ADULT OBESITY IN MANITOBA: Prevalence, Associations, & Outcomes

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About the Manitoba Centre For Health Policy

The Manitoba Centre for Health Policy (MCHP) is located within the Department of Community Health Sciences, Faculty of Medicine, University of Manitoba. The mission of MCHP is to provide accurate and timely information to health care decision–makers, analysts and providers, so they can offer services which are effective and efficient in maintaining and improving the health of Manitobans. Our researchers rely upon the unique Population Health Research Data Repository (Repository) to describe and explain patterns of care and profiles of illness, and to explore other factors that influence health, including income, education, employment, and social status. This Repository is unique in terms of its comprehensiveness, degree of integration, and orientation around an anonymized population registry.

Members of MCHP consult extensively with government officials, health care administrators, and clinicians to develop a research agenda that is topical and relevant. This strength, along with its rigorous academic standards, enables MCHP to contribute to the health policy process. MCHP undertakes several major research projects, such as this one, every year under contract to Manitoba Health. In addition, our researchers secure external funding by competing for research grants. We are widely published and internationally recognized. Further, our researchers collaborate with a number of highly respected scientists from Canada, the United States, Europe, and Australia.

We thank the University of Manitoba, Faculty of Medicine, Health Research Ethics Board for their review of this project. MCHP complies with all legislative acts and regulations governing the protection and use of sensitive information. We implement strict policies and procedures to protect the privacy and security of anonymized data used to produce this report and we keep the provincial Health Information Privacy Committee informed of all work undertaken for Manitoba Health.

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Executive Summary

Key Findings and Implications

Obesity is a major public health concern in Canada and may continue to be for some time because it is influenced by a large number of factors, many of which are not easy to change. Indeed, some factors are not modifiable at all (e.g., age), and many of those that are potentially modifiable will require coordinated, long–term strategies to address. That said, this study and others show that there are factors that can be changed and have a significant impact (e.g., increased physical activity), so the 'obesity epidemic' should not be seen as inevitable or irreversible.

This report examines a number of aspects of obesity and its relationship with health status, health service use, and mortality. It focuses on adults (aged 18 and older) in Manitoba. While many of the results reflect findings reported in other studies, a number of important new findings have emerged.

In Manitoba, Aboriginal peoples (First Nations, Metis, and Inuit) comprise a significant proportion of the population. Unfortunately, most of the survey data used in this report excluded persons living in First Nations communities. Aboriginal residents living in all other areas of the province were included in the surveys and in this study, though their results are not reported separately. Other research (discussed in this report) has shown that the prevalence of obesity is higher in these groups, so the results in this report under–estimate the prevalence of obesity in Manitoba, especially in areas where a large proportion of residents live in First Nations communities (e.g., Burntwood).

Like many other studies, we assessed obesity using Body Mass Index (BMI) values, which are based on a person's height and weight as collected in a number of national and provincial surveys. BMI values are an imperfect indicator of body size and composition, but remain the only indicator available for a large, representative sample of Manitobans. BMI values were calculated from direct measurements of height and weight whenever available, though that was the minority of cases. For most people, only self–reported values were available, so we 'corrected' the BMI values using formulae derived from a Statistics Canada study designed for this purpose. This correction provided more accurate values and ensured that we drew valid conclusions from our analyses, but it also means that the obesity prevalence values in this report cannot be directly compared to other reports using 'uncorrected' values (which show considerably lower prevalence of obesity).

Two key characteristics distinguish this report from others: first, it provides detailed results for Manitoba including analyses at the Regional Health Authority (RHA) and sub–RHA levels; and second, it brings together data on BMI levels with data on the rates of use of a number of key health services. These are done using the unique Population Health Research Data Repository housed at the Manitoba Centre for Health Policy (MCHP).

Like Canada overall, Manitoba has experienced a significant increase in the prevalence of obesity over time; Manitoba values have consistently been higher than national averages. This study is based on Manitoba–specific data from 1989 through 2008. Over that period, 'corrected' adult obesity increased from 18.4% to 28.3% among males and from 16.6% to 25.9% among females. Interestingly, however, the increase in obesity prevalence over time appears to have stopped for females, who reached 25% in 2000 and then remained stable through 2008.

Geographic analyses showed that within Manitoba, the highest obesity prevalence values are in Northern areas and the lowest are in urban areas, though increases over time were noted in all areas. However, overall obesity levels were not strongly related to population health status across RHAs. It should be noted that the data available for this analysis could not be used to validly estimate obesity prevalence for Aboriginal residents separately, though other studies have shown that their obesity levels are higher than for other Manitobans.

Our analysis of the relationship between obesity and the various risk and protective factors (23 variables plus interaction terms) revealed that socio–demographic factors (age, sex, education, and others) were the most closely related to obesity levels. The influence of age was particularly strong, with obesity prevalence being low in young adults, higher in middle–age adults, and low among older adults. Where people lived, their marital status, and employment status were also significantly associated with obesity; whereas household income was only weakly associated and frequent consumption of fruits and vegetables was not significantly related to obesity levels. All of these findings reflect the impact of each variable while controlling for all other variables in the model.

We also found significant associations with leisure time activity levels and the number of hours spent in sedentary activities. These are important findings, as they support investment in interventions to improve those factors among the entire population. This pair of findings – that both leisure time activity levels and hours spent in sedentary activities were significant – is interesting. It means that both are independently related to obesity, so interventions on both factors should be considered. That is, initiatives to decrease the number of hours Manitobans spend in sedentary activities may be beneficial for all, including among those who are already active in their leisure time. The results also suggested that those who reported more hours of sleep were less likely to be obese, though this relationship did not reach statistical significance. Finally, while this analysis included many individual characteristics and risk and protective factors, their combined influence explained only a small proportion of the total variation in obesity, reminding us that many other factors are also important in understanding obesity. Hereditary effects and food consumption were likely the most important influences for which detailed data were not available for this study.

Relationships between obesity and a number of chronic diseases have been shown in many previous studies; similar analyses in this study largely mirrored those findings, though some findings did not reach statistical significance. The strongest and likely most important associations found here were between obesity and the incidence and prevalence of both hypertension and diabetes, which were dramatically higher among those with higher BMI levels. These are particularly important indicators because their impact often has a domino effect: hypertension and diabetes both cause a substantial burden of morbidity (illness) and mortality directly. They are also related to the development of other serious health problems, most notably heart disease and stroke, which are leading causes of death. We also analysed the incidence of the most common types of cancer, but found no significant relationships, likely owing to the relatively small sample size available. These findings for hypertension, diabetes, and cancer held for both sexes; other diseases showed some differences among BMI groups by sex.

We also investigated the relationship between obesity and the use of health care services including physician visits, hospital use, prescription drugs, home care, and personal care homes. This section, which capitalizes on the uniquely powerful health data system (the Repository) housed at MCHP, provides the most important contributions from this study. Overall, the results revealed that while the

Obese group almost always had the highest rates of health service use, the differences between it and the Normal and Overweight groups were relatively small. That is, the health care system is not being overwhelmed by the demand for health services related to obesity. This finding is particularly important because no previous studies have been able to provide this kind of analysis on a large representative sample with such comprehensive data on health service use.

Furthermore, for a number of indicators, the higher rates were only evident for those at particularly high BMI values. For example, the Obese group had more physician visits per year than others, but only about 15% more overall; moreover, the rise in rates only occurred above a BMI of 32 for females and 35 for males. Prescription drug costs were highest above a BMI of 35 for females and above 37 for males. Hospitalization rates were higher for the Obese group in both sexes, but only at BMIs of 33 or higher.

Causal modelling of health service use rates indicated that illness level was by far the strongest predictor of health service use, followed by sex, and then other factors including BMI, age, and socioeconomic status.

The 'reasons for' physician visits and inpatient hospitalizations were spread over many causes, though the visit category, which includes diabetes, was more prominent among the Obese group. Also, an interesting trend emerged to suggest that the Obese group used hospital services more frequently for conditions beyond the top 10 causes of hospitalization.

The final chapter is dedicated to the analysis of mortality (death rates). Long–term follow–up analyses show the highest mortality rates are among the Obese group, followed by the Overweight group, and finally the Normal group. However, further analysis revealed these effects to be indirect, as BMI group was not a significant predictor of mortality when age, sex, and other variables were also accounted for in the analysis. These findings suggest that obesity may not be a direct cause of mortality, but remains important because it is related to the development of a number of diseases, which are in turn related to mortality. The story may be different for the Overweight group, as our results and those from a number of other recent studies show that they face no higher mortality risk than the Normal group; indeed, some studies show the Overweight group is at lower risk of death than the Normal group.

Taken together, the results from several chapters in this report and other studies suggest a re–examination of our understanding of the concept of 'Overweight' and the risks with which it may be associated. Many of the findings from this study and others show that outcomes for the Overweight group are similar to, or even better than, those for the Normal group; so being overweight may not carry the level of risk previously thought. However, the likely 'catch' is the connection with age: since most adults gain weight over time (at least until about age 60), being in the Overweight group at a young age may mean a higher likelihood of reaching the Obese level at some point. And the results of this study and others clearly show that the Obese group experiences significantly higher morbidity and mortality.

Despite the vast body of work done to date, significant further research is needed to answer the many remaining questions. Ideally, future studies should use a longitudinal design and incorporate direct effects of BMI on health and mortality as well as indirect effects via related chronic diseases/events. Longitudinal analyses may also reveal that optimal health outcomes might be related to systematic changes in BMI level over the life course. And ideally, detailed food consumption data should also be included.

Summary of Key Findings by Chapter

Chapter 2: Prevalence of Obesity: Changes Over Time and Distribution by RHA

- As of 2007–2008[1], more than one in four Manitobans aged 18 and older were in the Obese (BMI > 30) group: 28.3% of males and 25.9% of females. Obesity rates for both sexes in Manitoba are higher than corresponding Canadian averages.
- The prevalence of obesity in Manitoba increased significantly from 1989–1990 to 2007–2008:
    - obesity in males increased by 54% (from 18.4% to 28.3% of the male population)
    - obesity in females increased by 56% (from 16.6% to 25.9% of the female population), though most of this change appears to have occurred by 2000–2001 with relatively little change since then
    - Note: these values exclude residents living in First Nations communities
- The largest increases in obesity prevalence over time were seen among young adults. This is a troublesome finding as it means that more people are exposed to the health risks associated with obesity from a younger age.
- While the sex difference in the prevalence of obesity is relatively small (28.3% for males versus 25.9% for females in 2007–2008), the sex differences in the other BMI groups are large:
    - Among females, 34.3% were in the Overweight group (BMIs between 25 and 29.9) and 39.8% were in the Normal group (BMIs between 18.5 and 24.9)
    - Among males, 45.0% were in the Overweight group and only 26.7% were in the Normal group
- Within Manitoba, obesity prevalence was highest in the North, though increases over time were seen in all RHAs.
- Average (mean) BMI values also increased over this period:
    - Among males, mean BMI increased by 5.3% (from 26.5 to 27.9)
    - Among females, mean BMI increased by 7.1% (from 25.5 to 27.3)
- The apparent discrepancy between the large increases in obesity prevalence and the modest increases in mean BMI is explained by the upward shift in the entire population's distribution of BMI values, which resulted in a much higher proportion in the Obese group.

Chapter 3: Risk and Protective Factors Associated with Obesity

The main analysis pooled together participants from seven national surveys conducted between 1996 and 2008 for a total sample of 31,795 participants. The results were largely similar to those reported by other studies, confirming that many factors influence obesity.

Results from the main analysis:

- Among the 23 variables and interactions included in the main analysis, the sociodemographic characteristics had the strongest association with adult obesity. In particular, location of residence, age, sex, education, employment status, and marital status provided the majority of the explanatory power of the final (full) model.
    - Obesity was lowest in urban areas, higher in rural areas, and highest in the North.
    - Obesity increased with age from young adulthood to middle age, then decreased with advancing age.
    - Obesity was slightly more common among males than females overall, though this difference varied with age and marital status.
- The addition of individual behaviours and policy–sensitive factors increased the explanatory power of the model. Among these variables, physical activity level during leisure and travel time was the most important. It showed a dose–response relationship: higher levels of activity were associated

1 Years refer to the time period over which the survey was completed (see Table 1.1 in Chapter 1). This notation is used throughout the report.

with lower likelihood of obesity. Other significant variables were smoking (which was associated with a lower likelihood of obesity) and time spent in sedentary activities (more than 30 hours per week was associated with a higher likelihood of obesity).
    - These findings are likely the most 'useful' from a health policy perspective, as they strongly support initiatives to increase physical activity and decrease sedentary activity among all adults.
- The addition of several 'psychological' variables (e.g., satisfaction with life) made only a very small independent contribution to the prediction of obesity.
- The key findings were similar in logistic regression models of obesity and in linear models using continuous BMI values as the outcome measure.
- Data from 'sleep' questions suggested that those who slept longer were less likely to be obese, but this association did not reach statistical significance.

Chapter 4: Selected Diseases/Conditions Associated with Obesity

Overall, the data in this chapter present a mixed picture regarding the relationship between BMI group (Normal, Overweight, Obese) and chronic diseases: some diseases show strong associations while others show no association. This is partly a consequence of the relatively small sample sizes involved, which resulted in large confidence intervals for disease values across BMI groups. However, the strong relationships with hypertension and diabetes are important because of their comparatively high prevalence and their direct and indirect relationships to other diseases and mortality.

The evidence also suggests that the Obese group is more consistently at higher risk for disease than the Overweight group. For some diseases, the Overweight group is closer to the Normal group than to the Obese group.

Among the diseases studied in this project:

- Diabetes prevalence and incidence were strongly related to BMI group, especially for females. Among males, diabetes prevalence was 2.6 times higher in the Obese group than the Normal group; the incidence rate was 4.4 times higher. The corresponding values for females were 4.4 and 7.5, respectively.
- Hypertension prevalence and incidence were also strongly related to BMI group in both sexes. The Obese group had rates nearly double those of the Normal group.
- Heart attack (AMI) incidence rates were strongly related to BMI for males, but not for females. Conversely, total respiratory morbidity (prevalence and incidence) was modestly related to BMI among females but not males.
- A number of indicators revealed no statistically significant associations: dialysis initiation, heart attack prevalence, ischemic heart disease prevalence and incidence, stroke incidence, and hip fracture rates. However, these non–significant findings do not allow us to conclude there is no association with BMI. In each case, the variation within the results was large owing to the relatively small number of cases involved (i.e., the number of outcomes among survey participants was limited and was divided into three BMI groups for each sex).
- Cancer incidence rates were also analysed and revealed few significant associations with BMI groups. This may be related to the relatively low number of cases and limited follow–up period available for most survey participants.
    - Among males, the rate for all cancers combined appeared to show lower incidence for the Obese group, though this difference did not reach statistical significance.
    - Among females, there appeared to be a positive relationship between higher BMI levels and higher breast cancer incidence rates, though the group differences did not reach statistical significance.

Chapter 5: Obesity and Health Service Use

Overall, the results revealed that while the Obese group almost always had the highest rates of health service use, the differences between it and the Normal and Overweight groups were often small. That is, the health care system is not being overwhelmed by the demand for health services related to obesity. This finding is important because no previous studies have been able to provide this kind of analysis on a large representative sample with such comprehensive data on health service use.

Furthermore, for a number of indicators, the higher rates were only evident for those at particularly high BMI values. For example, the Obese group used more physician visits per year than others, but only about 15% more overall, and the rise in rates only occurred above a BMI of 32 for females and 35 for males. Prescription drug costs were highest above a BMI of 35 for females and 37 for males. Hospitalization rates were higher for the Obese group in both sexes, but only at BMIs of 33 or higher.

Group differences were small or modest for physician visit rates, the number of different drugs used, inpatient hospitalization rates and days used (by males), and receipt of home care. Group differences were larger for prescription drug costs, joint replacement rates (among females), gallbladder surgery, level of care on admission to personal care home, and cardiac procedure rates (among males).

In many cases, the Overweight group used no more services than the Normal group (physician visits, number of different drugs used, inpatient hospitalization rates, joint replacements, and home care receipt). Two indicators revealed inverse relationships: admission rates to personal care homes among females were lower for the Overweight group than the Normal group and hospital day use among males in the Overweight group was lower than the Normal group.

For most indicators, the trends were similar for males and females, though absolute rates were often different (several higher among females, some higher among males). For a few indicators, the patterns across BMI groups differed considerably by sex.

Multivariate modelling of physician visit rates, prescription drug use, and hospital use pointed to illness level as the strongest predictor of health service use rates, followed by sex, and then other factors including BMI, age, and socioeconomic status.

The 'reasons for' physician visits and inpatient hospitalizations were spread over many causes though the visit category which includes diabetes was more prominent among the Obese group. Also, an interesting trend emerged to suggest that the Obese group used health services more often for causes beyond the top 10 conditions.

Chapter 6: Obesity and Mortality

Initial analysis of death rates by BMI value (and BMI group) revealed no systematic relationship between BMI and mortality, though the follow–up period for most participants was less than 10 years. Multivariate analysis including age, sex, and other variables confirmed that obesity does not have a significant direct association with mortality. That said, there is strong evidence of its indirect effect—obesity is related to the development of a number of chronic diseases/conditions, which are in turn significantly related to mortality (most notably hypertension, diabetes, and ischemic heart disease).

These findings are consistent with those from some previous research, but different from others. A number of recent studies suggest that the Overweight group have the lowest mortality rates. However, much depends on study designs and time frame, what data are available, and how they are analyzed.

Taken together, these results suggest that the relationships between BMI and mortality are not yet fully known and may be more complex than existing analyses have been able to account for, given limitations in available data. Additional research is needed, especially studies involving longitudinal designs, direct and indirect pathways, and incorporating more information on food consumption patterns.

Regarding causes of death, cancer and circulatory diseases were the most prominent categories for all three BMI groups, in both sexes. The 'endocrine and metabolic diseases' category, which includes diabetes, was more prominent among the Obese group than the Normal or Overweight groups. This is consistent with the higher incidence and prevalence of diabetes documented for the Obese group (Chapter 4).

Chapter 1: Introduction and Background

Context

Obesity is a major and growing public health concern in Manitoba and Canada, as in most countries, because of its increasing **prevalence**[2] and association with poor health outcomes. Obesity has been shown to be associated with increases in mortality as well as the **incidence** and/or prevalence of a number of diseases and deleterious health outcomes, which implies both direct and indirect associations between obesity and mortality/morbidity (illness).

There are innumerable studies and reports regarding obesity and health in the national and international literature. Indeed, a number of academic journals are dedicated exclusively to this topic. Several thorough reviews of this vast literature have been published; readers may find these sources helpful in providing a more complete background to complement the focused review in the last section of this chapter, which provides Canadian results.

Study Goal and Objectives

The main goal of this study was to combine administrative and survey data to provide Manitoba–specific results on the prevalence, trends, and outcomes related to obesity. These results will be used to inform public policy and program initiatives of Manitoba Health and the 11 **Regional Health Authorities (RHA)** in Manitoba. Throughout this report, data for males and females are presented separately to provide sex–specific results regarding the prevalence, associations, and outcomes associated with obesity.

This study used data available in the **Population Health Research Data Repository (Repository)** housed at the Manitoba Centre for Health Policy (MCHP). Most of the data in the Repository come from administrative health records related to health service use, which do not contain height or weight information. As a result, this study relies on data collected by a number of surveys conducted on Manitobans from 1989 through 2008. This study focused on adults (18 years and older) because the majority of the survey data was collected from adults and because Manitoba Health released an extensive report on children and youth, titled "Weight Status of Manitoba Children" (2007). Although the financial implications associated with obesity are not addressed in the current study, there are direct costs related to the increased use of health services, which is documented in detail in Chapter 5.

The key objectives of this study were:

1. To document the prevalence of obesity among adults in Manitoba, the changes over time, and provide results by RHA
2. To assess the association between obesity and a variety of risk and **protective factors**, using responses to questions asked in the surveys
3. To analyse the relationship between obesity and a number of health outcomes available in **administrative data**, including disease incidence and prevalence, rates of health service use, and mortality

2 Terms in **bold** type face are defined in the Glossary at the end of this report.

Report Organization

This report is organized in six chapters:

- Chapter 1 covers the introduction and background
- Chapter 2 describes the prevalence and distribution of obesity in Manitoba, over time
- Chapter 3 examines risk and protective factors associated with obesity
- Chapters 4, 5, and 6 analyze a number of outcomes related to obesity in terms of:
    - disease incidence and prevalence (Chapter 4)
    - health service use (Chapter 5)
    - mortality (Chapter 6)

Data Sources and Analyses

This section provides information regarding the data sources and the overall approach used for analyses throughout this report. Because the methods used were quite different, each chapter contains additional details regarding the analyses conducted in that chapter. All analyses were conducted at MCHP using SAS® version 9.2.

MCHP created and maintains the Repository, which contains a variety of datasets. Many of these datasets are based on health service use records and include the entire population of Manitoba. All data files in the Repository are 'de–identified', meaning that names and other identifying fields are not available, but unique (scrambled) identifiers are used to allow linkage across files and follow–up over time. Data in the MCHP Repository have been extensively documented and validated for this kind of research (Roos, Gupta, Soodeen, & Jebamani, 2005).

Most studies conducted at MCHP rely primarily on the administrative health data available in the Repository. Information from these files was used in this report; but since these datasets do not contain information on height and weight, the survey data also available in the Repository were essential for the analyses in this report. This combination of survey and administrative data represents a unique strength of this study. Furthermore, the inclusion of data from numerous surveys is a major advantage because it provides information from a large number of residents and allows examination of trends over time.

Survey Data

The surveys are described briefly here, with sample sizes listed later in this chapter. Additional information about each survey is available from the references cited. It is important to note that all surveys used in this study were of 'community–dwelling' Manitobans, so those residing in **personal care homes** or other institutional settings were not included in these surveys. In all analyses in this report, we used the **sample weights** provided by the surveys to ensure the results represent values for the entire population, not just the survey participants.

1. The **Manitoba Heart Health Survey (HHS)** was conducted between late 1989 and early 1990, as part of a national initiative. It focused on adults, included residents of **urban** and rural areas, as well as residents of First Nations communities. It conducted interviews and arranged visits to medical clinics to gather detailed clinical data on each survey participant, thus providing rich data for follow–up. In this report, HHS data was particularly valuable for long–term 'survival' analyses, as it allowed over 19 years of follow–up. Full details about the design, methods, and results are available elsewhere (Gelskey, MacDonald, & Young, 1991; Young, 1991).

2. The **National Population Health Survey (NPHS)** is an ongoing longitudinal survey conducted by **Statistics Canada** that started in 1994–1995[3] and re–interviews participants every two years. It was designed to provide province–level estimates of health status and health–related behaviours and characteristics, using a relatively small sample size. In the 1996–1997 wave, the government of Manitoba invested additional funds to allow a much larger sample of Manitobans to be surveyed (approximately 10,000). The NPHS includes many questions about risk and protective factors potentially related to obesity, which are included in the analyses in Chapter 3. However, this survey did not include people living in First Nations communities, so results must be interpreted with caution, especially in RHAs with significant populations living in First Nations communities. Full details about the design, methods, and results from the NPHS are available from Statistics Canada (http://www.statcan.gc.ca/concepts/nphs–ensp/index–eng.htm).

3. The **Canadian Community Health Survey (CCHS)** is a very large **cross–sectional survey** also conducted by Statistics Canada, starting in 2000–2001. It is also conducted every two years, but with a new sample drawn for every cycle (i.e., not the same people followed over time as in the NPHS). It included many of the same questions as the NPHS. The CCHS is designed to provide results at the provincial and regional levels. Initially, the CCHS was conducted in biennial cycles and involved two waves: a '.1' wave, which included a large sample size, and a '.2' wave, which included fewer participants but more questions. For this study, the data from all CCHS waves conducted between 2000 and 2008 were included[4]. However, the CCHS (like the NPHS) does not include people living in First Nations communities, so results must be interpreted with caution, especially in RHAs with significant populations living in First Nations communities. Full details about the design, methods, and results from the CCHS are available from Statistics Canada. (http://www.statcan.gc.ca/cgi–bin/imdb/p2SV.pl?Function=getSurvey&SDDS=3226&lang=en&db=imdb&adm=8&dis=2).

4. Analyses were also conducted on Manitoba participants in the longitudinal component of the NPHS, which started in 1994–1995 and re–interviewed participants every two years. In order to take advantage of the longitudinal design, we devised different analyses for these data. For example, we attempted to identify and analyse 'weight cyclers'—people whose weight fluctuated significantly over time (e.g., lost then regained weight). Unfortunately, only a minority of participants remained in the survey in later years, meaning that the final sample is relatively small. We also found that most participants' body weights did not change substantially over time; instead, most experienced a slow increase. Therefore, due to the combination of the sample size reductions and the slow change in most participants' bodyweight, we were not able to identify an adequate group of 'weight cyclers.' In the end, our report could not include any analyses from the Manitobans involved in the longitudinal component of the NPHS, except data from the large number of participants in the 1996–1997 cycle. Note: Statistics Canada has been able to conduct numerous analyses of the longitudinal data using the national sample, which maintains adequate sample size and representativeness. Results of several of these studies are cited in this report.

Administrative Data

This study also made extensive use of the administrative health data held in the Repository at MCHP to study the outcomes associated with obesity: **chronic disease** incidence and prevalence, rates of health service use, and mortality. Specifically we used the following databases: medical services (**physician claims**), hospital abstracts, drug data (**Drug Program Information Network (DPIN)**), **home care**, personal care homes, **Vital Statistics** (deaths and causes of death), and the population registry. CancerCare Manitoba kindly provided data on diagnoses of new **cancer** cases among our list of survey participants, and these data were linked to the population registry by staff of Manitoba Health.

3 Years refer to the time period over which the survey was completed (Table 1.1). This notation is used throughout the report.

4 Note: As of 2007, the CCHS changed from collecting data every other year to a continuous data collection routine with annual data releases. In this report, we combined data from 2007 and 2008, so that the total sample size and variability would be comparable to cycles 1.1, 2.1, and 3.1.

Body Mass Index (BMI) Values

This report uses the **Body Mass Index (BMI)** value, calculated as weight (in kilograms) divided by height (in metres) squared. BMI is the most available and most widely used measure of overweight and obesity; but like all measures, it has limitations (Janssen, Katzmarzyk, & Ross, 2002; Janssen, Katzmarzyk, & Ross, 2004; Prentice & Jebb, 2001). However, it is the only measure available in existing data sources that covers a large and representative sample of the population (excluding residents of First Nations communities, as noted above).

The Public Health Agency of Canada (PHAC) (Health Canada, 2003) follows the **World Health Organization** grouping (World Health Organization, 1995) for BMI values:

'Underweight'	BMI < 18.5
'Normal'	18.5 – 24.9
'Overweight'	25.0 – 29.9
'Obese'	BMI 30+

These categories were created by examining relationships between BMI, mortality, and morbidity. However, the cutoffs remain somewhat arbitrary and have changed over time: a BMI of 27 used to separate the low risk from the high risk categories (Health and Welfare Canada, 1988). Furthermore, these groupings may not be equally useful for older adults (Heiat, Vaccarino, & Krumholz, 2001; Zamboni et al., 2005) or different ethnic groups, including Aboriginal peoples (Razak et al., 2007; Tremblay, Perez, Ardern, Bryan, & Katzmarzyk, 2005). Therefore, analyses in this study used continuous BMI values whenever possible, with summarized data for the standard groups shown above as well. Special emphasis was given to findings for the Obese group, as this was the focus of this study.

In most analyses in this report, the Underweight group was excluded because it has very low prevalence, resulting in high variability and excessive **suppression** of data. Consideration was also given to combining the Underweight and Normal groups, but the possibility of different patterns of outcomes for the two groups made the Advisory Group decide against this approach for Chapters 3–6. The exception is Chapter 2, which describes the distribution of BMI values in Manitoba and how they have changed over time. For Chapter 2, the Underweight group was combined with the Normal group (and appropriately labelled) so that the results reflected the entire population and the full spectrum of BMI values.

Corrections to Body Mass Index (BMI) Values

For most of the surveys used in this study, height and weight values were 'self–reported', which means that an interviewer asked the participant their height and weight (in person or on the phone) and recorded the responses. Only the HHS and cycle 2.2 of the CCHS actually measured height and weight.[5]

Self–reported height and weight values are known to be inaccurate (Connor Gorber, Tremblay, Moher, & Gorber, 2007), though some researchers have suggested that the difference is acceptable for epidemiological studies (McAdams, Van Dam R.M., & Hu, 2007). Nevertheless, we used the measured values for height and weight whenever available and corrected all self–reported values using formulae derived from a Statistics Canada study designed to address this issue (Connor Gorber, Shields, Tremblay, & McDowell, 2008). The study used a sub–sample of the CCHS 3.1, in which survey participants were first asked their height and weight and then had their height and weight measured directly. On average, the

5 In both of these surveys, a proportion of participants did not allow height and weight measurements to be made, so self–reported values were taken, and corrected using the formulae shown.

corrections increase BMI values by about 4% for males and 5% for females. These corrections may seem small, but not doing them has been shown to result in significantly biased results and interpretation (Chiolero, Peytremann–Bridevaux, & Paccaud, 2007; Shields, Connor Gorber, & Tremblay, 2008a; Shields, Connor Gorber, & Tremblay, 2008b).

The correction formulae used were:[6]

Males: Corrected BMI = Self–reported BMI * 1.0531 – 0.4082

Females: Corrected BMI = Self–reported BMI * 1.0505 + 0.0849

The analyses and results in this report refer to 'measured/corrected BMI' to reflect the fact that we used measured values whenever available and corrected self–report values for all others.

Overall, doing these corrections was important and helpful; it is certainly better to do them than not do them, as documented by the studies cited above. However, there are some limitations involved in having done them as we did. For instance, Connor Gorber and Tremblay have shown that the inaccuracy with which Canadians report their BMI was higher in the 2005 CCHS than in the 1989–1990 HHS (2010). Also, Shields et al. (2011) have shown that the context and/or conduct of different surveys can affect reporting accuracy. However, the datasets required to derive and validate a separate set of correction formulae for each survey wave do not exist. Regarding the survey context, the '.2' CCHS cycles by Statistics Canada are indeed different from the '.1' cycles in a number of ways which could affect responses. However, the '.2' contributed only 10% of our total sample size, so any bias for these groups would have only a small effect on the results for the full sample. In the end, it seemed clearly better for our purposes to include all participants of all surveys—which maximized the available sample size (a major concern)—even though the single set of correction formulae might not have performed equally accurately in all survey cycles (a smaller concern).

These corrections provided more accurate values and ensured that we drew valid conclusions from our analyses. However, it also means that the obesity prevalence values in this report cannot be directly compared to other reports using 'uncorrected' values (which show considerably lower prevalence of obesity).

Exclusions

The following exclusions were used in this study:

1. Participants less than 18 years of age on the survey date[7]
2. Women who indicated that they were pregnant on the survey date
3. Those who did not provide responses to questions on height and weight
4. Those whose recorded height and weight values resulted in implausibly low or high BMI values (less than 10 or over 100)
5. Participants for whom a postal code or municipal code was not available (as this was needed to determine location of residence)

For those (few) Manitobans included in more than one survey/cycle, responses from the first interview only were used. To improve comparability of samples over time in Chapter 2 (distribution of BMI values and changes over time), residents of First Nations communities in the HHS were excluded from that analysis.

6 These formulae are slightly different from those in the published report cited, as we included all respondents in deriving our formulae; whereas in the original report, the formulae were created from the 'derivation' half of the sample.

7 Except for one sub–analysis in Chapter 3, in which responses from 12– to 18–year–olds were used.

Table 1.1 lists all the surveys/waves used and the sample sizes for each survey, including the initial 'total' sample size and the 'final' sample size used for analyses in this report after making the exclusions noted above. The "number of participants linked" indicates the number of Manitobans that provided permission for linkage of their survey data to administrative data and who were successfully linked in the data system. 'Year' refers to the time period over which the survey was completed. This notation is used throughout the report.

Table 1.1: Surveys Included and Sample Sizes

	Year	Number of Participants Linked	Number of Participants After Exclusions
Manitoba HHS	1989-1990	2,776	2,683
NPHS	1996-1997	10,129	8,888
CCHS 1.1	2000-2001	6,833	5,731
CCHS 1.2	2002	1,958	1,777
CCHS 2.1	2003	6,134	5,113
CCHS 2.2	2004	3,570	1,671
CCHS 3.1	2005	6,063	4,927
CCHS 4.1 & 2008	2007-2008	6,239	5,021
Total		**43,702**	**35,811**

HHS- Heart Health Survey
NPHS- National Population Health Survey
CCHS- Canadian Community Health Survey

Source: Manitoba Centre for Health Policy, 2011

Estimates and Confidence Intervals

Because this report relies on data collected in surveys of randomly selected Manitobans (not the entire population), the calculations can only provide estimates of the true values for the population they represent (all Manitobans). Statistically, this uncertainty is expressed by the use of **confidence intervals (CIs)** (usually at the 95% level with corrections for multiple testing as required). For example, results may indicate the prevalence of obesity to be 25% with 95% CIs from 22% to 28%. This means that we are 95% certain that the true prevalence of obesity in the population lies somewhere between 22% and 28%. In the tables and graphs in this report, the estimates are shown along with their CIs (in parentheses or as error bars on graphs). Confidence intervals will be wide for analyses containing a smaller number of survey participants or groups which contain a large amount of variation (or both). Confidence intervals were calculated via the **bootstrapping method**, using 500 sub–samples of the data. When using the Statistics Canada surveys (NPHS and CCHS), we used the bootstrap weights provided by Statistics Canada.

Geography

All analyses were conducted at the smallest geographical level possible, while maintaining reliable results. Many analyses were conducted only for Manitoba overall; while others provide results by RHA. Prevalence values are also provided at the sub–RHA level: the 54 Districts of the non–Winnipeg RHAs and the 12 **Community Areas (CAs)** of the Winnipeg RHA.

In some instances, Non–Winnipeg RHAs (Figure 1.1) are also grouped into three 'aggregate' areas as follows:

- **Rural South**: South Eastman RHA, Central RHA, and Assiniboine RHA
- **Rural Mid**: Interlake RHA, North Eastman RHA, and Parkland RHA
- **North**: NOR–MAN RHA, Burntwood RHA, and Churchill RHA

Winnipeg is also sub–divided into three 'aggregate' areas (groupings of the 25 **Neighbourhood Clusters**) based on the rates of premature mortality (death before age 75) in each area (Figure 1.2). The groups are:

- **Winnipeg Most Healthy**: Fort Garry South, St. Boniface East, River East North, Inkster West, Assiniboine South, Fort Garry North, St. Vital South, River Heights West, St. James–Assiniboia West, River East East, and River East West
- **Winnipeg Average Health**: Seven Oaks North, Seven Oaks West, Transcona, St. Vital North, Seven Oaks East, and River Heights East
- **Winnipeg Least Healthy**: Downtown West, St. James–Assiniboia East, St. Boniface West, Point Douglas North, River East South, Inkster East, Downtown East, and Point Douglas South

Review of Literature

As noted above, there is a vast body of literature on obesity and health, which makes a thorough review in this report impractical. However, key documents and sources providing information on the prevalence and outcomes related to obesity are discussed in this section. Focus is on Canadian studies. In addition, when references contain results that are comparable to the indicators used in this report, they are cited in the specific section discussing those results.

The Issue

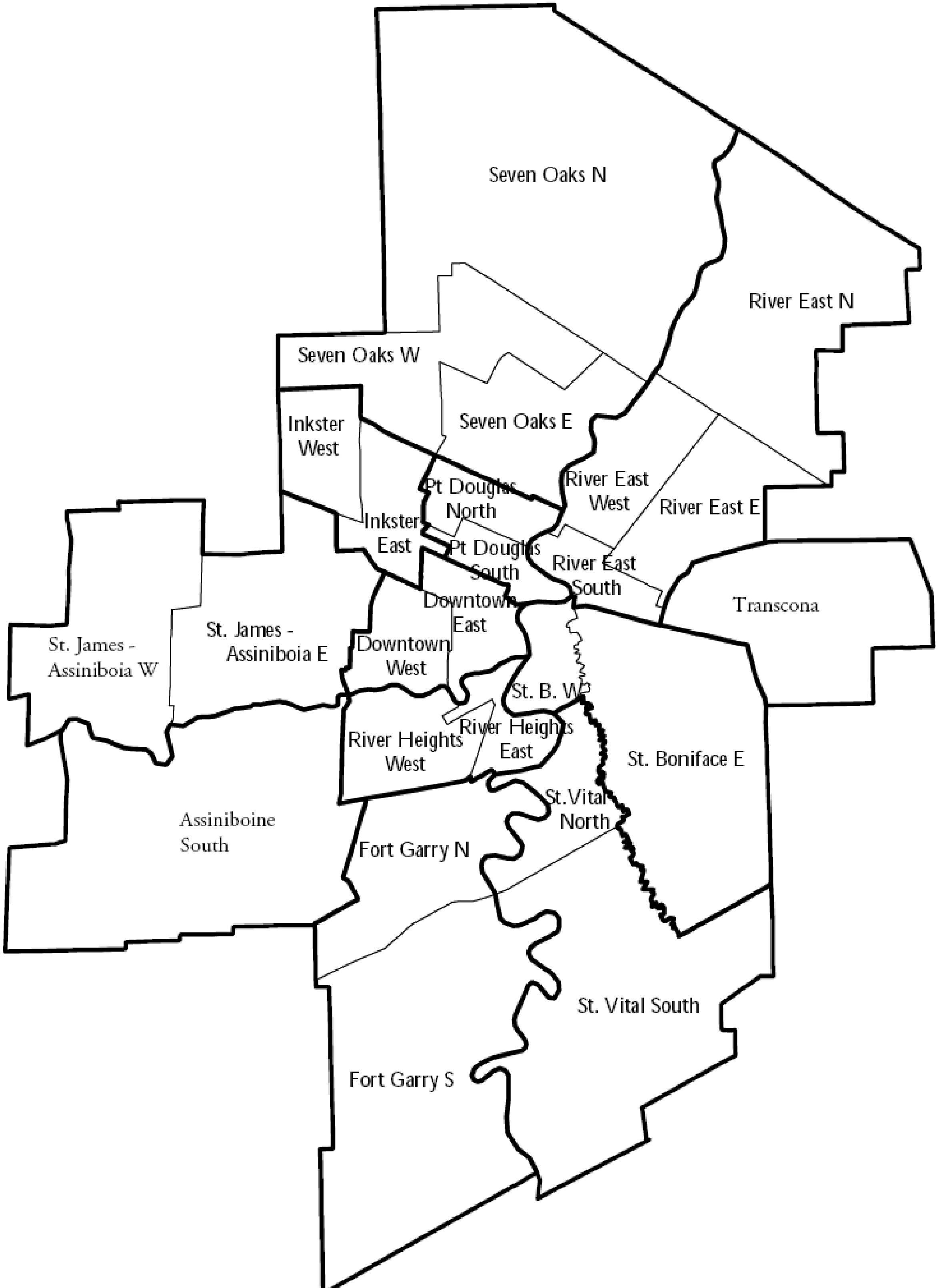
As a major public health issue for many years already, obesity has been the topic of countless research studies around the world. One aspect that almost all studies agree on is the multiple causes of obesity: literally hundreds of factors have been shown to influence or be associated with obesity. Perhaps the most thorough, integrated, and sophisticated description of this is shown in a recent report from the 'Foresight' project in the United Kingdom (2007).

The increasing prevalence of obesity is not a new problem in developed countries (Caballero, 2007; Kumanyika, 2001; Wang & Beydoun, 2007), but may require new kinds of solutions (Syme, 2007) given the overall modest success rate of traditional weight loss strategies (Elfhag & Rossner, 2005; Foresight, 2007; Miller & Jacob, 2001; World Health Organization, 1995). This puts extra emphasis on the importance of preventing obesity in the first place (Brown, Kelly, & Summerbell, 2007; Muller, Mast, Asbeck, Langnase, & Grund, 2001; Wareham, 2007). In 2007, the Canadian Medical Association Journal published "Canadian clinical practice guidelines on the management and prevention of obesity in adults and children" to help guide clinicians by outlining evidence–informed strategies that may help (Lau et al., 2007). There is also ongoing investigation of the effects of genetics and heritability on obesity (Coady et al., 2002; Farooqi & O'Rahilly, 2007; Hjelmborg et al., 2008). In addition to more research, this trend has led to numerous reviews, consensus meetings, and roundtable discussions regarding how this change has come about, and what might be done to reverse it and/or reduce its impact (Canadian Institute for Health Information, 2003; Raine et al., 2008; Raine, 2004; Sokar–Todd & Sharma, 2004).

Figure 1.1: Regional Health Authorities (RHAs) of Manitoba

Source: Manitoba Centre for Health Policy, 2011

Figure 1.2: Winnipeg Neighbourhood Clusters



Source: Manitoba Centre for Health Policy, 2011

On the contrary side, there is literature describing what is usually called the 'obesity paradox'. Numerous studies have shown that among patients with selected chronic diseases (most prominently, heart failure), obese and overweight patients have better survival than those in the normal BMI group (Curtis et al., 2005; Oreopoulos et al., 2008). However, higher BMI levels are associated with the risk of developing heart failure and other chronic diseases in the first place (Hubert, Feinleib, Mcnamara, & Castelli, 1983; Kenchaiah et al., 2002; Lavie, Milani, & Ventura, 2007), and this is likely more important from a population health perspective. Moreover, at least one study has suggested that patients at higher BMI levels may be more likely to receive guideline–recommended treatments, which may partially explain these differences (Steinberg et al., 2007).

The Prevalence of Obesity in Canada

As with most other countries, the prevalence of obesity in Canada has increased significantly over time. Katzmarzyk provides the historical perspective from 1953 to 1998. He showed that,while Canadians became taller over that period weight gain was even faster, resulting in rising prevalence of overweight (from 30.3% to 35.8%) and obesity (from 9.7% to 14.9%) (Katzmarzyk, 2002). However, the increases were likely under–estimated because the most recent data were self–reported; whereas the earlier data were from direct measurements of height and weight.

Macdonald et al. (1997), using directly measured data from the Canadian Heart Health Surveys, reported obesity rates according to the previous federal guidelines for healthy weights, which used a BMI value of 27 or higher to characterize obesity. At this cutoff, the prevalence of obesity was 35% among males aged 18 to 74 and 27% among females. Interestingly, using the current 30+ cutoff, the prevalence of obesity in their results was 13% for males and 14% for females.

Torrance, Hooper and Reeder (2002) showed significant increases in adult overweight and obesity by sex and other key variables from 1970 through 1992, using measured height and weight data from a number of surveys. The prevalence of obesity among males rose from 8.1% in 1970–1972 to 13.4% in 1986–1992; for females, prevalence rose from 12.7% to 15.4%. Prevalence of being overweight in males rose from 38.9% to 44.7% and in females, from 21.2% to 25.2%. This study also highlighted the need for updated data on obesity in Canada, especially studies which directly measured height and weight.

Shortly thereafter, more data on obesity in Canada started to become available because of new surveys designed and implemented by Statistics Canada: the NPHS and the CCHS (see descriptions on page 3). The data from the latter two sources provided most of the BMI data for this study, as described in the "Data Sources and Analyses" section of this chapter.

The 2004 wave of the CCHS contained a focus on nutrition, which included direct measurements of height and weight. Statistics Canada researchers (and co–investigators) took advantage of these new data to update the time trends in obesity prevalence in Canada. Numerous studies were reported in the August 2006 edition of Health Reports, as described below. These studies provide an excellent background for the current study of obesity in Manitoba. However, it should be noted that many participants (45% of males and 39% of females) in the 2004 CCHS did not allow direct measurements of their height and weight to be taken (Tjepkema, 2006).

Tjepkema (2006) analysed the time trend in BMI values using only directly measured height and weight data and reported a dramatic increase in the prevalence of overweight and obesity in Canada. Obesity rose from 13.8% of all adults in 1978/79 to 23.1% in 2004; an additional 36% of adults were in the Overweight group. Important sex differences were also reported: a higher proportion of females than males were in the Normal group (44% versus 34%); but for the Overweight group, the reverse was true

(43% of males and 30% of females). Obesity prevalence was similar for both sexes as of 2004: 22.9% for males and 23.2% for females. The study also provided a detailed distribution of BMI values by sex and age group and compared Canadian results to data from the United States, where the distribution of BMI values was and continues to be higher (Shields, Carroll, & Ogden, 2011). Risk and protective factors were analysed as well. Those results are included in Chapter 3 of this report, where we compare them to results of similar analyses conducted for this study. Tjepkema also reported significant associations between obesity and chronic disease prevalence, which is the topic of Chapter 4.

As noted above, the NPHS used a longitudinal design: they followed the same individuals from 1994–1995, re–interviewing them every two years. Using this data, LePetit and Berthelot reported in 2006 that most Canadians gained weight steadily over time. Over an eight–year period, 32% of those who started in the Normal group moved into the Overweight group, and 23% of those who started in the Overweight group moved into the Obese group. On the other hand, about 10% of those who started in the Overweight group lost weight and moved into the Normal group. Interestingly, these patterns differed by sex. Males were more likely to move from Normal to Overweight, and females were more likely to move from Overweight to Obese. This unique study incorporated many variables to analyse weight gain and reported a number of other interesting results. Using data from the same survey, Orpana et al. reported that on average Canadians gained from 0.5 to 1.0 kg every two years, though the rate of gain appeared to be slowing over time (2007). A smaller percentage of the population gained weight, but those who were gaining weight were gaining more over time. Of note, those in the Normal group reported the highest weight gain over time, those in the Overweight group reported smaller gains, and those in the Obese group reported losing weight over time. It should also be noted that these studies used self–reported data; and as mentioned earlier, the accuracy of self–reporting may be changing over time. This could confound the findings reported.

The Canadian Health Measures Survey (CHMS) completed its first cycle in 2007–2009, incorporating a household interview and a number of direct physical measurements in a mobile clinic. This survey has already led to a number of reports by Statistics Canada describing a variety of important outcomes, including obesity levels. The prevalence of measured obesity was 24.3% for males and 23.9% for females. Additional information about the CHMS can be found at http://www.statcan.gc.ca/cgi–bin/imdb/p2SV.pl?Function=getSurvey&SDDS=5071&lang=en&db=imdb&adm=8&dis=2.

Most recently, Public Health Agency of Canada and the Canadian Institute for Health Information released the report 'Obesity in Canada: A joint report from the Public Health Agency of Canada and the Canadian Institute for Health Information' (2011). It provides current results for the prevalence of obesity, compared Canadian results with those from other Organisation for Economic Co–operation and Development (OECD) countries, showed results by province, and importantly, and provided some results on obesity among Aboriginal peoples in Canada. The results they provide from measured height and weight closely match those in this report (i.e., 25%). Self–reported results for Aboriginal peoples indicate higher than average obesity prevalence among those groups, particularly among 'On–reserve First Nations groups'. The report also analyzed some of the determinants of health and found that physical inactivity was the one most strongly associated with obesity at the population level, after adjusting for age and other factors.

Chapter 2: Prevalence of Obesity: Changes Over Time and Distribution by RHA

Chapter Summary

- As of 2007–2008, more than one in four Manitobans aged 18 and older were in the Obese (BMI > 30) group: 28.3% of males and 25.9% of females. Obesity rates for both sexes in Manitoba are higher than corresponding Canadian averages.
- The prevalence of obesity in Manitoba increased significantly from 1989–1990 to 2007–2008:
    - obesity in males increased by 54% (from 18.4% to 28.3% of the male population)
    - obesity in females increased by 56% (from 16.6% to 25.9% of the female population), though most of this change appears to have occurred by 2000–2001 with relatively little change since then
    - Note: these values exclude residents living in First Nations communities
- The largest increases in obesity prevalence over time were seen among young adults. This is a troublesome finding as it means that more people are exposed to the health risks associated with obesity from a younger age.
- While the sex difference in the prevalence of obesity is relatively small (28.3% for males versus 25.9% for females in 2007–2008), the sex differences in the other BMI groups are large:
    - Among females, 34.3% were in the Overweight group (BMIs between 25 and 29.9) and 39.8% were in the Normal group (BMIs between 18.5 and 24.9)
    - Among males, 45.0% were in the Overweight group, and only 26.7% were in the Normal group
    - Analysis of sub–groups within the Obese category revealed that the prevalence of Class I obesity (BMIs from 30–34.9) was higher among males than females, while those for Classes II (35–39.9) and III (40+) were higher among females than males
- Within Manitoba, obesity prevalence was highest in the North, though increases over time were seen in all Regional Health Authorities (RHAs).
- Average (mean) BMI values also increased over this period:
    - Among males, mean BMI increased by 5.3% (from 26.5 to 27.9)
    - Among females, mean BMI increased by 7.1% (from 25.5 to 27.3)
- The apparent discrepancy between the large increases in obesity prevalence and the modest increases in mean BMI is explained by the upward shift in the entire population's distribution of BMI values, which resulted in a much higher proportion in the Obese group.

Introduction

This chapter documents the prevalence of obesity in Manitoba and the changes over time from 1989 to 2008. It also describes the distribution of obesity across and within each of the 11 RHAs of Manitoba.

As described in Chapter 1, most of the BMI values were calculated from self–reported height and weight and then corrected using validated correction formulae (see Chapter 1 "Body Mass Index (BMI) Values"). Measured values were used whenever available. Therefore, results are referred to as 'measured/corrected' BMI values.

The 'Underweight' Group

Since this report focuses on the Obese and Overweight groups, less emphasis is placed on the Underweight group (those people with a BMI value less than 18.5). The prevalence of Underweight is much lower than the other three groups; indeed, it is so low that none of the surveys included enough underweight survey participants to allow reliable estimation of its prevalence. Therefore, we combined the data from all survey waves together (1989 to 2008), to provide the following estimates of the prevalence of Underweight (BMI less than 18.5) in Manitoba:

- Females: 1.69% of the population (95% CI: 1.30% to 2.09%)
- Males: 0.56% of the population* (95% CI: 0.37% to 0.75%)
  *warning: male estimate must be interpreted with caution because of high variability

For this chapter only, survey participants in the Underweight group were put together with the Normal group so that the results included all participants and the full spectrum of BMI values. In all subsequent chapters, participants in the Underweight group were excluded to ensure that the results for the Normal group were not affected by the Underweight participants, whose outcomes may be significantly different from those in the Normal group.

The Impact of Age

Studies have shown that on average, Canadian adults gain weight with age (Le Petit & Berthelot, 2006; Orpana et al., 2007). To describe the distribution of obesity by age, the section on prevalence of obesity later in this chapter includes tables that show the proportion of the population in each BMI group by sex and age for each survey/wave.

Aboriginal Peoples

The survey data used for this report could not allow for valid estimation of obesity prevalence among First Nations, Inuit, or Metis peoples in Manitoba. This is primarily because of the survey sampling methodology for the national surveys, which does not include First Nations communities. However, all Aboriginal residents living in other areas of the province were eligible for the surveys and were included in this report. Results for Aboriginal peoples can be found in other sources, including the Regional Health Surveys and the recent report by PHAC/CIHI (2011). These reports show obesity prevalence to be higher among Aboriginal peoples than other Canadians.

Methods

As noted in Chapter 1, BMI values were taken from data collected during HHS, the NPHS and multiple waves of the CCHS. However, the NPHS and CCHS surveys did not include First Nations communities in their sampling frames which means that residents of these communities were excluded from the surveys. Therefore, the results must be interpreted with caution, especially in areas with a large populations living in First Nations communities (e.g., Burntwood and NOR–MAN RHAs). The Manitoba HHS included residents of First Nations communities, but we excluded them from analyses in this chapter to 'level the playing field' for the time–trend analyses (i.e., to make the HHS sample more comparable to the national surveys).

The BMI values used in this chapter are the 'measured/corrected' values as described in Chapter 1 (section on BMI Values). All analyses were 'weighted' using the sample weights provided by Statistics Canada. This ensures that the results reflect the population represented by the survey participants, not just the participants themselves. Confidence intervals for the estimates were calculated with the 'bootstrap' method (500 sub–samples), using the bootstrap weights provided by Statistics Canada.

Age–**adjusted rates** were calculated using the direct standardization method to allow fair comparisons of the sexes, over time, and across areas. The standard population was the combined group of participants from all survey waves. Comparisons between groups (e.g., males versus females or Normal versus Obese) were done by estimating the difference between the groups, and then bootstrapping the difference (500 sub–samples).

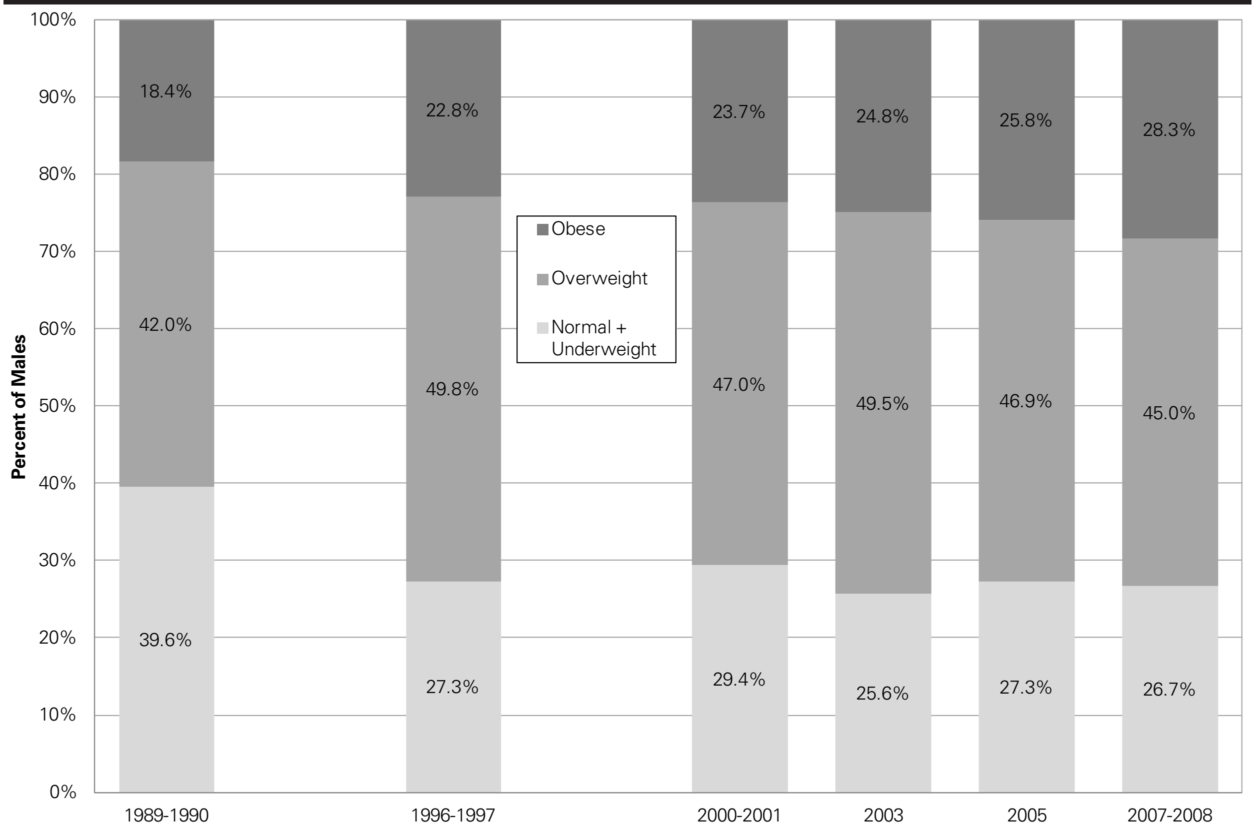
Poisson regression was used to test the change in the prevalence of obesity over time (the proportion of the population in the Obese group). Males and females were analysed separately.

Prevalence of Obesity in Manitoba and Changes Over Time

There has been a significant increase in the prevalence of obesity among both males and females in Manitoba from 1989 to 2008. Figure 2.1 summarizes the distribution of BMI values for males over time and Figure 2.2 shows the results for females. Data are not available for every year from 1989 through 2008, so only the years during which survey data were collected are shown in the figures and tables. Two things to note when examining these data:

1. There are some multi–year gaps in the data, especially in the early years.
2. The HHS did not include any participants aged 75 and older, so the numbers shown may over–estimate the obesity level for 1989–1990 to some extent.

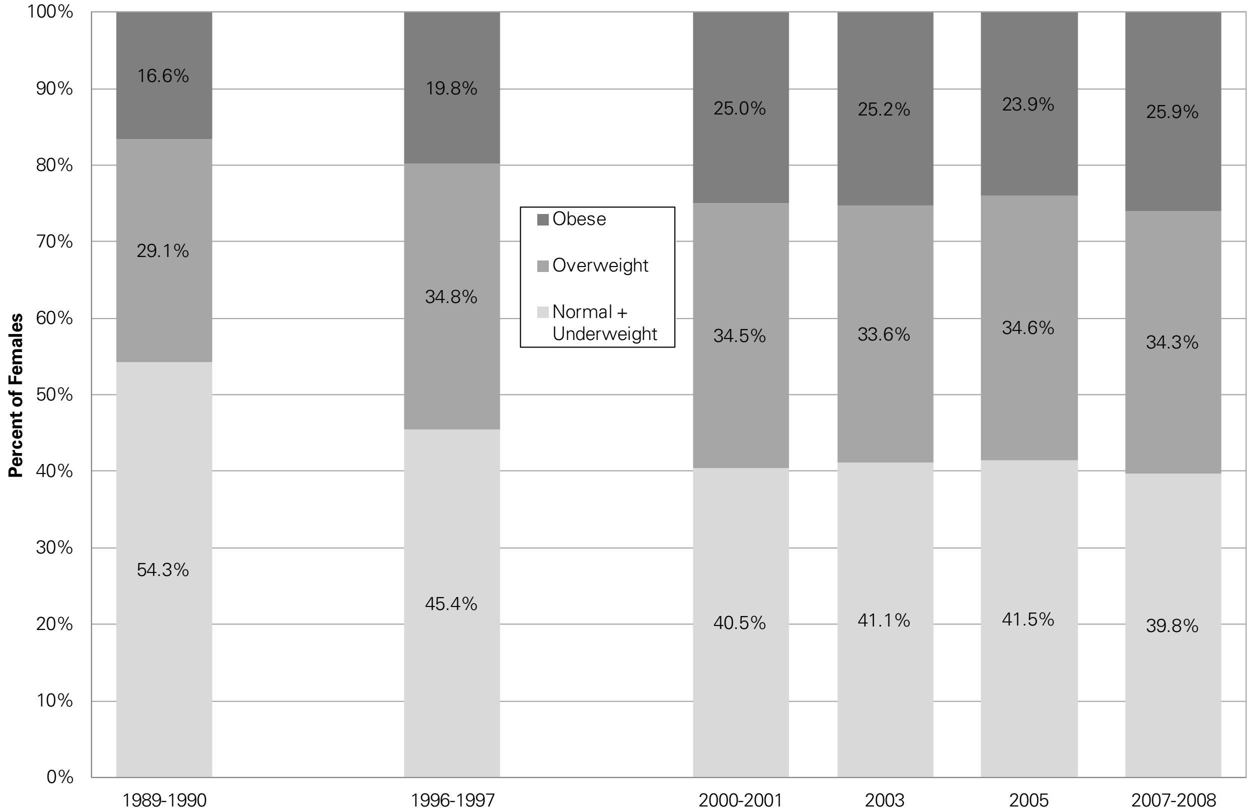
Figure 2.1: Male BMI Distribution Over Time, 1989–2008
Crude percent of males aged 18 and older (measured/corrected BMI)



Residents of First Nations communities excluded

Source: Manitoba Centre for Health Policy, 2011

Figure 2.2: Female BMI Distribution Over Time, 1989–2008
Crude percent of females aged 18 and older (measured/corrected BMI)



Residents of First Nations communities excluded

Source: Manitoba Centre for Health Policy, 2011

Figure 2.1 shows that the proportion of males in the Obese group increased by 54% (from 18.4% to 28.3% of all males), while the proportion in the Normal group decreased by 32% (from 39.6% to 26.7%). The proportion in the Overweight group fluctuated between 42.0% and 49.8% during this period, with no clear trend over time. Poisson regression analysis confirmed that the increase in the proportion of males in the Obese group over time was statistically significant ($p<0.05$).

Figure 2.2 shows that the proportion of females in the Obese group increased by 56% (from 16.6% to 25.9% of all females), while the proportion in the Normal group decreased by 27% (from 54.3% to 39.8%). The proportion in the Overweight group fluctuated between 29.1% and 34.8% during this period, with no clear trend over time. Poisson regression analysis confirmed that the increase in the proportion of females in the Obese group over time was statistically significant ($p<0.05$). However, the trend of increasing obesity rates over time appears to have stopped among females: the prevalence of obesity reached 25% in 2000–2001 and was relatively stable through 2007–2008.

Sex Differences

Comparing results for males and females reveals an important similarity and a striking difference. The proportion of males and females in the Obese group was relatively similar: 28.3% of males and 25.9% of females (2007–2008 results). However, there was a sharp sex difference in the other two groups: among females 39.8% were in the Normal group and 34.3% in the Overweight group, among males only 26.7% were in the Normal group and 45.0% were in the Overweight group. This predominance of males in the Overweight group may have important policy and program implications, especially if the Overweight group experiences similar outcomes as the Obese group. This question is explored in depth in Chapters 4–6.

