category (range kg/m^2)										
Underweight (less than 18.5)	18	52.2	59.1*	-6.9‡	-12.8 to -1.0	60	46.7	47.5	-0.7‡	-2.0 to 0.5
Normal weight (18.5 to 24.9)†	751	68.5	68.2	0.3	0.0 to 0.6	1,132	57.8	56.5*	1.3	1.1 to 1.5
Overweight (25.0 to 29.9)	853	83.3	81.4*	1.9‡	1.6 to 2.2	701	70.5	67.6*	2.9‡	2.5 to 3.3
Obese class I (30.0 to 34.9)	382	97.2	93.5*	3.8‡	3.2 to 4.3	339	83.0	79.1*	3.9‡	3.2 to 4.6
Obese class II (35.0 to 39.9)	85	112.6	106.5*	6.2‡	4.9 to 7.5	131	94.4	88.5*	5.9‡	4.1 to 7.7
Obese class III (40.0 or more)	23	118.5	113.5*	5.0‡	2.7 to 7.4	64	118.2	109.6*	8.6‡	6.0 to 11.1

* significantly different from estimate for measured ($p < 0.05$)
† reference category
‡ significantly different from estimate for reference category ($p < 0.05$)
Source: 2005 Canadian Community Health Survey (subsample 2).

Differences between self-reported and measured weight were strongly associated with measured BMI. Underweight males over-reported their weight by an average of 6.9 kg. Self-reported and measured weight did not differ significantly for males in the normal weight range, but those who were overweight or obese tended to under-report, with the greatest difference among the obese. For underweight females, self-reported and measured weight were not significantly different. Females in the normal, overweight and obese categories all under-reported, with discrepancies increasing at successively heavier BMI categories.

Figure 1
Percentage distribution of difference† between measured and self-reported weight (kg), by measured BMI category, household population aged 12 years or older, Canada excluding territories, 2005



† measured minus self-reported
Source: 2005 Canadian Community Health Survey (subsample 2).

When differences between self-reported and measured weight are displayed graphically (Figure 1), the increase in bias associated with BMI category is evident. As BMI moves from underweight to obese, the distribution of average differences shifts to the right of zero, showing that the extent of under-reporting rises with BMI.

In the multivariate analysis, the strongest predictor of a difference between self-reported and measured weight was measured weight (Appendix Table B), as evidenced by the standardized regression coefficients. In this case, the positive value of the regression coefficient for weight indicated an increase in the bias. The negative regression coefficient for measured height for males shows that as measured height increased, under-reporting of weight decreased. For females, an association with leisure-time physical activity level emerged—active females were slightly more likely to under-report their weight. Age and immigrant status were significant in the univariate analysis, but these associations did not persist in the multivariate analysis.

Body mass index

BMI based on self-reported height and weight was, on average, 1.1 kg/m^2 less than BMI based on measured values. Underestimation occurred for both sexes, but was slightly greater for females (1.2 kg/m^2) than for males (0.9 kg/m^2).

The extent of the difference between BMI based on self-reported rather than on measured height and weight was strongly associated with measured BMI (Table 4). For underweight males, BMI based on self-reported values was overestimated, and for underweight females, BMI based on self-reported and measured values did not differ significantly. For all other BMI categories, self-reported BMI underestimated measured BMI, with the degree of underestimation increasing with successively higher BMIs. For obese class III, underestimation was, on average, 4.0 kg/m^2 among males, and 5.0 kg/m^2 among females.

In the multivariate analysis, the strongest predictors of BMI differences were measured weight and height (Appendix Table C). There was also a weak association with age. Among females, an association with leisure-time physical activity level emerged: underestimation of BMI was slightly greater among active and moderately active females, compared with inactive females

Misclassification of BMI categories

The degree of misclassification that results when BMI categories are based on self-reported height and weight was assessed by calculating sensitivity and specificity (Table 5).

Sensitivity was high for those who, according to measured height and weight, were in the normal weight category. That is, 95% of males and 93% for females whose measured height and weight put them in the normal weight BMI category were correctly placed in this category based on their self-reported height and weight. For people who were overweight, sensitivity fell to 70% among males and to 63% among females. Sensitivity was low for males and females who were obese: 51% and 54% for those in obese class I, and 45% and 57% for those

Table 4
Mean body mass index (BMI kg/m²) and mean difference between measured and self-reported BMI, by selected characteristics, household population aged 12 years or older, Canada excluding territories, 2005

	Males					Females				
		Mean BMI		Mean difference			Mean BMI		Mean difference	
	Sample size	Measured	Self-reported	Measured minus self-reported	95% confidence interval	Sample size	Measured	Self-reported	Measured minus self-reported	95% confidence interval
Total	**2,113**	**26.8**	**25.8***	**0.9**	**0.8 to 1.0**	**2,422**	**26.0**	**24.8***	**1.2**	**1.1 to 1.3**
Age group										
12 to 24 years	436	23.2	22.6*	0.6‡	0.4 to 0.8	437	22.8	22.0*	0.8‡	0.5 to 1.1
25 to 44 years	688	26.9	26.2*	0.8‡	0.6 to 0.9	730	25.5	24.6*	0.9‡	0.8 to 1.1
45 to 64 years†	589	28.5	27.3*	1.1	0.9 to 1.4	668	27.8	26.4*	1.4	1.1 to 1.7
65 to 79 years	325	28.3	26.7*	1.6‡	1.3 to 1.9	426	27.6	26.0*	1.6	1.3 to 2.0
80 years or older	75	25.5	24.4*	1.1	0.7 to 1.4	161	26.3	24.5*	1.9	1.4 to 2.4
Household income decile										
1 to 3 (lowest)	587	26.4	25.4*	1.0	0.8 to 1.3	893	26.5	25.2*	1.3	1.0 to 1.5
4 to 7†	795	26.6	25.7*	0.8	0.7 to 1.0	815	26.1	25.0*	1.1	0.9 to 1.3
8 to 10 (highest)	588	27.6	26.6*	1.1	0.9 to 1.2	508	25.7	24.5*	1.2	0.9 to 1.4
Immigrant status										
Immigrant: (0 to 10 years in Canada)	91	25.2	24.7	0.5	-0.1 to 1.0	102	23.5	22.6*	0.9	0.6 to 1.1
Immigrant (11 or more years in Canada)	304	27.2	26.1*	1.1	0.9 to 1.3	333	26.5	25.0*	1.5	1.1 to 1.8
Canadian-born†	1,716	26.8	25.9*	1.0	0.8 to 1.1	1,987	26.1	25.0*	1.1	1.0 to 1.3
Leisure-time physical activity level										
Active	562	25.6	24.8*	0.9	0.7 to 1.1	478	24.5	23.4*	1.1	0.9 to 1.3
Moderate	550	26.6	25.7*	0.9	0.7 to 1.1	614	24.7	23.7*	1.0‡	0.9 to 1.2
Inactive†	1,001	27.4	26.4*	1.0	0.8 to 1.2	1,330	27.0	25.8*	1.3	1.1 to 1.5
End-digit preference for weight										
Yes	1533	26.9	25.9*	1.0	0.9 to 1.1	1,628	26.6	25.3*	1.3‡	1.1 to 1.5
No†	580	26.5	25.6*	0.9	0.6 to 1.1	794	24.7	23.8*	0.9	0.8 to 1.0
Measured BMI category (range kg/m²)										
Underweight (less than 18.5)	18	16.9	19.5*	-2.6‡	-4.9 to -0.4	60	17.6	17.8	-0.2‡	-0.6 to 0.2
Normal weight (18.5 to 24.9)†	751	22.3	22.1*	0.1	0.0 to 0.3	1,132	21.8	21.3*	0.5	0.4 to 0.6
Overweight (25.0 to 29.9)	853	27.2	26.2*	1.0‡	0.9 to 1.2	701	27.1	25.7*	1.4‡	1.2 to 1.6
Obese class I (30.0 to 34.9)	383	31.9	30.0*	1.9‡	1.6 to 2.2	341	32.1	30.1*	2.1‡	1.7 to 2.5
Obese class II (35.0 to 39.9)	85	36.7	34.0*	2.7‡	2.2 to 3.3	131	37.1	34.1*	3.0‡	2.1 to 3.8
Obese class III (40.0 or more)	23	41.6	37.6*	4.0‡	2.7 to 5.3	57	47.3	42.4*	5.0‡	3.0 to 6.9

