The Cost of Obesity in Alberta

Summary Report

January 2010

Alberta Health Services

Acknowledgements

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Alberta Health Services

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Introduction

Over the last three decades, obesity has become a global population and public health challenge. Over 1 billion adults were estimated to be overweight in 2008, with 300 million of these considered to be clinically obese.[1] In Canada, the directly-measured prevalence of obesity[a] among adults (individuals aged 20 and older) increased from 10.4% in 1970 to 22.7% in 2004.[2] Similar increases in obesity prevalence occurred within all Canadian provinces. In Alberta, between 1986 and 2004, the directly-measured prevalence[b] of obesity among adults rose from 16% to 25%.[3]

The World Health Organization notes that "obesity is a complex condition, with serious social and psychological dimensions, affecting virtually all ages and socioeconomic groups".[4] Moreover, obesity is responsible for increased costs to the health care system, employers, families and individuals. Through a reduction in obesity rates, substantial improvements in population health and subsequent cost savings can be achieved. Improvements in population health will both reduce demand on the health care system and improve economic productivity.

In 2008, Alberta Health Services' Cancer Prevention Program commissioned this study of the direct and indirect costs attributable to obesity among Albertans aged 15 years and older for 2004/2005. When possible, this study has also estimated costs attributable to overweight and obese classes 1, 2, and 3 (for definitions of obesity, please refer to the background information on page 3).

There have been few studies of the cost of obesity in Canada, and few of them have included cost breakdowns by age group, sex, or individual BMI classes. The studies that have estimated the cost of obesity have generally used out-dated definitions of obesity[5], self-reported obesity rates[6,7], and a limited number of obesity-related health conditions. This *Cost of Obesity in Alberta* report used both (i) directly-measured BMI data from the 2004 Canadian Community Health Survey (CCHS), and (ii) 2005 self-reported CCHS data that was adjusted to reflect directly measured BMI data.[8] It is also the first to include cost breakdowns by age group, sex, and obesity classes.

[a] Obesity is defined as a body mass index (BMI) $\geq$ 30 kg/m^2
[b] The directly-measured prevalence of obesity refers to the objective measurements of height and weight completed by trained researchers, as opposed to self-reported measurement of height and weight obtained from survey respondents.

Furthermore, it estimated obesity-related costs for a wider range of illnesses (particularly cancers) than do the previous studies. This more extensive cost breakdown enables the identification of demographic groups and special populations where needs and costs are greatest, and where targeted interventions will have the greatest impact and be most cost-effective.

Economic costing studies can provide a crucial first step for future economic evaluations of the cost-effectiveness of interventions designed to reduce obesity levels in society. The findings of this *Cost of Obesity in Alberta* report are relevant to policy makers, health care administrators, health researchers, planners, and other individuals and organizations engaged in population health programming, health promotion, and policy development. This report identifies obesity as a societal and public health problem that is larger than an individual-level, behavioural issue. By focusing attention on the economic burden of obesity, and on the associations of obesity with chronic disease and other health conditions, costing studies such as this one can mobilize societal and governmental interest and resources towards setting priorities for obesity prevention.

Background Information

Definition of Obesity

International and Canadian standards determine obesity in adults aged 18 years and older using the Body Mass Index (BMI), which is calculated by dividing weight in kilograms by height in metres squared:[9,10]

$$BMI = \frac{Weight}{Height^2}$$

Where weight is measured in kilograms and height is measured in metres.

In this study, body weights were classified according to the 2003 *Canadian Guidelines for Body Weight Classification in Adults.* [11] This classification system helps to identify health risks associated with body weight in individuals and populations, and is consistent with the World Health Organization (WHO) recommendations released in 2000 that have been adopted internationally.[12] In this report, obesity was considered to be a risk factor for chronic disease, rather than a disease in itself. The BMI categories and relative health risk levels associated with each BMI category are summarized in Table 1.