The results shown in Figures 2.1 and 2.2 are estimates of the actual population prevalence values derived from survey participants, which were weighted to represent the entire population. As explained in Chapter 1, the uncertainty associated with the use of a sample is expressed by CIs, usually at the 95% level. Tables 2.1 and 2.2 show the male and female prevalence estimates for each BMI group, along with their CIs, for every survey wave. For example (last column, bottom row of Table 2.1), the estimate of the prevalence of obesity for males in 2007–2008 is 28.3% with an interval from 25.7% to 31.0%. This means that based on the sample of males surveyed, we are 95% certain that the prevalence of obesity for all males in the population is between 25.7% and 31.0%. Confidence intervals are strongly affected by the number of participants involved—the smaller the sample, the wider the CI. This is evident in the intervals shown for the 2002 and 2004 results, which were based on the smaller '.2' cycles of the CCHS.

Table 2.1: Prevalence of Male BMI Groups by Survey Wave
Crude percent of males aged 18 and older (measured/corrected BMI)

Year	Survey	Normal + Underweight Rates (95% CI)	Overweight Rates (95% CI)	Obese Rates (95% CI)
1989-1990	HHS	39.6% (35.6, 43.6)	42.0% (37.8, 46.3)	18.4% (15.2, 21.5)
1996-1997	NPHS	27.3% (24.7, 30.0)	49.8% (47.0, 52.6)	22.8% (20.6, 25.1)
2000-2001	CCHS 1.1	29.4% (26.7, 32.1)	47.0% (44.3, 49.6)	23.7% (21.5, 25.8)
2002	CCHS 1.2	24.6% (21.3, 28.0)	46.8% (43.0, 50.6)	28.5% (24.9, 32.2)
2003	CCHS 2.1	25.6% (22.9, 28.3)	49.5% (46.3, 52.8)	24.8% (22.3, 27.4)
2004	CCHS 2.2	29.3% (24.9, 33.7)	39.2% (33.6, 44.7)	31.5% (25.9, 37.2)
2005	CCHS 3.1	27.3% (24.8, 29.8)	46.9% (43.9, 49.9)	25.8% (23.2, 28.4)
2007-2008	CCHS 4.1 & 2008	26.7% (23.9, 29.4)	45.0% (41.9, 48.2)	28.3% (25.7, 31.0)

Residents of First Nations communities excluded
HHS- Heart Health Survey
NPHS- National Population Health Survey
CCHS- Canadian Community Health Survey

Source: Manitoba Centre for Health Policy, 2011

Table 2.2: Prevalence of Female BMI Groups by Survey Wave
Crude percent of females aged 18 and older (measured/corrected BMI)

Year	Survey	Normal + Underweight Rates (95% CI)	Overweight Rates (95% CI)	Obese Rates (95% CI)
1989-1990	HHS	54.3% (49.9, 58.7)	29.1% (25.1, 33.2)	16.6% (13.3, 19.9)
1996-1997	NPHS	45.4% (42.6, 48.3)	34.8% (32.2, 37.4)	19.8% (17.7, 21.9)
2000-2001	CCHS 1.1	40.5% (37.9, 43.1)	34.5% (32.2, 36.8)	25.0% (22.6, 27.4)
2002	CCHS 1.2	41.9% (37.9, 45.9)	30.7% (27.1, 34.3)	27.4% (24.0, 30.8)
2003	CCHS 2.1	41.1% (37.8, 44.5)	33.6% (30.4, 36.9)	25.2% (22.5, 27.9)
2004	CCHS 2.2	42.0% (37.1, 46.9)	30.1% (25.4, 34.8)	27.9% (23.4, 32.4)
2005	CCHS 3.1	41.5% (38.5, 44.4)	34.6% (31.8, 37.4)	23.9% (21.5, 26.3)
2007-2008	CCHS 4.1 & 2008	39.8% (37.1, 42.5)	34.3% (31.5, 37.1)	25.9% (23.7, 28.1)

Residents of First Nations communities excluded
HHS- Heart Health Survey
NPHS- National Population Health Survey
CCHS- Canadian Community Health Survey

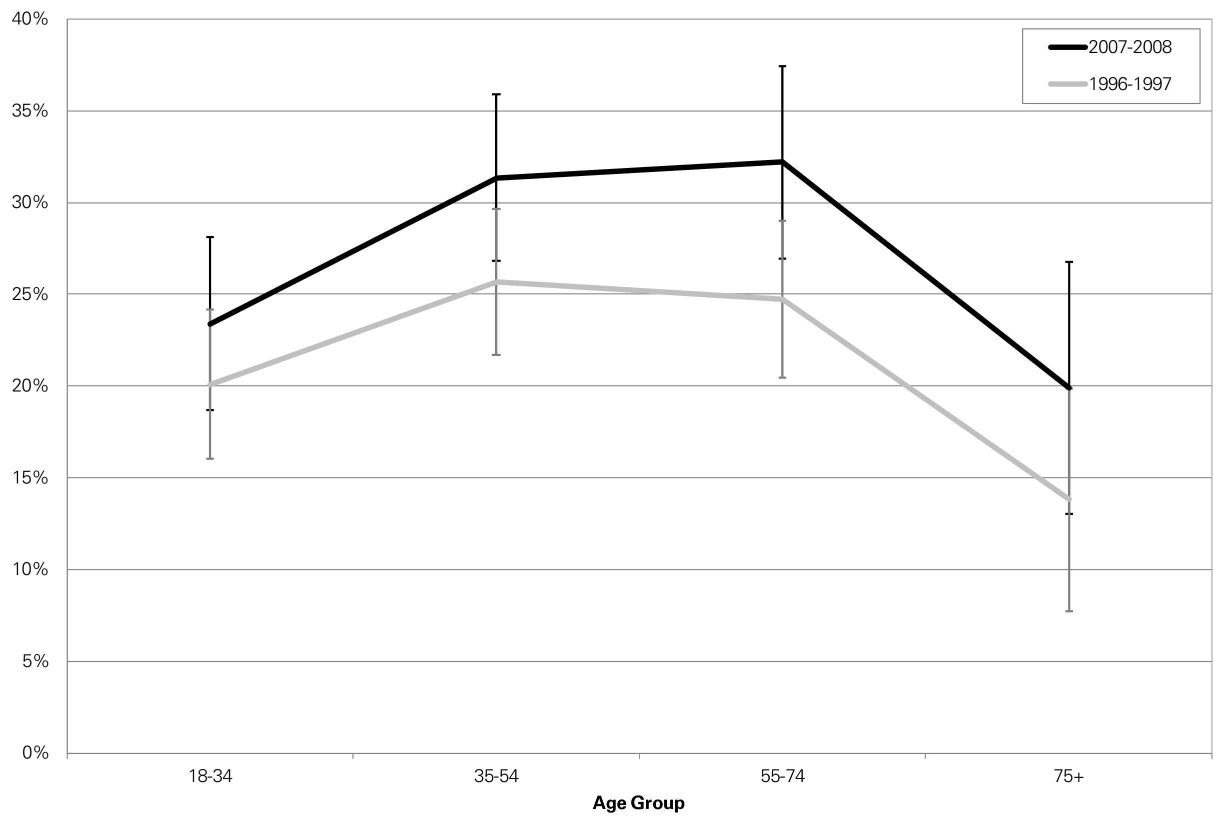
Source: Manitoba Centre for Health Policy, 2011

The data in Tables 2.1 and 2.2 show that underlying the apparently steady trends shown in Figures 2.1 and 2.2, there is considerable variability in the estimates for all three BMI groups, at every time point. The CIs are particularly wide for the smaller surveys—the CCHS '.2' cycles. Furthermore, the estimates of obesity prevalence are considerably higher in those '.2' cycles. This may be due to the fact that, for most participants in the '.2' cycles, height and weight were directly measured rather than taken from self–report as in the '.1' cycles (bearing in mind that self–reported values were all 'corrected'). It may also reflect a slightly different bias in the accuracy of self–reporting due to the different nature and conduct of the '.2' cycles. Either way, the results from these two cycles appear quite different from the others; and since these cycles also had much smaller sample sizes, the main conclusions were drawn from the upward trend in the '.1' cycles.

Obesity Rates by Age

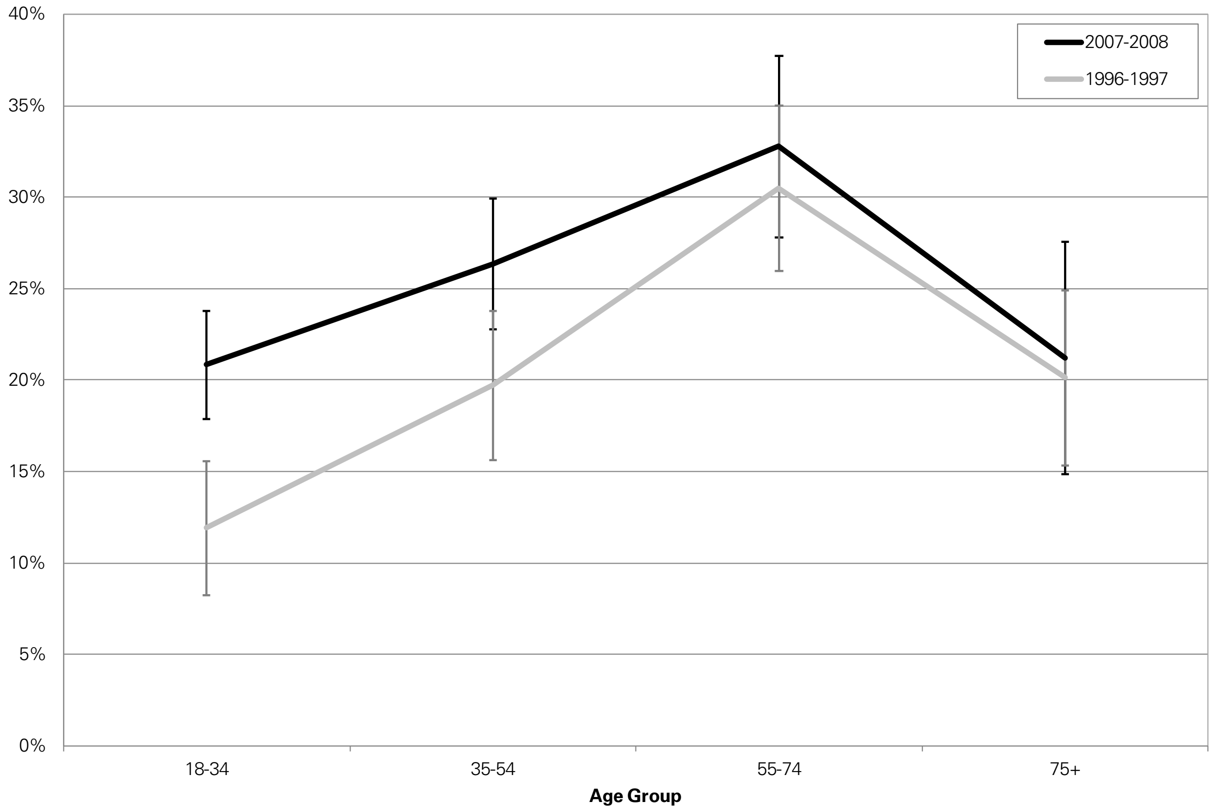
In addition to the sex differences noted above, the prevalence of obesity varies with age and the distributions have changed over time. Figures 2.3 and 2.4 show crude obesity prevalence for males and females in 1996–1997 and 2007–2008, using four broad age groups. (Data from the HHS were not included in these graphs, as it did not include people over age 75; however, HHS results for younger age groups are shown in Tables 2.3 and 2.4).

Figure 2.3: Obesity Prevalence by Age Group for Males, 1996-1997 and 2007-2008
Crude percent (measured/corrected BMI)



Source: Manitoba Centre for Health Policy, 2011

Figure 2.4: Obesity Prevalence by Age Group for Females, 1996-1997 and 2007-2008
Crude percent (measured/corrected BMI)



Source: Manitoba Centre for Health Policy, 2011

The 2007–2008 results in Figures 2.3 and 2.4 show that for both males and females, the prevalence of obesity is higher among older age groups from 18–34 through 55–74 and lower among those 75 and older. However the patterns differ by sex:

- among females, obesity prevalence is lowest among 18– to 34–year–olds, followed by a relatively steady increase with age up to 55– to 74–year–olds, and then a decreased prevalence among those 75 and older
- among males, the prevalence in 18– to 34–year–olds is relatively low, followed by a sharp increase in the 35– to 54–year–old group, a small increase in the 55– to 74–year–old group, and a sharp decrease among those 75 and older, which had the lowest obesity prevalence for males

The largest changes over time were observed in the youngest age group (18–34) for females, and in the 55– to 74–year–old group for males. If results from the HHS are also included (as in Tables 2.3 and 2.4), then the increase in obesity among young females appears even larger, and the largest change among males is also seen in the 18–34 age group. Similar results were reported in the national longitudinal study using NPHS data (Le Petit & Berthelot, 2006).

Results for smaller age groups are shown in Appendix tables A1.1 and A1.2.

Tables 2.3 and 2.4 contain prevalence values (and CIs) for males and females for all three BMI groups by age group and survey.

Table 2.3: Prevalence of Male BMI Groups by Age Group and Survey Wave
Crude percent (measured/corrected BMI)

Age Group	Year	Survey	Males		
			% Normal Rates (95% CI)	% Overweight Rates (95% CI)	% Obese Rates (95% CI)
18-34	1989-1990	HHS	55.6% (49.3, 61.9)	34.6% (28.5, 40.7)	9.8% (6.1, 13.6)
	1996-1997	NPHS	37.6% (32.3, 43.0)	42.3% (37.1, 47.5)	20.1% (16.0, 24.2)
	2000-2001	CCHS 1.1	42.8% (37.9, 47.8)	38.2% (33.4, 43.0)	19.0% (15.1, 22.9)
	2002	CCHS 1.2	36.9% (29.3, 44.5)	38.7% (31.2, 46.3)	24.4% (17.7, 31.0)
	2003	CCHS 2.1	32.1% (26.9, 37.4)	49.7% (44.1, 55.3)	18.1% (14.0, 22.3)
	2004	CCHS 2.2	41.6% (31.9, 51.3)	30.5% (21.0, 39.9)	28.0% (16.9, 39.0)
	2005	CCHS 3.1	39.0% (33.8, 44.2)	44.0% (38.6, 49.3)	17.0% (13.4, 20.7)
	2007-2008	CCHS 4.1 & 2008	37.9% (31.7, 44.1)	38.7% (32.9, 44.5)	23.4% (18.7, 28.1)
35-54	1989-1990	HHS	25.2% (18.2, 32.3)	49.1% (40.6, 57.5)	25.7% (18.5, 33.0)
	1996-1997	NPHS	21.0% (16.9, 25.1)	53.3% (48.6, 58.0)	25.7% (21.7, 29.7)
	2000-2001	CCHS 1.1	20.6% (17.2, 23.9)	50.4% (46.5, 54.2)	29.1% (25.4, 32.8)
	2002	CCHS 1.2	16.0% (11.4, 20.7)	51.0% (44.2, 57.8)	32.9% (26.0, 39.8)
	2003	CCHS 2.1	23.0% (18.7, 27.3)	49.3% (44.2, 54.4)	27.7% (23.5, 31.9)
	2004	CCHS 2.2	21.9% (15.8, 27.9)	46.0% (37.7, 54.3)	32.1% (24.5, 39.8)
	2005	CCHS 3.1	20.9% (16.9, 24.9)	50.1% (45.1, 55.1)	29.0% (24.4, 33.5)
	2007-2008	CCHS 4.1 & 2008	19.4% (15.5, 23.4)	49.2% (44.3, 54.1)	31.4% (26.8, 35.9)
55-74	1989-1990	HHS	31.2% (24.5, 37.8)	45.6% (38.6, 52.5)	23.3% (17.2, 29.4)
	1996-1997	NPHS	17.8% (13.5, 22.1)	57.5% (52.1, 62.8)	24.8% (20.5, 29.0)
	2000-2001	CCHS 1.1	24.3% (18.6, 30.1)	51.9% (45.5, 58.4)	23.7% (18.9, 28.6)
	2002	CCHS 1.2	20.3% (14.2, 26.5)	49.7% (42.4, 57.1)	30.0% (23.0, 36.9)
	2003	CCHS 2.1	19.6% (14.5, 24.7)	50.5% (44.6, 56.3)	29.9% (24.5, 35.4)
	2004	CCHS 2.2	21.0% (13.1, 28.9)	41.6% (31.5, 51.6)	37.4% (27.9, 46.9)
	2005	CCHS 3.1	21.4% (16.7, 26.1)	44.3% (39.0, 49.6)	34.3% (29.0, 39.6)
	2007-2008	CCHS 4.1 & 2008	21.2% (16.9, 25.5)	46.6% (41.2, 52.0)	32.2% (26.9, 37.5)
75+	1989-1990	HHS	no data		
	1996-1997	NPHS	42.4% (32.4, 52.4)	43.8% (34.5, 53.0)	13.8% (7.7, 19.9)
	2000-2001	CCHS 1.1	34.9% (25.9, 43.8)	53.3% (44.0, 62.6)	11.9% (6.7, 17.0)
	2002	CCHS 1.2	31.7% (19.5, 43.9)	50.0% (37.7, 62.3)	18.3% (7.0, 29.5)
	2003	CCHS 2.1	30.7% (23.3, 38.1)	46.8% (38.5, 55.1)	22.5% (14.4, 30.6)
	2004	CCHS 2.2	31.3% (18.3, 44.3)	41.9% (28.3, 55.5)	26.8% (15.3, 38.4)
	2005	CCHS 3.1	29.7% (21.1, 38.2)	51.3% (41.9, 60.7)	19.0% (10.6, 27.5)
	2007-2008	CCHS 4.1 & 2008	32.1% (24.4, 39.9)	48.0% (39.6, 56.3)	19.9% (13.0, 26.8)

Residents of First Nations communities excluded
Italics indicates that rate is highly variable and should be interpreted with caution
HHS- Heart Health Survey
NPHS- National Population Health Survey
CCHS- Canadian Community Health Survey

Source: Manitoba Centre for Health Policy, 2011

Table 2.4: Prevalence of Female BMI Groups by Age Group and Survey Wave
Crude percent (measured/corrected BMI)

Age Group	Year	Survey	Females		
			% Normal Rates (95% CI)	% Overweight Rates (95% CI)	% Obese Rates (95% CI)
18-34	1989-1990	HHS	70.4% (64.3, 76.4)	22.7% (17.2, 28.2)	6.9% (3.6, 10.2)
	1996-1997	NPHS	62.5% (58.0, 67.0)	25.6% (21.4, 29.8)	11.9% (9.0, 14.9)
	2000-2001	CCHS 1.1	52.6% (47.4, 57.9)	27.5% (23.4, 31.6)	19.9% (15.7, 24.0)
	2002	CCHS 1.2	60.7% (53.6, 67.8)	18.9% (13.2, 24.7)	20.3% (14.8, 25.9)
	2003	CCHS 2.1	59.7% (53.9, 65.6)	20.0% (15.3, 24.8)	20.2% (14.3, 26.1)
	2004	CCHS 2.2	54.4% (44.4, 64.4)	27.6% (18.8, 36.4)	18.0% (10.6, 25.4)
	2005	CCHS 3.1	53.0% (48.0, 57.9)	28.2% (23.6, 32.9)	18.8% (15.1, 22.6)
	2007-2008	CCHS 4.1 & 2008	52.5% (47.5, 57.6)	26.6% (22.5, 30.8)	20.8% (17.2, 24.5)
35-54	1989-1990	HHS	54.0% (45.7, 62.4)	24.4% (17.3, 31.5)	21.5% (14.6, 28.5)
	1996-1997	NPHS	40.9% (36.2, 45.6)	39.4% (34.8, 44.0)	19.7% (16.2, 23.3)
	2000-2001	CCHS 1.1	37.2% (33.4, 40.9)	36.6% (32.9, 40.4)	26.2% (22.3, 30.0)
	2002	CCHS 1.2	37.9% (30.4, 45.4)	29.2% (22.8, 35.6)	32.9% (26.4, 39.4)
	2003	CCHS 2.1	36.3% (30.6, 42.1)	38.8% (33.1, 44.5)	24.9% (20.5, 29.2)
	2004	CCHS 2.2	38.5% (28.6, 48.3)	28.4% (19.0, 37.8)	33.1% (23.5, 42.7)
	2005	CCHS 3.1	40.0% (34.6, 45.4)	35.6% (30.4, 40.8)	24.4% (20.0, 28.8)
	2007-2008	CCHS 4.1 & 2008	35.3% (30.6, 40.0)	38.4% (33.0, 43.7)	26.4% (22.3, 30.5)
55-74	1989-1990	HHS	33.5% (26.4, 40.6)	43.4% (35.9, 50.8)	23.1% (16.8, 29.4)
	1996-1997	NPHS	30.0% (25.2, 34.9)	39.5% (34.5, 44.4)	30.5% (25.5, 35.5)
	2000-2001	CCHS 1.1	29.3% (24.3, 34.3)	38.4% (33.4, 43.3)	32.3% (27.7, 37.0)
	2002	CCHS 1.2	28.9% (23.0, 34.8)	42.2% (35.7, 48.6)	28.9% (22.1, 35.7)
	2003	CCHS 2.1	24.3% (19.9, 28.7)	39.8% (34.6, 45.0)	35.9% (30.8, 41.0)
	2004	CCHS 2.2	35.9% (28.4, 43.4)	31.8% (24.5, 39.2)	32.3% (23.9, 40.6)
	2005	CCHS 3.1	31.9% (26.7, 37.1)	38.2% (33.3, 43.1)	29.9% (25.3, 34.5)
	2007-2008	CCHS 4.1 & 2008	29.8% (24.5, 35.2)	37.4% (31.9, 42.8)	32.8% (28.3, 37.3)
75+	1989-1990	HHS	no data		
	1996-1997	NPHS	45.6% (36.9, 54.4)	34.2% (27.1, 41.4)	20.1% (13.8, 26.5)
	2000-2001	CCHS 1.1	41.5% (34.6, 48.4)	38.8% (32.5, 45.1)	19.7% (14.2, 25.3)
	2002	CCHS 1.2	35.0% (25.9, 44.2)	43.4% (34.0, 52.8)	21.6% (13.6, 29.5)
	2003	CCHS 2.1	40.4% (30.3, 50.5)	39.9% (30.2, 49.7)	19.6% (14.1, 25.2)
	2004	CCHS 2.2	33.9% (23.0, 44.8)	39.2% (29.7, 48.7)	26.9% (18.2, 35.6)
	2005	CCHS 3.1	35.5% (29.5, 41.5)	41.3% (35.0, 47.7)	23.2% (18.1, 28.3)
	2007-2008	CCHS 4.1 & 2008	44.4% (38.3, 50.6)	34.4% (28.6, 40.1)	21.2% (16.4, 26.0)

Residents of First Nations communities excluded
Italics indicates that rate is highly variable and should be interpreted with caution
HHS- Heart Health Survey
NPHS- National Population Health Survey
CCHS- Canadian Community Health Survey

Source: Manitoba Centre for Health Policy, 2011

The age and sex distribution of obesity in Manitoba is similar to that for Canada overall (Shields & Tjepkema, 2006b; Tjepkema, 2006). The substantial increases in obesity prevalence among young adults in Manitoba reflect similar findings from national data (Shields & Tjepkema, 2006b). These increases are disturbing findings. They mean that more people are in the Obese group from a younger age and are therefore exposed to the risks associated with obesity from a younger age.

Sub–Groups Within the Obese Group

The Obese group is often sub–divided into three classes:

Class I: BMI 30 – 34.9
Class II: BMI 35 – 39.9
Class III: BMI 40+

Sub–dividing the Obese group into these three classes provides additional insight into population trends over time. Also, health risks are known to increase with increasing levels of obesity, so these trends may have implications for morbidity, health service use, and mortality (as will be explored in Chapters 4–6).

The following tables show the prevalence of the three subgroups of obesity by sex and over time.

Table 2.5: Male Obesity Prevalence by Obesity Class and Time
Crude percent of males aged 18 and older (measured/corrected BMI)

Year	Survey	Obese I Rates (95% CI)	Obese II Rates (95% CI)	Obese III Rates (95% CI)
1989–1990	HHS	14.6% (11.8, 17.3)	*2.8% (1.3, 4.3)*	*1.0% (0.2, 1.8)*
1996–1997	NPHS	17.8% (15.7, 19.8)	4.2% (3.2, 5.3)	*0.8% (0.5, 1.1)*
2000–2001	CCHS 1.1	17.2% (15.3, 19.1)	4.9% (3.7, 6.0)	*1.5% (0.8, 2.2)*
2002	CCHS 1.2	21.0% (17.8, 24.2)	5.1% (3.3, 7.0)	*2.5% (1.0, 4.0)*
2003	CCHS 2.1	17.9% (15.6, 20.2)	5.8% (4.4, 7.2)	*1.1% (0.6, 1.7)*
2004	CCHS 2.2	22.4% (17.1, 27.7)	6.9% (4.6, 9.1)	*2.3% (1.0, 3.6)*
2005	CCHS 3.1	18.7% (16.3, 21.0)	5.5% (4.2, 6.8)	*1.6% (1.0, 2.2)*
2007–2008	CCHS 4.1 & 2008	20.6% (18.1, 23.1)	6.2% (4.8, 7.6)	*1.5% (1.0, 2.0)*

Residents of First Nations communities excluded
Italics indicates that rate is highly variable and should be interpreted with caution
HHS- Heart Health Survey
NPHS- National Population Health Survey
CCHS- Canadian Community Health Survey

Source: Manitoba Centre for Health Policy, 2011

The data in Table 2.5 show that among males, Class II obesity had the highest increase over time, more than doubling, from 2.8% to 6.2% of all males. Class I obesity increased by 41% (from 14.6% to 20.6%), and Class III increased by 50% (from 1% to 1.5%). However, all the estimates for Class III were highly variable, so need to be interpreted with caution.

Among females, both Class II and Class III increased by about 71% (from 3.9% to 6.7% of all females for Class II, and from 2.1% to 3.6% for Class III). Class I increased by 47%, from 10.6% of all females to 15.6%. As with males, some of the estimates for females in Class III were highly variable, so need to be interpreted with caution.

Together, these obesity sub–group results show more substantial sex differences than those for the Obese group overall: at almost all time periods, the prevalence of both Class II and Class III obesity was

Table 2.6: Female Obesity Prevalence by Obesity Class and Time
Crude percent of females aged 18 and older (measured/corrected BMI)

Year	Survey	Obese I Rates (95% CI)	Obese II Rates (95% CI)	Obese III Rates (95% CI)
1989–1990	HHS	10.6% (7.9, 13.3)	*3.9% (2.2, 5.5)*	*2.1% (0.7, 3.5)*
1996–1997	NPHS	13.5% (11.6, 15.4)	4.4% (3.4, 5.4)	*1.9% (1.2, 2.5)*
2000–2001	CCHS 1.1	15.9% (13.9, 17.9)	6.3% (4.9, 7.7)	2.8% (2.1, 3.6)
2002	CCHS 1.2	16.1% (13.2, 18.9)	7.9% (5.7, 10.0)	*3.5% (2.1, 4.9)*
2003	CCHS 2.1	16.1% (13.6, 18.5)	6.5% (4.8, 8.2)	2.6% (1.8, 3.4)
2004	CCHS 2.2	16.3% (12.7, 19.9)	5.7% (3.9, 7.4)	*5.9% (3.2, 8.6)*
2005	CCHS 3.1	16.0% (14.0, 18.1)	5.1% (4.0, 6.1)	2.9% (2.0, 3.7)
2007–2008	CCHS 4.1 & 2008	15.6% (13.8, 17.4)	6.7% (5.3, 8.2)	3.6% (2.8, 4.5)

Residents of First Nations communities excluded
Italics indicates that rate is highly variable and should be interpreted with caution
HHS- Heart Health Survey
NPHS- National Population Health Survey
CCHS- Canadian Community Health Survey

Source: Manitoba Centre for Health Policy, 2011

higher among females than males. Both sexes increased over time. As of 2007–2008, 10.3% of females were in Classes II or III, compared with 7.7% of males.

Distribution of BMI Values Using Continuous Measures

In the previous section, results were summarized into the three main groups of BMI values: Normal and Underweight, Overweight, and Obese. However, the data can also be analysed using 'continuous' BMI values, allowing a more detailed view of the distribution and changes in BMI values in Manitoba. Table 2.7 shows the average (or 'mean') BMI value for males and females for each survey wave, along with the 95% CIs for each estimate.

Table 2.7: Average BMI Values for Males and Females Aged 18 and Older, 1989–2008
Measured/corrected BMI

Year	Survey	Males Mean (95% CI)	Females Mean (95% CI)
1989-1990	HHS	26.5 (26.1, 26.9)	25.5 (25.0, 26.0)
1996-1997	NPHS	27.4 (27.2, 27.7)	26.4 (26.1, 26.7)
2000-2001	CCHS 1.1	27.5 (27.2, 27.7)	27.1 (26.8, 27.5)
2002	CCHS 1.2	28.1 (27.7, 28.5)	27.3 (26.9, 27.8)
2003	CCHS 2.1	27.8 (27.6, 28.1)	27.0 (26.7, 27.4)
2004	CCHS 2.2	28.2 (27.7, 28.7)	27.6 (26.8, 28.3)
2005	CCHS 3.1	27.8 (27.5, 28.0)	27.0 (26.7, 27.4)
2007-2008	CCHS 4.1 & 2008	27.9 (27.7, 28.2)	27.3 (27.0, 27.6)

Residents of First Nations communities excluded
HHS- Heart Health Survey
NPHS- National Population Health Survey
CCHS- Canadian Community Health Survey

Source: Manitoba Centre for Health Policy, 2011

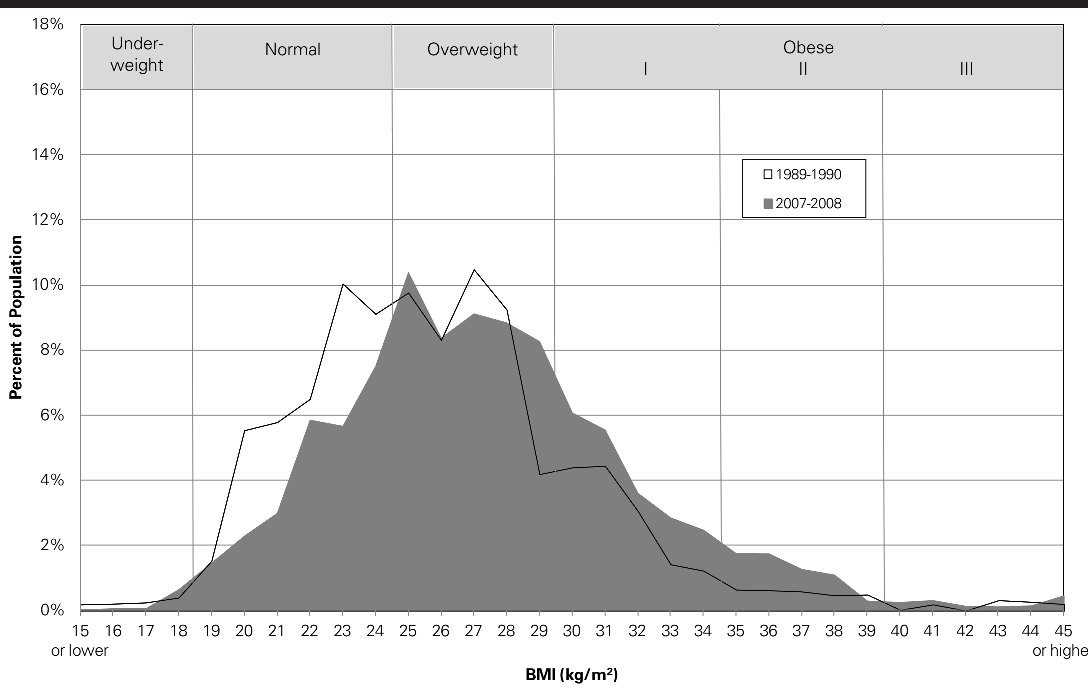
The results in Table 2.7 show increasing average BMI values over time: the mean BMI for males increased by 5.3% (from 26.5 to 27.9) and for females by 7.1% (from 25.5 to 27.3) [8]. These changes are statistically significant for both males and females, as indicated by the non–overlapping CIs for the 1989–1990 results versus all other cycles. However, the overlapping CIs for all subsequent time periods implies that the largest increases were seen in the earliest time period in this study, with relatively small increases thereafter.

The changes may seem like relatively small increases in average BMI values, but they represent substantial changes for individuals and for the population. For example, for a woman 5 feet 6 inches tall, a 1.8 unit increase in BMI reflects a difference of 11 pounds in weight.

The increases in mean BMI values shown in Table 2.7 may seem discrepant from the results in the previous section because the increases in the prevalence of obesity were much larger. This difference is explained by a shift in the distribution of BMI values for the entire population: while the increase in mean values may seem smaller, the shift in the entire distribution results in large increases in the proportion of the population in the Obese group. This difference can be illustrated using histograms—figures that show the percentage of the population at each BMI value.

Figures 2.5 and 2.6 are histograms that show the distribution of BMI values for males and females in the earliest time period (1989–1990) and the latest time period (2007–2008). The older data are indicated by the black lines, and the newer data are shown by the gray shading. These figures illustrate how the distribution of BMI values has shifted to the right (higher BMI values) over time, among both males and females. This shift caused an increase in the mean BMI values and a large increase in the proportion of the population with a BMI of 30 or higher (the Obese group).

Figure 2.5: Male Measured/Corrected BMI Distribution Over Time

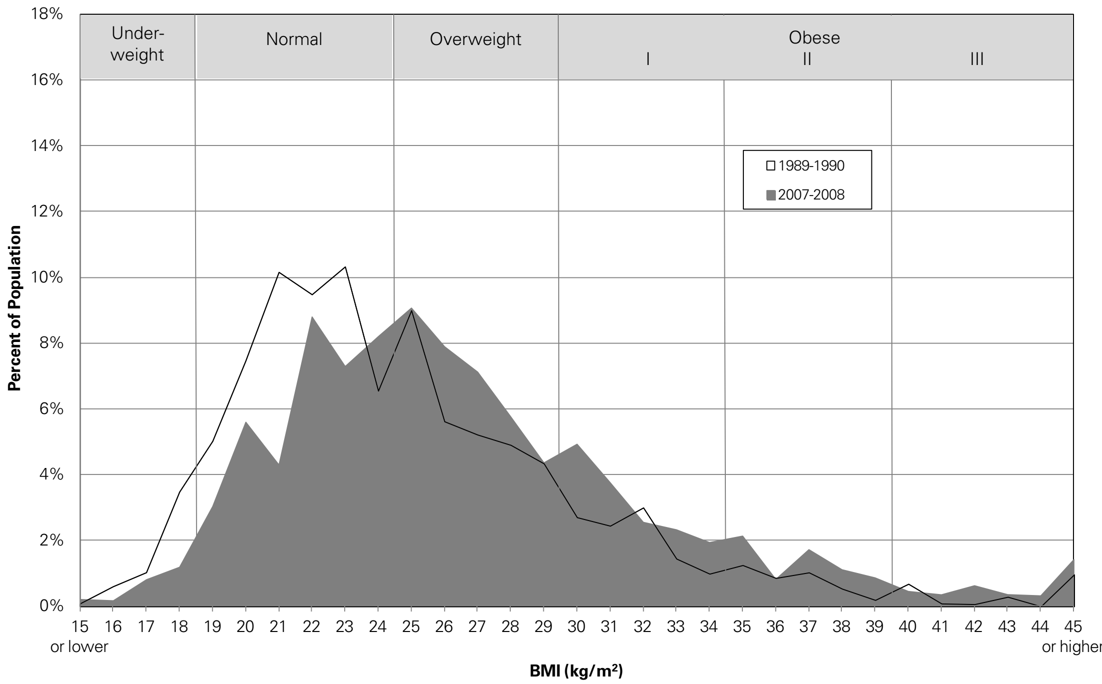


Residents of First Nations communities are excluded

Source: Manitoba Centre for Health Policy, 2011

8 As seen in the analyses of BMI groups in section "Prevalence of Obesity in Manitoba and Changes Over Time", the results from the smaller survey waves are a bit different and have wider confidence intervals, but the long–term trend remains clear.

Figure 2.6: Female Measured/Corrected BMI Distribution Over Time



Residents of First Nations communities are excluded

Source: Manitoba Centre for Health Policy, 2011

Among males, the most frequently occurring BMI values in 1989–1990 were in the 23–28 range, whereas by 2007–2008, the peak was from 25–29. For females, the peak shifted from being in the 20–23 range to the 22–26 range. The entire curve shifted up, so a much lower proportion were in the Normal group and a much higher proportion were in the Obese group. Re–stating the values from the previous section: 18.4% of males were in the Obese group in 1989–1990, versus 28.3% in 2007–2008; the corresponding values for females were 16.6% and 25.9%.

Comparison to Other Results for Manitobans

We found no other studies reporting population–based BMI or obesity values for Manitoba adults except those using the same data sources as this study (i.e., Statistics Canada surveys and HHS). Therefore, this section primarily compares Manitoba results to those for Canada overall, using those sources (see the last section of Chapter 1 for a review of literature on obesity in Canada).

The results shown in this report are consistent with those reported for Manitoba in a previous MCHP study (Fransoo et al., 2009), although the obesity prevalence values are higher and more accurate in this report because of the BMI corrections used. While the correction changes each person's BMI only slightly, it has a large impact on the proportion of the population in the Obese range. This association has been documented by national studies as well (Shields et al., 2008a).

For this report, 'corrected' BMI values were calculated from self–reported height and weight, but only results for Manitobans were available (i.e., not all Canadians). Therefore, comparisons with national results had to be conducted using 'uncorrected' values. Tables 2.8 and 2.9 below show self–report BMI values over time in Manitoba and Canada for males and females, respectively, from Statistics Canada

Table 2.8: Uncorrected Prevalence of Male BMI Groups, Aged 18 and Older, Canada and Manitoba
Age-adjusted, self-reported values

Year	Males					
	Normal		Overweight		Obese	
	Canada	Manitoba	Canada	Manitoba	Canada	Manitoba
1994	43.2	38.1	42.8	42.9	12.4	17.2
1996	42.0	37.8	43.2	44.0	12.4	16.5
1998	40.4	34.5	43.7	45.0	14.0	19.5
2000	44.6	42.0	38.4	40.3	15.0	16.8
2003	42.2	36.2	40.3	42.1	15.6	19.3
2005	41.6	37.6	40.3	41.7	16.2	18.9
2007	39.5	35.6	38.6	40.7	16.7	19.9

Persons less than 3 feet (0.914 metres) tall or greater than 6 feet 11 inches (2.108 metres) were excluded.

Adapted from: Statistics Canada. Table 105-4009 - Body mass index (BMI), by sex, household population aged 18 and over excluding pregnant females, Canada, provinces and territories, occasional.
Accessed: April 28, 2011

Table 2.9: Uncorrected Prevalence of Female BMI Groups, Aged 18 and Older, Canada and Manitoba
Age-adjusted, self-reported values

Year	Females					
	Normal		Overweight		Obese	
	Canada	Manitoba	Canada	Manitoba	Canada	Manitoba
1994	55.5	54.8	25.4	28.7	12.5	12.6
1996	56.3	51.3	24.4	26.4	10.9	12.8
1998	55.4	52.9	25.4	29.5	13.3	15.3
2000	54.2	49.2	24.9	26.8	13.2	17.1
2003	53.5	48.7	24.5	25.7	13.3	16.8
2005	53.3	48.0	24.8	27.3	13.6	16.2
2007	52.1	47.2	24.2	27.3	14.3	15.6

Pregnant females and persons less than 3 feet (0.914 metres) tall or greater than 6 feet 11 inches (2.108 metres) were excluded.

Adapted from: Statistics Canada. Table 105-4009 - Body mass index (BMI), by sex, household population aged 18 and over excluding pregnant females, Canada, provinces and territories, occasional.
Accessed: April 28, 2011

(Statistics Canada, 2008). Compared to the corrected values used in this study, the obesity prevalence using 'uncorrected' values in Tables 2.8 and 2.9 are markedly lower.

Compared to Canada overall, Manitoba has a consistently higher proportion of males and females in the Obese group and a lower proportion in the Normal group. This difference has persisted in all cycles of the NPHS and CCHS, including those employing direct height and weight measurements (Shields & Tjepkema, 2006a; Shields & Tjepkema, 2006b; Tjepkema, 2006).

The results suggest several interesting trends and differences:

- Among males, the story is relatively simple: the prevalence of obesity among males in Manitoba (corrected and uncorrected) and in Canada increased from 1994 through 2008, but the trend in the Manitoba data was less consistent over time.
- Among females, the uncorrected prevalence of obesity in Manitoba appears to have peaked at about 17% by the year 2000, with slight decreases thereafter. The national data show an early increase, then stabilization at around 13.5% by the year 1998, followed by another increase in the most recent data.

It is evident that the trend in female obesity in Manitoba is not exactly the same as that in the rest of Canada. These differences have the effect of narrowing the gap between provincial and national values for females.

- It should be noted, however, that these trends in 'self–reported' BMI values are not the same as for the 'measured/corrected' values shown in the "Prevalence of Obesity" and "Distribution of BMI Values" sections; those data suggest that obesity among females has stabilized, but with no apparent decrease in the most recent results. Given that the 'measured/corrected' values are more accurate, the conclusion of stabilized rates seems more supportable.

The shape of the BMI distribution in Manitoba ("Distribution of BMI Values" section) is also similar to that reported for Canada (Tjepkema, 2006). For both, the curves shifted to the right over time (Shields & Tjepkema, 2006b).

Distribution of Obesity by RHA

This section describes the distribution and changes over time of BMI values in the 11 RHAs in Manitoba. To provide results at this smaller level of geography, data from multiple years/surveys were combined. Results from the HHS were not included in this section because that survey was too small to provide RHA–level results (we also considered grouping it with NPHS data, but decided not to because the data collection periods were six years apart and prevalence values likely changed over that time.)

Data were grouped into three time periods:

Time 1: 1996–1997	NPHS
Time 2: 2000–2003	CCHS 1.1, 1.2, and 2.1
Time 3: 2004–2008	CCHS 2.2, 3.1, 4.1 (2007), and 2008

Note: Results for areas that have a substantial proportion of residents living in First Nations communities (e.g., Burntwood RHA) must be interpreted with caution, as the NPHS and CCHS excluded these communities. However, First Nations residents living elsewhere in those RHAs were eligible for inclusion in the surveys.

Tables 2.10 through 2.15 show the prevalence of the three BMI groups by RHA for males, females, and each time period. In these tables, the RHAs are ranked by a measure of overall population health status (the **premature mortality rate**), such that the RHAs listed near the top have the most healthy populations and those listed near the bottom have the least healthy populations.

Table 2.10: Male BMI Distribution by RHA, 1996–1997
Age–adjusted percent of males aged 18 and older (measured/correlated BMI)

RHA	% Normal	% Overweight	% Obese
South Eastman	24.3% (17.3, 31.3)	50.7% (42.8, 58.5)	25.0% (18.5, 31.6)
Central	23.6% (17.5, 29.8)	48.1% (40.0, 56.1)	28.3% (20.6, 35.9)
Assiniboine	26.3% (20.5, 32.1)	49.2% (42.5, 56.0)	24.5% (19.7, 29.3)
Brandon	29.5% (21.9, 37.0)	48.5% (40.5, 56.4)	22.1% (15.9, 28.2)
Winnipeg	29.5% (23.6, 35.3)	50.0% (43.8, 56.2)	20.5% (15.6, 25.5)
Interlake	**19.7% (13.3, 26.0)**	50.8% (42.0, 59.6)	29.5% (20.6, 38.5)
North Eastman	**20.1% (14.3, 26.0)**	57.3% (48.1, 66.5)	22.6% (15.8, 29.5)
Parkland	22.1% (15.6, 28.7)	51.2% (43.6, 58.8)	26.6% (19.7, 33.6)
Churchill	s	s	s
Nor-Man	23.5% (15.4, 31.7)	48.3% (38.7, 57.9)	28.2% (20.2, 36.1)
Burntwood	*24.0% (12.4, 35.6)*	48.2% (30.5, 65.9)	27.8% (17.2, 38.3)
Rural South	24.8% (21.0, 28.6)	48.9% (44.3, 53.5)	26.3% (22.2, 30.4)
Mid	**20.2% (16.5, 24.0)**	52.9% (47.5, 58.3)	26.9% (22.0, 31.8)
North	27.3% (18.4, 36.3)	44.1% (36.1, 52.2)	28.5% (21.7, 35.4)
Manitoba	27.0% (23.6, 30.5)	49.9% (46.2, 53.6)	23.1% (20.1, 26.1)

Residents of First Nations communities excluded
Bold indicates that the area's rate was statistically different from the Manitoba average (p<0.05)
Italics indicates that the area's rate is highly variable and should be interpreted with caution
"s" indicates data suppressed due to small numbers

Source: Manitoba Centre for Health Policy, 2011

Table 2.11: Female BMI Distribution by RHA, 1996–1997
Age–adjusted percent of females aged 18 and older (measured/correlated BMI)

RHA	% Normal	% Overweight	% Obese
South Eastman	42.3% (35.9, 48.8)	38.4% (31.7, 45.1)	19.2% (14.1, 24.4)
Central	44.2% (36.9, 51.6)	32.5% (25.7, 39.3)	23.2% (17.1, 29.4)
Assiniboine	41.1% (35.3, 46.8)	36.3% (30.8, 41.7)	22.7% (18.3, 27.0)
Brandon	49.6% (43.3, 55.9)	32.0% (25.8, 38.3)	18.4% (13.5, 23.2)
Winnipeg	47.5% (41.8, 53.2)	34.3% (29.0, 39.6)	18.2% (13.9, 22.6)
Interlake	**37.7% (30.4, 44.9)**	39.7% (32.4, 47.0)	22.6% (17.3, 27.9)
North Eastman	40.7% (32.6, 48.8)	34.0% (26.6, 41.5)	25.3% (18.9, 31.7)
Parkland	40.8% (34.2, 47.3)	35.7% (29.4, 42.0)	23.5% (17.4, 29.6)
Churchill	s	s	s
Nor-Man	36.3% (27.1, 45.4)	31.7% (23.5, 39.8)	**32.1% (23.4, 40.7)**
Burntwood	**32.9% (22.3, 43.4)**	41.5% (28.7, 54.2)	25.7% (16.9, 34.4)
Rural South	42.8% (38.7, 46.8)	35.2% (31.5, 38.9)	22.1% (18.7, 25.4)
Mid	**39.3% (34.9, 43.7)**	37.4% (32.9, 41.8)	23.3% (19.8, 26.8)
North	**36.5% (29.0, 43.9)**	34.7% (27.7, 41.8)	**28.8% (22.0, 35.6)**
Manitoba	45.3% (41.7, 49.0)	34.7% (31.3, 38.1)	20.0% (17.2, 22.8)

Residents of First Nations communities excluded
Bold indicates that the area's rate was statistically different from the Manitoba average (p<0.05)
Italics indicates that the area's rate is highly variable and should be interpreted with caution
"s" indicates data suppressed due to small numbers

Source: Manitoba Centre for Health Policy, 2011

Table 2.12: Male BMI Distribution by RHA, 2000–2003
Age–adjusted percent of males aged 18 and older (measured/correlated BMI)

RHA	% Normal	% Overweight	% Obese
South Eastman	29.3% (23.1, 35.5)	46.7% (37.9, 55.6)	24.0% (16.5, 31.5)
Central	26.3% (20.5, 32.1)	43.9% (35.2, 52.6)	29.8% (22.2, 37.4)
Assiniboine	20.1% (12.8, 27.4)	51.3% (43.8, 58.8)	28.6% (20.4, 36.8)
Brandon	26.5% (17.5, 35.5)	44.3% (34.0, 54.7)	29.1% (22.2, 36.1)
Winnipeg	**28.6% (25.3, 31.9)**	48.8% (45.2, 52.5)	**22.6% (19.5, 25.7)**
Interlake	**18.6% (11.5, 25.8)**	44.8% (36.4, 53.1)	**36.6% (29.4, 43.8)**
North Eastman	28.9% (19.0, 38.8)	48.1% (39.3, 56.9)	23.0% (14.4, 31.6)
Parkland	**19.1% (11.9, 26.3)**	43.3% (34.1, 52.5)	**37.6% (28.0, 47.1)**
Churchill	s	s	s
Nor-Man	***14.5% (5.4, 23.6)***	52.7% (45.9, 59.6)	32.7% (24.7, 40.8)
Burntwood	*22.5% (12.7, 32.2)*	40.7% (30.8, 50.7)	**36.8% (27.7, 46.0)**
Rural South	25.0% (21.2, 28.8)	47.5% (42.3, 52.6)	27.5% (22.9, 32.2)
Mid	21.7% (16.4, 26.9)	45.0% (40.0, 49.9)	**33.3% (28.1, 38.6)**
North	**17.3% (10.3, 24.3)**	47.2% (41.1, 53.3)	**35.5% (29.5, 41.6)**
Manitoba	26.5% (24.2, 28.8)	47.8% (45.3, 50.3)	25.7% (23.5, 27.9)

Residents of First Nations communities excluded
Bold indicates that the area's rate was statistically different from the Manitoba average (p<0.05)
Italics indicates that the area's rate is highly variable and should be interpreted with caution
"s" indicates data suppressed due to small numbers

Source: Manitoba Centre for Health Policy, 2011

Table 2.13: Female BMI Distribution by RHA, 2000–2003
Age–adjusted percent of females aged 18 and older (measured/correlated BMI)

RHA	% Normal	% Overweight	% Obese
South Eastman	42.4% (34.7, 50.2)	34.5% (24.6, 44.4)	23.1% (16.0, 30.1)
Central	40.4% (35.1, 45.7)	33.7% (27.4, 40.0)	25.9% (19.8, 32.1)
Assiniboine	38.2% (30.9, 45.6)	32.6% (24.7, 40.5)	29.2% (24.0, 34.3)
Brandon	43.1% (34.2, 52.0)	35.6% (28.6, 42.5)	21.4% (15.7, 27.0)
Winnipeg	42.8% (39.2, 46.4)	32.6% (29.4, 35.9)	24.6% (21.2, 27.9)
Interlake	35.8% (27.2, 44.5)	33.4% (27.1, 39.7)	30.8% (23.5, 38.1)
North Eastman	38.2% (28.1, 48.3)	32.0% (25.6, 38.4)	29.8% (20.6, 39.1)
Parkland	**26.1% (18.2, 34.1)**	40.9% (30.5, 51.3)	33.0% (24.4, 41.6)
Churchill	s	s	s
Nor-Man	*41.2% (22.7, 59.7)*	*29.0% (16.2, 41.8)*	29.8% (20.9, 38.7)
Burntwood	36.3% (25.9, 46.7)	26.8% (17.8, 35.7)	**37.0% (27.3, 46.6)**
Rural South	40.7% (36.8, 44.6)	33.0% (28.7, 37.3)	26.3% (22.9, 29.7)
Mid	**34.1% (28.7, 39.6)**	34.2% (29.5, 38.8)	**31.7% (26.4, 36.9)**
North	38.0% (26.1, 50.0)	27.8% (19.8, 35.9)	**34.1% (27.1, 41.1)**
Manitoba	41.2% (38.7, 43.7)	32.8% (30.4, 35.2)	26.0% (23.7, 28.3)

Residents of First Nations communities excluded
Bold indicates that the area's rate was statistically different from the Manitoba average (p<0.05)
Italics indicates that the area's rate is highly variable and should be interpreted with caution
"s" indicates data suppressed due to small numbers

Source: Manitoba Centre for Health Policy, 2011

Table 2.14: Male BMI Distribution by RHA, 2004–2008
Age–adjusted percent of males aged 18 and older (measured/correlated BMI)

RHA	% Normal	% Overweight	% Obese
South Eastman	28.0% (19.8, 36.1)	42.3% (32.7, 52.0)	29.7% (21.7, 37.7)
Central	**22.2% (17.6, 26.9)**	45.5% (38.9, 52.1)	32.2% (25.9, 38.5)
Assiniboine	23.3% (16.1, 30.4)	39.9% (32.1, 47.6)	36.9% (28.2, 45.5)
Brandon	30.9% (23.2, 38.7)	40.5% (32.5, 48.5)	28.5% (20.3, 36.8)
Winnipeg	**29.7% (26.0, 33.4)**	45.5% (41.0, 49.9)	**24.8% (20.8, 28.8)**
Interlake	23.3% (16.2, 30.4)	38.7% (31.2, 46.2)	**38.0% (30.6, 45.4)**
North Eastman	21.1% (13.1, 29.0)	50.4% (40.9, 59.9)	28.5% (20.7, 36.4)
Parkland	*21.7% (11.0, 32.5)*	47.2% (36.8, 57.5)	31.1% (20.0, 42.2)
Churchill	s	s	s
Nor-Man	22.0% (14.5, 29.5)	35.4% (25.4, 45.5)	**42.6% (34.2, 51.0)**
Burntwood	**18.5% (11.0, 25.9)**	41.8% (31.5, 52.0)	**39.8% (29.7, 49.8)**
Rural South	23.9% (20.3, 27.5)	43.3% (38.7, 48.0)	32.7% (28.2, 37.3)
Mid	22.9% (17.6, 28.3)	42.8% (37.2, 48.4)	**34.3% (29.1, 39.4)**
North	**19.7% (15.2, 24.2)**	40.0% (33.4, 46.5)	**40.3% (34.5, 46.2)**
Manitoba	27.4% (25.1, 29.8)	44.1% (41.2, 47.0)	28.4% (25.7, 31.1)

Residents of First Nations communities excluded
Bold indicates that the area's rate was statistically different from the Manitoba average ($p<0.05$)
Italics indicates that the area's rate is highly variable and should be interpreted with caution
"s" indicates data suppressed due to small numbers

Source: Manitoba Centre for Health Policy, 2011

Table 2.15: Female BMI Distribution by RHA, 2004–2008
Age–adjusted percent of females aged 18 and older (measured/correlated BMI)

RHA	% Normal Rates (95% CI)	% Overweight Rates (95% CI)	% Obese Rates (95% CI)
South Eastman	36.2% (25.9, 46.4)	37.8% (28.8, 46.8)	26.0% (18.8, 33.3)
Central	37.4% (30.8, 43.9)	29.9% (23.9, 35.8)	**32.8% (26.6, 39.0)**
Assiniboine	36.2% (28.9, 43.4)	33.1% (26.2, 40.1)	30.7% (22.7, 38.8)
Brandon	38.8% (31.3, 46.3)	32.8% (25.6, 40.1)	28.3% (21.7, 35.0)
Winnipeg	**45.2% (41.2, 49.2)**	33.0% (29.3, 36.8)	**21.7% (18.7, 24.8)**
Interlake	**27.4% (19.9, 34.9)**	33.9% (25.8, 42.0)	**38.7% (31.3, 46.1)**
North Eastman	32.7% (24.1, 41.4)	36.2% (26.0, 46.4)	31.1% (22.9, 39.2)
Parkland	**31.8% (22.9, 40.7)**	37.0% (27.4, 46.6)	31.2% (23.3, 39.1)
Churchill	s	s	s
Nor-Man	34.3% (24.3, 44.4)	34.0% (22.9, 45.1)	31.7% (22.0, 41.4)
Burntwood	**25.1% (17.1, 33.0)**	34.1% (24.0, 44.1)	**40.9% (31.2, 50.5)**
Rural South	36.8% (32.1, 41.4)	33.2% (29.0, 37.3)	**30.1% (25.7, 34.4)**
Mid	**29.6% (24.4, 34.7)**	35.0% (29.5, 40.4)	**35.5% (30.4, 40.5)**
North	**30.5% (23.7, 37.2)**	33.9% (26.6, 41.1)	**35.7% (28.8, 42.6)**
Manitoba	41.0% (38.2, 43.7)	33.2% (30.7, 35.8)	25.8% (23.6, 28.0)

Residents of First Nations communities excluded
Bold indicates that the area's rate was statistically different from the Manitoba average ($p<0.05$)
Italics indicates that the area's rate is highly variable and should be interpreted with caution
"s" indicates data suppressed due to small numbers

Source: Manitoba Centre for Health Policy, 2011

The results in Tables 2.10 through 2.15 show that there are differences in the prevalence of the three BMI groups across RHAs and over time. However, because the sample sizes are relatively small, the CIs for each estimate are quite wide. This makes it impossible to draw firm conclusions regarding, for example, which RHAs have the highest or lowest rates of obesity. Such comparisons are further complicated by the fact that these surveys excluded residents of First Nations communities, which means that the results must be interpreted with caution in areas with significant First Nations populations (most notably Burntwood and NOR–MAN RHAs, but also portions of several other RHAs).

Notwithstanding those caveats, some general trends can still be observed:

- Mirroring the provincial results shown in the "Prevalence of Obesity" section, the prevalence of obesity appears to be increasing over time in all RHAs for both males and females (though none of the RHA–level changes reached statistical significance).
- Excluding the RHAs which have a large proportion of their populations living in First Nations communities (Burntwood and NOR–MAN), there appears to be no strong relationship between obesity rates and the overall health status of the population: some of the most healthy RHAs (e.g., Central, Assiniboine) have obesity rates comparable to those in RHAs with less healthy populations (e.g., North Eastman, Parkland).
- Winnipeg consistently has among the lowest prevalence of obesity for both males and females in all three time periods analysed. Statistically, the obesity rates in Winnipeg were significantly lower than average in 2000–2003 for males and for males and females in 2004–2008.
- Results at the level of the aggregate areas provide stronger findings: obesity rates for females in the North were significantly higher than the provincial averages in all three time periods; those for males were higher in the second and third time periods. Similarly, obesity among male and female residents of the 'Mid' areas were high in the second and third time periods.

Results for Sub–RHA Areas

Analyses were also conducted to provide estimates at the sub–RHA level, using the 54 Districts of the non–Winnipeg RHAs and the 12 Winnipeg Community Areas. Data for males and females had to be combined to avoid excessive suppression of results. These results are shown in Appendix tables A1.3 and A1.4 and reflect even greater variation and wider CIs than the RHA–level results. Many of the estimates must be interpreted with caution because of the large variation and because of the exclusion of residents of First Nations communities.

Chapter 3: Risk and Protective Factors Associated with Obesity

Chapter Summary

The main analysis pooled together participants from seven national surveys conducted between 1996 and 2008 for a total sample of 31,795 participants. The results were largely similar to those reported by other studies, confirming that many factors influence obesity.

Results from the Main Analysis:

- Among the 23 variables and interactions included in the main analysis, the sociodemographic characteristics had the strongest association with adult obesity. In particular, location of residence, age, sex, education, employment status, and marital status provided the majority of the explanatory power of the final (full) model.
    - Obesity was lowest in urban areas, higher in rural areas, and highest in the north.
    - Obesity increased with age from young adulthood to middle age, then decreased with advancing age.
    - Obesity was slightly more common among males than females overall, though this difference varied with age and marital status.
- The addition of individual behaviours and policy–sensitive factors increased the explanatory power of the model. Among these variables, physical activity level during leisure and travel time was the most important. It showed a dose–response relationship: higher levels of activity were associated with lower likelihood of obesity. Other important variables were **smoking** (which was associated with a lower likelihood of obesity) and time spent in **sedentary activities** (more than 30 hours per week was associated with a higher likelihood of obesity).
    - These findings are likely the most 'useful' from a health policy perspective, as they strongly support initiatives to increase physical activity and decrease sedentary activity among all adults.
- The addition of several 'psychological' variables (e.g., satisfaction with life) made only a very small independent contribution to the prediction of obesity.
- The key findings were similar in **logistic regression** models of obesity (0/1 outcome) and in linear models using continuous BMI values as the outcome measure.

Focused Sub–Analyses:

- The sub–analysis which included sleep characteristics (N=6,687) suggested that those who reported sleeping a higher number of hours each night were less likely to be obese, but the association did not quite reach statistical significance. Having trouble getting to sleep or staying asleep was not associated with obesity.
- The sub–analysis on birth characteristics (N=1,465 youth aged 12 to 18) showed that only age and geography were significantly related to BMI levels among youth. Older survey participants and those living in the Rural Mid or North areas had higher BMI levels. **Breastfeeding initiation** and higher leisure time physical activity levels appeared to be associated with lower BMI levels, but neither association reached statistical significance in this analysis.

Introduction

An understanding of the key risk and protective factors associated with obesity is crucial for prevention efforts and population health promotion. The analyses in this chapter were undertaken to examine the associations between obesity and the many risk and protective factors included in the NPHS and CCHS surveys. (The Manitoba HHS did not ask the same questions, so could not be included in these analyses.)

It is critical to bear in mind the 'cross–sectional' nature of the data used in this analysis: the information on risk and protective factors was gathered at the same time as survey participants' height and weight (from which their BMI was calculated). With cross–sectional data, we can only document the existence of associations or relationships between obesity and the various risk and protective factors—we cannot establish causal connections. Furthermore, it is virtually impossible for any single study to gather information on all the variables known or thought to impact on obesity, simply because they are so many and varied (as discussed in Chapter 1). Therefore, the findings from this kind of analysis can only provide partial explanations and must be interpreted from that perspective.

