

# Overweight and Obesity Mortality Trends in Canada, 1985-2000

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## ABSTRACT

**Objectives:** To investigate the temporal trends in the mortality burden attributed to overweight and obesity in Canada between 1985 and 2000.

**Design:** Overweight and obesity prevalence data from six cross-sectional national population surveys, including the 1985 and 1990 Health Promotion Surveys, 1994, 1996 and 1998 National Population Health Surveys, and 2000 Canadian Community Health Survey, in conjunction with one published prospective cohort study on overweight, obesity and mortality.

**Participants:** Adults 20-64 years of age.

**Main Outcome Measure:** The number of deaths attributable to overweight and obesity at the national and provincial levels. Attributable deaths were estimated using the Population Attributable Risk (PAR), which combined the prevalence data with the relative risks of mortality associated with overweight and obesity. A two-way sensitivity analysis was conducted by simultaneously varying the population prevalences and relative risk estimates by  $\pm 10\%$ .

**Results:** Between 1985 and 2000, the national PAR for overweight and obesity increased from 5.1% to 9.3%, and the annual number of deaths attributable to overweight and obesity increased from 2,514 (966 – 4,061) to 4,321 (2,114 – 6,542). Cumulatively, 57,181 (25,075 - 89,227) deaths were attributed to overweight and obesity between 1985 and 2000. Although overweight- and obesity-related mortality is increasing in every province, the problem is particularly pronounced in Eastern Canada.

**Conclusions:** Overweight and obesity are important public health problems in Canada, accounting for approximately 57,000 deaths over the last 15 years. Immediate and sweeping public health campaigns and interventions are required to slow or reverse the recent trends.

*La traduction du résumé se trouve à la fin de l'article.*

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Several recent studies have documented substantial increases in the prevalences of overweight and obesity in Canada over the past two decades; similar to what has been observed in other developed countries.<sup>1-5</sup> The adverse health effects associated with an excessive accumulation of adipose tissue have also been recently summarized, and include an increased risk of Type 2 diabetes mellitus, coronary artery disease, dyslipidemia, hypertension, stroke, gall bladder disease, osteoarthritis, and several cancers.<sup>6</sup> It has been estimated that the direct health care costs associated with obesity in Canada were \$1.8 billion in 1997.<sup>7</sup>

In addition to specific health issues, overweight and obese individuals have an elevated risk of mortality by comparison to those of normal weight.<sup>8,9</sup> However, only limited attempts to quantify the impact of overweight and obesity on population mortality rates have been made. For example, it has been estimated that between 280,000 and 325,000 deaths annually are attributed to obesity in the United States in the 1990s among adults 18 years of age and older.<sup>10</sup> The purpose of this study was to estimate the effects of overweight and obesity on mortality rates in the Canadian population between 1985 and 2000. To this end, obesity surveillance data for the population were analyzed in combination with a recently published mortality follow-up study in the Canadian population.