* significantly different from estimate for measured ($p < 0.05$)
† reference category
‡ significantly different from estimate for reference category ($p < 0.05$)
Source: 2005 Canadian Community Health Survey (subsample 2).

in obese class II/III. Among people who were underweight, sensitivity was particularly low for males at 40%, but higher for females at 78%.

For the obese category overall (BMI 30 kg/m² or more), sensitivity was 63%, and was somewhat higher for females than for males (Table 6). Sensitivity was particularly low for seniors.

Specificity was very high (more than 95%) for the obese categories, indicating that very few respondents reported height and weight that put them in the obese category unless they really were obese.

Table 5
Self-reported body mass index (BMI) category, by measured BMI category and sex, household population aged 12 years or older, Canada excluding territories, 2005

	Measured BMI category (range kg/m²)									
	Underweight (less than 18.5)		Normal weight (18.5 to 24.9)		Overweight (25.0 to 29.9)		Obese class I (30.0 to 34.9)		Obese class II/III (35 or more)	
	'000	%	'000	%	'000	%	'000	%	'000	%
Self-reported BMI category (range kg/m²)										
Both sexes	**402**	**100**	**10,859**	**100**	**8,746**	**100**	**4,288**	**100**	**1,562**	**100**
Underweight (less than 18.5)	271	67	308	3	1	0	6	0	0	0
Normal weight (18.5 to 24.9)	131	33	10,163	94	2,651	30	120	3	4	0
Overweight (25.0 to 29.9)	0	0	388	4	5,851	67	1,894	44	134	9
Obese class I (30.0 to 34.9)	0	0	0	0	244	3	2,247	52	603	39
Obese class II/III (35.0 or more)	0	0	0	0	0	0	22	1	822	53
Sensitivity										
% true positives (95% confidence interval)	67 (53 to 82)		94 (92 to 95)		67 (63 to 71)		52 (46 to 58)		53 (44 to 62)	
Specificity										
% true negatives (95% confidence interval)	99 (98 to 99)		81 (78 to 83)		86 (84 to 88)		96 (95 to 97)		100 (100 to 100)	
Males	**110**	**100**	**4,620**	**100**	**5,130**	**100**	**2,595**	**100**	**556**	**100**
Underweight (less than 18.5)	44	40	43	1	0	0	6	0	0	0
Normal weight (18.5 to 24.9)	66	60	4,374	95	1,387	27	37	1	0	0
Overweight (25.0 to 29.9)	0	0	203	4	3,584	70	1,208	47	56	10
Obese class I (30.0 to 34.9)	0	0	0	0	159	3	1,325	51	248	45
Obese class II/III (35.0 or more)	0	0	0	0	0	0	20	1	252	45
Sensitivity										
% true positives (95% confidence interval)	40 (8 to 71)		95 (93 to 97)		70 (65 to 75)		51 (43 to 59)		45 (32 to 59)	
Specificity										
% true negatives (95% confidence interval)	100 (99 to 100)		82 (79 to 85)		81(78 to 84)		96 (95 to 98)		100 (100 to 100)	
Females	**293**	**100**	**6,238**	**100**	**3,617**	**100**	**1,693**	**100**	**1,006**	**100**
Underweight (less than 18.5)	227	78	265	4	1	0	0	0	0	0
Normal weight (18.5 to 24.9)	65	22	5,789	93	1,265	35	83	5	4	0
Overweight (25.0 to 29.9)	0	0	185	3	2,267	63	686	41	78	8
Obese class I (30.0 to 34.9)	0	0	0	0	85	2	922	54	355	35
Obese class II/III (35 or more)	0	0	0	0	0	0	2	0	570	57
Sensitivity										
% true positives (95% confidence interval)	78 (63 to 92)		93 (90 to 95)		63 (57 to 68)		54 (46 to 63)		57 (45 to 68)	
Specificity										
% true negatives (95% confidence interval)	98 (97 to 99)		79 (75 to 82)		90 (88 to 92)		96 (95 to 97)		100 (100 to 100)	

Source: 2005 Canadian Community Health Survey (subsample 2).

Table 6
Accuracy of classification of obesity (BMI 30 kg/m² or more) based on self-reported weight and height, by sex and age group, household population aged 12 years or older, Canada excluding territories, 2005

	Sensitivity (% true positives)			Specificity (% true negatives)		
	Both sexes	Males	Females	Both sexes	Males	Females
Total	**63.1**	**58.5**	**68.5**	**98.8**	**98.4**	**99.2**
Age group						
12 to 24 years	56.6	47.1	66.6	99.0	99.8	98.2
25 to 44 years†	70.0	67.8	73.0	98.7	98.0	99.4
45 to 64 years	63.8	56.7	72.4	98.3	97.1	99.4
65 years or older	52.5*	49.9*	55.0*	99.7	99.7	99.8

† reference category
* significantly different from estimate for reference category ($p < 0.05$)
Source: 2005 Canadian Community Health Survey (subsample 2).

Prevalence of obesity

Prevalence estimates of BMI categories differed substantially when calculated with measured rather than self-reported height and weight (Table 7). The prevalence of obesity based on measured data was 7 percentage points higher than the estimate based on self-reported data (22.6% versus 15.2%). Among males, the prevalence was 9 percentage points higher, and among females, 6 percentage points higher.

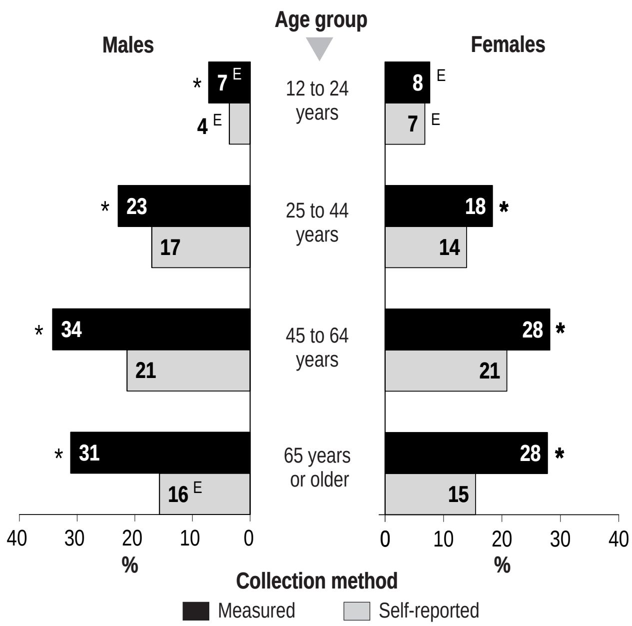
Differences were particularly pronounced among people aged 65 years or older (Figure 2). For elderly men, the estimate of obesity based on measured values was 15 percentage points higher than the estimate based on self-reported values, and for elderly women, 13 percentage points higher.