Table 1: Relative health risk levels associated with BMI levels[13]

Weight Classification		Body Mass Index (kg/m^2)	Relative Health Risk Level for Chronic Diseases
Underweight		under 18.5	Increased
Normal Weight		18.5 to 24.9	Least
Overweight		25.0 to 29.9	Increased
Obese	Obese class 1	30.0 to 34.9	High
	Obese class 2	35.0 to 39.9	Very High
	Obese class 3	40 or greater	Extremely High

The BMI classification system is somewhat limited in its ability to accurately estimate weight-related health risks in specific groups (children and youth, muscular individuals, adults over age 65, and certain ethnic and racial groups). However, the classification system is generally considered to be appropriate for population measurement purposes within Canada.[14]

Directly-Measured versus Self-Reported BMI

This study used directly-measured height and weight data from the 2004 Canadian Community Health Survey (CCHS, Cycle 2.2) to estimate the prevalence of obesity and associated costs whenever possible. For obesity-related health conditions that were not included in the 2004 CCHS (cerebrovascular disease, osteoarthritis, asthma, and depression), it was necessary to use self-reported height and weight data from the 2005 CCHS (Cycle 3.1). In those cases, the self-reported BMI data was adjusted to better reflect measured BMI data using methodology developed and validated by Statistics Canada specifically for use with the 2005 dataset.[15]

The use of directly measured BMI data in this current report represents a considerable improvement over past cost of obesity reports completed in Canada. The accuracy of the association between health conditions and obesity may not be precise when the data used are based on self-reports.[16,17,18] Specifically, when self-reported BMI data is used, a substantial proportion of individuals who are actually 'obese' are misclassified as 'overweight', because many individuals tend to underestimate weight and overestimate height. This misclassification results in a relative overestimation of the disease risk associated with being overweight and a corresponding underestimation of the disease risk associated with obesity. When directly-measured data is used in the calculations, BMI misclassification is avoided and the burden of disease associated with obesity increases.

The magnitude of this reporting bias is illustrated in Figures 1 and 2, which compare self-reported and directly-measured rates of obesity in Canada obtained from a sub-sample (n=4535) of 2005 CCHS (Cycle 3.1) respondents.[19] The overall prevalence of obesity was 7.4 percent higher using the measured data than using the self-reported data—8.8 percent higher for males, and 6.0 percent higher for females (Figure 1).[20] This reporting bias occurred across all age and sex categories, with the largest differences between self-reported and measured obesity occurring in men compared to women, and in the 45-64 years and ≥65 years age groups compared to younger age groups (Figure 2).

Figure 1: Directly-measured and self-reported prevalence of obesity (BMI≥30) for individuals aged ≥12 years, by sex, Canada, excluding territories, CCHS 2005 (Cycle 3.1)

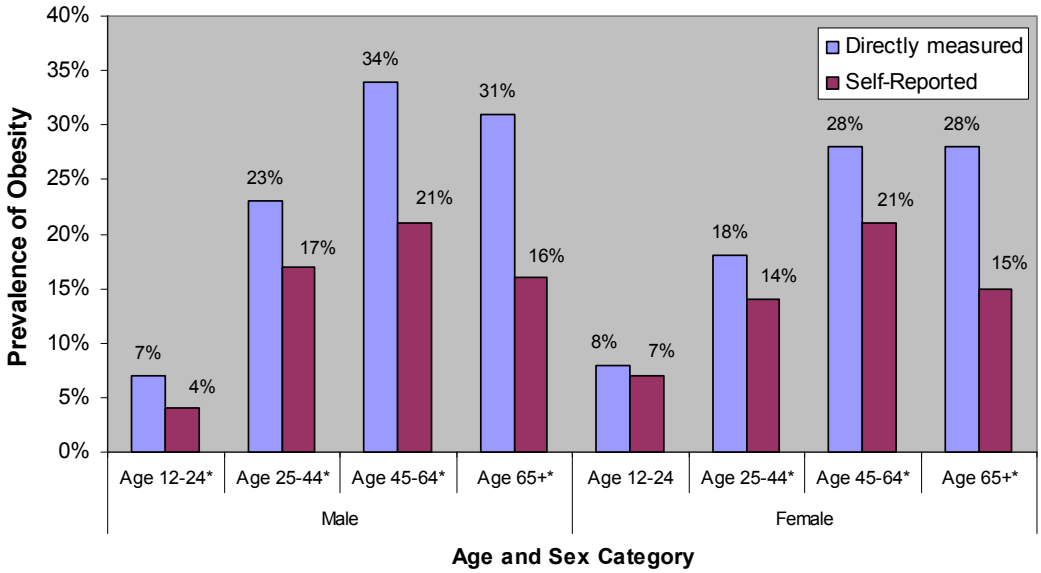
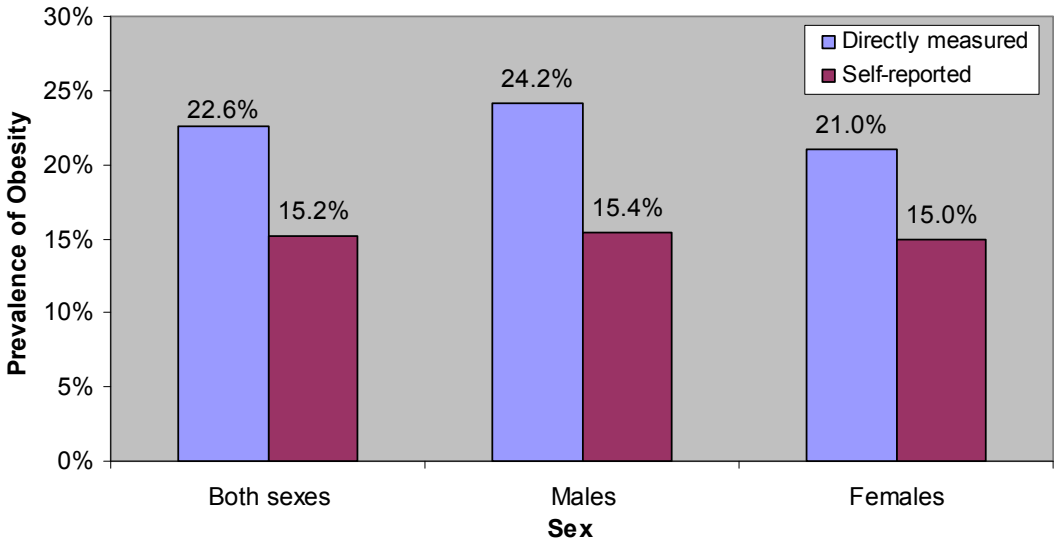