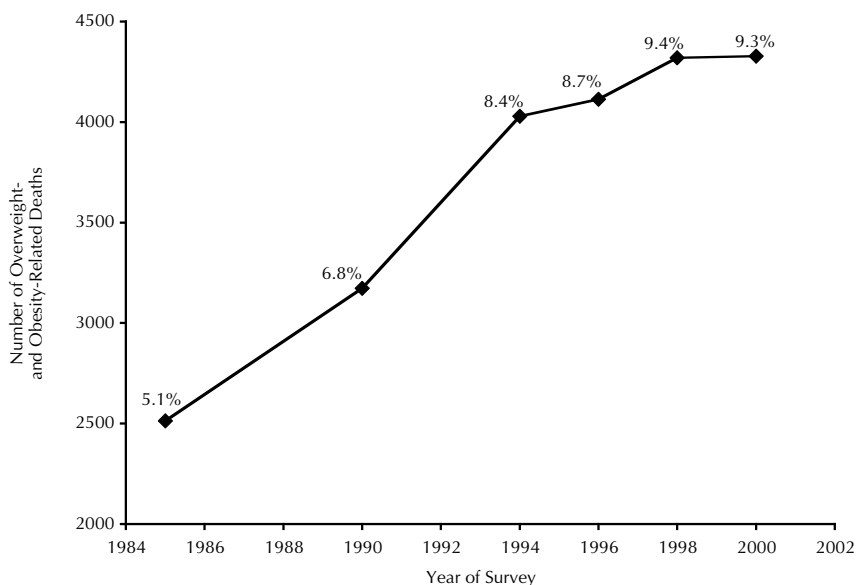
## METHODS

The annual numbers of overweight- and obesity-related deaths in Canada among adults were determined using the Population Attributable Risk (PAR), which combines the population prevalence of a risk factor with the relative risk of mortality associated with that risk factor. The body mass index (BMI) categories of overweight (25-29.9 kg/m<sup>2</sup>), obese I (30-34.9 kg/m<sup>2</sup>), and obese II and III ( $\geq 35$  kg/m<sup>2</sup>) adopted by the U.S. National Institutes of Health<sup>6</sup> and World Health Organization<sup>11</sup> were used. The PAR was calculated separately for overweight, obese class I and obese class II and III and then added, using the following equation:  $PAR = \sum [P(RR-1)/RR]$ , where P is the population prevalence of overweight or obesity class and RR is the relative risk of mortality.<sup>12,13</sup> Calculation of the PAR allowed for

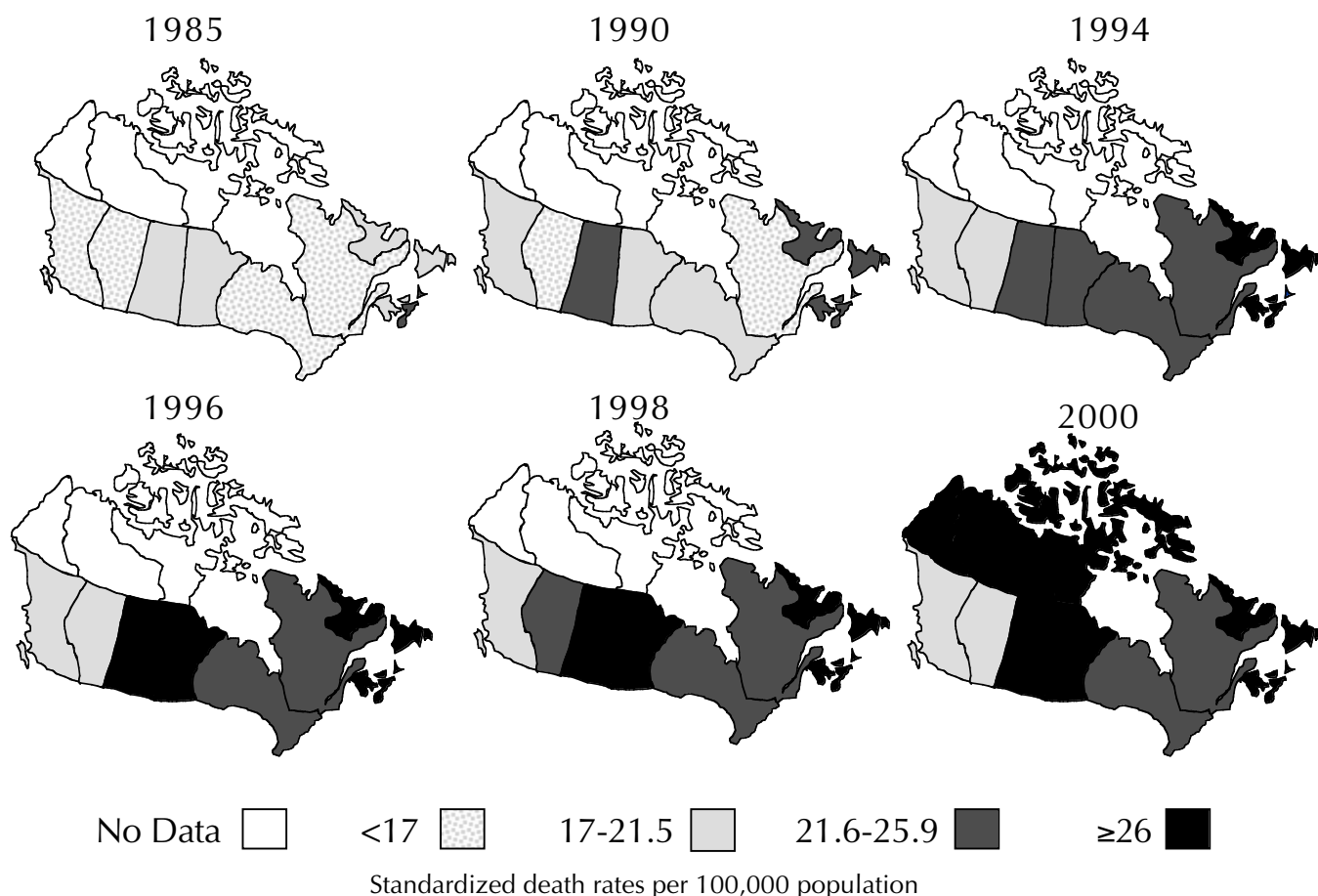
examination of the secular trend of overweight and obesity on all-cause mortality as a way to quantify the *excess* mortality associated with these conditions, and can be interpreted as the percent of all mortality that is potentially preventable if all cases of overweight or obesity were eliminated. The PARs for overweight and obesity were derived based on their association with all-cause mortality alone, and no inferences can be made regarding specific causes of death. Due to age restrictions in some surveys, data were available only for adults 20-64 years of age. Thus, elderly mortality due to obesity was not considered in this study.