Table 7
Body mass index (BMI) prevalence distribution, by collection method and sex, household population aged 12 years or older, Canada excluding territories, 2005

BMI category (range kg/m²)	Collection method: Measured	Collection method: Self-reported	Percentage point difference: Measured minus self-reported	Percentage point difference: 95% confidence interval
		%		
Both sexes				
Obese (30.0 or more)	22.6	15.2*	7.4	6.0 to 8.8
Overweight/Obese (25.0 or more)	56.5	47.2*	9.3	7.8 to 10.7
Underweight (less than 18.5)	1.6	2.3*	-0.7	-1.2 to -0.2
Normal weight (18.5 to 24.9)	42.0	50.5*	-8.5	-10.0 to -7.1
Overweight (25.0 to 29.9)	33.8	32.0	1.9	-0.1 to 3.8
Obese class I (30.0 to 34.9)	16.6	12.0*	4.6	3.2 to 6.1
Obese class II/III (35.0 or more)	6.0	3.3*	2.8	2.1 to 3.4
Males				
Obese (30.0 or more)	24.2	15.4*	8.8	6.7 to 11.0
Overweight/Obese (25.0 or more)	63.6	54.2*	9.4	7.5 to 11.4
Underweight (less than 18.5)	0.8E	0.7E	0.1	-0.4 to 0.6
Normal weight (18.5 to 24.9)	35.5	45.1*	-9.6	-11.6 to -7.5
Overweight (25.0 to 29.9)	39.4	38.8	0.6	-2.4 to 3.6
Obese class I (30.0 to 34.9)	19.9	13.3*	6.6	4.3 to 8.9
Obese class II/III (35.0 or more)	4.3	2.1E*	2.2	1.4 to 3.0
Females				
Obese (30.0 or more)	21.0	15.0*	6.0	4.4 to 7.5
Overweight/Obese (25.0 or more)	49.2	40.1*	9.1	6.9 to 11.3
Underweight (less than 18.5)	2.3E	3.8*	-1.6	-2.4 to -0.7
Normal weight (18.5 to 24.9)	48.6	56.1*	-7.5	-9.9 to -5.2
Overweight (25.0 to 29.9)	28.2	25.0*	3.1	0.7 to 5.6
Obese class I (30.0 to 34.9)	13.2	10.6*	2.6	0.9 to 4.3
Obese class II/III (35.0 or more)	7.8	4.4*	3.4	2.4 to 4.4

* significantly different from estimate for measured ($p < 0.05$)
E use with caution (coefficient of variation 16.6% to 33.3%)
Source: 2005 Canadian Community Health Survey (subsample 2).

Figure 2
Percentage obese (BMI 30 kg/m² or more), by collection method, sex and age group, household population aged 12 years or older, Canada excluding territories, 2005



* significantly higher than estimate for same sex based on self-reported values ($p < 0.05$)
E use with caution (coefficient of variation 16.6% to 33.3%)
Source: 2005 Canadian Community Health Survey (subsample 2).

Discussion

This is the first nationally representative study to compare self-reported and measured height, weight and BMI for the Canadian population. Consistent with other research,[1] systematic errors emerged, with height over-reported, and weight under-reported.

As in other studies,[5,7,8,17,18] over-reporting of height rose with age for both sexes and was substantial at age 65 years or older. Loss of stature commonly occurs among seniors as a result of aging-related processes such as osteoporosis and loss of muscle tone,[19] and they may report their height as it was in earlier years.

The degree of under-reporting of weight in the 2005 CCHS was greater than in studies based on population health surveys conducted in the past in other countries, including the United States,[5,20,21] England,[22,23] Scotland,[24] Wales,[7] Spain,[17] New Zealand,[18] Mexico,[25] Finland,[26] and Brazil.[27] Most of the data for these studies were collected at least 10 years ago.

As well, for Canada, two decades ago, self-reported weight from the 1985 Health Promotion Survey was compared with measured weight from the 1981 Canada Fitness Survey.[28] For those aged 20 to 69 years, males' average weight did not differ between the two surveys, and for females, average weight based on measured values was actually 0.6 kg lower than that based on self-reports. These results are similar to findings from a contemporaneous American study,[29] and indicate that the reporting bias for weight has increased in the intervening years.

In recent years, the percentage of Canadians with excess weight has risen considerably,[30,31] mirroring a worldwide trend.[32] Because the extent to which weight is under-reported increases with BMI, the greater overall bias may reflect the higher percentages of Canadians in the overweight and obese categories in 2005. Another possibility is the stigma associated with obesity. The increasing prevalence of obesity does not seem to have made excess weight more acceptable, and some evidence suggests that the stigma is intensifying.[33] This may also explain the greater tendency to under-report weight among females, who may feel more pressure to conform to "desirable" standards.[34]

Limitations

For various reasons, measured height and weight were obtained for only 64% of the respondents who were selected for the physical measures component (subsample 2) of the CCHS. A special sampling weight was created to minimize the non-response bias associated with factors such as age, sex and region of the country (see Data source). Nonetheless, estimates of obesity based on measured values could still be biased if the height and weight of non-respondents differed systematically from the height and weight of those for whom measured data were obtained. However, because self-reported height and weight were collected for both respondents and non-respondents to the physical measures, it was possible to partially evaluate the extent of this bias by comparing obesity estimates based on these self-reported data. Among all respondents selected for the physical measures, the prevalence of obesity based on self-reported values was 15.9% (Appendix Table D). The prevalence was substantially higher among non-respondents than among those whose height and weight were measured (19.1% versus 14.0%), indicating that heavier people were less likely to agree to be measured. But when the special sampling weight was applied to respondents to the physical measures, the prevalence of obesity based on self-reported data was 15.2%, fairly close to the estimate for all respondents selected for physical measures.

Some of the bias associated with under-reporting weight may be due to clothing. Respondents were weighed fully clothed, but people may weigh themselves at home with minimal or no clothing, and if asked, interviewers told respondents to report their weight without clothing.

Some of the bias associated with over-reporting height may be due to rounding. Interviewers were instructed to round up to the nearest inch for respondents who reported half-inch values, while for the measurement component, height was measured to the nearest 0.5 cm.

A number of other studies have been designed to ensure participants were unaware that measurements would be taken,[2,18] because it is believed that if respondents know they are going to be measured, they may report more accurate values. Although CCHS interviewers were not instructed to ensure that respondents in subsample 2 did not know that they would be measured, this did not seem to have affected the self-reported values—there were no differences between the average self-reported height and weight of respondents from the area frame who were selected to be measured and those who were not.