The main analysis pooled together participants from seven national surveys conducted between 1996 and 2008 for a total sample of 31,795 participants.

Methods and Variables

Methods

Among the NPHS and CCHS surveys from 1996–1997 through 2007–2008, there were many similarities, but some differences, in the questions asked in each wave. Therefore, the main analysis for this chapter included the data which were common among all or most survey waves.

Two additional sub–analyses were conducted to address specific issues for which data were only available in selected survey waves:

- to examine the associations between sleep patterns and obesity—using CCHS cycles 1.1 and 1.2 (the only surveys that included questions about sleep)
- to examine the associations between birth circumstances and obesity—using youth in CCHS cycles from years 2000 through 2008 (those for whom birth records were available in administrative data at MCHP)

For each of the three analyses, two different types of models were created—a logistic regression to analyse obesity as a dichotomous outcome (obese = 1 for those with BMI 30+, otherwise obese = 0) and a **linear regression** to analyse BMI values on a continuous scale. Each analysis started with a 'univariate' model, in which the relationship between each predictor and the outcome was examined individually. Then a series of **multivariate models** were created, using groups of predictor variables as described later in this chapter. Results from multivariate models indicate the unique contribution of each variable, while controlling for the influences of all other variables in the model. The potential for **multi–collinearity** among variables was examined for each multivariate model; in all cases, this was not significant.

Missing Data

For the main analysis, a technique called '**multiple imputation**' was used to overcome the problem of missing data for some questions in some surveys. For example, if a certain question was asked in most but not all survey waves, we included that variable and used multiple imputation to overcome the missing data problem. This increases statistical power for finding associations without artificially reducing the variation in the data, as can happen with other methods. Multiple imputation does not simply 'interpolate' a value for each missing data point, or replace it with the mean from all other survey participants, but rather creates a set of imputed values for the missing data, in a way which ensures that the **variance**/covariance structure present within the collected data remains the same. Ten imputations were done, and each was bootstrapped 50 times to estimate the variance of the parameters.

Model Fit/Strength

To assess the overall strength of the logistic models, we used the **C–statistic**. Values for this measure range from 0.5 to 1.0; a value of 0.5 indicates that the model is no better than chance at predicting obesity, and a value of 1.0 indicates that the model perfectly identifies those in the Obese group and those not. Models are typically considered reasonable when the C–statistic is higher than 0.7 and strong when the C–statistic exceeds 0.8 (Hosmer & Lemeshow, 1989).

Analysis Process

The main analysis was a multiple logistic (0/1) regression model to determine which factors were associated with obesity (everybody with a measured/corrected BMI value of 30 or higher was in the Obese group). The analysis was performed at the individual level, involving 31,795 people across all waves of the CCHS and NPHS. The analysis was done to determine the direction and strength of association between obesity and each of the factors included. The results reflect the independent association of each variable, controlling for the influence of all other variables in the model. Coefficients above 1.0 indicate that the variable is related to an increased likelihood of being in the Obese group, whereas those below 1.0 indicate a decreased likelihood. Confidence intervals are also provided (at the 99% level for adult analyses and at the 95% level for analyses of youth because the sample size was much smaller). Variables strongly related to obesity will have narrow CIs and reach significance at high levels. However, the units of measure of each variable are different and some are dichotomous (0/1), so directly comparing coefficients for different variables is not insightful. Therefore, descriptions are provided for each variable, to indicate the scale and independent impact of that variable.

The analysis proceeded in four stages: Stage 1 was a simple correlation between each variable alone and obesity. This is helpful to determine the 'raw' relationship—that is, without simultaneous control for other variables. Stage 2 was the first multi–variable model, which included only the control variables and sociodemographic variables—things that are not readily modifiable (e.g., age, sex, location of residence). Stage 3 added the variables reflecting the psychological characteristics of survey participants (e.g., stress level, mental health). Results for stages 1–3 are shown in Appendix Table A2.1. Stage 4 was the final model including all variables. Stage 4 results are shown and described in detail in the rest of this chapter and followed by discussion and comparison to other studies.

Variables Included in the Models

The main analysis included the following variables, collected during the NPHS and CCHS interviews. The variables are organized into groups. The first two groups represent 'control' variables: factors that are considered not readily modifiable by public policy or individual behaviour change (e.g., age, sex, marital status, **region of residence**). The third group represents psychological characteristics of survey participants (e.g., stress level, **self–rated mental health**, etc.). The fourth group represents the modifiable factors: things that can be influenced by individual behaviour and/or public policy initiatives (e.g., physical activity levels, fruit and vegetable consumption).

Control variables:

1. Year of survey: Since responses from surveys conducted from 1996 through 2008 were included in the analysis and obesity rates have increased over time, it was necessary to control for the year in which the participant was surveyed. The variable was coded as survey year minus 1996, resulting in values from 0 (for those interviewed in 1996) to 12 (for those interviewed in 2008).
2. Surveyed by phone: Overall, 62% of survey interviews were conducted by phone and 38% in person, though this varied by survey. Previous research has shown that inaccuracies in self–reporting of height and weight values were larger for those interviewed on the telephone versus in–person (St–Pierre & Beland, 2004). Therefore, we included this variable to account for this systematic difference and to ensure that this factor did not affect the relationships among the predictor variables and the outcome.
3. Geography: To determine the influence of geography on BMI, a series of variables were used to compare residents of the 'most healthy' areas of Winnipeg (listed in Chapter 1) to residents of other areas.

Socio–demographic control variables: (variables that cannot be changed, or cannot easily be changed, by individual choices/behaviours or straightforward policy initiatives)

1. Age: The age of the participant, in years, based on birth year reported in the survey. Because age is measured in years, the coefficient will likely be relatively small compared to other variables.
2. We also included a quadratic term (age^2) to capture the non–linear impact of age.
3. Sex: A categorical variable describing whether the participant was male or female.
4. Age * sex: This interaction term was created to examine whether the association of age with BMI values was different for males than females.
5. Married/common–law: Marital status was identified through survey data and was categorized into two groups—married/common law or single.
6. Sex * married/common–law: This interaction term was created to examine whether the association of marital status with BMI values was different for males than females.
7. High School Graduate: To represent each person's level of education, participants were categorized into two groups—those who have graduated from high school, and those who have not.
8. Employed: Participants were categorized as employed if they reported any paid work at a job or a business within seven days prior to the survey being administered.
9. Household income: This was recorded in the surveys using the income groupings shown below. For analysis, the values were re–coded into those shown in the right hand column below (each representing a scaled mid–point of its corresponding group):

Household Income Values

Reported Income Level	Assigned Value
No Income	0
LESS THAN $5,000	2.5
$5,000 TO $9,999	7.5
$10,000 TO $14,999	12.5
$15,000 TO $19,999	17.5
$20,000 TO $29,999	25
$30,000 TO $39,999	35
$40,000 TO $49,999	45
$50,000 TO $59,999	55
$60,000 TO $79,999	70
$80,000 OR MORE	90

10. **Activity restrictions**: This is a derived variable from CCHS that combines responses to a number of questions on activity restrictions. This variable is a measure of the impact of long–term physical conditions, mental conditions, and health problems on the principal domains of life—home, work, school, and other activities.

11. **Physical activity–occupational**: This variable describes **energy expenditure** levels for participants based on physical activity undertaken during work–time (daily) activities in the previous three months. Participants were grouped into three categories (active, moderate, or inactive) based on their average daily energy expenditure.

Psychological variables:

1. High level of life stress: Participants were grouped into two categories based on their reported level of **self–perceived life stress**—High ('extremely stressful' or 'quite a bit stressful') versus all others ('not at all stressful', 'not very stressful', or' a bit stressful').
2. Very satisfied with life: **Satisfaction with life** was categorized into two groups—those who were 'very satisfied' with life versus all others ('satisfied', 'neither satisfied nor dissatisfied', 'dissatisfied', or 'very dissatisfied').
3. Self–rated mental health: Participant's self–perceived mental health status was grouped into two categories—excellent/very good or good/fair/poor.
4. Sense of community: This variable describes participants' sense of belonging to their local community, with responses grouped as strong ('very strong' or 'somewhat strong') versus weak ('very weak' or 'somewhat weak').

Behavioural and other 'modifiable' variables:

1. **Eat fruits or vegetables five or more times/day**: participants were grouped into two categories based on the number of times they consumed fruits or vegetables—five or more times per day versus fewer than five times per day. This dichotomy at five or more has been used by many previous studies.
2. **Physical activity–leisure and travel** time: This variable describes energy expenditure levels for participants based on physical activity undertaken during leisure– and travel–time activities in the previous three months. Participants were grouped into three categories (active, moderate, or inactive) based on their average daily energy expenditure.
3. Sedentary activities: The number of hours engaged in sedentary activities (such as watching TV, reading, playing computer or video games, and surfing the Internet) outside of school or work was recoded as shown below:

Sedentary Activity Values

Number of Hours/Week	Assigned Values
LESS THAN 5 HOURS	2
FROM 5 TO 9 HOURS	7
FROM 10 TO 14 HOURS	12
FROM 15 TO 19 HOURS	17
FROM 20 TO 24 HOURS	22
FROM 25 TO 29 HOURS	27
FROM 30 TO 34 HOURS	32
FROM 35 TO 39 HOURS	37
FROM 40 TO 44 HOURS	42
45 HOURS OR MORE	47

4. **Current smoker**: A variable describing whether the participant is a current smoker (includes 'daily smoker', 'occasional smoker who was previously a daily smoker', and 'always an occasional smoker') or not.
5. Frequent **binge drinking**: This indicates that the participant reported consuming five or more alcoholic drinks on one occasion, at least once per month.
6. **Made changes to improve health**: This indicates whether the participant made changes to improve their health in the past 12 months or not.

7. **Food insecurity**: Participants were categorized as food insecure (i.e., couldn't afford enough food, couldn't afford balanced meals, etc.) or not.
8. Has a regular doctor: A categorical variable describing whether the participant reported having a regular medical doctor or not.

When survey participants did not provide an answer to a question (i.e., they did not know or refused to answer), their record was set to 'missing' and was removed from that analysis; however, if a survey did not contain data on an item listed above because the question had not been asked, values were imputed as described previously.

Main Analysis

Key Findings

The variables in this study that were most strongly related to obesity were those in the sociodemographic group. Among those, location of residence, age, sex, education, employment, and marital status were particularly strong variables. The model containing only these sociodemographic and control variables provided a large portion of the explanatory power of the final model (C–statistic 0.6279 versus 0.6406 for full model; see Appendix Table A2.1 for details).

The addition of the 'psychological' group of variables increased the C–statistic only minimally (from 0.6279 to 0.6285). This indicates that they made very little independent contribution to the explanation of obesity (given other variables in the model), even though all of the individual variables were statistically significantly related to obesity.

The 'behaviour/policy' group of variables added significantly to the model, increasing the C–statistic from 0.6285 to 0.6406. Among these variables, leisure– and travel–time activity level was the most strongly associated variable and showed a dose–response relationship—higher levels of activity were associated with lower likelihood of obesity. Other important variables were smoking (which was associated with a lower likelihood of obesity) and time spent in sedentary activities (more than 30 hours per week was associated with a higher likelihood of obesity).

A series of examples may help clarify the relative contributions of various factors for predicting obesity, according to the statistical model. Table 3.1 shows information about 11 people who are different on six key characteristics, along with the probability they would be in the Obese group.[9] Bold entries highlight the key change(s) from row to row. Interpretation and comparisons are described on the next page.

9 For the sake of simplicity, the other 17 variables and interactions are not shown in the examples, though their influences were included in the calculations. In these examples, the people were all married, interviewed in person (not by phone) in 2007—2008, living in one of the most healthy areas of Winnipeg, had no activity restrictions, were employed (in jobs with low activity levels), not highly stressed, not current smokers, not engaging in frequent binge drinking, had not recently made changes to improve their health, not experiencing food insecurity, and have a regular doctor.

Table 3.1: Examples Illustrating the Association between Key Characteristics and the Probability of Being in the Obese Group (Based on Modelled Rates)

Example Number	Sex	Age	High School Graduate	Household Income	Active During Leisure and Travel Time	Eats Fruits or Vegetables 5+ Times/Day	Probability of Being in Obese Group
1	Female	25	Yes	$60,000	Yes	Yes	**13.0%**
2	Female	**50**	Yes	$60,000	Yes	Yes	**21.6%**
3	Female	**75**	Yes	$60,000	Yes	Yes	**14.0%**
4	**Male**	25	Yes	$60,000	Yes	Yes	**17.7%**
5	Male	**50**	Yes	$60,000	Yes	Yes	**25.2%**
6	Male	50	**No**	$60,000	Yes	Yes	**31.3%**
7	Male	50	Yes	**$20,000**	Yes	Yes	**25.3%**
8	Male	50	Yes	$60,000	**No**	Yes	**32.4%**
9	Male	50	Yes	$60,000	Yes	**No**	**26.6%**
10	Male	50	**No**	**$20,000**	**No**	**No**	**41.2%**
11	**Female**	50	No	$20,000	No	No	**36.5%**

Bold entries highlight the key change(s) from row to row.

Source: Manitoba Centre for Health Policy, 2011

The first example is a healthy 25 year old female, who graduated from high school, lives in a household with high income ($60,000), is active in her leisure time, and eats fruits or vegetables five or more times per day. According to our models, she has a 13% probability of being in the Obese group.

A similar female at age 50 (row 2) has a 21.6% probability, and another at age 75 (row 3) has a 14.0% probability. These examples illustrate the dramatic and non–linear impact of age on obesity—it is least prevalent among young adults, increases sharply into middle age, then declines sharply with advancing age (this key relationship is also illustrated in Figure 3.1).

The fourth and fifth rows show 25 and 50–year–old males otherwise identical to the females in rows 1 and 2 above. These males both have about a 4% higher probability of being obese than their same–age female counterparts, illustrating the effect of sex on obesity.

Row 6 shows the influence of education: a 50–year–old male who did not graduate from high school has a 31.3% probability of being obese, compared to 25.2% for one who did graduate (row 5).

Conversely, row 7 shows the modest influence of income: this 50–year–old male who graduated but is living in a low income household ($20,000) has a 25.3% probability of being obese—only 0.1% higher than the one in the $60,000 income household (row 5).

The impact of being active in leisure and travel time is demonstrated by the difference between row 5 and row 8: the active man had a 25.2% chance of being obese; whereas for the inactive man, it is 32.4%.

Row 9 demonstrates the modest impact of lower fruit and vegetable consumption: this man's probability of being in the Obese group is 26.6%, or 1.4% higher than one who eats them five or more times per day (row 5).

Rows 10 and 11 show results for a middle–age male and female who did not graduate from high school, who live in low income households, are not active in leisure and travel time, and do not frequently eat fruits and vegetables: this male faces a 41.2% probability of being obese; the female 36.5%.

These examples show that age, sex, education, and physical activity are strong influences, while household income and frequent fruit & vegetable consumption were considerably weaker. The full model contained more variables, including many that were not significantly related to obesity. Several others had strong influences, including geography, employment, activity restrictions, time spend in sedentary activities, and smoking. Full details are shown and discussed in the following section.

Detailed Results

Table 3.2 below shows the results for the final (full) model. These data show the impact of each variable, while controlling for the influence of all other variables listed. Statistically significant variables are indicated by asterisks reflecting the level of significance. Results for each variable are discussed below.

Control variables:

- The **odds ratio** for 'Year of Survey' was significant and above one (1.02), indicating that participants of later surveys were more likely to be in the Obese group, consistent with the documented increase in obesity prevalence over time.
- 'Surveyed by Phone' was significant and below one (0.83), indicating that participants interviewed by phone reported height and weight values which made them less likely to be in the Obese group than those interviewed in person. This finding is consistent with previous research (St–Pierre & Beland, 2004), which motivated the inclusion of this variable.

Geography: Overall, location of residence was very strongly related to obesity, reflected in the small CIs and statistical significance at a very high level for the geographic variables. In this analysis, residents of the 'most healthy' Winnipeg areas were the reference group. Residents of other areas were compared to this group.

- Residents of all areas outside Winnipeg had significantly higher likelihood of being in the Obese group than residents of the 'most healthy' areas of Winnipeg: Brandon 1.17, Rural South 1.25, Rural Mid 1.55, and North 1.78.
- Residents of the 'average health' (0.89) and 'least healthy' (0.95) areas of Winnipeg were both less likely to be in the Obese group than those living in the 'most healthy' Winnipeg areas. These differences seem unexpected at first because one might have expected to find more obesity in these areas compared to the 'most healthy' areas. However, similar findings were reported for **diabetes** prevalence in Ontario; and that study noted that residents of 'central' parts of Toronto had lower than expected diabetes prevalence, which they related to higher rates of walking, bicycling, and public transit use compared to suburban dwellers (Glazier & Booth, 2007). The inclusion of other variables in our model also impacted these relationships because, when analysed 'alone', living in the Least Healthy areas was associated with a higher likelihood of obesity (Appendix Table A2.1).

Table 3.2: Factors Related to Obesity
Logistic regression; measured/corrected BMI

Group	Variable	Odds Ratio (99% CI)	Significance
Control			
	Year of Survey	1.017 (1.015, 1.019)	****
	Surveyed by Phone	0.83 (0.82, 0.84)	****
Geographic *(Compared to Winnipeg Most Healthy areas)*			
	Rural South	1.25 (1.22, 1.28)	****
	Rural Mid	1.55 (1.53, 1.58)	****
	North	1.78 (1.74, 1.81)	****
	Brandon	1.17 (1.14, 1.20)	****
	Winnipeg Average Health Areas	0.89 (0.87, 0.91)	****
	Winnipeg Least Healthy Areas	0.95 (0.92, 0.97)	**
Sociodemographic			
	Age	1.098 (1.09, 1.101)	****
	Age^2	0.99909 (0.99905, 0.99912)	****
	Sex (male)	1.11 (1.04, 1.18)	**
	Age*Sex (male)	1.003 (1.0001, 1.0065)	**
	Age^2*Sex (male)	0.99987 (0.99984, 0.99990)	****
	Married/Common-Law	0.96 (0.93, 0.986)	**
	Sex*Married/Common-Law	1.30 (1.25, 1.35)	***
	High School Graduate	0.74 (0.72, 0.76)	****
	Employed	0.85 (0.84, 0.87)	****
	Household Income	0.9988 (0.9977, 0.9998)	**
	Activity Restrictions	1.31 (1.22, 1.41)	***
	Energy Expenditure - Occupational: Active	1.02 (0.87, 1.18)	
	Energy Expenditure - Occupational: Moderate	0.94 (0.80, 1.10)	
Psychological			
	High Level of Life Stress	1.12 (1.06, 1.18)	**
	Very Satisfied with Life	0.82 (0.76, 0.88)	**
	Self-Rated Mental Health	1.09 (1.01, 1.17)	**
	Sense of Community	1.08 (1.03, 1.13)	**
Behavioural & Other			
	Eat Fruits or Vegetables 5+ times/day	0.93 (0.85, 1.02)	
	Energy Expenditure - Leisure: Active	0.70 (0.64, 0.77)	***
	Energy Expenditure - Leisure: Moderate	0.92 (0.82, 1.03)	
	Sedentary Activities	1.15 (1.05, 1.26)	**
	Current Smoker	0.80 (0.71, 0.90)	**
	Frequent Binge Drinking	1.003 (0.98, 1.02)	
	Made Changes to Improve Health	1.16 (0.97, 1.39)	
	Food Insecurity	1.08 (0.91, 1.28)	
	Regular Doctor	1.05 (0.95, 1.16)	
	C-statistic	*0.6406*	

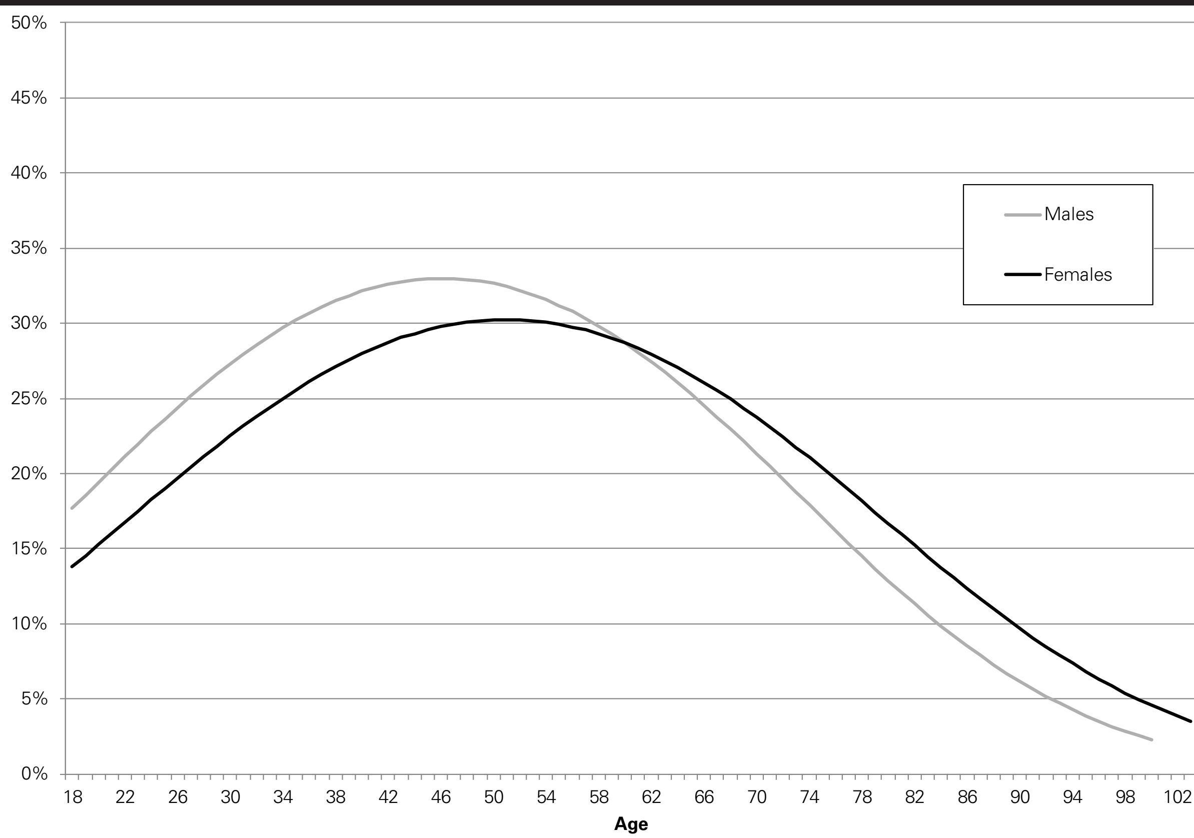
** Indicates significance at p<0.01
*** Indicates significance at p<0.00001 (p<1E-5)
**** Indicates significance at p<1E-10

Source: Manitoba Centre for Health Policy, 2011

Sociodemographic variables:

- Age (1.10) and sex (1.11) were both very strongly related to obesity, indicating that overall, the likelihood of being in the Obese group increased with age and was higher for males than females. These findings are consistent among all studies done in Western countries. However, the relationship between age, sex, and obesity was much more complex and non–linear:
    - Figure 3.1 below illustrates the likelihood of being in the Obese group for both males and females across the age spectrum, including the combined effects of all terms and interactions. As illustrated, obesity prevalence for both sexes increased sharply with age from young adulthood into middle age (during which time prevalence was higher among males), then decreased sharply with advancing age (during which time prevalence was higher among females). [10]
    - Because of these non–linear relationships, the models also had to incorporate a quadratic age term (age^2), as well as interactions between age and sex and between age^2 and sex.

Figure 3.1: Probability of Being in the Obese Group by Age and Sex (Based on Logistic Regression)



Source: Manitoba Centre for Health Policy, 2011

10 Appendix tables A1.1 and A1.2 show the actual values of mean BMI by age group for each survey/wave. The data suggest an influence of demographic trends on obesity prevalence. This merits further research.

- 'Married/Common–law' was significant and below one (0.96), indicating that those who reported being married or in common–law relationships were less likely to be in the Obese group than those who reported being single, divorced, or widowed.
- However, the influence of marriage on obesity differed by sex: the interaction term 'Sex*Married/Common–law' was significant and above one (1.30), indicating that married/common–law males were more likely to be in the Obese group than married/common–law females. Similar findings were reported by other cross–sectional studies (Tjepkema, 2006), but different results were seen in a longitudinal analysis where marital status was not significantly associated with moving from the Overweight to the Obese group (Le Petit & Berthelot, 2006).
- 'High school graduate' was significant and below one (0.74), indicating that those who reported having graduated from high school were less likely to be in the Obese group. Similar findings have been reported by others (Trakas, Lawrence, & Shear, 1999).
- 'Employed' was significant and below one (0.85), indicating that those who reported being employed were less likely to be in the Obese group. This is similar to results reported by others (Tjepkema, 2006).
- 'Household income' was slightly but significantly below one (0.999), indicating that those with higher household incomes were (slightly) less likely to be in the Obese group. Others have reported similar findings (Lopez, 2007; Shields & Tjepkema, 2006b; Trakas et al., 1999). Tjepkema also reported findings by income. It showed an effect for males that is similar to that reported here, but a different pattern for females, among whom the relationship was not linear (Tjepkema, 2006). Longitudinal data from the NPHS suggest a much stronger protective effect of income on the likelihood of moving from the Overweight to the Obese group (Le Petit & Berthelot, 2006).
- 'Activity restrictions' was significant and above one (1.31), indicating that those who reported having a physical or mental condition that limited the amount or kind of activities they can perform were more likely to be in the Obese group. Other studies have shown similar findings, including an increased likelihood of moving from the Overweight to the Obese group (Le Petit & Berthelot, 2006).
- 'Occupational physical activity' was not significantly associated with obesity, though other studies have reported results that suggest an effect at least among females (Le Petit & Berthelot, 2006).

Psychological:

- 'High level of life stress' was significant and above one (1.12), indicating that those who reported having a high level of stress in their life were more likely to be in the Obese group, similar to previous reports (Craig, Cameron, & Bauman, 2005).
- 'Very satisfied with life' was significant and below one (0.82), indicating that those who reported being very satisfied with their life overall were less likely to be in the Obese group.
- 'Self–rated mental health' was significant and above one (1.09), indicating that those who reported 'Excellent' or 'Very Good' self–rated mental health were more likely to be in the Obese group. Other studies in this area suggest inconsistent findings with some reporting no association between BMI and mental health (Doll, Petersen, & Stewart–Brown, 2000; Trakas et al., 1999), and others reporting negative impacts (Kushner & Foster, 2000; Simon et al., 2006; Whitmer, Gunderson, Barrett–Connor, Quesenberry, Jr., & Yaffe, 2005). These disparate findings suggest that either the relationship is subtle or differences in participant selection, indicators chosen, or analysis techniques used may affect the findings.
- 'Sense of community' was significant and above one (1.08), indicating that those who reported a strong **sense of community** were more likely to be in the Obese group.

Behavioural and other:

- 'Eat fruits or vegetables five or more times/day' appeared to be related to a lower likelihood of obesity (0.93), but the association did not reach statistical significance. Other studies using national data have found this relationship to be statistically significant (Craig et al., 2005; Tjepkema, 2006).
    - Related studies have demonstrated that the availability of food items (cost, proximity, quality) is also related to obesity (White, 2007), including a multilevel analysis by Lopez (2007). Interestingly, that study also found only a weak association between obesity and the concentration of fast food outlets.
- 'Leisure time activity level' was significantly associated with obesity. Those in the 'active' category were significantly less likely to be in the Obese group, while those in the 'moderate' category were slightly, but not significantly, less likely. These findings are similar to those reported by others (Craig et al., 2005; Tjepkema, 2006; Trakas et al., 1999).
    - However, different results were seen in the longitudinal NPHS study, which showed no significant association between leisure time physical activity and the likelihood of moving from the Overweight to the Obese group.
- 'Sedentary activities' was significant and above one (1.15), indicating that those who reported spending 30 or more hours in sedentary activities each week were more likely to be in the Obese group. Interestingly, this association is independent of 'Leisure time activity level', meaning that both are significant factors for obesity. These findings are similar to results of other studies (Craig et al., 2005; Shields & Tremblay, 2008; Tjepkema, 2006).
- 'Current smoker' was significant and below one (0.80), indicating that those who reported smoking (daily or occasionally) were less likely to be in the Obese group. Similar results have been reported by others (Craig et al., 2005; Trakas et al., 1999).
- 'Binge drinking' was not significantly associated with obesity.
- 'Made changes to improve health' was not significantly associated with obesity.
- 'Food insecurity' was not significantly related to obesity in this analysis, though other studies have reported higher obesity levels among the food insecure (Craig et al., 2005).
- 'Has a regular doctor' was not significantly related to obesity.

Results from the full linear model (outcome: continuous BMI value) were largely similar—see Appendix Table A2.2 for details. The explanatory power of the linear model was also relatively weak (R^2 of full model = 8.0%). This suggests that the model explained only 8% of the variance in BMI values. The same groups of variables shown to be significant above had the strongest relationships with continuous BMI values. The similarity of these findings provides confidence that the relationships discussed, in the previous section, are reliable.

Model Fit/Power

The C–statistic for the final logistic model including all variables was 0.6406 indicating that, overall, this was not a powerful model for explaining obesity (values above 0.7 are considered acceptable; those above 0.8 are strong). This low value likely reflects several limitations of the data and analysis:

1. Lack of data on other important variables: While the surveys asked many questions on issues relevant to obesity, other factors that also influence obesity were not included in the surveys, i.e., food production and consumption patterns, genetic/hereditary influences, and early life experiences. Information on these other factors would improve the ability of the model to 'explain' obesity, but valid data for these factors are not easy to obtain.
2. Cross–sectional nature of the data: It could be that the variables included in the model would be capable of explaining more of the variance in obesity if the survey participants were followed over time with a longitudinal study design.

   a. Such data are available in the longitudinal portion of the NPHS, but the sample size for Manitobans was not large enough to conduct such an analysis. Results from analyses of the national sample have been published (Le Petit & Berthelot, 2006; Orpana et al., 2007).
3. Limitations in the data: Information collected in surveys inevitably contains some inaccuracy, most prominently because of biases in participants' recall and responses, as well as issues with the measurements used (e.g., response categories used).

However, none of these limitations invalidate the findings listed above.

Focused Sub–Analyses

This section describes results from the two sub–analyses conducted to assess factors which were only available for one or two survey waves and, therefore, could not be included in the main analysis. As much as possible, these sub–analyses used the same approach and included the same set of variables that were used in the main analysis.

Sub–Analysis on 'Sleep' Variables

CCHS cycles 1.1 and 1.2 were the only waves that included questions about participants' sleep experiences. Two variables were the focus here:

1. Trouble sleeping—participants were asked how often they had trouble going to sleep or staying asleep. Responses were put into one of three groups: 'Never' (the reference group for this analysis), 'Sometimes', or 'Most of the time'.
2. Number of hours of sleep—participants were asked how long they usually spend sleeping each night. The variable is coded as number of hours.

The models also included the variables from the main analysis that were available[11] in CCHS cycles 1.1 and 1.2. This analysis included the 6,687 adult participants in cycles 1.1 and 1.2 that had complete data for the variables used.

Results:

Table 3.3 shows the results from the final logistic model which included sleep variables; statistically significant variables are noted by asterisks in the significance column. (Intermediate models are shown in Appendix Table A2.3.)

Most of the values reveal findings largely similar to those from the main analysis—the geographic and sociodemographic variables were strongly related to obesity, whereas psychological factors were not significant. Fewer variables reached statistical significance in this analysis because of the smaller sample size.

The number of hours slept per night appeared to be related to obesity—those who reported sleeping longer were less likely to be in the Obese group, though the association did not quite reach statistical significance. Having trouble going to sleep or staying asleep was not associated with obesity. These findings of modest associations are consistent with those found in other studies on this topic (Marshall, Glozier, & Grunstein, 2008; Patel & Hu, 2008; Vorona et al., 2005).

Appendix Table A2.4 shows results from the corresponding linear model (outcome: continuous BMI value), which provided results similar to those shown in Table 3.3.

11 Variables that were not available for these cycles: energy expenditure in work–, transport–, and leisure–time activities; sedentary activities; fruit and vegetable consumption; smoking; changes made to improve health; food insecurity; having a regular doctor; and most of the variables in the 'psychological' group.

Table 3.3: Factors Related to Obesity: Sub-Analysis including Sleep Variables
Logistic regression; measured/corrected BMI

Group	Variable	Odds Ratio (99% CI)	Significance
Control			
	Surveyed by Phone	0.76 (0.60, 0.97)	**
Geographic *(Compared to Winnipeg Most Healthy areas)*			
	Rural South	1.10 (0.79, 1.54)	
	Rural Mid	1.50 (1.08, 2.08)	**
	North	1.52 (1.08, 2.15)	**
	Brandon	0.986 (0.60, 1.63)	
	Winnipeg Average Health areas	1.11 (0.72, 1.71)	
	Winnipeg Least Healthy Areas	1.06 (0.70, 1.60)	
Sociodemographic			
	Age	1.11 (1.06, 1.16)	**
	Age^2	0.9990 (0.9986, 0.9994)	**
	Sex (male)	1.14 (0.53, 2.46)	
	Age*Sex (male)	0.992 (0.98, 1.01)	
	Married/Common-Law	1.10 (0.77, 1.56)	
	Sex*Married/Common-Law	1.33 (0.80, 2.21)	
	High School Graduate	0.65 (0.49, 0.86)	**
	Employed	1.10 (0.81, 1.49)	
	Household Income	0.9997 (0.994, 1.01)	
	Activity Restrictions	1.53 (1.14, 2.04)	**
Sleep			
	Hours of Sleep	0.94 (0.85, 1.04)	
	Trouble Sleeping Most of the Time	1.05 (0.71, 1.57)	
	Trouble Sleeping Sometimes	1.01 (0.77, 1.31)	
Psychological			
	High Level of Life Stress	1.02 (0.77, 1.35)	
	Sense of Community	1.08 (0.83, 1.40)	
Behavioural & Other			
	Frequent Binge Drinking	1.13 (0.84, 1.52)	
	C-statistic	*0.6372*	

** Indicates significance at $p<0.01$

Source: Manitoba Centre for Health Policy, 2011

Sub–Analysis on Birth Characteristics and Obesity Among Youth

The majority of this report deals with obesity among adults. However, during the research, it became clear that a unique opportunity was available to study obesity among those youth included in the survey data and for whom data on birth characteristics are available in the MCHP Repository. The objective was to analyse the impact of birth weight, **gestational age**, and initiation of breastfeeding on obesity among youth, while controlling for several other factors. The definition of obesity in youth was taken from the frequently–used method developed by Cole et al. (2000), which defines overweight and obesity for each sex and each six–month age group. The analysis included 1,465 Manitoba survey participants aged 12 to18.

As with the preceding analyses on adults, we created models using both logistic regression (outcome: 0/1 obese) and linear regression (outcome: continuous BMI). However, obesity is less common among children than adults, so only 106 of the youth surveyed were in the 'obese' group. Therefore, we rely primarily on the results of the **multiple linear regression** because this model includes all 1,465 children, providing more power to find significant relationships.

Table 3.4 shows the results for all variables in the multiple linear regression. For results of the logistic regression and intermediate linear models, see Appendix Tables A2.5 and 2.6.

Table 3.4: Factors Related to Obesity: Sub-Analysis on Birth Characteristics Among Youth Born in Manitoba
Linear regression; measured/corrected BMI

Group	Variable	Estimates (95% CI)	Significance
Geographic *(Compared to Winnipeg Most Healthy areas)*			
	Rural South	0.37 (-0.45, 1.19)	
	Rural Mid	1.19 (0.20, 2.19)	*
	North	0.98 (0.03, 1.92)	*
	Brandon	0.48 (-0.52, 1.48)	
	Winnipeg Average Health Areas	0.50 (-0.85, 1.85)	
	Winnipeg Least Healthy Areas	1.01 (-0.36, 2.37)	
Sociodemographic			
	Age	0.52 (0.25, 0.80)	*
	Sex (male)	-3.35 (-8.44, 1.74)	
	Age*Sex (male)	0.27 (-0.09, 0.63)	
	Breastfed	-0.72 (-1.57, 0.12)	
	Gestational Age	-0.17 (-0.54, 0.19)	
	Birth Weight	-0.16 (-5.90, 5.57)	
	Gestational Age*Birth Weight	0.03 (-0.11, 0.17)	
	Household Income	-0.007 (-0.02, 0.008)	
Behavioural & Other			
	Current Smoker	-0.81 (-2.26, 0.63)	
	Frequent Binge Drinking	-0.28 (-1.70, 1.15)	
	Physical Activity - Leisure: Moderate	-0.08 (-0.81, 0.66)	
	Physical Activity - Leisure: Active	0.77 (-0.11, 1.65)	
	R-squared value	*12.5%*	

* Indicates significance at p<0.05

Source: Manitoba Centre for Health Policy, 2011

The results in Table 3.4 show that only age and geography were significantly related to BMI values among youth. The association of age was strong, with older children having higher BMI values. Children living in the Rural Mid areas had BMIs that were on average 1.19 units higher than the reference group (Winnipeg's most healthy areas), and children living in the North had BMIs 0.98 units higher. Breastfeeding appears to provide a protective effect, though the difference did not quite reach statistical significance. Birth weight and gestational age (the other two key variables of interest) were not significantly related to obesity in this analysis.

For extensive analyses of obesity among children and youth, see 'A Report on the Weight Status of Manitoba Children' by Manitoba Health and Healthy Living (2007).

Chapter 4: Selected Diseases/Conditions Associated with Obesity

Chapter Summary

Overall, the data in this chapter present a mixed picture regarding the relationship between BMI group (Normal, Overweight, Obese) and chronic diseases: some diseases show strong associations while others show no association. This is partly a consequence of the relatively small sample sizes involved, which resulted in large CIs for disease values across BMI groups. However, the strong relationships with **hypertension** and diabetes are important because of their comparatively high prevalence and their direct and indirect relationships to other diseases and mortality.

The evidence also suggests that the Obese group is more consistently at higher risk for disease than the Overweight group. For some diseases, the Overweight group is closer to the Normal group than to the Obese group.

Among the diseases studied in this research:

- Diabetes prevalence and incidence were strongly related to BMI group, especially for females. Among males, diabetes prevalence was 2.6 times higher in the Obese group than the Normal group; the incidence rate was 4.4 times higher. The corresponding values for females were 4.4 and 7.5, respectively.
- Hypertension prevalence and incidence were also strongly related to BMI group in both sexes. The Obese group had rates nearly double those of the Normal group.
- **Heart attack** (AMI) incidence rates were strongly related to BMI group for males, but not for females. Conversely, **total respiratory morbidity (TRM)** (prevalence and incidence) was modestly related to BMI group among females but not males.
- A number of indicators revealed no statistically significant associations with BMI group: **dialysis initiation**, heart attack prevalence, ischemic heart disease prevalence and incidence, **stroke** incidence, and hip fracture rates. However, these non–significant findings do not allow us to conclude there is no association with BMI. In each case, the variation within the results was large, owing to the relatively small number of cases involved (i.e., the number of outcomes among survey participants was limited and divided into three BMI groups for each sex).
- Cancer incidence rates were also analysed and revealed few significant associations with BMI groups. This may be related to the relatively low number of cases and limited follow–up period available for most survey participants.
    - Among males, the rate of all cancers combined appeared to show somewhat lower incidence for the Obese group, though this difference did not reach statistical significance.
    - Among females, there appeared to be a positive relationship between higher BMI levels and higher breast cancer incidence rates, though the group differences did not reach statistical significance.
- In addition to these associations with individual diseases, other researchers have reported that obesity is related to lower levels of overall quality of life, especially physical well–being (Doll et al., 2000; Fontaine & Barofsky, 2001; Kolotkin, Meter, & Williams, 2001; Kushner & Foster, 2000; Sturm & Wells, 2001; Trakas et al., 1999). Interestingly, the association between obesity and mental health/ emotional well–being appears inconsistent, as noted in Chapter 3.

Introduction

Many studies have shown associations between obesity and numerous chronic diseases. This chapter documents the association between obesity and chronic disease in Manitobans who participated in any of the surveys used in this study. BMI values were calculated from height and weight in the survey data. As explained in Chapter 1, whenever measured height and weight values were available we used those; when only self–reported values were available, we corrected them using formulae derived from a Statistics Canada study to address this issue.

Chronic disease incidence and prevalence were measured from the administrative health data at MCHP, using case definitions developed in previous MCHP studies. This approach was chosen to take advantage of the longitudinal nature of the administrative data, which allows identification of disease status both before and after the survey. Naturally, not all diseases could be studied this way, so in this chapter we included only those conditions for which validated case definitions have been developed. This approach also brings a limitation that 'undiagnosed' conditions could not be included.

Incidence and Prevalence

When studying chronic disease in populations, two main measures are important: the incidence rate and the prevalence. The prevalence is the proportion of the population that already 'has' the disease at a given point (or period) in time. The incidence rate is the number of people in the population who 'get' the disease during a given time period (e.g., per year). In studying cause–and–effect relationships, incidence is usually the primary measurement, as it is the most helpful for identifying causes of new cases. However, in assessing the relationship between obesity and chronic disease, it is critical to include both prevalence and incidence, as studying incidence rates alone would underestimate the true impact of obesity by ignoring existing cases.

Diseases which are strongly related to obesity would be expected to show relationships with both incidence rates and prevalence. For example, consider diabetes: many studies have shown a relationship between obesity and diabetes. Therefore, we would expect more 'new' cases of diabetes to develop among those in the Obese group than among those in the Normal group. However, if the relationship is strong, we would also expect a higher prevalence of diabetes in the Obese group. In other words, we would expect the obese to have both a higher diabetes prevalence as of the survey date, and a higher incidence rate in the years that follow. Therefore, we assessed both incidence rates and prevalence of various chronic diseases by BMI group.

This study measures prevalence in the period of time just before the participant completed one of the surveys, in order to get an estimate of the prevalence of various chronic diseases closest in time to the BMI measurement or self–report. Incidence is measured after the survey date to obtain the rate of new cases among those who were not already diagnosed with a particular disease at the time of their survey. Some indicators are analysed using incidence rates only because they are not chronic diseases but rather health–related 'events' (e.g. hip fractures and the initiation of dialysis).

For stroke, the initial analysis plan included incidence rates only, as the 'prevalence' of this condition is difficult to calculate, and its association with obesity is not as clear. However, it was decided later to also include prevalence values to allow comparison with the many previous studies in this area (which did not separate prevalence from incidence).

Methods

Body Mass Index (BMI) values were calculated from height and weight data collected from survey participants, using measured or corrected values, as explained in Chapter 1. Case definitions for disease prevalence measures were taken from methods developed in previous MCHP studies. Details of disease codes used and years included are described in the 'Definition' for each indicator.

For measuring incidence rates of diseases, we used a 10–year clearance period (aka washout period). That is, a person had to not meet the case definition for a given disease at any point in the 10 years preceding their survey date. This approach is supported by the work of Brameld et al. (2003), who showed that there were diminishing returns with more than five to seven years of data and almost no change after 10 years. AMI and stroke were exceptions where individuals could still be considered incident even if they had already experienced one event since people can experience multiple AMIs or strokes in their lifetime.

Incidence rates and prevalence values are shown in bar graphs by sex and BMI group (Normal, Overweight, and Obese). Each value is accompanied by lines illustrating the 95% CI of the estimate. The CIs are quite large for some indicators, reflecting the relatively small sample sizes involved (recall that BMI values are available for survey participants only, not the entire population). Incidence rates are shown as the number of new cases per 100 person–years. Differences between groups (within each sex) were tested statistically. The results are discussed in the 'Key findings' for each indicator.

Relative Risk (RR) values were also calculated to compare incidence rates and prevalence values among the Normal, Overweight, and Obese groups. Asterisks indicate statistically significant differences (adjustment was made for multiple testing, which provides a combined Type I error rate of 5% for each sex).

All analyses in this chapter were '**age–adjusted**' to account for age differences of the people and groups at different BMI values.

Hypertension

Hypertension, also known as high blood pressure, is a serious health problem because it is highly prevalent, yet often has no symptoms. If left untreated, hypertension can lead to heart attack, stroke, or kidney damage.

Definition: Hypertension incidence and prevalence were measured for survey participants aged 18 and older at the time of survey. Participants were considered to have hypertension if they met one of the following conditions in one year:

1. one or more hospitalizations with a diagnosis of hypertension: ICD–9–CM codes 401–405; ICD–10–CA codes I10–I13, I15
2. one or more **physician visits** with a diagnosis of hypertension (ICD–9–CM codes as above)
3. two or more prescriptions dispensed for medications to treat hypertension (listed in Appendix 3)

Note that for participants of the Manitoba HHS (1989–1990), only conditions 1) or 2) could be used since the prescription drug database only started in 1995. To help overcome this, a three–year period was used to define hypertension for HHS participants (versus one year for all other surveys' participants).

Hypertension prevalence was determined using data from one year prior to each participant's survey date, and incidence rates were measured per 100 person–years after survey. Individuals whose first confirmed date of hypertension was within the 10 years before their survey date were not eligible to be a new case (i.e., 'prevalent' cases could not also be 'incident' cases). Both measures were weighted to the Manitoba population and age–adjusted in a **generalized linear model**. Variance was estimated via bootstrapping.

The prevalence of hypertension by sex and BMI group is shown in Figure 4.1, and the incidence rates (new cases) are shown in Figure 4.2. The RR values comparing incidence rates and prevalence values for each of the three groups are shown in Table 4.1.

Table 4.1: Relative Risks for Hypertension
Measured/corrected BMI

	Males			Females		
	Obese vs. Normal	**Obese vs. Overweight**	**Overweight vs. Normal**	**Obese vs. Normal**	**Obese vs. Overweight**	**Overweight vs. Normal**
Prevalence (Percent of pop. aged 18+)	1.91*	1.60*	1.20	2.06*	1.45*	1.42*
Incidence (Per 100 person-years)	1.61*	1.21	1.34	2.03*	1.50*	1.36

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Key Findings

The prevalence of hypertension was positively and strongly associated with BMI in both sexes. Prevalence was lowest in the Normal group, higher in the Overweight group, and highest in the Obese group, though among males the difference between the Normal and Overweight group was not statistically significant.

Hypertension incidence rates were positively and strongly associated with BMI in both sexes. Incidence rates were lowest in the Normal group, higher in the Overweight group, and highest in the Obese group.

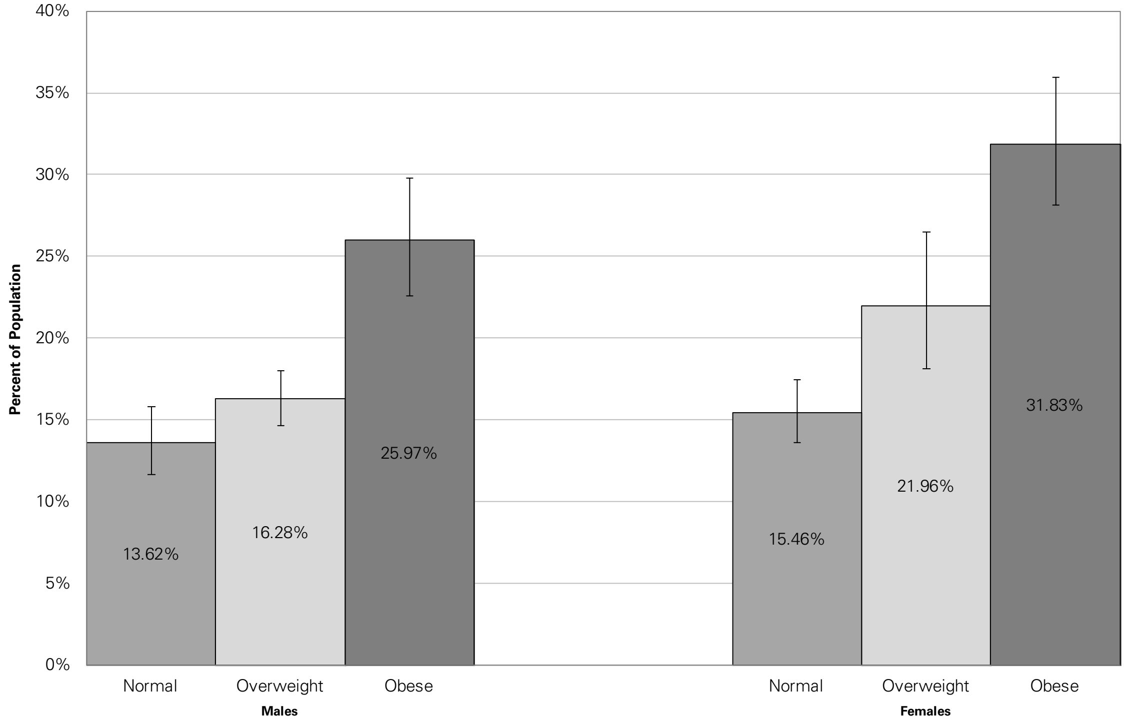
Among males, the hypertension incidence rate for the Obese group was significantly higher than the Normal group. The rate for the Overweight group was not significantly different from either the Obese group or the Normal group.

Among females, the hypertension incidence rate for the Obese group was significantly higher than the Normal and Overweight groups. The Normal and Overweight groups were not significantly different from each other.

These associations between BMI and hypertension are similar to those reported by many other studies, including several large reviews (Brown et al., 2000; Gilmore, 1999; Luo et al., 2007; Must et al., 1999; Pi–Sunyer, 1993; Poirier et al., 2006; Reeder et al., 1992; Tjepkema, 2006; Trakas et al., 1999; Wilson, D'Agostino, Sullivan, Parise, & Kannel, 2002).

Figure 4.1: Hypertension Prevalence by BMI Group

Age–adjusted prevalence of hypertension at survey date, percent of residents aged 18 and older (measured/corrected BMI)

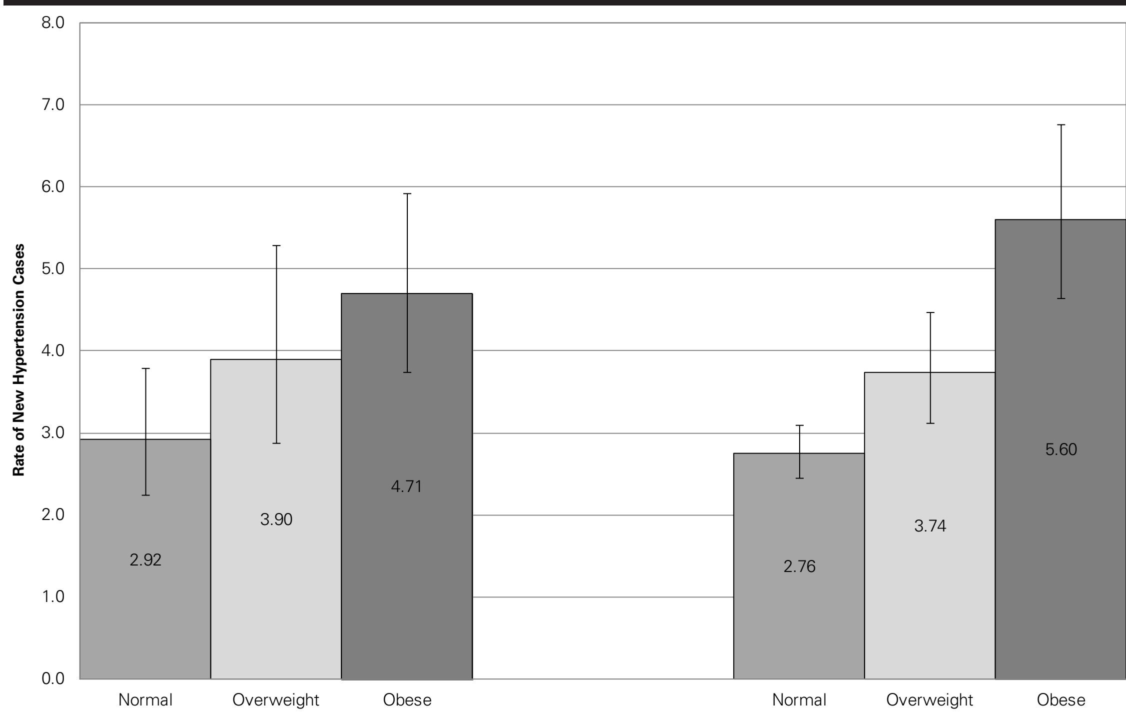


Prevalence measured within one year prior to the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Figure 4.2: Hypertension Incidence Rates by BMI Group

Age–adjusted incidence rates from survey date until March 31, 2009, per 100 person-years, residents aged 18 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Diabetes

Diabetes mellitus is the most common disorder of the endocrine system, and its prevalence is increasing over time. It affects many organ systems and body functions and can cause serious health complications including renal failure, neuropathy, vascular disorders, heart disease, stroke, and blindness. Type 1 and Type 2 diabetes could not be distinguished in the data used for this analysis, so this indicator combines both types. Gestational diabetes has a separate code, so should not be confounded with Type 1 or 2.

Definition: Diabetes incidence and prevalence were measured for survey participants aged 18 and older at the time of survey. Participants were considered to have diabetes if they met one of the following conditions:

1. one or more hospitalizations in three years with a diagnosis of diabetes: ICD–9–CM code 250, ICD–10–CA codes E10–E14
2. two or more physician visits in three years with a diagnosis of diabetes (ICD–9–CM codes as above)
3. one or more prescriptions dispensed in three years for medications to treat diabetes (listed in Appendix 3)

Note that for participants of the Manitoba HHS who were surveyed in 1989–1990, there is no prescription data available as the DPIN database is available in the MCHP Repository from 1995 onwards. Thus for the HHS participants, only conditions 1) and 2) above were used to define diabetes. Also, note that this case definition is slightly different from that used by the National Chronic Disease Surveillance System, though previous reports have shown that the algorithms provide similar prevalence results and trends (Fransoo et al., 2009).

Diabetes prevalence was measured in the three years before survey date and incidence rates were measured per 100 person–years after survey. Individuals whose first confirmed date of diabetes was in the 10 years before their survey date were not eligible to be a new case (i.e., 'prevalent' cases could not also be 'incident' cases). Both measures were weighted to the Manitoba population and age–adjusted in a generalized linear model. Variance was estimated via bootstrapping.

The prevalence of diabetes by sex and BMI group is shown in Figure 4.3, and the incidence rates (new cases) are shown in Figure 4.4. The RR values comparing incidence rates and prevalence values for each of the three groups are shown in Table 4.2.

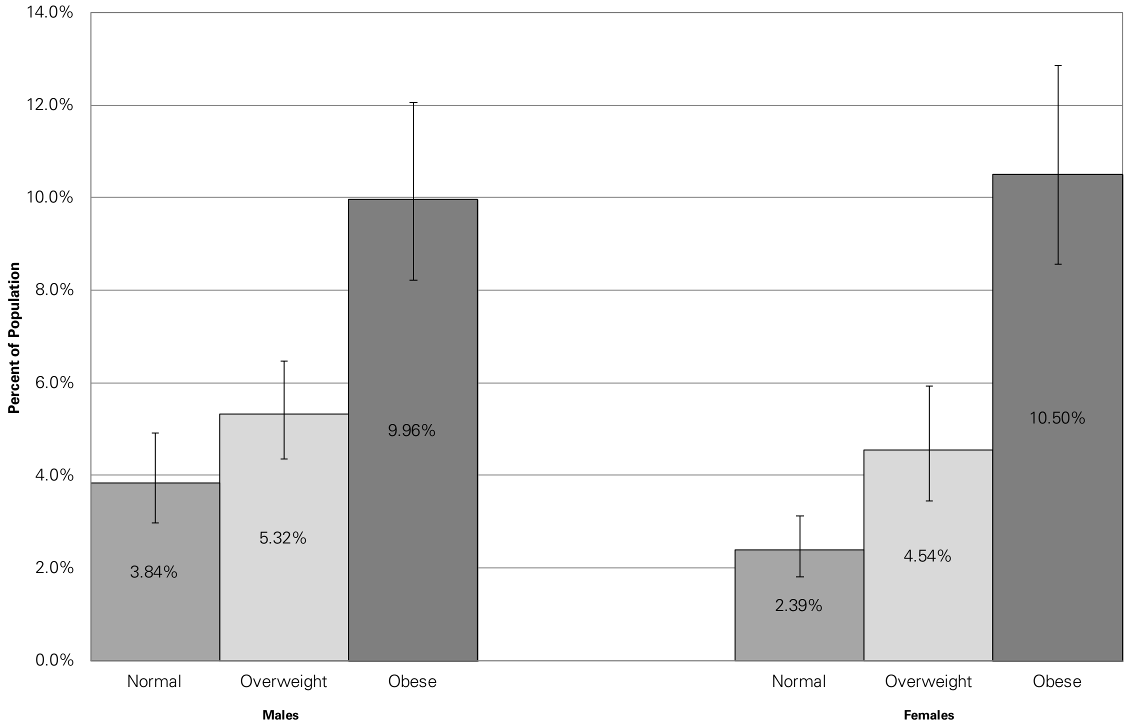
Table 4.2: Relative Risks for Diabetes
Measured/corrected BMI

	Males			Females		
	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Prevalence (Percent of pop. aged 18+	2.60*	1.87*	1.39	4.39*	2.31*	1.90*
Incidence (Per 100 person-years)	4.45*	2.77*	1.61	7.51*	1.82	4.12*

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

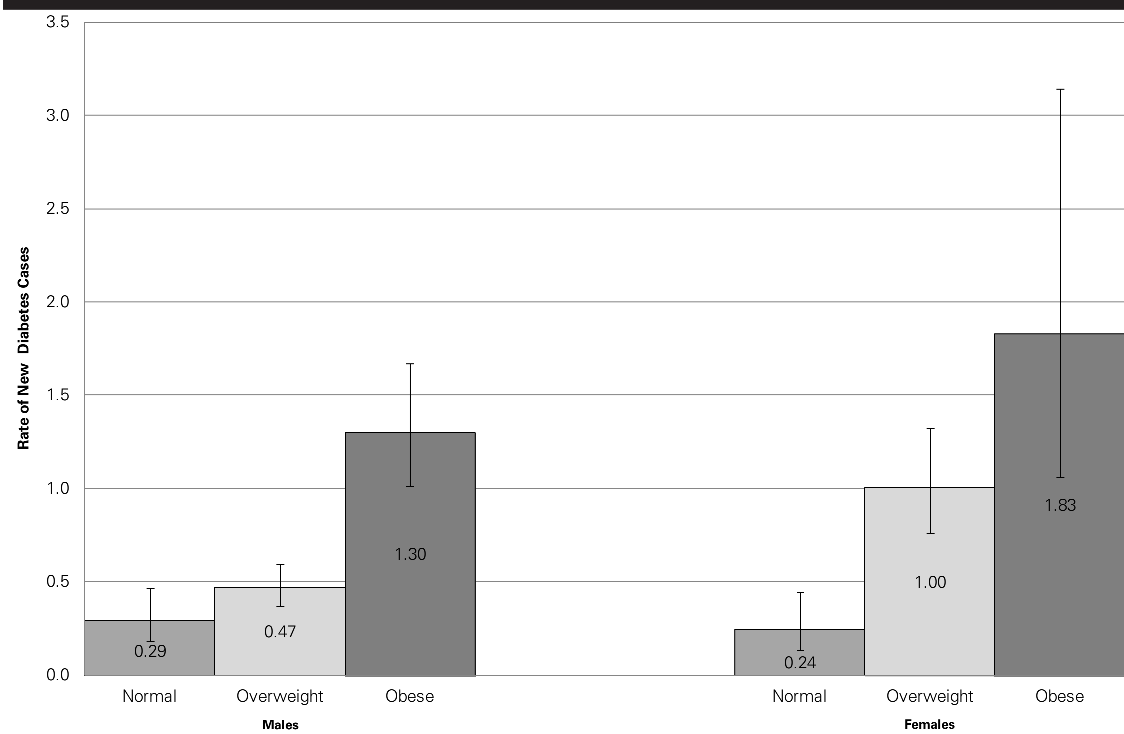
Figure 4.3: Diabetes Prevalence by BMI Group
Age–adjusted prevalence of diabetes at survey date, percent of residents aged 18 and older (measured/corrected BMI)



Prevalence measured within three years prior to the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Figure 4.4: Diabetes Incidence Rates by BMI Group
Age–adjusted incidence rates from survey date until March 31, 2009, per 100 person-years, residents aged 18 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Key Findings

The prevalence of diabetes was positively and strongly associated with BMI in both sexes, but especially among females. Prevalence was lowest in the Normal group, higher in the Overweight group, and highest in the Obese group, though among males the difference between the Normal and Overweight groups was not statistically significant.

Diabetes incidence rates were positively and very strongly associated with BMI in both sexes, again, more strongly for females than males. Incidence rates were lowest in the Normal group, higher in the Overweight group, and highest in the Obese group.

Among males, the diabetes incidence rate for the Obese group was significantly higher than in the Normal and Overweight groups, which were not significantly different from each other.

Among females, the diabetes incidence rates for the Obese and Overweight groups were significantly higher than the Normal group. The difference between the Obese and Overweight groups did not reach statistical significance.

Similar associations between BMI and diabetes have been reported by others (Gilmore, 1999; Luo et al., 2007; Must et al., 1999; Pi–Sunyer, 1993; Poirier et al., 2006; Reeder et al., 1992; Tjepkema, 2006; Trakas et al., 1999).

