Healthy today, healthy tomorrow? Findings from the National Population Health Survey

Obesity: a Growing Issue

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In 2000/01, an estimated 3 million adult Canadians were obese, and an additional 6 million were overweight.[1] Canada is part of what the World Health Organization has called a global epidemic of obesity. The prevalence of obesity is rising not only in western countries such as the United States, the United Kingdom, Australia, Germany, the Netherlands, Sweden, and Finland, but also in countries such as Brazil, China and Israel.[2] In Canada, the prevalence of obesity more than doubled in the last two decades. Even so, at 15% in 2002, Canada's obesity rate was still below the 21% reported for the United States.[3] Is Canada likely to follow the American lead to the point where one out of every five adults is obese?

Obesity is recognized as a major and rapidly worsening public health problem that rivals smoking as a cause of illness and premature death. Obesity has been linked with type 2 diabetes, cardiovascular disease, hypertension, stroke, gallbladder disease, some forms of cancer, osteoarthritis and psychosocial problems.[4] The impact on life expectancy is considerable: among American non-smokers, obesity at age 40 has been associated with a loss of 7.1 years of life for women and 5.8 years for men.[5] The same American study estimated that even being overweight reduced both male and female non-smokers' life expectancy by more than three years.

Obesity results when people consume far more calories than they work off each day (see *Calculating obesity*). This imbalance has been attributed to a variety of factors that characterize modern life: fast food, growing portion sizes, a sedentary lifestyle, and urban designs that discourage walking.[6] However, some groups may be more susceptible to these influences than others, and therefore, may be contributing disproportionately to the overall increase in obesity.

This analysis uses longitudinal data to follow a large sample of people over eight years to determine the percentage who made the transition from normal to overweight, and the percentage who shifted from overweight to obese. The characteristics that increased the chances that overweight people would become obese are examined. Such information can facilitate targeting of public health interventions to prevent new cases of obesity. Once gained, surplus weight is hard to shed, so interventions that focus on prevention may be more effective than weight reduction efforts.[7]

The study is based on the National Population Health Survey (NPHS), which interviewed the same individuals every two years from 1994/95 to 2002/03 (see *Methods* and *Definitions*). Because patterns of weight gain differ by sex, separate analyses were conducted for men and women.

Steady gains

In 1994/95, the prevalence of obesity was similar among men and women in the 20 to 56 age range. That year, just under 13% were obese—about 900,000 of each sex. However, men were much more likely than women to be overweight: 44% versus 24%. An estimated 3.1 million men were overweight, compared with 1.7 million women.

Chart 1
A third of adults whose weight had been normal in 1994/95 were overweight by 2002/03 . . .

% of normal weight in 1994/95
who became overweight
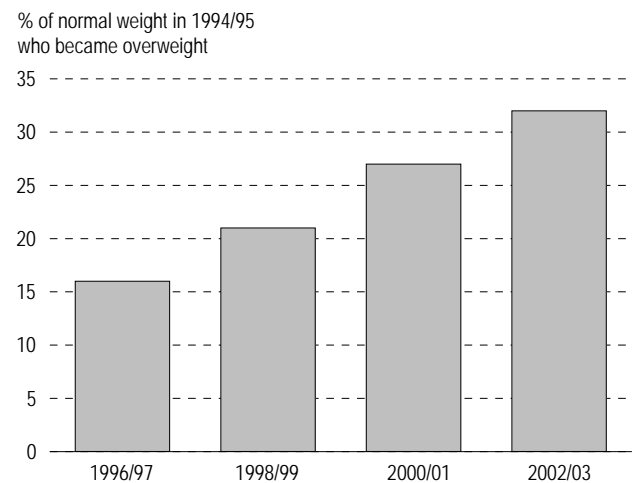
. . . and nearly a quarter who had been overweight had become obese.
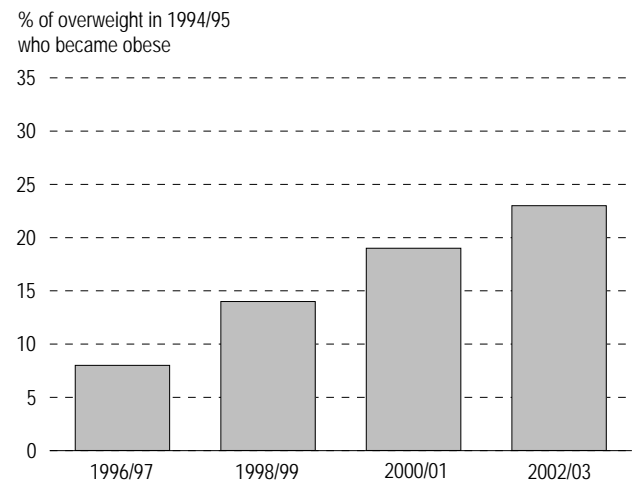
% of overweight in 1994/95
who became obese