Although measured height and weight were considered "true" values, some factors may have limited their accuracy. Trained Statistics Canada interviewers measured the height and weight of respondents; measures taken by health technicians, as have been used in other studies, may be more accurate.[5,29] The Statistics Canada interviewers used identically calibrated scales and measuring tapes, but validity and reliability studies to assess inter- and intra-interviewer accuracy and reproducibility were not performed. Stadiometers might have provided more accurate measures of height than measuring tapes.

Finally, this study compares measured height and weight with self-reported values obtained in face-to-face interviews. Self-reports from face-to-face interviews may yield higher prevalence estimates of obesity than do data collected by telephone.[35] Even so, the estimate of obesity based on self-reports for the sample from the telephone frame was only one percentage point lower than the estimate for subsample 2, which was based on self-reported data from interviews conducted in person.

Why is this study important?

- For fiscal and logistical reasons, self-reported height and weight data are collected in the large-scale health surveys conducted by Statistics Canada.
- It is important to document the extent to which the use of self-reported data biases estimates of overweight and obesity, and to identify factors associated with reporting error.

What else is known on this topic?

- The majority of studies have found that self-reports underestimate weight and overestimate height, resulting in lower estimates of the prevalence of obesity, compared with estimates based on measured data.

What does this study add?

- In 2005, the estimate of the prevalence of obesity based measured data was 7 percentage points higher than the estimate based on self-reported data: 22.6% versus 15.2%.
- The degree of underestimation of weight in the 2005 CCHS was greater than that reported by other studies based on population health surveys conducted in the past in various countries.
- Over-reporting of height and under-reporting of weight increased with rising levels of BMI.

Conclusion

For fiscal and logistical reasons, the collection of self-reported height and weight data will continue in large-scale health surveys conducted by Statistics Canada. As this study reveals, this practice yields biased values for height and weight, which result in substantial misclassification of the population by BMI category. The prevalence of obesity based on measured data was 7 percentage points higher than the estimate based on self-reported data (22.6% versus 15.2%).

The implications of this study are relevant to policy-makers, researchers and data users. Until now, trends in the prevalence of obesity in Canada have generally been based on self-reports, but the use of such data means that the accuracy of estimates and true changes in prevalence over time are unknown.

As well, the results raise the question of whether associations between BMI and obesity-related health conditions are distorted when BMI is derived from self-reported data. It is often suggested that underestimating the prevalence of obesity may *diminish* associations between obesity and health outcomes. However, a second study, also based on 2005 CCHS data,[36] found that associations between obesity-related conditions and overweight and obesity were *exaggerated* when BMI was based on self-reported rather than measured data. To correct the bias, researchers may wish to consider adjusting self-reported values or lowering BMI cut-points for the overweight and obese categories.

Finally, it will be important to measure the magnitude of the bias periodically to see if it changes over time. In 2007, Statistics Canada launched the Canadian Health Measures Survey (CHMS), the most comprehensive national survey using physical measurements ever conducted in Canada. The CHMS data will provide the opportunity for further analysis of the bias resulting from using self-reported measures in estimating the prevalence of obesity. As well, the data set will be used to study measured BMI in comparison with other anthropometric measures such as waist and hip circumference and skinfold measurements.

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Appendix

Table A
Regression coefficients relating selected characteristics to difference[†] between measured and self-reported height (cm), household population aged 12 years or older, Canada excluding territories, 2005

	Males			Females		
	Regression coefficient (B)	95% confidence interval	Standardized regression coefficient (beta)	Regression coefficient (B)	95% confidence interval	Standardized regression coefficient (beta)
Age group						
12 to 24 years	0.17	-0.48 to 0.82	0.02	0.15	-0.43 to 0.74	0.02
25 to 44 years	0.02	-0.54 to 0.58	0.00	-0.14	-0.62 to 0.33	-0.02
45 to 64 years[‡]	...	...	...	...	...	...
65 to 79 years	-0.99*	-1.68 to -0.29	-0.09	-0.75*	-1.29 to -0.22	-0.07
80 years or older	-1.55*	-2.71 to -0.39	-0.06	-2.08*	-2.98 to -1.18	-0.13
Household income decile						
1 to 3 (lowest)	-0.14	-0.64 to 0.36	-0.02	-0.16	-0.62 to 0.30	-0.02
4 to 7[‡]	...	...	...	...	...	...
8 to 10 (highest)	-0.34	-0.85 to 0.18	-0.04	-0.34	-0.80 to 0.11	-0.04
Immigrant status						
Immigrant (0 to 10 years in Canada)	-0.22	-1.10 to 0.66	-0.02	-0.35	-1.01 to 0.31	-0.03
Immigrant (11 or more years in Canada)	-0.18	-0.73 to 0.38	-0.02	-0.43	-1.01 to 0.15	-0.05
Canadian-born[‡]	...	...	...	...	...	...
Leisure-time physical activity level						
Active	-0.10	-0.61 to 0.41	-0.01	-0.10	-0.56 to 0.36	-0.01
Moderate	-0.05	-0.51 to 0.42	-0.01	-0.31	-0.76 to 0.13	-0.04
Inactive[‡]	...	...	...	...	...	...
Measured height (cm)	0.16*	0.12 to 0.19	0.38	0.14*	0.10 to 0.18	0.32
Measured weight (kg)	-0.05*	-0.06 to -0.03	-0.22	-0.03*	-0.05 to -0.02	-0.15
Intercept	-24.24			-20.86		
Model information						
R^2	0.14			0.15		
Sample size	2,106			2,429		

† measured minus self-reported
‡ reference category
* significantly different from estimate for reference category or from 0 for continuous variables ($p < 0.05$)
... not applicable
Source: 2005 Canadian Community Health Survey (subsample 2).

Table B
Regression coefficients relating selected characteristics to difference† between measured and self-reported weight (kg), household population aged 12 years or older, Canada excluding territories, 2005

	Males			Females		
	Regression coefficient (B)	95% confidence interval	Standardized regression coefficient (beta)	Regression coefficient (B)	95% confidence interval	Standardized regression coefficient (beta)
Age group						
12 to 24 years	0.81	-0.03 to 1.66	0.08	-0.04	-0.64 to 0.56	0.00
25 to 44 years	-0.21	-0.87 to 0.45	-0.03	-0.33	-0.89 to 0.22	-0.04
45 to 64 years‡	...	...	...	...	...	...
65 to 79 years	0.25	-0.43 to 0.93	0.02	0.07	-0.92 to 1.06	0.01
80 years or older	-0.26	-1.28 to 0.77	-0.01	-0.15	-0.95 to 0.64	-0.01
Household income decile						
1 to 3 (lowest)	0.31	-0.26 to 0.87	0.03	-0.24	-0.69 to 0.21	-0.03
4 to 7‡	...	...	...	...	...	...
8 to 10 (highest)	0.12	-0.40 to 0.64	0.01	0.08	-0.51 to 0.66	0.01
Immigrant status						
Immigrant (0 to 10 years in Canada)	-0.88	-2.05 to 0.29	-0.06	0.45	-0.27 to 1.17	0.03
Immigrant (11 or more years in Canada)	0.05	-0.61 to 0.72	0.01	0.22	-0.36 to 0.79	0.02
Canadian-born‡	...	...	...	...	...	...
Leisure-time physical activity level						
Active	0.31	-0.20 to 0.83	0.04	0.79*	0.32 to 1.25	0.08
Moderate	0.09	-0.41 to 0.59	0.01	0.25	-0.13 to 0.63	0.03
Inactive‡	...	...	...	...	...	...
End-digit preference for weight						
Yes	-0.18	-0.63 to 0.28	-0.02	0.47*	0.15 to 0.78	0.06
No‡	...	...	...	...	...	...
Measured weight (kg)	0.13*	0.10 to 0.15	0.52	0.11*	0.09 to 0.14	0.50
Measured height (cm)	-0.09*	-0.13 to -0.05	-0.20	-0.03	-0.05 to 0.00	-0.06
Intercept	6.91			-1.48		
Model information						
R^2	0.20			0.25		
Sample size	2,110			2,427		

† measured minus self-reported
‡ reference category
* significantly different from estimate for reference category or from 0 for continuous variables ($p < 0.05$)
... not applicable
Source: 2005 Canadian Community Health Survey (subsample 2).