Dialysis Initiation

Kidney failure is a potential long–term complication of diabetes. Since diabetes was shown in the previous section to be strongly related to obesity, dialysis initiation rates were also examined by BMI group. People whose kidneys cannot adequately dialyze ('filter') blood require either kidney transplant or ongoing dialysis treatments. Dialysis is far more common than transplantation. Only incidence rates are shown because dialysis initiation is well coded in administrative data, whereas ongoing dialysis treatments are not, making prevalent cases more difficult to identify.

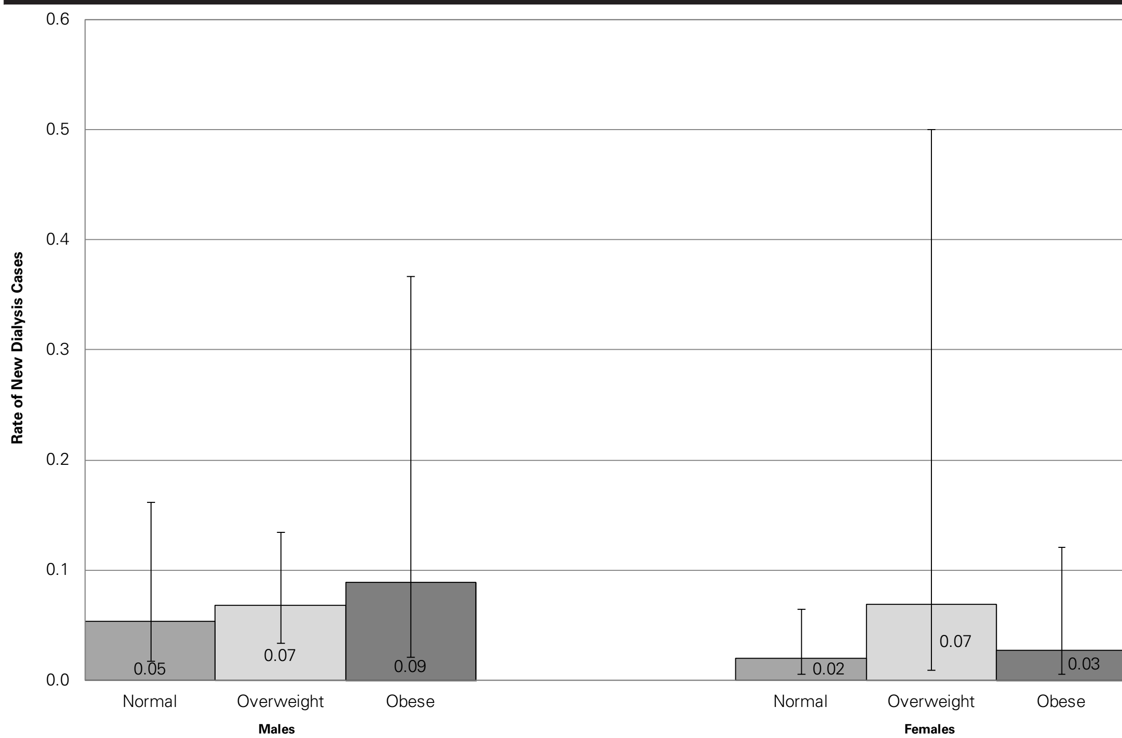
Definition: Dialysis initiation incidence rates were measured for survey participants aged 18 and older at the time of survey. Participants were considered to have begun dialysis treatment if they had one or more physician visits with one of the following Manitoba tariff codes:

- 9610—chronic ambulatory peritoneal dialysis, in hospital, per day
- 9798—acute renal failure initial hemodialysis
- 9799—acute renal failure subsequent hemodialysis
- 9801—chronic renal failure initial hemodialysis
- 9802—chronic renal failure subsequent hemodialysis
- 9805—acute renal failure initial peritoneal dialysis, complete medical management, up to two weeks
- 9806—chronic renal failure initial peritoneal dialysis, first 24 hours
- 9807—acute renal failure subsequent (peritoneal) dialysis, after two weeks
- 9819—chronic renal failure intermittent subsequent (peritoneal) dialysis
- 9820—home (peritoneal) dialysis and self–care dialysis weekly retainer for administration, routine visits, and supervision
- 9821—chronic renal failure home dialysis and self–care dialysis and self–care dialysis weekly retainer

Incidence rates of dialysis initiation were measured per 100 person–years after survey. Individuals whose first confirmed date of dialysis (defined by one of the tariff codes above) was in the 10 years before their survey date were excluded from incidence calculations as they were not eligible to be a new case. Rates were weighted to the Manitoba population and age–adjusted in a generalized linear model. Variance was estimated via bootstrapping.

The (incidence) rate of dialysis initiation by sex and BMI group is shown in Figure 4.5. The RR values comparing incidence rates for each of the three groups are shown in Table 4.3.

Figure 4.5: Dialysis Incidence Rates by BMI Group
Age–adjusted incidence rates after survey date until March 31, 2009, per 100 person-years, residents aged 18 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Table 4.3: Relative Risks for Dialysis
Measured/corrected BMI

	Males			Females		
	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Incidence (Per 100 person-years)	1.68	1.32	1.27	1.38	0.39	3.53

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- Dialysis initiation rates were not significantly related to obesity in males or females.
- The large CIs shown in Figure 4.5 reflect the small number of incident cases of dialysis treatment in each BMI group. There were no statistically significant differences among any of the group comparisons.

Acute Myocardial Infarction (AMI)

An **acute myocardial infarction** (heart attack) occurs when the arteries that supply blood to the heart are blocked and prevent enough oxygen from reaching the heart, which damages or kills heart muscle cells. The blockage is usually caused by a clot that blocks one of the coronary arteries, which are often narrowed because of long–term accumulation of plaque inside the arterial walls.

Definition: The rate of hospitalization or death due to AMI was measured for survey participants aged 40 and older at the time of survey. Participants were considered to have experienced an AMI if they met one of the following conditions:

- an **inpatient hospitalization** with the most responsible diagnosis of AMI: ICD–9–CM code 410, ICD–10–CA code I21, and a length of stay of three or more days (unless the patient died in hospital)
- a death with AMI listed as the primary cause of death on the Vital Statistics death record (ICD codes as above)

Persons discharged alive from hospital after less than three days were excluded as likely 'rule out' AMI cases.

AMI incidence rates were measured per 100 person–years after survey. Individuals who had a hospitalization for an AMI prior to their survey date were still eligible to be included in the incidence rates calculations after survey date as individuals can experience multiple heart attacks in their lifetime. Rates were weighted to the Manitoba population and adjusted for age and smoking status as reported by survey participants in a generalized linear model. Variance was estimated via bootstrapping.

AMI incidence rates by sex and BMI group are shown in Figure 4.6. The RR values comparing incidence rates for each of the three groups are shown in Table 4.4.

Table 4.4: Relative Risks for Acute Myocardial Infarction (AMI)
Measured/corrected BMI

	Males			Females		
	Obese vs. Normal	**Obese vs. Overweight**	**Overweight vs. Normal**	**Obese vs. Normal**	**Obese vs. Overweight**	**Overweight vs. Normal**
Incidence (Per 100 person-years)	1.77	2.38*	0.75	0.68	1.22	0.56

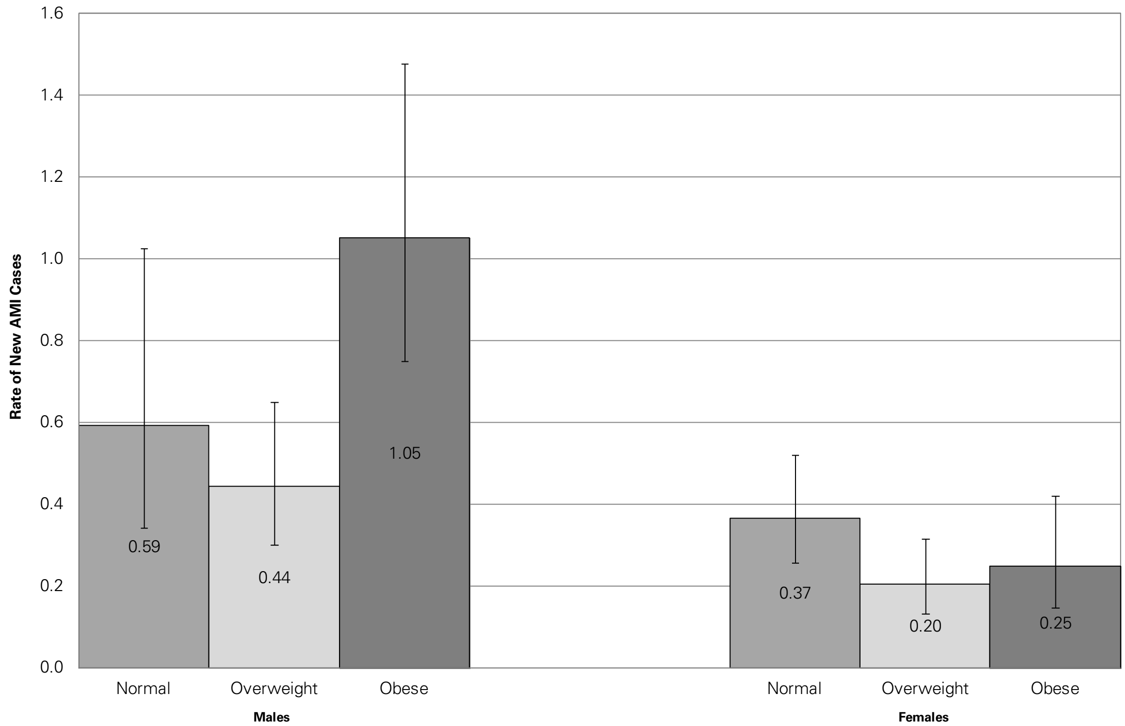
* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- AMI incidence rates were also not consistently related to BMI group, though some differences were found:
    - Among males, the Obese group had the highest AMI incidence rate, the Overweight group had the lowest rate, and the Normal group was in between. The rate for the Obese group was significantly higher than the Overweight group, but not the Normal group.
    - Among females, the Normal group had the highest rate, and the Overweight and Obese groups were somewhat lower, though none of the group differences reached statistical significance.

Figure 4.6: Acute Myocardial Infarction (AMI) Incidence Rates by BMI Group
Age– & smoking–adjusted incidence rates from survey date until March 31, 2009, per 100 person-years, residents aged 40 and older (measured/corrected BMI



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Ischemic Heart Disease (IHD)

Ischemic heart disease (IHD) is a term used to describe a group of conditions related to restricted blood flow to the heart. This IHD group includes patients who have experienced an AMI (who comprise about 50% of the IHD group), but also includes patients experiencing angina (chest pain upon exertion) and other related conditions (see definition below). Many patients with these other conditions are at high risk of AMI.

Definition: Survey participants aged 18 and older (at time of survey) were considered to have IHD if they met one of the following conditions:

1. one or more hospitalizations in five years with a diagnosis of IHD: ICD–9–CM codes 410–414; ICD–10–CA codes I20–I22, I24, I25
2. two or more physician visits in five years with a diagnosis of IHD (ICD–9–CM codes as above)
3. one physician visit with a diagnosis of IHD (ICD–9–CM codes as above) and two or more prescriptions dispensed for medications used to treat IHD (listed in Appendix 3) in five years

Note that for participants of the HHS (1989–1990), there are no prescription data available as the DPIN database only began in 1995. Thus for the HHS participants, only conditions 1) or 2) above were used to define IHD.

IHD prevalence was measured in the five years before survey date and incidence rates were measured per 100 person–years after survey. Individuals whose first confirmed date of IHD was in the 10 years before their survey date were not eligible to be a new case (i.e., 'prevalent' cases could not also be 'incident' cases). Rates were weighted to the Manitoba population and adjusted for age and smoking status as reported by survey participants in a generalized linear model. Variance was estimated via bootstrapping.

The prevalence of IHD by sex and BMI group is shown in Figure 4.7. IHD incidence rates by sex and BMI group are shown in Figure 4.8. The RR values comparing incidence rates for each of the three groups are shown in Table 4.5.

Table 4.5: Relative Risks for Ischemic Heart Disease (IHD)
Measured/corrected BMI

	Males			Females		
	Obese vs. Normal	**Obese vs. Overweight**	**Overweight vs. Normal**	**Obese vs. Normal**	**Obese vs. Overweight**	**Overweight vs. Normal**
Prevalence (Percent of pop. aged 18+)	0.77	1.18	0.65	1.66	2.04	0.81
Incidence (Per 100 person-years)	1.24	1.43	0.87	1.57	2.13	0.74

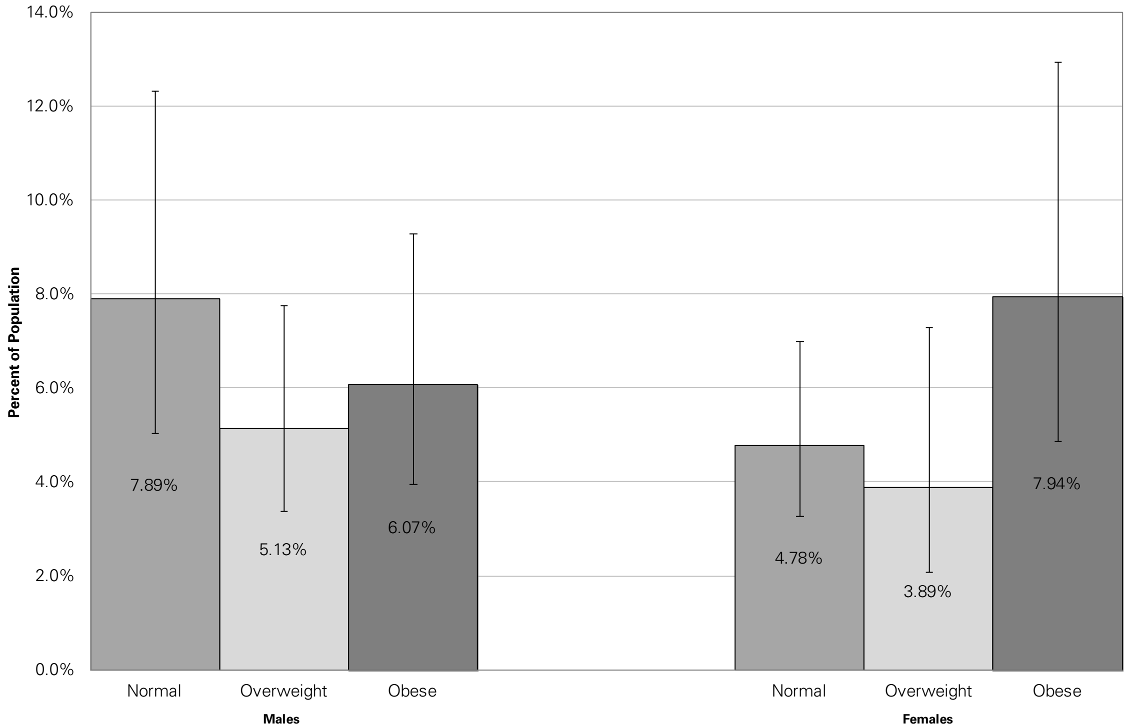
* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- IHD prevalence was not consistently related to BMI group in either sex.
  - Among males, the Normal group had the highest prevalence, followed by the Obese and Overweight groups, but none of these group differences were statistically significant.
  - Among females, the Obese group had the highest prevalence, followed by the Normal and Overweight groups, though none of these differences were statistically significant.
- IHD incidence rates were also not significantly related to BMI group in either sex.
  - Among males, the Obese group had the highest IHD incidence rate, the Overweight group had the lowest rate, and the Normal group was in between, though none of the group differences reached statistical significance.
  - Among females, the Obese group had the highest rate, and the Normal and Overweight groups were somewhat lower, though none of the group differences reached statistical significance.
- Many previous studies, including several large reviews, have shown positive associations between BMI and IHD prevalence and/or incidence (Gilmore, 1999; Lavie, Milani, & Ventura, 2009; Luo et al., 2007; Must et al., 1999; Pi–Sunyer, 1993; Poirier et al., 2006; Tjepkema, 2006; Trakas et al., 1999; Twells, Knight, & Alaghehbandan, 2010; Wilson et al., 2002), though not all were statistically significant. Most studies reported a steady increase in IHD prevalence with increasing BMI, though in some, higher rates were noted for the Obese group only.

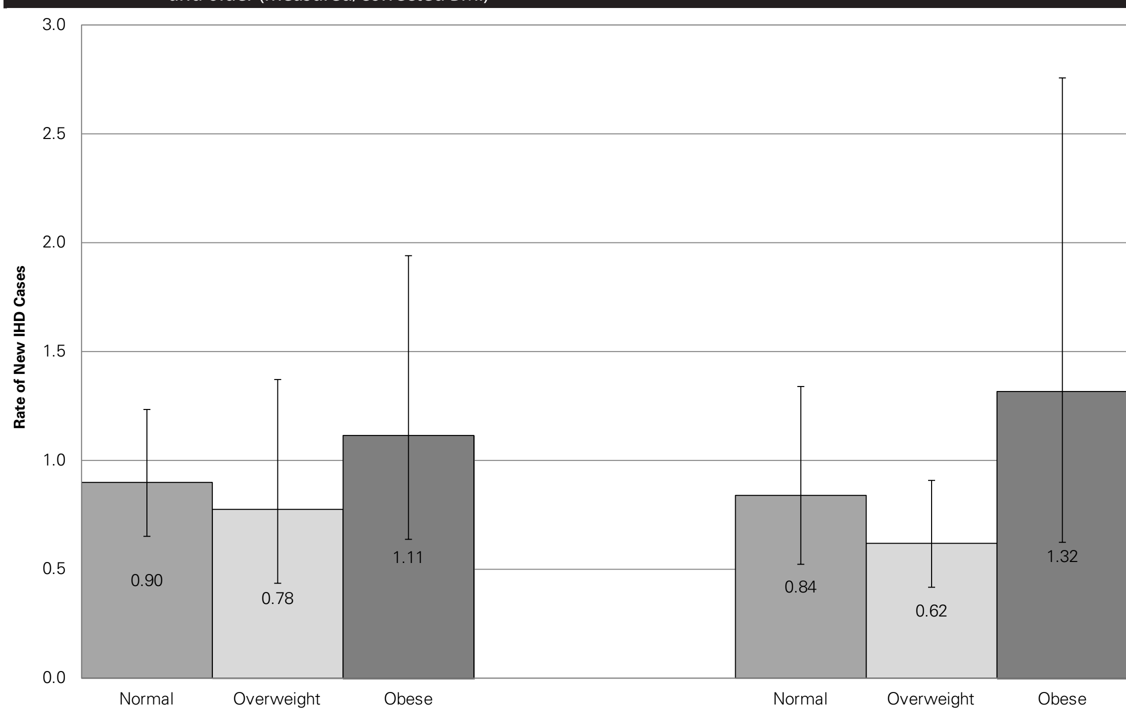
Figure 4.7: Ischemic Heart Disease (IHD) Prevalence by BMI Group
Age– & smoking–adjusted prevalence of IHD at survey date, percent of residents aged 18 and older (measured/corrected BMI)



Prevalence measured within five years prior to the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Figure 4.8: Ischemic Heart Disease (IHD) Incidence Rates by BMI Group
Age– & smoking–adjusted incidence rates from survey date until March 31, 2009, per 100 person-years, residents aged 18 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Stroke

A stroke occurs when the arteries that supply blood to the brain are blocked and prevent enough oxygen from reaching the brain, which damages or kills brain cells.

Definition: The rate of hospitalization or death due to stroke was measured for survey participants aged 40 and older at the time of survey. Participants were considered to have experienced a stroke if they met one of the following conditions:

1. a hospitalization with the most responsible diagnosis of stroke: ICD–9–CM codes 431, 434, 436; ICD–10–CA codes I61, I63, I64 as:
    a. an inpatient with a length of stay of at least one day
    b. without being admitted, but having died in hopsital (e.g., died of a stroke in the Emergency Department but without being admitted to the hospital as an inpatient)
2. a death with stroke listed as the primary cause of death on the Vital Statistics death record (ICD codes as above)

Note that this definition will not capture minor strokes that did not result in hospitalization or death.

Stroke prevalence was measured in the five–year period preceding each participant's survey date, and incidence rates were measured per 100 person–years after survey. Individuals who had a hospitalization for a stroke prior to their survey date were still eligible to be included in the incidence rates calculations after survey date as individuals can experience multiple strokes in their lifetime. Rates were weighted to the Manitoba population and adjusted for age and smoking status as reported by survey participants in a generalized linear model. Variance was estimated via bootstrapping.

The prevalence of stroke by sex and BMI group is shown in Figure 4.9. Stroke incidence rates by sex and BMI group are shown in Figure 4.10. The RR values comparing incidence rates for each of the three groups are shown in Table 4.6.

Table 4.6: Relative Risks for Stroke
Measured/corrected BMI

	Males			Females		
	Obese vs. Normal	**Obese vs. Overweight**	**Overweight vs. Normal**	**Obese vs. Normal**	**Obese vs. Overweight**	**Overweight vs. Normal**
Prevalence (Percent of pop. aged 40+)	0.81	2.79	0.29	5.12	28.01*	0.18*
Incidence (Per 100 person-years)	1.90	0.50	3.80*	0.49	0.60	0.81

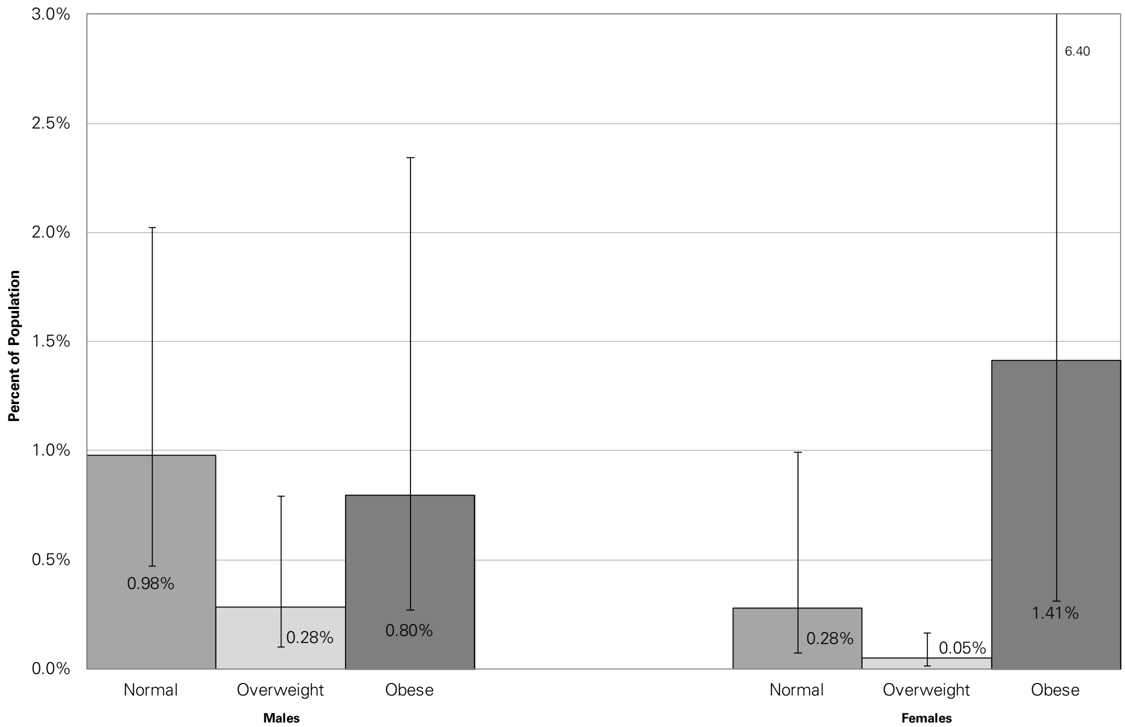
* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- Stroke prevalence was not consistently related to BMI group, although the Overweight group did have the lowest rates for both sexes.
    - Among males, the Normal and Obese groups were similar; both were higher than the Overweight group, though these differences did not reach statistical significance.
    - Among females, the Obese group had the highest rate, which was significantly higher than the Overweight group (28 times higher). The Normal group was also significantly higher than the Overweight group. Even though the prevalence for the Obese group was considerably higher than that for the Normal group (five times), this difference was not statistically significant, likely because the variation for each group was large (as indicated by the tall error bars).

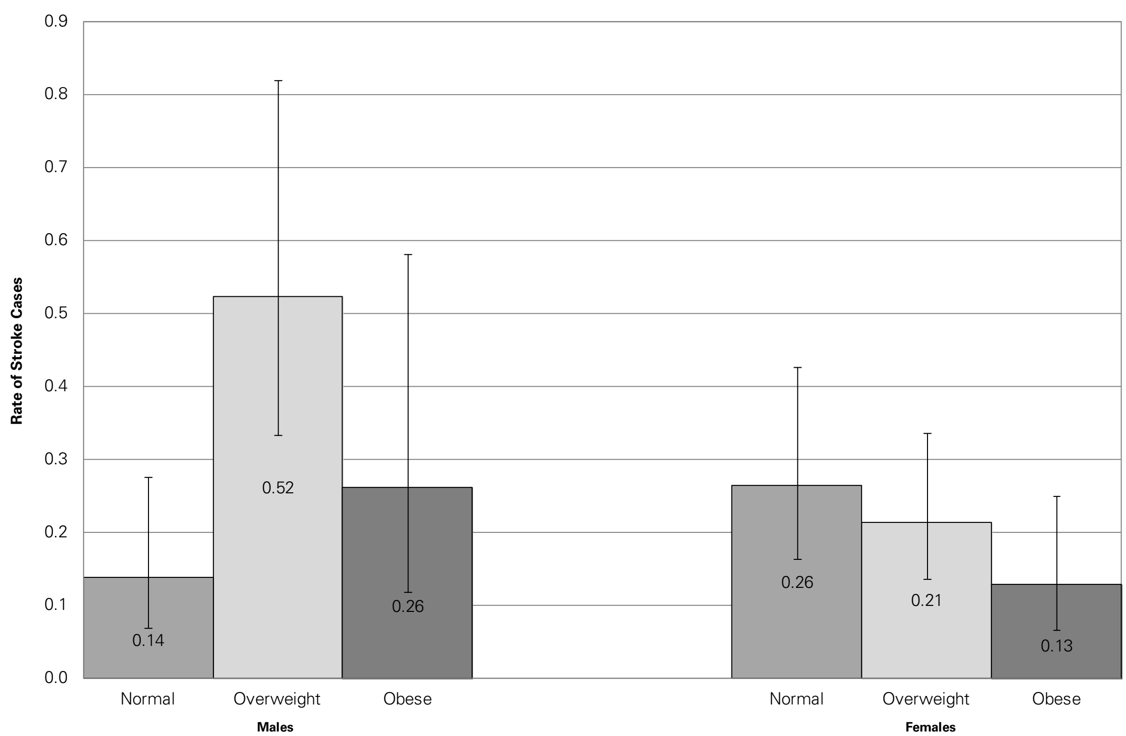
Figure 4.9: Stroke Prevalence by BMI Group
Age– & smoking–adjusted prevalence of stroke at survey date, percent of residents aged 40 and older (measured/corrected BMI)



Prevalence measured within five years prior to the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Figure 4.10: Stroke Incidence Rates by BMI Group
Age– & smoking–adjusted incidence rates from survey date until March 31, 2009, per 100 person-years, residents aged 40 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

- Stroke incidence rates were not directly related to BMI in either sex.
  - Among males, the Overweight group had the highest stroke incidence rate, which was significantly higher than the Normal group but not the Obese group. The Normal group had the lowest rate. The rate for the Obese group was almost double that of the Normal group, though this difference was not statistically significant.
  - Among females, an inverse gradient was seen: stroke incidence rates were lower for the Overweight than the Normal group and lower for the Obese than the Overweight group, though none of the differences reached statistical significance.
- Previous studies (including large reviews) have shown significant positive relationships between BMI values and the incidence and/or prevalence of stroke (Gilmore, 1999; Kurth et al., 2002; Luo et al., 2007; Poirier et al., 2006; Trakas et al., 1999).

Hip Fracture

A hip fracture is a fracture of the femur (the long bone of the upper leg) near the hip joint. Hip fractures are often associated with **osteoporosis**, in which bones are weaker and more likely to break. Low BMI has been shown to be associated with higher risk of osteoporosis and hip fracture. This analysis was undertaken to examine the other extreme: whether obesity might be protective for hip fractures.

Definition: Hip fracture incidence was measured for survey participants aged 50 and older at the time of survey. Participants were considered to have had a hip fracture if they met all of the following conditions:

1. one or more hospitalizations or physician visits in five years with a diagnosis of hip fracture: ICD–9–CM codes 820–821, ICD–10–CA code S72 **AND**
2. one or more physician claims for hip fracture reduction or fixation, open or closed, within two weeks of hip fracture diagnosis, physician tariff codes 0865, 0868, 0870, 0872, 0874

Hospitalizations for fractures associated with a diagnosis code for a major trauma (crushing injuries or motor vehicle accidents) were excluded: ICD–9–CM codes 925–929, E800–E848; ICD–10–CA codes S07, S17, S18, S28.0, S38, S47, S57, S67, S77, S87, S97, T04, T14.7, V01–V99.

Hip fracture incidence rates were measured per 100 person–years after survey. Individuals whose first confirmed date of hip fracture (meeting the definition criteria above) in the 10 years before their survey date were excluded from incidence calculations as they were not eligible to be a new case. Rates were weighted to the Manitoba population and age–adjusted in a generalized linear model. Variance was estimated via bootstrapping.

Hip fracture (incidence) rates by sex and BMI group are shown in Figure 4.11. The RR values comparing incidence rates for each of the three groups are shown in Table 4.7.

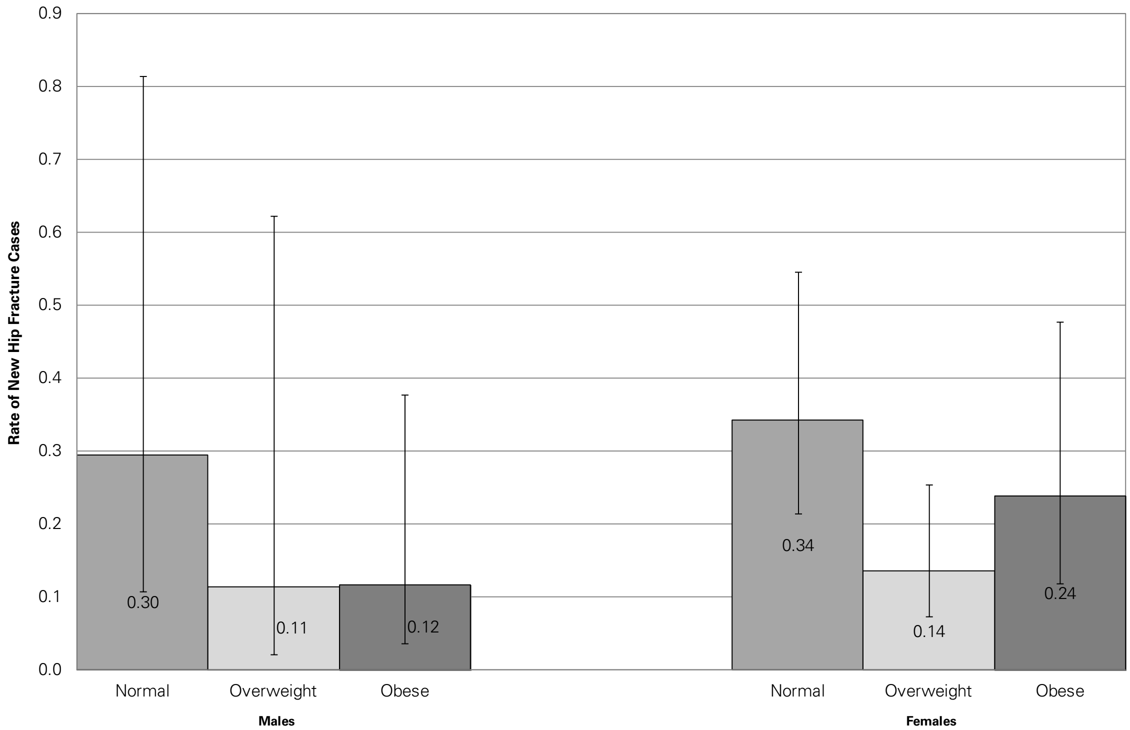
Table 4.7: Relative Risks for Hip Fracture
Measured/corrected BMI

	Males			Females		
	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Incidence (Per 100 person-years)	0.39	1.03	0.38	0.70	1.75	0.40

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Figure 4.11: Hip Fracture Incidence Rates by BMI Group
Age– & smoking–adjusted incidence rates from survey date until March 31, 2009, per 100 person-years, residents aged 50 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- Hip fracture rates were not significantly related to BMI in males or females, though in both sexes the Normal group had the highest hip fracture rate.
    - It is important to recall here that the Normal group does not include those in the Underweight range, who are known to be at much higher risk of hip fracture; see De Laet et al. (2005). However, these results suggest that the fracture risk associated with lower BMI values may creep into the lower portion of the 'Normal' BMI range as well.
- The large CIs shown in Figure 4.11 reflect the small number of incident cases of hip fracture in each BMI group. There were no statistically significant differences among any of the groups.
- The small sample size included in this analysis included too few cases to draw strong conclusions, but our results are consistent with previous findings that lower BMI values are associated with higher fracture risk (De Laet et al., 2005). (Recall that there were too few Underweight participants in the surveys used in this study to allow inclusion of that group in this analysis.)
- Conversely, high BMI values do not appear to be protective against hip fracture; the rates for the Obese group were not lower than the Overweight group.

Total Respiratory Morbidity

This indicator is a grouping of a number of respiratory diseases, including **asthma**, **bronchitis**, and chronic airway obstruction. This combination of diagnoses is used to overcome problems resulting from different diagnoses being used to describe the same underlying illness (e.g., asthma versus chronic bronchitis).

Definition: Total respiratory morbidity incidence and prevalence were measured for survey participants aged 18 and older at the time of survey. Participants were considered to have **respiratory disease** if they had at least one physician visit or hospitalization in one year with a diagnosis of asthma, acute bronchitis, chronic bronchitis, bronchitis not specified as acute or chronic, **emphysema**, or chronic airway obstruction: ICD–9–CM codes 466, 490, 491, 492, 493, 496; ICD–10–CA codes J20, J21, J40–J45.

Total respiratory morbidity prevalence was measured in the one year before survey date and incidence rates were measured per 100 person–years after survey. Individuals whose first confirmed date of respiratory disease (meeting one of the definition criteria above) in the 10 years before their survey date were excluded from incidence calculations as they were not eligible to be a new case. Both measures were weighted to the Manitoba population and adjusted for age and smoking status as reported by survey participants in a generalized linear model. Variance was estimated via bootstrapping.

The prevalence of respiratory diseases by sex and BMI group is shown in Figure 4.12, and the incidence rates (new cases) are shown in Figure 4.13. The RR values comparing incidence rates and prevalence values for each of the three groups are shown in Table 4.8.

Table 4.8: Relative Risks for Total Respiratory Morbidity
Measured/corrected BMI

	Males			Females		
	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Prevalence (Percent of pop. aged 18+)	1.08	1.02	1.05	1.25*	1.15	1.09
Incidence (Per 100 person-years)	1.25	1.23	1.02	1.51*	1.15	1.31

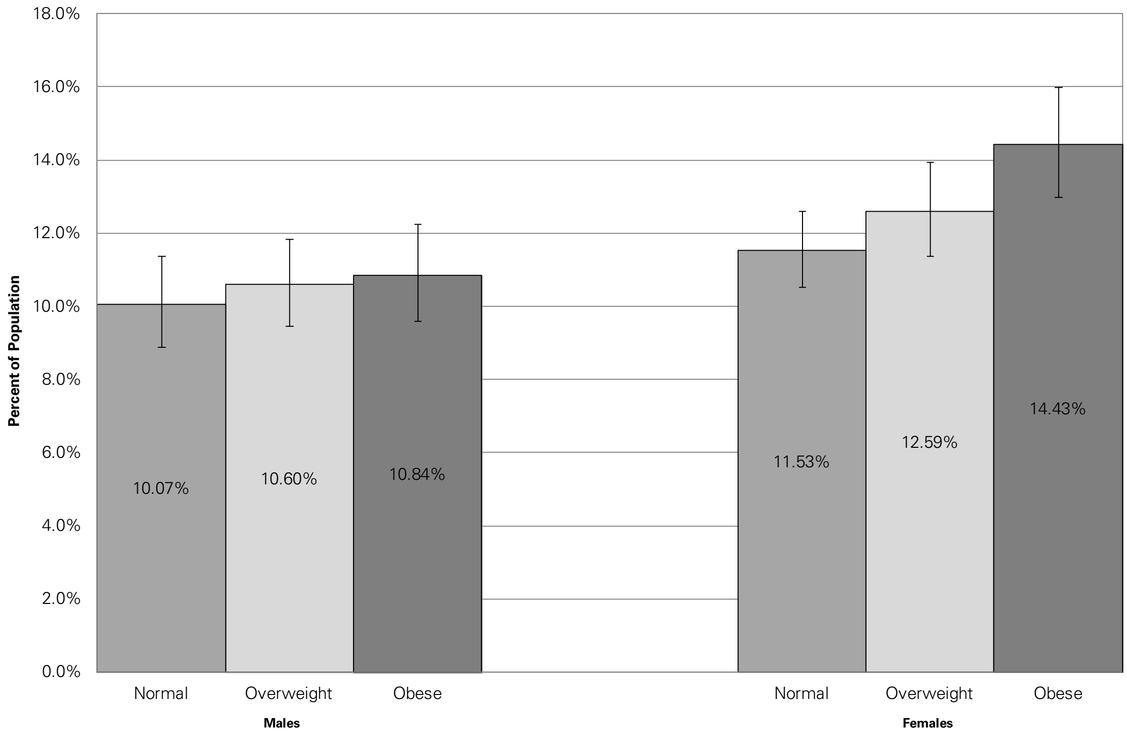
* Indicates statistically a significant difference

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- The prevalence of respiratory disease was positively associated with BMI among females, but not among males.
  - Among females, the Obese group had the highest prevalence, followed by the Overweight group, then the Normal group, though the only statistically significant difference was that between the Normal and Obese groups.
  - Among males, the Obese group had the highest prevalence, followed closely by the Overweight group; the Normal group was lower. None of the differences reached statistical significance.
  - Other studies and reviews have also reported higher rates of respiratory disorders among those in the Overweight and/or Obese groups (Chen, Dales, Krewski, & Breithaupt, 1999; Gilmore, 1999; Pi–Sunyer, 1993; Trakas et al., 1999; Twells et al., 2010).
- As with the prevalence values above, the incidence rates for respiratory disease were positively associated with BMI among females, but not among males.
  - Among females, the Obese group had the highest incidence rate, followed by the Overweight group, then the Normal group, though the only statistically significant difference was that between the Normal and Obese groups.
  - Among males, the Obese group had the highest prevalence and the Overweight and Normal groups were lower, though none of the differences reached statistical significance.

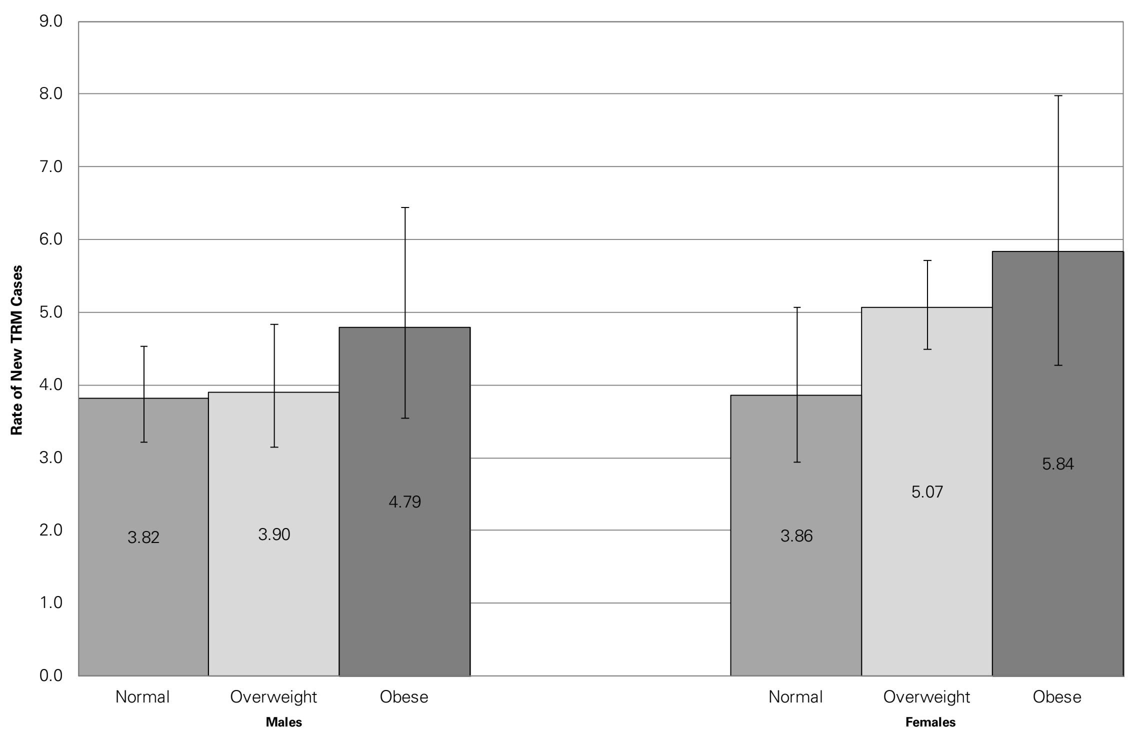
Figure 4.12: Total Respiratory Morbidity (TRM) Prevalence by BMI Group
Age– & smoking–adjusted prevalence of total respiratory morbidity at survey date, percent of residents aged 18 and older (measured/corrected BMI)



Prevalence measured within one year prior to the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Figure 4.13: Total Respiratory Morbidity (TRM) Incidence Rates by BMI Group
Age– & smoking–adjusted incidence rates from survey date until March 31, 2009, per 100 person years, residents aged 18 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Cancer Incidence (Any Type)

Cancer is a group of diseases characterized by the uncontrolled invasive growth of cells which intrude upon and destroy adjacent tissues. Cancers are more common among older adults, so all analyses for this report excluded residents under the age of 50 years at the time of diagnosis.

Definition: this indicator includes all invasive cancers (non–melanoma skin cancers are excluded). Incidence rates were calculated for those aged 50 and over and were adjusted for age and smoking status.

Cancer incidence rates by sex and BMI group are shown in Figure 4.14. The RR values comparing incidence rates for each of the three groups are shown in Table 4.9.

Table 4.9: Relative Risks for Any Cancer
Measured/corrected BMI

	Males			Females		
	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Incidence (Per 100 person-years)	0.68	0.45	1.52	1.39	1.37	1.02

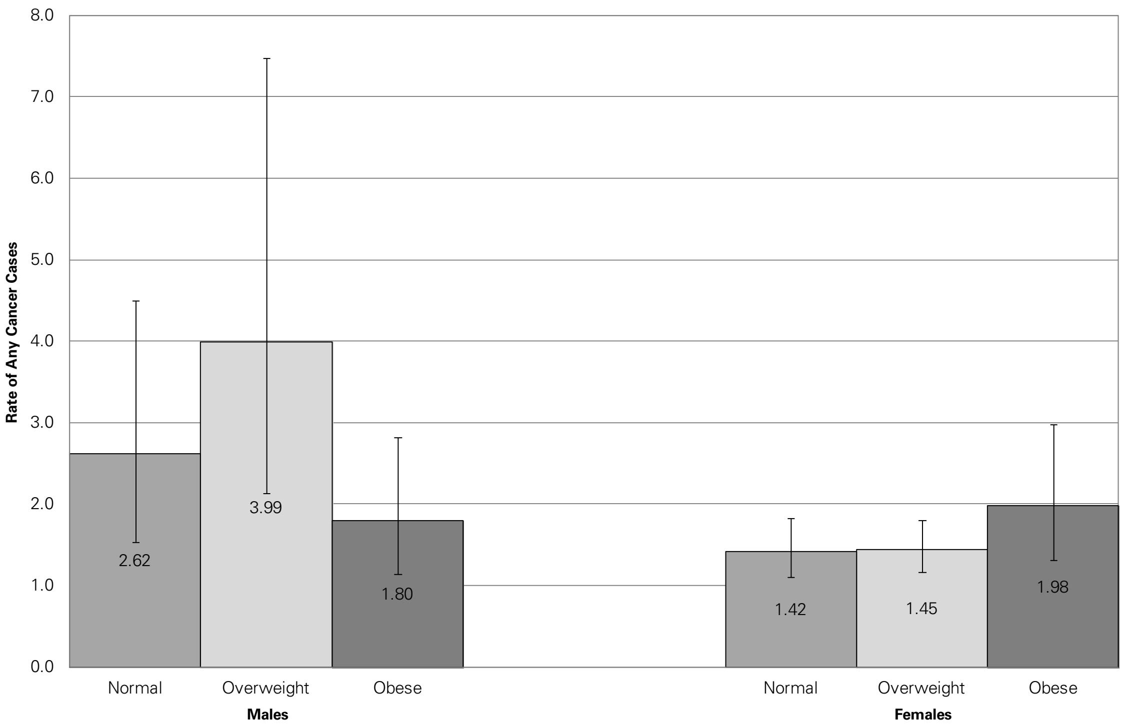
* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- Incidence rates of all cancers combined (except non–melanoma skin cancer) were not significantly related to BMI levels in either sex.
- Among males, cancer incidence rates were highest among the Overweight group and lowest among the Obese group, with the Normal group in between. The difference between the Obese and Overweight groups was close to, but did not quite reach, statistical significance.
- Among females, cancer incidence rates were virtually identical for the Normal and Overweight groups. The rate for Obese group appeared higher, but the differences were not significant.
- Previous studies have shown mixed results when analyzing the relationship between BMI and cancer incidence with some studies showing positive associations (Samanic, Chow, Gridley, Jarvholm, & Fraumeni, 2006), and others showing no significant association (Gilmore, 1999; Trakas et al., 1999), as we showed here. Many other studies have focused on specific cancer types or sites, some of which are noted below.

Figure 4.14: Any Cancer Incidence Rates by BMI Group
Age– & smoking–adjusted incidence rates of any cancer from survey date until March 31, 2009, per 100 person-years, residents age 50 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Lung Cancer Incidence

Definition: this indicator includes new cases of lung cancer: ICD–9–CM codes 162.2–162.9, ICD–10–CA code C34. Incidence rates were calculated for those aged 50 and over and were adjusted for age and smoking status.

Lung cancer incidence rates by sex and BMI group are shown in Figure 4.15. The RR values comparing incidence rates for each of the three groups are shown in Table 4.10.

Key Findings

- Incidence rates of lung cancer were not related to BMI levels in either sex.
- Among males, the rate was similar among the Normal and Overweight groups and somewhat lower among the Obese group, though none of the group differences were significant.
- Among females, rates were similar across all three BMI groups.

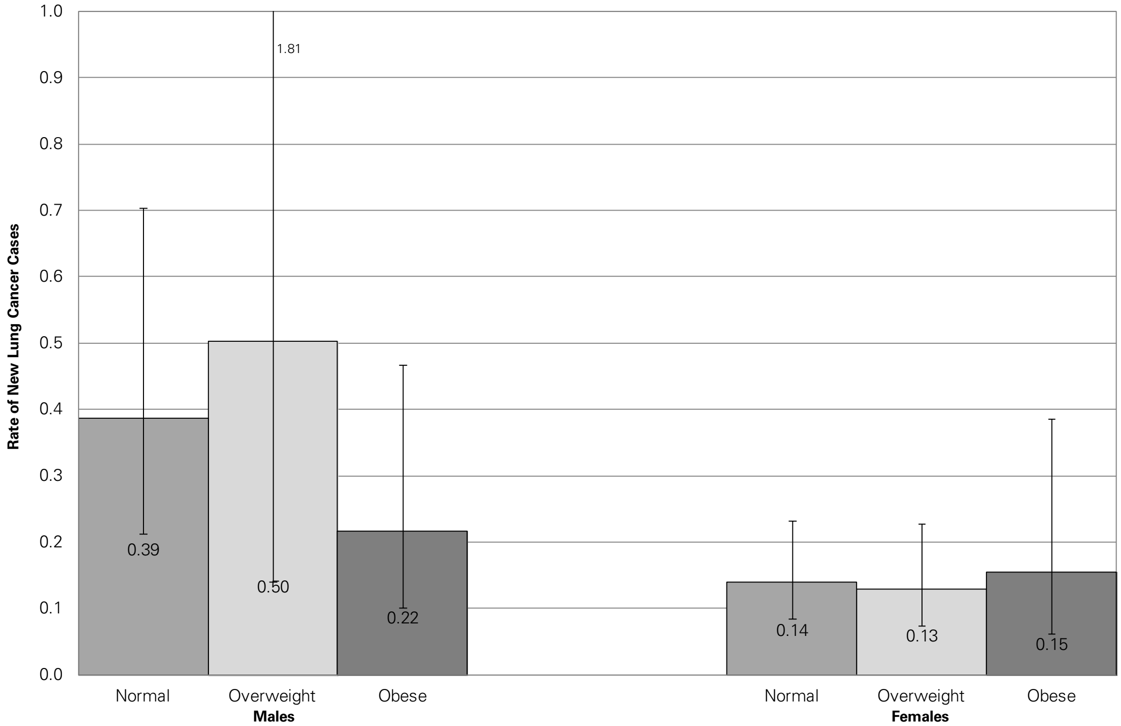
Table 4.10: Relative Risks for Lung Cancer
Measured/corrected BMI

	Males			Females		
	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Incidence (Per 100 person-years)	0.56	0.43	1.30	1.10	1.19	0.92

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Figure 4.15: Lung Cancer Incidence Rates by BMI Group
Age– & smoking–adjusted incidence rates of lung cancer from survey date until March 31, 2009, per 100 person-years, residents age 50 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Colorectal Cancer Incidence

Definition: this indicator includes new cases of colorectal cancer: ICD–9–CM codes 153, 154.0, 154.1, 159.0; ICD–10–CA codes C18, C19, C20, C26.0. Incidence rates were calculated for those aged 50 and over and were adjusted for age and smoking status.

The incidence rates of colorectal cancer by sex and BMI group are shown in Figure 4.16. The RR values comparing incidence rates for each of the three groups are shown in Table 4.11.

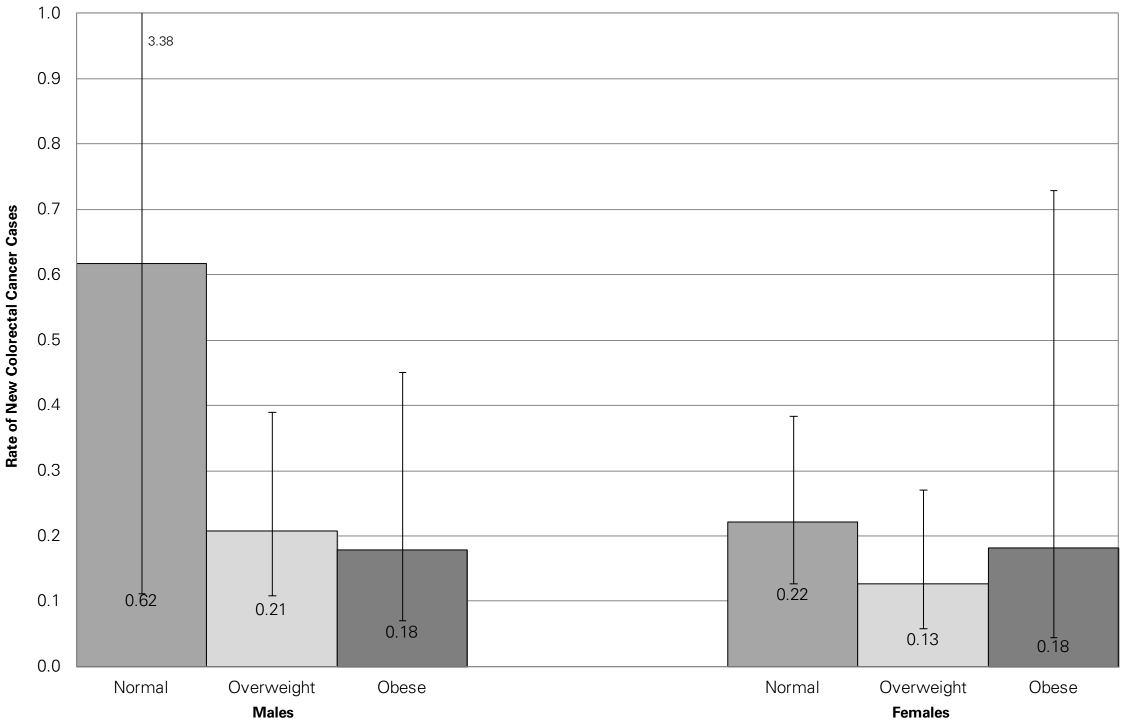
Table 4.11: Relative Risks for Colorectal Cancer
Measured/corrected BMI

	Males			Females		
	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Incidence (Per 100 person-years)	0.29	0.86	0.34	0.82	1.43	0.57

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Figure 4.16: Colorectal Cancer Incidence Rates by BMI Group
Age– & smoking–adjusted incidence rates of colorectal cancer from survey date until March 31, 2009, per 100 person-years, residents age 50 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- Incidence rates of colorectal cancer were not related to BMI levels in either sex.
- Among males, the Normal group had the highest rate. The Overweight and Obese groups were lower and similar to each other. None of the group differences were significant.
- Among females, the Normal group had the highest rates, followed by the Obese and Overweight groups. None of the group differences were significant.
- Previous studies have shown a positive association between BMI and colorectal cancer incidence (Luo et al., 2007).

Breast Cancer Incidence

Definition: this indicator includes new cases of breast cancer: ICD–9–CM code 174, ICD–10–CA code C50. While breast cancer does occur among males, it is rare, so only females were included in this analysis. Incidence rates were calculated for females aged 50 and over and were adjusted for age and smoking status.

Breast cancer incidence rates by BMI group are shown in Figure 4.17. The RR values comparing incidence rates for each of the three groups are shown in Table 4.12.

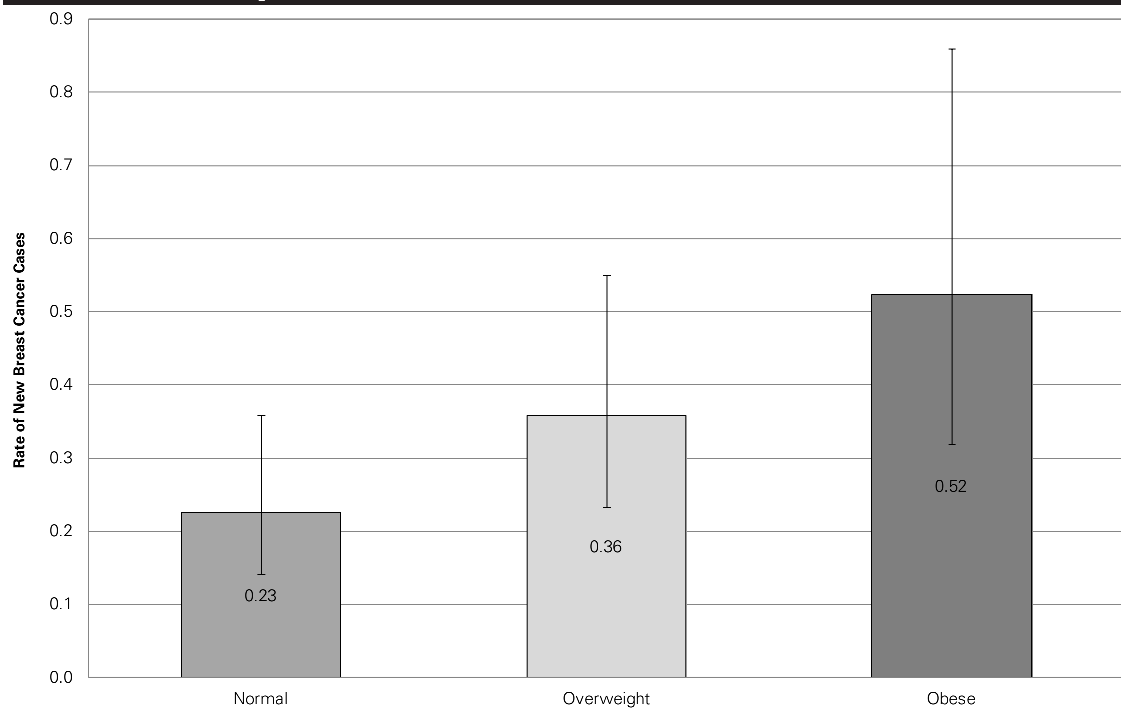
Table 4.12: Relative Risks for Breast Cancer
Measured/corrected BMI

	Females		
	Obese vs. Normal	**Obese vs. Overweight**	**Overweight vs. Normal**
Incidence (Per 100 person-years)	2.32	1.46	1.59

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Figure 4.17: Breast Cancer Incidence Rates by BMI Group
Age– & smoking–adjusted incidence rates of breast cancer from survey date until March 31, 2009, per 100 person-years, females age 50 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- Breast cancer incidence rates among females were lowest in the Normal group, higher in the Overweight group, and highest among the Obese. However, none of the group differences were statistically significant (the difference between the Normal and Obese groups was closeto, but did not quite reach, statistical significance).
- Previous studies have shown a positive association between BMI and breast cancer incidence among post–menopausal women (Luo et al., 2007).

Prostate Cancer Incidence

Definition: this indicator includes new cases of prostate cancer: ICD–9–CM code 185, ICD–10–CA code C61. Only males were included in this analysis. Incidence rates were calculated for males aged 50 and over and were adjusted for age and smoking status.

The incidence rates of prostate cancer by BMI group are shown in Figure 4.18. The RR values comparing incidence rates for each of the three groups are shown in Table 4.13.

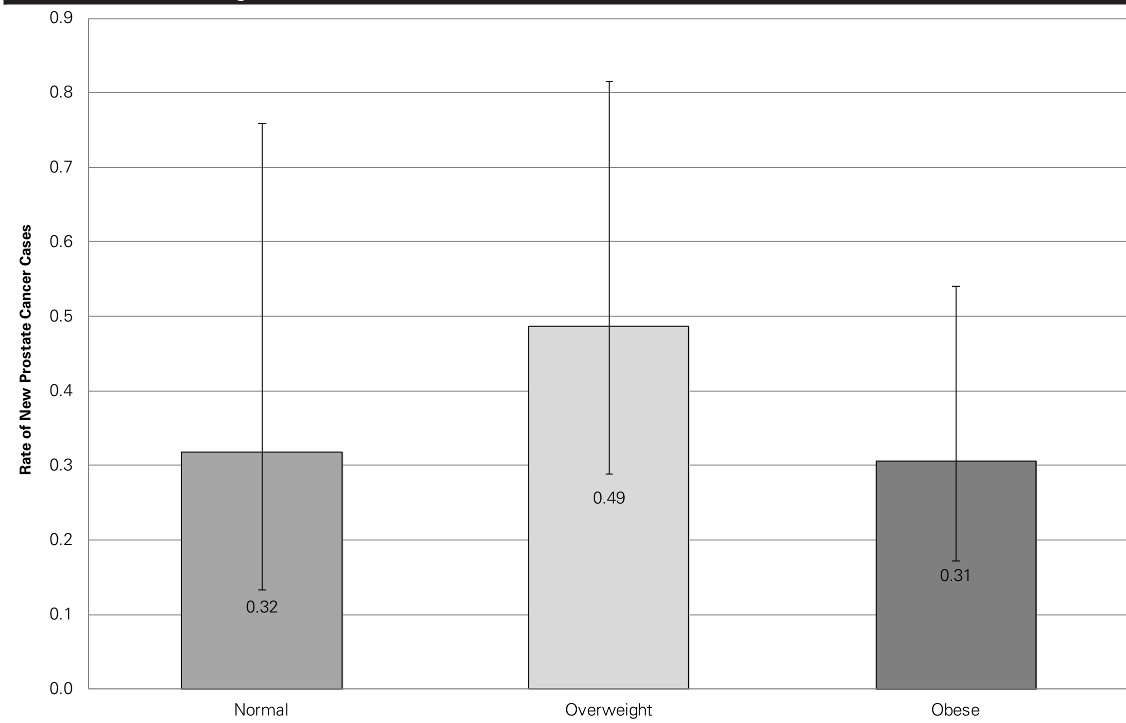
Table 4.13: Relative Risks for Prostate Cancer
Measured/corrected BMI

	Males		
	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Incidence (Per 100 person-years)	0.96	0.63	1.53

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Figure 4.18: Prostate Cancer Incidence Rates by BMI Group
Age– & smoking–adjusted incidence rates of prostate cancer from survey date until March 31, 2009, per 100 person-years, males age 50 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- Prostate cancer incidence was not related to BMI. Incidence rates were highest in the Overweight group, followed by the Normal and Obese groups, which were very close to each other. None of the group differences were statistically significant. Similar results have been reported by others (Baillargeon et al., 2006).