Figure 2: Directly-measured and self-reported prevalence of obesity (BMI≥30) for individuals aged ≥12 years, by age and sex, Canada, excluding territories, CCHS 2005 (Cycle 3.1)

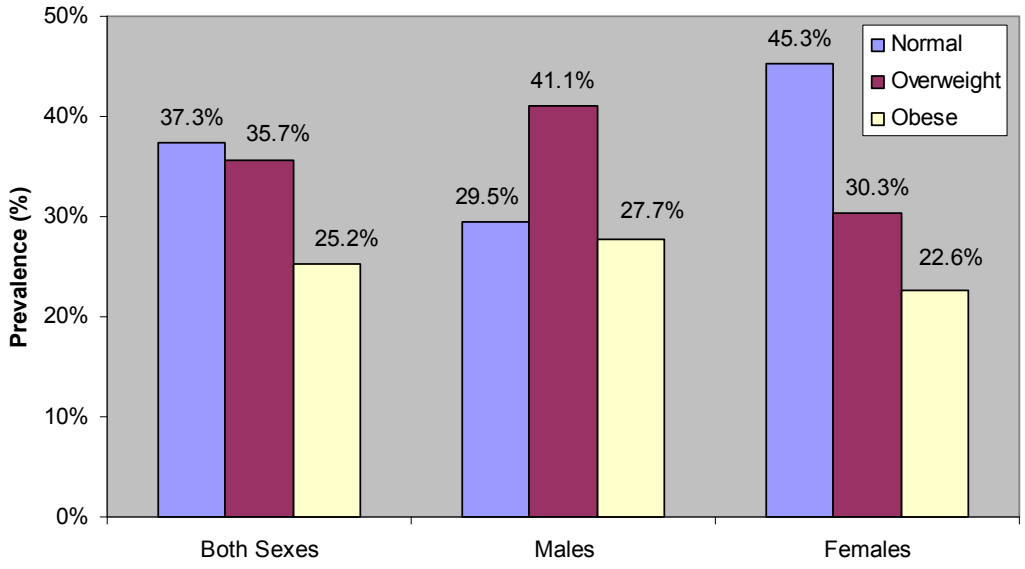


Notes: * Significant difference between directly-measured and self-reported prevalence of obesity for sex and age category ($p < 0.05$); Self-reported and measured values for males and females aged 12-24 and self-reported values for males >65 years should be used with caution because they are based on small sample sizes and have coefficients of variation between 16.6%-33.3%.