Table C
Regression coefficients relating selected characteristics to difference† between measured and self-reported body mass index (BMI kg/m²), household population aged 12 years or older, Canada excluding territories, 2005

	Males			Females		
	Regression coefficient (B)	95% confidence interval	Standardized regression coefficient (beta)	Regression coefficient (B)	95% confidence interval	Standardized regression coefficient (beta)
Age group						
12 to 24 years	0.38*	0.01 to 0.74	0.09	0.19	-0.22 to 0.61	0.04
25 to 44 years	-0.01	-0.29 to 0.28	0.00	-0.07	-0.34 to 0.20	-0.02
45 to 64 years‡	...	...	...	...	...	...
65 to 79 years	0.41*	0.06 to 0.75	0.07	0.21	-0.21 to 0.63	0.03
80 years or older	0.29	-0.14 to 0.73	0.02	0.57*	0.07 to 1.07	0.06
Household income decile						
1 to 3 (lowest)	0.17	-0.06 to 0.40	0.04	-0.01	-0.26 to 0.25	0.00
4 to 7‡	...	...	...	...	...	...
8 to 10 (highest)	0.11	-0.12 to 0.33	0.03	0.17	-0.15 to 0.49	0.04
Immigrant status						
Immigrant (0 to 10 years in Canada)	-0.20	-0.63 to 0.22	-0.03	0.22	-0.10 to 0.54	0.03
Immigrant (11 or more years in Canada)	0.00	-0.26 to 0.27	0.00	0.21	-0.05 to 0.47	0.04
Canadian-born‡	...	...	...	...	...	...
Leisure-time physical activity level						
Active	0.10	-0.12 to 0.32	0.03	0.31*	0.06 to 0.56	0.06
Moderate	0.09	-0.14 to 0.32	0.02	0.19*	0.01 to 0.38	0.04
Inactive‡	...	...	...	...	...	...
End-digit preference for weight						
Yes	0.09	-0.12 to 0.29	0.02	0.11	-0.04 to 0.27	0.03
No‡	...	...	...	...	...	...
Measured weight (kg)	0.06*	0.05 to 0.07	0.57	0.06*	0.05 to 0.08	0.52
Measured height (cm)	-0.10*	-0.12 to -0.09	-0.48	-0.08*	-0.10 to -0.06	-0.31
Intercept	+13.33			9.64		
Model information						
R^2	0.29			0.28		
Sample size	2,111			2,422		

† measured minus self-reported
‡ reference category
* significantly different from estimate for reference category or from 0 for continuous variables ($p < 0.05$)
... not applicable
Source: 2005 Canadian Community Health Survey (subsample 2).

Table D
Self-reported body mass index (BMI) percentage distribution, by response to measured BMI, household population aged 12 years or older, Canada excluding territories, 2005

Self-reported BMI category (range kg/m²)	Total sub-sample 2	Measured	Not measured	Measured (with weight adjustment for non-response)
		%		
Total	**100.0**	**100.0**	**100.0**	**100.0**
Underweight (less than 18.5)	2.5	2.7	2.1	2.3
Normal weight (18.5 to 24.9)	49.3	52.0	44.8	50.5
Overweight (25.0 to 29.9)	32.4	31.4	34.1	32.0
Obese (30.0 or more)	15.9	14.0	19.1	15.2

Source: 2005 Canadian Community Health Survey (sub-sample 2).

Effects of measurement on obesity and morbidity

Margot Shields, Sarah Connor Gorber and Mark S. Tremblay

Abstract

Objectives

This article compares associations between body mass index (BMI) categories based on self-reported versus measured data with selected health conditions. The goal is to see if the misclassifications resulting from the use of self-reported data alters associations between excess body weight and these health conditions.

Methods

The analysis is based on 2,667 respondents aged 40 years or older from the 2005 Canadian Community Health Survey (CCHS) who, during a face-to-face interview, provided self-reported values for height and weight and were then measured by trained interviewers. Multiple logistic regression analysis was used to examine associations between BMI categories (based on self-reported and measured data) and obesity-related health conditions.

Results

On average, BMI based on self-reported height and weight was 1.3 kg/m^2 lower than BMI based on measured values. Consequently, based on self-reported data, a substantial proportion of individuals with excess body weight were erroneously placed in lower BMI categories. This misclassification resulted in elevated associations between overweight/obesity and morbidity.

Keywords

body mass index, measurement error, misclassification, self-report, sensitivity and specificity, validity

Authors

Margot Shields (613-961-4177; Margot.Shields@statcan.ca) and Sarah Connor Gorber (613-951-1193; Sarah.Connorgorber@statcan.ca) are with the Health Information and Research Division, and Mark S. Tremblay (613-951-4385; Mark.Tremblay@statcan.ca) is with the Physical Health Measures Division at Statistics Canada, Ottawa, Ontario, K1A 0T6.

Numerous studies from around the world have documented associations between excess body weight and a wide range of chronic conditions, including type 2 diabetes, cardiovascular disease, hypertension, gallbladder disease and certain types of cancer.[1] In these studies, it is common practice to use body mass index (BMI) categories to examine health risks of excess weight. BMI is a measure of an individual's weight in relation to height and is a simple way of measuring excess weight in population health surveys.

When comparing results across studies, the method used to collect information on weight and height should be considered. Some studies are based on data from surveys that directly measured the height and weight of respondents, while other studies are based on self-reported weight and height.[1,2] Conclusions of a recent systematic review of the literature[3] were consistent with recent findings from Canadian data:[4] self-reports tend to underestimate weight and overestimate height. As a result, significant misclassification occurs when BMI categories are estimated from self-reported data. An important question is whether such misclassification alters our understanding of associations between BMI category and obesity-related diseases.

In 2005, the Canadian Community Health Survey (CCHS) collected both self-reported and measured height and weight from a subsample of respondents. Based on these data, this study compares associations between BMI categories and selected health conditions to see if the use of self-reported data alters associations between excess weight and morbidity. The study focuses on the household population aged 40 or older. Before associations between BMI categories and morbidity are examined, the misclassification bias for the study population is summarized.

