OBESITY
IN CANADA

A JOINT REPORT FROM THE PUBLIC HEALTH AGENCY OF CANADA
AND THE CANADIAN INSTITUTE FOR HEALTH INFORMATION

Public Health Agency of Canada
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ABBREVIATIONS

APS	Aboriginal Peoples Survey
CCHS	Canadian Community Health Survey
CDC	Centers for Disease Control and Prevention (US)
CFS	Canada Fitness Survey
CHHS	Canadian Heart Health Survey
CHMS	Canadian Health Measures Survey
CHS	Canada Health Survey
CIHI	Canadian Institute for Health Information
CMA	Census Metropolitan Area
GSS	General Social Survey
IOTF	International Obesity Task Force
LTPA	Leisure time physical activity
NEAT	Non-exercise activity thermogenesis
NHANES	National Health and Nutrition Examination Survey (US)
NPHS	National Population Health Survey
OECD	Organisation for Economic Co-operation and Development
PAR	Population Attributable Risk
PHAC	Public Health Agency of Canada
PIN	Population Impact Number
RHS	First Nations Regional Longitudinal Health Survey
RR	Relative risk
SES	Socioeconomic status
UK	United Kingdom
US	United States of America
WHO	World Health Organization

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EXECUTIVE SUMMARY

This report highlights new analyses of the prevalence, determinants and impact of obesity in Canada. The first three chapters describe the prevalence of obesity among adults, children and youth, and Aboriginal Peoples, combining new and existing estimates. This is followed by new analysis of the determinants of obesity, using an innovative measure of risk, and the impact of modifying determinants, as well as an updated estimate of the health and economic costs of obesity. The final chapter summarizes key lessons learned from the international literature on obesity prevention and management.

PREVALENCE

Over one in four Canadian adults (estimates range from 24.3%-25.4%) are obese, according to measured height and weight data from 2007-2009. Of children and youth aged 6 to 17, 8.6% are obese. Generally, actual measurements of height and weight result in higher estimates of obesity than data obtained from self-reports.

Between 1981 and 2007/09, measured obesity roughly doubled among both males and females in most age groups in the adult and youth categories. Not only has the prevalence of obesity increased over time but obesity is becoming more severe and fitness levels are decreasing as well. Since the late 1970s, for example, increases in the prevalence of obesity have been proportionately greater for the heaviest weight classes. Research also suggests a trend toward increased adiposity and decreased fitness for children, youth and adults.

Obesity varies substantially by geographic area. Obesity prevalence ranges from 3.4% to 34.3% across countries in the Organisation for Economic Co-operation and Development (OECD). New analyses show that the variation in self-reported obesity across health regions within Canada is similarly large, ranging from 5.3% to 35.9%.

As with previous studies, new analysis discussed in this report also show that self-reported obesity remains more prevalent among Aboriginal peoples than in the Canadian non-Aboriginal adult population: for example, 25.7% among off-reserve Aboriginal adults compared with 17.4% among non-Aboriginal adults in Canada (according to self-reported data from the 2007/08 CCHS). On-reserve First Nations groups tend to have a higher prevalence still, with over one-third (36.0%) estimated as obese, based on 2002/03 data. Self-reported obesity among adults is similar for Inuit, off-reserve First Nations, and Métis populations (23.9%, 26.1% and 26.4%, respectively), whereas childhood obesity varies from 16.9% among Métis to 20.0% among off-reserve First Nations to 25.6% among Inuit. The estimated prevalence of obesity among Aboriginal peoples in Canada can be derived from several sources, but no single source offers a complete picture of on- and off-reserve First Nations, Inuit and Métis.

DETERMINANTS

Research has identified a number of determinants associated with obesity, including physical activity, diet, socioeconomic status, ethnicity, immigration, and environmental factors. A population health approach to understanding obesity examines both the proximal or more immediate factors linked to obesity, such as diet and activity, as well as more distal factors, such as community and socioeconomic characteristics. However, the patterns involved are complex, and determinants are interconnected; furthermore some factors, such as income and education, tend to give rise to different associations for men than women.

Because risk factors for obesity often occur together, analyses are presented that statistically account for several social determinants of health and health-related behaviours. These analyses, which report their findings in terms of population attributable risk (PAR) and population impact number (PIN), offer insight from a population perspective into the proportion and number of cases of overweight and obesity that may be associated with these determinants.

For example, on the basis of this approach, physical inactivity emerged as most strongly associated with obesity at the population level for both men and women after adjusting for age and other health, behavioural and social determinants. As well, distal or indirect factors such as income, rural residence and minority status continued to have an association with obesity even after controlling for more direct health behaviours, such as inactivity, fruit and vegetable consumption and alcohol use.

Such research, while theoretical, may help to inform decisions by Canadian policy-makers, health promoters and health care providers on targeting obesity prevention and treatment interventions. However, because these analyses use cross-sectional data and rely on a number of assumptions, they cannot be used to make inferences about the causes of obesity. Our collective understanding of the determinants of obesity will continue to evolve as the effectiveness of policies, programs and interventions are monitored and assessed.

DISEASE AND FINANCIAL BURDEN

Obesity is an important population health concern. Obesity increases the risk of a number of chronic conditions, such as type 2 diabetes, hypertension, cardiovascular disease, and some forms of cancers. It is also associated with stigma and reduced psychological well-being. Some of these health issues may begin in childhood. Current evidence also suggests that people who are severely obese have a greater risk of premature mortality than those in the normal weight and overweight ranges. Determining the precise number of deaths attributable to obesity is difficult, however, as obesity often co-occurs with other risk factors such as physical inactivity and/or chronic conditions.

It has been estimated that obesity cost the Canadian economy approximately $4.6 billion in 2008, up $735 million or about 19% from $3.9 billion in 2000. This is a conservative estimate, as it is limited to those costs associated with the eight chronic diseases most consistently linked to obesity. Another study using a comparable methodology and looking at 18 chronic diseases estimated the cost to be even higher, at close to $7.1 billion.

APPROACHES FOR ADDRESSING OBESITY

A review of the national and international literature found that strategies to combat obesity and address obesogenic environments can be classified into three main categories: 1) health services and clinical interventions that target individuals; 2) community-level interventions that directly influence individual and group behaviours; and 3) public policies that target broad social or environmental determinants. Like smoking cessation, effective obesity prevention may require a multifaceted, long-term approach involving interventions that operate at multiple levels and in complementary ways.

Relatively few population-level obesity prevention and management interventions – especially public policy approaches that target broader environmental factors – have been systematically evaluated in terms of their effectiveness or cost-effectiveness. Developing and implementing effective interventions will require close and frequent monitoring to identify which approaches work in different settings and with different populations, as well as economic analysis to understand their potential value for money.

INTRODUCTION

The causes of, and contributors to, obesity are complex and multifaceted. They include not only individual choices (what to eat and whether to be active) but also environmental and social determinants that shape people's ability to make healthier choices. Our understanding of the underlying factors that contribute to obesity is often incomplete, spread out between different studies and research findings.

This report pulls together both new data analyses on the prevalence, determinants and impacts of obesity, as well as a summary of recent research reviewing what we know about obesity in Canada. The report will also provide an overview of obesity prevention and treatment.

While overweight is recognized as both a precursor to obesity and a health concern in its own right, this report will focus primarily on obesity (class I through III), as this is the weight class associated with the greatest health risks. New analyses discussed in this report include an updated estimate of the societal cost of obesity, updated obesity estimates from the 2007/08 Canadian Community Health Survey (CCHS) and the 2006 Aboriginal Peoples Survey, and research on behavioural and social factors contributing to obesity. These analyses are presented within the context of other Canadian research, including findings from the 2007-2009 Canadian Health Measures Survey, published analyses of previous health surveys, reviews by the Canadian Institute for Health Information (CIHI) and a scan of the related medical and scientific research literature on obesity among Canadian populations. In the case of Aboriginal peoples, the scan was extended to include studies that investigated diabetes or other chronic conditions and collected data on body weight as part of the research protocol.

This combination of new and existing analyses aims to provide an overview for health planners, promoters and decision-makers of what is currently known about the prevalence, determinants and impacts of obesity in Canada.

BOX 1. MEASURING OBESITY IN CANADA: KEY POPULATION HEALTH SURVEYS

Canadian Health Measures Survey (CHMS)

The CHMS is an extensive national survey of physical health measures, collected through interview as well as direct measurement, capturing height and weight, fitness, flexibility, muscular strength and many other health and environmental elements. Data were collected from approximately 5,600 people aged 6 to 79 years at 15 sites across Canada between March 2007 and February 2009; the results are considered representative at the national level.[1]

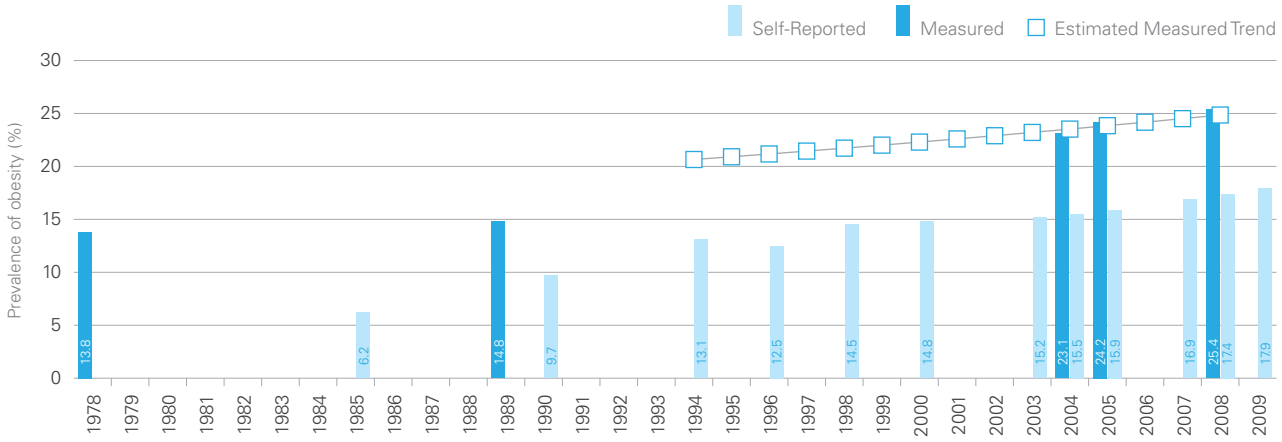
Canadian Community Health Survey (CCHS)

Information is collected from about 65,000 respondents aged 12 and over, including Aboriginal peoples living off-reserve, and is reported annually starting in 2007. Previously, the sample consisted of 130,000 respondents every two years. In order to achieve more accurate estimates for smaller populations, in this report 2007 and 2008 samples were pooled together and used for most analyses unless trends or measured height and weight data were required. Height and weight measures were collected most recently in 2008 and 2005 for a subsample of respondents. In a 2004 cycle focusing on nutrition, measured height and weight were also collected for approximately 20,000 respondents aged 2 and over. For more detail on the CCHS see APPENDIX 1.

PREVALENCE AMONG ADULTS

About one-quarter of Canadian adults are obese, according to measured height and weight data from both the 2008 CCHS (25.4%) and the 2007-2009 CHMS (24.3%).[2] The prevalence of obesity is lower when derived from self-reported height and weight data from the combined 2007/08 CCHS (17.4%). When obesity is combined with overweight, the prevalence in 2008 was 62.1% when based on measured data and 51.1% when self-reported data were used. Self-reported data are easier and less expensive to collect in population-level surveys but tend to underestimate the prevalence of obesity when compared with measured data.[3] One study has suggested that self-reporting bias has increased since the early 1990s.[4] However, both measured and self-reported data indicate that the prevalence of adult obesity in Canada has increased in recent decades (FIGURE 1).

FIGURE 1. Prevalence of Obesity, Ages 18 Years and Older, Canada, 1978-2009



NOTE: Excludes the Territories.
SOURCE: Analysis of 1978/79 Canada Health Survey; 1989 Canadian Heart Health Survey (ages 18-74); 1985 and 1990 Health Promotion Surveys; 1994/95, 1996/97 and 1998/99 National Population Health Surveys; and 2000/01, 2003, 2004, 2005, 2007, 2008, and 2009 Canadian Community Health Surveys, Statistics Canada and CANSIM Table 105-0501.

BOX 2. BODY MASS INDEX (BMI)

Body mass index (BMI) is calculated by dividing an individual's weight (kilograms) by height (metres) squared. A BMI over 30 kg/m^2 is considered to be in the obese class for adults aged 18 and over.[6] BMI is the most commonly used measure of overall body fat and associated health risks in population-level studies. However, because it does not accurately account for differential musculature or bone mass among individuals and across ethnocultural groups and sexes, BMI should be used at the individual level as one part of a more comprehensive assessment (e.g., including waist circumference, waist-to-hip ratio and/or skinfold measurements) of health risk.[7]

Concern about obesity is not a new phenomenon. By the 1930s, life insurance companies had begun using height and weight charts to identify clients at increased risk of death.[8] Since the 1950s, health surveys have made possible the study of heights and weights of Canadians.[9]

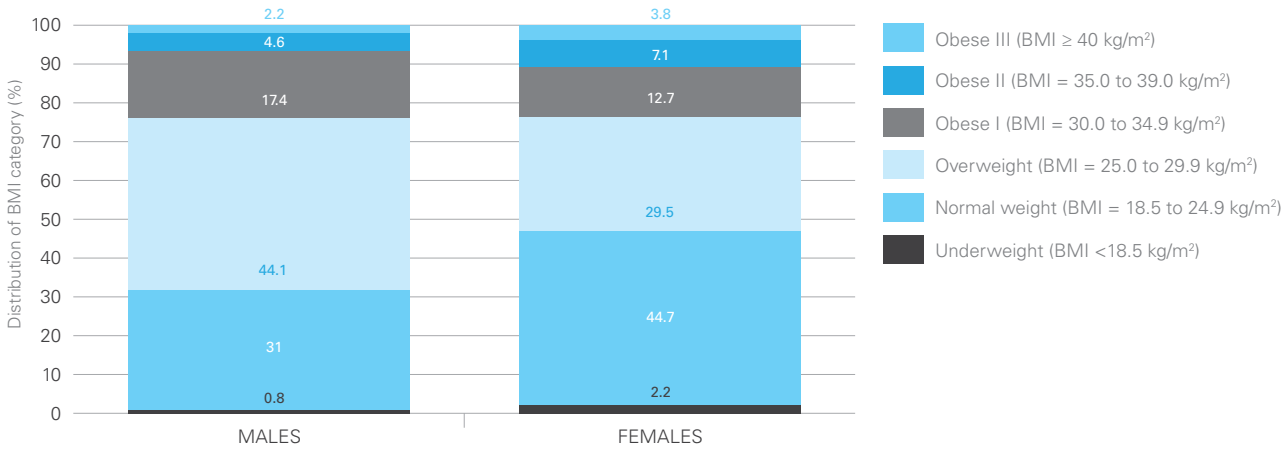
A comparison between the 1981 Canada Fitness Survey (CFS) and the 2007-2009 CHMS found that measured obesity roughly doubled across all age groups studied.[2] Findings from surveys conducted in recent decades, comparing the Canadian Heart Health Survey 1986/92 and the CCHS 2004, also showed increases in obesity.[2,10,11] Further, these studies have demonstrated increases in the proportions of men and women with a BMI in the obese category[10,11] and with a body composition measure in the high health-risk categories.[2]

There has been a marked shift in the distribution of BMI over time, the greatest increases occurring in the heaviest weight classes:

- The proportion of adults falling into obese class I (BMI 30.0-34.9 kg/m^2) increased from 10.5% in 1978/79 to 15.2% in 2004.[2,12]
- The proportion in obese class II (BMI 35.0-39.0 kg/m^2) doubled between 1978/79 and 2004, increasing from 2.3% to 5.1%.[12]
- The proportion falling into obese class III (BMI ≥ 40 kg/m^2) , while small, also appears to have increased over time. In 1978/79 obese class III made up 0.9% of the population and increased three-fold, to 2.7%, by 2004.[12]

FIGURE 2 shows the proportion of males and females that fell within categories of underweight, normal, overweight and obese classes I, II and III in 2007-2009 and the cut-off points defining each weight class. Although females appear more likely than males to be within the normal weight group and less likely to be in the overweight group, they are more likely to fall into obese classes II and III.[2]

FIGURE 2. Distribution of BMI Categories by Sex, Ages 18 to 79, 2007-2009



SOURCE: 2007-2009 Canadian Health Measures Survey, Statistics Canada.[2]

VARIATION BY AGE AND SEX

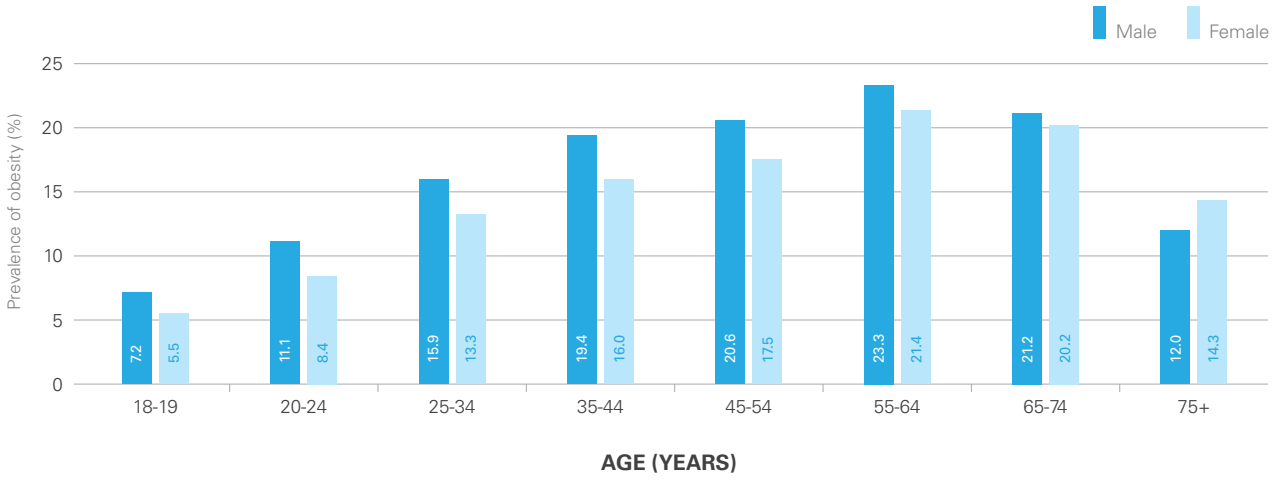
For both men and women, analyses of the 2007/08 CCHS show that the prevalence of obesity generally increases with each successive age group up to age 65 (FIGURE 3). After age 65, the prevalence of obesity declines. A similar pattern of lower obesity among the youngest and oldest age groups was also found in the 2004 CCHS, which collected measured data.[12]

In the 2007/08 CCHS, obesity (based on self-reported heights and weights) was more prevalent among men than women, with the exception of the oldest age group (FIGURE 3). Based on direct measures, findings from the 2007-2009 CHMS show that, while obesity increased with age, it was not always higher among men than women. For example, in the population aged 20 to 39, 19% of males and 21% of females were obese, and among those aged 40 to 59, 27% of males and 24% of females were obese.[2]

PROVINCIAL/TERRITORIAL VARIATION

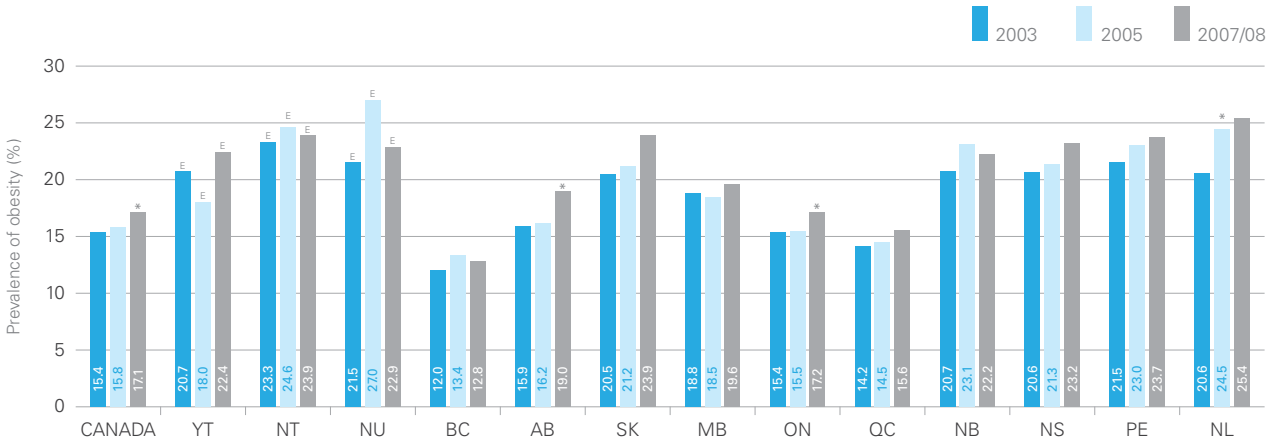
In 2007/08 self-reported obesity in Canada varied across provinces and territories, from a low of 12.8% in British Columbia to a high of 25.4% in Newfoundland and Labrador (FIGURE 4). Estimates of obesity in 2007/08 were found to be significantly higher than in 2005 in Canada overall as well as in Alberta and Ontario, and significantly higher in 2005 than 2003 in Newfoundland and Labrador (FIGURE 4). Because of sample size limitations for measured obesity, calculations of obesity by province and health region were based on self-reported data.

FIGURE 3. Prevalence of Self-Reported Obesity by Age and Sex, Canada, 2007/08



SOURCE: Analysis of the 2007/08 Canadian Community Health Survey, Statistics Canada.