Obesity Prevalence in Alberta

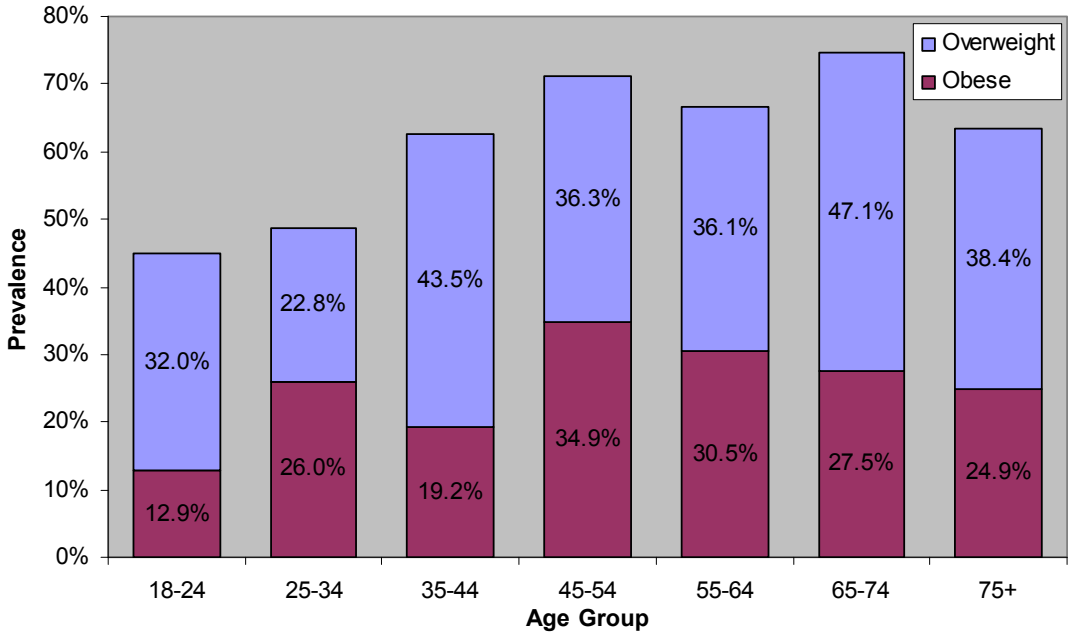
Among Albertans aged 18 and older in 2004, 37.3% were of normal weight, 35.7% were overweight, and 25.2% were obese (Figure 3). Breaking down the obese adults even further, 15.4% of Albertan adults aged ≥18 were classified as obese class 1 (BMI 30–34.9), 6.7% as obese class 2 (BMI 35–39.9), and 3.2% as obese class 3 (BMI≥40). As Figure 3 shows, rates of overweight and obesity were higher among males than females.

Figure 3: Distribution of BMI (%) for Albertans aged ≥18 years, by sex, CCHS 2004 (Cycle 2.2)[21]



The prevalence of overweight and obesity in Alberta increased with age for both men and women, with the highest prevalence observed among individuals aged 65-74 (74.6%) (Figure 4). The prevalence of *obesity alone* in Alberta was highest among individuals aged 45-54 years (34.9%) followed by individuals aged 55–64 years (30.5%), which is consistent with evidence that the likelihood of obesity increases with age at least into the fifties.[22,23] It is particularly alarming that 25–34 year-old Albertans appear to have a relatively high rate of obesity (26.0%). This result was considerably higher than the national average for this age group (20.5%),[24] and could have serious implications for future health risks with respect to weight-related chronic diseases and the resulting burden on Alberta's health care system.

Figure 4: Prevalence of overweight and obesity (%) among Albertans aged ≥18 years, by age, CCHS 2004 (Cycle 2.2) (See note) [25]



Note: According to Statistics Canada, the prevalence of overweight and obesity when measured by age should be interpreted with caution due to significant variation in the age-specific estimates.

In addition to age and sex, the full *Cost of Obesity in Alberta* report provides a more detailed look at the differences in obesity rates by income, education level, health status, health care utilization, place of residency, smoking status, physical activity and dietary behaviours. Information on obesity prevalence and trends among children, youth, and Aboriginal populations is also presented in the full report. The cost of obesity in children could not be included in the costing calculations because the health risks associated with obesity in children have not been established. Similarly, the cost of obesity in Alberta's Aboriginal population was also not included since over 50% of this group is not represented by Statistic's Canada's general population surveys (such as the CCHS). Without representative data, it was not possible to estimate the magnitude of obesity-related health conditions affecting the Aboriginal population as a whole.