Other Cancers Incidence

Definition: this indicator includes new cases of all 'other' types of cancer, excluding the four shown separately above (i.e., lung, colorectal, breast, and prostate) and non–melanoma skin cancers. Incidence rates were calculated for those aged 50 and over and were adjusted for age and smoking status.

The incidence rates of other cancers (excluding lung, colorectal, breast, prostrate, and non–melanoma skin cancers) by sex and BMI group are shown in Figure 4.19. The RR values comparing incidence rates for each of the three groups are shown in Table 4.14.

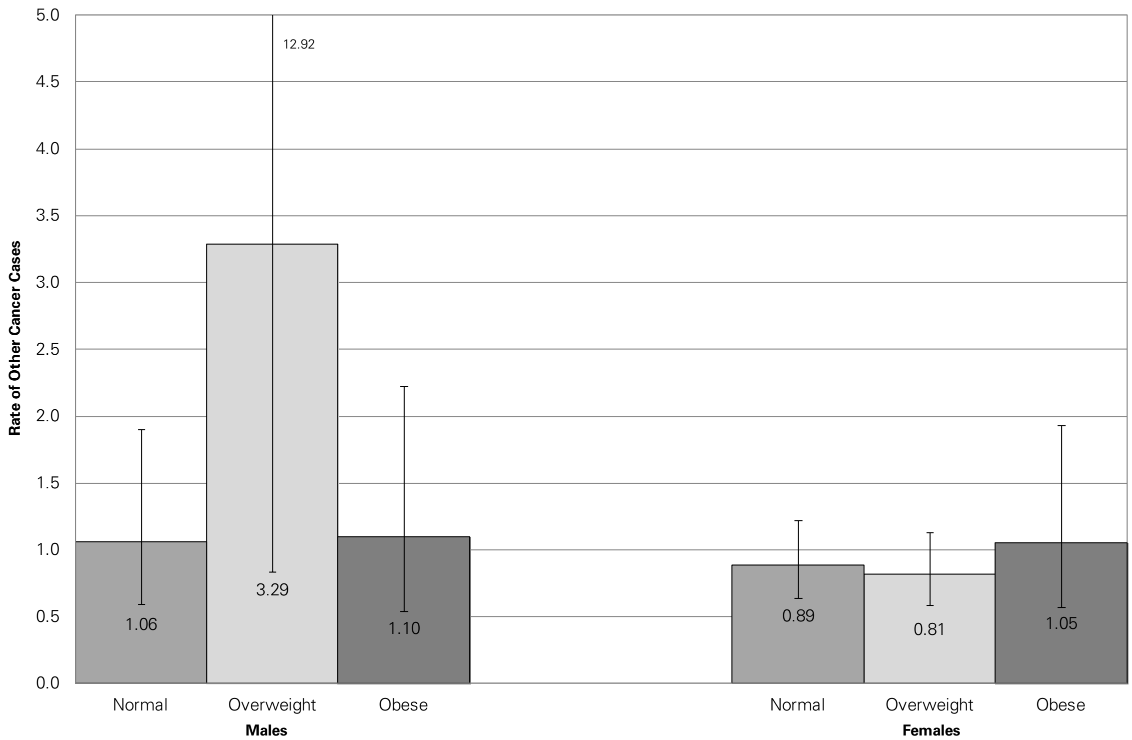
Table 4.14: Relative Risks for Other Cancers
Measured/corrected BMI

	Males			Females		
	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Incidence (Per 100 person-years)	1.04	0.33	3.10	1.18	1.29	0.92

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Figure 4.19: Other Cancer Incidence Rates by BMI Group
Age– & smoking–adjusted incidence rates of other cancers from survey date until March 31, 2009, per 100 person–years, residents aged 50 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- Incidence rates of all 'other' types of cancers (i.e., all cancers except lung, colorectal, breast, prostate, and non–melanoma skin cancers) were not related to BMI in either sex.
- Among males, rates were highest among the Overweight group, followed by the Obese and Normal groups, which were close to each other. None of the group differences were significant.
- Among females, rates were similar across all three BMI groups.

Chapter 5: Obesity and Health Service Use

Chapter Summary

Overall, the results revealed that while the Obese group almost always had the highest rates of health service use, the differences between it and the Normal and Overweight groups were often small. That is, the health care system is not being overwhelmed by the demand for health services related to obesity. This finding is important because no previous studies have been able to provide this kind of analysis on a large representative sample with such comprehensive data on health service use.

Furthermore, for a number of indicators, the higher rates were only evident for those at particularly high BMI values. For example, the Obese group used more physician visits per year than others, but only about 15% more overall. Moreover, the rise in rates only occurred above a BMI of 32 for females and 35 for males. Prescription drug costs were highest above a BMI of 35 for females and 37 for males. Hospitalization rates were higher for the Obese group in both sexes, but only at BMIs of 33 or higher.

Group differences were small or modest for physician visit rates, the number of different drugs used, inpatient hospitalization rates and days used (by males), and receipt of home care. Group differences were larger for prescription drug costs, joint replacement rates (among females), gallbladder surgery, level of care on **admission to personal care home**, and cardiac procedure rates (among males).

In many cases, the Overweight group used no more services than the Normal group (physician visits, number of different drugs used, inpatient hospitalization rates, joint replacements, and home care receipt). Two indicators revealed inverse relationships: admission rates to personal care homes among females were lower for the Overweight group than the Normal group and the number of days of hospital care used by males in the Overweight group was lower than the Normal group.

For most indicators, the trends were similar for males and females, though absolute rates were often different (several higher among females, some higher among males). For a few indicators, the patterns across BMI groups differed considerably by sex.

Multivariate modelling of physician visit rates, prescription drug use, and hospital use pointed to illness level as the strongest predictor of health service use rates, followed by sex, and then other factors including BMI, age, and **socioeconomic status**.

The 'reasons for' physician visits and inpatient hospitalizations were spread over many causes, though the visit category, which includes diabetes, was more prominent among the Obese group. Also, an interesting trend emerged to suggest that the Obese group used health services more often for causes beyond the top 10 conditions.

Studies of health care costs (not analysed in this report) show significant positive associations with BMI level (Andreyeva et al., 2004; Borg et al., 2005; Raebel et al., 2004; Thompson et al., 2001). This is consistent with the higher use of some healthcare services as shown in this report, though the differences appeared to be higher in those studies than results from this study would suggest. Some of this may be due to differences in the context and costs of healthcare, as most of these studies were done in the United States.

Introduction

This chapter examines the rates of use of various health services by people at different BMI levels to determine whether people in the Overweight and Obese groups use significantly more health services than those in the Normal group. These findings carry important implications about the impact of obesity on future need for health services. All analyses in this chapter were 'age–adjusted' to account for age differences of the people and groups at different BMI values.

For some health services, results are shown by BMI group only: Normal, Overweight, and Obese. For more frequent health services (e.g., physician visits, prescription drug use, and inpatient **hospital separations** and days used), results are shown by continuous BMI value, providing more insight into the relationship between BMI values and the outcome. In such cases, summary values by BMI group are also shown in tables. It is also important to bear in mind that the statistical power of the analyses are restrained by the sample sizes involved—so for the less common events or procedures, even large differences between groups may not be statistically significant.

For physician visits, prescription drug use, and hospital separations, multivariate modelling was also undertaken. These analyses describe how BMI affects use rates of key health services while controlling for the effects of other factors.

Methods

As in previous chapters, we used the 'measured/corrected' BMI values for each survey participant (see Chapter 1 for details) and excluded women who reported being pregnant at the time of the survey. Because the surveys include only a sample and not the entire population, we used the sample weights provided by Statistics Canada, so that our results provide values that reflect the entire population.

Health service use results are presented by BMI group (Normal, Overweight, and Obese) or by continuous BMI value. Error bars indicate the 95% CI of the estimate. RR values were calculated to compare the BMI groups. Asterisks indicate statistically significant differences (adjustment was made for multiple testing, to provide a combined Type I error rate of 5% for each sex).

For most indicators in this chapter, health service use rates were calculated by generalized linear models, adjusted for age. Rates 'by cause' were calculated using direct standardization. Indicators for common services were based on a single year of data, whereas less common services required three or sometimes five years of data to provide reliable estimates of rates.

Multivariate Modelling

Several key indicators (physician visits, prescription drug use, and hospital separations) were analysed using multivariate modelling, which included BMI, age, sex, illness level, socioeconomic status, and location of residence, to see which of these variables were significantly related to the indicator. Quadratic terms for both age and BMI (i.e., age^2 and BMI^2) were also included to capture non–linear effects of these variables. These results show the independent influence of each variable, controlling for the other variables in the model. Socioeconomic status was represented by scores on the **Socio Economic Factor Index – Version 2 (SEFI–2)** created at MCHP using area–level data from the Canadian **Census** (Metge et al., 2009). Illness level was measured by **The Johns Hopkins Adjusted Clinical Group (ACG)® System** (version 9), a risk adjustment system developed by researchers at Johns Hopkins University that has been widely validated (Weiner, Starfield, Steinwachs, & Mumford, 1991), including at MCHP (Reid, Roos, MacWilliam, Frohlich, & Black, 2002). Individual–level scores were produced from medical, hospital and prescription drug use over one year. Individuals were then grouped into **quintile**s based on ACG values.

It should be noted that the decision to include illness level in such models is controversial, as some diseases may be 'intermediaries' between obesity and health service use; thus, their inclusion could be viewed as 'over–controlling' or 'over–adjusting'. However, it is not clear how much illness could be attributed to obesity itself, as opposed to other factors—which may cause both obesity and the other illnesses. Therefore, failing to include illness level would cause much of the variation in service use to be attributed to obesity, when in fact obesity may not be the cause. Furthermore, these analyses did not include specific diseases (e.g., diabetes or heart disease), but rather a more 'global' measure of each person's sickness level.

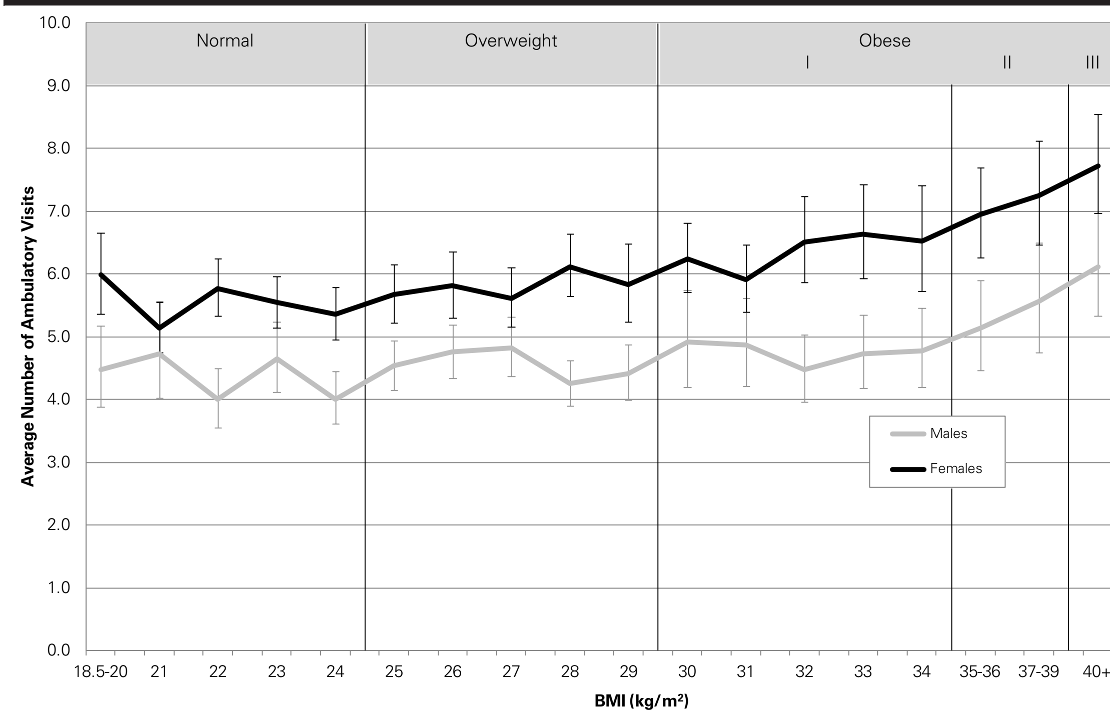
Physician Visit Rates

A visit to a physician often represents the entry point into the health care system for a variety of diseases or health issues. Those with more serious health issues and/or a higher number of health issues generally visit physicians more often.

Definition: the average number of visits to physicians per survey participant in the year after their survey date. **Ambulatory visits** include almost all contacts with physicians (general and family practitioners and specialists): office visits, walk–in clinics, home visits, personal care home visits, visits to outpatient departments, and some emergency room visits (where data are recorded). Excluded are services provided to patients while admitted to hospital and visits for prenatal care. Rates were weighted to the Manitoba population and age–adjusted.

Physician visit rates by BMI value for males and females are shown in Figure 5.1. Averages for the three BMI groups (Normal, Overweight and Obese) are shown in Table 5.1, along with the RR values comparing these three groups with each other.

Figure 5.1: Physician Visit Rates by BMI
Age–adjusted rates of ambulatory visits to all physicians within one year of survey date, per resident aged 18 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Table 5.1: Rates of Physician Visits by BMI Group for Males and Females Aged 18 and Older
Measured/corrected BMI

	Ambulatory Visits per Resident			Relative Risks		
	Normal	Overweight	Obese	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Male	4.36	4.55	5.05	1.16*	1.11*	1.04
Female	5.55	5.81	6.70	1.21*	1.15*	1.05

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- Overall, higher BMI values were modestly associated with higher physician visit rates, especially among those in the Obese range.
- The line for males in Figure 5.1 shows that the physician visit rate was remarkably stable across a wide range of BMI values: from 18.5 through 34, males made between four and five visits per year. It was only among males with BMI values 35 and higher that visit rates were above five and increased (exponentially) with BMI.
- Females showed a somewhat different pattern: there was a slight increase in visit rates with BMI from about five visits a year for women with a BMI of 21 to about six visits per year for women with BMI of 31. Among women with BMI between 32 and 34, the rate was about 6.5 visits per year, after which the visit rate increased exponentially (for BMI values of 35 and higher).
- The results in Table 5.1 show that for both males and females, physician visit rates are lowest for the Normal group, slightly higher for the Overweight group, and highest for the Obese group. In both sexes, the visit rates for the Obese group were significantly higher than those for the Overweight and Normal groups, but the differences between the Normal and Overweight groups were not significant.
- Previous studies have shown that obese patients reported higher use of physicians (Andreyeva et al., 2004; Raebel et al., 2004; Reidpath, Crawford, Tilgner, & Gibbons, 2002; Trakas et al., 1999; Twells et al., 2010).
  - However, in some of those studies and in others, this was shown only for family physicians (Bertakis & Azari, 2006; van, Otters, & Schuit, 2006; von, Happich, Reitmeir, & John, 2005).
  - Furthermore, some of these studies used self–reported values of physician visits, which are not always accurate.

Multivariate Modelling

The results of the multivariate model of physician visits are shown in Table 5.2.

The results show that the strongest predictors of physician visit rates were illness level (ACG quintiles) and sex. These were followed by location of residence, age^2, BMI^2, and socioeconomic status (SEFI–2). Physician visit rates were higher for those with higher levels of illness and for females (versus males). The linear terms for both age and BMI were not significant, though their quadratic terms both were; this means that physician visit rates were not strongly related to age and BMI through the entire range of values, but just at very high values of each. Location of residence was significant for residents of the Rural South (who had lower visit rates), but was not significant for residents of any other areas of the province once other factors were taken into account.

Table 5.2: Factors Related to Physician Visits in the Year After Survey Date, Survey Participants Aged 18 and Older Measured/corrected BMI
Negative binomial regression (measured/corrected BMI)

Parameter	Relative Risk (95% CIs)	Significance
BMI (linear)	0.986 (0.97, 1.0005)	
BMI (quadratic)	1.0004 (1.0001, 1.0006)	**
Age (linear)	1.002 (0.9986, 1.01)	
Age (quadratic)	1.00007 (1.00004, 1.00011)	**
Females (vs. Males)	1.27 (1.24, 1.30)	****
Region (*Reference = Winnipeg Most Healthy areas*)		
Rural South	0.87 (0.82, 0.93)	***
Rural Mid	0.94 (0.88, 1.01)	
North	0.96 (0.89, 1.02)	
Brandon	0.98 (0.91, 1.06)	
Winnipeg Average Health areas	0.97 (0.89, 1.05)	
Winnipeg Least Healthy areas	1.02 (0.94, 1.10)	
SEFI–2	1.03 (1.01, 1.06)	*
ACG Quintile (*Reference = Q1 (healthiest)*)		
Q2	1.30 (1.24, 1.36)	****
Q3	1.74 (1.67, 1.81)	****
Q4	2.59 (2.48, 2.70)	****
Q5 *(sickest)*	2.89 (2.81, 2.98)	****

* Indicates significance at p<0.05
** Indicates significance at p<0.01
*** Indicates significance at p<0.00001 (p<1E-5)
**** Indicates significance at p<1E-10

Survey date indicates the date of completion of the HHS, NPHS, or CCHS.

Source: Manitoba Centre for Health Policy, 2011

Physician Visit Rates by Cause

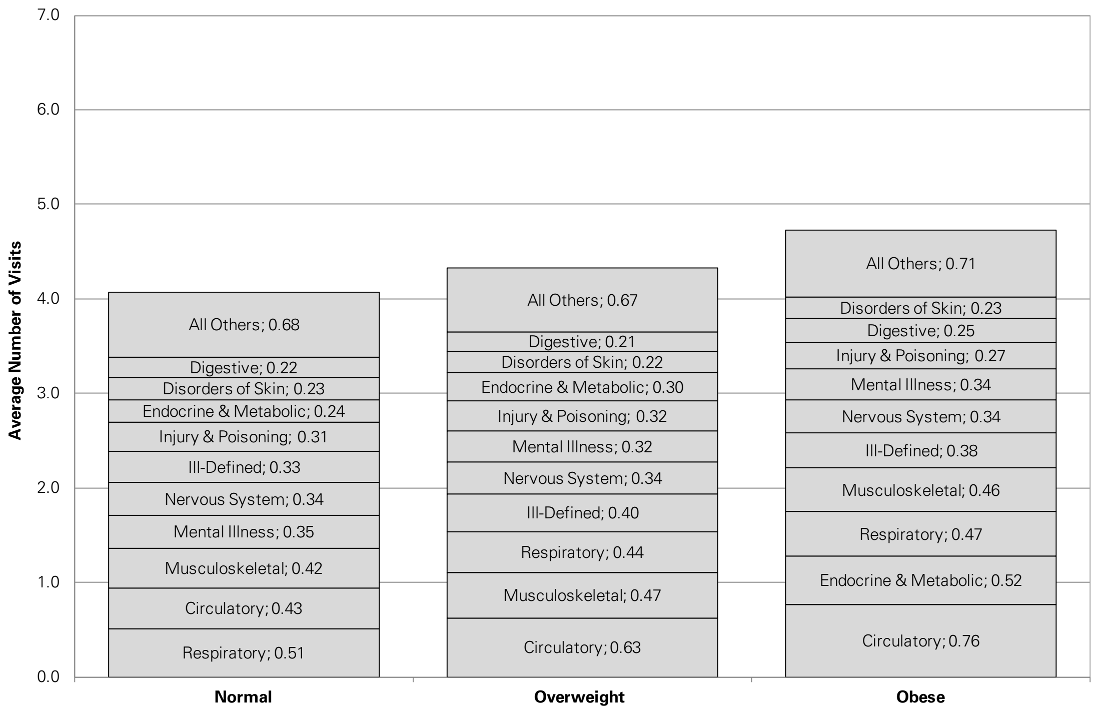
The primary reason for each physician visit is captured by a diagnosis code that is assigned to each visit by the physician. Visits are grouped according to the 19 chapters of the **International Classification of Diseases system (ICD**–9–CM). This analysis calculates the rate of visits for each of the top 10 ICD chapters by sex and BMI group. Pregnancy–related visits are not shown because pregnant women were excluded from this study. (Note: the sum of rates for all causes is not precisely the same as the total rates shown in the previous section, as they were modeled separately.)

Figure 5.2 shows the rates for each of the top 10 causes of physician visits by BMI group for males; Figure 5.3 shows corresponding rates for females. The top 10 causes are listed in order from the bottom (along with the actual rates), followed by the 'All Others' group.

Key Findings

- In both sexes, the causes of physician visits were broadly distributed across many groups; there were not three or four categories that dominated the distribution. As a result, caution is needed in interpreting these results, as differences of one or two positions in the rankings may not reflect important differences among the groups.
- In both sexes, the Endocrine & Metabolic category was more prominent in the Obese group than the Normal group (though by rankings, this effect was stronger in males than females). The Endocrine & Metabolic category includes diabetes, so its higher prominence in the Obese group is consistent with the higher prevalence of diabetes in the Obese group (see Chapter 4).
- Among males, the difference in the Endocrine & Metabolic category ranking was by far the biggest difference: it was ranked #8 in the Normal group and #2 in the Obese group. The Respiratory category ranking differed only slightly (#2 in Normal versus #1 in Obese), but the visit rate was almost twice as high, so it accounted for a larger proportion of all visits in the Obese group (16.2%) than in the Normal group (10.6%). The ranking for Mental Illness also differed considerably: it was #4 in the Normal group and #7 in the Obese group.
- Among females, there were more differences, the largest being that the **Genitourinary** and Breast category was the #1 rank among the Normal group, but #8 among the Obese. Visits for Mental Illness were also less prominent among the Obese group (#5) than the Normal group (#2). Conversely, several categories were more prominent among the Obese group, most notably Circulatory and Endocrine & Metabolic disorders, but also **Musculoskeletal** and Ill–Defined conditions.

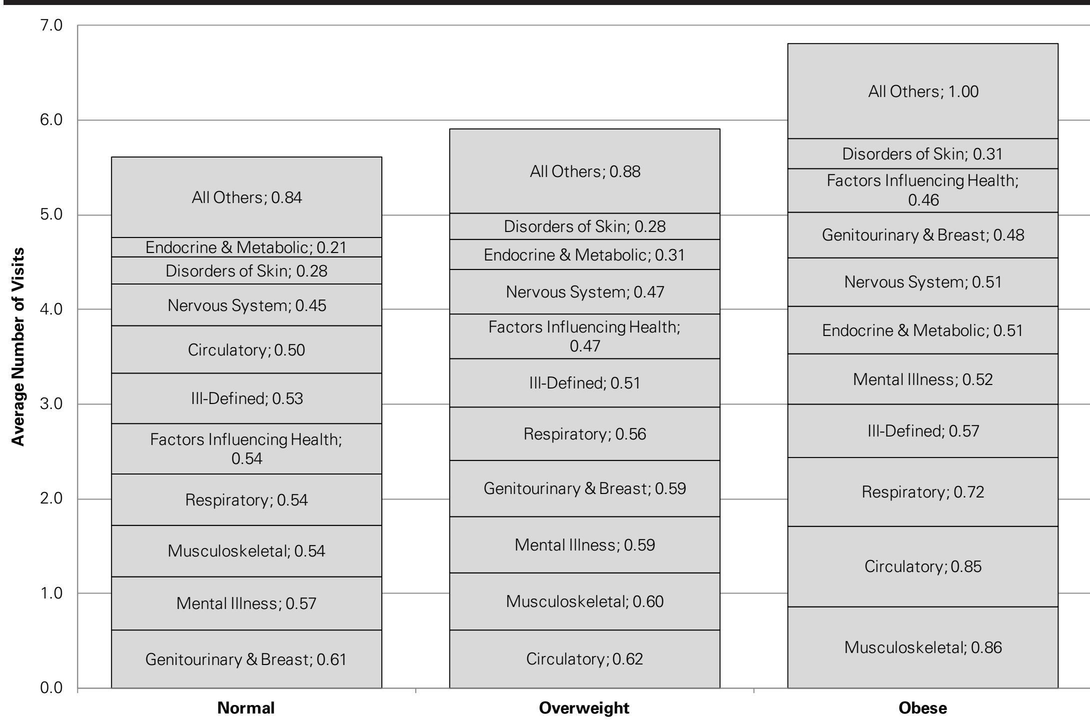
Figure 5.2: Male Physician Visit Rates by Cause
Age-adjusted rates by BMI group and ICD Chapter, per individual aged 18 and older, within one year after survey date (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Figure 5.3: Female Physician Visit Rates by Cause
Age-adjusted rates by BMI group and ICD Chapter, per individual aged 18 and older, within one year after survey date (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

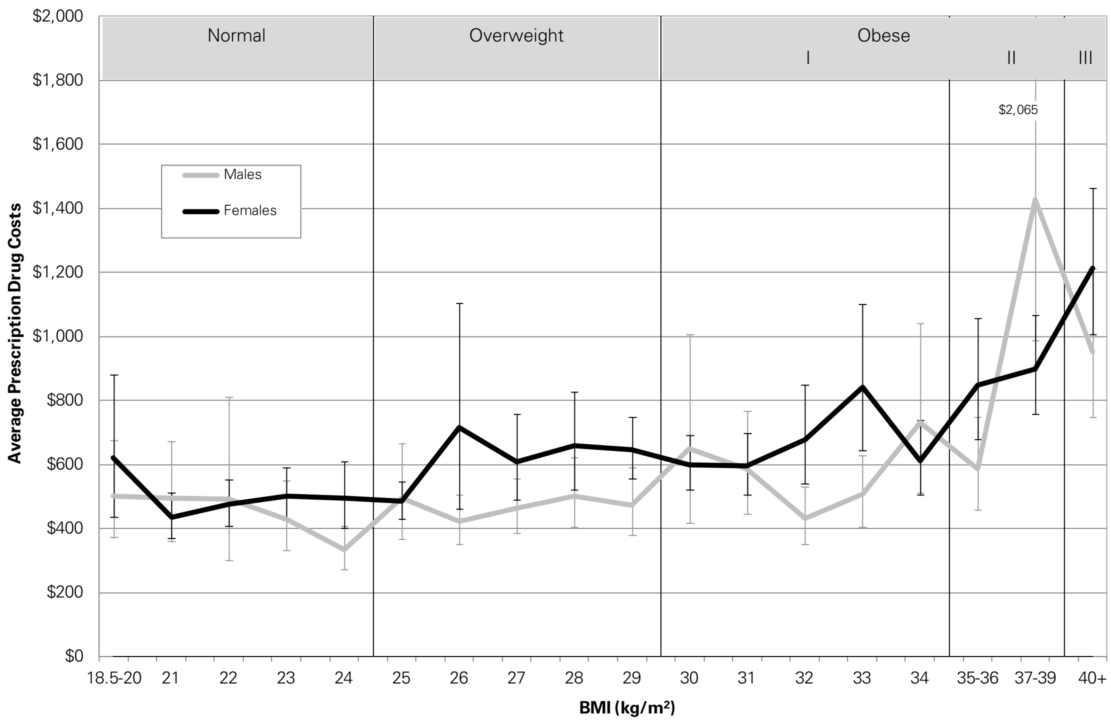
Cost of Prescription Drugs Used

This indicator shows the total cost of all prescription drugs dispensed to each survey participant in the year following their survey. It was included to examine whether drug costs differ for residents at different BMI values.

Definition: the average cost of all prescription drugs dispensed from community–based pharmacies in Manitoba in the year after each participant's survey date (information regarding drugs provided to hospital inpatients were not available). Prescription drug information is available for all Manitobans from 1995 forward, so participants in the Manitoba HHS (1989–1990) could not be included.

Figure 5.4 shows the average cost of prescription drugs dispensed by BMI value for males and females. Table 5.3 lists the RR values comparing the three BMI groups with each other for each sex and indicates which differences were statistically significant.

Figure 5.4: Average Prescription Drug Costs by BMI
Age-adjusted average prescription drug costs, per individual aged 18 and older one year after survey date (measured/corrected BMI)



Survey date indicates the date of completion of the NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Table 5.3: Average Prescription Drug Costs by BMI Group for Males and Females Aged 18 and Older
Measured/corrected BMI

	Average Prescription Drug Costs			Relative Risks		
	Normal	Overweight	Obese	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Male	$444.97	$470.38	$684.57	1.54*	1.46*	1.06
Female	$501.86	$617.02	$763.19	1.52*	1.24*	1.23*

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- Overall, drug costs increased with BMI for both males and females, though the relationships were relatively weak through much of the BMI range and differed by sex. Sharp increases were seen for females at a BMI value of 35 or higher and for males at 37 or higher.
- Among males, drug costs were at or below the $500 per year level for BMIs from 18.5 through 29—encompassing the entire Normal and Overweight groups. Average costs were slightly higher in the Obese range and highest among those with BMIs of 37 and higher.
- Among females, costs were almost exactly $500 per year for those with BMIs from 18.5 through 25, then increased for those from 26 to 32, and were highest for those with BMIs of 33 or higher.
- Table 5.3 shows that all the group differences were significant, except for Normal versus Overweight males, which had virtually identical costs.
- Other research has shown similar overall differences between groups, though some found increases even within the Normal and Overweight groups (Counterweight Project Team, 2008; Esposti et al., 2006; Rappange, Brouwer, Hoogenveen, & Van Baal, 2009; Stuart, Lloyd, Zhao, & Kamal–Bahl, 2008; Wang et al., 2003).

Multivariate Modelling

The results of the multivariate model of total prescription drug costs are shown in Table 5.4.

The results show that the strongest predictors of total drug costs were illness level (represented by the quintiles of ACG scores), age, sex, BMI, and socioeconomic status. Those with higher levels of illness, older adults, females, those at high BMI, and those living in low socioeconomic status areas had higher prescription drug costs.

Table 5.4: Factors Related to Prescription Drug Costs in the Year After Survey Date, Survey Participants Aged 18 and Older
Negative binomial regression (measured/corrected BMI)

Parameter	Relative Risk (95% CIs)	Significance
BMI (linear)	0.96 (0.92, 0.997)	*
BMI (quadratic)	1.0011 (1.0005, 1.002)	**
Age (linear)	1.04 (1.02, 1.05)	***
Age (quadratic)	0.99995 (0.9998, 1.0001)	
Females (vs. Males)	1.18 (1.09, 1.28)	**
Region (*Reference = Winnipeg Most Healthy areas*)		
Rural South	0.92 (0.80, 1.06)	
Rural Mid	0.96 (0.86, 1.07)	
North	0.97 (0.86, 1.09)	
Brandon	0.92 (0.80, 1.05)	
Winnipeg Average Health Areas	0.85 (0.74, 0.97)	*
Winnipeg Least Healthy Areas	1.17 (0.97, 1.41)	
SEFI–2	1.07 (1.02, 1.12)	**
ACG Quintile (*Reference = Q1 (healthiest)*)		
Q2	1.29 (1.12, 1.48)	**
Q3	1.70 (1.53, 1.89)	****
Q4	2.79 (2.48, 3.14)	****
Q5 *(sickest)*	4.54 (4.18, 4.92)	****

* Indicates significance at p<0.05
** Indicates significance at p<0.01
*** Indicates significance at p<0.00001 (p<1E-5)
**** Indicates significance at p<1E-10

Survey date indicates the date of completion of the HHS, NPHS, or CCHS.

Source: Manitoba Centre for Health Policy, 2011

Number of Different Types of Prescription Drugs Used

This indicator tracks the number of different types of prescription drugs dispensed to each resident in the year following their survey date. It was included to determine whether BMI values were related to the number of different types of prescription drugs used.

Definition: the average number of different types of drugs dispensed to each survey participant who had at least one prescription in the year after their survey date. A 'different' drug type was determined by the fourth–level class of the **Anatomical Therapeutic Chemical (ATC) Drug Classification sSystem**. This level essentially separates drugs used for different health problems. A person could have several prescriptions for drugs in the same fourth–level ATC class, but this would only count as one drug type in that year. Rates were weighted to the Manitoba population and age–adjusted. Prescription drug information is available for all Manitobans from 1995 forward, so participants in the Manitoba HHS (1989–1990) could not be included.

Figure 5.5 shows the number of different drug types used by BMI value for males and females. Averages for the three BMI groups (Normal, Overweight and Obese) are shown in Table 5.5, along with the RR values comparing these three groups with each other.

Key Findings

- Overall, the **number of different types of prescription drugs used** per person was not strongly associated with BMI values, though values were slightly higher among those at the highest BMI levels (33 and higher).
- Among males, the number of different drugs used increased slightly with BMI, but not consistently: those in the 21–23 BMI range used more than those in the 24–27 range; but above the 24–27 range, the numbers generally increased with BMI.
- Among females, there was virtually no relationship between the number of different drugs used and BMI: the average was near 3.0 for all women, except those with BMI of 40 or above who used a higher number of different drugs. (The spike at BMI of 24 was unexpected and highly variable, so must be interpreted with caution.)
- The results in Table 5.5 show that among males, the Obese group received a higher number of different prescription drugs than the Overweight group. Among females, there were no significant differences among the groups.
- Others (Narbro et al., 2002; Raebel et al., 2004; Reidpath et al., 2002; Trakas et al., 1999; van et al., 2006) have reported on individual drug classes and/or costs, finding that Obese patients were more likely to be receiving drugs (for example, drugs for hypertension, diabetes, cardiovascular disease, asthma, and others).

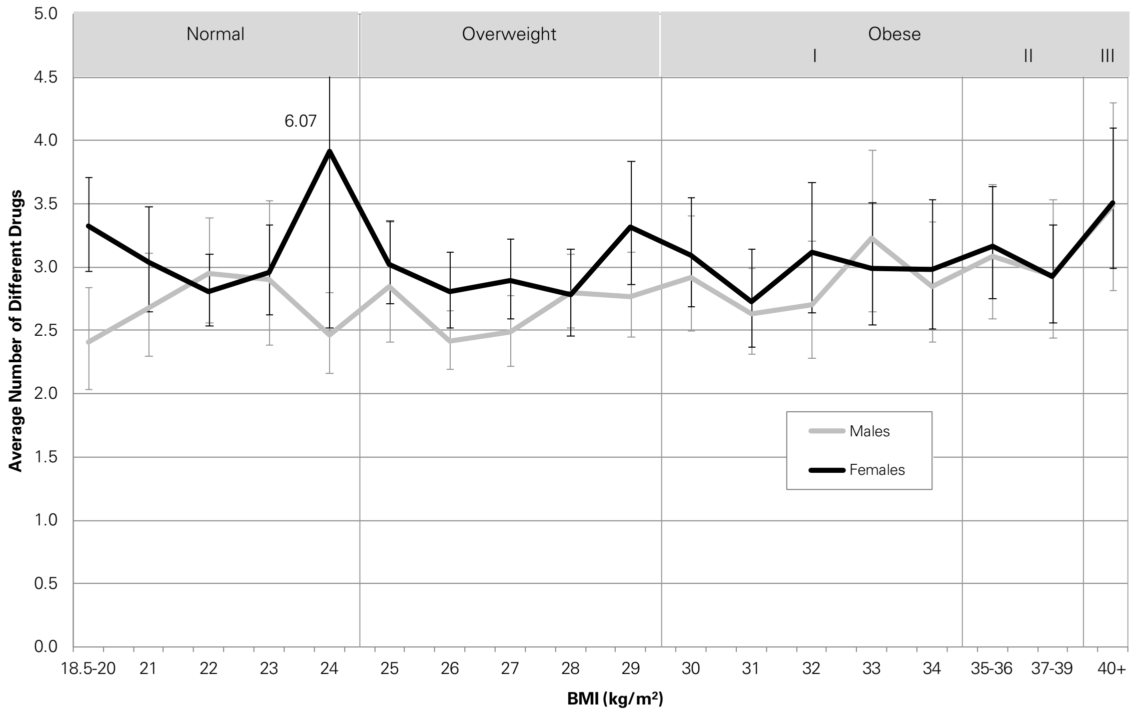
Table 5.5: Rates for Number of Different Types of Drugs Dispensed by BMI Group for Males and Females Aged 18 and Older Who Had At Least One Prescription
Measured/corrected BMI

	Number of Different Drugs per 1,000 Residents			Relative Risks		
	Normal	Overweight	Obese	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Male	2.67	2.66	2.97	1.11	1.12*	1.00
Female	3.19	2.96	3.06	0.96	1.03	0.93

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Figure 5.5: Number of Different Types of Drugs Dispensed per Resident by BMI
Age–adjusted average number of different types of drugs dispensed within one year of survey date, per resident aged 18 and older who had at least one prescription (measured/corrected BMI)



Survey date indicates the date of completion of the NPHS or CCHS

Source: Manitoba Centre for Health Policy, 2011

Inpatient Hospital Separation Rates

Admission to an acute care hospital is an important measure of health service use that involves a more serious health issue than can be treated in a community setting. This indicator was included to determine whether inpatient hospitalization rates were related to BMI values. Pregnant women were excluded as were hospitalizations for childbirth. Since less than 10% of all residents are hospitalized in any given year, results are shown as the rate per 1,000 residents rather than per resident. Also, the lower number of events results in larger CIs for the estimates at each BMI value.

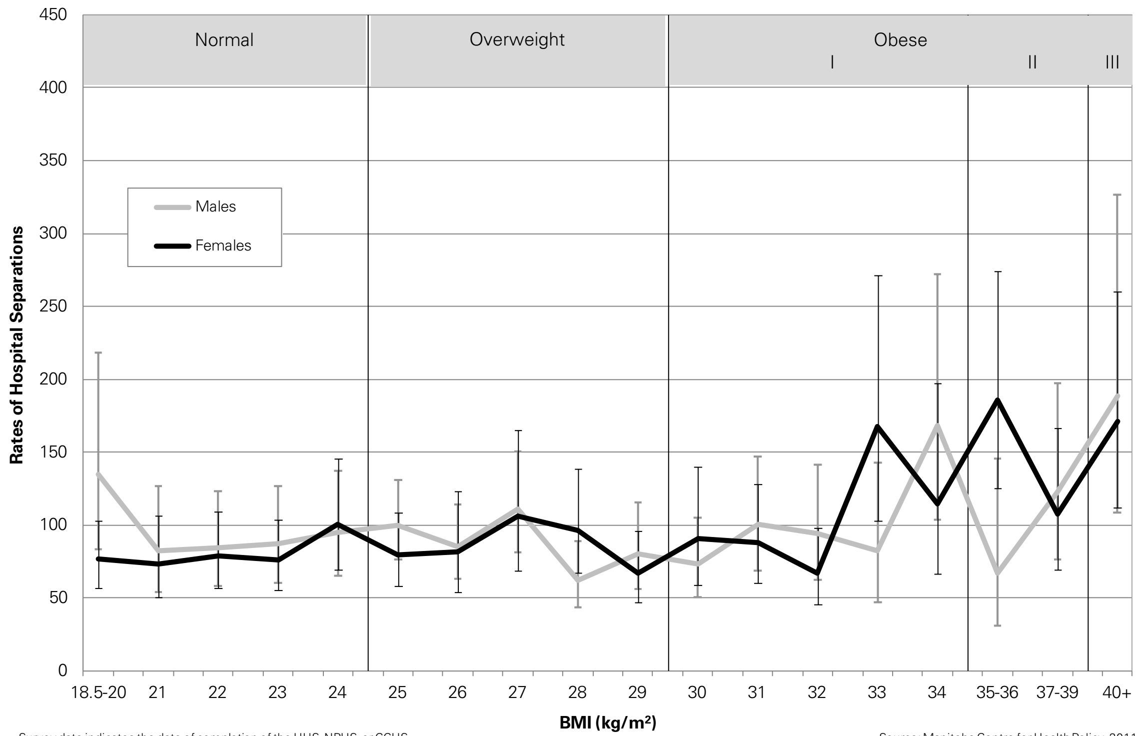
Definition: The total number of inpatient hospital separations per 1,000 survey participants in the year after their survey date. Inpatient hospitalizations are hospital stays in which patients are admitted to hospital for at least one day. Rates were weighted to the Manitoba population and age–adjusted. All Manitoba hospitals were included; personal care homes (PCH) and long–term care facilities (Riverview, Deer Lodge, Rehabilitation Centre for Children and Manitoba Adolescent Treatment Centre) were excluded. Newborn (birth) and obstetric hospitalizations were excluded.

Inpatient hospitalization rates by BMI value for males and females are shown in Figure 5.6. Averages for the three BMI groups (Normal, Overweight and Obese) are shown in Table 5.6, along with the RR values comparing these three groups with each other.

Key Findings

- Overall, inpatient hospitalization rates were not strongly related to BMI values, though the highest inpatient hospitalization rates were found among those with high BMI values.
- Among females, inpatient hospitalization rates fluctuated for those in the Normal and Overweight range, but increased for those with BMI values of 33 and higher (where variability also increased due to small sample sizes).

Figure 5.6: Inpatient Hospital Separation Rates by BMI
Age–adjusted rates of inpatient hospital separations within one year of survey date, per 1,000 residents aged 18 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Table 5.6: Rates of Inpatient Hospital Separations by BMI Group for Males and Females Aged 18 and Older
Measured/corrected BMI

	Inpatient Hospitalizations per 1,000 Residents			Relative Risks		
	Normal	Overweight	Obese	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Male	95.06	86.03	104.88	1.10	1.22	0.91
Female	80.28	85.10	116.91	1.46*	1.37*	1.06

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

- Among males, the inpatient hospitalization rate was elevated for those at the lowest end of the Normal range (18.5–20), followed by relatively stable lower rates from BMI 21 through 27. This was followed by a decrease for those at BMI of 28, 29, and 30, followed by a rebound for those with BMI of 31, 32, and 33, then an inconsistent pattern with high variability among those with BMI 34 and higher.
- The results in Table 5.6 show that for females, the Normal group had the lowest inpatient hospitalization rates, the Overweight group had slightly higher rates, and the Obese group had the highest rates. The rate for the Obese group was significantly higher than both the Normal and Overweight groups, which were not significantly different from each other.
- Among males, the Overweight group had the lowest inpatient hospitalization rate, followed by the Normal group, and then the Obese group, though none of these differences were statistically significant.

- Our findings are similar to those of some previous studies ((Twells et al., 2010; von et al., 2005), but not others—some which reported significantly higher hospital use rates (or costs) with higher BMI (Borg et al., 2005; Folmann et al., 2007; Han et al., 2009; Raebel et al., 2004) and others which reported lower hospital use rates (Trakas et al., 1999). These disparate findings suggest the association may be subtle or that differences in participant selection, indicators chosen, or analysis techniques used may affect the findings.

Multivariate Modelling

The results of the multivariate model of inpatient hospitalization rates are shown in Table 5.7. Because of the lower number of events involved in this analysis, values on the SEFI–2 had to be categorized into four groups, rather than using continuous values as in previous models.

Table 5.7: Factors Related to Inpatient Hospital Separations in the Year After Survey Date, Survey Participants Aged 18 and Older
Negative binomial regression (measured/corrected BMI)

Parameter	Relative Risk (95% CIs)	Significance
BMI (linear)	0.92 (0.87, 0.97)	**
BMI (quadratic)	1.0015 (1.0007, 1.002)	**
Age (linear)	0.98 (0.97, 0.994)	**
Age (quadratic)	1.0005 (1.0004, 1.001)	****
Females (vs. Males)	0.86 (0.80, 0.93)	**
Region (*Reference = Winnipeg Most Healthy areas*)		
Rural South	1.53 (1.31, 1.79)	***
Rural Mid	1.52 (1.30, 1.78)	***
North	1.95 (1.62, 2.36)	****
Brandon	1.27 (1.05, 1.55)	*
Winnipeg Average Healthy Areas	0.94 (0.75, 1.19)	
Winnipeg Least Healthy Areas	0.94 (0.74, 1.18)	
SEFI–2 Group (*Reference = Group 1 (highest SES)*)		
Group 2	1.12 (0.91, 1.38)	
Group 3	1.34 (1.09, 1.65)	**
Group 4 *(lowest SES)*	1.71 (1.36, 2.16)	***
ACG Quintile (*Reference = Q1 (healthiest)*)		
Q2	1.38 (1.13, 1.68)	**
Q3	1.48 (1.27, 1.73)	***
Q4	2.50 (2.17, 2.87)	****
Q5 *(sickest)*	3.67 (3.33, 4.03)	****

* Indicates significance at p<0.05
** Indicates significance at p<0.01
*** Indicates significance at p<0.00001 (p<1E-5)
**** Indicates significance at p<1E-10

Survey date indicates the date of completion of the HHS, NPHS, or CCHS.

Source: Manitoba Centre for Health Policy, 2011

The results show that by far the strongest predictor of inpatient hospitalization rates was illness level (represented by the quintiles of ACG scores), followed by location of residence, age^2, socioeconomic status, sex, BMI^2, BMI, and age. Those with higher levels of illness; those living in the North, Rural South, Rural Mid, or Brandon areas; older adults; those living in areas with low socioeconomic status; and those with high BMI values were hospitalized more often.

Inpatient Hospitalization Rates by Cause

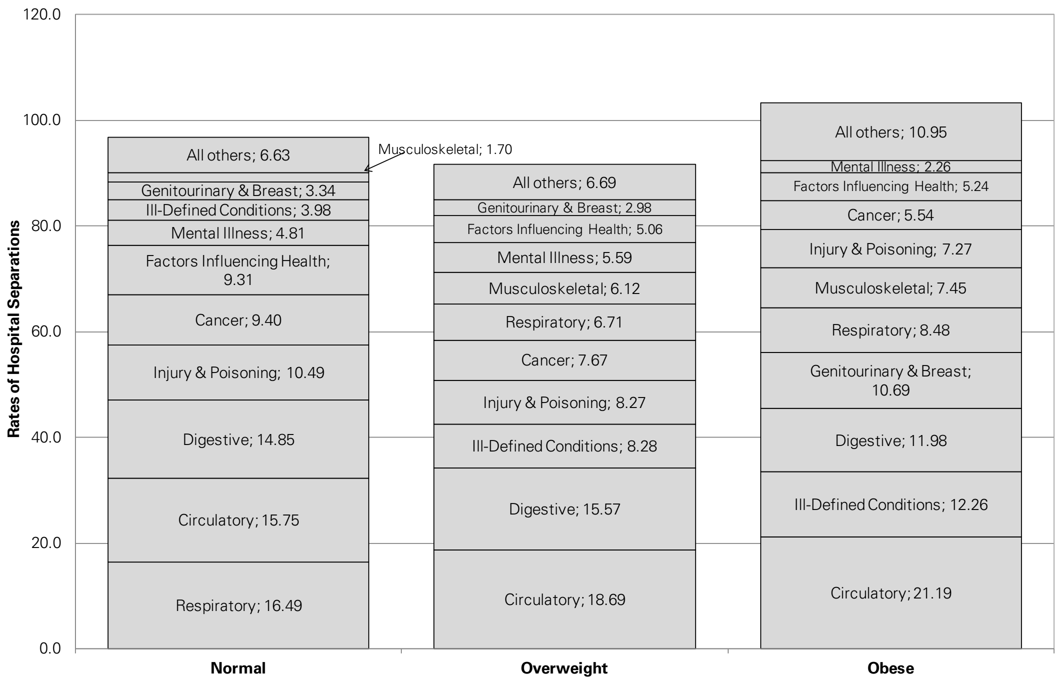
For every hospital separation, one diagnosis is coded as being 'Most Responsible' for the hospitalization. Most responsible diagnoses are grouped according to the 19 chapters of ICD–9–CM. Hospital separations after April 1, 2004 were originally coded in ICD–10–CA, so diagnosis codes were converted to ICD–9–CM equivalents using the Canadian Institute for Health Information conversion files. This analysis calculates the rate of inpatient hospitalizations for each of the top 10 ICD–9–CM chapters by sex and BMI group. (Note: the sum of rates for all causes is not precisely the same as the total rates shown in the previous section as they were modeled separately.)

Figure 5.7 shows the rates for each of the top 10 causes of inpatient hospitalizations by BMI group for males; Figure 5.8 shows corresponding rates for females. The top 10 causes are listed in order from the bottom (along with the actual rates), followed by the 'All Others' group.

Key Findings

- Distinctly different rankings of the causes of inpatient hospitalizations were noted by sex, but two overall findings are also apparent:
    - In both sexes, the 'All Others' group comprised a larger proportion of all inpatient hospitalizations among the Obese group than the Normal group. This means that those in the Obese group were hospitalized more often for conditions beyond the top 10 causes.
    - The causes of inpatient hospitalization among females are more distributed among the various causes, whereas among males, the rates are more concentrated in the top six or seven causes with the others being considerably smaller. This too was reflected in the size of the 'All Others' groups, which were smaller for males than females across all BMI groups.
- Among males there was a lot of movement among the rankings of the causes across the different BMI groups. Comparing the Normal group to the Obese group, several changes in rankings were seen:
    - The biggest change was that inpatient hospitalizations for Ill–Defined diagnoses (things like chest pain and abdominal pain) were much more prominent in the Obese group (rank #2) than the Normal group (rank #8). Inpatient hospitalizations for Genitourinary & Breast and Musculoskeletal conditions were also higher–ranking in the Obese group than in the Normal group.
    - Conversely, a number of other causes were less prominent among the Obese group than the Normal group, notably Respiratory (rank #5 versus #1), Injury & Poisoning, Cancer, Factors Influencing Health, and Mental Illness.
- Among females, there were fewer differences among the rankings of the causes across the BMI groups, but a much more pronounced difference in total inpatient hospitalization rates (i.e., among females, the Obese group had a considerably higher total rate of inpatient hospitalizations than the Normal and Overweight groups, whereas for males the differences across groups were smaller).
    - Among the causes, only two revealed substantial changes in rankings across BMI groups: Musculoskeletal causes were more prominent for the Obese group (rank #3) than the Normal group (rank #8) and Cancer showed the opposite trend (rank #6 in the Obese group and #3 in the Normal group).

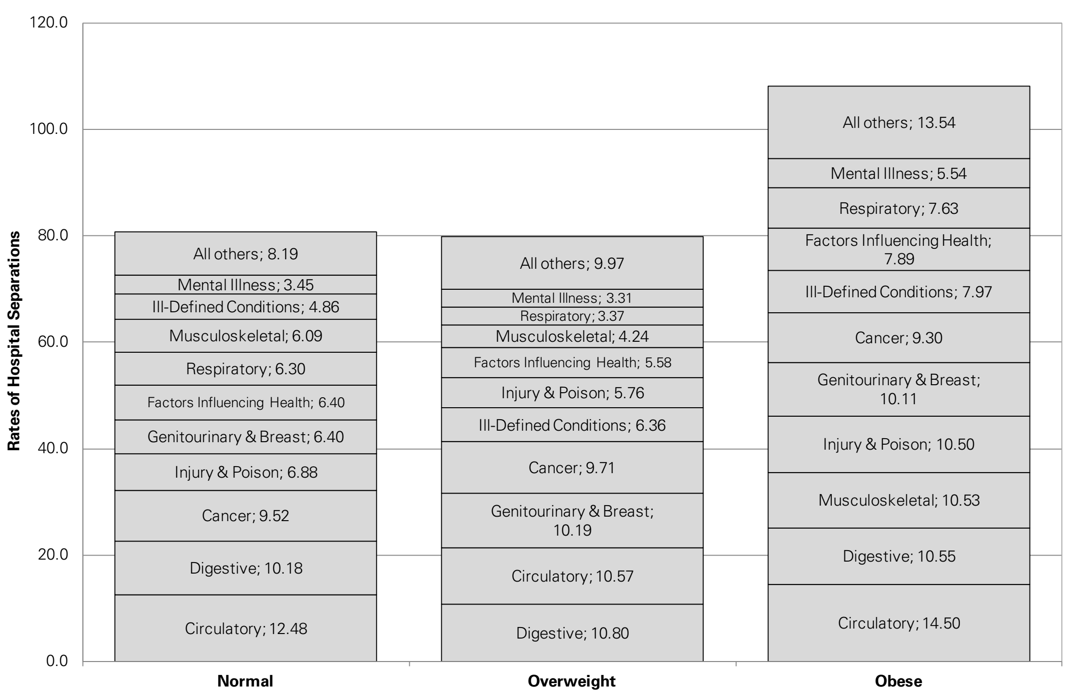
Figure 5.7: Male Inpatient Hospital Separation Rates by Cause
Age-adjusted rates by BMI group and ICD chapter, per 1,000 males aged 18 and older, within one year after survey date (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Figure 5.8: Female Inpatient Hospital Separation Rates by Cause
Age-adjusted rates by BMI group and ICD chapter, per 1,000 females aged 18 and older, within one year after survey date (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

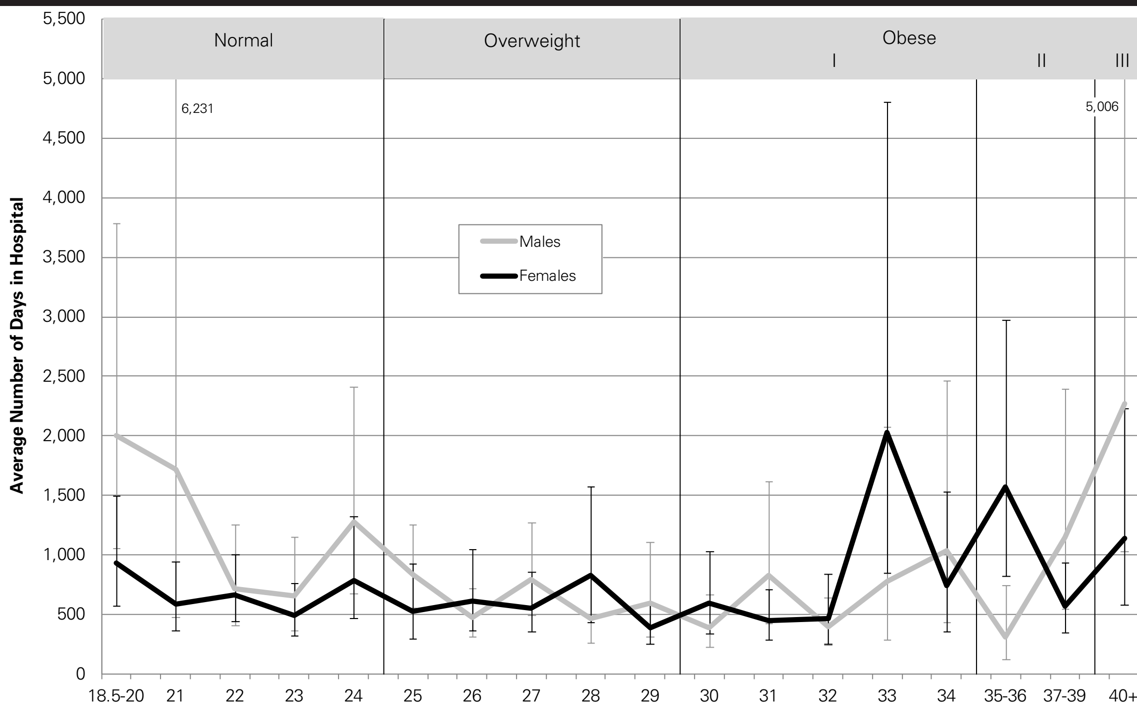
Inpatient Hospital Days Used

This indicator counts the number of days spent in 'inpatient' care in hospitals, which is important and distinct from the inpatient hospitalization rate (see the "Inpatient Hospital Separation Rates" section), because hospitalizations vary significantly in their length of stay.

Definition: The number of **inpatient hospital days used** per 1,000 survey participants in the year after their survey date. If a resident had more than one hospitalization in the year, then the days used in all hospitalizations were summed. Each hospitalization was limited to 365 days maximum length of stay. Hospitalizations in long–term care facilities (e.g., Deer Lodge and Riverview) were excluded. Rates were weighted to the Manitoba population and age–adjusted.

Inpatient hospital days used by BMI value for males and females are shown in Figure 5.9. Averages for the three BMI groups (Normal, Overweight and Obese) are shown in Table 5.8, along with the RR values comparing these three groups with each other.

Figure 5.9: Inpatient Hospital Days Used by BMI
Age–adjusted days used within one year of survey date, per 1,000 residents aged 18 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Table 5.8: Rates of Inpatient Hospital Days Used by BMI Group for Males and Females Aged 18 and Older
Measured/corrected BMI

	Inpatient Hospital Days per 1,000 Residents			Relative Risks		
	Normal	Overweight	Obese	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Male	1157.04	614.54	734.60	0.63	1.20	0.53*
Female	678.27	564.77	813.71	1.20	1.44	0.83

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- Overall, there was no consistent trend in the rate of hospital days used across most values of BMI. This largely mirrors the findings for inpatient hospitalization rates.
- Among males, those at lower BMI values had high rates of days used, which then dropped and remained low through to BMI of 32. Those at the very highest BMI values (40+) had the highest rates.
- Among females, rates of inpatient hospital days used were consistently low throughout the Normal and Overweight range and up to BMI of 32, after which sharp changes and much volatility of rates were seen.
- The rates by BMI group (Table 5.8) show that among males the Normal group had the highest rate of inpatient hospital days used, followed by the Obese group and the Overweight group. The Normal group was significantly higher than the Overweight group; no other differences were statistically significant.
- Among females the Overweight group had the lowest rate (as in males), but the Obese group was higher than the Normal group (opposite of males), though none of these differences were statistically significant.

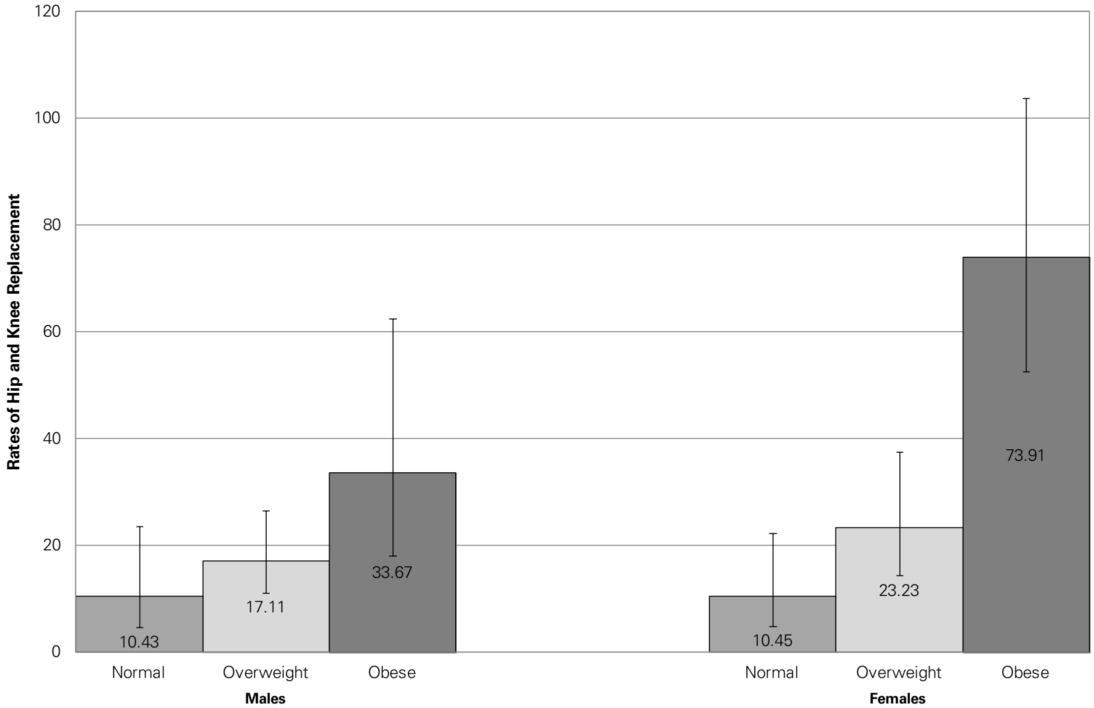
Joint Replacement Surgery

Surgery to provide total replacement of hip or knee joints is becoming more common as a treatment for severe arthritis and joint problems, which may be related to obesity.

Definition: The number of **total hip replacements** and **total knee replacements** performed per 1,000 survey participants aged 40 and older, up to five years after their survey date. Hip replacements were defined by hospitalizations with ICD–9–CM codes 81.50, 81.51, or 81.53 or **Canadian Classification of Health Interventions (CCI)** code 1.VA.53.LA–PN^^ or 1.VA.53.PN–PN^^ in any procedure field. Knee replacements were defined by hospitalizations with ICD–9–CM codes 81.54, 81.55 or CCI code 1.VG.53 in any procedure field. Rates were weighted to the Manitoba population and age–adjusted.

Figure 5.10 shows the **joint replacement surgery** rates by BMI group (Normal, Overweight, and Obese) for males and females. Averages for the three BMI groups are shown in Table 5.9, along with the RR values comparing these three groups with each other.

Figure 5.10: Joint Replacement Surgery Rates by BMI Group
Age–adjusted rates of hip and knee replacements within five years of survey date, per 1,000 residents aged 40 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Table 5.9: Rates of Joint Replacement Surgery by BMI Group for Males and Females Aged 40 and Older
Measured/corrected BMI

	Joint Replacement Surgeries per 1,000 Residents			Relative Risks		
	Normal	Overweight	Obese	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Male	10.43	17.11	33.67	3.23	1.97	1.64
Female	10.45	23.23	73.91	7.07*	3.18*	2.22

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- In both males and females, those in the Obese group had the highest rates of joint replacement surgery.
- Among females, the rate for the Obese group was over three times higher than both the Overweight and Normal groups, which were not different from each other.
- Among males, none of the group differences reached statistical significance (though the difference between the Obese and Overweight groups was close).
- Other research has shown a higher prevalence and incidence of osteoarthritis (the main problem requiring joint replacement) among those with higher BMI (Gilmore, 1999; Must et al., 1999; Wilkins, 2004).