Date source: 1994/95 to 2002/03 National Population Health Survey, longitudinal file.

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Among people whose weight had been in the normal range in 1994/95, a shift into the overweight range by 2002/03 was relatively common (Chart 1). By the end of the eight years, 32% of those whose weight had been normal were overweight. Weight gain is usually a slow process, however, since very few people (2%) whose weight had been in the normal range in 1994/95 had become obese by 2002/03 (data not shown).

Once people are overweight, they tend to gain even more. Almost a quarter of those who had been overweight in 1994/95 had become obese by 2002/03. On the other hand, only half as many—10%—who had been overweight were in the normal weight range in 2002/03.

Patterns differ for men and women

Men were more likely than women to make the transition from normal to overweight (Chart 2). By 2002/03, 38% of the men whose weight had been in the normal range in 1994/95 had become overweight, compared with 28% of the women.

However, the likelihood of going from overweight to obese was greater for women. At the end of the eight years, 28% of women and 20% of men who had been overweight had become obese. Nonetheless, even for men, given the large number who had been overweight in 1994/95 (3.1 million), this

Chart 2

Between 1994/95 and 2002/03, men were more likely than women to go from normal to overweight . . .

% of normal weight in 1994/95
who became overweight
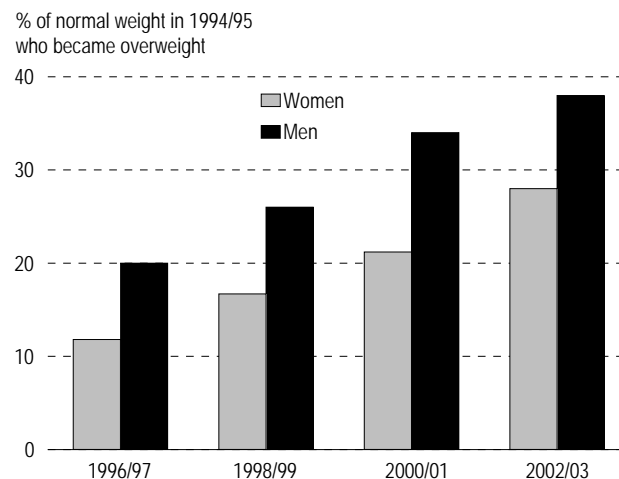
. . . but among people who were overweight, women were more likely than men to become obese

% of overweight in 1994/95
who became obese
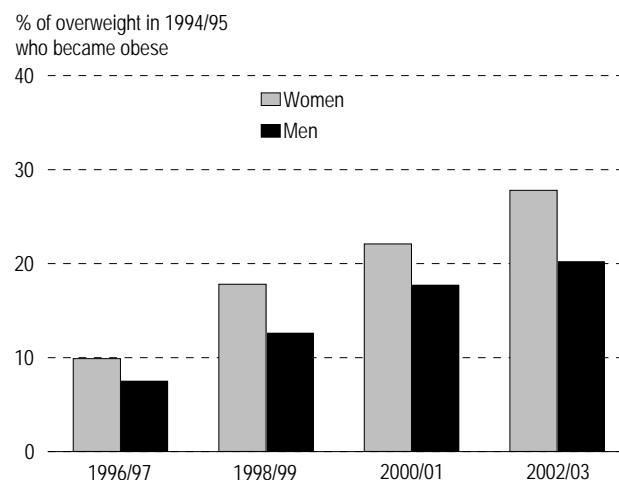
Date source: *1994/95 to 2002/03 National Population Health Survey, longitudinal file.*