FIGURE 4. Prevalence of Self-Reported Obesity by Province/Territory, Ages 18 and Older, 2003-2007/08

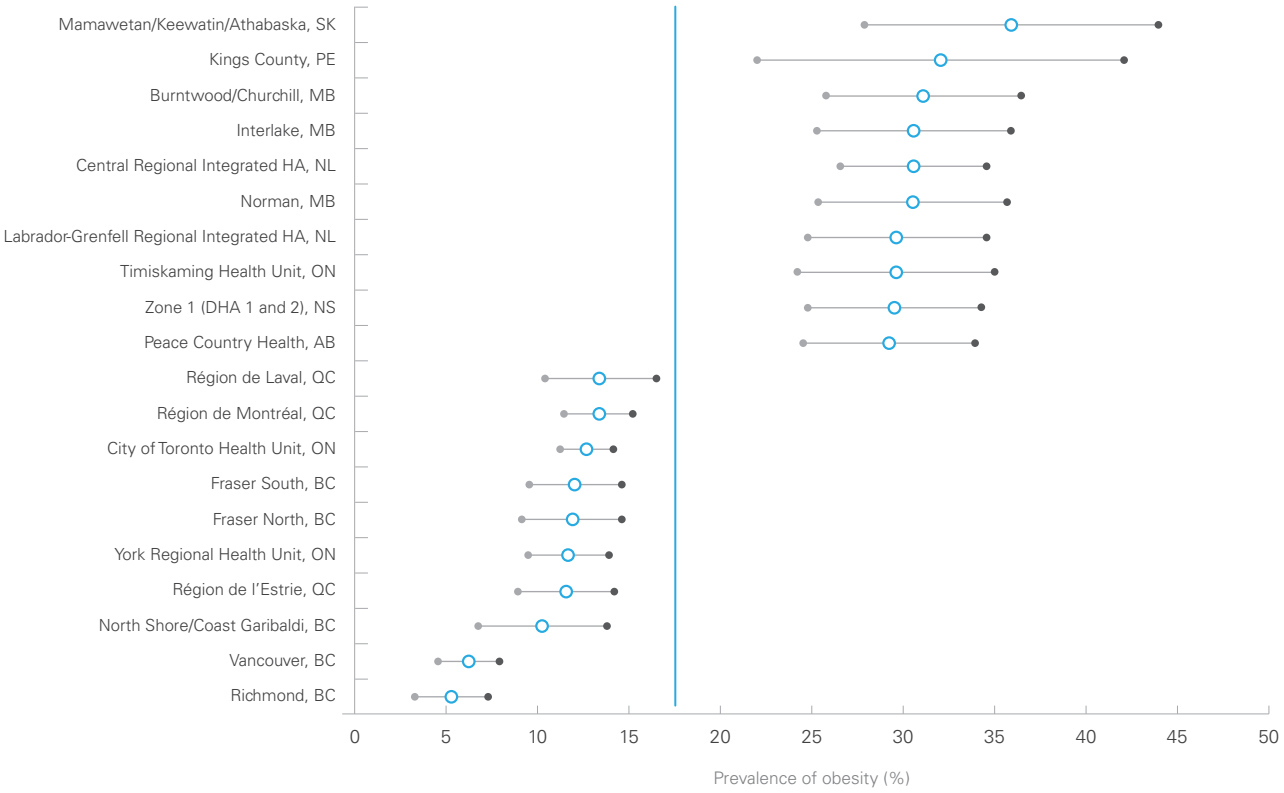


NOTES: * Significantly different from previous year estimate. [E] High sampling variability, interpret with caution.
SOURCE: Analysis of the 2007/08 Canadian Community Health Survey, Statistics Canada.

REGIONAL VARIATION

Variation in obesity was also observed at the Health Region level in 2007/08. Obesity estimates ranged from a low of 5.3% in urban/suburban Richmond, British Columbia, to a high of 35.9% in the northern Mamawetan/Keewatin/Athabasca region of Saskatchewan (FIGURE 5, see APPENDIX 1 for all Health Regions). Studies have found that the prevalence of obesity tends to be lower in more urban regions, one study showing that obesity was significantly below the national average in Montreal, Toronto and Vancouver on the basis of 2003 CCHS estimates.[13,14] Among both adults[15] and youth,[16] the proportion of overweight tends to be higher in rural areas than in metropolitan areas. In particular, in all the Canadian regions considered, obesity has been found to be most prevalent among boys in small town regions of 2,500 to 19,999.

FIGURE 5. Prevalence of Self-Reported Obesity, Ages 18 Years and Older, 2007/08: Top and Bottom 10 Ranked Health Regions



NOTES: Vertical line represents the national Canadian obesity prevalence (17%). Obesity prevalence and 95% confidence intervals for the top and bottom 10 ranked health regions are represented by horizontal bars. For complete results for all health regions, see APPENDIX 1.
SOURCE: Analysis of the 2007/08 Canadian Community Health Survey, Statistics Canada.

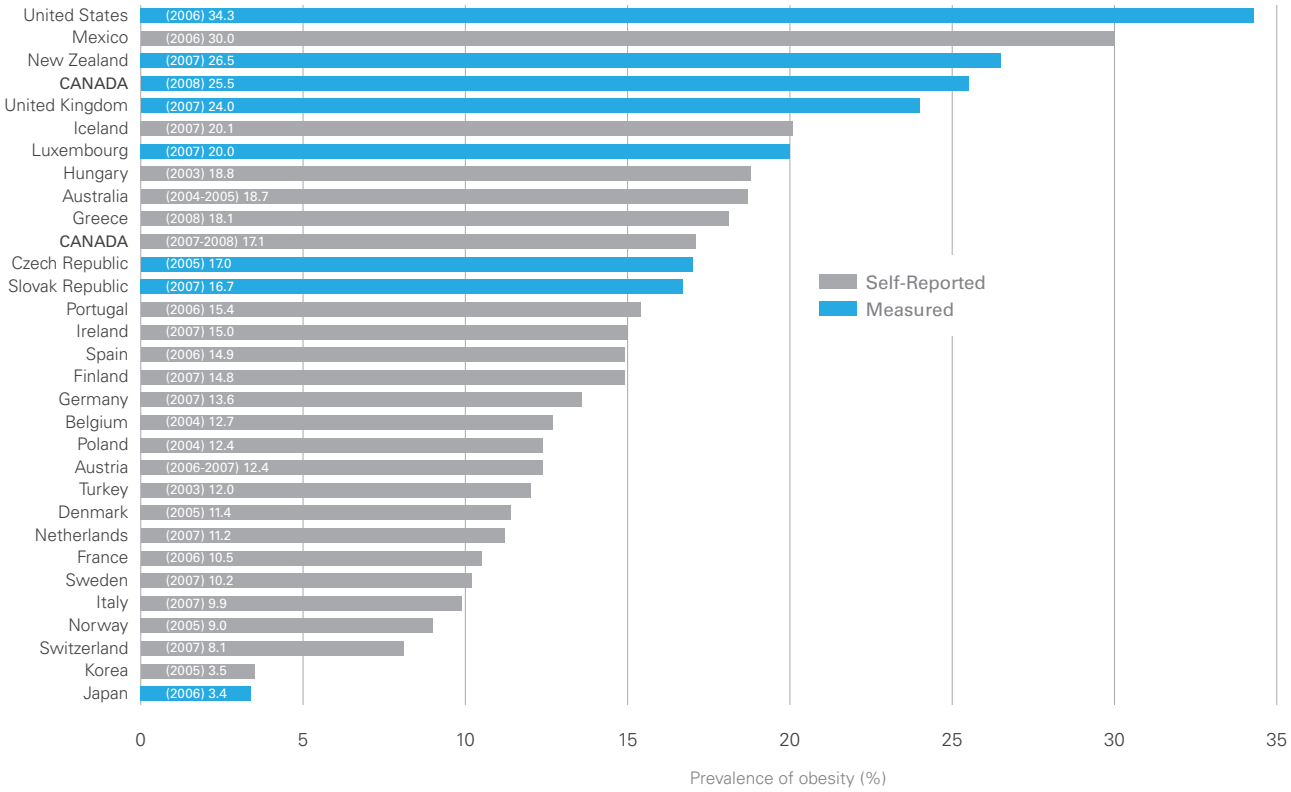
INTERNATIONAL COMPARISONS

Canada is not alone in observing increases in obesity. Research in the US and the UK also documents increases in the proportion of the population in the obese class,[17,18] in average BMI[19] and in the proportion of the population in the heaviest weight classes.[17,19]

In recent decades, obesity has become a worldwide issue. The World Health Organization (WHO) has estimated that more than 1 billion adults worldwide are overweight and at least 300 million are clinically obese.[6] Recent obesity estimates for adults in OECD member nations are shown in FIGURE 6. They indicate that measured obesity ranges from 3.4% in Japan to 34.3% in the United States, a 10-fold difference.

Another analysis of OECD data, from 13 countries including Canada, found that the prevalence of obesity had increased among men and women between the 1980s and 2005 in Canada, Australia, Austria, England, France, Hungary, Sweden and the US.[20] Moreover, these researchers projected that substantial further increases in obesity could be expected in Canada, Australia, England and the US until 2019.[20]

FIGURE 6. Prevalence of Obesity in OECD Countries, 2004-2008



NOTES: The definition of adult population differs by country. The year listed for each country represents the year in which the data were collected.
SOURCE: Organisation for Economic Co-operation and Development (OECD) Health Data 2009.

KEY POINTS

- On the basis of measured height and weight from multiple sources during 2007-2009, more than one in four adults in Canada are obese.
- Self-reported obesity is lower (17.4%) than measured estimates, but both show increases since the late 1970s.
- Significant increases in self-reported obesity in Canada have also been reported between 2003 and 2008.
- Obesity is more prevalent in older age groups, up to approximately 65 years.
- Obesity tends to be more prevalent among males than females; however, this depends to some extent on the age group and whether obesity is self-reported or measured.
- There is a more than a six-fold variation in self-reported obesity across health regions in Canada, and the variation among OECD countries is more than 10-fold.
- Continued surveillance, longitudinal studies and improved methodologies for measuring weight and adiposity could enhance our understanding of the prevalence and distribution of obesity.

PREVALENCE AMONG CHILDREN AND YOUTH

Many of the physical and psychological complications and comorbidities of obesity may begin during childhood.[21] According to the 2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children, it can be more challenging to identify obesity among children and youth than among adults, as body composition and anthropometric indicators change with normal growth and maturation.[22] The calculation of BMI is the same as for adults, but the cut-offs for weight status vary by age and sex.[22] For example, using the International Obesity Task Force (IOTF) system the BMI cut-off for the obese class would be 21.22 kg/m^2 for a 12-year-old boy and 26.02 kg/m^2 for a 12-year-old girl.[23]

There are also different systems of BMI cut-offs, and obesity estimates can vary among systems. For example, using the IOTF system obesity among children and youth aged 2 to 17 in the 2004 CCHS was 8.2%. However, obesity in this age group was 12.7% based on the WHO child growth standards (0-5 years) and growth reference (5-19 years), or 12.5% based on US Centers for Disease Control and Prevention (CDC) cut-offs. The size of the difference between estimates also appears to vary by age group.[24]

Estimates of obesity cited in this report, derived from CCHS and CHMS data for the population 18 and under, were produced using age-specific IOTF cut-offs.

Among children and youth aged 6 to 17, the prevalence of obesity was 8.6% according to the CHMS 2007-2009.[25] Measured obesity by age and sex for the CHMS as well as for CCHS 2004 is shown in TABLE 1. Obesity is similar by sex in the youngest age group, but in older age groups it appears to be more common among males than females. The prevalence of obesity tends to increase by age group, as was the case for adults.

TABLE 1. Prevalence of Measured Obesity Among Children and Youth by Age, Sex and Source

DATA SOURCE

	2004 CCHS			2007-2009 CHMS		
AGE GROUP	**MALES**	**FEMALES**	**COMBINED**	**MALES**	**FEMALES**	**COMBINED**
Age 2 to 5	6.3E	6.4E	6.3	–	–	–
Age 6 to 11	8.5	7.5	8.0	7.1	5.8E	6.4
Age 12 to 17	11.1	7.4	9.4	12.4E	8.3E	10.5E

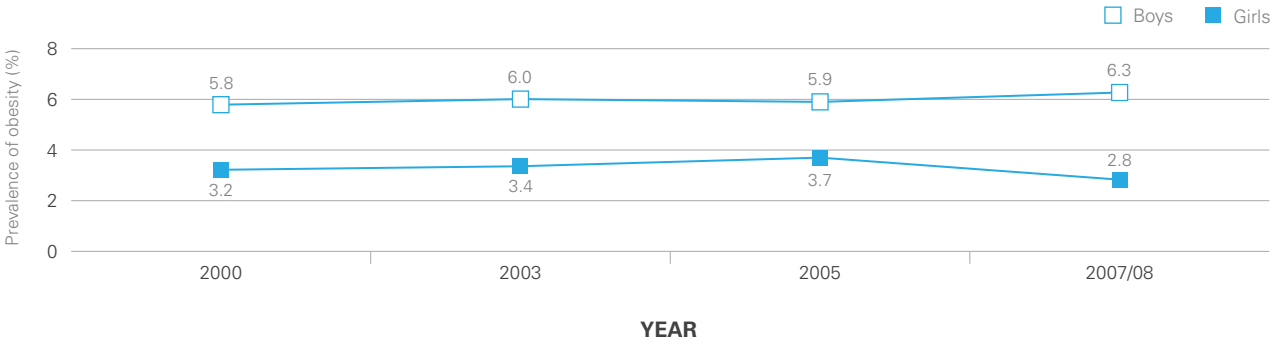
NOTE: E Coefficient of variation between 16.6% and 33.3%, interpret with caution.
SOURCE: Canadian Community Health Survey 2004 sourced from Shields,[26] Canadian Health Measures Survey.[25]

CHANGE OVER TIME

The prevalence of measured obesity was 2.5 times higher in 2004 than 1978/79 among children and youth aged 2 to 17.[26] In particular, among youth aged 12 to 17 obesity tripled from 3% to 9.4%.[26] Increases in childhood obesity have been reported using BMI,[26] waist circumference and skin fold measurements.[27] Further, results from the CHMS suggest that increases in BMI among children and youth are associated with greater adiposity, rather than greater muscularity.[27]

While measured obesity has increased in the last decades, between 2000 and 2008 self-reported obesity among youth aged 12 to 17 has been relatively stable (FIGURE 7). As is the case with adults, self-reported obesity prevalence tends to be lower than measured estimates.

FIGURE 7. Prevalence of Self-Reported Obesity by Sex, Ages 12 to 17, 2000-2007/08



SOURCE: Analysis of the 2000, 2003, 2005 and 2007/08 Canadian Community Health Surveys, Statistics Canada.

KEY POINTS

- Measured obesity is 8.6% among children and youth aged 6 to 17, and earlier estimates suggest that 6.3% of children aged 2 to 5 are obese.
- Measured obesity has increased 2.5 times in the last decades.
- Studies suggest that these increases in obesity may reflect increases in adiposity, rather than increases in muscularity.
- Self-reported obesity has been stable among youth aged 12 to 17 in the last few years.
- As with adults, self-reported obesity is lower than measured values.
- In most age groups of children and youth, according to self-reported and measured data, obesity is more prevalent among boys than girls.
- There are a number of research gaps and methodological challenges in studying obesity in this population, including different systems for defining overweight and obesity at different ages and the study of prevalence among very young children.
- The development of improved measurement, ongoing surveillance and longitudinal studies could help to enhance the understanding of obesity in children and youth.

PREVALENCE AMONG ABORIGINAL POPULATIONS

Because there is no one data source for obesity among all First Nations, Inuit and Métis peoples in Canada, this section provides a picture of obesity prevalence in Aboriginal populations by summarizing the findings from a number of relevant surveys (see BOX 3). It begins by presenting recent estimates of obesity and research results for Aboriginal people including First Nations off-reserve, Inuit and Métis, and continues with separate group-specific data for First Nations (on and off-reserve), Inuit and Métis populations.

The use of BMI to estimate obesity among Aboriginal peoples provides a common reference point for comparing data among Aboriginal populations as well as with non-Aboriginal populations. However, it has been suggested that, among the Inuit, BMI may overestimate the prevalence of overweight and obesity, and their associated health risks.[31,32] Further research is needed to confirm the prevalence of unhealthy body weights and their metabolic effects among the Inuit and in other Aboriginal populations.[7]

BOX 3. ESTIMATING OBESITY AMONG FIRST NATIONS, INUIT AND MÉTIS: KEY SURVEYS

In addition to the Canadian Community Health Survey (CCHS; see BOX 1), the following key surveys are discussed in this chapter:

First Nations Regional Longitudinal Health Survey[28,29]
The First Nations Regional Longitudinal Health Survey (RHS) provides estimates of obesity, based on self-reported data, among on-reserve First Nations populations. For the 2002/03 survey, the final sample included 10,962 adults, 4,983 youth and 6,657 children from 238 communities across Canada. The 2007/08 RHS has been completed; however, results were not available at the time this report was prepared. Initiation of Phases 3 and 4 of the RHS are anticipated in 2011 and 2015, respectively.

Aboriginal Peoples Survey 2006[30]
The Aboriginal Peoples Survey (APS) 2006 is a national survey of Aboriginal peoples (First Nations peoples living off-reserve, Métis and Inuit) living in urban, rural, and northern locations throughout Canada. The survey provides data on the social and economic conditions of Aboriginal children and youth (6-14 years) and Aboriginal people (15 years and over). Although First Nations living on-reserve were not included in the provinces, Aboriginal people living in the territories were included.

The APS is a post-censal survey, that is, the sample was selected from people living in households whose response on their 2006 Census questionnaire indicated that they (i) had Aboriginal ancestors; and/or (ii) identified as North American Indian and/or Métis and/ or Inuit; and/or (iii) had treaty or registered Indian status; and/or (iv) had Indian Band membership.

Approximate sample sizes for youth and adults by population were as follows: all Aboriginal responses and multiple respondents (9,160 youth, 17,000 adults), North American Indian respondents (4,500 youth, 7,700 adults), Métis respondents (3,800 youth, 6,500 adults) and Inuit respondents (500 youth, 1,900 adults). Obesity estimates for Aboriginal groups are based on single responses for Aboriginal identity. For the purposes of this report, the term "First Nations off-reserve" is used in lieu of "North American Indian" when discussing findings from the APS.

The methods for calculating the prevalence of obesity and using BMI to determine weight classes are consistent with the methodology of the CCHS (including the use of self-reported data). However, as the findings included in this report were based on the public use microdata file, statistical significance testing was not performed.

Other Data Sources
Other data sources referenced in this chapter include the Nunavut Inuit Child Health Survey as well as region-specific surveys.

- *Aboriginal peoples living off-reserve*: Some health data pertaining to First Nations off-reserve, Inuit and Métis is available through the CCHS. According to the self-reported 2007/08 CCHS, just over one-quarter (25.7%) of Aboriginal adults (excluding First Nations on-reserve) were obese (TABLE 2 and FIGURE 8). This is comparable to the 26.0% estimate from the 2006 Aboriginal Peoples Survey (APS; also based on self-reported data). However, as with the general population, prevalence estimates among Aboriginal peoples are lower when based on self-reported data than when measured data are used. For example, on the basis of measured heights and weights, the 2004 CCHS estimated that 37.8% of off-reserve Aboriginal adults were obese.[33]
- Among children and youth, 18.8% of Aboriginal peoples (excluding First Nations on-reserve) aged 6 to 14 were obese, according to the 2006 APS. Results were not available from the APS for those under 6 years or those 15 to 17 years, although data from the 2007/08 CCHS indicate that 6.7% of Aboriginal youth aged 12 to 17 were obese. Obesity among young children in Aboriginal populations is high but tends to be lower among youth across all Aboriginal groups (TABLE 2).

TABLE 2. Prevalence of Obesity Among Aboriginal Peoples in Canada by Age, Sex, and Source

	2007/08 CCHS	ABORIGINAL PEOPLES SURVEY 2006				2002/03 RHS
	Total Aboriginal population (excluding First Nations on-reserve)	Total Aboriginal population (excluding First Nations on-reserve)	First Nations Off-reserve	Métis	Inuit	First Nations On-reserve
CHILDREN AND YOUTH (6 TO 14)	–	18.8	20.0	16.9	25.6	–
Males	–	20.4	21.3	19.1	24.9	–
Females	–	17.2	18.7	14.8	26.3	–
ADULTS (18 AND OVER)	25.7	26.0	26.1	26.4	23.9	36.0
Males	27.3	27.0	26.1	28.4	22.8	31.8
Females	24.0	25.1	26.1	24.5	25.2	41.1
AGE GROUP						
3 to 5	–	–	–	–	–	48.7
6 to 8	–	32.8	35.2	28.6	45.8	41.2
9 to 11(14)*	–	13.1	14.0	12.1	16.5	26.4
12 to 17	6.7	–	–	–	–	14.1
18 to 24	11.8	13.2	13.8	13.0	11.8	–
25 to 34	22.6	24.3	24.2	24.9	30.0	–
35 to 44	27.6	29.5	29.8	29.1	24.5	–
45 to 54	33.7	30.1	30.3	29.8	28.2	–
55 and over	31.9	29.9	29.4	31.8	27.2	–

NOTE: * Aboriginal Peoples Survey age group represented is ages 9 to 14 years.
SOURCE: 2007/08 Canadian Community Health Survey Share File, Statistics Canada (excludes non-responses); 2006 Aboriginal Peoples Survey Public Use File; 2002/03 First Nations Regional Longitudinal Health Survey.[28]

- *First Nations On-reserve*: The First Nations Regional Longitudinal Health Survey (RHS) provides estimates for obesity (based on self-reported data) among First Nations living on-reserve.