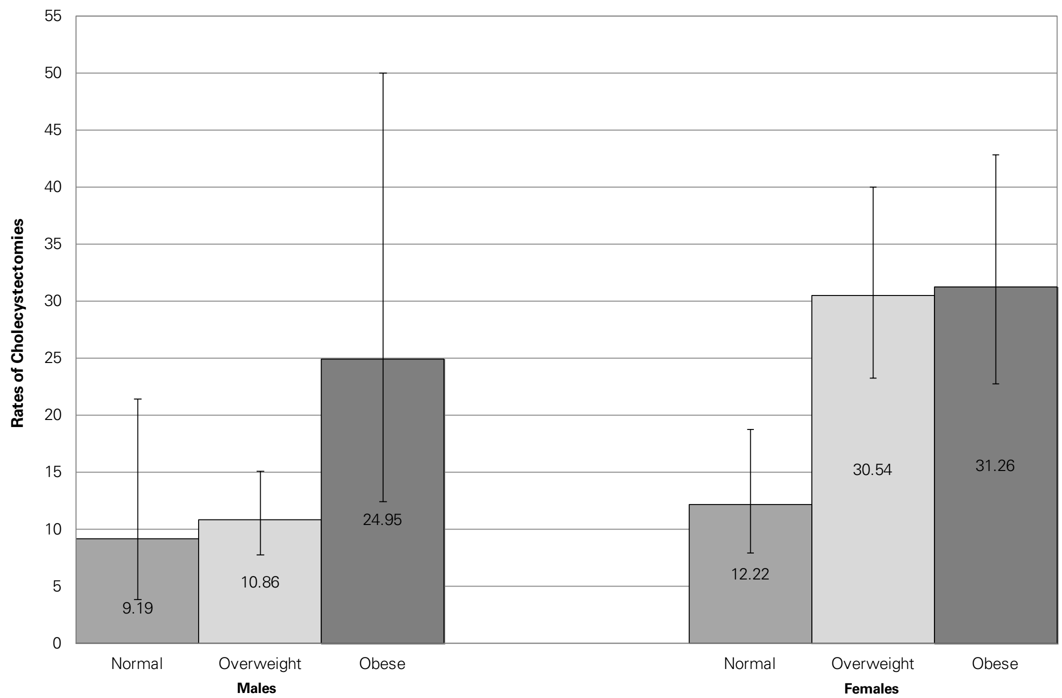
Cholecystectomy

Cholecystectomy is the surgical removal of the gallbladder, usually by laparoscopic methods but sometimes in 'open' procedures. It is the most common method for treating symptomatic gallstones. Previous studies have shown an association between BMI and gallbladder disease (Luo et al., 2007; Must et al., 1999; Pi–Sunyer, 1993).

Definition: The number of cholecystectomies performed per 1,000 survey participants up to five years after their survey date. Cholecystectomies were defined by hospitalizations with ICD–9–CM codes 51.21, 51.22, 51.23 and 51.24 or CCI codes 1.OD.57, 1.OD.89 and 1.OA.87 in any procedure field. Rates were weighted to the Manitoba population and age–adjusted.

Cholecystectomy rates by BMI group for males and females are shown in Figure 5.11. Averages for the three BMI groups are shown in Table 5.10, along with the RR values comparing these three groups with each other.

Figure 5.11: Cholecystectomy Rates by BMI Group
Age–adjusted rates of gallbladder removal within five years of survey date, per 1,000 residents aged 18 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Table 5.10: Rates of Cholecystectomies by BMI Group for Males and Females Aged 18 and Older
Measured/corrected BMI

	Cholecystectomies per 1,000 Residents			Relative Risks		
	Normal	Overweight	Obese	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Male	9.19	10.86	24.95	2.71	2.30	1.18
Female	12.22	30.54	31.26	2.56*	1.02	2.50*

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- Cholecystectomy rates increased with BMI, but with different trends among males and females.
- Among females, the rates for the Overweight and Obese groups were significantly higher than the Normal group. The Overweight and Obese groups were not different from each other.
- Among males, the rate for the Obese group appeared higher than those for the Normal and Overweight groups, but did not quite reach statistical significance. The Normal and Overweight groups were not different from each other.

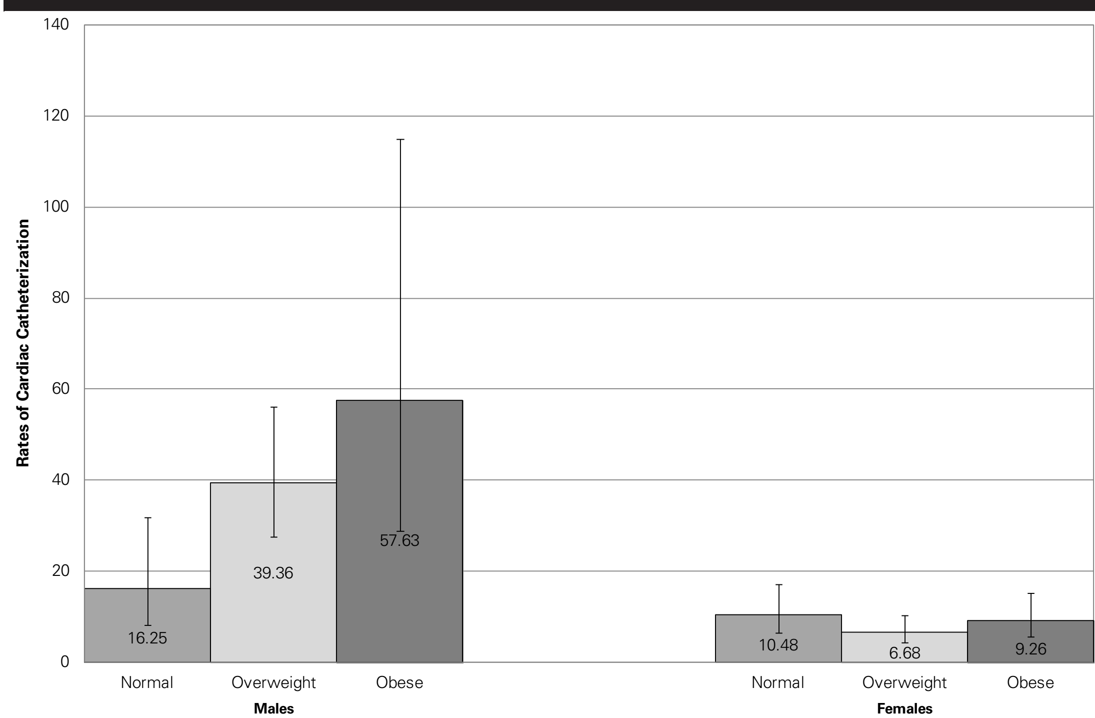
Cardiac Catheterization

Also known as an angiogram, a **cardiac catheterization** is a diagnostic procedure used to assess the extent and location of blockages in the coronary arteries. It is a key procedure for heart disease patients, as the information gathered is crucial in deciding if any subsequent procedures (**angioplasty**, **stent insertion**, or **bypass surgery**) should be considered.

Definition: the number of cardiac catheterizations performed per 1,000 survey participants aged 40 and older up to three years after their survey date. Cardiac catheterizations were defined by hospitalizations with ICD–9–CM procedure codes 37.21–37.23 or 88.52–88.57 or CCI code 3.IP.10 in any procedure field. Rates were weighted to the Manitoba population and age–adjusted. Cardiac catheterizations are only performed at the two **tertiary hospitals** in Manitoba (Health Sciences Centre and St. Boniface General Hospital), so only hospital separations from those two hospitals were included in the analysis.

Figure 5.12 shows the cardiac catheterization rates by BMI group for males and females. Averages for the three BMI groups are shown in Table 5.11, along with the RR values comparing these three groups with each other.

Figure 5.12: Cardiac Catheterization Rates by BMI Group
Age–adjusted rates within three years of survey date, per 1,000 residents aged 40 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Table 5.11: Rates of Cardiac Catheterization by BMI Group for Males and Females Aged 40 and Older
Measured/corrected BMI

	Cardiac Catheterizations per 1,000 Residents			Relative Risks		
	Normal	Overweight	Obese	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Male	16.25	39.36	57.63	3.55*	1.46	2.42
Female	10.48	6.68	9.26	0.88	1.39	0.64

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- Cardiac catheterization rates were strongly related to BMI in males, but not in females.
- Among males, catheterization rates rose steadily from the Normal group to the Overweight group to the Obese group. However, only the Obese and Normal groups were statistically different.
- Among females, catheterization rates were remarkably similar across BMI groups; none of the groups were significantly different from each other.
- Fransoo et al. (2005) also reported large sex differences in catheterization rates after AMI, but the difference was driven by the younger age at which males experience AMIs.

Cardiac Revascularization

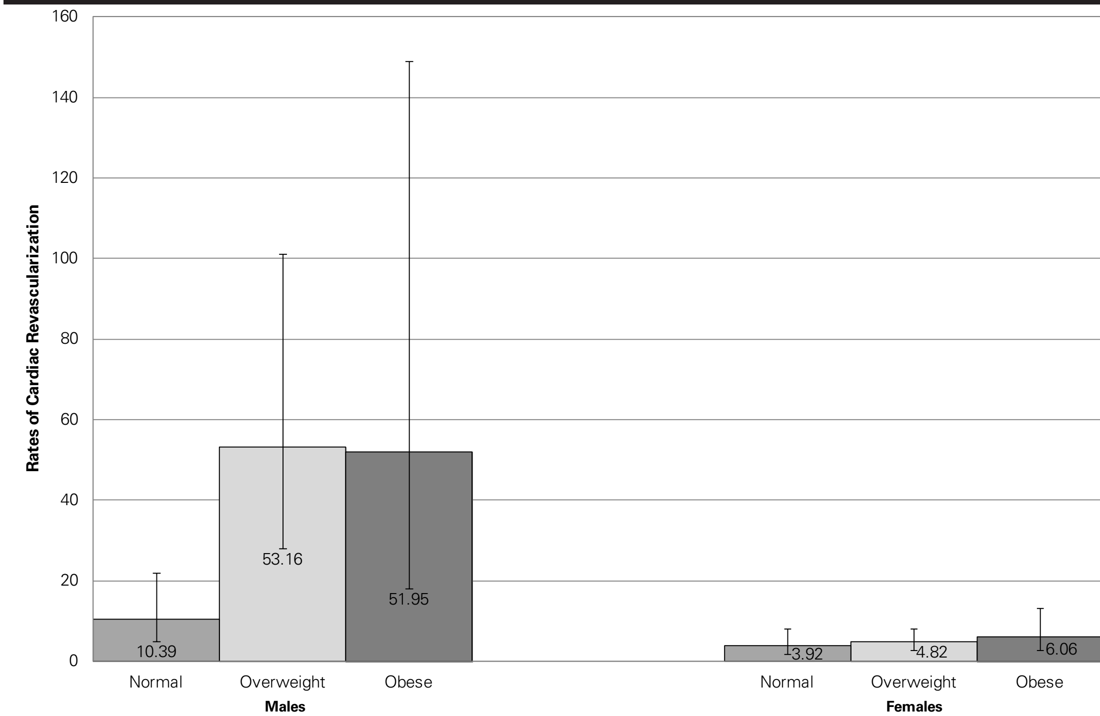
This indicator combines the rates of three procedures: **balloon angioplasty**, cardiac stent insertion, and cardiac bypass surgery (though virtually all angioplasties are now accompanied by a stent insertion). Balloon angioplasty is a procedure which expands a narrowed artery. Stent insertion is when a hollow metal cylinder is inserted after a narrowed artery has been expanded by a balloon to increase blood flow. In bypass surgery, segments of severely blocked coronary arteries are surgically removed and replaced with grafts from other parts of the body.

Definition: The number of hospitalizations in which at least one **cardiac revascularization** procedure was performed, including angioplasty, stent insertion, and cardiac bypass surgery, per 1,000 survey participants up to five years after their survey date. Bypass surgeries were defined by hospitalizations with ICD–9–CM codes 36.01, 36.02, 36.05, 36.06, 36.10–36.14, and 36.19 or CCI codes 1.IJ.50, 1.IJ.57, and 1.IJ.76 in any procedure field. Rates were weighted to the Manitoba population and age–adjusted.

These procedures are only performed at the two tertiary hospitals in Manitoba (Health Sciences Centre and St. Boniface General Hospital), so only hospital separations from those two hospitals were included in the analysis.

Cardiac revascularization rates by BMI group for males and females are shown in Figure 5.13. Averages for the three BMI groups are shown in Table 5.12, along with the RR values comparing these three groups with each other.

Figure 5.13: Cardiac Revascularization Rates by BMI Group
Age–adjusted rates within five years of survey date, per 1,000 residents aged 40 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Table 5.12: Rates of Cardiac Revascularization by BMI Group for Males and Females Aged 40 and Older
Measured/corrected BMI

	Cardiac Revascularizations per 1,000 Residents			Relative Risks		
	Normal	Overweight	Obese	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Male	10.39	53.16	51.95	5.00*	0.98	5.12*
Female	3.92	4.82	6.06	1.55	1.26	1.23

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Key Findings

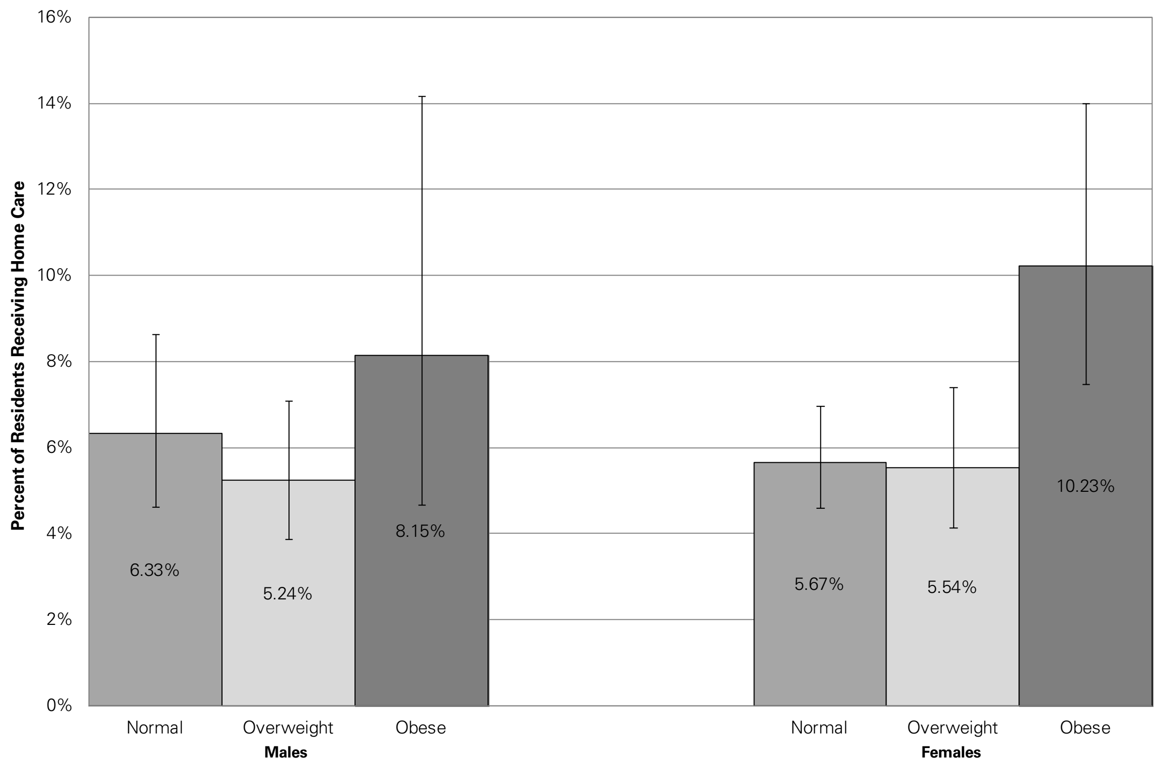
- The trends in cardiac revascularization rates were different for males and females:
  - Among males, the Overweight and Obese groups both had much higher rates than the Normal group (over five times higher).
  - Among females, cardiac revascularization rates were similar across the three BMI groups, with no significant differences among them.
- Fransoo et al. (2005) also reported large sex differences in revascularization rates after AMI, but the difference was driven by the younger age at which males experience AMIs.

Home Care Prevalence

Manitoba has a comprehensive program of **home care** services (including nursing, allied health care, personal care, meal preparation, etc.) to provide care to those with defined needs. These services often avoid or delay the need for institutionalization.

Definition: The percentage of survey participants with an open home care case for at least one day in the three years after their survey date. Some home care clients had more than one case in a year, but were only counted once for this indicator. Rates were weighted to the Manitoba population and age–adjusted.

Figure 5.14: Home Care Prevalence by BMI Group
Age–adjusted percent of residents receiving home care within three years of survey date, residents aged 18 and older (measured/corrected BMI)



Prevalence measured within three years prior to the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Table 5.13: Home Care Prevalence by BMI Group for Males and Females Aged 18 and Older
Measured/corrected BMI

	Home Care Prevalence (% Residents)			Relative Risks		
	Normal	Overweight	Obese	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Male	6.33%	5.24%	8.15%	1.29	1.55	0.83
Female	5.67%	5.54%	10.23%	1.81*	1.85	0.98

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- Overall, a higher percentage of those in the Obese group received home care services, though the results varied by sex.
- Among females, the Obese group had a higher rate of receipt of home care services than the Normal and Overweight groups, though the difference between the Obese and Overweight groups did not reach statistical significance. The Normal and Overweight groups were not statistically different from each other.
- Among males, the Obese group had the highest rate, but none of the group differences were statistically significant.

Days of Home Care Service Received

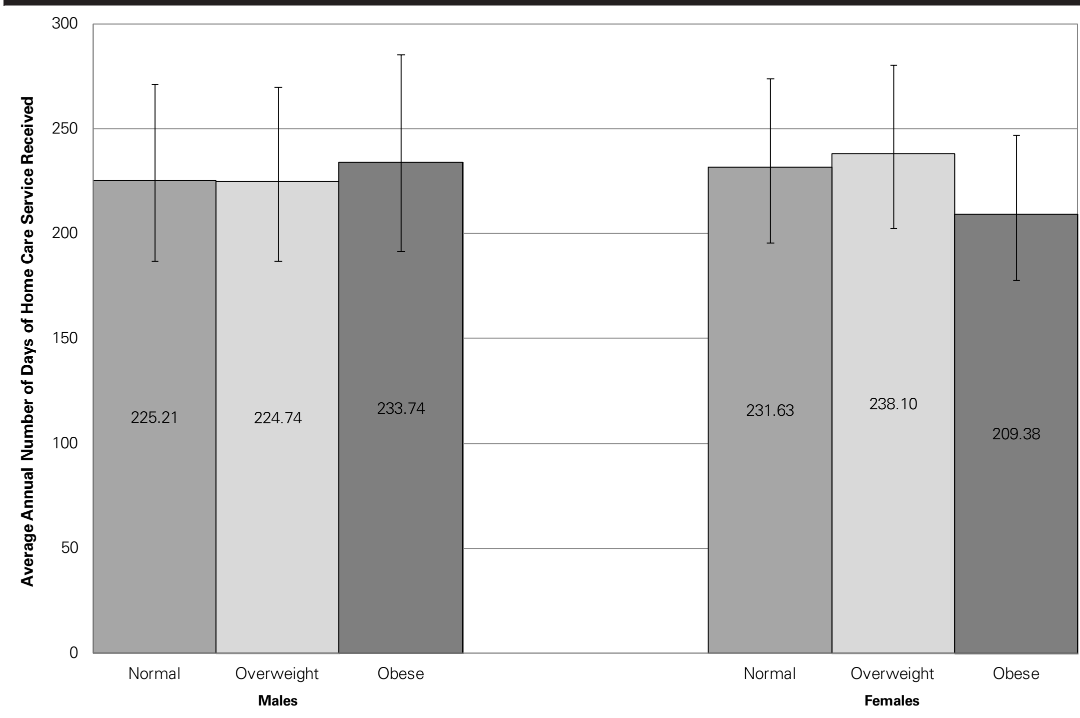
Definition: The average number of days of home care service received per year in three years after their survey date. A home care client may have more than one case in the three years; and if so, the days for all cases would be added together. Rates were weighted to the Manitoba population and age–adjusted.

Figure 5.14 shows the **home care prevalence** by BMI group for males and females. Averages for the three BMI groups are shown in Table 5.13, along with the RR values comparing these three groups with each other. Figure 5.15 shows the annual average days of home care service received by BMI group for males and females. Table 5.14 shows the averages for the three BMI groups, as well as the RR values comparing the three groups.

Key Findings

- The results in Table 5.14 and Figure 5.15 show that there were no significant differences across BMI groups within either sex (and that the rates for both sexes were similar to each other).

Figure 5.15: Average Annual Number of Days of Home Care Service Received by BMI Group
Age–adjusted annual average days of service received within three years after survey date, per home care client aged 18 and older (measured/corrected BMI)



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Table 5.14: Average Annual Days of Home Care Service Received by BMI Group for Males and Females Aged 18 and Older
Measured/corrected BMI

	Average Annual Home Care Days Used per 1,000 Residents			Relative Risks		
	Normal	Overweight	Obese	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Male	225.21	224.74	233.74	1.04	1.04	1.00
Female	231.63	238.10	209.38	0.90	0.88	1.03

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

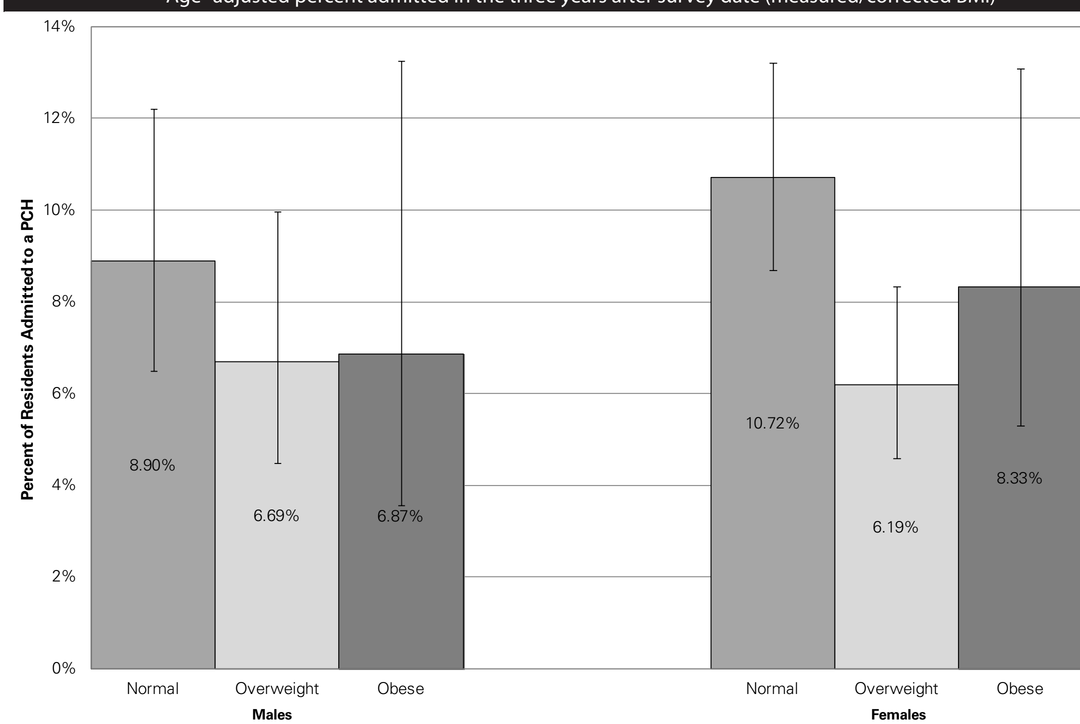
Admission to Personal Care Home (PCH)

Personal care homes (PCH), also known as nursing homes, are government–licensed facilities providing institutional care for those who cannot be managed in community settings.

Definition: The percentage of survey participants aged 75 and older admitted to a PCH in the three years after their survey date. Area of residence was assigned based on where people lived at the time they were surveyed. Rates were weighted to the Manitoba population and age–adjusted.

The proportion of the population aged 75 and older that was admitted to PCH by BMI group for males and females is shown in Figure 5.16. Averages for the three BMI groups are shown in Table 5.15, along with the RR values comparing these three groups with each other.

Figure 5.16: Proportion of Population Aged 75 and Older Admitted to a Personal Care Home (PCH) by BMI Group
Age–adjusted percent admitted in the three years after survey date (measured/corrected BMI)



Prevalence measured within three years prior to the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Table 5.15: Rates of PCH Admissions by BMI Group for Males and Females Aged 75 and Older
Measured/corrected BMI

	PCH Admissions (% Residents)			Relative Risks		
	Normal	Overweight	Obese	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Male	8.90%	6.69%	6.87%	0.77	1.03	0.75
Female	10.72%	6.19%	8.33%	0.78	1.35	0.58*

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- Overall, the PCH admission rate was inversely related to BMI: rates were higher among those in the Normal group in both sexes, though most of the group differences were not significant.
- Among females, those in the Normal group had a higher PCH admission rate than those in the Overweight group. The Obese group was not significantly different from either the Normal or Overweight groups.
- Among males, none of the group differences were significant.

Level of Care at Admission to Personal Care Home (PCH)

Residents can be admitted to PCHs at any of four levels (1–4), which is determined by the severity of their physical and mental health impairments (1 reflecting lowest need; 4 reflecting highest need). In recent years, very few residents were admitted at Level 1, so it was combined with Level 2 for this analysis. Also, because relatively few residents are admitted at Level 4, data for males and females had to be combined to avoid excessive suppression of results.

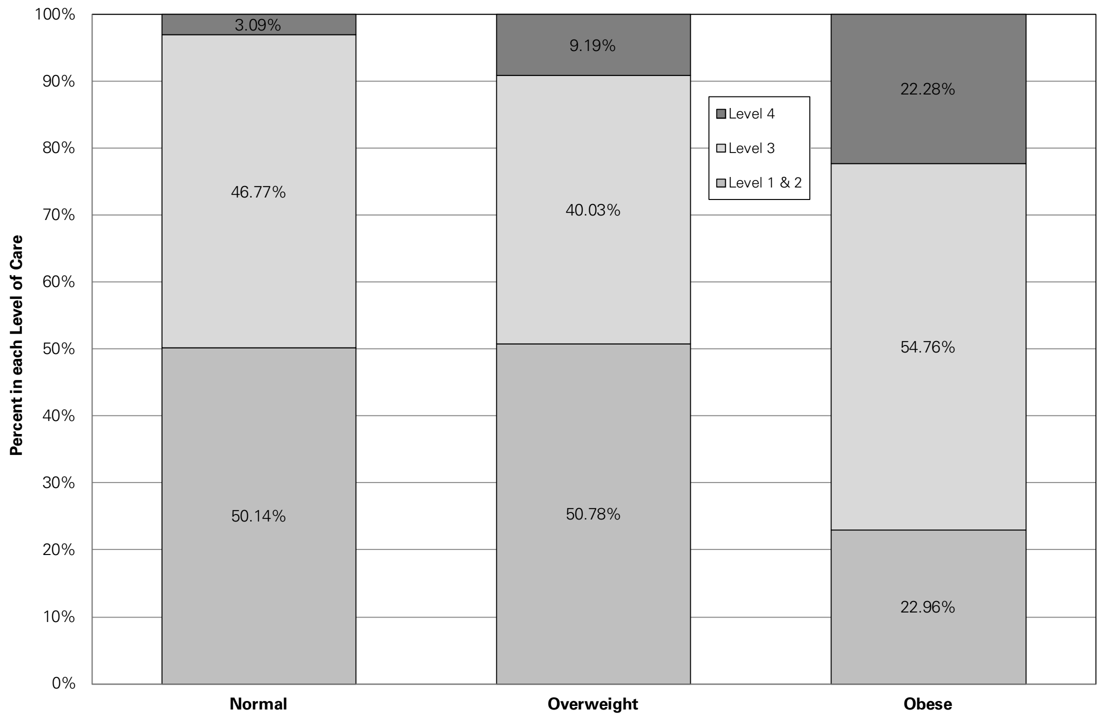
Definition: The distribution of levels of care assigned to PCH residents at the time of their admission. Level 1 represents the lowest level of need, and Level 4 represents the highest. These are **crude rates**.

Figure 5.17 shows the proportion for levels of care at PCH admission by BMI group.

Key Findings

- **Level of care on admission to a PCH** was strongly related to BMI group: those in the Obese group were much more likely to be admitted at Level 4 or Level 3 than those in the Normal or Overweight groups.
- The pattern among the Level 1 & 2 admissions was interesting in that it was virtually identical at 50% of both the Normal and Overweight groups, but only 23% of the Obese group.
- Taken together, these results suggest that among those admitted to PCHs, the Obese have poorer health status and higher need for care.

Figure 5.17: Level of Care at Personal Care Home (PCH) Admission by BMI Group (Aged 75 and Older)
Percent of those admitted within three years of survey date (males and females combined; measured/corrected BMI



Survey date indicates the date of completion of the HHS, NPHS, or CCHS

Source: Manitoba Centre for Health Policy, 2011

Chapter 6: Obesity and Mortality

Chapter Summary

Initial analysis of death rates by BMI value (and BMI group) revealed no systematic relationship between BMI and mortality, though the follow–up period for most survey participants was less than 10 years. Multivariate analysis including age, sex, and other variables revealed that obesity does not have a significant direct association with mortality. That said, there is strong evidence of its indirect effect — obesity is related to the development of a number of chronic diseases/conditions, which are in turn significantly related to mortality (most notably hypertension, diabetes and ischemic heart disease).

These findings are consistent with those from some previous research, but different from others. A number of recent studies suggest that the Overweight group have the lowest **mortality rate**s. However, much depends on study designs and time frame, what data are available, and how they are analyzed. Taken together, these results suggest that the relationships between BMI and mortality are not yet fully known and may be more complex than existing analyses have been able to account for, given limitations in available data. Additional research is needed, especially studies involving longitudinal designs, direct and indirect pathways, and incorporating more information on food consumption patterns.

Regarding causes of death, cancer and circulatory diseases were the most prominent categories for all three BMI groups, in both sexes. The endocrine and metabolic diseases category, which includes diabetes, was more prominent among the Obese group than the Normal or Overweight groups. This is consistent with the higher incidence and prevalence of diabetes documented for the Obese group (Chapter 4).

Introduction

Mortality is important to analyse because a key objective for studying obesity and health is to avoid or delay death (in addition to other deleterious outcomes). However, the relationship of obesity and mortality requires careful analysis because the impact is more indirect than direct. That is, not many people die of obesity, but many people die of diseases/conditions which are related to obesity. This also implies a time delay before the full impact of obesity on mortality would be seen. As a result, some of the analyses in this chapter only involve participants in the 1989–1990 Manitoba HHS as we have over 19 years of follow–up for those people.

Methods

Different methods are used in each section of this chapter, and details are provided in each section.

Mortality Rates by BMI Value

This indicator represents 'all–cause' mortality rates, meaning death by any cause (e.g., heart disease, cancer, injury, etc.).

Definition: The number of deaths among survey participants per 1,000 person–years of follow–up. Participants were followed from survey date until: a) death, b) loss to follow–up (e.g., moved out of Manitoba), or c) March 31, 2009 (the end of the study period). Rates were weighted to the Manitoba population and adjusted for age.

Mortality rates by BMI value for males and females are shown in Figure 6.1. Averages for the three BMI groups (Normal, Overweight and Obese) are shown in Table 6.1, along with the RR values comparing these three groups with each other.

Figure 6.1: Mortality Rates by BMI
Age–adjusted rates of mortality from survey date until March 31, 2009, per 1,000 residents aged 18 and older (measured/corrected BMI)

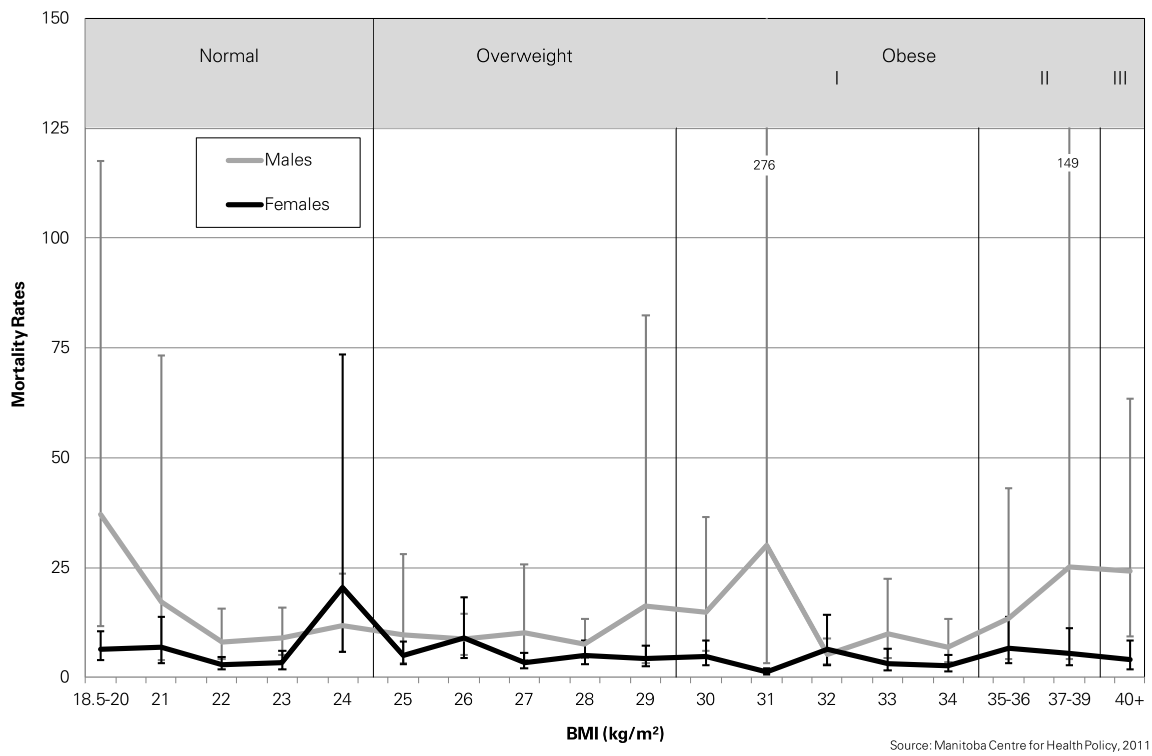


Table 6.1: Age–Adjusted Mortality Rates by BMI, per 1,000 Person-Years After Survey Date, Aged 18 and Older
Measured/corrected BMI

	Mortality Rates			Relative Risks		
	Normal	Overweight	Obese	Obese vs. Normal	Obese vs. Overweight	Overweight vs. Normal
Male	14.00	10.08	13.77	0.98	1.37	0.72
Female	6.14	5.01	3.88	0.63	0.77	0.82

* Indicates a statistically significant difference

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- Results in Figure 6.1 show that overall, there was no clear association between BMI level and mortality rates for either sex. Males at very low and very high BMI levels had elevated mortality rates, but these differences were not significant (largely related to the high variability). No systematic trend was evident among females. Table 6.1 shows that there were no statistically significant differences between BMI groups for either sex.
- These findings suggest that mortality rates were not significantly related to BMI levels at all. However, these results alone do not tell the whole story: they likely under–estimate the total impact of obesity on mortality because of the relatively short follow–up period available for many of the survey participants (i.e., for about half of all survey participants, we have less than seven years of follow–up data). This is critical because obesity is related to the development of numerous chronic diseases, which in turn are related to mortality, so the full impact of obesity on mortality likely takes longer to become evident (Dyer, Stamler, Garside, & Greenland, 2004).
- To address this, we conducted further analyses focussing on participants in the HHS only because we have over 19 years of follow–up for those people. Results are shown in the next section.

Multivariate Modelling of Survival Rates

Mortality/survival rates are affected by many factors, so a multivariate analysis was undertaken to examine how numerous factors affect survival rates among the three BMI groups (unadjusted Kaplan–Meier survival curves are shown in Appendix Figures A4.1 and A4.2). This was conducted using a multivariate **Cox Proportional Hazards Regression Analysis**[12]. Because the Manitoba HHS included clinical examinations with blood tests, two variables representing blood chemistry were also included among the variables in the analysis:

- BMI group (Overweight, Obese, Normal was the reference group)
- Age (as of the survey date, in years)
- Sex (females were the reference group)
- Region of residence (Winnipeg most healthy areas were the reference group)
- Current smoker (as of survey date)
- Frequent binge drinker (as of survey date)
- Diagnosed with diabetes (incident or prevalent case anytime in study period using the case definition described in Chapter 4)
- Diagnosed with hypertension (incident or prevalent case anytime in study period using the case definition described in Chapter 4)
- Diagnosed with IHD (incident or prevalent case anytime in study period using the case definition described in Chapter 4)
- Cholesterol ratio (total/High Density Lipoprotein (HDL) level)
- Low Density Lipoprotein (LDL) level (mg/dL)

Table 6.2 below shows the results of the final (full) model; results of intermediate models are shown in Appendix Table A4.1. The coefficients for each variable represent the independent impact of each factor on mortality rates, after controlling for differences in all other factors in the model.

Note: Some might contend that including diabetes, hypertension, IHD, and cholesterol values in this survival model constitutes inappropriate control of the biological effects of obesity (because they may be consequences of obesity, which themselves affect mortality, and so should not be included in the analysis).

12 The proportionality assumption was tested and found to be satisfied.

We agree that such an analysis could mis–attribute variance to the diseases rather than obesity itself, thereby underestimating the true impact of obesity on mortality. However, we guarded against this problem by analyzing several models, as shown in Appendix Table A4.1. We started with a simple univariate analysis and then added BMI, age, and sex. Then we analyzed 'just' geography, then just the behavioural variables, then just the diseases, then just the cholesterol data, and then finished with the final model including all variables. The results show that while overweight and obesity were significantly associated with mortality in the univariate analysis, they became statistically non–significant once age and sex were added to the model and remained non–significant in all subsequent models. This suggests that the final model is valid, because even when the diseases and cholesterol measures were not in the model, overweight and obesity were not significantly (directly) related to mortality. This is consistent with the idea that obesity is indirectly related to mortality, working through the intervening effect of a number of chronic diseases, which is likely why they were significant in this analysis.

Table 6.2: Factors Related to Mortality
Cox Proportional hazards model, Manitoba Heart Health Survey only; measured/corrected BMI

Group	Variable	Model 6 Hazard Ratio (95% CI)	Significance
BMI Class *(Compared to Normal)*			
	Overweight	1.04 (0.74, 1.46)	
	Obese	0.96 (0.65, 1.42)	
Sociodemographic			
	Age (Years)	1.10 (1.08, 1.11)	*
	Male (vs. Female)	1.36 (0.9995, 1.84)	
Geographical *(Compared to Winnipeg Most Healthy areas)*			
	Rural South	1.32 (0.85, 2.03)	
	Rural Mid	1.06 (0.63, 1.77)	
	North	2.01 (1.06, 3.79)	*
	Brandon	1.02 (0.15, 6.91)	
	Winnipeg Average Healthy Area	1.16 (0.65, 2.06)	
	Winnipeg Least Healthy Area	1.33 (0.68, 2.59)	
Behavioural			
	Current Smoker	1.996 (1.37, 2.91)	*
	Frequent Binge Drinker	1.70 (1.02, 2.82)	*
Diseases			
	Diabetes	2.22 (1.52, 3.24)	*
	Hypertension	0.86 (0.60, 1.21)	
	Ischemic Heart Disease	1.72 (1.28, 2.31)	*
Cholesterol			
	Ratio (Total/HDL)	1.03 (0.93, 1.15)	
	LDL	1.03 (0.85, 1.26)	

* Indicates significance at $p<0.05$

Source: Manitoba Centre for Health Policy, 2011

Key Findings

- Many variables in the model were statistically significant predictors of mortality:
    - Age: the hazard ratio of 1.10 may seem to indicate a subtle association, but the small CI and the fact that this represents the effect of a single year of age actually imply this is a very strong effect (likely the strongest in the model, which makes sense as age is strongly related to mortality risk). Other similar research has also shown age to be the strongest predictor of mortality (Orpana et al., 2011).
    - Geography: those living in the North had a much higher likelihood of death (2.01) than those living in the most healthy areas of Winnipeg; no other areas were significantly different.
    - **Smoking**: those who were 'current smokers' at the time of the survey had a much higher likelihood of death (2.00) than non–smokers.
    - Alcohol: those who reported **frequent binge drinking** in the year before the survey had a much higher likelihood (1.70) of death.
    - Diabetes: those diagnosed with diabetes at any time in the study period had a much higher likelihood of death (2.22) than those who were not.
    - Heart disease: those diagnosed with IHD at any time in the study period had a much higher (1.72) likelihood of death than those who were not.
    - Male sex appeared to be related to higher mortality, but this association did not quite reach statistical significance (CI extends just below 1.0).
- In this analysis, the direct impact of overweight or obesity on mortality was not significant after controlling for the effects of other variables. However, indirect effects are also important, as obesity is related to a number of chronic diseases which are in turn related to mortality (including those listed above).
    - *We tried to assess the direct and indirect effects using structural equation modelling, but were not able to develop valid models, despite numerous attempts. This was primarily due to the dichotomous nature of many variables (including the outcome: mortality).*

Comparison to previous studies:

- These results are consistent with findings from many other studies including several recent reviews, which support an indirect impact of obesity on mortality (Calle, Thun, Petrelli, Rodriguez, & Heath, 1999; Dyer et al., 2004; Lavie et al., 2009; Lenz, Richter, & Muhlhauser, 2009; Pi–Sunyer, 1993; Zamboni et al., 2005). This may not apply to the Overweight group.
- Other studies have reported significant direct relationships between obesity and mortality rates (Flegal, Graubard, Williamson, & Gail, 2005; Flegal, Graubard, Williamson, & Gail, 2007; Katzmarzyk, Craig, & Bouchard, 2001; Katzmarzyk, Craig, & Bouchard, 2002; Lenz et al., 2009; Luo et al., 2007; Poirier et al., 2006), including a large meta–analysis (Mcgee & Diverse, 2005) and a very large multinational study (Pischon et al., 2008).
    - However, these studies did not include chronic diseases or illness level as predictors of mortality, so could not have found indirect effects. As a result, these analyses may have inappropriately attributed some of the variance in outcomes to obesity, as discussed previously.
    - The results of these studies are more comparable to the findings of our univariate analyses, which showed similar results (Appendix Table A4.1 and the 'Note' just before Table 6.2).
    - Either way, all of the studies cited above support the notion that obesity is related to mortality, either directly, indirectly, or both, whereas Overweight may not be.
- Some recent studies have reported the intriguing finding that mortality rates among the Overweight group were actually lower than the Normal group (Flegal et al., 2007; Orpana et al., 2011).
    - However, in the large US study (Flegal et al., 2007), this was true only for deaths attributed to causes other than cardiovascular diseases or cancer (the top two causes of death, which together account for over 60% of all deaths).

- In the Canadian study (Orpana et al., 2011), the Overweight group was found to have significantly lower mortality from all causes combined. This difference may be related to the inclusion of activity level, smoking, and alcohol consumption in this study (Orpana et al., 2011).
  - The importance of activity level was highlighted in a meta–analysis by Katzmarzyk et al. (2003), who reported that physically active people have a lower mortality risk than inactive people, independent of adiposity (body fat) level.
- A related study showed that overweight and even mild obesity (BMI 30–35) were not significantly associated with a reduction in life expectancy, whereas higher BMI values were (Finkelstein, Brown, Wrage, Allaire, & Hoerger, 2010).
- Furthermore, Fontaine et al. (2003) showed that obesity among younger adults reduces life expectancy significantly, and Adams et al. (2006) showed that obesity in mid–life was related to higher mortality.
- Taken together, these results suggest that the relationships between BMI and mortality are not yet fully known and may be more complex than existing analyses have been able to account for, given limitations in available data.
- Additional research is needed, especially studies involving longitudinal designs, direct and indirect pathways, and incorporating more information on food consumption patterns.

Causes of Mortality

This analysis was conducted to determine whether people in different BMI groups are more likely to die from different causes/diseases.

Definition: The distribution of causes of death based on Vital Statistics files, using the 17 chapters of the ICD–9–CM system. Data were analyzed from survey date until March 31, 2008. From January 1, 2000, Vital Statistics data were coded using ICD–10–CA, so these codes were converted to ICD–9–CM codes, using the conversion file created by CIHI.

Initial analyses separated deaths by BMI group, sex, age group, and ICD chapter. However, there were relatively few deaths in a number of these cells. Upon examination, two things became evident: 1) that within each age and BMI grouping, there was strong similarity in the causes of death for males and females and 2) that the top three causes captured 70% or more of all deaths. Therefore, Table 6.3 contains results which combine males and females and shows the top three causes only, followed by 'all others'.[13] Note that the youngest age group shown (18–49 years) had many fewer deaths than the other age groups, so results and rankings are more variable.

The results in Table 6.3 show that for all age and BMI groups (except Normal 18–49 year olds), cancer and circulatory diseases are the top two causes. They often comprise 60% or more of all deaths. Circulatory diseases overtake cancer in the oldest age group by a considerable margin (in all BMI groups).

Perhaps the most interesting observation for this report is the presence of the endocrine and metabolic diseases category (which includes diabetes) as the third most common cause of death among the two older age groups for those in the Obese group. These two age groups include the vast majority of deaths (over 91%). This finding represents an important difference in that, among middle age and older adults, the 'Endocrine and Metabolic' category is a leading cause of death. Furthermore, the endocrine and metabolic group was the fourth most common cause among overweight members of the middle

13 Recall that these are causes of death for survey participants, who had to be living in the community at the time of the survey (nursing home and other institutionalized persons were not included).

Table 6.3: Top Three Causes of Death (by ICD-9-CM Chapter) by Age Group and BMI Group, Males and Females Combined, Aged 18 and Older

	Causes of Death					
	Normal		Overweight		Obese	
Ages 18-49	Cancer	29.27%	Cancer	43.75%	Cancer	36.35%
	Injury	29.07%	Circulatory	21.55%	Circulatory	22.65%
	Circulatory	14.01%	Ill-Defined	10.30%	Genitourinary	11.81%
	All others	27.66%	All others	24.40%	All others	29.18%
Ages 50 -74	Cancer	39.62%	Cancer	44.86%	Cancer	37.86%
	Circulatory	28.06%	Circulatory	26.81%	Circulatory	30.02%
	Respiratory	9.39%	Respiratory	6.66%	Endocrine & Metabolic	8.63%
	All others	22.93%	All others	21.67%	All others	23.49%
Ages 75+	Circulatory	40.14%	Circulatory	37.46%	Circulatory	31.90%
	Cancer	22.00%	Cancer	23.47%	Cancer	18.61%
	Respiratory	13.71%	Respiratory	12.43%	Endocrine & Metabolic	11.08%
	All others	24.15%	All others	26.64%	All others	38.41%

Source: Manitoba Centre for Health Policy, 2011

age group. These findings show that the endocrine and metabolic category became a more prominent cause of death with increasing BMI and increasing age. This is consistent with the documented increases in diabetes prevalence and incidence with increasing BMI (Chapter 4).

Finally, in all three age groups, the 'all other' category for the Obese group contained a higher proportion of deaths than for the Normal or Overweight groups. This suggests that those in the Obese group die more frequently due to conditions beyond the top 3 causes of death, though further research with a larger sample would be required to confirm this finding.

Reference List

Adams KF, Schatzkin A, Harris TB, et al. Overweight, obesity, and mortality in a large prospective cohort of persons 50 to 71 years old. *New England Journal of Medicine.* 2006;355(8):763–778.

Andreyeva T, Sturm R, Ringel JS. Moderate and severe obesity have large differences in health care costs. *Obes Res.* 2004;12(12):1936–1943.

Baillargeon J, Platz EA, Rose DP, et al. Obesity, adipokines, and prostate cancer in a prospective population–based study. *Cancer Epidemiol Biomarkers Prev.* 2006;15(7):1331–1335.

Bertakis KD, Azari R. The influence of obesity, alcohol abuse, and smoking on utilization of health care services. *Fam Med.* 2006;38(6):427–434.

Borg S, Persson U, Odegaard K, Berglund G, Nilsson JA, Nilsson PM. Obesity, survival, and hospital costs–findings from a screening project in Sweden. *Value Health.* 2005;8(5):562–571.

Brameld KJ, Holman CDJ, Lawrence DM, Hobbs MST. Improved methods for estimating incidence from linked hospital morbidity data. 2003. http://ije.oxfordjournals.org.proxy1.lib.umanitoba.ca/content/32/4/617.full.pdf. Accessed April 26, 2011.

Brown CD, Higgins M, Donato KA, et al. Body mass index and the prevalence of hypertension and dyslipidemia. *Obesity Research.* 2000;8(9):605–619.

Brown T, Kelly S, Summerbell C. Prevention of obesity: a review of interventions. *Obes Rev.* 2007;8 Suppl 1:127–130.

Caballero B. The global epidemic of obesity: an overview. *Epidemiologic Reviews.* 2007;29:1–5.

Calle EE, Thun MJ, Petrelli JM, Rodriguez C, Heath CW. Body–mass index and mortality in a prospective cohort of US adults. *New England Journal of Medicine.* 1999;341(15):1097–1105.

Canadian Institute for Health Information. Obesity in Canada: identifying policy priorities—proceedings of a roundtable. 2003. http://secure.cihi.ca/cihiweb/products/CPHI_proceed_e.pdf. Accessed March 1, 2011.

Chen Y, Dales R, Krewski D, Breithaupt K. Increased Effects of Smoking and Obesity on Asthma among Female Canadians: The National Population Health Survey, 1994–1995. 1999. http://aje.oxfordjournals.org/content/150/3/255.full.pdf+html. Accessed May 3, 2011.

Chiolero A, Peytremann–Bridevaux I, Paccaud F. Associations between obesity and health conditions may be overestimated if self–reported body mass index is used. *Obesity Reviews.* 2007;8:373–374.

Coady SA, Jaquish CE, Fabsitz RR, Larson MG, Cupples LA, Myers RH. Genetic variability of adult body mass index: a longitudinal assessment in Framingham families. *Obesity Research.* 2002;10(7):675–681.

Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. 2000. http://www.bmj.com/content/320/7244/1240.full.pdf?sid=bc1ca3a6–07e9–401b–8996–344f740a1b1d. Accessed April 26, 2011.

Connor Gorber S, Shields M, Tremblay MS, McDowell I. The feasibility of establishing correction factors to adjust self–reported estimates of obesity. *Health Reports.* 2008;19(3):71–82.

Connor Gorber S, Tremblay M, Moher D, Gorber B. A comparison of direct vs. self–report measures for assessing height, weight and body mass index: a systematic review. *Obesity Reviews.* 2007;8:307–326.

Connor Gorber S, Tremblay MS. The Bias in Self–reported Obesity From 1976 to 2005: A Canada–US Comparison. *Obesity.* 2010;18:354–361.

Counterweight Project Team. Influence of body mass index on prescribing costs and potential cost savings of a weight management programme in primary care. J Health Serv Res Policy. 2008;13(3):158–166.

Craig CL, Cameron C, Bauman A. *Socio–Demographic and Lifestyle Correlates of Obesity*. Ottawa, ON: Canadian Institute for Health Information; 2005.

Curtis JP, Selter JG, Wang Y, et al. The obesity paradox: body mass index and outcomes in patients with heart failure. *Arch Intern Med.* 2005;165(1):55–61.

De Laet C, Kanis JA, Oden A, et al. Body mass index as a predictor of fracture risk: a meta–analysis. *Osteoporos Int.* 2005;16(11):1330–1338.

Doll HA, Petersen SEK, Stewart–Brown SL. Obesity and physical and emotional well–being: Associations between body mass index, chronic illness, and the physical and mental components of the SF–36 questionnaire. *Obesity Research.* 2000;8(2):160–170.

Dyer AR, Stamler J, Garside DB, Greenland P. Long–term consequences of body mass index for cardiovascular mortality: the Chicago Heart Association Detection Project in Industry study. *Ann Epidemiol.* 2004;14(2):101–108.

Elfhag K, Rossner S. Who succeeds in maintaining weight loss? A conceptual review of factors associated with weight loss maintenance and weight regain. *Obes Rev.* 2005;6(1):67–85.

Esposti ED, Sturani A, Valpiani G, et al. The relationship between body weight and drug costs: An Italian population–based study. *Clin Ther.* 2006;28(9):1472–1481.

Farooqi IS, O'Rahilly S. Genetic factors in human obesity. *Obesity Reviews.* 2007;8(Suppl. 1):37–40.

Finkelstein EA, Brown DS, Wrage LA, Allaire BT, Hoerger TJ. Individual and aggregate years–of–life–lost associated with overweight and obesity. *Obesity (Silver Spring).* 2010;18(2):333–339.

Flegal KM, Graubard BI, Williamson DF, Gail MH. Excess deaths associated with underweight, overweight, and obesity. *JAMA.* 2005;293(15):1861–1867.

Flegal KM, Graubard BI, Williamson DF, Gail MH. Cause–Specific Excess Deaths Associated With Underweight, Overweight, and Obesity. November 7, 2007. http://jama.ama–assn.org.proxy2.lib.umanitoba.ca/content/298/17/2028.full.pdf. Accessed May 26, 2011.

Folmann NB, Bossen KS, Willaing I, et al. Obesity, hospital services use and costs. *Adv Health Econ Health Serv Res.* 2007;17:319–332.

Fontaine KR, Barofsky I. Obesity and health–related quality of life. *Obes Rev.* 2001;2(3):173–182.

Fontaine KR, Redden DT, Wang CX, Westfall AO, Allison DB. Years of life lost due to obesity. *JAMA.* 2003;289(2):187–193.

Foresight. Tackling obesities: future choices—project report, 2nd edition. Department of Innovation Universities and Skills. October, 2007. http://www.bis.gov.uk/assets/bispartners/foresight/docs/obesity/17.pdf. Accessed March 1, 2011.

Fransoo R, Martens P, Burland E, The Need to Know Team, Prior H, Burchill C. Manitoba RHA Indicators Atlas 2009. Manitoba Centre for Health Policy. 2009. http://mchp–appserv.cpe.umanitoba.ca/reference/RHA_Atlas_Report.pdf. Accessed April 29, 2011.

Fransoo R, Martens P, The Need to Know Team, Burland E, Prior H, Burchill C, Chateau D, Walld R. Sex Differences in Health Status, Health Care Use, and Quality of Care: A Population–Based Analysis for Manitoba's Regional Health Authorities. Manitoba Centre for Health Policy. 2005. http://mchp–appserv.cpe.umanitoba.ca/reference/sexdiff.pdf. Accessed April 29, 2011.

Gelskey D, MacDonald S, Young K. Highlights Report of the Manitoba Heart Health Survey. Winnipeg, MB: Dept. of Community Health Sciences, Faculty of Medicine, University of Manitoba; 1991.

Gilmore J. Body mass index and health. Health Reports. 1999;11(1):31–43.

Glazier R, Booth G. Neighbourhood Environments and Resources for Healthy Living—A Focus on Diabetes in Toronto: ICES Atlas. November, 2007. http://www.ices.on.ca/webpage.cfm?site_id=1&org_id=67&morg_id=0&gsec_id=0&item_id=4406&type=atlas. Accessed May 2, 2011.

Han E, Truesdale KP, Taber DR, Cai J, Juhaeri J, Stevens J. Impact of overweight and obesity on hospitalization: race and gender differences. Int J Obes (Lond). 2009;33(2):249–256.

Health and Welfare Canada. Canadian Guidelines for Healthy Weights. Ottawa, ON; Health and Welfare Canada. 1988.

Health Canada. Canadian guidelines for body weight classification in adults. 2003. http://www.hc–sc.gc.ca/fn–an/alt_formats/hpfb–dgpsa/pdf/nutrition/weight_book–livres_des_poids–eng.pdf. Accessed March 1, 2011.

Heiat A, Vaccarino V, Krumholz HM. An evidence–based assessment of federal guidelines for overweight and obesity as they apply to elderly persons. Arch Intern Med. 2001;161(9):1194–1203.

Hjelmborg JvB, Fagnani C, Silventoinen K, et al. Genetic influences on growth traits of BMI: a longitudinal study of adult twins. *Obesity.* 2008;16(4):847–852.

Hosmer DW, Lemeshow S. *Applied Logistic Regression*. New York, NY: John Wiley & Sons, Inc.; 1989.

Hubert HB, Feinleib M, Mcnamara PM, Castelli WP. Obesity as an Independent Risk Factor for Cardiovascular–Disease—A 26–Year Follow–Up of Participants in the Framingham Heart–Study. *Circulation.* 1983;67(5):968–977.

Janssen I, Katzmarzyk PT, Ross R. Body mass index, waist circumference, and health risk: evidence in support of current national institutes of health guidelines. *Arch Intern Med.* 2002;162:2074–2079.

Janssen I, Katzmarzyk PT, Ross R. Waist circumference and not body mass index explains obesity–related health risk. 2004. http://www.ajcn.org/content/79/3/379.full.pdf+html. Accessed May 3, 2011.

Katzmarzyk PT. The Canadian obesity epidemic: an historical perspective. *Obesity Research.* 2002;10(7):666–674.

Katzmarzyk PT, Craig CL, Bouchard C. Original Article Underweight, overweight and obesity: relationships with mortality in the 13–year follow–up of the Canada Fitness Survey. *Journal of Clinical Epidemiology.* 2001;54(9):916–920.

Katzmarzyk PT, Craig CL, Bouchard C. Adiposity, adipose tissue distribution and mortality rates in the Canada Fitness Survey follow–up study. *International Journal of Obesity.* 2002;26(8):1054–1059.

Katzmarzyk PT, Janssen I, Ardern CI. Physical inactivity, excess adiposity and premature mortality. *Obes Rev.* 2003;4(4):257–290.

Kenchaiah S, Evans JC, Levy D, et al. Obesity and the risk of heart failure. *New England Journal of Medicine.* 2002;347(5):305–313.

Kolotkin RL, Meter K, Williams GR. Quality of life and obesity. *Obes Rev.* 2001;2:219–229.

Kumanyika SK. Minisymposium on obesity: overview and some strategic considerations. *Annu Rev Public Health.* 2001;22:293–308.

Kurth T, Gaziano JM, Berger K, et al. Body mass index and the risk of stroke in men. *Arch Intern Med.* 2002;162(22):2557–2562.

Kushner RF, Foster GD. Obesity and quality of life. *Nutrition.* 2000;16(10):947–952.

Lau DCW, Douketis JD, Morrison KM, Hramiak IM, Sharma AM, Ur E. 2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children [summary]. *CMAJ.* 2007;176(8):S1–S13.

Lavie CJ, Milani RV, Ventura HO. Obesity, Heart Disease, and Favorable Prognosis—Truth or Paradox? *The American Journal of Medicine.* 2007;120:825–826.

Lavie CJ, Milani RV, Ventura HO. Obesity and cardiovascular disease: risk factor, paradox, and impact of weight loss. *Journal of the American College of Cardiology.* 2009;53(21):1925–1932.

Le Petit C, Berthelot JM. Obesity—a growing issue. *Health Reports.* 2006;17(3):43–50.

Lenz M, Richter T, Muhlhauser I. The morbidity and mortality associated with overweight and obesity in adulthood: a systematic review. *Dtsch Arztebl Int.* 2009;106(40):641–648.

Lopez RP. Neighborhood risk factors for obesity. *Obesity (Silver Spring).* 2007;15(8):2111–2119.

Luo W, Morrison H, de Groh M, et al. The burden of adult obesity in Canada. *Chronic Dis Can.* 2007;27(4).

Macdonald SM, Reeder BA, Chen Y, et al. Obesity in Canada: A descriptive analysis. *Canadian Medical Association Journal.* 1997;157:S3–S9.

Manitoba Health and Health Living. A Report on the Weight Status of Manitoba Children. 2007. http://www.gov.mb.ca/health/chronicdisease/docs/weight.pdf. Accessed March 1, 2011.

Marshall NS, Glozier N, Grunstein RR. Is sleep duration related to obesity? A critical review of the epidemiological evidence. *Sleep Med Rev.* 2008;12(4):289–298.

McAdams MA, Van Dam R.M., Hu FB. Comparison of self–reported and measured BMI as correlates of disease markers in U.S. adults. *Obesity.* 2007;15(1):188–196.

Mcgee DL, Diverse PC. Body mass index and mortality: A meta–analysis based on person–level data from twenty–six observational studies. *Annals of Epidemiology.* 2005;15(2):87–97.

Metge C, Chateau D, Prior H, Soodeen RA, De Coster C, Barre L. Composite Measures/Indices of Health and Health System Performance. Manitoba Centre for Health Policy. 2009. http://mchp–appserv.cpe.umanitoba.ca/reference/Chip.pdf. Accessed April 29, 2011.

Miller WC, Jacob AV. The health at any size paradigm for obesity treatment: the scientific evidence. *Obesity Reviews.* 2001;2:37–45.

Muller MJ, Mast M, Asbeck I, Langnase K, Grund A. Prevention of obesity—is it possible? *Obes Rev.* 2001;2(1):15–28.

Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. The disease burden associated with overweight and obesity. *JAMA.* 1999;282(16):1523–1529.

Narbro K, Agren G, Jonsson E, Naslund I, Sjostrom L, Peltonen M. Pharmaceutical costs in obese individuals: comparison with a randomly selected population sample and long–term changes after conventional and surgical treatment: the SOS intervention study. *Arch Intern Med.* 2002;162(18):2061–2069.

Oreopoulos A, Padwal R, Kalantar–Zadeh K, et al. Body mass index and mortality in heart failure: A meta–analysis. 2008. http://www.mdconsult.com.proxy1.lib.umanitoba.ca/das/article/body/240023601–7/jorg=journal&source=MI&sp=20806314&sid=1151746091/N/650068/s0002870308001543.pdf?SEQNO=1&issn=0002–8703. Accessed April 27, 2011.

Orpana HM, Berthelot J–M, Kaplan MS, et al. BMI and Mortality: Results from a National Longitudinal Study of Canadian Adults. January, 2011. http://www.nature.com.proxy2.lib.umanitoba.ca/oby/journal/v18/n1/pdf/oby2009191a.pdf. Accessed May 26, 2011.

Orpana HM, Tremblay MS, Fines P. Trends in weight change among Canadian adults. *Health Reports.* 2007;18(2):9–16.

Patel SR, Hu FB. Short sleep duration and weight gain: a systematic review. *Obesity (Silver Spring).* 2008;16(3):643–653.

Pi–Sunyer FX. Medical Hazards of Obesity. *Annals of Internal Medicine.* 1993;119(2):655–660.

Pischon T, Boeing H, Hoffmann K, et al. General and Abdominal Adiposity and Risk of Death in Europe. *New England Journal of Medicine.* 2008;359(20):2105–2120.

Poirier P, Giles TD, Bray GA, et al. Obesity and Cardiovascular Disease: Pathophysiology, Evaluation, and Effect of Weight Loss: An Update of the 1997 American Heart Association Scientific Statement on Obesity and Heart Disease From the Obesity Committee of the Council on Nutrition, Physical Activity, and Metabolism. *Circulation.* 2006;113(6):898–918.

Prentice AM, Jebb SA. Beyond body mass index. *Obesity Reviews.* 2001;2:141–147.

Public Health Agency of Canada, Canadian Institute for Health Information. Obesity in Canada: A joint report from the Public Health Agency of Canada and the Canadian Institute for Health Information. 2011. http://secure.cihi.ca/cihiweb/products/Obesity_in_canada_2011_en.pdf. Accessed August 2, 2011.

Raebel MA, Malone DC, Conner DA, Xu S, Porter JA, Lanty FA. Health services use and health care costs of obese and nonobese individuals. *Arch Intern Med.* 2004;164(19):2135–2140.

Raine K, Spence JC, Church J, et al. State of the evidence review on urban health and healthy weights. Canadian Institute for Health Information. 2008. http://secure.cihi.ca/cihiweb/products/Urban%20Health%20and%20Healthy%20Weights.pdf. Accessed March 1, 2011.

Raine KD. Overweight and obesity in Canada: a population health perspective. Canadian Institute for Health Information. 2004. http://secure.cihi.ca/cihiweb/products/CPHIOverweightandObesityAugust2004_e.pdf. Accessed March 1, 2011.

Rappange DR, Brouwer WB, Hoogenveen RT, Van Baal PH. Healthcare costs and obesity prevention: drug costs and other sector–specific consequences. *Pharmacoeconomics.* 2009;27(12):1031–1044.

Razak F, Anand SS, Shannon H, et al. Defining obesity cut points in a multiethnic population. *Circulation.* 2007;115(16):2111–2118.

Reeder BA, Angel A, Ledoux M, et al. Obesity and its relation to cardiovascular disease risk factors in Canadian adults. 1992. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1490327/pdf/cmaj00300–0147.pdf. Accessed May 3, 2011.

Reid RJ, Roos NP, MacWilliam L, Frohlich N, Black C. Assessing Population Health Care Need Using a Claims–based ACG Morbidity Measure: A Validation Analysis in the Province of Manitoba. 2002. http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1464032/pdf/hesr_01029r.pdf?tool=pmcentrez. Accessed April 26, 2011.

Reidpath DD, Crawford D, Tilgner L, Gibbons C. Relationship between body mass index and the use of healthcare services in Australia. *Obes Res.* 2002;10(6):526–531.

Roos L, Gupta S, Soodeen RA, Jebamani L. Data quality in an information–rich environment: Canada as an example. 2005. http://journals.cambridge.org.proxy2.lib.umanitoba.ca/action/displayFulltext?type=1&fid=7079680&jid=CJG&volumeId=24&issueId=S1&aid=7079672&bodyId=&membershipNumber=&societyETOCSession=. Accessed April 26, 2011.

Samanic C, Chow WH, Gridley G, Jarvholm B, Fraumeni JF. Relation of body mass index to cancer risk in 362,552 Swedish men. *Cancer Causes & Control.* 2006;17(7):901–909.

Shields M, Carroll MD, Ogden CL. Adult Obesity Prevalence in Canada and the United States. March, 2011. http://www.cdc.gov/nchs/data/databriefs/db56.pdf. Accessed May 3, 2011.

Shields M, Connor Gorber S, Janssen I, Tremblay MS. Bias in self–reported estimates of obesity in Canadian health surveys: An update on correction equation for adults. *Health Reports.* 2011;22(3):1–11.

Shields M, Connor Gorber S, Tremblay MS. Effects of measurement on obesity and morbidity. *Health Reports.* 2008a;19(1):1–8.

Shields M, Connor Gorber S, Tremblay MS. Estimates of obesity based on self–report versus direct measurements. *Health Reports.* 2008b;19(2):1–16.

Shields M, Tjepkema M. Regional differences in obesity. *Health Reports.* 2006a;17(3):61–67.

Shields M, Tjepkema M. Trends in adult obesity. *Health Reports.* 2006b;17(3):53–59.

Shields M, Tremblay MS. Sedentary behaviour and obesity. Statistics Canada. June, 2008. http://www.statcan.gc.ca/pub/82–003–x/2008002/article/10599–eng.pdf. Accessed January 28, 2011.

Simon GE, Von KM, Saunders K, et al. Association between obesity and psychiatric disorders in the US adult population. *Arch Gen Psychiatry.* 2006;63(7):824–830.

Sokar–Todd HB, Sharma AM. Obesity research in Canada: literature overview of the last 3 decades. *Obesity Research.* 2004;12(10):1547–1553.

St–Pierre M, Beland Y. Mode effects in the Canadian Community Health Survey: a comparison of CAPI and CATI. 2004 Proceedings of the American Statistical Association Meeting, Survey Research Methods. American Statistical Association. 2004. http://www.statcan.gc.ca/imdb–bmdi/document/3226_D16_T9_V1–eng.pdf. Accessed March 1, 2011.

Statistics Canada. CANSIM Table 105–4009—Body mass index (BMI), by sex, household population aged 18 and over excluding pregnant females, Canada, provinces and territories, occasional. September 7, 2008. http://www5.statcan.gc.ca/cansim/pick–choisir?lang=eng&searchTypeByValue=1&id=1054009. Accessed April 29, 2011.

Steinberg BA, Cannon CP, Hernandez AF, et al. Medical Therapies and Invasive Treatments for Coronary Artery Disease by Body Mass: The "Obesity Paradox" in the Get With The Guidelines Database. 2007. http://www.mdconsult.com.proxy1.lib.umanitoba.ca/das/article/body/240023601–5/jorg=journal&source=MI&sp=20076510&sid=1151741631/N/613471/s0002914907014191.pdf?SEQNO=1&issn=0002–9149. Accessed April 27, 2011.

Stuart B, Lloyd J, Zhao L, Kamal–Bahl S. Obesity, disease burden, and prescription spending by community–dwelling Medicare beneficiaries. *Curr Med Res Opin.* 2008;24(8):2377–2387.

Sturm R, Wells KB. Does obesity contribute as much to morbidity as poverty or smoking? *Public Health.* 2001;115(3):229–235.

Syme SL. The prevention of disease and promotion of health: the need for a new approach. *European Journal of Public Health.* 2007;17(4):329–330.

Thompson D, Brown JB, Nichols GA, Elmer PJ, Oster G. Body mass index and future healthcare costs: a retrospective cohort study. *Obes Res.* 2001;9(3):210–218.

Tjepkema M. Adult obesity. *Health Reports.* 2006;17(3):9–25.

Torrance GM, Hooper MD, Reeder BA. Trends in overweight and obesity among adults in Canada (1970–1992): evidence from national surveys using measured height and weight. *International Journal of Obesity.* 2002;26:797–804.

Trakas K, Lawrence K, Shear NH. Utilization of health care resources by obese Canadians. *CMAJ.* 1999;160(10):1457–1462.

Tremblay MS, Perez CE, Ardern CI, Bryan SN, Katzmarzyk PT. Obesity, overweight and ethnicity. *Health Reports.* 2005;16(4):23–34.

Twells LK, Knight J, Alaghehbandan R. The relationship among body mass index, subjective reporting of chronic disease, and the use of health care services in Newfoundland and Labrador, Canada. *Popul Health Manag.* 2010;13(1):47–53.

van DL, Otters HB, Schuit AJ. Moderately overweight and obese patients in general practice: a population based survey. *BMC Fam Pract.* 2006;7:43.

von LT, Happich M, Reitmeir P, John J. Utilization of out– and inpatient health services by obese adults: a population–based study in the Augsburg region, Germany. *Gesundheitswesen.* 2005;67 Suppl 1:S150–S157.

Vorona RD, Winn MP, Babineau TW, Eng BP, Feldman HR, Ware JC. Overweight and obese patients in a primary care population report less sleep than patients with a normal body mass index. *Arch Intern Med.* 2005;165(1):25–30.

Wang FF, Schultz AB, Musich S, McDonald T, Hirschland D, Edington DW. The relationship between National Heart, Lung, and Blood Institute weight guidelines and concurrent medical costs in a manufacturing population. *American Journal of Health Promotion.* 2003;17(3):183–189.

Wang Y, Beydoun MA. The obesity epidemic in the United States—gender, age, socioeconomic, racial/ethnic, and geographic characteristics: a systematic review and meta–regression analysis. *Epidemiologic Reviews.* 2007;29:6–28.

Wareham N. Physical activity and obesity prevention. *Obes Rev.* 2007;8 Suppl 1:109–114.

Weiner JP, Starfield BH, Steinwachs DM, Mumford LM. Development and Application of a Population–Oriented Measure of Ambulatory Care Case–Mix. 1991. http://www.jstor.org.proxy1.lib.umanitoba.ca/stable/pdfplus/3766037.pdf?acceptTC=true. Accessed April 26, 2011.

White M. Food access and obesity. *Obes Rev.* 2007;8 Suppl 1:99–107.

Whitmer RA, Gunderson EP, Barrett–Connor E, Quesenberry CP, Jr., Yaffe K. Obesity in middle age and future risk of dementia: a 27 year longitudinal population based study. *BMJ.* 2005;330(7504):1360.

Wilkins K. Incident arthritis in relation to excess weight. *Health Reports.* 2004;15(1):39–49.

Wilson PWF, D'Agostino RB, Sullivan L, Parise H, Kannel WB. Overweight and obesity as determinants of cardiovascular risk—The Framingham experience. *Archives of Internal Medicine.* 2002;162(16):1867–1872.

World Health Organization. Physical status: the use and interpretation of anthropometry: a report of a WHO expert committee. 1995. http://whqlibdoc.who.int/trs/WHO_TRS_854.pdf. Accessed March 1, 2011.

Young TK. *The Manitoba Heart Health Survey: Technical Report*. Winnipeg, MB: Dept. of Community Health Sciences, Faculty of Medicine, University of Manitoba; 1991.

Zamboni M, Mazzali G, Zoico E, et al. Health consequences of obesity in the elderly: a review of four unresolved questions. *International Journal of Obesity.* 2005;29:1011–1029.

Glossary

Acronyms used in this report

ACG	Adjusted Clinical Group
AMI	Acute Myocardial Infarction
ATC	Anatomical Therapeutic Chemical
BMI	Body Mass Index
CCHS	Canadian Community Health Survey
CCI	Canadian Classification of Health Interventions
CIHI	Canadian Institute for Health Information
CI	Confidence Interval
DPIN	Drug Program Information Network
HHS	Manitoba Heart Health Survey
ICD	International Classification of Disease
IHD	Ischemic Heart Disease
MCHP	Manitoba Centre for Health Policy
NPHS	National Population Health Survey
PCH	Personal Care Home
PHAC	Public Health Agency of Canada
RHA	Regional Health Authority
RR	Relative Risk
SAS	Statistical Analysis Software
SEFI–2	Socio Economic Factor Index–Version 2
TRM	Total Respiratory Morbidity
WHO	World Health Organization

Activity Restrictions

According to the **Public Health Agency of Canada**, approximately one in eight Canadians live with some physical or mental disability. Disabilities can range from mild limitations such as back pain, to moderate limitations such as arthritis, to severe limitations such as paraplegia. Individuals living with disabilities can face challenges with their daily activities from climbing a flight of stairs to dressing and feeding themselves.

This is a derived variable from CCHS that combines a number of questions on activity restrictions. This variable is a crude measure of the impact of long–term physical conditions, mental conditions, and health problems on the principal domains of life: home, work, school, and other activities. The question was "Does a long–term physical condition or mental condition or health problem reduce the amount or the kind of activity you can do (at home, in school, at work, in other activities)?" with the available responses of sometimes, often, never, or not stated. In our analyses, the responses sometimes and often were combined to get a yes/no variable. Participants whose derived variable response was 'not stated' were excluded from analyses.

Acute Myocardial Infarction (AMI)

Also known as a heart attack, a myocardial infarction occurs when the heart muscle (the myocardium) experiences sudden (acute) deprivation of circulating blood. The interruption of blood is usually caused by narrowing of the coronary arteries leading to a blood clot. The clogging frequently is initiated by cholesterol piling up on the inner wall of the blood vessels that distribute blood to the heart muscle.

In this study, the rate of hospitalization or death due to AMI was measured for survey participants aged 40 or older at the time of the survey. Participants were considered to have experienced an AMI if they met one of the following conditions:

1) an **inpatient hospitalization** with the most responsible diagnosis of AMI: ICD–9–CM code 410, ICD–10–CA code I21, and a length of stay of three or more days (unless the patient died in hospital)

2) a death with AMI listed as the primary cause of death on the **Vital Statistics** death record (ICD codes as above)

Persons discharged alive from hospital after less than three days were excluded as likely "rule out" AMI cases.

Incidence rates of AMI were measured per 100 person–years after survey. Individuals who had a hospitalization for an AMI prior to their survey date were still eligible to be included in the incidence rates calculations after survey date as individuals can experience multiple heart attacks in their lifetime. Rates were weighted to the Manitoba population and adjusted for age, sex, BMI, and **smoking** status as reported by survey participants in a generalized linear model. **Variance** was estimated via bootstrapping.

Adjusted Clinical Group (ACG) System – see Johns Hopkins Adjusted Clinical Group (ACG) System

Adjusted Rates

These rates mathematically remove the effects of different population structures that influence overall rates. Also called Rate Standardization or Standardized Rates.

Adjusted rates are estimates of what an area's rate might have been, if that area's age and sex distribution was the same as that for the province overall. This adjustment is done to ensure that rates for different areas can be fairly compared—knowing that the demographic profile of the two areas is not affecting the comparison. Adjusted rates allow comparisons of rates across areas or groups (such as the BMI categories in this study) by removing the effects of demographic differences.

Administrative Data

Refers to information collected "usually by government, for some administrative purpose (e.g., keeping track of the population eligible for certain benefits, paying doctors or hospitals), but not primarily for research or surveillance purposes" (Spasoff, 1999). MCHP's research uses administrative data from hospital discharge summaries, physician billing claims, claims for prescription drugs, and other health related data. Using these data, researchers can study the utilization of health resources over time and the variations in rates within and across the provinces.

Admission to Personal Care Home (PCH) – see Personal Care Home Admissions

Age–adjusted – see Adjusted Rate

Ambulatory Visits

Almost all contacts with physicians: office visits, walk–in clinics, home visits, personal care home (nursing home) visits, visits to **outpatient departments**, some emergency room visits (where data are recorded), and in northern/remote nursing stations. Services provided to patients while admitted to hospital and most visits for prenatal care are excluded.

Anatomical Therapeutic Chemical (ATC) Drug Classification System

A drug classification system widely used in Europe and for research purposes. The drugs are divided into different groups at five levels according to the organ or system on which they act and/or therapeutic and chemical characteristics:

1. anatomical group
2. therapeutic main group
3. therapeutic/pharmacological subgroup
4. chemical/therapeutic/pharmacological subgroup
5. subgroup for chemical substance

ATC classifications are available online from the World Health Organization (WHO), and are updated and published once a year by the W.H.O. Collaborating Centre for Drug Statistics Methodology. See the WHO online ATC/DDD Index: http://www.whocc.no/atc_ddd_index.

The ATC system is becoming more common in Canada, and the ATC classification is a component of the Health Canada Drug Product Database (World Health Organization (WHO), 1996). See the Health Canada Web Site on the Drug Product Database (DPD): http://www.hc–sc.gc.ca/dhp–mps/prodpharma/databasdon/index–eng.php for more information.

Angioplasty

A procedure (technically called a 'percutaneous transluminal coronary angioplasty') that uses a balloon–tipped catheter to enlarge a narrowing in a coronary artery. If necessary, a **stent** is inserted permanently into the artery to help hold it open so that blood can flow through it more easily.

Asthma

A disease in which inflammation of the airways restricts airflow into and out of the lungs.

Balloon Angioplasty – see Angioplasty

Binge Drinking

Binge drinking is commonly defined in the social sciences as having five or more alcoholic drinks on one occasion. According to Health Canada, binge drinking is linked to motor vehicle accidents, Fetal Alcohol Spectrum Disorder and other health issues, family problems, crime and violence. In the **Canadian Community Health Survey (CCHS)**, one drink was defined as: one bottle or can of beer or a glass of draft, one glass of wine or a wine cooler, or one drink or cocktail with 1 and 1/2 ounces of liquor.

In the CCHS, participants were asked, "During the past 12 months, have you had a drink of beer, wine, liquor or any other alcoholic beverage?" Those who did not answer 'No' were then asked, "How often in the past 12 months have you had five or more drinks on one occasion?" Possible responses include never, less than once a month, once a month, 2 to 3 times a month, once a week, more than once a week, *don't know*, not stated or refusal to answer.

In this report, the term 'frequent binge drinking' indicates that the participant reported consuming five or more alcoholic drinks on one occasion at least once per month.

Body Mass Index (BMI)

A statistical measure used to classify and compare individuals according to their height and weight. BMI is calculated as weight (in kilograms) divided by height (in metres) squared and, typically, ranges from 15 to 45.

Bootstrap Method

A technique for estimating the **variance** and the bias of an estimator by repeatedly drawing random samples with replacement from the observations at hand. One applies the estimator to each sample drawn, thus obtaining a set of estimates. The observed variance of this set is the bootstrap estimate of variance. The difference between the average of the set of estimates and the original estimate is the bootstrap estimate of bias (Last, 1995).

Breastfeeding Initiation

The time at when a mother begins to feed her infant milk from her breast. It is identified as any live born newborn hospitalization (ICD–9–CM codes V30–V39 or ICD–10–CA code Z38) that indicates partial or exclusive breastfeeding initiation on the hospital discharge abstract.

In this study, stillborn infants and infants with missing breastfeeding codes were excluded.

Bronchitis

Inflammation of the bronchial tubes.

Bypass surgery

Surgical procedure that reroutes blood around a blocked coronary artery using a healthy blood vessel from another part of the body, thereby improving oxygen and blood flow to the heart.

Canadian Classification of Health Interventions (CCI)

A classification system for coding health care procedures in Canada, used in companion with the International Classification of Diseases, version 10, with Canadian Enhancements (ICD–10–CA).

Canadian Community Health Survey (CCHS)

An annual survey (biennial until 2007) survey conducted by **Statistics Canada** to provide regular and timely cross–sectional estimates of health determinants, health status, and health system utilization for 136 health regions in Canada, including the territories. In Manitoba, survey participants were sampled from 11 different regions. Participants for most surveys were 12 years of age and older; the sampling methodology was designed to ensure over–representation of youth under 19 years of age and seniors 65 years of age and older. The survey excludes populations living in Indian Reserves, on Canadian Forces Bases, in some remote areas, and those not living in households.

Cancer

An abnormal growth of cells which tend to proliferate in an uncontrolled way, and in some cases, to metastasize (spread). Cancer can involve any tissue of the body and have many different forms in each body area. Most cancers are named for the type of cell or organ in which they start.

Cardiac Catheterization

The most accurate method for evaluating and defining **ischemic heart disease** (IHD), also known as coronary artery disease (CAD). Cardiac catheterization is used to identify the location and severity of CAD. During cardiac catheterization, a small catheter (a thin hollow tube with a diameter of 2–3 mm) is inserted through the skin into an artery in the groin or the arm. Guided with the assistance of a fluoroscope (a special x–ray viewing instrument), the catheter is then advanced to the opening of the coronary arteries, the vessels supplying blood to the heart. When the catheter is used to inject radiographic contrast (a solution containing iodine, which is easily visualized with x–ray images) into each coronary artery, the cardiac catheterization is termed coronary angiography. The images that are produced are called the angiogram, which shows the extent and severity of blockages in coronary arteries.

In this study, we calculated the number of cardiac catheterizations performed per 1,000 survey participants age 40 or older up to three years after their survey date. Cardiac catheterizations were defined by hospitalizations with ICD–9–CM procedure codes 37.21–37.23, or 88.52–88.57, or CCI code 3.IP.10 in any procedure field. Rates were weighted to the Manitoba population and adjusted for age, sex, and BMI group. Cardiac catheterizations were only performed at the two **tertiary hospitals** (Health Sciences Centre and St Boniface General Hospital), so only **hospital separations** from those two hospitals were included in the analysis, in order to eliminate the potential for double–counting of procedures.

Cardiac Revascularization

This indicator combines the rates of three procedures: balloon **angioplasty**, **cardiac stent insertion**, and cardiac **bypass surgery** (though virtually all angioplasties are now accompanied by a stent insertion).

In this study, we calculated the number of hospitalizations in which at least one cardiac revascularization procedure was performed, including angioplasty, stent insertion, and cardiac bypass surgery graft (CABG), per 1,000 survey participants, up to five years after their survey date. Cardiac revascularization surgeries were defined by hospitalizations with ICD–9–CM codes 36.01, 36.02, 36.05, 36.06, 36.10–36.14 and 36.19 or CCI codes 1.IJ.50, 1.IJ.57 and 1.IJ.76 in any procedure field. Rates were weighted to the Manitoba population and adjusted for age, sex, and BMI group.

These procedures were only performed at the two **tertiary hospitals** (Health Sciences Centre and St Boniface General Hospital), so only **hospital separations** from those two hospitals were included in the analysis, in order to eliminate the potential for double–counting of procedures.

Census

An official count of a population, often including demographic information such as age, sex, employment, and income. **Statistics Canada** conducts a Census every five years. It takes account of all persons living in Canada, including any individuals residing in Canada on a temporary basis. The Census also includes Canadians abroad on military missions or on merchant vessels that are registered in Canada (Statistics Canada, 2006).

Cholecystectomy

The surgical removal of a gallbladder, which is done if it is inflamed, blocked, filled with gallstones, or cancerous. It can be done through an abdominal incision (open cholecystectomy) or through smaller incisions using a small video camera on a tube called a laparoscope (laparoscopic cholecystectomy).

In this study, we calculated the number of cholecystectomies performed, per 1,000 survey participants, up to three years after their survey date. Cholecystectomies were defined by hospitalizations with ICD–9–CM codes 51.21–51.24 or CCI codes 1.OD.57, 1.OD.89 and 1.OA.87 (with location code = right extended) in any procedure field. Rates were weighted to the Manitoba population and adjusted for age, sex, and BMI group.

Chronic Disease

Conditions that are generally incurable, are often caused by a complex interaction of factors, and usually have a prolonged clinical course.

Community Areas (CAs) – see Winnipeg Community Areas

Confidence Interval (CI)

The computed interval with a given probability that the true value of a variable (e.g., a mean or rate) is contained within the interval. For example, a 95% CI would have a 95% probability of containing the true population value.

Cox Proportional Hazards Regression Analysis

A regression model for analyzing the effect of several risk factors on survival. The probability of the endpoint (e.g., death) is called the hazard. This model assumes that the effects of the predictor variables are constant over time. Source: http://www.medcalc.org/manual/cox_proportional_hazards.php

Cross–sectional Survey

A study that examines the relationship between diseases (or other health–related characteristics) and other variables of interest as they exist in a defined population at one point in time. The presence or absence of disease and the presence or absence of the other variables (or, if they are quantitative, their level) are determined in each member of the study population or in a representative sample at one particular time. The temporal sequence of cause and effect cannot necessarily be determined in a cross–sectional study. Consequently, disease **prevalence** rather than **incidence** is normally recorded in a cross–sectional study.

Crude Rates

The number of events in a given population over a certain period of time. In epidemiology, crude rates are helpful in determining the burden of disease and/or number of residents with that condition or procedure. These rate could potentially be affected by the age and sex distribution of an area; hence in our study, as much as possible, we report **adjusted rates** to allow fair comparisons between areas.

C–statistic

The probability that predicting the outcome is better than chance. Used to compare the goodness of fit of **logistic regression** models, values for this measure range from 0.5 to 1.0. A value of 0.5 indicates that the model is no better than chance at making a prediction of membership in a group and a value of 1.0 indicates that the model perfectly identifies those within a group and those not. Models are typically considered reasonable when the C–statistic is higher than 0.7 and strong when C exceeds 0.8 (Hosmer & Lemeshow, 2000)(Hosmer & Lemeshow, 1989)

Current Smoker – see Smoking

Days of Home Care Service Received – see Home Care, Days of Service Received

Diabetes

A chronic condition in which the pancreas no longer produces enough insulin (Type I Diabetes) or when cells stop responding to the insulin that is produced (Type II Diabetes), so that glucose in the blood cannot be absorbed into the cells of the body. The most common endocrine disorder, Diabetes Mellitus affects many organs and body functions, especially those involved in metabolism, and can cause serious health complications including renal failure, heart disease, **stroke**, and blindness. Symptoms include frequent urination, fatigue, excessive thirst, and hunger. Also called insulin–dependent diabetes, Type 1 Diabetes begins most commonly in childhood or adolescence and is controlled by regular insulin injections. The more common form of diabetes, Type II, can usually be controlled with diet and oral medication. Another form of diabetes called gestational diabetes can develop during pregnancy and generally resolves after the baby is delivered.

Type I and Type II diabetes could not be distinguished in the data used for this analysis, so this indicator combines both types.

In this study, diabetes **incidence** and **prevalence** were measured for survey participants aged 18 or older at the time of survey completion. Participants were considered to have diabetes if they met one of the following conditions:

1) one or more hospitalizations in three years with a diagnosis of diabetes: ICD–9–CM code 250, ICD–10–CA codes E10–E14

2) two or more **physician visits** in three years with a diagnosis of diabetes (ICD–9–CM codes as above)

3) one or more prescriptions in three years for medications to treat diabetes (listed in Appendix 3)

Note that for participants of the **Manitoba Heart Heatlh Survey (HHS)** who were surveyed in 1989–1990, there is no prescription data available as the **DPIN** database is available in MCHP's **Population Health Research Data Repository** only from 1995 onwards. Thus, for HHS participants, only conditions 1) and 2) above were used to define diabetes.

Diabetes prevalence was measured in the three years before survey date and incidence rates were measured per 100 person–years after survey. Individuals whose first confirmed date of diabetes (as defined above) in the 10 years before their survey date were excluded from incidence calculations as they were not eligible to be a new case. Both measures were weighted to the Manitoba population and adjusted for age, sex, and BMI in a **generalized linear model**.

Dialysis Initiation

Dialysis is a treatment for people in the end stage of chronic renal insufficiency (kidney failure). This treatment cleans the blood and removes wastes and excess water from the body.

Drug Program Information Network (DPIN)

An electronic, on–line, point–of–sale drug database. It links all community pharmacies (but not pharmacies in hospitals or nursing homes/**personal care homes**) and captures information about all Manitoba residents, including most prescriptions dispensed to status Indians. DPIN contains information such as unique patient identification, age, birthdate, sex, medication history, over–the–counter medication history, patient postal code, new drugs prescribed, date dispensed, and unique pharmacy identification number. DPIN is maintained by the Government of Manitoba's Ministry of Health.

NOTE: In the Health Inequities deliverable (Martens et al., 2010), it was reported that up to the year 2005 northern First Nations community pharmaceutical data may be missing due to lack of prescription data being entered into the DPIN system. However, as of 2005 to the present, prescriptions for First Nations communities are dispensed through a private pharmaceutical company that reports all prescriptions through DPIN.

Eat Fruits or Vegetables Five or More Times/Day

Canada's Food Guide recommends that children should eat 4–6 servings of fruits or vegetables daily, and teenagers and adults should eat 7–8 servings of fruits or vegetables daily as part of a healthy diet. One serving means ½ cup of fresh, frozen, or canned fruits or vegetables; 1 piece of fruit; or ½ cup of fruit juice. Canada's Food Guide states that the benefits to eating well include better overall health, looking and feeling better, lower risk of disease, more energy, a healthy body weight, and stronger muscles and bones.

In the **Canadian Community Health Survey (CCHS)**, the total daily consumption of fruits and vegetables is a derived variable that indicates the total number of times per day the participant eats fruits and vegetables (i.e., not the number of servings eaten). Participants are asked a series of questions regarding their dietary practices, such as "How often do you usually eat potatoes, not including French fries, fried potatoes, or potato chips?" and the total daily consumption of fruits and vegetables is determined based on the participant's answers. Possible responses include less than 5 times/servings per day, 5 to 10 times/servings per day, more than 10 times/servings per day, or not stated.

In this study, participants were grouped into two categories based on the number of times they consumed fruits or vegetables: five or more times per day versus fewer than five times per day.

Emphysema

A condition of the lung in which the air sacs are damaged, resulting in difficulty breathing.

Energy Expenditure

A measure of physical activity in the **Canadian Community Health Survey (CCHS)**, it is calculated using the frequency and duration per session of the physical activity as well as the metabolic equivalent (MET) value of the activity. Energy expenditure is expressed as the average kilocalories expended per kilogram of body weight per day. The MET is a value of metabolic energy cost expressed as a multiple of the resting metabolic rate. For example, an activity of 4 METS requires four times the amount of energy as compared to when the body is at rest. The energy expenditure is calculated by multiplying the length of time (in hours) an individual spent doing an activity by the MET value for that activity. For example, if an individual goes cycling daily for two hours on average, and bicycling has a MET value of 4, their energy expenditure would be 8 kcal/kg/day.

Food Insecurity

The inability to have access to an adequate supply of food or the fear that one may soon have an inadequate food supply. It can arise due to poverty or natural or man–made disasters. Individuals do not have to be starving to be food insecure, simply living with hunger or the fear that you may have to go hungry would classify someone as food insecure.

In the **Canadian Community Health Survey (CCHS)**, household food security status is a derived variable that indicates whether a participant feels that all members of their household have access to an adequate supply of food or not, both currently and in the future. Participants were ask a variety of questions about their food security status, such as, "In the past 12 months, did you or other adults in your household ever cut the size of your meals or skip meals because there wasn't enough money for food?" Participants were categorized as food secure, food insecure without hunger, food insecure with moderate hunger, food insecure with extreme hunger, or not stated.

In this study, participants were grouped as either food insecure (including "food insecure without hunger", "food insecure with moderate hunger", "food insecure with extreme hunger") or food secure.

Frequent Binge Drinking – see Binge Drinking

Generalized Linear Model (GLM)

A unified class of models for regression analysis of independent observations of a discrete or continuous response. A characteristic feature of generalized linear models (GLMs) is that a suitable non–linear transformation of the mean response is a linear function of the covariates. GLMs provide a unified method for analyzing diverse types of univariate responses (e.g., continuous, binary, counts).

Genitourinary

Also known as urogenital, a term describing both the genital (reproductive) and urinary organ systems.

Gestational Age

The age of a newborn infant, approximated from the first day of the woman's last menstrual period to birth and is often reported in weeks of gestation. The average gestational age of a newborn is 37 weeks.

Heart Attack – see Acute Myocardial Infarction

Home Care

Health services provided free–of–charge to residents of all ages within their own homes based on assessed need and taking into account other resources available to the individual including families, community resources, and other programs. Reassessments at pre–determined intervals are the basis for decisions by case managers to discharge individuals from the program or to change the type or amount of service delivered.

The Manitoba Home Care Program, established in 1974, is the oldest comprehensive, province–wide, universal home care program in Canada.

The types of services available through this Program include: personal care assistance, home support, health care, family relief, respite care, and supplies and equipment provided to individuals within their own home.

Home Care, Days of Service Received

In this study, this was calculated as the average length (in days) of all **home care** cases open in a three–year period (values shown are the annual average for a three–year period). A home care client may have more than one case in a period. Each would be counted as a separate case with a separate length.

For residents with at least one home care case, days in home care were counted for each case open in the fiscal year (April 1–March 31). If the case was open prior to the start of the fiscal year, the case was assigned April 1st as its start date; and similarly, if the case was not closed prior to the end of the fiscal year, the case was assigned March 31st as its end date so that the maximum number of days for a home care case would be 365 days within a fiscal year.

Home Care Prevalence

The percentage of the population with at least one open **home care** case in a three–year period.

Use of home care outside of Winnipeg was identified from the Manitoba Support Services Payroll (MSSP) system. Within Winnipeg home care was identified using the Winnipeg **Regional Health Authority** MDS–Home Care database. In cases where individuals were found in both the MSSP and MDS data, the MDS data was used.

In this study, we calculated the percentage of survey participants with an open home care case for at least one day in the three years after their survey date. Rates were weighted to the Manitoba population and adjusted for age, sex, and BMI group.

Hospital Separations

A separation from a health care facility occurs anytime a patient (or resident) leaves because of death, discharge, sign–out against medical advice, or transfer. The number of separations is the most commonly used measure of the utilization of hospital services. Separations, rather than admissions, are used because hospital abstracts for inpatient care are based on information gathered at the time of discharge. In some cases, both inpatient and surgical outpatient records are included. In addition, hospital separations may not include newborn separations, since this would essentially result in a double counting (the mother and the baby being discharged).

In this study, we calculated the total number of inpatient hospital separations per 1,000 survey participants in the year after their survey date. **Inpatient hospitalizations** are hospital stays in which patients are admitted to hospital for at least one day. Rates were weighted to the Manitoba population and adjusted for age, sex, and BMI. All Manitoba hospitals were included; **personal care homes (PCH),** long–term care facilities (Riverview, Deer Lodge, Rehabilitation Centre for Children and Manitoba Adolescent Treatment Centre) were excluded, as were newborns (birth) and obstetric hospitalizations.

Hypertension

Often referred to as high blood pressure. The "tension" in hypertension describes the vascular tone of the smooth muscles in the artery and arteriole walls. Hypertension is a major health problem, especially because it often has no symptoms. If left untreated, hypertension can lead to heart attack, **stroke**, enlarged heart, or kidney damage.

In this study, hypertension **incidence** and **prevalence** were measured for survey participants aged 18 or older at the time of survey. Participants were considered to have hypertension if they met one of the following conditions:

1) one or more hospitalizations in one year with a diagnosis of hypertension: ICD–9–CM codes 401–405; ICD–10–CA codes I10–I13, I15

2) one or more **physician visits** in one year with a diagnosis of hypertension (ICD–9–CM codes as above)

3) two or more prescriptions in one year for medications to treat hypertension (listed in Appendix 3)

Note that for participants of the **Manitoba Heart Health Survey (HHS)** who were surveyed in 1989–1990, there is no prescription data available as the DPIN database is available in the MCHP Repository from 1995 onwards. Thus, in this study, the definition for these individuals the following definition was used:

1) one or more hospitalizations in three years with a diagnosis of hypertension (ICD–9–CM codes as above)

2) one or more physician visits in three years with a diagnosis of hypertension (ICD–9–CM codes as above)

Hypertension prevalence was measured in the year before survey date (three years for HHS participants) and incidence rates were measured per 100 person–years after survey. Individuals whose first confirmed date of hypertension (meeting one of the definition criteria above) in the 10 years before their survey date were excluded from incidence calculations as they were not eligible to be a new case. Both measures were weighted to the Manitoba population and adjusted for age, sex, and BMI in a generalized linear model. **Variance** was estimated via bootstrapping.

Incidence

The number of new cases of a specific disease/condition/event over a specified time period. The incidence rate uses new cases in the numerator; individuals with a history of the disease/condition are not included. The denominator for incidence rates is the population at risk.

Inpatient Hospital Days Used

The number of days spent in 'inpatient' care in hospitals. This is distinct from the **inpatient hospitalization** rate because hospitalizations vary significantly in their length of stay. Multiple admissions of the same person are counted as separate events, and all days are summed together.

In this study, we calculated the number of inpatient hospital days used, per 1,000 survey participants in the year after their survey date. If a resident had more than one hospitalization in the year, then the days used in all hospitalizations were summed. Each hospitalization was limited to 365 days maximum length of stay. Hospitalizations in long–term care facilities were excluded (e.g., Deer Lodge and Riverview). Rates were weighted to the Manitoba population and adjusted for age, sex, and BMI.

Inpatient Hospitalization

Hospital stays in which patients are admitted to hospital for at least one day.

International Classification of Disease (ICD)

A classification system of diseases, health conditions, and procedures developed by the World Health Organization (WHO), which represents the international standard for the labeling and numeric coding of diseases and health related problems. Within this system, all diseases/conditions are assigned numbers in hierarchical order. There are several versions of the ICD coding system, including ICD–8, ICD–9, ICD–9–CM (Clinical Modifications), ICD–O (Oncology), ICD–10, and ICD–10–CA (Canadian Enhancements).

Ischemic Heart Disease (IHD)

Ischemia is a condition in which the blood flow (and thus oxygen) is restricted to a part of the body. Cardiac ischemia is the name for lack of blood flow and oxygen to the heart muscle. Thus, the term 'ischemic heart disease' refers to heart problems caused by narrowed heart arteries. When arteries are narrowed, less blood and oxygen reaches the heart muscle. This is also called coronary artery disease and coronary heart disease. It can ultimately lead to heart attack.

In this study, IHD **incidence** was measured for survey participants aged 18 or older at the time of survey. Participants were considered to have IHD if they met one of the following conditions:

1) one or more hospitalizations in five years with a diagnosis of IHD: ICD–9–CM codes 410–414; ICD–10–CA codes I20–I22, I24, I25

2) two or more **physician visits** in five years with a diagnosis of IHD (ICD–9–CM codes as above)

3) one physician visit with a diagnosis of IHD (ICD–9–CM codes as above) and two or more prescriptions for medications to treat IHD (listed in Appendix 3) in five years

Note that for **Manitoba Heart Health Survey (HHS)** participants who were surveyed in 1989–1990, there is no prescription data available as the DPIN database is available in the MCHP Repository from 1995 onwards. Thus, for these individuals only conditions 1) and 2) above were used to define IHD.

IHD incidence rates were measured per 100 person–years after survey. Individuals whose first confirmed date of IHD (meeting one of the definition criteria above) in the 10 years before their survey date were excluded from incidence calculations as they were not eligible to be a new case. Rates were weighted to the Manitoba population and adjusted for age, sex, BMI, and **smoking** status as reported by survey participants in a generalized linear model. **Variance** was estimated via bootstrapping.

Johns Hopkins Adjusted Clinical Group (ACG) System

A risk adjustment tool developed to measure the illness burden (**morbidity**) of individual patients and enrolled populations. This system quantifies morbidity by grouping individuals based on their age, gender and all known medical diagnoses assigned by their health care providers over a defined time period (typically one year).

Joint Replacement Surgery – see also Total Hip Replacement and Total Knee Replacement

Surgery to provide total replacement of hip or knee joints.

In this study, we calculated the number of **total hip** and **total knee replacements** performed, per 1,000 survey participants aged 40 or older, up to five years after their survey date. Rates were weighted to the Manitoba population and adjusted for age, sex, and BMI group.

Level of Care on Admission to a PCH

This indicator measures the distribution of levels of care assigned to PCH residents at the time of their admission. Level 1 represents the lowest level of need, and Level 4 represents the highest.

Linear Regression

Regression analysis is a statistical approach that looks to find the best mathematical model to describe *y* (a dependent variable) as a function of *x* (an independent variable), or to predict *y* from *x*. In linear regression, the data is analyzed using linear models in which *y* is assumed to equal *a* + *bx*, where *a* and *b* are constants (Last, 1995).

Logistic Regression

The regression technique used when the outcome is a binary, or dichotomous, variable. **Logistic regression** models the probability of an event as a function of other factors. Note that these models are only able to state that there is a relationship ("association") between the explanatory and the outcome variables. This is not necessarily a causal relationship. The explanatory variable may be associated with an increase or decrease (not that it caused the increase or decrease).

Made Changes to Improve Health

In the **Canadian Community Health Survey (CCHS)** survey, participants were asked the question, "In the past 12 months, did you do anything to improve your health? (For example, lost weight, quit **smoking**, increased exercise)." Available answers were yes, no, or *don't know*.

In this study, this variable describes whether the participant had made changes to improve their health in the past 12 months or not.

Manitoba Heart Health Survey (HHS)

A cross–sectional survey of a representative sample of non–institutionalized Manitoba residents (including First Nation community residents) between the ages of 18 and 74 years. It was conducted as a part of the Canadian Heart Health Initiative to estimate the prevalence of cardiovascular risk factors and to ascertain the level of cardiovascular–related knowledge among Canadians. Sociodemographic information, chronic disease history, measures of hypertension, and cardiovascular risk factors were collected via an interviewer–administered questionnaires and clinic visits.

Mortality Rate

The rate of death from all causes. It is used as an indication of the overall health of the population, similar to what is measured by life expectancy.

In this study, we calculated the number of deaths among survey participants per 1,000 person–years. Participants were followed from survey date until: a) death, b) loss to follow–up, or c) March 31, 2009. Rates were weighted to the Manitoba population and adjusted for age, sex, and **body mass index (BMI)**.

Multi–collinearity

"In multiple regression analysis, a situation in which at least some of the independent variables are highly correlated with each other" (Last, 1995). This can result in inaccurate estimates of the parameters in the model.

Multiple Imputation

A technique used to overcome the problem of missing data, which increases statistical power for finding associations without artificially reducing the variation in the data. Multiple imputation does not simply insert a value for each missing data point or replace it with the mean of the other data points. Rather, it creates a set of imputed values for the missing data in a way that ensures that the **variance**/covariance structure present within the collected data remains the same.

Multiple imputation can be used to overcome the problem of missing data for some questions in some surveys, for example, if a certain question was asked in most but not all survey waves.

Multiple Linear Regression

An extension of **linear regression** whereby the relationship between two or more explanatory variables and a continuous outcome variable can be described.

Multivariate Model

A statistical model that studies the variation in several variables simultaneously (Last, 1995).

Musculoskeletal

The organ system comprised of bones, muscles, joints, ligaments, and tendons that enable the body to move and keep its form.

National Population Health Survey (NPHS)

The NPHS, administered by **Statistics Canada**, collects sample information related to the health of the Canadian population and related socio–demographic information. It is composed of three components: the Households, the Health Institutions, and the **North** components. The survey excludes populations living in Indian Reserves, on Canadian Forces Bases, and in some remote areas. In 2000, the NPHS was replaced with the **Canadian Community Health Survey (CCHS)**.

Neighbourhood Clusters

Aggregate geographies of neighborhoods within Winnipeg defined based on population and natural community boundaries (census divisions). Twenty–three of the neighborhood clusters are within the boundaries of the City of Winnipeg; two additional divisions are (East and West St. Paul) just outside the city boundaries.

North

An aggregate geography area, co–developed by MCHP and ***The Need to Know* Team** for use in MCHP research, which includes all of the **Regional Health Authorities (RHAs)** in northern Manitoba: Burntwood, NOR–MAN, and Churchill.

Number of Different Types of Prescription Drugs Used

The average number of different types of drugs prescribed to each resident who had at least one prescription in the year. Each pharmaceutical agent that falls under a different fourth–level **Anatomical Therapeutic Chemical (ATC) class** is counted as a new drug for each resident. This level essentially separates drugs used for different health problems. A person could have several prescriptions for one particular drug in the same 4th level ATC class, but this would only count as one drug type in that year.

In this study, the average number of different types of drugs dispensed was measured for each survey participant who had at least one prescription in the year after their survey date. Rates were weighted to the Manitoba population and adjusted for age, sex, and BMI.

Odds Ratio

The ratio of the odds of an event occurring in one group to the odds of it occurring in another group or to a data–based estimate of that ratio. These groups might be men and women, an experimental group and a control group, or any other dichotomous classification.

Osteoporosis

A disease that leads to a reduction in bone density, which causes the bones to become weak and more likely to break.

Personal Care Homes (PCH)

Residential facilities for predominantly older persons with chronic illness or disability, also known as nursing homes. They may be proprietary (for profit) or non–proprietary. Non–proprietary PCHs may further be classified as secular or ethno–cultural (associated with a particular religious faith or language other than English) as well as either freestanding or juxtaposed with an acute care facility. In order to be admitted to a PCH, an application form must be completed and reviewed by a panel which determines whether the person requires admission.

Personal Care Home (PCH) Admissions

In this study, we calculated the percentage of survey participants aged 75 and older who were admitted to a PCH in the three years after their survey date. Area of residence was assigned based on where people lived at the time they were surveyed. Rates were weighted to the Manitoba population and adjusted for age, sex, and BMI group.

Physical Activity–Leisure and Travel

In the **Canadian Community Health Survey (CCHS)**, physical activity levels during leisure and travel–related physical activity is a derived variable for survey participants based on their average daily **energy expenditure** values (kcal/kg/day) calculated from a series of questions on physical activity. It includes physical activity for travel, such as biking or walking to school or work, and leisure time physical activity, such as walking, running, gardening, soccer, by the participant in the past three months. Participants were asked questions such as, "In the past 3 months, how many times did you walk for exercise? About how much time did you spend on each occasion?"

In this study, participants were grouped into three categories based on their average daily energy expenditure: active (3 or more metabolic equivalent values or METs), moderate (1.5 to less than 3 METs), or inactive (0 to less than 1.5 METs). These categories follow the same criteria used to categorize individuals in the Ontario Health Survey (OHS) and in the Campbell's Survey on Well Being.

Physical Activity–Occupational

In the **Canadian Community Health Survey (CCHS)**, physical activity levels during occupational activities is a derived variable for survey participants based on their average daily **energy expenditure** values (kcal/kg/day) calculated from participants usual daily activities or occupational–related physical activity in the past 3 months. Participants were asked, "Thinking back over the past 3 months, which of the following best describes your usual daily activities or work habits (usually sit, stand or walk quite a lot, usually lift or carry light loads, do heavy work or carry very heavy loads)?" Individuals were assigned the following metabolic equivalent (MET) values for their usual daily activities: 1.5 for "usually sit", 2.5 METs for "stand or sit quite a lot", 5.0 METs for "usually lift or carry light loads", and 7.0 METs for "do heavy work or carry very heavy loads."

In this study, participants were grouped into three categories based on their average daily energy expenditure: active (25 METs or more), moderate (12.8571 to less than 25 METs), or inactive (0 to less than 12.8571 METs). These indices are based on provincial average MET values divided into three roughly equal–sized groups.

Physician Claims

Claims (billings) for payment submitted to the provincial government by individual physicians for services they provide. Fee–for–service physicians receive payment based on these claims; while physicians who are salaried, sessional, or hired on contract submit claims for administrative purposes only (sometimes referred to as "shadow billing"). The physician claims are collected and stored in the Medical Services Database, which is part of the **Population Health Research Data Repository**.

Physician Visits – see Ambulatory Visits

Poisson Regression

Regression analyses for data that follow a Poisson distribution, which has the assumption that the mean of an outcome is equal to its **variance**. Poisson regression is often the best choice for modelling counts of rare events, such as death.

Population Health Research Data Repository (Repository)

A comprehensive collection of administrative, registry, survey, and other databases primarily comprised of residents of Manitoba that is housed at the Manitoba Centre for Health Policy. It was developed to describe and explain patterns of health care and profiles of health and illness, which facilitates inter–sectoral research in areas such as health care, education, and social services. The administrative health database, for example, holds records for virtually all contacts with the provincial health care system, the Manitoba Health Services Insurance Plan (including physicians, hospitals, personal care homes, home care, and pharmaceutical prescriptions) of all registered individuals.

Premature Mortality Rate

The rate of deaths of residents aged 0-74 years, per 1,000 residents aged 0 to 74 years. The values are standardized to account for age/sex differences in populations. The rate is usually expressed as a number per thousand, in order to provide an indicator that is comparable among different areas or regions. **Premature mortality rates** are often used as an overall indicator of population health and are correlated with other commonly used measures. The PMR is an important indicator of the general health of a population; a high PMR indicates poor health status.

Prevalence

The proportion of the population that "has" a given disease at a given time. The **administrative data** used for this study do not directly indicate who has a disease, but rather who received health services treatment for that disease; that is, they received some combination of **physician visits**, hospitalizations, or prescription drugs.

Protective Factors

Those things that help individuals contend more effectively with **risk factors** and adverse health events. They enhance the current and future resiliency of an individual and are important to healthy development.

Quintile

The unit obtained by dividing something into five equal groups.

Region of Residence

The region of residence is the area where people live at any given point in time and where their health service use is allocated, regardless of where the service was provided. Regions can be assigned based on municipal code or postal code.

Regional Health Authorities (RHA)

Regional governance structure set up by the province to be responsible for the delivery and administration of health services in specified areas. In Manitoba, as of July 1, 2002, there are 11 RHAs: Winnipeg, Brandon, South Eastman, Assiniboine, Central, Parkland, North Eastman, Interlake, Burntwood, NOR–MAN, and Churchill.

Relative Risk (RR)

In epidemiology, the ratio of the risk of disease or death among the group exposed (to the risk) to the risk among the unexposed group.

In this study, relative risk was used to compare **incidence** rates and/or **prevalence** values for various **chronic diseases** and uses of health services of the Normal, Overweight, and Obese groups.

Respiratory Disease – see Total Respiratory Morbidity

Rural Mid

An aggregate geography, co–developed by MCHP and ***The Need to Know*** **Team** for use in MCHP research, which includes all of the **Regional Health Authorities (RHAs)** in central Manitoba: Interlake, North Eastman, and Parkland.

Rural South

An aggregate geography area, co–developed by MCHP and ***The Need to Know*** **Team** for use in MCHP research, which includes all of the **Regional Health Authorities (RHAs)** in the south and the **mid**–province of Manitoba except the two **urban** centres of Winnipeg and Brandon. The RHAs included are: South Eastman, Central, and Assiniboine.

Sample Weight

A statistical correction factor that adjusts for sampling bias due to over– or under–representation of certain segments of a population. Using these weights ensures that all estimates can be considered representative of the entire population.

The principle behind estimation in a probability sample such as the **Canadian Community Health Survey (CCHS)** is that in addition to "representing" themselves, each person in the sample also represents several other people who are not in the sample. For example, in a simple random 2% sample of the population, each person in the sample represents 50 people in the population. Thus, it can be said that each person has a weight of 50.

Satisfaction with Life

A measure of an individual's perceived level of well–being and happiness and has been shown to be positively correlated with health status.

In the **Canadian Community Health Survey (CCHS)** , participants were asked: "How satisfied are you with your life in general: Very satisfied, Satisfied, Neither satisfied nor dissatisfied, Dissatisfied, or Very dissatisfied?" Other possible responses include *don't know, not stated*, or *refusal to answer*.

In this study, participants were categorized as either "Very Satisfied", or not (includes "satisfied", neither satisfied nor dissatisfied", "dissatisfied", or "very dissatisfied").

Sedentary Activities

Activities that require a person to sit or stand for an extended period of time (e.g., watching television or movies, playing video games, reading, working at a computer). Leading a sedentary lifestyle, without regularly engaging in physical activity, can contribute to obesity and be a risk factor for other health concerns.

In the **Canadian Community Health Survey (CCHS)**, the estimated total number of hours engaged in sedentary activities in a typical week is a derived variable based on participants' responses to questions about their activities outside of school or work in the past 3 months. Participants were asked questions such as, "In a typical week in the past 3 months, how much time did you usually spend watching television or videos?"

Self–Perceived Life Stress

Stress is an emotional and/or physical response by the body to any situation or thought that causes a disparity in a person's usual biological, psychological, or social systems. Stressful events can be positive, such as receiving a promotion, or negative, such as the death of family member. Some stress is normal part of life. Prolonged exposure to stress can have harmful effects on mental and physical health and wellbeing.

In the **Canadian Community Health Survey (CCHS)**, participants were asked, "Thinking about the amount of stress in your life, would you say that most days are: not at all stressful, not very stressful, a bit stressful, quite a bit stressful, or extremely stressful?" Participants could also answer "*don't know*."

In this study, participants were grouped into two categories based on their level of self–perceived life stress: High ('extremely stressful' and 'quite a bit stressful') and not high ('not at all stressful', 'not very stressful', 'a bit stressful').

Self–Rated Mental Health

A person's state of psychological well–being as perceived by that person. Mental health can be affected by various social, psychological, and biological factors. Strong mental health exists when a person is able to cope with life's normal stresses, work productively, and make a contribution to society. Poor mental health can result from such things as stressful work conditions, social exclusion, and an unhealthy lifestyle.

In the **Canadian Community Health Survey (CHHS)**, participants were asked, "In general, would you say your mental health is: excellent, very good, good, fair, or poor?" Participants could also answer "*don't know*."

In this study, participants' self–perceived mental health status was grouped into two categories: excellent/very good or good/fair/poor.

Sense of Community

A general feeling of belonging to one's community. It can "influence people's sense of identity and the extent to which they participate in society. Generally, a strong sense of belonging is positively associated with better self–reported physical and mental health. A strong sense of belonging also contributes to individual and community well–being." (Source: http://www4.hrsdc.gc.ca/.3ndic.1t.4r@–eng.jsp?iid=71)

In the **Canadian Community Health Survey (CHHS)**, participants were asked, "How would you describe your sense of belonging to your local community? Would you say it is: very strong, somewhat strong, somewhat weak, very weak?" Participants could also answer "*don't know*."

In this study, participants sense of belonging to their local community was categorized as either strong ("very strong", "somewhat strong") or weak ("somewhat weak", "very weak").

Smoking

The act of inhaling tobacco smoke from cigarettes, pipes, or cigars. Tobacco smoke contains nicotine, an addictive substance that causes some individuals to become addicted to smoking. Smoking damages the lungs and increases the risk of developing **cancer**, especially lung cancer, as well as chronic obstructive pulmonary disease, **asthma**, heart disease, and many others.

In the **Canadian Community Health Survey (CCHS)**, type of smoker is a derived variable that indicates the type of smoker the participant is based on responses to questions on his/her smoking habits, such as, "Have you ever smoked cigarettes daily?" Possible responses include daily smoker, occasional daily smoker who previously was a daily smoker, always an occasional smoker, former daily smoker, former occasional smoker, never smoked, or not stated.

In this study, respondents were categorized as either "Current smoker" (includes daily smoker, occasional smoker who was previously a daily smoker, and always an occasional smoker) or not.

Socio Economic Factor Index – Version 2 (SEFI–2)

A factor score based on Census data that reflects non–medical social determinants of health and includes the following variables:

- average household income
- percent of single parent households
- unemployment rate
- high school education rate

SEFI–2 is calculated at the geographic level of the dissemination area and is then assigned to residents based on their postal codes. SEFI–2 scores less than zero indicate more favourable socioeconomic conditions, while scores greater than zero indicate less ideal socioeconomic conditions. SEFI–2 is a simplified version of the original SEFI, which utilizes prior factor scores of multiple education variables and multiple employment variables, an additional measure of single parent families, and an age–dependency ratio. Importantly, due to data restrictions of prior censuses, the SEFI does not include a measure of income in its calculation of socioeconomic risk. The SEFI–2 was developed to take advantage of this data.

Socioeconomic Status

Characteristics of economic, social, and physical environments in which individuals live and work, as well as, their demographic and genetic characteristics.

In this study, SES was measured using the **Socio Economic Factor Index – Version 2 (SEFI–2)**

Statistics Canada

The federal government agency commissioned with producing statistics to help better understand Canada's population, resources, economy, society and culture. See their website: http://www.statcan.gc.ca.

Stent Insertion

A procedure, technically called 'stenting', in which an artificial 'tube' is inserted into an artery, blood vessel, or other duct to keep it open during treatment to improve flow. For example, during angioplasty, a cardiac stent (a small lattice–shaped metal tube) may be inserted into a previously narrowed artery, which has been expanded by a balloon, to increase blood flow.

Stroke

The rapidly developing loss of brain function due to an interruption in the supply of blood to the brain. It occurs when there is a sudden death of brain cells due to a lack of oxygen when the blood flow to the brain is impaired by blockage or rupture of an artery to the brain. Symptoms depend on the area of the brain affected. The most common symptom is weakness or paralysis of one side of the body with partial or complete loss of voluntary movement or sensation in a leg or arm. Other common symptoms include speech problems, weak facial muscles, numbness, and tingling. A stroke involving the base of the brain can affect balance, vision, swallowing, breathing, and consciousness.

In this study, the rate of hospitalization or death due to stroke was measured for survey participants aged 40 or older at the time of survey. Participants were considered to have experienced a stroke if they met one of the following conditions:

1) an **inpatient hospitalization** with the most responsible diagnosis of stroke: ICD–9–CM codes 431, 434, 436; ICD–10–CA codes I61, I63, I64; and a length of stay of one or more days (unless the patient died in hospital)

2) a death with stroke listed as the primary cause of death on the **Vital Statistics** death record (ICD codes as above)

Note that this definition will not capture minor strokes which did not result in hospitalization or death.

Incidence rates of stroke were measured per 100 person–years after survey. Individuals who had a hospitalization for a stroke prior to their survey date were still eligible to be included in the incidence rates calculations after survey date as individuals can experience multiple strokes in their lifetime. Rates were weighted to the Manitoba population and adjusted for age, sex, BMI, and **smoking** status as reported by survey participants in a generalized linear model. **Variance** was estimated via **bootstrapping**.

Tertiary Hospitals

Facilities that provide medical care that requires highly specialized skills, technology, and support services. In Manitoba, the only tertiary hospitals are Health Sciences Centre and St. Boniface General Hospital.

The Need to Know Team

A collaborative research team of the Manitoba Centre for Health Policy (MCHP), the 11 Manitoba **regional health authorities (RHAs)**; and Manitoba Health. The goal of the team is to: create new knowledge directly relevant to rural and northern RHAs; develop useful models for health information infrastructure, training, and interaction that increase the capacity for collaborative research; and disseminate and apply health research to increase the effectiveness of health services and the health of RHA populations.

Total Hip Replacement – see also Joint Replacement Surgery

During hip replacement surgery, the ball and socket of the hip joint are completely removed and replaced with artificial materials. A metal ball with a stem (a prosthesis) is inserted into the femur (thigh bone) and an artificial plastic cup socket is placed in the acetabulum (a "cup–shaped" part of the pelvis).

In this study, we calculated the number of total hip replacements performed, per 1,000 survey participants aged 40 or older, up to five years after their survey date. Hip replacements were defined by hospitalizations with ICD–9–CM codes 81.50, 81.51 or 81.53 or CCI code 1.VA.53.LA–PN^^ or 1.VA.53. PN–PN^^ in any procedure field. Rates were weighted to the Manitoba population and adjusted for age, sex, and BMI group.

Total Knee Replacement – see also Joint Replacement Surgery

In knee replacement surgery, parts of the knee joint are replaced with prosthetic components. The surgery is done by separating the muscles and ligaments around the knee to expose the inside of the joint. The ends of the thigh bone (femur) and the shin bone (tibia) are removed as is often the underside of the kneecap (patella). The artificial parts are then cemented into place.

In this study, we calculated the number of total knee replacements performed, per 1,000 survey participants aged 40 or older, up to five years after their survey date. Knee replacements were defined by hospitalizations with ICD–9–CM codes 81.54, 81.55 or CCI code 1.VG.53 in any procedure field. Rates were weighted to the Manitoba population and adjusted for age, sex, and BMI group.

Total Respiratory Morbidity (TRM)

A measure of the burden of all types of respiratory illnesses in the population and includes any of the following respiratory illnesses: **asthma**, chronic or acute **bronchitis**, **emphysema,** and chronic airway obstruction. This combination of diagnoses is used to overcome problems resulting from different physicians (or specialists) using different diagnosis codes for the same underlying illness (e.g., asthma versus chronic bronchitis).

In this study, total respiratory **morbidity incidence** and **prevalence** were measured for survey participants aged 18 or older at the time of survey. Participants were considered to have respiratory disease if they had at least one physician visit or hospitalization in one year with a diagnosis of asthma, acute bronchitis, chronic bronchitis, bronchitis not specified as acute or chronic, emphysema, or chronic airway obstruction: ICD–9–CM codes 466, 490, 491, 492, 493, 496; ICD–10–CA codes J20, J21, J40–J45.