translated into more than 600,000 new cases of obesity in less than a decade, compared to almost 500,000 new cases for women.

Obesity occurs in the context of a variety of demographic, socio-economic, lifestyle and health variables. Moreover, these factors are often related to each other. For instance, an older person with a chronic condition may be sedentary, and people in low-income

Calculating obesity

Obesity is based on *body mass index* (BMI), which is calculated by dividing weight in kilograms by height in metres squared. For example, the BMI of an individual 1.7 metres tall (5 feet 7 inches) weighing 70 kilograms (154 pounds) would be:

$$70 \div 1.7^2 = 24.2$$

If this person weighed 80 kilograms (176 pounds), his or her BMI would be:

$$80 \div 1.7^2 = 27.7$$

The BMI categories used for this article are: less than 18.5 (underweight); 18.5 to 24.9 (normal weight); 25.0 to 29.9 (overweight), and 30.0 or more (obese).

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households may be more likely to smoke than those in more affluent households. When such confounding effects were taken into account, along with the weight in 1994/95 (obviously, an important predictor of future weight gain), several factors emerged as being related to an overweight individual's chances of becoming obese.

Younger men more likely to become obese

Among people who were overweight in 1994/95, young adults, especially men, had an elevated risk of obesity (Table 1). During the eight-year period, overweight men in their

twenties and thirties were more likely than those in their fifties to become obese. For overweight women in their twenties, the risk of becoming obese was high compared with those in their fifties, but just failed to reach statistical significance ($p = 0.07$).

Lower income/Higher risk

Overweight Canadians in high-income households were less likely to become obese than were those in the lowest income category. Among overweight men, the risk of becoming obese was about 40% less for those in the two highest household income quintiles than for

Table 1

Adjusted risk ratios for overweight men and women aged 20 to 56 becoming obese, by selected characteristics, household population, Canada excluding territories, 1994/95 to 2002/03