  Analyses of the 2002/03 RHS estimated obesity* prevalence to be 36.0% among adults aged 18 and older (31.8% of males, 41.1% of females). Among youth ages 12-17, 14.1% were found to be obese, while among children 11 years and under, obesity ranged from 26.4% among 9-11 year olds to 48.7% among 3-5 year olds (see TABLE 2).[28]

- *First Nations Off-reserve*: According to analysis of the 2006 APS, 26.1% of off-reserve First Nations adults and 20.0% of children ages 6 to 14 were estimated to be obese (see TABLE 2). Results were not available from the APS for those under 6 years or those 15 years and older.

- *Métis*: According to the 2006 APS, the prevalence of obesity in the Métis population was 26.4% among adults 18 and over. Among children ages 6 to 14, 16.9% were obese (see TABLE 2).

- *Inuit*: Among Inuit adults, 23.9% were obese, according to the 2006 APS. Among Inuit children ages 6 to 14, 25.6% were obese (TABLE 2).

Although the APS did not include children under the age of 6 years in its sample, results from the Nunavut Inuit Child Health Survey, conducted in Nunavut and involving 388 children aged 3 to 5 years, have estimated the prevalence of obesity to be 28%.[34]

CHANGES OVER TIME

Limited data are available to examine changes in obesity prevalence over time in Aboriginal populations.

Surveys of the Inuit populations in Nunavik, a 500,000 km^2 region of Quebec located north of the 55th parallel, were conducted in 1992 and again in 2004. Findings, based on measured data, indicate that obesity prevalence among adults ages 18 to 74 had increased by 49% (from 19% to 28%). Although prevalence rose among both sexes, the increase was more substantial among males than females (73% increase vs. 31% increase, respectively).[35]

According to self-reported CCHS data, obesity among Aboriginal people (excluding First Nations on-reserve) living both in the North (i.e., Yukon, Northwest Territories, and Nunavut) and in southern Canada appear to have increased between 2000/01 and 2005: in the North, from 20.2% to 25.4%, and in southern Canada, from 22.7% to 25.3%. However, only among North-residing Aboriginals ages 55 and older was the difference over time statistically significant.[36] When the effects of age and sex were taken into account, the odds ratio of being obese was greater for Aboriginal people living in the North than for those in the south.[36] Additionally, a 2007 review paper of recent epidemiological evidence of obesity among the Inuit in the circumpolar region also concluded that obesity prevalence has "very likely" increased over the past several decades.[37]

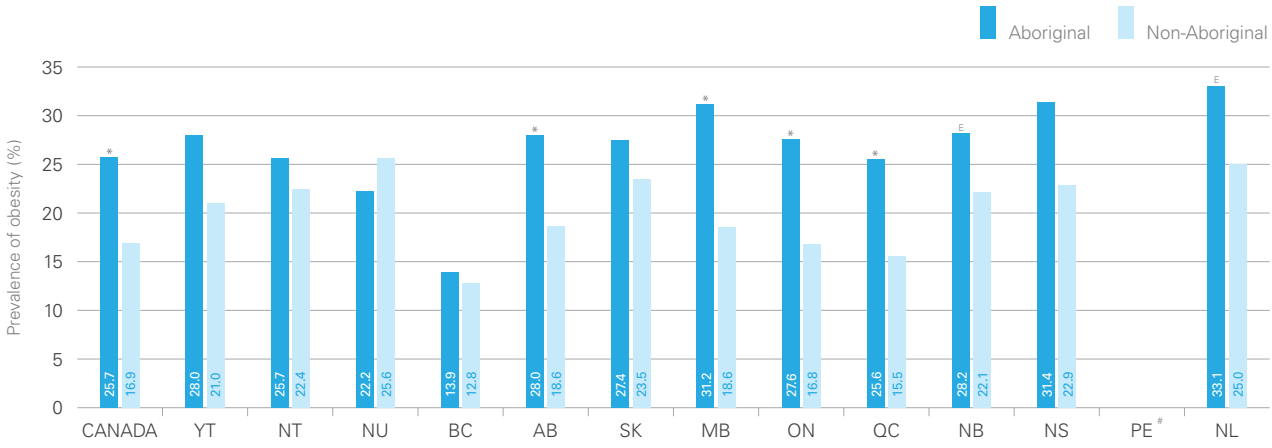
* The RHS reports data separately for "obese" (30.0 kg/m^2 > BMI > 40.0 kg/m^2) and "morbidly obese" (BMI > 40.0 kg/m^2) body mass index groups. For comparability, these results are combined in this report into a single "obese" category (i.e., BMI > 30.0 kg/m^2).

COMPARISON BETWEEN ABORIGINAL AND NON-ABORIGINAL POPULATIONS

Self-reported obesity prevalence was significantly higher among Aboriginal people (excluding First Nations on-reserve) than non-Aboriginal people in Quebec, Ontario, Manitoba, Alberta and Canada as a whole (FIGURE 8). In most other provinces and territories the data seemed to follow the same pattern, but differences were not statistically significant. Additional analysis of the 2007/08 CCHS found obesity prevalence among Aboriginal youth (excluding First Nations on-reserve) aged 12 to 17 years to be 6.7%, compared with 4.4% among non-Aboriginal youth. This difference was not statistically significant.

Higher prevalence of obesity in Aboriginal than non-Aboriginal peoples has also been observed in other studies at both the national[33,38] and regional levels – for example, among members of the Six Nations of the Grand River in southern Ontario,[39] First Nations and Métis populations in Alberta,[40] members of the Nuxalk Nation in British Columbia[41] and Aboriginal women in Manitoba.[42]

FIGURE 8. Prevalence of Self-reported Obesity of Aboriginal and non-Aboriginal Adults Aged 18 Years and Older by Province/Territory, Canada 2007/08



NOTES: * Statistically different from non-Aboriginal people at p<0.05. [E] High sampling variability, interpret with caution.
[#] Prince Edward Island was excluded from the analysis because of the small sample.
SOURCE: Analysis of the 2007/08 Canadian Community Health Survey, Statistics Canada.

KEY POINTS

- Obesity in Canada remains higher in Aboriginal populations compared with non-Aboriginal populations. At the provincial and territorial level, differences are statistically significant in Alberta, Manitoba, Ontario, and Quebec.
- 25.7% of Aboriginal adults (excluding First Nations on-reserve) were estimated to be obese on the basis of self-reported height and weight data from the 2007/08 CCHS.
- As with the general population, self-estimates are lower than measured data – from the 2004 CCHS, an estimated 37.8% of Aboriginal adults (excluding First Nations on-reserve) were obese according to measured height and weight data.
- Adult obesity is similar for Inuit, Métis and off-reserve First Nations populations (23.9%, 26.4%, and 26.1%, respectively; 2006 APS).
- Over one-third (36.0%) of on-reserve First Nation adults are estimated to be obese, according to self-reported data (RHS 2002/03).
- Obesity among children and youth is also high, varying from 16.9% among Métis to 20.0% among off-reserve First Nations to 25.6% among Inuit (ages 6 to 14 years; self-reported data from the 2006 APS).
- Although no single source offers a comprehensive assessment of obesity among First Nations, Inuit, and Métis populations, estimated prevalence among Aboriginal peoples in Canada can be derived from several sources, leading to a picture that shows obesity is a concern.

DETERMINANTS AND CONTRIBUTING FACTORS

Obesity is a complex phenomenon that involves a wide and interactive range of biological, behavioural and societal factors.[43-46] While genetics play a role, genes do not operate in a vacuum; behaviours and social, cultural and physical environments also make important contributions.[47]

A population health approach looks at patterns of health across different populations and also considers a range of determinants or factors associated with the health outcome. This section discusses current evidence and analysis for a range of behavioural and contextual factors associated with obesity in Canada.

Research suggests that, to be relevant to health in Aboriginal populations, frameworks of health determinants need to address the specificity of the experiences of those populations.[48-49,50] Aboriginal populations have distinct histories, but they share common experiences of colonialism, racism and social exclusion.[48] Reflecting these histories and a more holistic cultural perspective on health,[49] for Aboriginal peoples the range of determinants of health may also include factors such as cultural continuity and the relationship to land.[50] Although it is not the goal of this report to explore these issues at length, the historical experiences of Canada's Aboriginal peoples provide important context in considering the determinants of Aboriginal health, including obesity.

PHYSICAL ACTIVITY

There is considerable evidence of an inverse relation between the prevalence of obesity and leisure-time physical activity (LTPA).[12,46,51] Energy expended during non-exercise activity (known as "non-exercise activity thermogenesis" [NEAT])[52,53] includes activities of daily living, occupational or work-related activity, active commuting and incidental movement. Evidence is still emerging, but it has been suggested that the relation between physical activity and health outcomes such as obesity may be moderated by a number of lifestyle factors, including NEAT activities, sedentary behaviours and sleep.[53]

For the most part, physical activity studies in Canada have tended to focus on LTPA.[54] Many of these studies have relied on self-reported data that may be susceptible to respondent and response bias.[55] Systematic reviews have suggested that indirect (e.g., questionnaire or diary) and direct (e.g., accelerometry) measures may produce differing estimates of physical activity in adults,[56] and children and youth.[57]

Available data show that many Canadians get less than the daily recommended amount of physical activity for their age group. The OECD has suggested that, in addition to an obesity epidemic, "there is also a less visible, but no less important, epidemic of 'lack of cardio-respiratory fitness'."[20] The Canadian Physical Activity Levels Among Youth (CAN PLAY) study estimated that during the 2007-2009 period, 88% of children and youth aged 5 to 19 did not meet the guidelines of Canada's Physical Activity Guide.[58] In the 2007/08 CCHS, only half (51%) of Canadians aged 12 and over were active or moderately active (analysis not shown here). In the 2007-2009 CHMS, the proportion of adults whose aerobic fitness was categorized as "fair" or "in need of improvement" increased with age, from 32% of males and 20% of females aged 15 to 19 years[26] to 59% of males and 92% of females aged 60 to 69 years.[2]

SEDENTARY BEHAVIOURS AND SCREEN TIME

Sedentary behaviours include screen time (i.e., time spent watching television or videos or using a computer), reading, sitting during transit and sedentary hobbies. Being sedentary is often confused with physical inactivity, but the relation between the two is still unclear.[59] As with physical activity, sedentary behaviour can be measured directly or indirectly, and conducting research can be methodologically challenging.[60]

A high level of screen time is associated with a greater likelihood of being obese for Canadian adults[61] and children.[26,62] One study found that overweight and non-overweight boys and girls in Canada did not differ significantly by reported physical activity patterns but did differ by screen time, in that overweight groups were more likely to spend two hours or more in front of a screen daily.[63]

According to the 2009 *Report Card on Physical Activity for Children and Youth* by Active Healthy Kids Canada, only 19% of children and youth are currently meeting the guideline of less than two hours per day of screen time.[64] Screen time for both adults[65] and children[66] is influenced by a number of demographic and socioeconomic factors, including age, sex, education, household income and urban vs. rural residency. Screen time can also vary by the type of screen time activity.

DIET

Along with physical (in)activity, diet is the most well-studied behavioural factor influencing body weight and overweight and obesity risk. Although much of the available evidence is limited to correlational findings, overall, the balance of the data underscores the importance of healthy eating patterns and access to healthy food as key factors associated with obesity at a population level.

A number of studies have found an association between low consumption of fruits and vegetables, an indicator of a poor diet, and obesity.[12,46] As well, modelling research of Canadian energy intake and expenditure levels from 1976 to 2003 has also shown a strong association between rising obesity prevalence and rising energy consumption, with most of the latter accounted for by seven food commodities (salad oils, wheat flour, soft drinks, shortening, rice, chicken and cheese).[67]

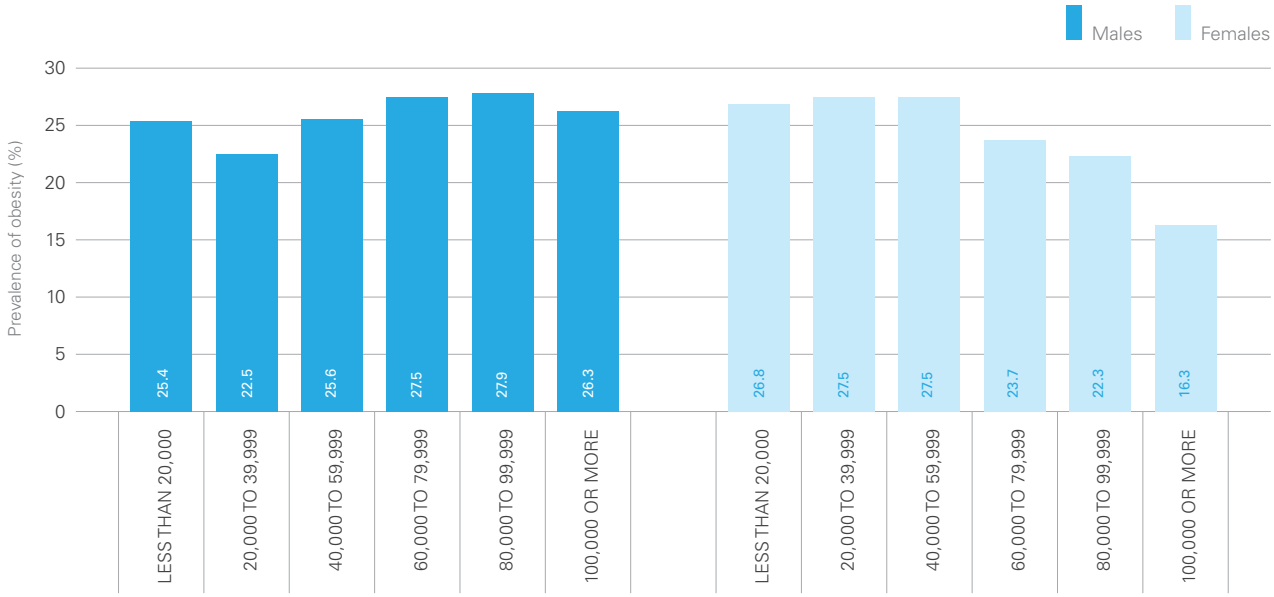
In children and adolescents, familial and environmental factors may be associated with dietary choices and behaviours.[68-70] For example, snacking or eating dinner while watching television,[71,72] consumption of sugar-sweetened beverages between meals[73] and skipping breakfast[74] have been associated with an increased risk of obesity in children and youth. As well, a study of middle-school-aged children found that a greater frequency of family dinners was associated with less soft drink consumption, more frequent breakfast eating, less concern over high body weight and higher self-efficacy for healthy eating at home and during social times with friends.[75]

More broadly, food insecurity (defined as an income-related problem in accessing food)[76] during the preschool years has been found to increase the likelihood of overweight later in childhood.[77] However, a relationship between food insecurity and overweight or obesity has not been shown among adult men, and findings have been inconsistent for adult women.[76]

SOCIOECONOMIC STATUS

Analyses of the 2007/08 CCHS suggest that the relation between income and obesity varies by sex (analysis not shown here). Among females, as income increases obesity tends to decrease, a pattern not observed for males. This inverse trend between income and obesity for females and lack of an apparent pattern for males has also been observed among Aboriginal peoples (FIGURE 9).

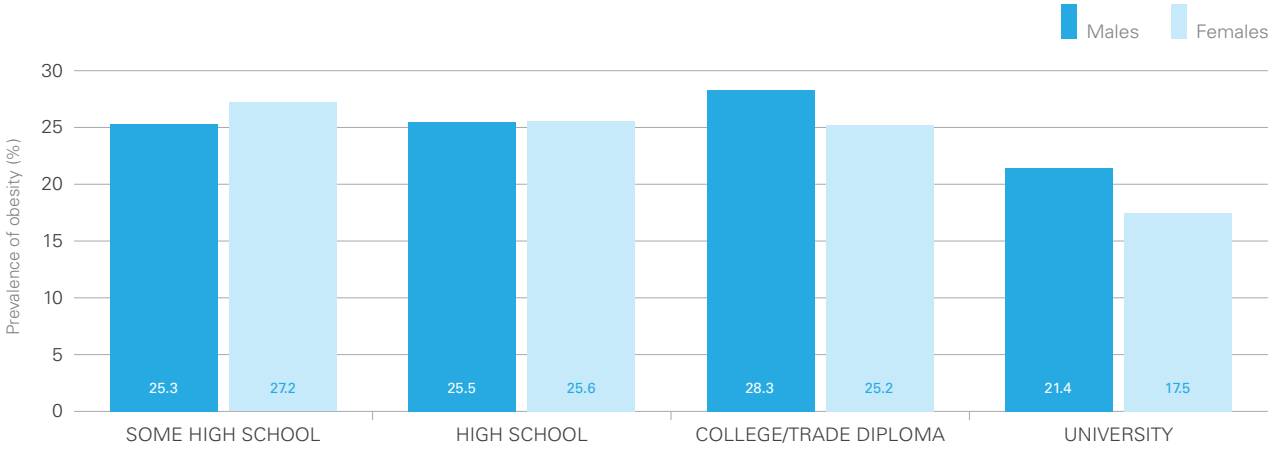
FIGURE 9. Prevalence of Self-Reported Obesity among Aboriginal Peoples by Sex and Income, Ages 18 and Older, 2006



SOURCE: Analysis of the Aboriginal Peoples Survey 2006 Public Use File, Statistics Canada.

Education is another key dimension of socioeconomic status (SES). A generally inverse pattern between education level and obesity prevalence was observed for both men and women in the total Canadian population aged 25 and older (analysis not shown here). Similarly, for the Aboriginal population aged 18 and older (FIGURE 10), obesity appears less prevalent among men and women with the highest levels of educational attainment.

FIGURE 10. Prevalence of Self-Reported Obesity among Aboriginal Peoples by Sex and Education, Ages 18 and Older, 2006



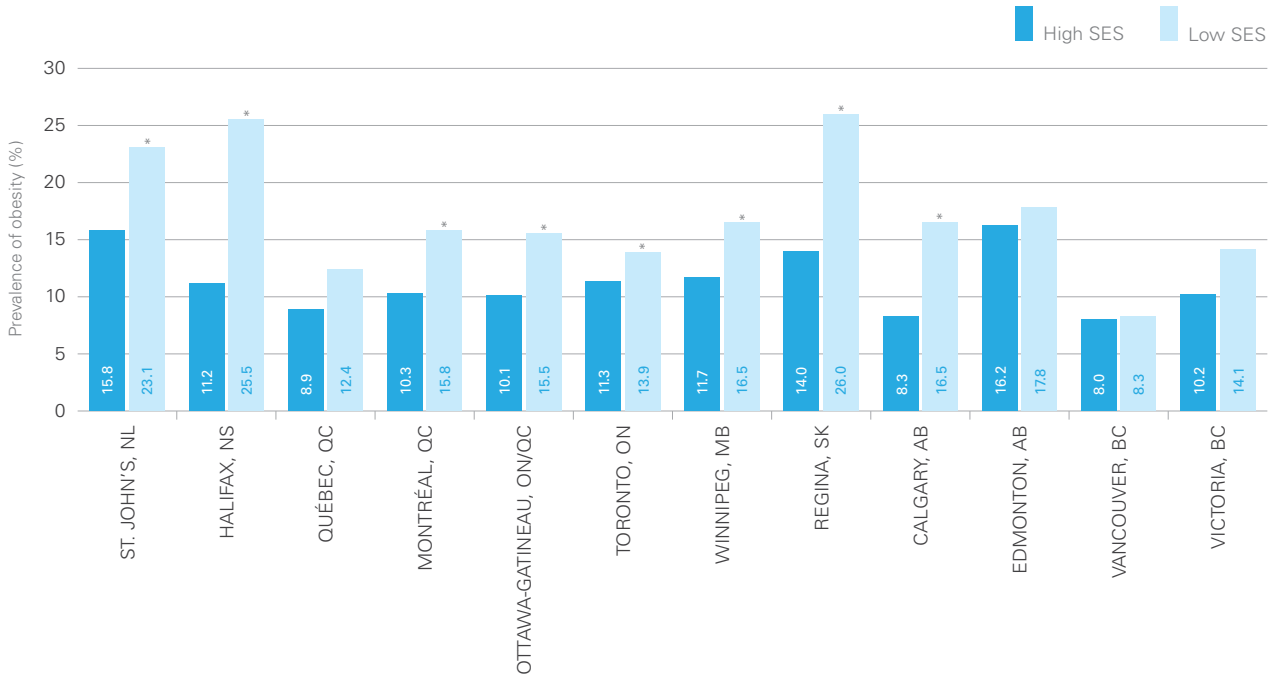
SOURCE: Analysis of the Aboriginal Peoples Survey 2006 Public Use File, Statistics Canada.

A study of body weight and occupational prestige reported different patterns for men and women. Among men, after adjusting for age, income and education, no linear associations between occupational prestige and overweight were found. Among women, increasing occupational prestige was associated with lower BMI on average, even after adjusting for age and income. However, this effect was almost eliminated after education had been taken into account, suggesting that, for women, the relation between occupational prestige and BMI is largely attributable to education.[78]

COMMUNITY-LEVEL FACTORS

Analyses have shown that indicators of area- or neighbourhood-level SES are correlated with obesity in adults,[79] and children and youth.[70,80,81] New analysis of data from the 2005, 2007 and 2008 CCHS looked at disparities in obesity by SES in Canada's Census Metropolitan Areas (CMAs). In most CMAs, obesity was more prevalent in the most socioeconomically deprived areas than in the least deprived (FIGURE 11). In Halifax, for example, 25.5% of people in the lowest SES areas were obese compared with 11.2% of people in the highest SES areas. However, in some CMAs, no significant disparities were found. Results and detailed maps identifying low SES areas for all CMAs are available on the CIHI website.[82]

FIGURE 11. Prevalence of Self-Reported Obesity by Area-Level SES in Select Census Metropolitan Areas, 2005-2008



NOTE: * Significantly different from High SES estimate at p<0.05.
SOURCE: Analysis of the 2005 and 2007/08 Canadian Community Health Surveys, Statistics Canada.