Total respiratory morbidity prevalence was measured in the year before survey date and incidence rates were measured per 100 person–years after survey. Individuals whose first confirmed date of respiratory disease (meeting the definition criteria above) in the 10 years before their survey date were excluded from incidence calculations as they were not eligible to be a new case. Both measures were weighted to the Manitoba population and adjusted for age, sex, BMI, and **smoking** status as reported by survey participants in a generalized linear model. **Variance** was estimated via **bootstrapping**.

Urban

An aggregate geography area, co–developed by MCHP and ***The Need to Know*** **Team** for use in MCHP research, which includes the two urban **Regional Health Authorities** in Manitoba: Winnipeg and Brandon.

Variance

"A measure of the extent of the variation present in a set of data. It is obtained by taking the average of the sum of squares and hence is measured in squared units." (Hassard, 1991).

Vital Statistics

A Manitoba government department responsible for keeping records and registries of all births, deaths, marriages and stillbirths that take place in Manitoba.

Winnipeg Community Areas (CAs)

The 12 planning districts within the Winnipeg **Regional Health Authority** (WRHA) that have similar populations to the rural and northern RHAs. The 12 CAs are: St. James–Assiniboia, Assiniboine South, Fort Garry, St. Vital, St. Boniface, Transcona, River East (includes East St. Paul), Seven Oaks (includes West St. Paul), Inkster, Point Douglas, Downtown, and River Heights.

Winnipeg Average Health

Winnipeg Average Health is an aggregate geography area of Winnipeg **Neighbourhood Clusters (NCs)** that have a **premature mortality rate** statistically similar to the **premature mortality rate** of Winnipeg overall over calendar years 1996–2005. This aggregate area was co–developed by MCHP and ***The Need to Know*** **Team** for use in MCHP research. The Winnipeg NCs included are: River Heights East, Seven Oaks North, Seven Oaks East, Seven Oaks West, St. Vital North, and Transcona.

Winnipeg Most Healthy

Winnipeg Most Healthy is an aggregate geography area of Winnipeg **Neighbourhood Clusters (NCs)** that have a **premature mortality rate** statistically lower than the **premature mortality rate** of Winnipeg overall over calendar years 1996–2005. This aggregate area was co–developed by MCHP and ***The Need to Know*** **Team** for use in MCHP research. The Winnipeg NCs included are: Assiniboine South, Fort Garry North, Fort Garry South, Inkster West, River East North, River East East, River East West, River Heights West, St. Boniface East, St. James–Assiniboia West, and St. Vital South.

Winnipeg Least Healthy

Winnipeg Least Healthy is an aggregate geography area of Winnipeg **Neighbourhood Clusters (NCs)** that have a **premature mortality rate** statistically higher than the **premature mortality rate** of Winnipeg overall over calendar years 1996–2005. This aggregate area was co–developed by MCHP and ***The Need to Know*** **Team** for use in MCHP research. The Winnipeg NCs included are: Downtown East, Downtown West, Inkster East, Point Douglas North, Point Douglas South, River East South, St. Boniface West, and St. James–Assiniboia East.

World Health Organization

The United Nations agency for health. One role of the organization is to set health care standards for classifying and coding diseases, diagnoses, and procedures, such as the **International Classification of Disease (ICD).**

Reference List for Glossary

Hassard TH. Understanding Biostatistics. St. Louis, MO: Mosby Year Book; 1991.

Hosmer DW, Lemeshow S. Applied Logistic Regression. New York, NY: John Wiley & Sons, Inc.; 1989.

Last JM. A Dictionary of Epidemiology. New York, NY: Oxford University Press; 1995.

Spasoff RA. Epidemiologic Methods for Health Policy. New York, NY: Oxford University Press; 1999.

Statistics Canada. Census reference material. 2006. http://www12.statcan.ca/census-recensement/2006/ref/about-apropos/index-eng.cfm?CFID=3689285&CFTOKEN=50228177. Accessed May 3, 2011.

World Health Organization (WHO). W.H.O.'s Collaborating Centre for Drug Statistics Methodology: Guidelines for ATC Classification and DDD Assignment. Oslo, Norway: World Health Organization; 1996.

Appendix 1: Additional Results for Obesity Prevalence

Appendix Table A1.1: Male Mean BMI Distribution by Age Group and Survey Wave
Measured/corrected BMI

Age Group	HHS (95% CI)	NPHS	CCHS 1.1 & 1.2	CCHS 2.21 & 2.2	CCHS 3.1	CCHS 2007 & 2008
18-24	24.0 (25.6, 27.2)	25.8 (25.1, 26.6)	25.6 (25.1, 26.2)	25.8 (25.0, 26.7)	25.2 (24.5, 25.9)	25.6 (24.8, 26.4)
25-29	25.8 (25.7, 28.5)	26.7 (25.9, 27.5)	27.3 (26.4, 28.3)	27.7 (26.6, 28.8)	26.7 (25.6, 27.8)	27.3 (26.5, 28.0)
30-34	26.4 (26.5, 28.8)	27.5 (26.7, 28.2)	27.7 (27.0, 28.4)	28.0 (26.9, 29.1)	27.7 (27.0, 28.5)	27.9 (26.8, 29.0)
35-39	27.1 (26.8, 28.6)	27.7 (27.1, 28.3)	27.6 (27.1, 28.1)	28.4 (27.5, 29.4)	29.2 (28.3, 30.0)	29.2 (28.0, 30.5)
40-44	27.6 (26.5, 28.9)	27.8 (27.0, 28.7)	28.3 (27.7, 28.9)	28.7 (28.0, 29.4)	28.3 (27.5, 29.1)	28.9 (28.1, 29.7)
45-49	27.7 (25.9, 30.0)	27.9 (27.1, 28.7)	29.6 (28.7, 30.5)	28.1 (27.1, 29.0)	28.2 (27.2, 29.2)	28.1 (27.2, 29.0)
50-54	27.7 (26.8, 28.8)	29.1 (28.2, 29.9)	29.3 (28.2, 30.5)	28.6 (27.6, 29.6)	28.2 (27.5, 28.9)	28.7 (27.9, 29.5)
55-59	28.0 (25.9, 27.1)	28.6 (27.8, 29.5)	28.4 (27.4, 29.4)	28.8 (27.8, 29.7)	29.3 (28.0, 30.5)	28.6 (27.8, 29.3)
60-64	27.8 (26.4, 28.3)	28.6 (27.8, 29.4)	28.9 (27.8, 30.0)	28.8 (27.6, 30.0)	28.8 (28.1, 29.6)	28.5 (27.5, 29.4)
65-69	26.5 (23.7, 28.9)	27.6 (26.7, 28.4)	27.6 (26.8, 28.4)	28.6 (27.5, 29.8)	28.4 (27.5, 29.4)	29.0 (28.2, 29.9)
70-74	27.3 (22.7, 24.1)	27.6 (26.8, 28.3)	26.9 (26.2, 27.7)	28.2 (27.6, 28.9)	27.5 (26.5, 28.4)	28.0 (27.3, 28.7)
75-79	26.3 (22.4, 25.0)	26.8 (25.8, 27.7)	26.9 (25.9, 28.0)	28.8 (27.8, 29.9)	27.6 (26.6, 28.5)	27.5 (26.7, 28.3)

HHS- Heart Health Survey
NPHS- National Population Health Survey
CCHS- Canadian Community Health Survey

Source: Manitoba Centre for Health Policy, 2011

Appendix Table A1.2: Female Mean BMI Distribution by Age Group and Survey Wave
Measured/corrected BMI

Age Group	HHS (95% CI)	NPHS	CCHS 1.1 & 1.2	CCHS 2.21 & 2.2	CCHS 3.1	CCHS 2007 & 2008
18-24	23.4 (22.7, 24.1)	23.9 (23.2, 24.6)	24.4 (23.7, 25.2)	24.2 (23.1, 25.2)	24.6 (23.8, 25.4)	25.0 (24.0, 26.0)
25-29	23.7 (22.4, 25.0)	25.6 (24.5, 26.7)	26.6 (25.6, 27.6)	26.9 (25.7, 28.1)	27.5 (26.0, 29.0)	26.6 (25.5, 27.6)
30-34	24.3 (23.4, 25.3)	25.4 (24.7, 26.2)	27.4 (26.5, 28.4)	26.7 (25.4, 28.0)	26.8 (26.0, 27.7)	26.8 (25.8, 27.9)
35-39	25.7 (23.4, 27.9)	26.5 (25.8, 27.1)	27.2 (26.1, 28.4)	28.4 (26.8, 29.9)	26.2 (25.3, 27.2)	27.5 (26.4, 28.6)
40-44	25.1 (23.6, 26.5)	26.4 (25.6, 27.3)	27.2 (26.3, 28.1)	28.2 (25.8, 30.5)	27.4 (26.4, 28.4)	28.1 (26.5, 29.7)
45-49	26.5 (25.1, 28.0)	27.3 (26.3, 28.4)	27.8 (26.8, 28.8)	28.5 (27.4, 29.6)	27.6 (26.4, 28.7)	27.5 (26.7, 28.3)
50-54	25.9 (23.8, 27.9)	27.9 (26.9, 28.9)	29.3 (28.3, 30.4)	27.7 (26.9, 28.6)	27.1 (26.2, 28.0)	27.8 (26.8, 28.8)
55-59	27.9 (26.3, 29.6)	27.9 (26.9, 28.9)	28.5 (27.4, 29.6)	28.5 (27.2, 29.8)	28.5 (27.1, 30.0)	29.2 (28.0, 30.4)
60-64	26.9 (25.4, 28.5)	28.3 (27.3, 29.3)	28.4 (27.5, 29.3)	27.9 (26.8, 29.0)	28.8 (27.3, 30.2)	28.7 (27.1, 30.2)
65-69	27.1 (26.2, 28.1)	28.2 (27.3, 29.1)	28.1 (27.1, 29.0)	28.7 (27.7, 29.6)	27.0 (26.0, 28.0)	27.8 (26.8, 28.7)
70-74	25.8 (24.9, 26.7)	26.9 (26.0, 27.9)	28.0 (27.0, 28.9)	27.8 (26.8, 28.7)	28.3 (27.4, 29.3)	27.5 (26.1, 29.0)
75-79	24.7 (18.5, 30.9)	27.5 (26.4, 28.7)	27.1 (26.4, 27.9)	27.6 (26.5, 28.6)	27.6 (26.7, 28.5)	27.1 (26.1, 28.1)

HHS- Heart Health Survey
NPHS- National Population Health Survey
CCHS- Canadian Community Health Survey

Source: Manitoba Centre for Health Policy, 2011

Appendix Table A1.3: BMI Distribution by RHA District (All CCHS Waves)
Age–adjusted percent (males and females combined, aged 18 and older)

RHA District	% Normal + Underweight Rates (95% CI)	% Overweight Rates (95% CI)	% Obese Rates (95% CI)
South Eastman Northern	37.6% (28.0, 47.3)	37.1% (27.3, 46.9)	25.2% (15.6, 34.9)
South Eastman Central	34.2% (25.7, 42.6)	38.6% (30.3, 46.8)	27.3% (20.8, 33.7)
South Eastman Western	34.5% (24.5, 44.5)	45.8% (37.9, 53.7)	19.7% (12.4, 26.9)
South Eastman Southern	*21.3% (8.9, 33.8)*	37.9% (22.8, 53.0)	40.8% (29.0, 52.6)
Central Altona	26.3% (17.0, 35.5)	35.8% (25.6, 46.1)	37.9% (24.5, 51.3)
Central Cartier/SFX	40.7% (25.4, 56.0)	35.6% (25.9, 45.4)	*23.7% (10.8, 36.6)*
Central Louise/Pembina	*41.5% (20.6, 62.4)*	*33.6% (17.3, 49.9)*	*24.9% (11.1, 38.7)*
Central Morden/Winkler	30.5% (23.9, 37.1)	39.2% (32.3, 46.1)	30.3% (24.0, 36.5)
Central Carman	32.5% (22.3, 42.6)	41.4% (32.2, 50.6)	26.1% (15.5, 36.8)
Central Red River	36.2% (25.9, 46.5)	34.7% (26.2, 43.1)	29.1% (16.9, 41.4)
Central Swan Lake	*28.7% (7.6, 49.8)*	*50.7% (25.3, 76.2)*	s
Central Portage	29.0% (22.5, 35.4)	37.9% (30.1, 45.6)	33.2% (26.2, 40.1)
Central Seven Regions	*20.0% (5.1, 35.0)*	37.3% (20.6, 54.0)	*42.7% (22.5, 62.9)*
Assiniboine East 2	28.9% (21.7, 36.1)	43.2% (34.3, 52.2)	27.9% (17.7, 38.1)
Assiniboine West 1	26.8% (16.8, 36.8)	44.5% (35.3, 53.7)	28.7% (19.4, 38.0)
Assiniboine North 1	26.7% (15.2, 38.3)	35.3% (26.2, 44.5)	38.0% (23.3, 52.7)
Assiniboine West 2	26.4% (17.1, 35.7)	42.5% (33.0, 52.0)	31.2% (22.9, 39.4)
Assiniboine East 1	29.8% (19.6, 40.1)	36.3% (26.8, 45.7)	33.9% (23.1, 44.7)
Assiniboine North 2	35.3% (24.3, 46.3)	31.4% (20.4, 42.4)	33.3% (24.4, 42.2)
Brandon Rural	*29.8% (14.4, 45.3)*	*34.8% (15.0, 54.6)*	35.3% (22.2, 48.5)
Brandon Southeast	*32.2% (16.8, 47.6)*	48.0% (32.2, 63.9)	19.8% (10.7, 28.8)
Brandon West	32.6% (23.8, 41.4)	36.1% (28.6, 43.5)	31.3% (22.0, 40.6)
Brandon Southwest	37.1% (25.2, 49.0)	37.5% (22.6, 52.4)	25.4% (16.8, 34.0)
Brandon North End	40.8% (28.1, 53.5)	42.2% (32.1, 52.3)	*17.0% (6.6, 27.3)*
Brandon East	31.5% (19.6, 43.5)	38.7% (28.1, 49.3)	29.8% (19.1, 40.5)
Brandon Central	41.0% (29.1, 52.9)	28.8% (19.5, 38.1)	30.2% (18.6, 41.8)
Interlake Southwest	27.0% (19.4, 34.7)	39.4% (31.8, 47.0)	33.6% (26.2, 41.0)
Interlake Northeast	29.6% (20.7, 38.5)	34.8% (26.5, 43.1)	35.6% (28.2, 43.0)
Interlake Southeast	24.7% (18.0, 31.4)	38.3% (32.0, 44.6)	37.0% (30.9, 43.1)
Interlake Northwest	*19.6% (9.7, 29.5)*	30.6% (21.0, 40.3)	49.8% (37.7, 61.9)
North Eastman Iron Rose	27.9% (16.7, 39.0)	44.1% (31.1, 57.1)	28.0% (16.6, 39.4)
North Eastman Springfield	33.6% (22.6, 44.6)	38.9% (27.2, 50.7)	27.5% (16.8, 38.1)
North Eastman Winnipeg River	29.5% (18.6, 40.3)	40.1% (29.0, 51.1)	30.5% (19.1, 41.8)
North Eastman Brokenhead	27.4% (14.8, 40.0)	43.7% (33.5, 53.9)	28.9% (19.7, 38.1)
North Eastman Blue Water	26.1% (16.1, 36.1)	37.5% (27.2, 47.8)	36.4% (26.5, 46.3)
North Eastman Northern Remote	s	s	s
Parkland West	*20.5% (10.3, 30.7)*	46.7% (31.4, 61.9)	32.8% (20.4, 45.2)
Parkland East	*13.5% (3.0, 24.1)*	46.3% (30.9, 61.6)	40.2% (26.1, 54.4)
Parkland Central	22.8% (15.5, 30.1)	41.7% (32.1, 51.4)	35.5% (25.1, 45.9)
Parkland North	31.3% (20.4, 42.2)	37.4% (28.7, 46.2)	31.3% (22.8, 39.8)
Nor-Man F Flon/Snow L/Cran	28.2% (20.8, 35.6)	38.9% (31.0, 46.9)	32.8% (27.4, 38.3)
Nor-Man The Pas/OCN/Kelsey	26.9% (21.0, 32.8)	36.8% (29.7, 43.9)	36.3% (29.5, 43.2)
Nor-Man Other	*44.5% (16.1, 73.0)*	s	*25.6% (6.0, 45.3)*
Burntwood Thompson	22.3% (18.4, 26.2)	36.5% (31.6, 41.3)	41.2% (36.4, 46.1)
Burntwood Gillam/Fox Lake	s	*39.8% (7.8, 71.8)*	s
Burntwood Lynn/Leaf/SIL	*45.3% (15.8, 74.9)*	s	*26.8% (5.7, 47.9)*
Burntwood Thick Por/Pik/Wab	s	s	s
Burntwood Oxford H & Gods	s	s	s
Burntwood Cross Lake	s	s	s
Burntwood Tad/Broch/Lac Br	s	s	s
Burntwood Norway House	s	s	s
Burntwood Island Lake	s	s	s
Burntwood Sha/York/Split/War	s	s	s
Burntwood Nelson House	s	s	s

Residents of First Nations communities excluded
Bold indicates that the area's rate was statistically different from the Manitoba average (p<0.05)
Italics indicates that the area's rate is highly variable and should be interpreted with caution
"s" indicates data suppressed due to small numbers

Source: Manitoba Centre for Health Policy, 2011

Appendix Table A1.4: BMI Distribution by Winnipeg Community Areas (All CCHS Waves)
Age–adjusted percent (males and females combined, aged 18 and older)

Winnipeg Community Area	% Normal + Underweight Rates (95% CI)	% Overweight Rates (95% CI)	% Obese Rates (95% CI)
Fort Garry	**42.8% (37.4, 48.2)**	38.2% (32.4, 44.0)	**19.0% (14.4, 23.5)**
Assiniboine South	35.1% (27.8, 42.3)	41.7% (33.9, 49.4)	23.3% (16.2, 30.3)
St. Boniface	38.0% (31.0, 45.1)	40.8% (34.0, 47.6)	**21.2% (16.1, 26.3)**
St. Vital	30.3% (24.8, 35.8)	43.8% (38.3, 49.4)	25.9% (19.7, 32.1)
Transcona	36.2% (28.1, 44.4)	41.2% (32.9, 49.6)	22.5% (15.3, 29.8)
River Heights	**43.4% (36.8, 49.9)**	42.3% (36.7, 47.9)	**14.4% (9.6, 19.1)**
River East	35.6% (31.0, 40.3)	36.3% (31.5, 41.1)	28.1% (23.2, 33.0)
Seven Oaks	35.9% (28.6, 43.2)	39.1% (31.2, 47.0)	25.0% (19.4, 30.5)
St. James - Assiniboia	33.7% (28.5, 39.0)	38.9% (32.5, 45.2)	27.4% (21.8, 33.0)
Inkster	33.7% (25.0, 42.4)	43.2% (34.2, 52.2)	23.1% (15.7, 30.5)
Downtown	**42.3% (37.2, 47.3)**	35.9% (30.8, 40.9)	21.9% (17.0, 26.7)
Point Douglas	26.0% (16.1, 35.9)	48.5% (37.4, 59.7)	25.5% (18.6, 32.4)

Residents of First Nations communities excluded
Bold indicates that the area's rate was statistically different from the Manitoba average (p<0.05
Italics indicates that the area's rate is highly variable and should be interpreted with cautior
"s" indicates data suppressed due to small numbers

Source: Manitoba Centre for Health Policy, 2011

Appendix 2: Additional Results for Chapter 3 - Risk and Protective Factors Associated with Obesity

Appendix Table A2.1: Factors Related to Obesity—Intermediate Models
Logistic regression; measured/corrected BMI

Group	Variable	Univariate Odds Ratio (99% CI)	Model 1 Odds Ratio (99% CI)	Model 2 Odds Ratio (99% CI)
Control				
	Year of Survey	**1.02 (1.01, 1.04)**	**1.024 (1.022, 1.03)**	**1.024 (1.022, 1.03)**
	Surveyed by Phone	**0.80 (0.72, 0.89)**	**0.82 (0.81, 0.83)**	**0.82 (0.81, 0.83)**
Geographic *(Compared to Winnipeg Most Healthy areas)*				
	Rural South	**1.37 (1.18, 1.60)**	**1.26 (1.23, 1.29)**	**1.25 (1.23, 1.28)**
	Rural Mid	**1.71 (1.46, 2.00)**	**1.52 (1.50, 1.55)**	**1.52 (1.50, 1.55)**
	North	**1.86 (1.58, 2.19)**	**1.72 (1.69, 1.76)**	**1.73 (1.69, 1.77)**
	Brandon	1.17 (0.95, 1.45)	**1.15 (1.13, 1.18)**	**1.16 (1.14, 1.18)**
	Winnipeg Average Health Areas	0.96 (0.76, 1.22)	**0.90 (0.88, 0.91)**	**0.89 (0.88, 0.91)**
	Winnipeg Least Healthy Areas	1.03 (0.83, 1.27)	**0.94 (0.93, 0.96)**	**0.94 (0.92, 0.96)**
Sociodemographic				
	Age	**1.007 (1.004, 1.010)**	**1.095 (1.09, 1.097)**	**1.09 (1.09, 1.10)**
	Age^2	**0.9992 (0.9991, 0.9994)**	**0.99912 (0.99910, 0.99914)**	**0.99913 (0.99912, 0.99915)**
	Sex (male)	1.07 (0.96, 1.20)	0.99 (0.94, 1.05)	1.02 (0.97, 1.08)
	Age*Sex (male)	0.996 (0.991, 1.001)	**1.007 (1.004, 1.009)**	**1.005 (1.003, 1.008)**
	Age^2*Sex (male)	0.9998 (0.9994, 1.0001)	**0.99984 (0.99982, 0.99986)**	**0.99985 (0.99983, 0.99988)**
	Married/Common-Law	**1.32 (1.18, 1.48)**	**0.95 (0.93, 0.97)**	**0.97 (0.95, 0.996)**
	Sex*Married/Common-Law	**1.32 (1.05, 1.65)**	**1.31 (1.29, 1.33)**	**1.31 (1.28, 1.33)**
	High School Graduate	**0.70 (0.61, 0.80)**	**0.74 (0.73, 0.76)**	**0.75 (0.73, 0.77)**
	Employed	0.90 (0.80, 1.003)	**0.87 (0.85, 0.89)**	**0.86 (0.84, 0.87)**
	Household Income	0.998 (0.996, 1.0004)	**0.9986 (0.9976, 0.9995)**	**0.9988 (0.9978, 0.9997)**
	Activity Restrictions	**1.54 (1.35, 1.76)**	**1.36 (1.28, 1.45)**	**1.34 (1.25, 1.43)**
	Physical Activity - Occupational: Active	1.15 (0.94, 1.42)	0.97 (0.84, 1.12)	0.97 (0.84, 1.13)
	Physical Activity - Occupational: Moderate	0.95 (0.79, 1.16)	0.92 (0.79, 1.08)	0.92 (0.78, 1.08)
Psychological				
	High Level of Life Stress	**1.24 (1.06, 1.44)**		**1.11 (1.04, 1.18)**
	Very Satisfied with Life	**0.73 (0.62, 0.85)**		**0.81 (0.75, 0.87)**
	Self-Rated Mental Health	0.88 (0.75, 1.05)		1.07 (0.9995, 1.15)
	Sense of Community	1.09 (0.95, 1.23)		**1.07 (1.02, 1.13)**
Behavioural & Other				
	Eat Fruits or Vegetables 5+ times/day	0.85 (0.71, 1.01)		
	Physical Activity - Leisure: Active	**0.65 (0.57, 0.75)**		
	Physical Activity - Leisure: Moderate	0.90 (0.78, 1.05)		
	Sedentary Activities	**1.34 (1.08, 1.66)**		
	Current Smoker	**0.81 (0.71, 0.93)**		
	Frequent Binge Drinking	0.87 (0.75, 1.01)		
	Made Changes to Improve Health	**1.24 (1.09, 1.42)**		
	Food Insecurity	1.15 (0.91, 1.47)		
	Regular Doctor	1.15 (0.98, 1.35)		
	C-statistic		*0.6279*	*0.6285*

Bold indicates significance at p<0.01

Source: Manitoba Centre for Health Policy, 2011

Appendix Table A2.2: Factors Related to BMI —Intermediate Models
Linear regression; measured/corrected BMI

Group	Variable	Univariate Estimates (99% CI)	Model 1 Estimates (99% CI)	Model 2 Estimates (99% CI)	Model 3 Estimates (99% CI)
Control					
	Year of Survey	**0.06 (0.03, 0.09)**	**0.05 (0.03, 0.07)**	**0.05 (0.03, 0.08)**	**0.04 (0.02, 0.06)**
	Surveyed by Phone	**-0.47 (-0.74, -0.21)**	**-0.40 (-0.55, -0.25)**	**-0.40 (-0.55, -0.25)**	**-0.35 (-0.51, -0.20)**
Geographic *(Compared to Winnipeg Most Healthy areas)*					
	Rural South	**0.81 (0.48, 1.14)**	**0.62 (0.40, 0.85)**	**0.61 (0.39, 0.84)**	**0.61 (0.39, 0.83)**
	Rural Mid	**1.45 (1.08, 1.82)**	**1.12 (0.88, 1.37)**	**1.12 (0.88, 1.37)**	**1.16 (0.92, 1.41)**
	North	**1.89 (1.46, 2.32)**	**1.67 (1.24, 2.10)**	**1.68 (1.26, 2.11)**	**1.73 (1.31, 2.16)**
	Brandon	0.34 (-0.17, 0.85)	**0.38 (0.01, 0.75)**	**0.38 (0.02, 0.75)**	**0.41 (0.04, 0.78)**
	Winnipeg Average Health areas	-0.03 (-0.51, 0.45)	-0.08 (-0.34, 0.17)	-0.09 (-0.34, 0.16)	-0.09 (-0.34, 0.17)
	Winnipeg Least Healthy Areas	0.13 (-0.37, 0.64)	0.06 (-0.17, 0.30)	0.05 (-0.18, 0.29)	0.08 (-0.16, 0.32)
Sociodemographic					
	Age	**0.03 (0.02, 0.04)**	**0.31 (0.29, 0.34)**	**0.31 (0.28, 0.33)**	**0.32 (0.29, 0.34)**
	Age^2	**-0.0026 (-0.0030, -0.002)**	**-0.0029 (-0.0032, -0.0027)**	**-0.0029 (-0.0031, -0.0026)**	**-0.0030 (-0.0032, -0.0027)**
	Sex (male)	**0.60 (0.35, 0.86)**	**1.20 (0.76, 1.63)**	**1.22 (0.78, 1.66)**	**1.26 (0.82, 1.71)**
	Age*Sex (male)	-0.01 (-0.02, 0.004)	**-0.02 (-0.03, -0.01)**	**-0.02 (-0.03, -0.01)**	**-0.02 (-0.03, -0.01)**
	Married/Common-Law	**1.002 (0.74, 1.27)**	-0.14 (-0.37, 0.09)	-0.07 (-0.31, 0.16)	-0.09 (-0.33, 0.15)
	Sex*Married/Common-Law	**0.70 (0.20, 1.21)**	**0.67 (0.35, 0.99)**	**0.64 (0.32, 0.96)**	**0.62 (0.30, 0.94)**
	High School Graduate	**-0.86 (-1.18, -0.54)**	**-0.61 (-0.80, -0.41)**	**-0.57 (-0.77, -0.37)**	**-0.63 (-0.83, -0.43)**
	Employed	-0.15 (-0.42, 0.13)	-0.19 (-0.40, 0.02)	-0.21 (-0.42, 0.001)	-0.19 (-0.41, 0.02)
	Household Income	-0.003 (-0.01, 0.002)	**-0.004 (-0.01, -0.001)**	**-0.004 (-0.01, -0.0005)**	**-0.004 (-0.01, -0.0001)**
	Activity Restrictions	**1.33 (0.97, 1.69)**	**0.91 (0.66, 1.17)**	**0.85 (0.59, 1.12)**	**0.80 (0.53, 1.07)**
	Physical Activity - Occupational: Active	0.39 (-0.05, 0.84)	-0.13 (-0.50, 0.24)	-0.14 (-0.51, 0.23)	-0.03 (-0.41, 0.34)
	Physical Activity - Occupational: Moderate	0.01 (-0.41, 0.43)	-0.23 (-0.56, 0.11)	-0.23 (-0.58, 0.11)	-0.18 (-0.52, 0.16)
Psychological					
	High Level of Life Stress	**0.66 (0.32, 1.001)**		**0.35 (0.14, 0.56)**	**0.36 (0.15, 0.57)**
	Very Satisfied with Life	**-0.75 (-1.11, -0.39)**		**-0.46 (-0.69, -0.23)**	**-0.43 (-0.66, -0.20)**
	Self-Rated Mental Health	-0.40 (-0.83, 0.02)		0.09 (-0.12, 0.29)	0.12 (-0.09, 0.32)
	Sense of Community	0.23 (-0.09, 0.54)		0.093 (-0.095, 0.28)	0.10 (-0.08, 0.29)
Behavioural & Other					
	Eat Fruits or Vegetables 5+ times/day	**-0.40 (-0.79, -0.004)**			-0.16 (-0.40, 0.09)
	Physical Activity - Leisure: Active	**-1.07 (-1.38, -0.75)**			**-0.80 (-1.08, -0.52)**
	Physical Activity - Leisure: Moderate	**-0.50 (-0.84, -0.16)**			**-0.41 (-0.75, -0.07)**
	Sedentary Activities	**0.89 (0.38, 1.40)**			**0.46 (0.18, 0.75)**
	Current Smoker	**-0.63 (-0.94, -0.33)**			**-0.73 (-0.995, -0.46)**
	Frequent Binge Drinking	**-0.31 (-0.61, -0.02)**			0.15 (-0.05, 0.35)
	Made Changes to Improve Health	**0.57 (0.29, 0.85)**			**0.44 (0.05, 0.83)**
	Food Insecurity	0.52 (-0.22, 1.26)			0.40 (-0.10, 0.90)
	Regular Doctor	0.29 (-0.06, 0.65)			0.01 (-0.33, 0.35)
	R-squared value		*6.8%*	*7.0%*	*8.0%*

Bold indicates significance at p<0.01

Source: Manitoba Centre for Health Policy, 2011

Appendix Table A2.3: Factors Related to Obesity: Sub-Analysis including Sleep Variables—Intermediate Models

Logistic regression; measured/corrected BMI

Group	Variable	Univariate Odds Ratio (99% CI)	Model 1 Odds Ratio (99% CI)
Control			
	Surveyed by Phone	**0.75 (0.59, 0.95)**	**0.76 (0.60, 0.97)**
Geographic *(Compared to Winnipeg Most Healthy areas)*			
	Rural South	1.16 (0.84, 1.61)	1.11 (0.79, 1.54)
	Rural Mid	**1.65 (1.22, 2.23)**	**1.51 (1.09, 2.09)**
	North	**1.76 (1.28, 2.43)**	**1.54 (1.09, 2.19)**
	Brandon	0.97 (0.60, 1.58)	1.002 (0.60, 1.67)
	Winnipeg Average Health areas	1.09 (0.72, 1.67)	1.10 (0.71, 1.71)
	Winnipeg Least Healthy Areas	1.04 (0.71, 1.53)	1.06 (0.70, 1.60)
Sociodemographic			
	Age	1.005 (0.9998, 1.011)	**1.11 (1.06, 1.15)**
	Age^2	**0.9990 (0.9986, 0.9993)**	**0.9990 (0.9986, 0.9994)**
	Sex (male)	1.01 (0.81, 1.26)	1.17 (0.55, 2.50)
	Age*Sex (male)	0.997 (0.986, 1.01)	0.99 (0.98, 1.01)
	Married/Common-Law	**1.48 (1.17, 1.88)**	1.08 (0.76, 1.54)
	Sex*Married/Common-Law	1.32 (0.83, 2.09)	1.34 (0.81, 2.22)
	High School Graduate	**0.70 (0.55, 0.90)**	**0.65 (0.49, 0.86)**
	Employed	1.13 (0.90, 1.42)	1.11 (0.82, 1.50)
	Household Income	1.0003 (0.996, 1.005)	0.9998 (0.994, 1.01)
	Activity Restrictions	**1.56 (1.19, 2.04)**	**1.53 (1.14, 2.04)**
Sleep			
	Hours of Sleep	**0.90 (0.83, 0.98)**	0.94 (0.85, 1.04)
	Trouble Sleeping Most of the Time	1.26 (0.90, 1.75)	1.06 (0.72, 1.57)
	Trouble Sleeping Sometimes	1.05 (0.82, 1.35)	1.01 (0.78, 1.32)
Psychological			
	High Level of Life Stress	1.21 (0.92, 1.58)	
	Sense of Community	1.13 (0.89, 1.43)	
Behavioural & Other			
	Frequent Binge Drinking	1.03 (0.80, 1.34)	
	C-statistic		*0.6368*

Bold indicates significance at p<0.01

Source: Manitoba Centre for Health Policy, 2011

Appendix Table A2.4: Factors Related to BMI: Sub-Analysis including Sleep Variables

Linear regression; measured/corrected BMI

Group	Variable	Univariate Esimates (99% CI)	Model 1 Estimates (99% CI)	Model 2 Estimates (99% CI)
Control				
	Surveyed by Phone	**-0.60 (-1.10, -0.11)**	**-0.49 (-0.96, -0.01)**	**-0.48 (-0.96, -0.004)**
Geographic	*(Compared to Winnipeg Most Healthy areas)*			
	Rural South	0.52 (-0.18, 1.21)	0.39 (-0.29, 1.07)	0.37 (-0.31, 1.05)
	Rural Mid	**1.16 (0.44, 1.88)**	**0.83 (0.08, 1.58)**	**0.80 (0.05, 1.55)**
	North	**1.93 (1.17, 2.70)**	**1.57 (0.90, 2.23)**	**1.52 (0.85, 2.19)**
	Brandon	-0.08 (-1.15, 0.99)	-0.02 (-1.01, 0.98)	-0.07 (-1.04, 0.91)
	Winnipeg Average Health areas	0.21 (-0.64, 1.06)	0.21 (-0.61, 1.04)	0.23 (-0.59, 1.05)
	Winnipeg Least Healthy Areas	0.04 (-0.88, 0.95)	0.06 (-0.85, 0.96)	0.06 (-0.84, 0.96)
Sociodemographic				
	Age	**0.03 (0.02, 0.04)**	**0.30 (0.23, 0.38)**	**0.30 (0.23, 0.38)**
	Age^2	**-0.003 (-0.004, -0.002)**	**-0.003 (-0.004, -0.002)**	**-0.003 (-0.004, -0.002)**
	Sex (male)	0.50 (-0.01, 1.01)	0.72 (-0.78, 2.21)	0.64 (-0.85, 2.13)
	Age*Sex (male)	-0.01 (-0.04, 0.02)	-0.02 (-0.05, 0.005)	-0.02 (-0.05, 0.01)
	Married/Common-Law	**1.10 (0.56, 1.63)**	-0.11 (-0.95, 0.72)	-0.08 (-0.92, 0.77)
	Sex*Married/Common-Law	**1.23 (0.20, 2.27)**	**1.10 (0.10, 2.10)**	**1.07 (0.07, 2.08)**
	High School Graduate	**-0.70 (-1.32, -0.09)**	-0.57 (-1.22, 0.07)	-0.58 (-1.22, 0.06)
	Employed	0.27 (-0.28, 0.81)	0.35 (-0.38, 1.08)	0.33 (-0.41, 1.06)
	Household Income	-0.002 (-0.011, 0.008)	-0.004 (-0.02, 0.01)	-0.005 (-0.02, 0.01)
	Activities Restricted	**1.56 (0.87, 2.25)**	**1.38 (0.70, 2.05)**	**1.38 (0.71, 2.06)**
Sleep				
	Hours of Sleep	**-0.35 (-0.56, -0.14)**	-0.19 (-0.42, 0.03)	-0.20 (-0.42, 0.03)
	Trouble Sleeping Most of the Time	0.62 (-0.14, 1.37)	0.06 (-0.77, 0.88)	0.05 (-0.78, 0.87)
	Trouble Sleeping Sometimes	0.06 (-0.52, 0.63)	-0.04 (-0.61, 0.52)	-0.06 (-0.63, 0.51)
Psychological				
	High Level of Life Stress	0.48 (-0.14, 1.10)		-0.01 (-0.63, 0.61)
	Sense of Community	0.39 (-0.13, 0.90)		0.19 (-0.33, 0.70)
Behavioural & Other				
	Frequent Binge Drinking	0.09 (-0.54, 0.72)		0.38 (-0.24, 1.001)
	R-squared value		*8.1%*	*8.2%*

Bold indicates significance at p<0.01

Source: Manitoba Centre for Health Policy, 2011

Appendix Table A2.5: Factors Related to Obesity: Sub-Analysis on Birth Characteristics Among Youth Born in Manitoba

Logistic regression; self-reported/measured BMI

Group	Variable	Univariate Odds Ratio (95% CI)	Model 1 Odds Ratio (95% CI)	Model 2 Odds Ratio (95% CI)	Model 3 Odds Ratio (95% CI)
Geographic *(Compared to Wpg Most Healthy areas)*					
	Rural South	0.61 (0.22, 1.68)	0.65 (0.23, 1.85)	0.65 (0.22, 1.89)	0.59 (0.19, 1.85)
	Rural Mid	1.54 (0.47, 5.04)	1.51 (0.46, 4.94)	1.42 (0.44, 4.57)	1.40 (0.41, 4.80)
	North	0.997 (0.37, 2.69)	1.07 (0.39, 2.97)	1.01 (0.37, 2.79)	1.02 (0.35, 3.01)
	Brandon	1.45 (0.47, 4.46)	1.47 (0.47, 4.57)	1.43 (0.45, 4.55)	1.19 (0.38, 3.74)
	Winnipeg Average Health Areas	1.28 (0.36, 4.54)	1.49 (0.38, 5.78)	1.48 (0.37, 6.01)	1.41 (0.35, 5.68)
	Winnipeg Least Healthy Areas	2.67 (0.81, 8.85)	2.71 (0.83, 8.86)	2.77 (0.82, 9.34)	2.09 (0.55, 7.97)
Sociodemographic					
	Age	**1.26 (1.01, 1.56)**	1.19 (0.69, 2.05)	1.15 (0.69, 1.92)	1.17 (0.76, 1.81)
	Sex (male)	1.83 (0.86, 3.91)	0.75 (0.0002, 3.60E3)	0.53 (0.0002, 1.65E3)	0.31 (0.0002, 475.13)
	Age*Sex (male)	1.03 (0.58, 1.86)	1.06 (0.60, 1.86)	1.08 (0.63, 1.85)	1.13 (0.69, 1.83)
	Breastfed	0.50 (0.22, 1.14)		0.59 (0.27, 1.31)	0.59 (0.25, 1.41)
	Gestational Age	1.08 (0.90, 1.30)		1.92 (0.59, 6.21)	1.87 (0.57, 6.14)
	Birth Weight	1.33 (0.72, 2.43)		1.96E3 (0.002, 1.57E9)	1.03E3 (0.001, 9.40E8)
	Gestational Age*Birth Weight	0.87 (0.64, 1.17)		0.83 (0.59, 1.17)	0.84 (0.60, 1.19)
	Household Income	**0.986 (0.97, 0.9992)**			0.985 (0.97, 1.001)
Behavioural & Other					
	Current Smoker	0.79 (0.07, 9.35)			0.39 (0.02, 6.80)
	Frequent Binge Drinking	1.76 (0.59, 5.21)			1.11 (0.31, 4.05)
	Physical Activity - Leisure: Active	0.92 (0.42, 1.998)			1.12 (0.46, 2.72)
	Physical Activity - Leisure: Moderate	1.68 (0.69, 4.08)			1.93 (0.69, 5.37)
	C-statistic		*0.669*	*0.683*	*0.674*

Bold indicates significance at p<0.05

Source: Manitoba Centre for Health Policy, 2011

Appendix Table A2.6: Factors Related to BMI: Sub-Analysis on Birth Characteristics Among Youth Born in Manitoba—Intermediate Models

Linear regression; self-reported/measured BMI

Group	Variable	Univariate Esimates (95% CI)	Model 1 Esimates (95% CI)	Model 2 Esimates (95% CI)
Geographic *(Compared to Winnipeg Most Healthy areas)*				
	Rural South	0.23 (-0.54, 0.9986)	0.39 (-0.38, 1.16)	0.40 (-0.38, 1.17)
	Rural Mid	**1.33 (0.26, 2.39)**	**1.23 (0.25, 2.20)**	**1.20 (0.23, 2.17)**
	North	0.86 (-0.11, 1.84)	**1.03 (0.09, 1.96)**	**0.92 (0.01, 1.84)**
	Brandon	0.57 (-0.51, 1.66)	0.62 (-0.41, 1.65)	0.59 (-0.44, 1.62)
	Winnipeg Average Health Areas	0.29 (-1.20, 1.78)	0.57 (-0.81, 1.96)	0.55 (-0.85, 1.95)
	Winnipeg Least Healthy Areas	1.12 (-0.38, 2.62)	1.06 (-0.46, 2.58)	1.10 (-0.29, 2.49)
Sociodemographic				
	Age	**0.64 (0.44, 0.84)**	**0.48 (0.18, 0.77)**	**0.45 (0.18, 0.73)**
	Sex (male)	0.70 (-0.01, 1.41)	-3.20 (-8.52, 2.13)	-3.51 (-8.73, 1.70)
	Age*Sex (male)	0.26 (-0.12, 0.65)	0.26 (-0.11, 0.64)	0.27 (-0.09, 0.64)
	Breastfed	**-1.01 (-1.97, -0.06)**		-0.67 (-1.49, 0.14)
	Gestational Age	0.05 (-0.10, 0.20)		-0.17 (-0.54, 0.20)
	Birth Weight	**0.71 (0.13, 1.30)**		0.10 (-5.70, 5.91)
	Gestational Age*Birth Weight	0.04 (-0.11, 0.19)		0.02 (-0.12, 0.17)
	Household Income	-0.005 (-0.02, 0.009)		
Behavioural & Other				
	Current Smoker	0.50 (-0.71, 1.71)		
	Frequent Binge Drinking	1.34 (-0.10, 2.78)		
	Physical Activity - Lesiure: Active	-0.37 (-1.16, 0.42)		
	Physical Activity - Lesiure: Moderate	0.55 (-0.45, 1.55)		
	R-squared value		*9.9%*	*11.3%*

Bold indicates significance at p<0.05

Source: Manitoba Centre for Health Policy, 2011

Appendix 3: Drugs Used in Chronic Disease Definitions

Drugs used to Treat Hypertension		
	ATC Code	**Generic Drug Name**
Antihypertensives	C02AB01	Methyldopa (levorotatory)
	C02AB02	Methyldopa (racemic)
	C02AC01	Clonidine
	C02CA04	Doxazosin
	C02CA05	Terazosin
	C02CC02	Guanethidine
	C02DB02	Hydralazine
	C02DC01	Minoxidil
	C02KX01	Bosentan
	C02LA01	Reserpine and diuretics
	C02LB01	Methyldopa (levorotatory) and diuretics
Diuretics	C03AA03	Hydrochlorothiazide
	C03BA04	Chlortalidone
	C03BA11	Indapamide
	C03CA01	Furosemide
	C03BD	Xanthine Derivatives
	C03CA02	Bumetanide
	C03CC01	Etacrynic acid
	C03DA01	Spironolactone
	C03DB01	Amiloride
	C03DB02	Triamterene
	C03EA01	Hydrochlorothiazide and potassium–sparing agents
Beta Blocking Agents	C07AA02	Oxprenolol
	C07AA03	Pindolol
	C07AA05	Propranolol
	C07AA06	Timolol
	C07AA12	Nadolol
	C07AB02	Metoprolol
	C07AB03	Atenolol
	C07AB04	Acebutolol
	C07AB07	Bisoprolol
	C07AG01	Labetalol
	C07BA05	Propranolol and thiazides
	C07BA06	Timolol and thiazides
	C07CA03	Pindolol and other diuretics
	C07CB03	Atenolol and other diuretics
Calcium Channel Blockers	C08CA01	Amlodipine
	C08CA02	Felodipine
	C08CA04	Nicardipine
	C08CA05	Nifedipine
	C08CA06	Nimodipine
	C08DA01	Verapamil
	C08DB01	Diltiazem
Agents Acting on the Renin–Angiotensin System	C09AA01	Captopril
	C09AA02	Enalapril
	C09AA03	Lisinopril
	C09AA04	Perindopril
	C09AA05	Ramipril
	C09AA06	Quinapril
	C09AA07	Benazepril
	C09AA08	Cilazapril
	C09AA09	Fosinopril
	C09AA10	Trandolapril
	C09BA02	Enalapril and diuretics

Drugs used to Treat Hypertension		
	ATC Code	**Generic Drug Name**
Agents Acting on the Renin–Angiotensin System	C09BA03	Lisinopril and diuretics
	C09BA04	Perindopril and diuretics
	C09BA06	Quinapril and diuretics
	C09BA08	Cilazapril and diuretics
	C09CA01	Losartan
	C09BB05	Ramipril and Felodipine
	C09BB10	Trandolapril and Verapamil
	C09CA02	Eprosartan
	C09CA03	Valsartan
	C09CA04	Irbesartan
	C09CA06	Candesartan
	C09CA07	Telmisartan
	C09DA01	Losartan and diuretics
	C09DA02	Eprosartan and diuretics
	C09DA03	Valsartan and diuretics
	C09DA04	Irbesartan and diuretics
	C09DA06	Candesartan and diuretics
	C09DA07	Telmisartan and diuretics
Drugs used to Treat Diabetes		
Insulins and Analogues	A10A	Insulin
Blood Glucose Lowering Drugs, excluding Insulin	A10BA02	Metformin
	A10BB01	Glibenclamide
	A10BB02	Chlorpropamide
	A10BB03	Tolbutamide
	A10BB09	Gliclazide
	A10BB12	Glimepiride
	A10BB31	Acetohexamide
	A10BD03	Metformin and Rosiglitazone
	A10BD04	Glimepiride and Rosiglitazone
	A10BF01	Acarbose
	A10BG01	Troglitazone
	A10BG02	Rosiglitazone
	A10BG03	Pioglitazone
	A10BX02	Repaglinde
	A10BX03	Nateglinide
Drugs used to Treat Ischemic Heart Disease (IHD)		
Cardiac Therapy Drugs	C01DA02	Glyceryl trinitrate
	C01DA05	Pentaerithrityl tetranitrate
	C01DA08	Isosorbide dinitrate
	C01DA14	Isosorbide mononitrate
	C01EB09	Ubidecarenone
Beta Blocking Agents	C07AA02	Oxprenolol
	C07AA03	Pindolol
	C07AA05	Propranolol
	C07AA06	Timolol
	C07AA12	Nadolol
	C07AB02	Metoprolol
	C07AB03	Atenolol
	C07AB04	Acebutolol
	C07AB07	Bisoprolol
	C07AG01	Labetalol
	C07BA05	Propranolol and thiazides
	C07BA06	Timolol and thiazides
	C07BA07	Sotalol and thiazides
	C07CA03	Pindolol and other diuretics
	C07CB03	Atenolol and other diuretics

Drugs used to Treat Ischemic Heart Disease (IHD)		
	ATC Code	Generic Drug Name
Calcium Channel Blockers	C08CA01	Amlodipine
	C08CA02	Felodipine
	C08CA04	Nicardipine
	C08CA05	Nifedipine
	C08CA06	Nimodipine
	C08DA01	Verapamil
	C08DB01	Diltiazem
Agents Acting on the Renin–Angiotensin System	C09AA01	Captopril
	C09AA02	Enalapril
	C09AA03	Lisinopril
	C09AA04	Perindopril
	C09AA05	Ramipril
	C09AA06	Quinapril
	C09AA07	Benazepril
	C09AA08	Cilazapril
	C09AA09	Fosinopril
	C09AA10	Trandolapril
	C09BA02	Enalapril and diuretics
	C09BA03	Lisinopril and diuretics
	C09BA04	Perindopril and diuretics
	C09BA05	Ramipril and diuretics
	C09BA06	Quinapril and diuretics
	C09BA08	Cilazapril and diuretics
	C09BB05	Ramipril and felodipine
	C09BB10	Trandolapril and verapamil
	C09CA01	Losartan
	C09CA02	Eprosartan
	C09CA03	Valsartan
	C09CA04	Irbesartan
	C09CA06	Candesartan
	C09CA07	Telmisartan
	C09DA01	Losartan and diuretics
	C09DA02	Eprosartan and diuretics
	C09DA03	Valsartan and diuretics
	C09DA04	Irbesartan and diuretics
	C09DA06	Candesartan and diuretics
	C09DA07	Telmisartan and diuretics
Other	C02LA01	Reserpine and diuretics
	C03AA01	Bendroflumethiazide
	C03AA03	Hydrochlorothiazide

Appendix 4: Additional Results for Chapter 6 - Survival Analyses

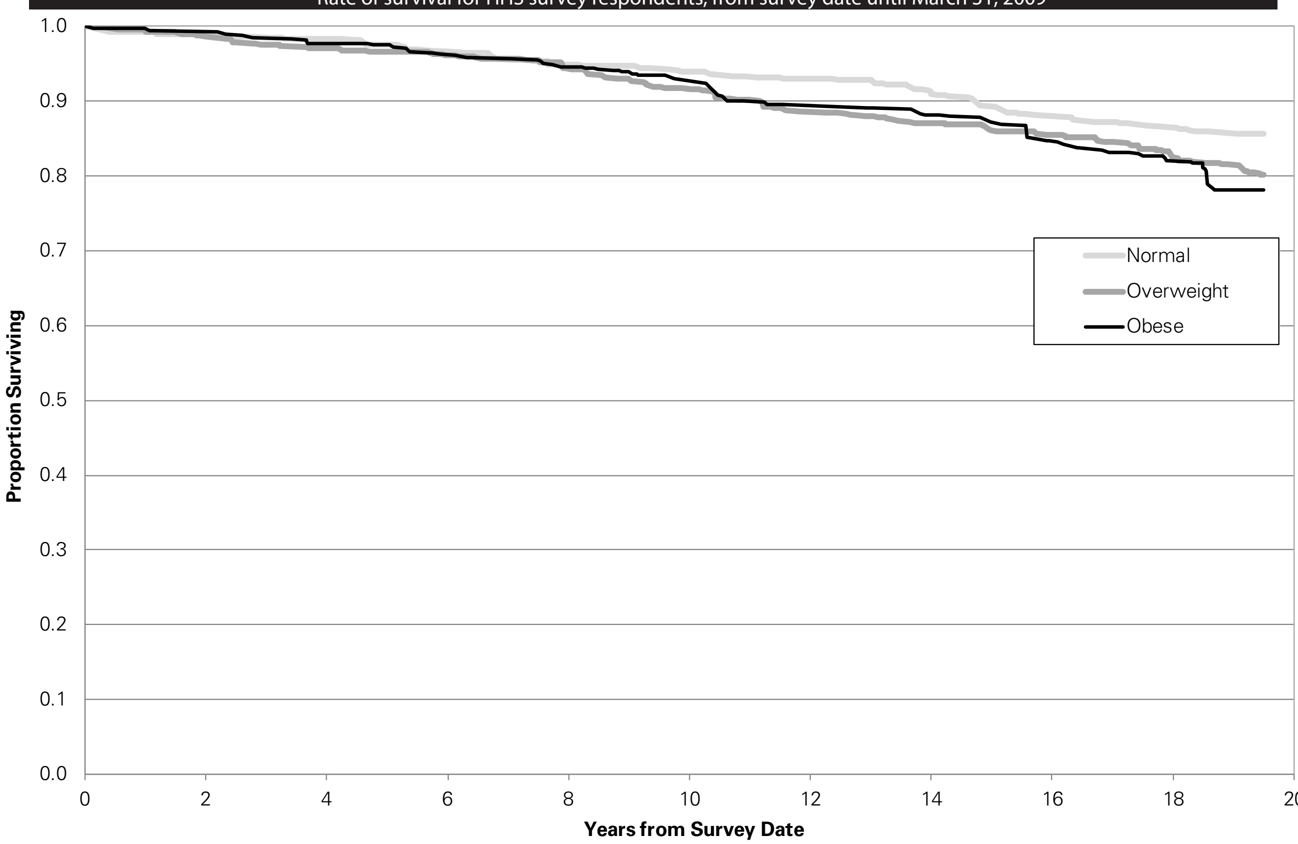
Kaplan-Meier Curves of Survival

Survival Analysis of Heart Health Survey Participants

The Manitoba Heart Health Survey (HHS) was conducted in 1989-1990, providing a much longer follow-up period than was available for participants in the Statistics Canada surveys, especially the more recent waves of the CCHS. This analysis examines the survival of HHS participants by sex and BMI group.

This section uses a very common tool for survival analyses, which involves the creation of 'Kaplan-Meier survival curves.' The analysis begins with a certain number of people, then follows each group forward in time, plotting the proportion of each group who remain alive over the follow-up period. Kaplan-Meier curves are excellent at illustrating the 'raw' differences between groups – that is, without adjustment for age, sex, or other variables. However, this lack of adjustment is a major limitation, since it is known that obesity prevalence varies with age. Therefore, 'adjusted' analyses were also performed, and are discussed in the Multivariate Modeling Section in Chapter 6.

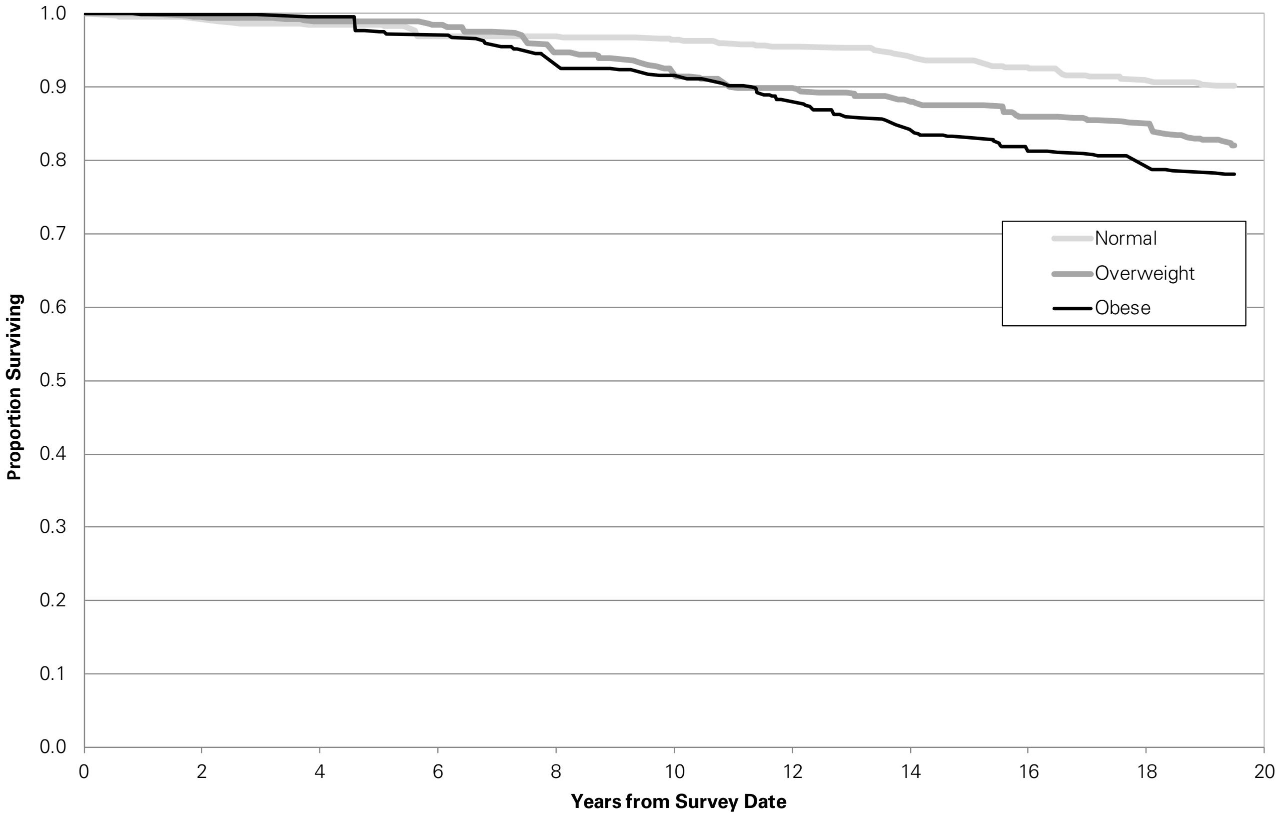
Appendix Figure A4.1: Kaplan-Meier Survival Curve for Time Until Death for Males Aged 18 and Older, by BMI Group
Rate of survival for HHS survey respondents, from survey date until March 31, 2009



HHS- Heart Health Survey
Survey date indicates the date of completion of the HHS

Source: Manitoba Centre for Health Policy, 2011

Appendix Figure A4.2: Kaplan-Meier Survival Curve for Time Until Death for Females Aged 18 and Older, by BMI Group
Rate of survival for HHS survey respondents, from survey date until March 31, 2009



HHS- Heart Health Survey
Survey date indicates the date of completion of the HHS

Source: Manitoba Centre for Health Policy, 2011

Key findings:

- In both sexes, those in the Obese group had the lowest survival rates (highest mortality) of all three groups, though the difference was only pronounced near the end of the study period, 19 years after the survey was conducted.
- However, it must be stressed again that these analyses do not control for the effect of age, and since obesity prevalence is known to be strongly related to age, an adjusted analysis is required to examine the potential impact of obesity independent of that of age, sex, and other variables. The Multivariate Modeling section in Chapter 4 provides such an analysis.

Appendix Table A4.1: Factors Related to Mortality

Cox Proportional Hazards Model, Manitoba Heart Health Survey only; measured/corrected BMI

Group	Variable	Univariate Hazard Ratio (95% CI)	Model 1 Hazard Ratio (95% CI)	Model 2 Hazard Ratio (95% CI)	Model 3 Hazard Ratio (95% CI)	Model 4 Hazard Ratio (95% CI)	Model 5 Hazard Ratio (95% CI)	Model 6 Hazard Ratio (95% CI)
BMI Class *(Compared to Normal)*								
	Overweight	**1.66 (1.20, 2.29)**	1.05 (0.76, 1.45)	1.03 (0.74, 1.43)	1.09 (0.79, 1.51)	1.03 (0.74, 1.44)	1.02 (0.74, 1.41)	1.04 (0.74, 1.46)
	Obese	**1.92 (1.35, 2.73)**	1.20 (0.84, 1.71)	1.15 (0.80, 1.64)	1.20 (0.82, 1.74)	0.996 (0.69, 1.44)	1.14 (0.80, 1.63)	0.96 (0.65, 1.42)
Sociodemographic								
	Age (Years)	**1.10 (1.08, 1.11)**	**1.10 (1.08, 1.11)**	**1.10 (1.08, 1.11)**	**1.11 (1.09, 1.12)**	**1.09 (1.07, 1.10)**	**1.10 (1.08, 1.11)**	**1.10 (1.08, 1.11)**
	Male (vs. Female)	1.28 (0.96, 1.69)	**1.51 (1.13, 2.01)**	**1.52 (1.13, 2.04)**	**1.37 (1.02, 1.83)**	**1.46 (1.09, 1.96)**	**1.44 (1.07, 1.94)**	1.36 (0.9995, 1.84)
Geographical *(Compared to Winnipeg Most Healthy areas)*								
	Rural South	1.34 (0.92, 1.95)		1.27 (0.86, 1.87)				1.32 (0.85, 2.03)
	Rural Mid	1.30 (0.81, 2.08)		1.02 (0.63, 1.66)				1.06 (0.63, 1.77)
	North	1.30 (0.74, 2.28)		**2.82 (1.61, 4.95)**				**2.01 (1.06, 3.79)**
	Brandon	0.70 (0.09, 5.32)		0.92 (0.14, 6.05)				1.02 (0.15, 6.91)
	Winnipeg Average Health	1.07 (0.59, 1.94)		1.08 (0.63, 1.87)				1.16 (0.65, 2.06)
	Winnipeg Least Healthy	1.60 (0.87, 2.93)		1.31 (0.69, 2.50)				1.33 (0.68, 2.59)
Behavioural								
	Current Smoker	1.18 (0.85, 1.62)			**1.98 (1.39, 2.84)**			**2.00 (1.37, 2.91)**
	Frequent Binge Drinking	0.86 (0.57, 1.30)			**1.84 (1.13, 2.98)**			**1.70 (1.02, 2.82)**
Diseases								
	Diabetes	**4.53 (3.26, 6.30)**				**2.31 (1.59, 3.33)**		**2.22 (1.52, 3.24)**
	Hypertension	**3.46 (2.49, 4.80)**				0.90 (0.64, 1.26)		0.86 (0.60, 1.21)
	Ischemic Heart Disease	**5.57 (4.19, 7.39)**				**1.69 (1.27, 2.25)**		**1.72 (1.28, 2.31)**
Cholesterol								
	Ratio (total/HDL)	**1.26 (1.18, 1.34)**					1.07 (0.97, 1.17)	1.03 (0.93, 1.15)
	LDL	**1.59 (1.40, 1.81)**					0.96 (0.79, 1.17)	1.03 (0.85, 1.26)

Bold indicates significance at p<0.05

Source: Manitoba Centre for Health Policy, 2011

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