Methods

Data source

Data are from the 2005 CCHS. The CCHS covers the population aged 12 years or older living in private households. It does not include residents of Indian reserves, institutions and some remote areas; full-time members of the Canadian Forces; and civilian residents of military bases. For the 2005 CCHS, interviews were conducted between January and December 2005. The response rate was 79%, yielding a sample of 132,947 respondents.

Three sampling frames were used to select the sample of households for the 2005 CCHS: 49% of the sample of households came from an area frame; 50% from a list frame of telephone numbers; and the remaining 1% from a Random Digit Dialing (RDD) sampling frame. Owing to cost considerations, measured height and weight were collected for only a subsample ("subsample 2") of respondents, all of whom were from the area frame. Residents of the territories were not included in this subsample.

Since the health conditions considered in this analysis are most prevalent among older adults, the study population was restricted to respondents aged 40 years or older. In total, 4,357 CCHS respondents selected for sub-sample 2 were 40 years or older. Measured height and weight were obtained for 2,711 of them. The main reason for non-response was refusal.

Because measured height and weight were recorded for only a subset of respondents in subsample 2, an adjustment was made to minimize non-response bias. A special sampling weight was created by redistributing the sampling weights of non-respondents to measured height and weight to respondents using response propensity classes. The variables used to create these classes were region (British Columbia, Prairies, Ontario, Quebec, Atlantic provinces), age, sex, household size, marital status, rural/urban indicator, and quarter of collection.

Of the 2,711 respondents for whom measured height and weight were collected, an additional 44 records were excluded from this analysis because they were missing either self-reported height or weight, or were women who were pregnant at the time of the survey. This left 2,667 respondents.

A detailed description of the CCHS methodology is available in a published report.[5]

Analytical techniques

The bias associated with using self-reported data for weight, height and BMI was estimated by calculating the difference between measured and self-reported values (measured minus self-reported value). A positive difference indicates underreporting, and a negative difference, overreporting. Respondents whose measured minus self-reported value was five or more standard deviations from the mean were considered outliers and dropped from the analysis (14 records were dropped for weight, 18 for height, and 23 for BMI).

Respondents were classified into BMI categories (see Definitions). Because of small sample sizes, obese categories II and III were combined. The degree of misclassification that resulted from the use of self-reported values to estimate the prevalence of the various BMI categories was assessed by calculating sensitivity and specificity. Sensitivity refers to the percent of true positives, and specificity, the percent of true negatives. For example, for estimates of obesity (BMI 30 kg/m^2 or more), sensitivity would be the percent of respondents classified as obese based on self-reported values among those classified as obese based on measured values (in other words, the percent of obese people who actually reported that they were obese). Specificity is the percentage of respondents classified as not obese (BMI less than 30 kg/m^2) based on self-reported values among those who were not obese based on measured values (in other words, the percent of people who reported that they were not obese, among those who actually were not obese).

To study the impact that misclassification of BMI categories has on the association between obesity and selected health conditions, two sets of logistic regression models were fitted. In each set, a total of 12 regression models were fitted—one for each of the 6 health conditions considered, controlling for BMI categories, and one for each of the 6 conditions controlling for continuous BMI. In the first set of models, BMI categories were based on self-reported height and weight, and in the second set, BMI categories were based on measured height and weight. In both sets of models, age and sex were entered as control variables. The purpose was to see if associations between BMI categories and health conditions differed, depending on whether they were based on self-reported or measured values. Both sets of models used data from the same respondents.

All estimates were weighted to represent the household population aged 40 years or older in 2005 (using the weight created to adjust for non-response to measured height and weight in subsample 2). To account for the survey design effect of the CCHS, standard errors, coefficients of variation and 95% confidence intervals were estimated using the bootstrap technique.[6-8] Differences between estimates were tested for statistical significance, which was established at the 0.05 level.

Definitions

Self-reported height and weight were collected with the questions:

- "How tall are you without shoes on?" Categories for height in feet and inches were listed on the questionnaire, with corresponding metric values in brackets. Interviewers were instructed to round up to the closest inch for respondents who reported half inch measures.
- "How much do you weigh?" If asked, interviewers told respondents to report weight without clothing. After reporting their weight, respondents were asked if they had reported in pounds or kilograms. Most respondents (94%) reported in pounds.

CCHS interviewers were trained to measure the height and weight of respondents. Height (with shoes removed) was measured to the nearest 0.5 cm, and weight, to the nearest 0.1 kg. Calibrated weigh scales (ProFit UC-321 made by Lifesource) and measuring tapes were used to ensure accuracy and consistency of measures.

The entire CCHS interview was about 50 minutes long. Self-reported height and weight were collected close to the beginning of the interview, and the measurements were taken near the end.

Body mass index (BMI) is a measure of weight adjusted for height. In this analysis, BMI was derived from both measured and self-reported weight and height. BMI is calculated by dividing weight in kilograms by the square of height in metres. Based on Canadian guidelines,[9] which are in line with those of the World Health Organization,[10] BMI for adults is classified into six categories:

Category	BMI kg/m^2 range
Underweight	(BMI less than 18.5)
Normal weight	(BMI 18.5 to 24.9)
Overweight	(BMI 25.0 to 29.9)
Obese class I	(BMI 30.0 to 34.9)
Obese class II	(BMI 35.0 to 39.9)
Obese class III	(BMI greater than or equal to 40.0)

Respondents were asked about long-term physical conditions that had lasted or were expected to last six months or longer and that had been diagnosed by a health professional. Interviewers read a list of conditions. Conditions considered in this analysis were *diabetes, high blood pressure, heart disease, and arthritis or rheumatism*.

Self-perceived general health was assessed with the question, "In general, would you say your health is: excellent, very good, good, fair or poor?"

To determine *activity limitation*, respondents were asked: "Do you have any difficulty hearing, seeing, communicating, walking, climbing stairs, bending, learning or doing any similar activities?" As well, a series of questions about limitations in various settings was asked: "Does a long-term physical condition or mental condition or health problem reduce the amount or the kind of activity you can do: at home, at work, or at school or other activities (e.g., transportation or leisure)?" The response categories were "often," "sometimes" or "never." Respondents were classified as having an activity limitation if they replied "often" or "sometimes" to at least one item.

Results

Self-reported and measured values for height and weight differed (Table 1). On average, height was over-reported by 1.1 cm, while weight was under-reported by 2.5 kg. BMI based on self-reported height and weight was, on average, 1.3 kg/m² lower than BMI based on measured values.

These systematic reporting errors resulted in extensive misclassification when BMI categories were derived from self-reported values. Misclassification errors were assessed by calculating sensitivity and specificity (Table 2). Sensitivity was high (91%) for those in the normal weight category; in other words, 91% of respondents whose self-reported height and weight put them in the normal weight range, were, indeed, in the normal range based on their measured height and weight. Among the overweight, sensitivity dropped to 69%. Sensitivity was particularly low for the obese categories: 52% for obese class I and 49% for obese class II and III combined. This was the result of a substantial proportion of individuals who were truly obese reporting values for height and weight that placed them in lower BMI categories. For the combined obese group (BMI 30 kg/m² or more), sensitivity was 62%, and for the overweight and obese combined (BMI 25 kg/m² or more), 83%.

Specificity was very high (95% or more) for the obese categories, indicating that very few respondents reported values for height and weight that placed them in the obese category unless they really were obese.