One avenue through which neighbourhood physical and sociocultural characteristics may influence obesity risk is their impact on the availability and accessibility of physical activity equipment, facilities or programs, though the direction and extent of influence may vary by age.[83] Other research has shown that the impacts for children vary by urban and rural residence: while access to recreational facilities and shops with modestly priced healthy foods was associated with less obesity, the former was particularly important to the activity level and body weight of children in rural areas, whereas the latter was particularly influential in the diet and body weights of children from urban areas.[69]

Another possible avenue of influence is through access to food retail outlets.[47, 84] A study in Edmonton, for example, showed that the odds of being obese increased with the concentration of convenience stores and fast-food outlets in the neighbourhood, regardless of covariates such as neighbourhood SES, age, sex and education.[85] However, the evidence of a relation between obesity and the community food environment is mixed.[86]

Community consumption of traditional foods has been shown to be associated with lower rates of obesity among First Nations children. In the 2002/03 RHS, compared with children in large First Nations communities (i.e., 1,500 or more residents), those who lived in small communities of less than 300 were more likely to consume traditional foods and less likely to be obese (the prevalence of obesity being 25.7% in small communities versus 44.2% in large communities). Among First Nations adults and youth, the association between community size and consumption of traditional foods remained but did not appear to be related to BMI.[28]

BOX 4. ADJUSTED POPULATION ATTRIBUTABLE RISK AND POPULATION IMPACT NUMBER

Adjusted Population Attributable Risk (PAR ^{adj})

Population attributable risk (PAR) is a measure of the theoretical reduction in disease incidence that would be observed in a population if a given risk factor were entirely eliminated, after controlling for other factors. It is calculated by multiplying the relative risk (RR) of the disease associated with that risk factor by the proportion of the population exposed to the risk factor. An adjusted PAR (PAR^{adj}) uses an RR that is adjusted for other factors, such as social determinants or health behaviours.

Population Impact Number (PIN)

A PIN is a measure of the number of cases of a certain disease or condition in a population that may be attributed to a given risk factor, after controlling for other factors, and reflects the potential reduction in the number of people in that population with the disease if that risk factor were entirely eliminated. It is calculated by multiplying the PAR^{adj} by the proportion exposed and by the number of people in the population.

For additional details about the methodology and descriptive estimates of the risk factors, see APPENDIX 3.

CONTRIBUTION OF MULTIPLE RISK FACTORS TO OBESITY

For this report, adjusted population attributable risks ($PARs^{adj}$) were calculated to estimate the proportion of overweight and obesity in the population that is attributable to specific demographic, social and behavioural risk factors, while taking into account (i.e., adjusting for) their correlation with other factors.

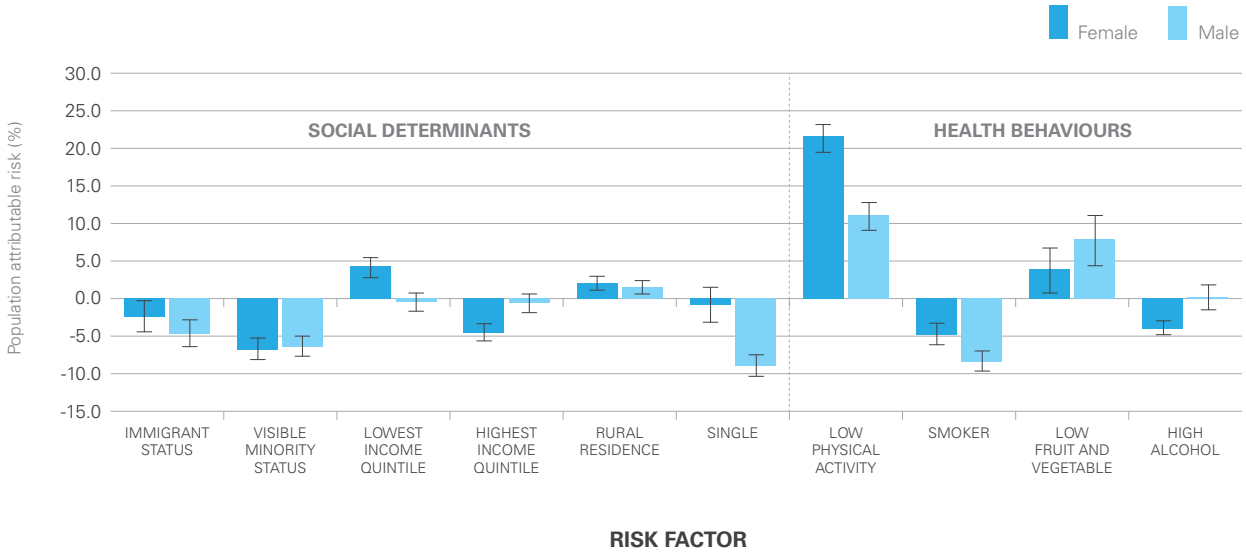
Two types of risk factor for overweight and obesity were included in this analysis:

- Social determinants: immigrant and visible minority status, household income (low, middle or high), urban vs. rural residence, and marital status; and
- Health behaviours: LTPA, smoking status, fruit and vegetable consumption, and alcohol consumption.

FIGURE 12 shows the PAR^{adj} of obesity associated with each of the six social determinant and four health behaviour risk factors. After adjustment for other factors including age, income, rural residence, and alcohol and cigarette use, low levels of LTPA emerged as having the strongest association with obesity at the population level for both men and women. But the analysis also found that LTPA was more strongly associated with obesity among women than it was among men (other types of physical activity were not included in this analysis).

Similarly, living on a low income was associated with obesity among women (again, after controlling for the other factors) but was not associated with obesity among men. In contrast, an association was found between consuming less than five fruits and vegetables daily and obesity for both men (7.9%) and women (3.9%).

FIGURE 12. Population Attributable Risk of Self-Reported Obesity, by Risk Factor and Sex, Ages 18 Years and Older, Canada



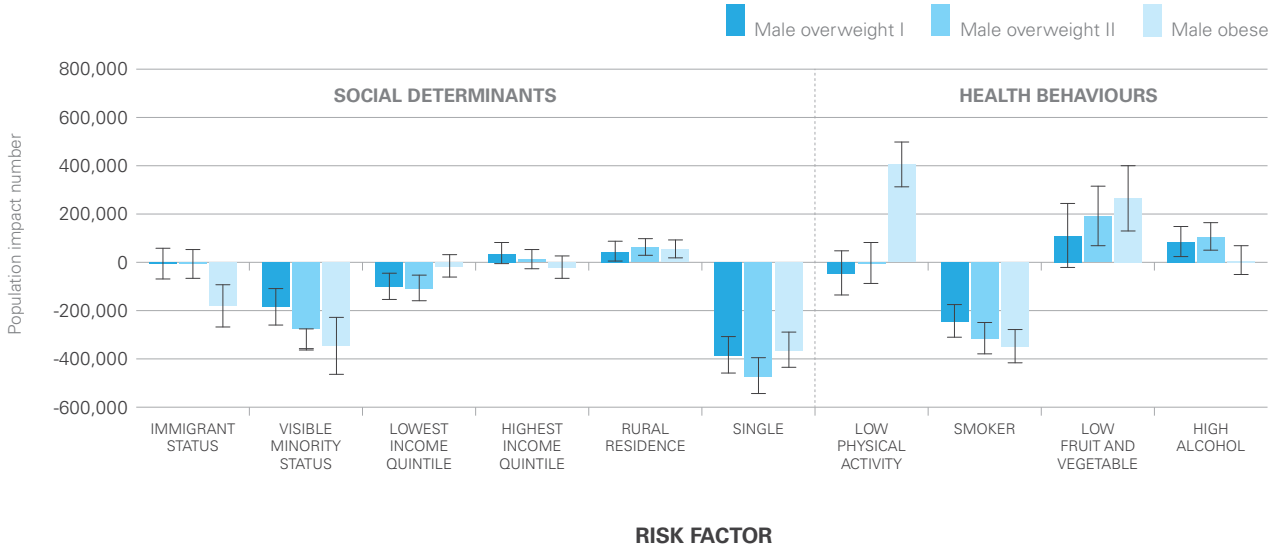
NOTE: Error bars represent 95% confidence intervals based on bootstrap variance estimates.
SOURCE: R. Hawes and P. Stewart, unpublished manuscript prepared for the Public Health Agency of Canada; based on analysis of pooled 2000/01, 2003 and 2005 Canadian Community Health Surveys, Statistics Canada.

PAR^{adj} can also be used to calculate the population impact number (PIN), the theoretical number of cases of overweight or obesity in a population that may be attributed to a specific risk factor, after taking into account the other risk factors in the study. For this analysis, three categories of excess weight were analyzed separately for men and women: overweight I (BMI = 25.0-27.4 kg/m^2), overweight II (BMI = 27.5-29.9 kg/m^2) and obesity (BMI $\geq$ 30 kg/m^2).

FIGURES 13 and 14 show the PINs obtained from the analysis for men and women, respectively. The equivalent of 405,000 cases of male obesity and 646,000 cases of female obesity could be averted if all individuals in the population attained high levels of physical activity, as measured in this study; this is consistent with the large PAR^{adj} values for low physical activity shown in FIGURE 12. Similarly, eliminating the consumption of a poor-quality diet, as measured by low fruit and vegetable consumption, may result in 265,000 fewer men and 97,000 fewer women being obese.

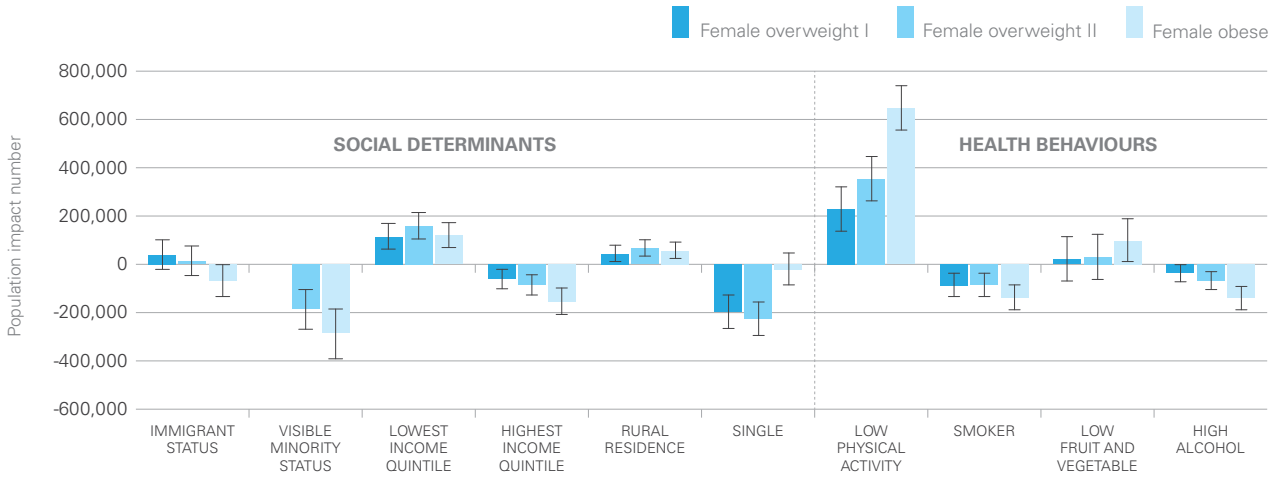
These figures also point to the importance of gender as a mediating factor. For example, whereas heavy alcohol consumption was associated with 190,000 cases of overweight among men, it was not associated with an increase in the number of obese men and did not substantially influence the number of overweight or obese women in Canada. Also, the findings suggest that shifting the risk profile of low-income people to that of high-income people could result in about 114,000 fewer women in the population being classified as overweight I, 158,000 fewer women as overweight II and 119,000 fewer women as obese, but may not be associated with changes in overweight or obesity among men.

FIGURE 13. Population Impact Number of Self-Reported Overweight and Obesity Among Males, by Risk Factor and Body Mass Index Category, Ages 18 Years and Older, Canada



NOTE: Overweight I = BMI 25.0-27.4 kg/m^2; Overweight II = BMI 27.5-29.9 kg/m^2; Obese = BMI 30.0+ kg/m^2.
Error bars represent 95% confidence intervals based on bootstrap variance estimates.
SOURCE: R. Hawes and P. Stewart, unpublished manuscript prepared for the Public Health Agency of Canada; based on analysis of pooled 2000/01, 2003 and 2005 Canadian Community Health Surveys, Statistics Canada.

FIGURE 14. Population Impact Number of Self-Reported Overweight and Obesity Among Females, by Risk Factor and Body Mass Index Category, Ages 18 Years and Older, Canada



NOTE: Overweight I = BMI 25.0-27.4 kg/m^2; Overweight II = BMI 27.5-29.9 kg/m^2; Obese = BMI 30.0+ kg/m^2.
Error bars represent 95% confidence intervals based on bootstrap variance estimates.
SOURCE: R. Hawes and P. Stewart, unpublished manuscript prepared for the Public Health Agency of Canada; based on analysis of pooled 2000/01, 2003 and 2005 Canadian Community Health Surveys, Statistics Canada

BOX 5. CAUTIONARY NOTE ON INTERPRETING PARS AND PINS

Population attributable risks (PARs) and population impact numbers (PINs) are useful measures for communicating characteristics of factors that may be associated with the prevalence of a disease or condition at a population level. However, caution should be used when interpreting their results. For example, PARs are non-additive, so individual PAR values for several risk factors cannot be summed together to derive an estimate of "total attributable risk" for the disease or condition of interest. This is because risk factors often cluster and influence one another, particularly in complex health issues such as obesity.

Another issue concerns the interpretation of PARs and PINs for non-modifiable risk factors. In general, where causality is known, these measures can be seen as reflecting the extent of the population burden of a disease or condition (e.g., obesity) that could be theoretically "eliminated" if all individuals in the exposed/target group (e.g., low physical activity) were converted to the non-exposed/referent group ("adequate" physical activity). Such an interpretation, which can help to inform decisions in public health settings about the modifiable risk factors on which to focus limited resources and efforts, is inappropriate when considering non-modifiable risk factors (e.g., immigrant status, urban vs. rural residence). However, the inclusion of such risk factors in PAR (and PIN) analyses can still be of value for informing public health action, as they can help to clarify which groups appear to be at higher or lower risk.

These estimates are theoretical and intended to illustrate in clear population terms the potential magnitude of change to overweight and obesity arising from various behavioural and social factors. To be valid, PAR estimates require an assumption of a cause-and-effect relation between the risk factor and outcome of interest. Such assumptions were made for the purposes of these analyses.

This necessarily oversimplifies the complex relations between obesity and its various drivers, particularly with respect to the more distal, or indirect, social determinants of obesity. However, the more pathologically distal factors, such as income, rural residence and minority status, continue to affect male and female overweight and obesity even after controlling for more proximal, or direct, determinants, like the health behaviours analyzed above. This suggests that a) social factors may have a measurable and direct effect on overweight and obesity, and/or b) contextual factors affect overweight and obesity through other, more proximal, determinants not investigated in the CCHS.

In a recent U.K. study that used a similar analytical approach to explore the potential population impact of several neighbourhood-level factors on physical activity, the authors noted that "in practice, given the paucity of community-based evaluations, policy-makers often rely on cause-effect relationships to be assumed to some degree" and that their analysis "merely applied a population perspective to such interpretation." Nevertheless, they underscored that their results, which assume a cause-effect relation, should be interpreted with caution.[87] Similar discretion should be used in considering the findings presented above.

Analyses such as the multifactorial research summarized in this chapter are providing new insights into the complex ways in which factors interact and contribute to obesity. However, there is still much to learn, for example:

- the effects of biological or genetic influences and pre- and post-natal factors, including birth weight and breastfeeding;
- how factors might differ for different populations, cultures and ethnic groups;
- the contribution of incidental, life-style-embedded and occupational activities, as well as sedentary behaviours, to physical activity and the risk of obesity; and

- the effect of socioeconomic and environmental factors such as food security, access to stores and recreational facilities, food supply factors, as well as the built environment.

In the future, further refinement and use of techniques incorporating multiple risk factors (such as PAR^{adj} and PIN) may be helpful in gaining insights into the distribution of obesity, as well as indicating opportunities for health promotion and prevention.

KEY POINTS

- Obesity is a complex phenomenon with a wide range of genetic, lifestyle, social, cultural and environmental factors contributing to variations in its prevalence.
- The association between income and obesity appears to be sex-specific, with an inverse association observed for females in the total population as well as Aboriginal populations but no clear pattern for males.
- Of the factors considered and currently measured through the CCHS, being inactive emerged as having the strongest association with obesity at the population level for both men and women.
- An estimated 405,000 cases of male obesity and 646,000 cases of female obesity could potentially be altered or averted if inactive populations became active.
- Distal or indirect factors, such as income, rural residence and minority status, continue to affect male and female obesity even after controlling for more proximal, or direct, health behaviours such as inactivity.
- Two population health measures – the PAR^{adj} and PIN – provide new perspectives on obesity and the potential contribution of specific factors to obesity prevalence, and they may be one consideration in setting priorities for the prevention and management of obesity.
- More research into the determinants of obesity is needed, particularly multifactorial research that looks at biological, environmental, socioeconomic and lifestyle factors and how they interact.
- More research is needed to understand the determinants of obesity – both direct and more indirect – that may be specific to Aboriginal peoples and communities.
- A limitation of using data and analysis to inform policy is that food-related factors (access to healthy foods and food outlets, consumption of traditional diets, caloric density, marketing of foods and beverages high in sugar and fat to children, and portion sizes) have not been considered in the analysis.

HEALTH AND ECONOMIC IMPLICATIONS

This section provides an overview of population-level impacts of obesity, with a focus on health impacts (morbidity), mortality and economic implications.

HEALTH IMPACTS

Obesity is associated with a number of health conditions or morbidities.[47, 88] A recent systematic review of the clinical literature found associations between obesity and the incidence of type 2 diabetes, asthma, gallbladder disease, osteoarthritis, chronic back pain, several types of cancers (colorectal, kidney, breast, endometrial, ovarian and pancreatic cancers) and major types of cardiovascular disease (hypertension, stroke, congestive heart failure and coronary artery disease).[89] There may also be a relation between psychiatric conditions and excess weight, although this may be confounded by the fact that some psychotropic medications can contribute to weight gain.[90]

Evidence from systematic reviews indicates that childhood obesity increases the risk of obesity during later life[91] and contributes to the early development of a number of conditions, such as type 2 diabetes, atherosclerotic heart disease and high blood pressure.[21,92]

In adults, abdominal obesity is associated with an increased risk of type 2 diabetes and cardiovascular disease,[93,94] and is the most prevalent feature of a set of metabolic disorders known as the metabolic syndrome*.[94] In the 2007-2009 CHMS, 21% of men aged 20 to 39 years, 38% of those 40 to 59 and 52% of those 50 to 69 had a waist circumference indicating a higher health risk. The prevalence was even higher among women: 31% of those aged 20 to 39, 47% of those 40 to 59 and 65% aged 60 to 69.[2] Among youth aged 15 to 19 years, 15% of males and 28% of females had a waist circumference indicating increased or high risk.[24]

Abdominal obesity has been studied in several Aboriginal populations because of its relation with diabetes and/or metabolic syndome.[39-41, 95-106] In the *Believing We Can Reduce the Aboriginal Incidence of Diabetes* (BRAID) study in rural northern Alberta, for example, approximately one-half of on-reserve First Nations adults met the criteria for metabolic syndrome, and abdominal obesity was the most prevalent abnormality.[100]

Analyses from the RHS also found associations between weight category and the prevalence of a number of health conditions, including cardiovascular disease, musculoskeletal disorders and respiratory diseases, in on-reserve First Nations communities. For example, the prevalence of self-reported cardiovascular disease increased by weight category: 8.3% of those of normal weight, 15.7% of the overweight, 26.5% of the obese and 44.6% of the severely obese.[28]

As noted in the Canadian clinical practice guidelines on obesity and elsewhere, complications of obesity include not only physical health problems but also psychological concerns (e.g., low self-esteem).[22,107-109] As well, negative attitudes and stereotypes about those who are obese have been linked to social and employment discrimination.[88] One systematic review reported perceptions of weight bias and negative stereotypes about obese people in a number of sectors: at work, in health care settings, in schools and in the media.[110] An analysis of the 2002/03 CCHS results found that, compared with men and women of normal weight, obese men and women were more likely to report high job strain and low co-worker support.[111]

* Metabolic syndrome is a cluster of metabolic abnormalities that is associated with an increased risk of type 2 diabetes and cardiovascular disease. Screening variables used to identify metabolic syndrome are abdominal obesity, low high-density lipoprotein cholesterol and elevated readings for triglycerides, blood pressure and fasting blood glucose.