**Overweight and obesity prevalences**

The prevalences of overweight, obese class I and obese class II and III were determined in six national surveys conducted in Canada between 1985 and 2000, including the 1985 and 1990 Health Promotion Surveys,<sup>14,15</sup> the 1994, 1996, and 1998 National Population Health Surveys,<sup>16-18</sup>



**Figure 1.** Number of overweight- and obesity-related deaths in Canada among adults 20-64 years of age, 1985-2000. The Population Attributable Risk (PAR) for overweight and obesity is indicated above the points for each year.



**Figure 2.** Adult overweight and obesity mortality maps of Canada, 1985-2000. Data are for adults 20-64 years of age from the 1985 and 1990 General Social Surveys, 1994, 1996, and 1998 National Population Health Surveys and the 2000 Canadian Community Health Survey.

TABLE I

**Sample Sizes and Weighted National Prevalences of Overweight and Obesity Among Adults 20-64 Years of Age in the Surveys Used in the Derivation of the Number of Overweight- and Obesity-related Deaths in Canada, 1985-2000**

Survey	Sample Size	Overweight (%)	Obese I (%)	Obese II & III (%)
1985 Health Promotion Survey	8,106	26.1	4.6	0.9
1990 Health Promotion Survey	10,456	30.8	7.4	1.6
1994 National Population Health Survey	12,318	34.0	11.3	2.2
1996 National Population Health Survey	50,347	35.4	10.8	2.7
1998 National Population Health Survey	10,683	34.4	11.1	3.7
2000 Canadian Community Health Survey	131,535	32.5	11.0	3.9

TABLE II

**Estimates of the Relative Risk of Mortality Associated with Overweight and Obesity Used in the Present Study**

	Relative Risk	95% Confidence Interval
Normal Weight	1.00	(reference)
Overweight	1.16	(0.96-1.39)
Obese Class I	1.25	(0.96-1.65)
Obese Class II & III	2.96	(1.39-6.29)

Relative risks have been adjusted for the confounding influences of gender, age, smoking status, and alcohol consumption.

Note: The relative risks are based on analyses of 13 years of follow-up from the 1981 Canada Fitness Survey (Adapted from reference 9)

and the 2000 Canadian Community Health Survey.<sup>19</sup> Table I presents the sample sizes and national prevalences of overweight and obesity for each survey. The BMI was calculated from self-reported height and weight in each survey, and the prevalences were weighted to be representative of the population at the time the survey was conducted using sample weights provided with the publicly available datasets. Data for the territories were only available in the 2000 Canadian Community Health Survey, and were pooled across the three territories (Yukon, Northwest Territories, and Nunavut) due to small sample sizes for class II and class III obesity (BMI  $\geq 35$  kg/m<sup>2</sup>) which led to data restrictions.

### Overweight and obesity mortality risk

A recent study has estimated the relative risk of mortality across levels of overweight and obesity in 10,725 adults from the 1981 Canada Fitness Survey (CFS), which was representative of the Canadian population.<sup>9</sup> The 13-year risk of mortality was determined by linking the CFS database to the Canadian Mortality Database at Statistics Canada. Table II presents a summary of the relative risk estimates associated with overweight, class I, and class II and III obesity, compared to normal weight from the study.<sup>9</sup> These values were used in the derivation of the PAR in the present

study. The relative risk estimates have been adjusted for age, gender, cigarette smoking and alcohol consumption. It should be noted that the low prevalence of class III obese participants necessitated the combination of class II and class III obesity in both the published mortality analysis and in the present study.