Excess weight affects a significant percentage of the Alberta population. In 2004, the combined prevalence of overweight and obesity in Albertan adults was 60.9%. Obesity is an established risk factor for many health conditions, each with associated financial costs. The identification of health conditions for which obesity is an established risk factor was the first step in determining the costs of obesity, and is described in the next section.

Health Impacts of Obesity

Obesity is associated with increased risks of chronic health conditions and premature mortality in adults, and exerts a significant impact on the health of general and special populations. An extensive literature review was completed to identify the specific health conditions that may be completely or partially attributable to obesity. Twenty-two health conditions for which epidemiological evidence supports a relationship between obesity and disease risk were identified, and used to estimate the costs attributable to obesity in Alberta. These health conditions include:

- Type 2 diabetes
- Cardiovascular diseases (hypertension, coronary heart disease, and cerebrovascular disease)
- Osteoarthritis
- Gallbladder disease
- Asthma
- Mental illnesses (e.g. depression and anxiety)
- 14 types of cancer
    - Bladder cancer
    - Colorectal cancer
    - Endometrial cancer
    - Esophageal cancer
    - Kidney cancer
    - Leukemia
    - Liver cancer
    - Multiple myeloma
    - Non-Hodgkin's lymphoma
    - Ovarian cancer
    - Pancreatic cancer
    - Postmenopausal breast cancer
    - Prostate cancer
    - Stomach cancer

The comprehensive obesity-related cancer analysis in this study was undertaken to meet the specific interests of the Alberta Health Services' Cancer Prevention Program and is the most detailed breakdown of its kind in Canada to date. Several other health conditions, such as obstructive sleep apnea, back pain, non-alcoholic fatty liver disease, gout, certain reproductive disorders, gallbladder cancer, and others have also been strongly associated with obesity.[26,27] Due to a lack of data required for the cost determination however, these conditions were not included in the obesity cost estimates.

Of the 22 obesity-related health conditions assessed in this report, type 2 diabetes, hypertension, gallbladder disease, asthma, and depression are known to have the strongest associations with excess weight (Table 2).[28] The relative risk (RR) is defined as the ratio of the risk of disease in exposed individuals to the risk of disease in non-exposed individuals.[29] In the context of this report, the RR quantifies the strength of the association between obesity and the risk of developing a specific health condition. For example, the RR of >3 for type 2 diabetes means that an obese person is over 3 times more likely to develop type 2 diabetes than a person of normal weight.

Table 2: Diseases associated with adult obesity and overweight, by category of relative risk (RR)[30]

Relative risk (RR) for association with overweight and obesity	Disease or Health Condition	
Greatly increased (RR >3)	▪ Type 2 diabetes* ▪ Hypertension* ▪ Gallbladder disease ▪ Dyslipidaemia ▪ Insulin resistance ▪ Non-alcoholic fatty liver disease	▪ Sleep apnea ▪ Breathlessness ▪ Asthma* ▪ Social isolation and depression* ▪ Daytime sleepiness and fatigue
Moderately increased (RR 2-3)	▪ Cardiovascular diseases* ▪ Cerebrovascular disease* ▪ Gout/hyperuricemia ▪ Osteoarthritis*	▪ Respiratory disease ▪ Hernia ▪ Psychological problems
Slightly increased (RR 1-2)	▪ Cancers (especially postmenopausal breast, endometrial, colon)* ▪ Reproductive abnormalities/impaired fertility ▪ Polycystic ovaries ▪ Skin complications ▪ Cataracts	▪ Varicose veins ▪ Musculoskeletal problems ▪ Back pain ▪ Stress incontinence ▪ Oedema/cellulitis