	Men		Women			Men		Women	
	Adjusted risk ratio	95% confidence interval	Adjusted risk ratio	95% confidence interval		Adjusted risk ratio	95% confidence interval	Adjusted risk ratio	95% confidence interval
Body mass index in 1994/95	2.05**	1.85, 2.28	1.90**	1.70, 2.12	Leisure-time physical activity‡				
					Sedentary†	1.00	...	1.00	...
Age group					Light	1.08	0.74, 1.58	0.89	0.59, 1.34
20-29	2.48**	1.54, 4.00	1.61	0.97, 2.68	Moderate	1.07	0.76, 1.50	0.73	0.51, 1.06
30-39	1.60*	1.06, 2.41	1.17	0.75, 1.83	Intense	1.06	0.77, 1.45	0.92	0.55, 1.55
40-49	1.33	0.88, 2.00	1.17	0.75, 1.83	Usual daily physical activity‡				
50-56†	1.00	...	1.00	...	Sit†	1.00	...	1.00	...
Household income quintile					Stand or walk	0.80	0.55, 1.16	0.72*	0.52, 1.00
Lowest†	1.00	...	1.00	...	Lift light loads	1.02	0.68, 1.52	0.72	0.48, 1.08
Low-middle	0.77	0.49, 1.23	0.79	0.52, 1.20	Heavy work	0.75	0.47, 1.17	0.77	0.26, 2.21
Middle	0.67	0.41, 1.09	0.60*	0.37, 0.97	Self-perceived health				
Middle-high	0.60*	0.37, 0.97	0.60*	0.38, 0.92	Excellent/Very good†	1.00	...	1.00	...
Highest	0.54**	0.34, 0.85	0.63	0.39, 1.01	Good	1.30	0.97, 1.73	0.75	0.54, 1.05
Marital status					Fair/Poor	1.04	0.58, 1.88	0.66	0.37, 1.19
Single†	1.00	...	1.00	...	Activity restriction				
Married/Common-law	1.18	0.82, 1.71	1.19	0.75, 1.91	No†	1.00	...	1.00	...
Separated/Divorced/Widowed	0.84	0.47, 1.51	0.86	0.50, 1.48	Yes	1.44*	1.02, 2.03	1.41	0.97, 2.07
Alcohol consumption					Region				
Never†	1.00	...	1.00	...	Atlantic	0.85	0.59, 1.24	1.00	0.67, 1.50
Regular	0.64	0.38, 1.10	0.65	0.37, 1.15	Québec	1.04	0.70, 1.54	1.13	0.77, 1.67
Occasional	0.56	0.29, 1.08	0.54*	0.30, 0.97	Ontario†	1.00	...	1.00	...
Former	1.20	0.64, 2.25	0.64	0.34, 1.23	Prairies	1.05	0.73, 1.51	1.09	0.73, 1.62
Smoking					British Columbia	1.02	0.71, 1.48	1.15	0.67, 1.96
Never†	1.00	...	1.00	...					
Daily	1.49*	1.06, 2.08	1.13	0.80, 1.60					
Occasional	1.33	0.75, 2.34	0.56	0.26, 1.20					
Former	1.26	0.91, 1.76	0.93	0.67, 1.30					

Data source: *1994/95 to 2002/03 National Population Health Survey, longitudinal file.*
Note: *If the value of an adjusted risk ratio is more than 1, it represents how much more likely a person in that group is to become obese than a person in the reference group. For example, men aged 30 to 39 were 1.6 times more likely to become obese than men aged 50 to 56. If the adjusted risk ratio is less than 1, subtract its value from 1 and multiply by 100%. This will give how much less likely is a person in that group is to become obese than a person in the reference group. For example, men in the middle-high income quintile were (1 - 0.60)*100% = 40% less likely to become obese than men in the lowest income quintile. The model also controls for wave length and wave length square.*
† Reference group.
‡ Measured at each survey cycle.
* Significantly different from reference group (p < 0.05).
** Significantly different from reference group (p < 0.01).

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those in the lowest quintile. Overweight women in the three highest income quintiles also had a significant reduction in the risk of obesity, again around 40%, compared to women in the lowest quintile.

The relationship between household income and obesity may result from the cost of food, as foods high in fat and sugar are often cheaper. Low-income families must balance grocery expenditures with those on other necessities such as housing and clothing.[8] As well, food costs have been shown to be higher in low-income neighborhoods, and travelling to shop in areas where prices are lower may not be feasible.[9]

Occasional drinking
The risk of becoming obese was almost 50% lower among overweight women who reported occasional drinking, compared with those who never drank. While a similar pattern was observed for men, the association did not reach statistical significance (p=0.08).

An association between alcohol consumption and a small reduction in weight for women has been reported in other studies.[10,11] Alcohol has been documented as increasing the metabolic rate, which results in more calories burned.[12] Also, people who drink occasionally may have health-conscious behaviors, especially with regard to their diet, that reduce their risk of becoming obese.

High risk for male smokers
Overweight men who smoked daily in 1994/95 were almost 50% more likely to have become obese by 2002/03 than were those who had never smoked. This is contrary to cross-sectional studies that have found smokers less likely to be obese than never-smokers. However, those studies also showed that former smokers are more likely to be obese than people who never smoked.[13] In fact, further analysis of the longitudinal NPHS data indicated that these results reflected, in part, a weight gain among people who had stopped smoking after 1994/95 (data not shown).