Given the substantial degree of misclassification that occurs when BMI is derived from self-reported

Table 1
Mean height, weight and body mass index (BMI), by collection method, household population aged 40 years or older, Canada excluding territories, 2005

	Collection method			95% confidence interval of difference
	Measured	Self-reported	Difference†	
Mean height (cm)	167.5	168.6	-1.1	-1.3 to -0.9
Mean weight (kg)	77.9	75.4*	2.5	2.3 to 2.7
Mean BMI (kg/m²)	27.7	26.4*	1.3	1.2 to 1.4

† measured minus self-reported
* significantly different from measured estimate ($p < 0.05$)
Source: 2005 Canadian Community Health Survey (sub-sample 2).

Table 2
Self-reported body mass index (BMI) category by measured BMI category, household population aged 40 years or older, Canada excluding territories, 2005

	Measured BMI category (range kg/m²)							
	Normal weight (18.5 to 24.9)		Overweight (25.0 to 29.9)		Obese class I (30.0 to 34.9)		Obese class II/III (35 or more)	
	Total ('000)	%	Total ('000)	%	Total ('000)	%	Total ('000)	%
Self-reported BMI category (range kg/m²)								
Underweight (less than 18.5)	167	4	1	0	0	0	0	0
Normal weight (18.5 to 24.9)	4,095	91	1,702	29	52	2	3	0
Overweight (25.0 to 29.9)	254	6	4,044	69	1,523	46	99	9
Obese class I (30.0 to 34.9)	0	0	143	2	1,694	52	451	42
Obese class II/III (35.0 or more)	0	0	0	0	13	0	521	49
Total	4,516	100	5,889	100	3,282	100	1,074	100
Sensitivity								
% true positives (95% confidence interval)	91 (87 to 94)		69 (65 to 73)		52 (44 to 59)		49 (39 to58)	
Specificity								
% true negatives (95% confidence interval)	82 (80 to 85)		79 (76 to 83)		95 (93 to 96)		100 (100 to 100)	

Note: Sensitivity and specificity estimates are not given for the measured underweight group (BMI less than 18.5) because of small sample sizes.
Source: 2005 Canadian Community Health Survey (sub-sample 2).

height and weight, it is important to determine if associations between BMI categories and various health conditions are different when BMI is derived from self-reported rather than measured data. Results of the regression analyses comparing associations between BMI categories and health conditions reveal that the odds ratios for the overweight and obese categories were generally higher for models based on self-reported values than the odds for models based on measured values (Table 3). In several cases, the differences were substantial. For example, the odds ratios for diabetes for the overweight, obese I, and obese II/III categories, were 2.6, 3.2, and 11.8, respectively, in the model based on self-reported data; the corresponding odds ratios in the model based on measured values were 1.4, 2.2 and 7.0.

The explanation for these differences becomes clear when the average weight in each BMI category based on measured values is compared with that based on self-reported values (Table 4). According to measured values, 22% of respondents were classified as obese I and 7% as obese II/III, with average weights of 91 kg and 106 kg, respectively. According to self-reported values, far fewer respondents were classified into these categories (15% obese I; 4% obese II/III), but their average measured weight was substantially greater: 95 kg for obese I and 113 kg for obese II/III. As a result, stronger associations with morbidity were observed for overweight and obese categories based on self-reported data because the respondents in them are, in fact, heavier.

Table 3
Adjusted odds ratios relating measured and self-reported body mass index (BMI) to selected health conditions, household population aged 40 years or older, Canada excluding territories, 2005

	Based on measured BMI		Based on self-reported BMI	
BMI category (range kg/m^2)	Adjusted odds ratios	95% confidence interval	Adjusted odds ratios	95% confidence interval
Diabetes				
Normal weight (18.5 to 24.9)	1.0	...	1.0	...
Overweight (25.0 to 29.9)	1.4	0.7 to 2.9	2.6*	1.6 to 4.3
Obese class I (30.0 to 34.9)	2.2*	1.0 to 4.5	3.2*	1.8 to 5.6
Obese class II/III (35.0 or more)	7.0*	2.9 to 16.5	11.8*	5.5 to 25.3
BMI (continuous)	1.11*	1.07 to 1.16	1.13*	1.09 to 1.18
High blood pressure				
Normal weight (18.5 to 24.9)	1.0	...	1.0	...
Overweight (25.0 to 29.9)	2.1*	1.5 to 3.0	2.7*	1.9 to 3.8
Obese class I (30.0 to 34.9)	3.4*	2.3 to 5.1	4.3*	2.9 to 6.3
Obese class II/III (35.0 or more)	5.5*	3.1 to 9.8	7.8*	3.7 to 16.6
BMI (continuous)	1.12*	1.09 to 1.15	1.14*	1.11 to 1.17
Heart disease				
Normal weight (18.5 to 24.9)	1.0	...	1.0	...
Overweight (25.0 to 29.9)	1.0	0.6 to 1.7	1.4	0.9 to 2.3
Obese class I (30.0 to 34.9)	1.5	0.8 to 2.9	1.6	1.0 to 2.6
Obese class II/III (35.0 or more)	2.6*	1.1 to 6.0	5.6*	2.3 to 13.8
BMI (continuous)	1.07*	1.02 to 1.12	1.08*	1.03 to 1.14
Arthritis				
Normal weight (18.5 to 24.9)	1.0	...	1.0	...
Overweight (25.0 to 29.9)	1.2	0.8 to 1.7	1.2	0.8 to 1.7
Obese class I (30.0 to 34.9)	1.2	0.8 to 1.8	2.0*	1.3 to 3.0
Obese class II/III (35.0 or more)	2.9*	1.7 to 4.8	3.5*	1.7 to 7.1
BMI (continuous)	1.05*	1.03 to 1.08	1.07*	1.04 to 1.11
Activity limitation				
Normal weight (18.5 to 24.9)	1.0	...	1.0	...
Overweight (25.0 to 29.9)	1.2	0.9 to 1.6	1.2	0.9 to 1.6
Obese class I (30.0 to 34.9)	1.5*	1.1 to 2.2	2.0*	1.3 to 3.0
Obese class II/III (35.0 or more)	3.0*	1.8 to 4.9	4.7*	2.5 to 8.9
BMI (continuous)	1.06*	1.04 to 1.08	1.07*	1.04 to 1.10
Fair/poor self-perceived health				
Normal weight (18.5 to 24.9)	1.0	...	1.0	...
Overweight (25.0 to 29.9)	0.8	0.5 to 1.2	1.3	0.9 to 2.0
Obese class I (30.0 to 34.9)	1.7*	1.0 to 2.7	2.8*	1.8 to 4.3
Obese class II/III (35.0 or more)	3.2*	1.8 to 5.6	5.4*	2.5 to 11.6
BMI (continuous)	1.09*	1.06 to 1.12	1.10*	1.06 to 1.14

* significantly different from estimate for normal weight category ($p < 0.05$)
... not applicable
Notes: Models control for age (continuous) and sex. Odds ratios for underweight group are not reported because of small sample sizes.
Source: 2005 Canadian Community Health Survey (sub-sample 2).