MORTALITY

While severe obesity is associated with premature mortality, calculating the exact number of deaths in a population that are attributable to obesity is difficult. The relative risk of death varies among studies, depending on the population characteristics (e.g., age) and risk factors included in the analyses.[112] Further complicating the issue are the methodological challenges of isolating the contribution of excess body weight from that of related risk factors, co-morbidities and confounding variables.[113]

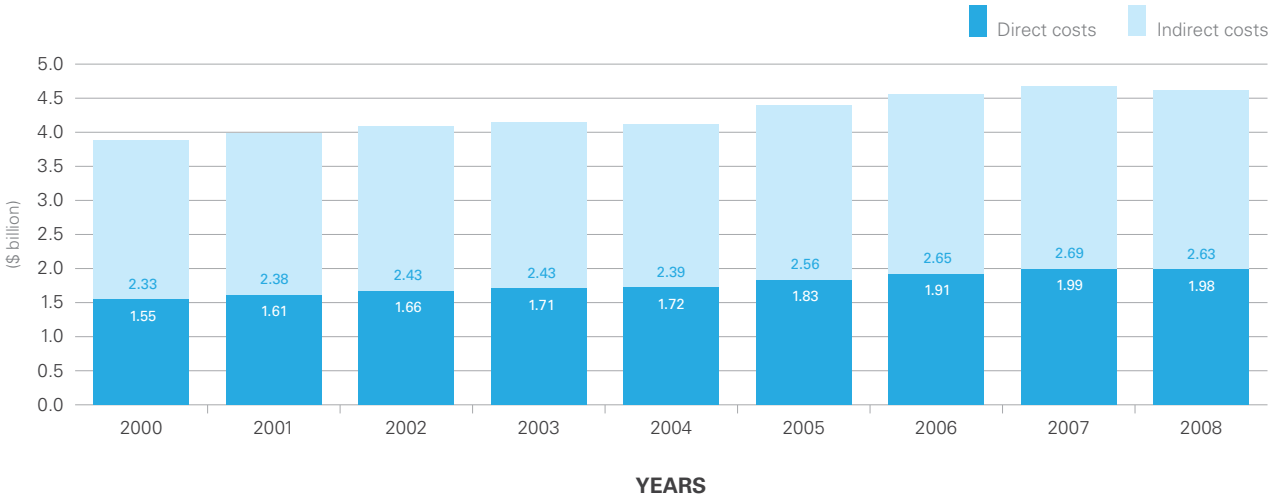
What does the current research say about how many deaths in Canada can be attributed to obesity? One Canadian study estimated that the proportion of all deaths among adults 20-64 years of age that could be theoretically attributed to overweight and obesity grew from 5.1% in 1985 to 9.3% in 2000.[114] Another study, involving 11,326 participants in the 1994/95 National Population Health Survey (NPHS) who were followed for 12 years, found that, compared with those in the normal weight category, those in the underweight or class II or III obesity categories had a significantly increased risk of all-cause mortality, even after key sociodemographic factors and health behaviours had been controlled for. In contrast, people who were overweight but not obese had a significantly lower risk than the normal-weight population. There was no significant difference in risk of mortality between obesity class I and normal-weight respondents.[115]

This pattern, in which mortality is higher in the highest and lowest weight categories compared with those who are of normal weight, has been described as a J- or U-shaped mortality curve.[116, 117] A similar J- or U-shaped relation between BMI and mortality has been reported in a number of US studies.[118, 119120] The reasons for this pattern are unclear, and the phenomenon may be influenced by body composition. A national longitudinal survey in the US (NHANES I and II) found that, among men, fat mass (i.e., adiposity) had a positive relation with all-cause mortality, and fat-free mass had a negative or protective effect.[121]

ASSOCIATED ECONOMIC COSTS

An analysis of CCHS, NPHS and *Economic Burden of Illness in Canada* data (see APPENDIX 2) was conducted to examine the change in the economic burden of obesity between 2000 and 2008, taking into account the impact of inflation on health care costs and average earnings over the period. In this study, the economic burden of obesity was defined as both the direct costs to the health care system (i.e., hospital care, pharmaceuticals, physician care and institutional care) and indirect costs to productivity (i.e., the value of economic output lost as a result of premature death and short- and long-term disability). The study focused on eight chronic diseases consistently associated with obesity. According to this analysis, between 2000 and 2008 the annual economic burden of obesity in Canada increased by $735 million, from $3.9 to $4.6 billion (FIGURE 15).

FIGURE 15. Estimated Annual Direct and Indirect Costs Associated with Obesity ($ billion), Adults Ages 18 and Older, Canada 2000-2008



SOURCE: I. Janssen, unpublished manuscript for the Public Health Agency of Canada; based on analysis of the1994/95 and 1996/97 National Population Health Surveys; 2000/01, 2003, 2004, 2005, 2007 and 2008 Canadian Community Health Surveys (Statistics Canada); and Economic Burden of Illness 2000 Database (Public Health Agency of Canada).

Another study, using a comparable methodology and looking at 18 obesity-related chronic diseases, estimated the economic burden of obesity to be as high as $7.1 billion (2006 dollars).[122]

A study of physician costs in Ontario found that obese male and female adults (aged 18 and over) incurred physician costs that were 14.7% and 18.2% greater than those of normal-weight peers. The effect of obesity on physician costs increased with age: compared with normal weight groups, costs were 5.3% higher for obese young adults (18-39 years), 7.0% higher for obese middle-aged adults (40-59 years) and 28.3% higher for obese older adults (60+ years).[123]

KEY POINTS

- Obesity significantly increases the risk of several chronic diseases, including type 2 diabetes, some forms of cardiovascular disease, certain types of cancer, and osteoarthritis.
- Obesity can also affect psychological health.
- The risk of obesity-related death appears to be greatest among those who are at the extreme BMI categories (i.e., underweight and obese), but this relation may be affected by body composition.
- Estimates of the economic burden of obesity in Canada range from $4.6 billion to $7.1 billion annually.
- There are currently few Canadian data on the long-term health impacts of obesity, particularly for children and youth.
- A better understanding of the contribution of obesity to morbidity and mortality could help to develop more accurate economic costs.

OPPORTUNITIES FOR INTERVENTION

The main focus of this report has been to highlight new data and findings concerning the prevalence of obesity in Canada, as well as to summarize our current understanding of its determinants and the health and economic burden. It states what we know about the issue. This chapter will highlight some promising evidence-based practices and opportunities for obesity prevention and management described in the national and international literature.

GENERAL PRINCIPLES

Even though scientific knowledge is still evolving and incomplete, waiting for the "perfect solution" may not be an option, and decisions about how best to address obesity at a population level must be made.[124,125] Such decisions may benefit from careful analysis of the feasibility of possible interventions, the available scientific evidence, the cost/benefit ratio (including the potential for unintended or negative outcomes such as stigmatization[126] or increased inequities[127]), as well as potential value for money.[128] In discussing actions to address childhood obesity in particular, Estabrooks, Fisher and Hayman make the point that interventions must carefully document not only outcomes, cost and robustness but also the broader legislative or community context, implementation issues and sustainability.[129]

Approaches to combat obesity can be categorized into three streams:[130]

1) health services and clinical interventions that target individuals,
2) community-level interventions that directly influence behaviours, and
3) public policies that target broad social or environmental determinants.

In practice, these are not mutually exclusive categories but, rather, overlapping and complementary lines of action.

The WHO recommends a number of core principles to underpin public health efforts against obesity:

- ensuring that they are of adequate duration and persistency;
- adopting a slow and staged approach over time to support the transition through the stages of change (i.e., awareness, motivation to change, experimentation, adopting a change and maintaining the changed behaviour);
- providing education to encourage and support changes in behaviour and attitudes;
- harnessing advocacy from respected elements of society;
- fostering shared responsibility for change among consumers, communities, industry and governments; and
- utilizing legislative action where appropriate.[6]

INDIVIDUAL-BASED INTERVENTIONS

The 2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children provide recommendations for health care professionals regarding the prevention, screening and management of obesity in clinical and community health settings.[22] The guidelines suggest that approaches be tailored to individual patients but can include one or more of the following:

- behaviour modification training or therapy, including family-oriented behaviour therapy for children;[47,131]
- dietary interventions, such as an energy-reduced diet;[132,133]
- regular physical activity in adults;[134]

- combined dietary and physical activity therapy;[135,136] and
- for some individuals, bariatric surgery and prescription medications.[137-138]

A 2009 Cochrane Collaboration review of health professionals' management of overweight and obesity suggested that brief training sessions, shared care with other health professionals and dietitian-led programs may be worth further investigation to demonstrate how the practice or organization of care could be improved.[139]

There is some evidence that face-to-face (e.g., individual or small-group) clinical counselling is more effective than remote communications (e.g., telephone or mail-based programs) in obesity prevention in adults.[140] Emerging evidence on Internet-based programs suggests that computer-tailored approaches show inconsistent results but have been associated with changes in physical activity, diet and/or weight loss in adults.[141,142] There is only limited evidence to guide obesity screening and management programs for children and youth.[143]

While individual interventions may be effective in promoting weight loss, avoiding weight regain is frequently a challenge.[144] For example, a US follow-up study of approximately 1,300 overweight or obese individuals aged 20-84 years who had lost at least 10% of their body weight found that, by one year, 34% had regained more than 5%.[145] Self-monitoring (e.g., frequent self-weighing) and regular physical activity may help to avoid weight regain,[146] and one study has suggested that even a relatively inexpensive intervention such as nurse counselling and support can help to prevent relapse.[147] However, frequent self-weighing has also been associated with increased risk of binge eating and unhealthy weight control among adolescent girls.[148]

COMMUNITY-BASED INTERVENTIONS

Community-based obesity prevention interventions include programs delivered in key settings, such as workplaces and schools, as well as both targeted and universal public educational and information campaigns delivered through print, broadcast and online media. One example of a comprehensive campaign that targets multiple risk factors (e.g., physical inactivity, low fruit and vegetable consumption, smoking, overweight and obesity, and alcohol use during pregnancy) is British Columbia's ActNow BC. For each factor, specific targets are pursued through a mix of collaborative strategies and mechanisms. For example, from 2005 to 2010, ActNowBC set a target to reduce by 20% the proportion of the population 18 and over who were overweight or obese from the 2003 estimate of 42.3%.[149]

Social marketing campaigns that emphasize physical activity, healthy eating and/or healthy weights are one type of common community-level health promotion tool. Some examples of social marketing campaigns that use mass media strategies are Canada's ParticipACTION (physical activity)[150,151] and *5 to 10 a Day* (fruit and vegetable consumption),[152] England's *Fighting Fat, Fighting Fit*[153] (revised as *Change4Life*[154]), Australia's *Measure Up* campaign[155] (healthy weights), and US campaigns such as the *VERB*[156] (youth physical activity) and *Fruits & Veggies More Matters*[157] (previously known as *5 A Day*). Evaluations have not been published for all campaigns; among those that have, the type of evidence collected has varied. Some evaluations have focused almost exclusively on measuring campaign awareness, public attitudes and knowledge,[158] whereas others have focused on the specific behaviour being targeted, such as physical activity within a specific target population.[159] *Fighting Fat, Fighting Fit* is one of the few campaigns that have been evaluated for impact on participants' body weight; results, although encouraging, were modest.[153]

Further study is required to more clearly understand the contribution that mass media campaigns can make to obesity prevention or management, as well as the manner by which they influence behaviour.

A recent systematic review of experimental and quasi-experimental studies, conducted primarily in the US, identified a number of initiatives that were effective in influencing two of the key behavioural factors known to affect obesity: physical activity and healthy eating.[160] The most promising approaches included the following:

- point-of-decision prompts such as signage encouraging the use of stairs;
- school-based interventions for children and youth (e.g., increased frequency/duration of physical education classes, additional training for teachers);
- comprehensive worksite programs that include counselling, education, incentives and access to supportive facilities such as locker rooms, showers and gyms;
- point-of-purchase strategies, such as menu and shelf labelling, to increase the purchase and consumption of healthier foods;
- workplace, school and municipal policies and environmental supports that increase access to healthier foods and beverages (e.g., in vending machines restaurants and cafeterias);
- systematic nutrition reminders and training for health care providers.[160]

It has been argued that a strong business case can be made for workplace wellness programs.[161] A review of 12 Canadian worksite programs reported a wide range of activities, such as addressing the physical work environment (e.g., safety/cleanliness, air quality, ergonomics, health and safety), the physical health of employees (fitness, smoking cessation, nutrition and lifestyle education or promotion) and mental health, stress and other psycho-social concerns (including work/family balance, work organization and stress reduction).[162] It has been reported that obesity is becoming an increasing focus of workplace wellness programs.[163] A recent meta-analysis of nine randomized controlled trials of such programs reported a net loss of 2.8 pounds at 6-12 months, with six trials showing a net reduction in BMI of 0.47.[164]

A 2006 review of 158 publications representing 147 studies of obesity prevention and management interventions for children and youth concluded that the majority led to positive outcomes, at least in the short term.[165] Targeted programs in clinical settings most frequently reported positive outcomes, and school-based programs, particularly those conducted in primary schools, were also found to be effective. Engagement in physical activity was considered a critical component of effective obesity prevention and management programs.[165]

The review paper concluded with a call for greater recognition of the roles that sex and gender, family dynamics and environment can play in childhood and adolescent obesity. It also highlighted a number of weaknesses in the current evidence base:

- little or no research on interventions for preschool-aged children, sex-specific interventions or interventions focusing on immigrant children and youth;
- under-utilization of the principles of population health;
- little stakeholder involvement;
- little or no investment in environmental modifications (with the exception of some school-based programs); and
- a focus on obesity in isolation, rather than as part of an integrated chronic disease prevention approach.[165]

Other studies have also shown that school-based health programs have the potential to educate children and youth about nutrition and healthy eating, and promote behaviours (e.g., physical activity and eating) related to achieving or maintaining a healthy weight.[166-168] Reviews of past studies, however, have produced mixed results in terms of effectiveness.[169-171]

PUBLIC POLICIES

The effectiveness of public health efforts to promote healthy weight by encouraging individuals and families to make healthier choices is often limited by factors in the physical, social and economic environments that preclude or undermine those choices. For example, analyses suggest that even after adjusting for behavioural and individual factors, living in a neighbourhood characterized by material deprivation is associated with a higher BMI for women, though not for men,[172] and that participation in organized sports is more prevalent among children from higher-income than lower-income households.[173] Studies from other jurisdictions have suggested that environmental factors, such as the lack of safe and accessible spaces for children to play[174] and a built environment that promotes motorized transportation over active commuting (cycling and walking),[175] can serve as barriers to physical activity. It has also been suggested that environmental factors may be linked to food choices, diet quality and obesity.[176]

A number of reports have commented on the connections between land use planning and health.[177, 178] It has been suggested that progress can be made in combating obesity by broadening public health efforts into comprehensive strategies that both promote healthy choices and simultaneously support environmental changes to make those choices easier.[166] Many municipalities have reported that broad stakeholder consultation is needed in order to balance environmental, economic, social and cultural needs and to manage and coordinate community planning and design.[179] Such approaches often require leadership by various levels of government, as well as a commitment to a long-term, multisectoral and progressive approach that is rooted in an ecological or environmental perspective.[47, 180]

Some examples of the types of public policy strategy that have been discussed or implemented to address the key influence on obesity, physical activity and nutrition are as follows:

- Subsidy programs to support healthy eating (e.g., the Food Mail Program for northern Canada,[181] the Northern Fruit and Vegetable Pilot Programme in Ontario[182] and community-based food security initiatives[183]);
- Land development, urban planning and transportation planning that promote active commuting and recreational physical activity;[6,166]
- Food labelling to help consumers understand the health implications of their choices;[6,166]
- Regulation of marketing to children, particularly for energy-dense, nutrient-poor foods and beverages;[6,166,184]
- Financial incentives to promote physical activity (e.g., the Children's Fitness Tax Credit and the Federal Tax Credit for Public Transit[185-187]); and
- Financial disincentives, such as a tax on "unhealthy" foods and beverages.[188]

It is unlikely that there is a single solution to reverse the rising prevalence of obesity in Canada; a comprehensive, multisectoral approach may be needed to respond effectively to this complex issue. A number of resources are available to assist policy-makers and health practitioners in assessing the evidence for potential population-based obesity prevention and management

interventions (see APPENDIX 4). Evidence from smoking cessation programs and other public health experiences suggest that an intervention is more likely to be effective if it is long term and multifaceted in nature, tackling multiple drivers and factors simultaneously.[189] Responses may also be improved by integrating evaluation into program development and implementation. By facilitating the emergence of new knowledge, ongoing evaluations could support the continual realignment and enhancement of resource investments.[189]

RESEARCH ISSUES

Relatively few population-level obesity prevention and management interventions, especially public policy approaches that target broader environmental factors, have been systematically evaluated either for their effectiveness or cost-effectiveness.[190] The need for more research is particularly pressing for obesity prevention, for which evidence of efficacy is limited to a small number of studies.[191] Developing and implementing effective interventions requires better knowledge about what approaches work (and do not work) in different settings and with different populations,[192] as well as economic analyses to assess value for money.[128]

More research is needed on how best to address obesity in specific target groups. For example, while current knowledge about interventions among children and youth is growing, a number of gaps remain, particularly for preschool-aged children. More information is also needed about the efficacy of interventions among immigrants, those living in economically deprived neighbourhoods and Aboriginal communities. Given the results of the multifactorial research presented earlier in this report, more information about the effects of intervention by sex, as well as the impact of sex-specific initiatives, could also offer important insights for program planners and policy-makers.

KEY POINTS

- Approaches to combating obesity can be categorized into three main types: 1) health services and clinical interventions that target individuals, 2) community-level intervention to influence behaviours, and 3) public policies that target broad social or environmental determinants.
- Guidelines suggest that a number of individual-based interventions can contribute to obesity prevention and management but that more evidence is currently available for interventions targeting adults than children. Moreover, weight maintenance (i.e., avoiding weight regain) is frequently a challenge.
- Community-based obesity interventions are delivered in the community and settings such as workplaces and schools. An example of a Canadian community-based intervention is ActNow BC.
- Systematic reviews and policy documents have identified some of the key principles and strategies for community-based interventions.
- The literature also suggests that a number of public policy approaches can be undertaken to address obesity at the population level.
- There is unlikely to be a single solution that will reverse the rising prevalence of obesity in Canada; rather, a comprehensive, multisectoral response may be needed.
- More research and information are needed about the effectiveness, transferability and generalizability, and value for money of prevention and management interventions, particularly in specific subgroups such as preschool-aged children, immigrants and Aboriginal communities. Given the results of the multifactorial analysis of the population attributable risk of obesity, additional research on the sex-specific effects of interventions could also offer important insights.

APPENDIX 1. ESTIMATING THE PREVALENCE OF OBESITY: METHODOLOGY AND ADDITIONAL 2007/08 CCHS ANALYSES

Using the Canadian Community Heath Survey (CCHS), new analyses presented in this report estimate the prevalence of obesity in Canadian populations stratified by age, sex, geographic location, and income and education levels. Data from the 2007 and 2008 CCHS share files, both separately and combined, were the focus of the new analyses. Data from previous cycles, covering the years 2000/2001, 2003, 2004 and 2005, were also used. Detailed descriptions of the variables used, analyses conducted and resulting limitations are outlined in this appendix.

CANADIAN COMMUNITY HEALTH SURVEY

The target population of the CCHS is all Canadians aged 12 and over (for the 2004 CCHS Nutrition Cycle (2.2), the target population was extended to all age groups*. People living on Indian Reserves and Crown Lands, institutional residents, full-time members of the Canadian Forces and residents of certain remote regions were not included in the survey. The survey population is representative of approximately 98% of the total population in the provinces, 90% in the Yukon, 97% in the Northwest Territories and 71% in Nunavut.[193]

Prior to 2007, core component data were collected every two years over a one-year period. Since 2007, data collection has occurred on an ongoing basis across 12-month collection periods. For both the annual data and two-year combined data (2007/08), sampling and bootstrap weights are provided by Statistics Canada such that resulting weighted estimates are representative of the population in the specified period.[194] Information on approximate CCHS sample size specific to each collection period is provided in TABLE 3.

TABLE 3. Sample Size Information for CCHS Cycles Used In Obesity Analyses

	2000/01 CCHS[195]	2003 CCHS[196]	2004 CCHS[197]	2005 CCHS[198]	2007 CCHS[199]	2008 CCHS[200]
Available survey sample size	130,827	134,072	35,107	132,947	65,946	66,013
Self-report BMI class available	86,000 (ages 20-64)	111,000 (18+)	3,200 (2-17) 7,300 (18+)	11000 (12-17) 114,000 (18+)	4,700 (12-17) 57,300 (18+)	4,900 (12-17) 56,900 (18+)
Measured BMI class available	Not available	Not available	8,660 (2-17) 11,800 (18+)	480 (12-17) 4,200 (18+)	Not available	400 (12-17) 4,100 (18+)

NON-RESPONSE

Valid responses for BMI are available for part of the sample, as illustrated in TABLE 4. All prevalence estimates for obesity are based on the total population for which BMI was available; non-responses and ineligible respondents for whom BMI was not calculated (e.g., pregnant women) were excluded from the analyses. In particular, for the combined 2007/08 obesity estimates, over 8,000 persons from the sample of approximately 132,000 are excluded.

Being female was the characteristic of the sample that showed the highest proportion for whom BMI class was not determined (TABLE 4), and this was due to the exclusion of pregnant women. Otherwise, characteristics were quite consistent between the sample excluded and the remaining sample.

* For children under the age of 6, the parent was the only person providing the information. For children aged 7 to 11, parents were there to help the child respond or to provide an answer directly.

TABLE 4. Characteristics of Sample Population and Non-respondents, CCHS 2007/08

	TOTAL POPULATION (*n*=123,723)	OBESITY RESPONSE NOT AVAILABLE (*n*=8236)
Average age	43 years	42 years
Female	5%	63%
Household income <$20,000/year	9%	11%
Single, separated, divorced, widowed	29%	29%
Aboriginal peoples	3%	4%

SOURCE: Canadian Community Health Survey 2007/08, Statistics Canada.