Activity
It is no surprise that overweight people who were restricted in their daily activities—at home, work or school—were at increased risk of becoming obese. While the association was statistically significant only for men, an indication of a similar relationship was present for women (p=0.07). Because of their physical restrictions, many of these people may be relatively inactive, which increases their risk of gaining weight.

Physical activity, in fact, seemed to offer overweight women some protection against obesity. Those whose daily activities involved a lot of walking or standing were less likely to become obese than overweight women who tended to sit most of the day. Even when the effects of the other variables were considered, this association remained statistically significant. As well, overweight women whose leisure-time entailed moderate physical activity were at less risk of becoming obese than those who were sedentary, although when the other variables were taken into account, this relationship was not significant (p=0.10). No statistically significant association between physical activity, as measured in the survey, and obesity was observed for overweight men.

Region not a factor
Despite geographic differences in the prevalence of obesity, no association was found between region of residence and the risk of becoming obese. Thus, an overweight individual's chances of becoming obese are influenced by factors such as age, income, smoking and physical activity, and not by the simple fact of residing in a specific part of the country.

Concluding remarks
Between 1994/95 and 2002/03, a third of people who had started out in the normal weight range became overweight, and almost a quarter of those who had been overweight became obese.

Once weight is gained, it appears hard to lose. Greater knowledge of the dynamics behind this trend toward obesity among Canadians is key to effective targeting of interventions that can prevent the gain of excess weight.

Not surprisingly, being overweight is an important predictor of obesity, and is, in fact, an intermediate step. But even when the 1994/95 weight was taken into account, several other factors were independently associated with becoming obese. Among people who were overweight, the risk of obesity was relatively high for younger men and for members of low-income households. Overweight men who smoked were more at risk of becoming obese, while occasional drinking was associated with a reduced risk of obesity among overweight women. Overweight men with activity restrictions were more likely to become obese. Physical activity helped overweight women avoid obesity. Unfortunately, information about nutrition was not available for this analysis.

Although the child obesity rate is rising,[14] this study does not include children. However, it has been shown that parental obesity significantly increases the risk of obesity among children.[15] Therefore, identifying groups in the adult population who are likely to gain weight and targeting them for intervention may be an indirect way of reaching their children. If parents are helped, an added benefit may be helping their children. ■■

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Definitions

Except for the two physical activity measures, the independent variables used in this analysis pertain to respondents' characteristics in 1994/95.

For this analysis, respondents aged 20 to 56 in 1994/95 were selected. By the fifth cycle (2002/03) of the National Population Health Survey, the selected respondents were aged 28 to 64. Pregnant women were excluded during their pregnancy.

Household income quintiles were determined based on household income adjusted to account for household size (household income / square root of household size):

Quintile	Household income
Low	Less than $12,500
Middle-low	$12,500 to $20,207
Middle	$20,208 to $27,500
Middle-high	$27,501 to $40,414
High	More than $40,414

Three *marital status* categories were defined: never married; married, common-law or living with partner; and separated, divorced or widowed.

Alcohol consumption was defined as: regular drinker; occasional drinker, former drinker, and never drinker.

Smoking was defined as: daily, occasional, former and never.

Respondents' level of physical activity at each survey cycle was calculated (time-varying covariate). Level of *leisure-time physical activity* was based on a combination of energy expenditure during a given activity and the frequency with which respondents engaged in that activity. Energy expenditure (EE) is kilocalories expended per kilogram of body weight per day (KKD). An EE of less than 1.5 KKD is considered low; 1.5 to 2.9 KKD, moderate; and 3 or more KKD, high. The frequency of physical activity was grouped in two categories, based on the number of times respondents participated in each activity for at least 15 minutes: regular (at least 12 times a month) or irregular (11 times or fewer per month). Four physical activity categories were defined:

- *Intense:* high energy expenditure (at least 3 KKD) during a regular physical activity
- *Moderate:* moderate energy expenditure (1.5 to 2.9 KKD) during a regular physical activity
- *Light:* light energy expenditure (less than 1.5 KKD) during a regular physical activity
- *Sedentary:* irregular physical activity, independent of energy expenditure

Usual daily physical activity was based on respondents' usual daily activities and work habits over the previous three months:

- Usually sit and don't walk around very much
- Stand or walk quite a lot
- Lift or carry light loads
- Do heavy work or carry very heavy load

Self-perceived health was measured on a five-category scale: poor, fair, good, very good or excellent. For this analysis, three categories were specified: excellent or very good, good, and fair or poor.

Respondents were considered to have an *activity restriction* if they reported being limited in the kind or amount of activities they could do at home, at work, in school or in other activities, or indicated they had a long-term disability or handicap.

The provinces were grouped into five *regions*: Atlantic (Newfoundland, New Brunswick, Nova Scotia, Prince Edward Island), Québec, Ontario, Prairies (Saskatchewan, Manitoba, Alberta), and British Columbia.

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Methods

Data source

This analysis is based on five longitudinal cycles of the National Population Health Survey (NPHS), conducted by Statistics Canada every two years from 1994/95 to 2002/03. The longitudinal panel selected for the first cycle in 1994/95 consisted of 17,276 members of private households. The survey does not cover members of the Canadian Forces, people living on Indian reserves or in some remote areas. Although persons living in health care institutions are part of the survey, they are excluded from the analysis.

Analytical techniques

To identify variables that were associated with an increased or decreased risk of becoming obese, the Cox Proportional Hazard model was used. This technique allows for the study of relationships between individual characteristics and an outcome when that outcome can take place over a period of time. The method accounts for the possibility that some events do not occur over the study period and minimizes the bias associated with attrition.

For the proportional hazard modelling, respondents who were overweight in 1994/95 (BMI 25 to 29.9) and had no missing covariates were selected: 1,937 men and 1,184 women. During the study period, 447 of these men and 402 of the women became obese. Starting in 1994/95, if their BMI in a subsequent cycle placed them in the obese category, this was considered an event. Given that weight gain is a continuous process that was measured only at discrete intervals (the NPHS interviews), many transitions to obesity occurred at the same time, either after 2, 4, 6, or 8 years. The proper specification of such a model is with a ties = exact option of SAS, which corresponds to a continuous process (becoming obese) inadequately observed at fixed intervals (the NPHS interviews). To allow the use of survey weights, the model was specified with Proc Logistic, with a cloglog link, which is documented as equivalent as a specification with a proportional hazards model, or the procedure Phreg, ties = exact in SAS.[16]

If the BMI value was missing for one or more cycles, but values for subsequent cycles were available, the cases were retained. This creates intervals of varying lengths between observations. To balance the fact that the longer the interval between observations, the more likely a transition from one BMI category to another, wave length and wave length square were entered as independent variables in the model.

Relationships between the independent variables (age, household income, alcohol consumption, etc.) as of 1994/95 and becoming obese between by 2002/03 were examined. The exceptions were the two physical activity variables (leisure-time physical activity and usual daily physical activity): associations between values for these variables through the whole period and becoming obese were examined.

The analysis pertains to the 10 provinces, excluding the territories. All the analyses were weighted using the longitudinal weights constructed to represent the total population of the provinces in 1994.

The bootstrap method was used to generate confidence intervals while taking into account the complex survey design.

Limitations

This analysis is based on personal or telephone interviews. As with every survey, some non-response occurred. If the non-response was not random, bias could have been introduced in the analysis.

The data are self- or proxy-reported; they have not been validated against an independent source or with direct measures. It is possible that respondents provided what they considered socially acceptable answers, for example, about issues like weight, smoking or drinking.

Other errors might have occurred during data collection and capture. Interviewers might have misunderstood some instructions, and errors might have been introduced in processing the data. However, considerable effort was made to ensure that such errors were kept to a minimum.

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