Table 4
Mean measured weight (kg) and mean measured body mass index (BMI kg/m^2), by BMI category based on measured and on self-reported values, household population aged 40 years or older, Canada excluding territories, 2005

	%	Mean measured weight (kg)	Mean measured BMI (kg/m^2)
BMI category (range kg/m^2) based on measured values			
Normal weight (18.5 to 24.9)	30.3	63.3	22.6
Overweight (25.0 to 29.9)	39.6	77.4	27.3
Obese class I (30.0 to 34.9)	22.0	90.8	31.9
Obese class II/III (35.0 or more)	7.2	106.1	39.6
BMI category (range kg/m^2) based on self-reported values			
Normal weight (18.5 to 24.9)	39.8*	65.8*	23.6*
Overweight (25.0 to 29.9)	39.8	81.4*	28.6*
Obese class I (30.0 to 34.9)	15.4*	94.5*	33.3*
Obese class II/III (35.0 or more)	3.6*	112.8*	42.3*

* significantly different from estimate for corresponding BMI category based on measured values ($p < 0.05$)
Source: 2005 Canadian Community Health Survey (sub-sample 2).

The two sets of models (for each condition) were also run using BMI as a continuous variable. The differences between regression coefficients for BMI for the two sets of models were small, but in all cases, the set of models based on self-reported data had slightly higher regression coefficients.

Discussion

This study of a representative sample of the Canadian population aged 40 years or older found that systematic over-reporting of height and under-reporting of weight caused substantial misclassification of people by BMI category, compared with results based on measured values. The finding that self-reported data overestimate height and underestimate weight is consistent with numerous other studies.[3] Few studies, however, have sought to determine if reporting biases in height and weight alter associations between BMI categories and morbidity.

In this analysis, the misclassification that occurred when BMI categories were derived from self-reported data resulted in *elevated* associations between the overweight and obese categories and obesity-related health conditions. Contrary to these findings, a study of Mexican adults found that the use of BMI categories based on self-reported data underestimated the associations between excess body weight and asthma among men.[11] However, the findings of a study of Greek adults were consistent with those in this analysis: the use of self-reported data resulted in stronger associations between obesity and diabetes, hypercholesterolemia, and high blood pressure.[12]

Based on self-reported data, this analysis found far fewer respondents being classified as overweight or obese. However, those whose self-reported height and weight placed them in the overweight or obese categories had substantially higher BMIs, on average, than did people assigned to these categories based on measured data.

Although associations with obesity-related conditions for the overweight and obese categories were exaggerated when based on self-reported data, this does not imply that the disease burden (the number of cases) is overestimated. In fact, the total burden is underestimated because of the underestimation of the prevalence of overweight and obesity. For example, among those classified as obese based on self-reported data, 360,000 people aged 40 years or older had diabetes. But among those classified as obese based on measured values, 530,000 people (nearly 50% more) had diabetes (data not shown). These differences simply reflect the greater number of people who are classified as obese when measured data are used.

It has often been proposed that using BMI as a continuous variable in analytical studies based on self-reported data can avoid the problem of the misclassification of BMI categories (because of the very high correlations between self-reported and measured height and weight). However, the use of BMI as a continuous variable assumes a linear association between BMI and morbidity, an assumption that has been challenged by recent research in the United States.[13] Moreover, using BMI as a continuous variable precludes the possibility of quantifying the degree to which the risk of disease differs among specific sub-groups with excess body weight. The report by Flegal et al.[13] examined associations between BMI categories based on measured data and cause-specific mortality. Compared with the normal weight group, the overweight group had similar risks of mortality from cancer and cardiovascular disease (CVD), and decreased risks of mortality from non-cancer, non-CVD causes. Obesity was associated with an increased risk of mortality from CVD and some cancers, but was not associated with non-cancer, non-CVD mortality. It would not have been possible to observe such distinctions of mortality risk for different BMI categories if BMI had been used as a continuous measure, and these distinctions would likely have been masked if BMI categories had been based on self-reported values.

Other approaches that have been suggested when dealing with self-reported data are to lower BMI cut-points for overweight and obesity, or to adjust self-reported values to account for the reporting bias. Several studies have evaluated the possibility of using linear regression to predict measured values (of height, weight and BMI) using self-reported values and other variables such as age. Although a study based on data from the United States collected during the late 1970s concluded that it was difficult or impossible to correct for reporting bias using linear regression,[14] more recent efforts (based on populations in which reporting bias was higher) have had greater success in using prediction equations to adjust self-reported values to produce estimates with higher levels of sensitivity.[15-17] A feasibility study using data from the 2005 CCHS is currently underway to assess the possibility of producing prediction equations to correct for the bias in self-reported data in the Canadian population. This is particularly important given the very low sensitivity of obesity estimates derived from self-reported data. But even if self-reported values can be adjusted to correct for bias, it will still be necessary to monitor reporting bias over time to determine the need for ongoing adjustments to the equations.

Limitations

This study compared health risks of excess body weight for BMI categories calculated from measured weight and height with health risks for BMI categories calculated from self-reported data obtained in face-to-face interviews. Self-reported data from face-to-face interviews yield higher prevalence estimates of obesity than do data collected in telephone interviews.[18] Therefore, studies based on data collected by telephone may further exaggerate associations between excess body weight and morbidity. Caution is necessary when extending the findings of this analysis to studies that employed other modes of data collection (telephone, mail).

Although this analysis considered measured height and weight to be "true" values, some factors may have limited their accuracy. Height and weight were measured by trained Statistics Canada interviewers; measures made by trained health technicians that have been used in other studies may be more accurate.[19,20] Although identically calibrated weigh scales and measuring tapes were used by the interviewers, validity and reliability studies to assess inter- and intra-interviewer accuracy and reproducibility were not performed.

Some of the bias associated with under-reporting weight may be due to clothing. Respondents were weighed fully clothed, but people may weigh themselves at home with minimal or no clothing. If interviewers were asked, they told respondents to report their weight without clothing.

Because only a small number of respondents' measured height and weight placed them in the underweight category, it was not possible to determine if the use of self-reported data altered associations with morbidity for this group.

Why is this study important?

- The practice of collecting self-reported data for height and weight is a fiscal necessity for large-scale health surveys conducted at Statistics Canada.
- It is important to examine the extent to which the use of self-reported data alters our understanding of the associations between excess body weight and morbidity.

What else is known on this topic?

- Many studies have found that self-reported data yield lower estimates of the prevalence of obesity, compared with estimates based on measured data, but few studies have examined the effect of the misclassification bias on the relationship between BMI categories and obesity-related health conditions.

What does this study add?

- Misclassification that occurred when BMI categories were derived from self-reported data resulted in erroneously elevated associations between overweight and obesity and obesity-related health conditions.

Conclusion

The practice of collecting self-reported data for height and weight is a fiscal necessity for large-scale health surveys conducted at Statistics Canada such as the Canadian Community Health Survey (CCHS) and the National Population Health Survey (NPHS). Users of CCHS and NPHS data should be aware that the misclassification of BMI categories that results from self-reported data may exaggerate associations between overweight/obesity and morbidity and underestimate the obesity-related burden of disease. Therefore, researchers may want to consider adjusting self-reported values or lowering BMI cut-points for the overweight and obese categories when examining associations between excess body weight and obesity-related health conditions. It will be important to monitor the magnitude of the bias over time to see if revisions to correction factors are required.

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