VARIABLES USED IN ANALYSES

In addition to age, sex, province/territory and health region, the following variables were used in the analyses.

Obesity: The BMI is a derived variable calculated by dividing the respondent's measured body weight (in kilograms) by the square of the respondent's height (in metres). This calculation is done similarly for self-reported, parental-reported or measured height and weight. Overweight and obese categories for children and youth were developed on the basis of IOTF cut-offs (Cole method)[23] with specific ranges for children by age and sex. For adults, BMI classes are based on international standards developed by the WHO.[7]

BMI is not calculated for adult respondents with a height of less than 0.91m (3') or more than 2.13m (7'), or for women who either reported being pregnant or did not respond to the question on pregnancy.

Aboriginal Peoples: The variable used in the analyses was based on the question "Are you an Aboriginal person, that is, North American Indian, Métis, or Inuit?"[193,198,199]

Income Deciles: This variable was derived by Statistics Canada and is based on self-reported household income before taxes. Ten categories with approximately the same percentage of respondents in each group were generated by province/territory according to the ratio of household income to the low income cut-off corresponding to the respondent's household and community size.

Household Educational Attainment: This variable was derived by Statistics Canada and represents the highest level of education attained by any member of the household.

METHODS OF ANALYSIS

Descriptive analyses were used to estimate the prevalence of obesity across different population subgroups by age, sex, education, income decile, Aboriginal identity, province/territory and health region. Corresponding sample sizes by CCHS year are available in TABLE 3, which highlights the number of respondents with a valid BMI classification. Non-overlapping 95% confidence intervals were considered as reflecting significantly different point estimates of obesity prevalence. Bootstrapping techniques were used in these analyses to generate confidence intervals, as this technique takes the complex survey design into account. Thus, more accurate estimates of the variability of prevalence values were provided.

LIMITATIONS

New analyses presented in the report have various limitations, depending on the population of subgroups used and the data cycle considered. One caveat when comparing obesity between Aboriginal and non-Aboriginal populations is that the CCHS does not include respondents who reside on reserves or in some remote communities. Therefore, there is no single obesity estimate that includes all Aboriginal peoples.

In addition, the estimates of obesity shown are not age-standardized, and therefore the age differences in obesity among groups or over time are not accounted for. TABLE 5 illustrates one example of the difference in age-standardized and non-age-standardized obesity prevalence. For the total population, using the four age groups specified to age-standardize the obesity estimate has a very minor impact, of less than half a percent, on the resulting estimate. However, for subgroups with different age and sex distributions, age and sex standardization might be warranted. The focus in this report was to obtain current prevalence estimates.

Analysis was limited to those measures captured by the CCHS. For example, nutrition was captured primarily by fruits and vegetables consumption only, and only in terms of number of times per day and not actual servings.

TABLE 5. Age-Standardized Obesity Estimates

AGE GROUP	1991 CENSUS AGE DISTRIBUTION	2007/08 CCHS POPULATION AGE DISTRIBUTION	PREVALENCE OF OBESITY
12 to 24	20.47%	19.21%	6.93%
25 to 44	35.68%	33.58%	16.31%
45 to 64	28.59%	32.71%	20.22%
65 and over	15.25%	14.51%	17.55%
Obesity Prevalence			15.97%
Age-Standardized Obesity (to 1991 population)			15.70%

SOURCE: Analysis of Canadian Community Health Survey 2007/08, Statistics Canada.

As discussed earlier in the report, there are limitations and critiques of the BMI classification system. As noted in Health Canada's Canadian Guidelines for Body Weight Classification in Adults,[7] particular caution should be used when classifying people who are very lean or very muscular, some ethnic and racial groups, and seniors.[201] In addition, research has shown that women are more likely to underestimate their weight and men more likely to overestimate their heights, both of which would result in a more conservative estimate of BMI.[4]

Finally, obesity estimates based on directly measured heights and weights could be calculated for a large representative population for the 2004 CCHS, but only for subsamples in the 2005 and 2008 CCHS. The lack of routine, national, measured obesity estimates has been a noted surveillance information gap. All other obesity estimates are calculated according to self-reported height and weight information which, as discussed earlier in this report, has been shown to underestimate BMI and therefore obesity.

ADDITIONAL ANALYSES: 2007/08 CCHS

FIGURE 5 illustrates the prevalence of obesity (self-reported data) in the top and bottom 10 ranked health regions. Obesity prevalence estimates for all health regions in Canada are provided below (TABLE 6).

TABLE 6. Prevalence of Self-Reported Obesity by Health Region, Ages 18 and Older, 2007/08

REGION	OBESITY PREVALENCE (%)	SIGNIFICANTLY DIFFERENT THAN CANADA
Canada	**17.1**	–
Eastern Regional Integrated HA, NL	24.4	1.0
Central Regional Integrated HA, NL	30.6	1.0
Western Regional Integrated HA, NL	21.3	1.0
Labrador-Grenfell Regional Integrated HA, NL	29.6	1.0
Kings County, PEI	32.1	1.0
Queens County, PEI	21.4	1.0
Prince County, PEI	24.5	1.0
Zone 1 (DHA 1 and 2), NS	29.5	1.0
Zone 2 (DHA 3), NS	23.0	1.0
Zone 3 (DHA 4 and 5), NS	25.6	1.0
Zone 4 (DHA 6 and 7), NS	26.1	1.0
Zone 5 (DHA 8), NS	21.7	1.0
Zone 6 (DHA 9), NS	20.6	1.0
Region 1, NB	23.8	1.0
Region 2, NB	22.4	1.0
Region 3, NB	20.3	0.0
Region 4, NB	21.3	0.0
Region 5, NB	24.5	1.0
Region 6, NB	19.9	0.0
Region 7, NB	26.1	1.0
Région du Bas-St. Laurent, QC	18.1	0.0
Région du Saguenay - Lac-Saint-Jean, QC	14.5	0.0
Région de la Capitale-Nationale, QC	14.7	0.0
Région de la Mauricie/Centre-du-Québec, QC	16.5	0.0
Région de l'Estrie, QC	11.6	-1.0
Région de Montréal, QC	13.4	-1.0
Région de l'Outaouais, QC	17.1	0.0

REGION	OBESITY PREVALENCE (%)	SIGNIFICANTLY DIFFERENT THAN CANADA
Région de l'Abitibi-Témiscamingue, QC	20.4	0.0
Région de la Côte-Nord, QC	16.8	0.0
Région du Nord-du-Québec, QC	21.7	1.0
Rég. de la Gaspésie-Île-de-la-Madeleine, QC	18.7	0.0
Région de la Chaudière-Appalaches, QC	13.6	-1.0
Région de Laval, QC	13.4	-1.0
Région de Lanaudière, QC	17.8	0.0
Région des Laurentides, QC	16.9	0.0
Région de la Montérégie, QC	18.1	0.0
District of Algoma Health Unit, ON	26.6	1.0
Brant County Health Unit, ON	25.5	1.0
Durham Regional Health Unit, ON	17.4	0.0
Elgin-St. Thomas Health Unit, ON	19.0	0.0
Grey Bruce Health Unit, ON	22.7	1.0
Haldiman-Norfolk Health Unit, ON	24.9	1.0
Haliburton/Kawartha/Pine Ridge DHU, ON	23.0	1.0
Halton Regional Health Unit, ON	16.3	0.0
City of Hamilton Health Unit, ON	20.2	0.0
Hasting and Prince Edward Counties HU, ON	22.7	1.0
Huron County Health Unit, ON	24.2	1.0
Chatham-Kent Health Unit, ON	23.7	1.0
Kingston/Frontenac/Lennox/Addington HU, ON	19.9	0.0
Lambton Health Unit, ON	21.5	1.0
Leeds, Grenville and Lanark DHU, ON	21.2	1.0
Middlesex-London Health Unit, ON	18.4	0.0
Niagara Regional Area Health Unit, ON	18.4	0.0
North Bay Parry Sound District Health Unit, ON	20.0	0.0
Northwestern Health Unit, ON	26.1	1.0
City of Ottawa Health Unit, ON	14.3	-1.0
Oxford County Health Unit, ON	20.0	0.0
Peel Regional Health Unit, ON	14.7	0.0
Perth District Health Unit, ON	19.6	0.0
Peterborough County-Regional Health Unit, ON	18.4	0.0

REGION	OBESITY PREVALENCE (%)	SIGNIFICANTLY DIFFERENT THAN CANADA
Porcupine Health Unit, ON	25.3	1.0
Renfrew County and District Health Unit, ON	23.3	1.0
The Eastern Ontario Health Unit, ON	25.4	1.0
Simcoe Muskoka District Health Unit, ON	21.3	1.0
Sudbury and District Health Unit, ON	18.8	0.0
Thunder Bay District Health Unit, ON	19.9	0.0
Timiskaming Health Unit, ON	29.6	1.0
Waterloo Health Unit, ON	21.6	1.0
Wellington-Dufferin-Guelph HU, ON	18.8	0.0
Windsor-Essex County Health Unit, ON	21.1	1.0
York Regional Health Unit, ON	11.7	-1.0
City of Toronto Health Unit, ON	12.7	-1.0
Winnipeg, MB	16.5	0.0
Brandon, MB	22.3	0.0
North Eastman, MB	20.9	0.0
South Eastman, MB	20.6	0.0
Interlake, MB	30.6	1.0
Central, ON	20.8	0.0
Assiniboine, MB	24.8	1.0
Parkland, MB	26.4	1.0
Norman, MB	30.5	1.0
Burntwood/Churchill, MB	31.1	1.0
Sun Country, SK	21.4	0.0
Five Hills, SK	20.3	0.0
Cypress, SK	24.9	1.0
Regina Qu'Appelle, SK	26.6	1.0
Sunrise, SK	24.0	1.0
Saskatoon, SK	21.8	1.0
Heartland, SK	26.7	1.0
Kelsey Trail, SK	29.1	1.0
Prince Alberta Parkland, SK	23.9	1.0
Prairie North, SK	21.1	0.0
Mamawetan/Keewatin/Athabaska, SK	35.9	1.0

REGION	OBESITY PREVALENCE (%)	SIGNIFICANTLY DIFFERENT THAN CANADA
Chinook Regional Health Authority, AB	21.2	1.0
Palliser Health Region, AB	22.0	0.0
Calgary Health Region, AB	15.2	0.0
David Thompson Regional Health Authority, AB	21.1	1.0
East Central Health, AB	25.0	1.0
Capital Health, AB	19.0	0.0
Aspen Regional Health Authority, AB	24.0	1.0
Peace Country Health, AB	29.2	1.0
Northern Lights Health Region, AB	27.4	1.0
East Kootenay, BC	16.7	0.0
Kootenay-Boundary, BC	17.1	0.0
Okanagan, BC	14.6	0.0
Thompson/Cariboo, BC	20.0	0.0
Fraser East, BC	16.7	0.0
Fraser North, BC	11.9	-1.0
Fraser South, BC	12.0	-1.0
Richmond, BC	5.3	-1.0
Vancouver, BC	6.2	-1.0
North Shore/Coast Garibaldi, BC	10.3	-1.0
South Vancouver Island, BC	13.8	-1.0
Central Vancouver Island, BC	16.9	0.0
North Vancouver Island, BC	14.8	0.0
Northwest, BC	24.2	1.0
Northern Interior, BC	17.9	0.0
Northeast, BC	24.1	0.0
Yukon	22.4	1.0
Northwest Territories	23.9	1.0
Nunavut	22.9	1.0

NOTE: Notes: Significantly lower than Canada (-1), significantly higher than Canada (1), not significantly different (0)
SOURCE: Analysis of Canadian Community Health Survey 2007/08, Statistics Canada.

APPENDIX 2. UPDATED ECONOMIC BURDEN OF OBESITY ANALYSIS: SUMMARY OF METHODOLOGY

I. JANSSEN, FOR PHAC

The economic costs of obesity by year (2000 to 2008) were estimated using a prevalence-based approach that included the following:

- risks of chronic conditions in obese individuals;
- population prevalence of obesity; and
- direct and indirect costs associated with these (specific) chronic conditions.

CALCULATION OF RISK OF CHRONIC CONDITIONS IN OBESE INDIVIDUALS

Risk estimates for the main chronic diseases associated with obesity in men and women were obtained from a 2004 meta-analysis by Katzmarzyk and Janssen,[202] updated to include studies published within the past five years. Eight chronic diseases for which obesity has been consistently shown to be a risk factor were included in the meta-analysis: coronary artery disease, stroke, hypertension, colon cancer, post-menopausal breast cancer, type 2 diabetes, gall bladder disease and osteoarthritis. For each disease, summary relative risk estimates were calculated separately for men and women using a general variance-based method. These summary relative risk estimates represent a weighted average of the relative risk provided in the various studies.

ESTIMATION OF THE POPULATION PREVALENCE OF OBESITY

The methodology used for estimating the prevalence of obesity among Canadian adults depended on the survey year. For 2004, 2005 and 2008, the prevalence was based directly on results from cycles of the CCHS, in which height and weight values used to calculate BMI were directly measured. For the remaining years (2000, 2001, 2002, 2003, 2006 and 2007), the prevalence of obesity based on self-reported height and weight was obtained from nationally representative surveys (cycles of the NPHS and the CCHS conducted in 1994/95, 1996/97, 2000/01, 2003, 2005 and 2007). These prevalence values and corresponding survey years were used to create simple linear regression equations by sex to predict the prevalence of self-reported obesity in 2000, 2001, 2002 and 2006. Next, for those years in which the prevalence of measured obesity was not available, the true prevalence was estimated on the basis of the relative difference in self-reported and measured obesity in the 2005 CCHS (34.2% relative underestimation for men and 35.0% for women).

DETERMINATION OF POPULATION ATTRIBUTABLE RISK (PAR)

The second step was to determine what proportion (or fraction) of each of the eight chronic conditions can be causally attributed to obesity within the adult population in Canada. The PAR combines the summary relative risk (RR) with the population prevalence (P) of obesity:

$$PAR\% = [P(RR-1)]/[1+P(RR-1)]$$

DETERMINATION OF DIRECT AND INDIRECT COSTS ASSOCIATED WITH THESE CHRONIC CONDITIONS

PAR% values were then applied to the total direct and indirect costs for each of the eight target conditions. Costs were based on information in the *Economic Burden of Illness in Canada* (EBIC) 2000 study and are estimated for the population aged 15 years or older. Direct costs are defined as the value of goods and services for treatment, care and rehabilitation related to the condition, such as hospital care, drug and physician care expenditures, expenditures for care in other

institutions and additional direct health expenditures. Indirect costs are defined as the value of economic output lost because of illness, disability or premature death. The indirect costs in the EBIC 2000 were measured in terms of the value of years of life lost due to premature death and the value of activity days lost due to short-term and long-term disability. At the time that the report was prepared, EBIC 2000 had yet to be publicly released. Instead, data were made available from the Population Health Economic Section, Knowledge Information and Data Systems, Office of Public Health Practice, Public Health Agency of Canada.

For the years 2001-2008, the direct health care costs calculated for each chronic condition were inflated to current dollars by using the percentage increase in health care costs in the Consumer Price Index in Canada from the year 2000 to the year of interest. In inflating these values, it was assumed that each disease made up a similar percentage of total health care expenditures throughout that period. The indirect health care costs were inflated to 2001-2008 values using the percentage increase in average earnings in Canada from 2000.

APPENDIX 3. IMPACT OF BEHAVIOUR AND SOCIOECONOMIC FACTORS ON THE PREVALENCE OF OBESITY IN THE POPULATION: SUMMARY OF METHODOLOGY

DATA SOURCES AND MEASURES[203]

For this study, CCHS cycles 2000/01, 2003 and 2005 were pooled to obtain a total sample size of 283,097 adults aged 18 and over. This method combines the data at the record level, and the resulting file is treated as a sample from one large "average" population from 2000 to 2005. Compared with other years, the method of data collection for the 2000/01 cycles was more often in person than by telephone.[204]

Body mass index (BMI) was computed according to self-reported height and weight as:

$$BMI = Weight\ (kg)/Height\ (m)^2$$

BMI was grouped according to internationally accepted classifications as follows:[7]

- normal weight: BMI = 18.5 kg/m^2-24.9 kg/m^2
- overweight: BMI = 25 kg/m^2-29.9 kg/m^2
- overweight I: BMI = 25 kg/m^2-27.4 kg/m^2
- overweight II: BMI = 27.5 kg/m^2-29.9 kg/m^2
- obese: BMI ≥ 30 kg/m^2

As this study focused exclusively on the risk of adult overweight and obesity, 7,322 participants (5,955 females and 1,367 males) with a BMI less than 18.5 kg/m^2 were excluded from the final study sample.

Explanatory variables of interest were set up as dichotomous variables and included the following: single/separated/divorced (Yes or No), total household income (lowest income quintile vs. highest income quintile), immigrant status (Y/N), visible minority status (Y/N), rural residence (Y/N), daily smoking (Y/N), physical inactivity (Y/N), low fruit and vegetable intake (Y/N) and high alcohol consumption (Y/N). See TABLE 7 for descriptive statistics.

ANALYSIS

For all variables descriptive estimates, including proportions and 95% confidence intervals, were calculated separately by sex.

Poisson models were used to evaluate the simultaneous contribution of demographic, social and behavioural risk factors in the prediction of adult overweight and obesity. The Poisson distribution is used here to estimate dichotomous outcomes, since logistic functions tend to overestimate the cross-sectional prevalence of common diseases.[205-207] An additional benefit of using the Poisson model is found in the production of prevalence ratios, which better approximate the relative risk than do odds ratios. All analyses used bootstrap and probability weights rescaled to the 2001 Canadian population and were estimated using the BSWREG re-sampling procedure.

Population attributable risks (PAR) were derived from adjusted risk ratios (RR) using a conservative equation for potential confounding:[208]

$$PAR^{adj} = proportion\ of\ population\ exposed\ to\ risk\ factor\ *\ [(RR^{adj} - 1)/RR^{adj}]$$

Where RRadj is the relative risk of obesity in this case associated with the specified risk factor.

Recently, the population impact number (PIN) has been proposed as a new measure to quantify and communicate the population burden of a risk factor – or, conversely, the potential number of disease events that may be prevented in a population through elimination of that risk factor – in a way that is easily conceptualized by policy-makers and the general public.[209-210] This measure may be applied to resource planning and the evaluation of public health interventions. The following formula for PIN, applicable to cross-sectional designs,[87] was used:

*PIN = proportion of population in outcome category * number in population * PAR^{adj}*

The computation of confidence intervals for PAR and PIN was based on a conservative Bonferroni inequality method.[211] Stata 9.2 (Stata Corp, Texas Station) was used exclusively to conduct the analyses.

It should be noted that this study used nationally representative cross-sectional data to estimate the contribution of various factors to the population burden of overweight and obesity. The analysis does not explicitly define a cause-effect relation between the predictor variables (e.g., immigrant status, fruit and vegetable intake) and the outcome of interest (e.g., overweight or obesity). Rather, as with other studies that have similarly used cross-sectional data to explore the potential population impact of eliminating a risk factor of interest, the interpretation of present findings should be considered as suggestive of a relation between the two variables, after controlling for other covariates.[87] Additional studies using longitudinal, nationally representative Canadian data should be used to confirm the results described here.

DESCRIPTIVE STATISTICS

TABLE 7. Sample Size, Demographic Characteristics and Prevalence of Social Determinant and Health Behaviour Risk Factors by Sex, Canada 2000/01, 2003, 2005

	FEMALES	MALES
Sample size (N)	148,844	134,253
Weighted sample (N)	10,217,995	10,568,461
Age (mean, 95% confidence interval [CI])	44.4 (44.3-44.5)	43.6 (43.5-43.7)
Lowest income (%, 95% CI)	23.6 (23.2-24.0)	17.4 (17.1-17.7)
Middle income (%, 95% CI)	61.8 (61.4-62.3)	63.4 (62.9-63.8)
Highest Income (%, 95% CI)	14.6 (14.2-15.0)	19.2 (18.8-19.6)
Immigrant (%, 95% CI)	21.7 (21.3-22.1)	21.9 (21.5-22.3)
Visible minority (%, 95% CI)	14.2 (13.8-14.5)	14.5 (14.1-14.8)
Single/separated/divorced (%, 95% CI)	33.8 (33.4-34.2)	31.3 (30.9-31.7)
Rural residence (%, 95% CI)	17.7 (17.4-18.0)	18.8 (18.6-19.1)
Daily smoking (%, 95% CI)	23.9 (23.6-24.3)	28.3 (27.9-28.6)
Physical inactivity (%, 95% CI)	53.1 (52.7-53.5)	49.2 (48.8-49.7)
High alcohol use (%, 95% CI)	12.1 (11.8-12.4)	31.2 (30.8-31.6)
Less than 5 servings fruit & vegetable (%, 95% CI)	54.1 (53.7-54.6)	67.8 (67.4-68.3)
Normal weight (18.5 ≤ BMI < 25) (%, 95% CI)	54.0 (53.6-54.4)	40.7 (40.3-41.2)
Overweight I (25 ≤ BMI < 27.5) (%, 95% CI)	16.5 (16.2-16.8)	24.3 (23.9-24.6)
Overweight II (27.5 ≤ BMI < 30) (%, 95% CI)	10.7 (10.5-10.9)	17.2 (16.9-17.5)
Obesity (BMI ≥ 30) (%, 95% CI)	14.8 (14.5-15.1)	16.8 (16.5-17.1)

NOTES: Significantly lower than Canada (-1), significantly higher than Canada (1), not significantly different (0)
SOURCE: Analysis of Canadian Community Health Survey 2007/08, Statistics Canada.