### Statistical analysis

The PAR for each survey year (1985, 1990, 1994, 1996, 1998, and 2000) was multiplied by the total annual number of deaths from all-causes in each province in 20 to 64 year olds, obtained from CAN-SIM, a national database of selected demographic and social data, such as population estimates and vital statistics.<sup>20</sup> The deaths attributable to overweight and obesity were then standardized to a death rate per 100,000 population to facilitate comparisons across provinces. Least squares regression of overweight and obesity-related deaths from the six measured PARs allowed for interpolation to non-study years and provides our best estimate of the cumulative number of overweight and obesity-related deaths in Canada over 15 years. A two-way sensitivity analysis was conducted by simultaneously varying the relative risk estimates and population prevalences of overweight, obesity class I and obesity class II and III by  $\pm 10\%$ .

## RESULTS

The number of overweight- and obesity-related deaths in Canada has increased from 2,514 in 1985 to 4,321 in 2000 (Figure 1). The sensitivity analysis indicates that the number of deaths in 1985 could be as low as 966 and as high as 4,061, and the number of deaths in 2000 could be as low as 2,114 and as high as 6,542. The PAR has increased from 5.1% to 9.3%, indicating that by 2000, 9.3% of all deaths among 20 to 64 year old adults could theoretically be attributed to overweight and obesity. The total accumulated deaths between 1985 and 2000, estimated by interpolating a least squares regression line between the year of the surveys and number of deaths, was 57,181 (25,075 – 89,227).

Figure 2 presents overweight and obesity mortality surveillance maps showing provincial-level results. It is apparent that the burden of obesity has increased in all geographic regions between 1985 and 2000; however, the Eastern provinces have consistently higher death rates than other regions of Canada. The province with the greatest relative increase in the number of overweight- and obesity-related deaths was Newfoundland, with a 58.9% increase over 15 years, whereas the province with the lowest relative increase was British Columbia, increasing 33.0%.

## DISCUSSION

This is the first study, to our knowledge, to document the direct effects of overweight and obesity on premature mortality rates in Canada at the population level. The results demonstrate significant increases in the mortality burden associated with overweight and obesity from 1985 to 2000. Previous studies have shown that the prevalences of overweight and obesity have increased over the past two decades in Canada; however, overweight and obesity are typically considered to be "conditions" or risk factors that predispose individuals to chronic disease, rather than diseases in and of themselves. As such, increases in their prevalence do not carry the same public health message as increases in disease or mortality rates.

The absolute number of deaths attributable to overweight and obesity in Canada

in 2000 is relatively low (4,321) compared to the estimated 300,000 deaths in the United States;<sup>10</sup> however, the two estimates are not directly comparable. The present study only included deaths among adults 20-64 years of age, whereas the U.S. study included all deaths among adults 18+ years of age. Given the high overall death rates among the elderly, compared to younger adults, this would have a large impact on the results. We chose a conservative approach by focusing on premature mortality, as the relationship between BMI and mortality in the elderly has not been fully explored.<sup>21</sup> Further, the higher prevalence of obesity, particularly class II and III obesity in the U.S., have also influenced the comparison.

Although the prevalence of overweight and obesity increased in all provinces from 1985-2000,<sup>3</sup> an alternative explanation for regional variations in overweight and obesity-related mortality rates may be the observed differences in overall provincial death rates over this time; Prince Edward Island had the lowest reduction in all-cause death rate from 1985-2000, with a reduction of 6.4%, whereas Ontario had the greatest improvement, representing a reduction of 32.8%. These regional disparities in all-cause death rates not only identify at-risk populations within Canada, but present important information about the relative impact of obesity on health-care disparities. For diseases associated with overweight and obesity, the influence of socio-economic status and level of education are intricately linked; in particular, any attempts at addressing the issue of overweight and obesity must be targeted towards the specific needs of the population, with overweight and obesity being one of the predisposing if not causal factors in subsequent disease development and progression.

Overweight and obesity surveillance data are not available for the Yukon, Northwest, and Nunavut territories in the public-use Health Promotion Survey and National Population Health Survey databases. Thus, the high overweight and obesity mortality rates observed in 2000 does not indicate a drastic increase from 1998 levels, rather that BMI surveillance in the territories was not available until the 2000 Canadian Community Health Survey. Although the overweight and obesity-

related mortality rate for the Territories is the highest in Canada (34.9/100,000), it is unlikely that this has influenced the estimated number of deaths for Canada in 2000 (by comparison to earlier years), given that this accounted for only 21 overweight and obesity-related deaths due to the small population sizes in Northern Canada.