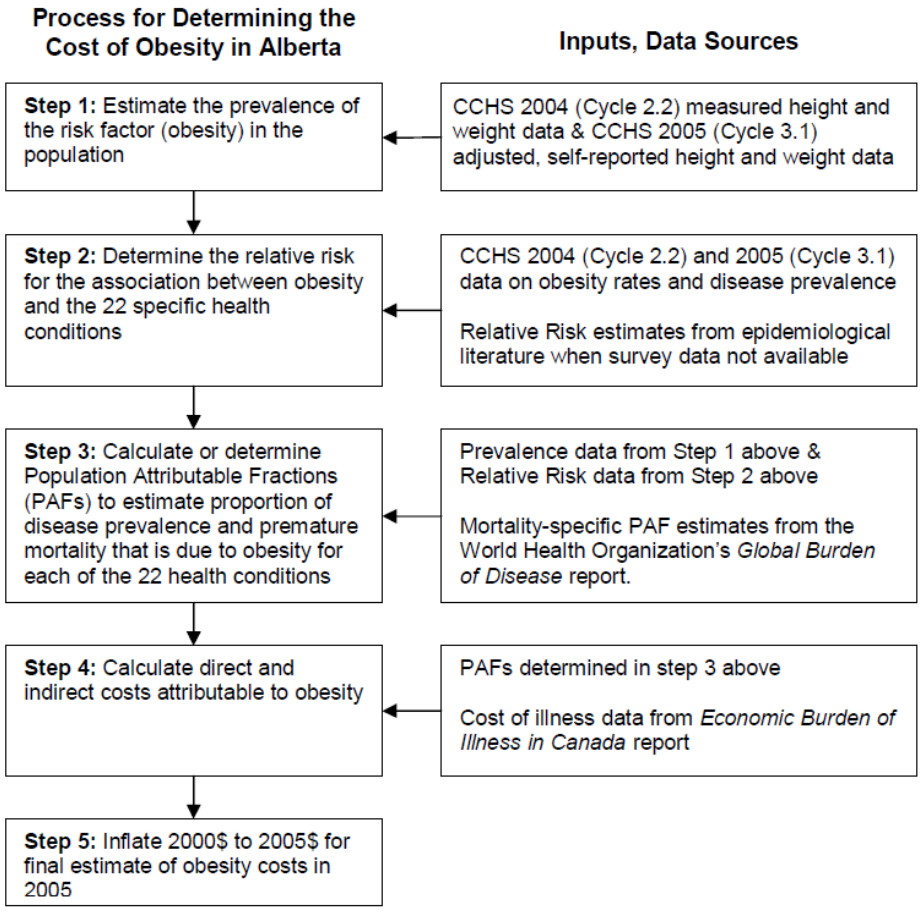
Note: * included in this costing study

The full *Cost of Obesity in Alberta* report provides a detailed illness-by-illness review of key evidence on obesity-related health outcomes, including an overview of the 22 health conditions and the physical pathways leading from obesity to the development of these conditions, and subsequent disability and premature mortality. Estimates of the prevalence and the magnitude of disease risk associated with obesity in Alberta and Canada are also discussed and compared for each of the 22 health conditions. This background information helps to place the prevalence statistics and relative risks used in this Alberta-specific report in the context of estimates most widely and currently in use.

Methodology

In order to determine the cost of obesity, it was necessary to sequentially determine the prevalence of obesity in Alberta, calculate the relative risk for the association between obesity and each of the 22 health conditions, estimate the percentage of disease prevalence and mortality that is attributable to obesity, determine the total direct and indirect costs associated with each of the 22 health conditions, and calculate the percentage of these costs that is attributable to obesity (Figure 5). This protocol is used in most burden of disease and cost of illness studies and is described in greater detail below. [31,32]

Figure 5: Overview of the obesity costing methodology



Step 1: Estimation of the prevalence of the risk factor (obesity) in the population

As was previously indicated, data on the prevalence and distribution of obesity among Albertan adults was obtained from the 2004 Canadian Community Health Survey (CCHS, Cycle 2.2), which directly measured heights and weights of survey respondents. In certain instances, self-reported data from the 2005 CCHS (Cycle 3.1) was used after adjustment for indirect measurement of BMI levels.

Step 2: Determination of the relative risk for the association between obesity and the 22 specific health conditions.

In this report, the relative risk (RR) identifies the *individual* risk of developing each of the 22 identified health conditions that are associated with obesity (see page 7 for definition of relative risk). In contrast, by incorporating data on the prevalence of obesity in the population, the population attributable fraction (PAF, discussed below) determines the percentage of each obesity-related health condition at the *population* level that can be attributed to obesity. For example, the RR quantifies the risk of developing colon cancer for an obese individual compared to the risk of developing colon cancer for a normal weight individual (e.g. 1.5 times greater risk), whereas the PAF quantifies the percentage of colon cancer in the entire population that is attributable to obesity (e.g. 11% of colon cancer cases in Alberta can be attributed to obesity).