APPENDIX 4. RESOURCES

CANADIAN BEST PRACTICES PORTAL

Developed by the Public Health Agency of Canada, the CBPP allows the user to search among more than 300 evaluated programs and interventions related to public and population health, and is sortable by population, health outcome or related determinants of health.

http://cbpp-pcpe.phac-aspc.gc.ca

COCHRANE REVIEWS

The Cochrane Collaboration is an international, not-for-profit, independent organization that focuses on creating evidence in the field of health care. It is a resource for finding systematic reviews produced by health care professionals on clinical trials and other research related to health care interventions. The database offers free access to abstracts and plain language summaries of systematic reviews that highlight the effectiveness of health care interventions covering a wide variety of topics.

http://cochrane.org/reviews

EVIDENCE INFORMED PUBLIC HEALTH TOOLS

Developed by the National Collaborating Centre-Methods and Tools (NCC-MT), this site covers the various stages of evidence-informed public health planning, including defining the issue, searching for evidence, critically appraising your findings, synthesizing information, adapting to your local situation/context, implementing programming and evaluating results. There are a number of useful links to aid in the location, appraisal and use of evidence.

http://www.nccmt.ca/eiph/index-eng.html

HEALTH EVIDENCE

Health Evidence is a free online registry designed to provide high-quality research evidence to public health decision-makers. Through this site, users can locate references to systematic reviews and meta-analyses gathered through a comprehensive search of electronic databases, journal tables of contents and reference lists. All reviews in the online registry have been screened for relevance to public health and appraised for quality.

http://www.health-evidence.ca

PUBLIC HEALTH +

Operated by the McMaster Health Knowledge Refinery, *Public Health +* is an online resource containing articles from over 140 medical and allied health academic journals that have been critically appraised for methodological soundness. Those selected are listed in a searchable archive.

http://www.nccmt.ca/tools/public_health_plus-eng.html

PUBMED – CLINICAL QUERIES

A publicly accessible search engine that enables users to search for systematic reviews, meta-analyses, clinical trial reviews, evidence-based medicine, conferences and guidelines related to clinical studies.

http://www.ncbi.nlm.nih.gov/corehtml/query/static/clinical.shtml#reviews

REFERENCES

1 Statistics Canada, Canadian Health Measures Survey: Cycle 1 Data Tables: Introduction (Ottawa, Ont.: Statistics Canada, 2010), [online] from www.statcan.gc.ca\pub\82-623-x\2010001\part-partie1-eng.htm

2 M. Shields et al., "Fitness of Canadian Adults: Results from the 2007-2009 Canadian Health Measures Survey," *Health Reports* 21 (2010): pp. 1-15.

3 F. Elgar and J. Stewart, "Validity of Self-Report Screening for Overweight and Obesity. Evidence from the Canadian Community Health Survey," *Canadian Journal of Public Health* 99 (2008): pp. 423-427.

4 S.C. Gorber and M.S. Tremblay, "The Bias in Self-Reported Obesity from 1976 to 2005: A Canada-US Comparison," *Obesity* (2009): pp.1-8.

5 Statistics Canada, *CANSIM Table 105-0501: Health indicator profile, annual estimates, by age group and sex, Canada, provinces, territories, health regions (2007 boundaries) and peer groups, occasional* (Ottawa, Ont.: Statistics Canada, 2010), [online] cited June 12, 2010, from http://www.statcan.gc.ca/pub/82-221-x/2009001/hip-pis-eng.htm.

6 World Health Organization, "Preventing and Managing the Global Epidemic," *WHO Technical Report Series 894* (2000).

7 Health Canada, *Canadian Guidelines for Body Weight Classification in Adults* (Ottawa, Ont.: Health Canada, 2003).

8 B. Caballero, "The Global Epidemic of Obesity: An Overview," *Epidemiologic Reviews* 29 (2007) pp. 1-5.

9 P.T. Katzmarzyk, "The Canadian Obesity Epidemic: An Historical Perspective," *Obesity* 10 (2002): pp. 666-674.

10 B. Torrance, M. Hooper and B. Reeder, "Trends in Overweight and Obesity Among Adults in Canada (1970-1991): Evidence from National Surveys Using Measured Height and Weight," *International Journal of Obesity* 26 (2002): pp. 797-804.

11 M. Shields and M. Tjepkema, "Trends in Adult Obesity," *Health Reports* 17 (2006): pp. 53-59.

12 M. Tjepkema, *Measured Obesity. Adult Obesity in Canada: Measured Height and Weight. Findings from the Canadian Community Health Survey* (Ottawa, Ont.: Statistics Canada, 2005).

13 M. Shields and S. Tremblay, "The Health of Canada's Communities," *Health Reports* 13 (2002): pp. 1-25.

14 A. Vanasse et al., "Obesity in Canada: Where and How Many?" *International Journal of Obesity* 30 (2005): pp. 677-683.

15 V. Mitura and R. Bollman, "The Health of Rural Canadians: A Rural-Urban Comparison of Health Indicators," *Rural and Small Town Canada Analysis Bulletin* 4 (2003): pp.1-23.

16 V. Mitura and R. Bollman, "Health Status and Behaviours of Canada's Youth: A Rural-Urban Comparison," *Rural and Small Town Canada Analysis Bulletin* 5 (2004): pp. 1-22.

17 K. Flegal and R. Troilano, "Changes in the Distribution of Body Mass Index of Adults and Children in the US Population," *International Journal of Obesity* 24 (2000): pp. 807-818.

18 K.M. Flegal et al, "Prevalence and Trends in Obesity Among US Adults, 1999-2008," *Journal of the American Medical Association* 303 (2010): pp. 235-241.

19 P. Contoyannis and J. Wildman, "Using Relative Distributions to Investigate the Body Mass Index in England and Canada," *Health Economics* 16 (2007): pp. 929-944.

20 F. Sassi et al., "The Obesity Epidemic: Analysis of Past and Projected Future Trends in Selected OECD Countries," *OECD Health Working Papers* 45 (2009).

21 K. Morrison and J. Chanoine, "Clinical Evaluation of Obese Children and Adolescents," *Canadian Medical Association Journal* 176, 8 suppl (2007); pp. online-45-49.

22 *2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children. Canadian Medical Association Journal* 176, 8 suppl (2007): pp. Online-1–117, [online] cited 10 December, 2010, from http://www.cmaj.ca/cgi/data/176/8/S1/DC1/1

23 T. Cole et al., "Establishing a Standard Definition for Child Overweight and Obesity Worldwide – International Survey," *British Medical Journal* 320 (2000): pp. 1240-1243.

24 M. Shields and M. Tremblay, "Canadian Childhood Obesity Estimates Based on WHO, IOTF and CDC Cut-offs," *International Journal of Pediatric Obesity* (2010): pp. 1-22.

25 Statistics Canada, *Canadian Health Measures Survey* (CHMS), *Cycle 1 Data Table 34 2007 to 2009.* (Ottawa Ont.: Statistics Canada, 2010) Cat No. 82-623-X.

26 M. Shields, "Overweight Canadian Children and Adolescents. Nutrition: Findings from the Canadian Community Health Survey," (Ottawa,Ont.: Statistics Canada, 2005), Cat. No. 82-620-MWE.

27 M.S. Tremblay et al., "Fitness of Canadian Children and Youth: Results from the 2007-2009 Canadian Health Measures Survey," *Health Reports* 21 (2010): pp.1-14.

28 First Nations Regional Longitudinal Health Survey (RHS) 2002/03, *Results for Adults, Youth and Children Living in First Nations Communities* (Ottawa, Ont.: RHS, 2007).

29 First Nations Longitudinal Regional Health Survey (RHS), *RHS Phase 2 (*Ottawa, Ont:. RHS, 2009), [online] from http://www.rhs-ers.ca/english/phase2.asp

30 Statistics Canada, *Aboriginal Peoples Survey – Concepts and Methods Guide* (Ottawa, Ont.: Statistics Canada, 2009).

31 T.K. Young, "Obesity, Central Fat Patterning, and their Metabolic Correlates Among the Inuit of the Central Canadian Arctic," *Human Biology* 68 (1996): pp. 245-263.

32 G. Charbonneau-Roberts et al., "Body Mass Index May Overestimate the Prevalence of Overweight and Obesity Among the Inuit," *International Journal of Circumpolar Health* 64 (2005): pp. 163-169.

33 K.P. Katzmarzyk, "Obesity and Physical Activity Among Aboriginal Canadians," *Obesity* 16 (2008): pp. 184-190.

34 G.M. Egeland, A. Pacey, Z. Cao, and I. Sobol. "Food Insecurity Among Inuit Preschoolers: Nunavut Inuit Child Health Survey, 2007-2008," *Canadian Medical Association Journal* 182 (2010): pp. 243-248.

35 B. Nolin, P. Lamontagne and A. Tremblay, *Nunavik Inuit Health Survey 2004, Quanuipptaa? How are we? Physical Activity, Anthropometry and Perception of Body Weight* (Québec.: Nunavik Regional Board of Health and Social Services, 2007).

36 L.M. Lix et al., "Risk Factors and Chronic Conditions Among Aboriginal and Non-Aboriginal Populations," *Health Reports* 20 (2009): pp. 21-29.

37 T.K. Young, "Are the Circumpolar Inuit Becoming Obese?" *American Journal of Human Biology* 19 (2007): pp. 181-189.

38 M. Tremblay et al., "Obesity, Overweight and Ethnicity," *Health Reports* 16 (2005): pp. 23-34.

39 S.S. Anand et al., "Risk Factors, Atherosclerosis, and Cardiovascular Disease among Aboriginal People in Canada: The Study of Health Assessment and Risk Evaluation in Aboriginal Peoples (SHARE-AP)," *Lancet* 358 (2001): pp. 1147-1153.

40 R. Oster and E. Toth, "Differences in the Prevalence of Diabetes Risk-Factors among First Nation, Metis and Non-Aboriginal Adults Attending Screening Clinics in Rural Alberta, Canada," *Rural and Remote Health* 9 (2009): pp. 1170-1177.

41 M. Monsalve et al., "Differences in Cardiovascular Risks in the Aboriginal and Non-Aboriginal People Living in Bella Coola, British Columbia," *Medical Science Monitor* 11 (2005): pp.21-28.

42 W. Leslie et al., "Bone Density and Bone Area in Canadian Aboriginal Women: The First Nations Bone Health Study," *Osteoporosis International* 17 (2006): pp. 1755-1762.

43 P.T. Katzmarzyk et al., "Familial Risk of Obesity and Central Adipose Tissue Distribution in the General Canadian Population," *American Journal of Epidemiology* 149 (1999): pp. 933-942.

44 M.S. Hunt et al., "Familial Resemblance of 7-year Changes in Body Mass and Adiposity," *Obesity* 10 (2002): pp. 507-517.

45 P.T. Katzmarzyk, J. Hebebrand and C. Bouchard, "Spousal Resemblance in the Canadian Population: Implications for the Obesity Epidemic," *International Journal of Obesity and Related Metabolic Disorders* 26 (2002): pp. 241-246.

46 C. Craig, C. Camerson and A. Bauman "*Socio-Demographic and Lifestyle Correlates of Obesity – Technical Report on the Secondary Analyses using the 2000-2001 Canadian Community Health Survey* (Ottawa, Ont.: Canadian Institute for Health Information, 2005).

47 K. Raine, *Overweight and Obesity in Canada, a Population Health Perspective* (Ottawa, Ont.: CIHI, 2004).

48 C. Loppie Reading and F. Wien, *Health Inequalities and Social Determinants of Aboriginal Peoples' Health* (National Collaborating Centre for Aboriginal Health, 2009).

49 M. Dyck, *Social Determinants of Métis Health* (Ottawa, Ont.: National Aboriginal Health Organization, 2009).

50 National Aboriginal Health Organization, *Broader Determinants of Health in an Aboriginal Context* (Ottawa, Ont.: NAHO, 2007).

51 M.S. Kaplan et al., "Prevalence and Correlates of Overweight and Obesity Among Older Adults: Findings from the Canadian National Population Health Survey," *Journal of Gerontology* 58, 11 (2003): pp. 1018-1030.

52 J.A. Levine, V.W.M. Hill, J. Klesges, "Non-Exercise Activity Thermogenesis: The Crouching Tiger Hidden Dragon of Societal Weight Gain," *Arteriosclerosis, Thrombosis, and Vascular Biology* 26 (2006): pp. 729-736.

53 M.S. Tremblay et al., "Incidental Movement, Lifestyle-Embedded Activity and Sleep: New Frontiers in Physical Activity Assessment," *Applied Physiology Nutrition Metabolism* 32 (2007): pp. S208-S217.

54 A. Probert and M. Tremblay, "Desk Potatoes: The Importance of Occupational Physical Activity on Health," *Canadian Journal of Public Health* 99 (2008): pp. 311-318.

55 P.T. Katzmarzyk and M.S. Tremblay, "Limitations of Canada's Physical Activity Data: Implications for Monitoring Trends," *Applied Physiology Nutrition Metabolism* 32 (2007): pp. S185-S194.

56 S.A. Prince et al., "A Comparison of Direct Versus Self-Report Measures for Assessing Physical Activity in Adults: A Systematic Review," *International Journal of Behavioral Nutrition and Physical Activity* 5, 56 (2008).

57 K.B. Adamo et al., "A Comparison of Indirect Versus Direct Measures for Assessing Physical Activity in the Pediatric Population: A Systematic Review," *International Journal of Pediatric Obesity* 4 (2009): pp. 2-27.

58 Canada Fitness and Lifestyle Research Institute, "*Kids CAN PLAY!" Activity Levels of Canadian Children and Youth* Bulletin 1 (Ottawa, Ont:. CFLRI, 2009).

59 Physical Activity and Health Alliance, *Physical Activity Briefing Paper 13: The Health Implications of Sedentary Behaviour* (Scotland.: NHS Scotland, 2007).

60 A. Must and D. Tybor, "Physical Activity and Sedentary Behavior: A Review of Longitudinal Studies of Weight and Adiposity in Youth. *International Journal of Obesity* 29 (2005): pp. S84-S96.

61 M. Shields and M. Tremblay, "Sedentary Behaviour and Obesity," *Health Reports* 19 (2008): pp. 19-30.

62 I. Janssen et al., "Comparison of Overweight and Obesity Prevalence in School-Aged Youth from 34 Countries and Their Relationships with Physical Activity and Dietary Patterns," *Obesity Reviews* 6 (2005): pp. 123-132.

63 Canadian Population Health Initiative, *Comparing Activity and Fruit and Vegetable Consumption by Weight Status Among Children and Youth* (Ottawa, Ont.: CPHI, 2009).

64 Canadian Fitness and Lifestyle Research Institute, *Report Card on Physical Activity for Children and Youth* (Ottawa, Ont.: Active Healthy Kids Canada, 2009).

65 M. Shields and M. Tremblay, "Screen Time Among Canadian Adults: A Profile," *Health Reports* 19 (2008): pp. 31-43.

66 M.S. Tremblay and J.D. Willms, "Is the Canadian Childhood Obesity Epidemic Related to Physical Inactivity?" *International Journal of Obesity and Related Metabolic Disorders* 27 (2003): pp. 1100-1105.

67 Slater G, Green CG, Sevenhuysen G, Edginton B, O'Neil J, Heasman M. The Growing Canadian Energy Gap: More the Can than the Couch? *Public Health Nutrition* 12 (2009) pp. 2216–2224.

68 L. Minaker et al., "School Region Socio-Economic Status and Geographic Locale is Associated with Food Behaviour of Ontario and Alberta Adolescents," *Canadian Journal of Public Health* 97 (2006): pp. 357-361.

69 P. Veugelers et al., "Neighborhood Characteristics in Relation to Diet, Physical Activity and Overweight of Canadian Children," *International Journal of Pediatric Obesity* 3 (2008): pp.152-159.

70 I. Janssen et al., "Influence of Individual- and Area-level Measures of Socioeconomic Status on Obesity, Unhealthy Eating, and Physical Inactivity in Canadian Adolescents," *American Journal of Clinical Nutrition* 83 (2006): pp.139-145.

71 L. Dubois et al., "Social Factors and Television Use During Meals and Snacks is Associated with Higher BMI Among Pre-school Children," *Public Health Nutrition* 11 (2008): pp. 1267-1279.

72 T. Liang, S. Kuhle and P. Veugelers, "Nutrition and Body Weights of Canadian Children Watching Television and Eating While Watching Television," *Public Health Nutrition* 12 (2009): pp. 2457-2463.

73 L. Dubois et al., "Regular Sugar-Sweetened Beverage Consumption Between Meals Increases Risk of Overweight Among Preschool-aged Children," *Journal of the American Dietetic Association* 107 (2007): pp. 924-934.

74 L. Dubois et al., "Breakfast Skipping is Associated with Differences in Meal Patterns, Macronutrient Intakes and Overweight among Pre-school Children," *Public Health Nutrition* 12 (2009): pp. 19-28.

75 S.J. Woodruff and R.M. Hanning, "Associations Between Family Dinner Frequency and Specific Food Behaviors Among Grade Six, Seven, and Eight Students from Ontario and Nova Scotia," *Journal of Adolescent Health* 44 (2009): pp. 431-436.

76 M. Mirza, D. Fitzpatrick-Lewis and H. Thomas, *Is There a Relationship Between Food Insecurity and Overweight/Obesity?* (Hamilton, Ont.: Effective Public Health Practice Project, 2007).

77 L. Dubois et al., "Family Food Insufficiency is Related to Overweight among Preschoolers," *Social Science & Medicine* 63 (2006): pp. 1503-1516.

78 L.J.G. McLaren, "Social Class and BMI Among Canadian Adults: A Focus on Occupational Prestige," *Obesity* 17 (2009): pp. 290-299.

79 D.W. Harrington and S.J. Elliott, "Weighing the Importance of Neighbourhood: A Multilevel Exploration of the Determinants of Overweight and Obesity," *Social Science & Medicine*. 68 (2009): pp. 593-600.

80 L. Oliver and M. Haynes, "Neighbourhood Socio-Economic Status and the Prevalence of Overweight Canadian Children and Youth," *Canadian Journal of Public Health* 96 (2005): pp. 415-420.

81 L. Oliver and M. Hayes, "Effects of Neighbourhood Income on Reported Body Mass Index: An Eight Year Longitudinal Study of Canadian Children," *BMC Public Health* 8, 16 (2008).

82 Canadian Institute for Health Information, *Exploring Urban Environments and Inequalities in Health* (Ottawa, Ont.: CIHI, 2010).

83 I. Ferreira et al., "Environmental Correlates of Physical Activity in Youth – A Review and Update," *Obesity Reviews* 8 (2006): pp. 29-154.

84 L. Elinder and M. Jansson, "Obesogenic Environments – Aspects on Measurement and Indictors," *Public Health Nutrition* 12 (2008): pp. 307-315.

85 J. Spence et al., "Relation Between Local Food Environments and Obesity Among Adults," *BMC Public Health* 9,192 (2009).

86 J.E. Holsten, "Obesity and the Community Food Environment: A Systematic Review," *Public Health Nutrition* 12 (2009): pp. 397-405.

87 R.A. Harrison, I. Gemmell and R.F. Heller, "The Population Effect of Crime and Neighbourhood on Physical Activity: An Analysis of 15 461 Adults," *Journal of Epidemiology and Community Health* 61 (2007): pp. 34-39.

88 I. Hramiak et al., "Assessment of Obesity and its Complications in Adults," *Canadian Medical Association Journal* 178 (2007): pp. 36-39.

89 D. Guh et al., "The Incidence of Co-Morbidities Related to Obesity and Overweight: A Systematic Review and Meta-Analysis," *Public Health* 9, 88 (2009).

90 R. Dent et al., "Psychiatric Issues in the Management of Obesity," *Canadian Medical Association Journal* 176, 8 suppl (2007): pp. online-40-44.

91 A. Singh et al., "Tracking of Childhood Overweight into Adulthood: A Systematic Review of the Literature," *Obesity Reviews* 9 (2008): pp. 474-488.

92 G. Ball and L. McCargar, "Childhood Obesity in Canada: A Review of Prevalence Estimates and Risk Factors for Cardiovascular Disease and Type 2 Diabetes," *Canadian Journal of Applied Physiology* 28 (2003): pp. 117-140.

93 J.P. Després and A. Tchernof, "Classification of Overweight and Obesity in Adults," *Canadian Medical Association Journal* 176, 8 suppl (2007): pp. online-21-26.

94 J.P. Deprés and I. Lemieux, "Abdominal Obesity and the Metabolic Syndrome," *Nature* 444 (2006): pp. 881-887.

95 J. Liu et al., "Characteristics and Prevalence of the Metabolic Syndrome among Three Ethnic Groups in Canada," *International Journal of Obesity* 30 (2006) pp. 669-676.

96 J. Gittelsohn et al., "Specific Patterns of Food Consumption and Preparation are Associated with Diabetes and Obesity in a Native Canadian Community," *Journal of Nutrition* 128 (1998): pp. 541-547.

97 L. Ho et al., "Food-Related Behavior, Physical Activity, and Dietary Intake in First Nations, a Population at High Risk for Diabetes," *Ethnicity & Health* 13 (2008): pp. 335-349.

98 T.K. Young et al., "Prevalence of Obesity and its Metabolic Correlates Among the Circumpolar Inuit in 3 Countries," *American Journal of Public Health* 97 (2007): pp. 691-695.

99 J.M. Ekoe et al., "Epidemiology of Obesity in Relationship to Some Chronic Medical Conditions Among Inuit and Cree Indian Populations in New Quebec, Canada," *Diabetes Research and Clinical Practice* 10 (1990): pp. S17-S27.

100 S. Kaler et al., "High Rates of the Metabolic Syndrome in a First Nations Community in Western Canada: Prevalence and Determinants in Adults and Children," *International Journal of Circumpolar Health* 65 (2006): pp. 389-402.