This study has several strengths and weaknesses. A major strength is the combination of several national surveys with a Canadian mortality follow-up study, which ensures a certain degree of representativeness for the Canadian population. The ability to estimate changes in the number of overweight and obesity-related deaths over the 15 years is also a major strength of the study design. The choice of the PAR equation used in studies such as this will impact the interpretation of the results. We chose an equation that provides a conservative estimate of the population impact of obesity ( $PAR = \sum[P(RR-1)/RR]$ ), as it produces an internally valid estimate when adjusted relative risks are used (as in the present study).<sup>13</sup> If another popular population equation had been used ( $PAR = [\sum(P)(RR-1)]/[1+\sum(P)(RR-1)]$ ), a greater impact would have been observed. For example, the equation used in the present study indicates that 4,321 deaths were attributable to overweight and obesity in 2000; had the alternative equation been used, 6,301 would have been attributable to obesity. However, the latter estimate is biased due to confounding in the relative risk of overweight and obesity.

A limitation in the present study is the use of overweight and obesity prevalences calculated from self-reported data, as individuals tend to over-report their height and under-report their weight, and the degree of under-reporting for body weight increases with the level of BMI.<sup>22,23</sup> Analyses using self-reported data tend to underestimate the prevalence of obesity by comparison to prevalences calculated using measured heights and weights. For example, data from the latest U.S. National Health and Nutrition Examination Survey (NHANES 1999-2000) indicate that the prevalence of obesity in the United States was 30.5%.<sup>4</sup> However, self-reported data from the Behavioral Risk Factor Surveillance System (BRFSS) indicated that the prevalence of obesity was 19.8%

in 2000.<sup>24</sup> Thus, the results reported in the present study should be considered conservative estimates of the impact of overweight and obesity on mortality.

In conclusion, the results of this study have quantified the impact of overweight and obesity on mortality in Canada. The finding that almost 1 in 10 premature deaths among adults 20 to 64 years of age can be attributed to overweight and obesity in 2000 indicates that this is a substantial health problem, especially in the Northern and Eastern regions of Canada. Aggressive public health campaigns are required to increase public awareness of the health risks associated with excess body weight and to combat further increases in the prevalence and burden of obesity in Canada.

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## RÉSUMÉ

**Objectifs :** Analyser les tendances temporelles du fardeau que l'embonpoint et l'obésité ont fait peser sur les chiffres de la mortalité au Canada entre 1985 et 2000.

**Conception :** Les données sur la prévalence de l'embonpoint et de l'obésité proviennent de six enquêtes transversales nationales sur la population, à savoir : l'Enquête promotion santé (1985 et 1990), l'Enquête nationale sur la santé de la population (1994, 1996 et 1998) et l'Enquête sur la santé dans les collectivités canadiennes (2000), ainsi que d'une étude prospective de cohortes, publiée, portant sur l'embonpoint, l'obésité et la mortalité.

**Participants :** Des adultes de 20 à 64 ans.

**Principal indicateur des résultats :** Le nombre de décès attribuables à l'embonpoint et à l'obésité à l'échelle nationale et provinciale. Les décès attribuables ont été estimés selon la méthode de la fraction étiologique du risque, en combinant les données sur la prévalence aux risques relatifs de mortalité associés à l'embonpoint et à l'obésité. Nous avons mené une analyse de sensibilité bidirectionnelle en modifiant simultanément de  $\pm 10\%$  les taux de prévalence dans la population et les estimations du risque relatif.

**Résultats :** Entre 1985 et 2000, la fraction étiologique du risque d'embonpoint et d'obésité à l'échelle nationale est passée de 5,1 % à 9,3 %, et le nombre annuel de décès attribuables à l'embonpoint et à l'obésité, de 2 514 (966 – 4 061) à 4 321 (2 114 – 6 542). Au total, 57 181 décès (25 075 – 89 227) ont été attribués à l'embonpoint et à l'obésité entre 1985 et 2000. Bien que la mortalité liée à l'embonpoint et à l'obésité soit en hausse dans toutes les provinces, le problème est particulièrement grave dans l'est du Canada.

**Conclusions :** L'embonpoint et l'obésité sont d'importants problèmes de santé publique au Canada et ont causé quelque 57 000 décès au cours des 15 dernières années. Des campagnes de santé publique et des mesures d'intervention immédiates et radicales sont nécessaires pour ralentir ou inverser les tendances récentes.