Because the CCHS 2004 (Cycle 2.2) did not assess the prevalence of all 22 health conditions, RR risk (and PAF estimates) for certain conditions were calculated from CCHS 2005 (Cycle 3.1) data or determined based on estimates from the epidemiological evidence when CCHS 2005 data was not available. The data sources used to determine RR (and PAFs) for each of the health conditions are provided in Table 3.

Step 3: Calculation or determination of the population attributable fractions (PAFs) to estimate the percentage of disease prevalence and mortality that is due to obesity

Population Attributable Fractions (PAFs) describe the fraction of disease cases in a population that is associated with exposure to a risk factor.[33] In the *Cost of Obesity in Alberta* report, PAFs were calculated to estimate the percentages of each of the 22 health conditions (disease cases) that were attributable to obesity (the risk factor).

When possible, PAFs for each health condition were estimated by sex (male, female, both sexes), by age (15-35 years, 35-64 years, and ≥65 years), and by obesity class level (overweight, total obesity, and obesity classes 1, 2, and 3).

The standard equation used to calculate the PAF is:[34]

$$PAF = \frac{P(RR-1)}{\left[P(RR-1)\right]+1}$$

Where P is the prevalence of the risk factor and RR is the relative risk.

PAFs were then used to estimate the percentage of the costs of each of the 22 health conditions that is attributable to obesity and the total of such costs. PAFs quantify the possible reduction of illness burden and change in population health that could potentially result from policies and programs designed to prevent and reduce obesity.

Different sources were used to determine the PAFs used in this report. The PAFs used to estimate the direct health care costs and the indirect disability costs that were attributable to overweight and obesity were calculated from CCHS 2004 and 2005 (Cycles 2.2 and 3.1) data or estimated from the epidemiological evidence (Table 3). The PAFs used to estimate the indirect premature mortality costs attributable to overweight and obesity combined came from the WHO *Global Burden of Disease* (GBD) report.[35]

Table 3: Data sources for relative risks (RR) and population attributable fractions (PAF) for each of the 22 health conditions

Health Condition	Source of data for RR and PAF calculation or estimation
Type 2 Diabetes Hypertension Coronary Heart Disease	CCHS 2004 (Cycle 2.2)*: Self-reported disease prevalence and directly-measured BMI
Cerebrovascular Disease Osteoarthritis Asthma Depression	CCHS 2005 (Cycle 3.1)*: Self-reported disease prevalence and self-reported BMI (adjusted)
Cancer (14 sites) Gallbladder Disease	PAFs estimated from epidemiological evidence [e.g. calculated using directly-measured BMI from CCHS 2004 (Cycle 2.2) and RRs estimated from epidemiological evidence]

* Because of the larger sample size and more stable estimates provided by the Canadian CCHS sample compared to the smaller Alberta sample, particularly for age, sex, and BMI sub-categories, the estimates of disease risk and exposure attributable to overweight and obesity used in the RR calculations were based on the prevalence of the disease in Canada rather than in Alberta. However, after careful comparison and testing, it has been assumed that the RRs and PAFs are sufficiently comparable between the Canadian and Albertan populations and that it is reasonable to apply the Canadian RRs and PAFs to the Alberta costing data.

Step 4: Calculation of the direct and indirect costs attributable to obesity

The total costs attributable to overweight and obesity were derived by multiplying the PAFs (determined in Step 3) by the total cost for each obesity-related health condition. This calculation requires the determination of the direct and indirect costs of the 22 obesity-related health conditions. Direct costs are defined as those costs borne by the health care system, the community and the patient's family (diagnosis and treatment costs).[36] Indirect costs are defined as the lost productivity caused by disease and borne by the individual, the family, society or the employer.[37]

The direct and indirect costs of the specific health conditions were based on estimates provided by the Public Health Agency of Canada's *Economic Burden of Illness in Canada, 2000* (EBIC) unpublished report.[38] The EBIC 2000 is the most recent source of disease-specific information on the magnitude of the economic burden of illness in Canada and its provinces[39]. All of the direct and indirect costs of illness were attributed to the prevalence of illness in 2000 and were allocated by cost component for various age groups, for both sexes, and by province or territory .[40,41]

The costs of overweight and obesity in Alberta were estimated for direct health care costs, indirect short-term and long-term disability costs, and costs of premature mortality for each of the 22 health conditions attributable to obesity. Definitions and components of direct and indirect costs are provided in Box 1. Direct and indirect costs are influenced by very different factors, with indirect costs being necessarily broader (Box 1). The indirect premature mortality costs in this report were limited to those associated with mortality occurring in 15-74 year olds.