101 M.L. Chateau-Degat et al., "Comparison of Diagnostic Criteria of the Metabolic Syndrome in Three Ethnic Groups of Canada," *Metabolism* 57 (2008): pp. 1526-1532.

102 J. Liu et al., "Lifestyle Variables, Non-Traditional Cardiovascular Risk Factors, and the Metabolic Syndrome in an Aboriginal Canadian Population," *Obesity* 14 (2006): pp. 500-508.

103 R.L. Pollex et al., "Metabolic Syndrome in Aboriginal Canadians: Prevalence and Genetic Associations," *Atherosclerosis* 184 (2006): pp. 121-129.

104 M. Daniel et al., "Variation by Body Mass Index and Age in Waist-to-Hip Ratio Associations with Glycemic Status in an Aboriginal Population at Risk for Type 2 Diabetes in British Columbia, Canada," *American Journal of Clinical Nutrition* 69 (1999): pp. 455-460.

105 S. Bruce, "Prevalence and Determinants of Diabetes Mellitus Among the Métis of Western Canada," *American Journal of Human Biology* 12 (2000): pp. 542-551.

106 T.K. Young, "Sociocultural and Behavioral Determinants of Obesity Among Inuit in the Central Canadian Arctic," *Social Science & Medicine* 43 (1996): pp. 1665-1671.

107 F. Wang and P.J. Veugelers, "Self-Esteem and Cognitive Development in the Era of the Childhood Obesity Epidemic," *Obesity Reviews* 9 (2008): pp. 615-623.

108 F. Wang et al., "The Influence of Childhood Obesity on the Development of Self-Esteem," *Health Reports* 20 (2009): pp. 21-27.

109 R. Puhl and J.D. Latner, "Stigma, Obesity, and the Health of the Nation's Children," *Psychological Bulletin* 133 (2007): pp. 557-557.

110 R. Puhl and C. Heuer, "The Stigma of Obesity: A Review and Update," *Obesity* 17 (2009): pp. 941-964.

111 J. Park, *Perspectives on Labour and Income: Obesity on the Job* (Ottawa, Ont.: Statistics Canada, 2009), Statistics Canada catalogue no. 75-001-X: pp. 14-22.

112 K.M. Flegal et al., "Estimating Deaths Attributable to Obesity in the United States," *American Journal of Public Health* 94 (2004): pp. 1486-1489.

113 P.T. Katzmarzyk, I. Janssen and C. Ardern, "Physical Inactivity, Excess Adiposity and Premature Mortality," *Obesity Reviews* 4 (2003): pp. 257-290.

114 P.T. Katzmarzyk and C. Ardern, "Overweight and Obesity Mortality Trends in Canada, 1985-2000," *Canadian Journal of Public Health* 95 (2004): pp. 16-20

115 H. Orpana et al., "BMI and Mortality: Results from a National Longitudinal Study of Canadian Adults," *Obesity* 18 (2009): pp. 214-218.

116 I. Lee and J. Manson "Body Weight and Mortality: What is the Shape of the Curve?" *Epidemiology* 9, 3 (1998): pp. 227-228.

117 D.B. Allison et al., "Hypothesis Concerning the U-Shaped Relation Between Body Mass Index and Mortality," *American Journal of Epidemiology* 146 (1997): pp. 339-349.

118 K.M. Flegal et al., "Excess Deaths Associated With Underweight, Overweight, and Obesity," *Journal of the American Medical Association* 293 (2005): pp. 1861-1867.

119 K.M. Flegal et al., "Cause-Specific Excess Deaths Associated With Underweight, Overweight, and Obesity," *Journal of the American Medical Association* 298 (2007): pp. 2028-2037.

120 J.P. Reis et al., "Comparison of Overall Obesity and Body Fat Distribution in Predicting Risk of Mortality," *Obesity* 17 (2009): pp. 1232-1239.

121 D. Allison et al., "Differential Associations of Body Mass Index and Adiposity With All-Cause Mortality Among Men in the First and Second National Health and Nutrition Examination Surveys (NHANES I and NHANES II) Follow-up Studies," *International Journal of Obesity* 26 (2002): pp. 410-416.

122 A. Anis et al., "Obesity and Overweight in Canada: An Updated Cost-of-Illness Study," *Obesity Reviews* 11, 1 (2009): pp. 31-40.

123 I. Janssen, M. Lam and P.T. Katzmarzyk, "Influence of Overweight and Obesity on Physician Costs in Adolescents and Adults in Ontario, Canada," *Obesity Reviews* 10 (2009): pp. 51-57.

124 D. Ludwig and K. Brownell, "Public Health Action Amid Scientific Uncertainty, the Case of Restaurant Calorie Labeling Regulations," *Journal of the American Medical Association* 302 (2009): pp. 434-435.

125 D. Manuel et al., *What Does it Take to Make a Healthy Province? A Benchmark Study of Jurisdictions in Canada and Around the World with the Highest Levels of Health and the Best Health Behaviours* (Toronto, Ont.,: Institute for Clinical Evaluative Sciences ICES, 2009).

126 L. MacLean et al., "Obesity, Stigma and Public Health Planning," *Health Promotion International* 24 (2009): pp. 88-93.

127 P. Braveman, "A Health Disparities Perspective on Obesity Research," *Preventing Chronic Disease* 6, 3 (2009): pp. 1-7.

128 F. Sassi et al., "Improving Lifestyles, Tackling Obesity: The Health and Economic Impact of Prevention Strategies," *OECD Health Working Paper 48* (2009).

129 P. Estabrooks, E. Fisher and L. Hayman, "What is Needed to Reverse the Trends in Childhood Obesity? A Call to Action," *Annals of Behavioral Medicine* 36 (2008): pp. 209-216.

130 G. Sacks, B. Swinburn and M. Lawrence, "Obesity Policy Action Framework and Analysis Grids for a Comprehensive Policy Approach to Reducing Obesity," *Obesity Reviews* 10 (2009): pp. 76-86.

131 M. Vallis, "Behaviour Therapy," *Canadian Medical Association Journal* 176, 8 suppl (2007): pp. online-54-56.

132 R. Mendelson et al., "Dietary Interventions for the Treatment of Obesity in Adults," *Canadian Medical Association Journal* 176, 8 suppl (2007): pp. online-57-59.

133 L. Gillis et al., "Dietary Intervention for the Treatment of Pediatric Obesity," *Canadian Medical Association* Journal 176, 8 suppl (2007): pp. online-79-82.

134 D. Prud'homme et al., "Physical Activity and Exercise Therapy – Adults," *Canadian Medical Association Journal* 176, 8 suppl (2007): pp. online-64-66.

135 V. Vance, R.M. Hanning and L. McCargar, "Combined Diet and Exercise Therapy for the Treatment of Obesity in Adults," *Canadian Medical Association Journal* 176, 8 suppl (2007): pp. online-60-64.

136 B. Barbarich et al., "Combined Diet and Exercise in the Treatment of Pediatric Overweight and Obesity," *Canadian Medical Association Journal* 176, 8 suppl (2007): pp. 87-88.

137 D. Birch, S. Biron and D. Grace, "Surgical Treatment of Morbid Obesity," *Canadian Medical Association Journal* 176, 8 suppl (2007): pp. online-72-75.

138 E. Sellers, "Pharmacotherapy and Bariatric Surgery for the Treatment of Obesity in Children and Adolescents," *Canadian Medical Association Journal* 176, 8 suppl (2007): pp. online-89-91.

139 E. Harvey et al., *Improving Health Professionals' Management and the Organisation of Care for Overweight and Obese People* (Cochrane Library, 2001) Cochrane Database of Systematic Reviews No. CD000984.

140 B. Reeder and P.T. Katzmarzyk, "Prevention of Obesity in Adults," *Canadian Medical Association Journal* 176, 8 suppl (2007): pp. online-92-94.

141 M. Leonie, A.J.M. Neville and B. O'Hara, "Computer-Tailored Weight Reduction Interventions Targeting Adults: A Narrative Systematic Review," *Health Promotion Journal of Australia* 20 (2009): pp. 48-57.

142 J. Gregory et al., "A Review of eHealth Interventions for Physical Activity and Dietary Behaviour Change," *American Journal of Preventive Medicine* 33, 4 (2007): pp. 336-345.

143 E.O. Whitlock et al., "Screening and Interventions for Childhood Overweight: A Summary of Evidence for the US Preventive Services Task Force," *Pediatrics* 116 (2005): pp. 125-144.

144 R. Ross, "The Challenge of Obesity Treatment: Avoiding Weight Regain," *Canadian Medical Association Journal* 180 (2009): pp. 997-998.

145 E.C. Weiss et al., "Weight Regain in U.S. Adults who Experienced Substantial Weight Loss, 1999-2002," *American Journal of Preventive Medicine* 33 (2007): pp. 34-40.

146 R. Wing et al., "Maintaining Large Weight Losses: The Role of Behavioral and Psychological Factors," *Journal of Consulting and Clinical Psychology* 76 (2008): pp. 1015-1021.

147 K.S. Dale et al., "Determining Optimal Approaches for Weight Maintenance: A Randomized Controlled Trial," *Canadian Medical Association Journal* 180 (2009): pp. E39-E46.

148 D. Neumark-Sztainer et al., "Self-Weighing in Adolescents: Helpful or Harmful? Longitudinal Associations with Body Weight Changes and Disordered Eating," *Journal of Adolescent Health* 39, 6 (2006): pp. 811-818.

149 R. Geneau et al., *Mobilizing Intersectoral Action to Promote Health: The Case of ActNow BC in British Columbia, Canada* (Public Health Agency of Canada, 2009).

150 R.C. Plotnikoff et al., "ParticipACTION: Baseline Assessment of the 'New ParticipACTION': A Quantitative Survey of Canadian Organizational Awareness and Capacity," *International Journal of Behavioral Nutrition and Physical Activity* 6, 86 (2009).

151 G. Faulkner et al., "ParticipACTION: Baseline Assessment of the Capacity Available to the 'New ParticipACTION': A Qualitative Study of Canadian Organizations," *International Journal of Behavioral Nutrition and Physical Activity* 6, 87 (2009).

152 Canadian Produce Marketing Association, *5 to 10 a Day for Better Health* (Ottawa, Ont.: CPMA, 2009), [online] from http://www.5to10aday.com

153 M. Miles et al., "Using the Mass-Media to Target Obesity: An Analysis of the Characteristics and Reported Behaviour Change of Participants in the BBC's `Fighting Fat, Fighting Fit' Campaign," *Health Education Research* 16 (2001): pp. 357-372.

154 Department of Health, *Change4life – Eat Well, Move More, Live Longer* (England, Department of Health, 2009), [online] from http://www.nhs.uk/change4life/Pages/change-for-life.aspx

155 Australian Better Health Initiative, *Measure Up* (ABHI, 2009), [online] from http://www.measureup.gov.au/internet/abhi/publishing.nsf/Content?About+the+campaign-lp

156 Division of Adolescent and School Health, *Youth Media Campaign: Verb It's What You Do* (National Center for Chronic Disease, 2009), [online] from http://www.cdc.gov/youthcampaign

157 Centers for Disease Control and Prevention, *Fruits and Veggies More Matters* (CDCP, 2009), [online] from http://www.fruitsandveggiesmatter.gov

158 B. Wammes, A. Oenema and J. Brug, "The Evaluation of a Mass Media Campaign Aimed at Weight Gain Prevention Among Young Dutch Adults," *Obesity* 15, 11 (2007); pp. 2780-2789.

159 J.M. Berkowitz, M. Huhman and M.J. Nolin, "Did Augmenting the Verb Campaign Advertising in Select Communities Have an Effect on Awareness, Attitudes, and Physical Activity?" *American Journal of Preventive Medicine* 34 (2008): pp. S257-S266.

160 D.M. Matson-Koffman et al., "A Site-Specific Literature Review of Policy and Environmental Interventions that Promote Physical Activity and Nutrition for Cardiovascular Health: What Works?" *American Journal of Health Promotion* 19 (2005): pp. 167-193.

161 J. Burton, *The Business Case for a Healthy Workplace* (Ontario, Industrial Accident Prevention Association, 2008).

162 Canadian Labour and Business Center, *Twelve Case Studies on Innovative Workplace Health Initiatives, Summary of Key Conclusions* (CLBC, 2002).

163 B. Rosen and L. Barrington, *Weights and Measures: What Employers Should Know about Obesity*, (The Conference Board, 2008), Research Report R-1419-08-RR.

[164] L. Anderson et al., "The Effectiveness of Worksite Nutrition and Physical Activity Interventions for Controlling Employee Overweight and Obesity, a Systematic Review," *American Journal of Preventive Medicine* 37, 4 (2009): pp. 340-357.

[165] M.A. Flynn et al., "Reducing Obesity and Related Chronic Disease Risk in Children and Youth: A Synthesis of Evidence with 'Best Practice' Recommendations," *Obesity Reviews* 7 (2006): pp. 7-66.

[166] K. Raine and E. Wilson, "Obesity Prevention in the Canadian Population: Policy Recommendations for Environmental Change," *Canadian Medical Association* Journal 176, 8 suppl (2007): pp. online-106-112.

[167] M. Day et al., "Action Schools! BC – Healthy Eating," *Canadian Journal of Public Health* 99 (2008): pp. 328-331.

[168] P.J. Veugelers and A.L. Fitzgerald, "Effectiveness of School Programs in Preventing Childhood Obesity: A Multilevel Comparison," *American Journal of Public Health* 95 (2005): pp. 432-436.

[169] T. Brown and C. Summerbell, "Systematic Review of School-Based Interventions that Focus on Changing Dietary Intake and Physical Activity Levels to Prevent Childhood Obesity: An Update to the Obesity Guidance Produced by the National Institute for Health and Clinical Excellence," *Obesity Review* 10 (2009): pp. 110-142.

[170] H. Thomas, "Obesity Prevention Programs for Children and Youth: Why are Their Results so Modest?" *Health Education Research* 21 (2006): pp. 783-795.

[171] K. Harris et al., "Effect of School-Based Physical Activity Interventions on Body Mass Index in Children: A Meta-analysis," *Canadian Medical Association Journal* 180 (2009): pp. 719-726.

[172] F. Mathseon, R. Moineddin and R. Glazier, "The Weight of Place: A Multilevel Analysis of Gender, Neighborhood Material Deprivation and Body Mass Index Among Canadian Adults," *Social Science & Medicine* 66, 3 (2008): pp. 675-690.

[173] W. Clark, "Kids' Sports," *Canadian Social Trends* (2008), Statistics Canada catalogue no.11-008-X.

[174] A. Carver, A. Timperio and D. Crawford, "Playing It Safe: The Influence of Neighbourhood Safety on Children's Physical Activity. A Review," *Health & Place* 14, 2 (2008): pp. 217-227.

[175] S. French, M. Story and R. Jeffrey, "Environmental Influences on Eating and Physical Activity," *Annual Review of Public Health* 22 (2001): pp. 309-335.

[176] S. Cummins and S. Macintyre, "Food Environments and Obesity–Neighbourhood or Nation?" *International Journal of Epidemiology* 35 (2006): pp. 100-104.

[177] S. Johnson and J. Marko, *Designing Healthy Places: Land Use Planning and Public Health* (Edmonton, Alta.: Population Health Capital Health, 2007).

[178] Public Health Agency of Canada, *Bringing Health to the Planning Table, a Profile of Promising Practices in Canada and Abroad* (Ottawa, Ont.: PHAC, 2009).

[179] Ministry of Municipal Affairs and Housing, *Planning by Design: A Healthy Communities Handbook* (Ontario Professional Planners Institute, 2009).

[180] Public Health Agency of Canada, *A Diagnostique of Overweight and Obesity in Canada* (unpublished manuscript).

[181] Canada Post, Food Mail Program (Ottawa, Ont.: Canada Post, 2009), [online] from http://www.canadapost.ca/cpo/mc/aboutus/community/foodmailprogram.jsf

[182] M. He et al., "Impact Evaluation of the Northern Fruit and Vegetable Pilot Programme – a Cluster-Randomised Controlled Trial" *Public Health Nutrition* 12, 11 (2009): pp. 2199-2208.

[183] Dietitians of Canada, *Community Food Security Position of Dietitians of Canada* (Toronto, Ont.: Dietitians of Canada, 2007).

[184] M. Story and S. French, "Food Advertising and Marketing Directed at Children and Adolescents in the US," *International Journal of Behavioral Nutrition and Physical Activity* 1, 3 (2004).

[185] Canada Revenue Agency, *Children's Fitness Tax Credit* (Ottawa, Ont.: Canada Revenue Agency, 2009), [online] from http://www.cra-arc.gc.ca/fitness

[186] Canada Revenue Agency, *Line 364 – Public Transit Amount* (Ottawa, Ont.: Canada Revenue Agency, 2009), [online] from http://www.cra-arc.gc.ca/tx/ndvdls/tpcs/ncm-tx/rtrn/cmpltng/ddctns/lns360-390/364-eng.html

[187] M. Tremblay, "Major Initiatives Related to Childhood Obesity and Physical Inactivity in Canada. The Year in Review," *Canadian Journal of Public Health* 98 (2007): pp. 457-459.

[188] B. Von Tigerstrom, *Tax and Subsidy Measures for Obesity Prevention: Background Paper, Submitted to the Public Health Agency of Canada* (2009).

[189] S. Mercer et al., "Possible Lessons from the Tobacco Experience for Obesity Control," *American Journal of Clinical Nutrition* 77 (2003): pp. 1073S-1082S.

[190] J. Ball et al., *The Economic Benefits of Prevention. Key Findings and Messages From a Survey of the Recent Evidence* (Ottawa, Ont.: Public Health Agency of Canada, 2009).

191 V.E.P.P. Lemmens et al., "A Systematic Review of the Evidence Regarding Efficacy of Obesity Prevention Interventions among Adults," *Obesity Reviews* 9 (2008): pp. 446-455.

192 World Health Organization, *Interventions on Diet and Physical Activity: What Works, Summary Report* (Geneva, Switzerland: WHO, 2009).

193 Statistics Canada, *Canadian Community Health Survey (CCHS) - Annual Component User Guide 2007-2008 Microdata Files, June 2009* (Ottawa, Ont.: Statistics Canada, 2009).

194 S. Thomas and S. Tremblay, *Interpreting Estimates from the Redesigned Canadian Community Health Survey* (Ottawa, Ont.: Statistics Canada, 2010).

195 Statistics Canada, C*anadian Community Health Survey Cycle 1.1 Data Dictionary* (Ottawa, Ont.: Statistics Canada, 2003).

196 Statistics Canada, *Canadian Community Health Survey Cycle 2.1 Data Dictionary* (Ottawa, Ont.: Statistics Canada, 2004).

197 Statistics Canada, *Canadian Community Health Survey Cycle (CCHS) 2.2 Data Dictionary* (Ottawa, Ont.: Statistics Canada, 2005).

198 Statistics Canada, *Canadian Community Health Survey Cycle 3.2 Data Dictionary* (Ottawa, Ont.: Statistics Canada, 2006).

199 Statistics Canada, *Canadian Community Health Survey 2007 Data Dictionary, Rounded Frequencies* (Ottawa, Ont.: Statistics Canada, 2008).

200 Statistics Canada, *Canadian Community Health Survey 2008 Data Dictionary, Rounded Frequencies* (Ottawa, Ont.: Statistics Canada, 2009).

201 Health Canada, *Food and Nutrition. Regulations and Compliance* (Ottawa, Ont.: Health Canada, 2009), [online] from http://www.hc-sc.gc.ca/fn-an/label-etiquet/nutrition/reg/index-eng.php

202 P. Katzmarzyk and I. Janssen, "The Economic Costs Associated with Physical Inactivity and Obesity in Canada: An Update," *Canadian Journal of Applied Physiology* 29 (2004): pp. 90-115.

203 R. Hawes and P. Stewart, *Social and Behavioural Determinants of Overweight and Obesity in Canada, 2000-2005: Epidemiologic Evidence for Health Policy* (Canadian Alliance on Risk Factors Surveillance Scientific Conference, 2008).

204 S. Thomas and B. Wannell, "Combining Cycles of the Canadian Community Health Survey," *Health Reports* 20 (2009): pp.53-58.

205 A. Barros and V. Hirakata, "Alternatives for Logistic Regression in Cross-Sectional Studies: An Empirical Comparison of Models that Directly Estimate the Prevalence Ratio," *BMC Medical Research Methodology* 3, 21 (2003).

206 A.V. Perruccio, J.D. Power and E.M. Badley, "The Relative Impact of 13 Chronic Conditions across Three Different Outcomes," *Journal of Epidemiology and Community Health* 61 (2007): pp. 1056-1061.

207 G. Zou, "A Modified Poisson Regression Approach to Prospective Studies with Binary Data," *American Journal of Epidemiology* 159 (2004): pp. 702-706.

208 D. Kleinbaum, L. Kupper and H. Morgenstern, *Epidemiologic Research: Principles and Quantitative Methods* (New York.: Van Nostrand Reinhold,1982).

209 A.K. Akobeng and R.F. Heller, "Assessing the Population Impact of Low Rates of Breast Feeding on Asthma, Celiac Disease and Obesity: The Use of a New Statistical Method," *Archives of Disease in Childhood* 92 (2007): pp. 483-485.

210 P. Torun, R. Heller and A. Verma, "Population Impact of Changes in Heroin Treatment and Smoking Prevalence Rates: Using Population Impact Measures," *European Journal of Public Health* 19 (2009): pp. 28-31.

211 S. Natarajan, S. Lipsitz and E. Rimm, "A Simple Method of Determining Confidence Intervals for Population Attributable Risk from Complex Surveys," *Statistics in Medicine* 26 (2007): pp. 3229-3239.