Box 1: Definitions and components of direct and indirect costs

Direct health care costs in this study included the value of goods and services for which payment was made and resources used in treatment, care, and rehabilitation related to illness or injury.[42] The following 5 direct cost components were assessed in this study:

1. Hospital care expenditures
2. Drug expenditures
3. Physician care expenditures
4. Expenditures for care in other institutions (e.g. nursing homes, residential facilities for people with mental and physical disabilities, and drug and alcohol problems)
5. Additional direct health care expenditures (includes expenditures for other health professionals, capital investments, public health, prepayment administration and health research)

Indirect health care costs in this study included the value of economic output lost as a result of illness, injury, or premature death.[43] Indirect costs assessed in this study were:

1. Morbidity costs, as the value of activity days lost due to short-term disability
2. Morbidity costs, as the value of activity days lost due to long-term disability
3. Mortality costs, as the value of years of life lost due to premature death[44]

The direct costs of diabetes, hypertension, coronary heart disease, cerebrovascular disease, asthma, osteoarthritis, colorectal cancer, breast cancer, endometrial cancer, and prostate cancer by gender and age group were based on estimates in the EBIC for Alberta in 2000. The direct costs for most other cancer sites by age group but not by gender were also based on the EBIC data. Since EBIC did not provide the direct costs for kidney cancer, depression, and gallbladder disease, the direct costs for these three health conditions were based on the Canadian percentages of the health conditions relative to malignant neoplasms, neuropsychiatric disorders, and digestive diseases, respectively.[c]

[c] The EBIC 2000 provided total direct costs for Alberta for all malignant neoplasms, but it did not provide specific costs for kidney cancer. Therefore, the direct costs of kidney cancer were estimated by multiplying the cost of all malignant neoplasms in Alberta by the percentage of total cancer incidence attributable to kidney cancer in Canada for 2005. The same calculations were used to estimate the direct costs associated with depression and gallbladder disease, using data on neuropsychiatric disorders and digestive diseases, respectively.

The EBIC did not breakdown total short-term and long-term disability costs for Alberta by diagnostic categories, gender, or age groups. Various methods were used to determine diagnostic categories for short- and long-term disabilities and estimate associated costs, for example:

- The EBIC 2000 did not provide the short-term disability costs of type 2 diabetes. However, the EBIC 1998 provided the short-term disability costs associated with endocrine disorders, and stated that diabetes accounts for 64.9% of endocrine disorders. Therefore, these proportions were used to estimate short-term disability costs for diabetes.

- The EBIC 2000 did not provide short or long-term disability costs for the provinces that disaggregated costs by diagnostic category, gender, or age group. Therefore, the short and long-term disability costs for these three categories in Alberta were based on the proportions found for the Canadian data.

The methodology used to estimate short and long-term disability costs for each health condition is described in greater detail within the full *Cost of Obesity in Alberta* report.

Step 5: Inflate 2000 dollars (2000$) to 2005 dollars (2005$) to obtain a final estimate of the cost of obesity in 2005.

Since the most recent available cost of illness data source in Canada is the 2000 EBIC database, the costs of the individual 22 health conditions were presented for Alberta in 2000. However, the obesity and disease prevalence data used in this study are from the 2004 and 2005 CCHS (Cycles 2.2 and 3.1), therefore the final summary costs attributable to overweight and obesity for each health condition and the total summary costs attributable to obesity were inflated to 2005 dollars. The costs attributable to obesity are considered to be excess costs that may be amenable or removed through population level interventions.

Limitations of Final Cost Estimates

The costs attributable to overweight and obesity estimated in this report are conservative, and the costs may be underestimated. For example, there are costs related to specific factors that are not included in this study, but are still likely to be partially attributable to obesity. It was not possible to include such costs because they could not be allocated to specific diagnostic categories or specifically attributed to obesity or could not be estimated accurately. These costs include:

- Private out-of-pocket costs such as those paid for private caregivers, illness-related aids, and home modifications not reimbursed by governmental agencies;
- Costs associated with reduced production during work hours (presenteeism) as a result of a health problem;
- The value of time lost from work;
- The value of lost leisure time of family members or friends who care for the patient; and,
- Intangible costs that involve pain and suffering borne by patients and their families.

The costs of obesity for children and youth under the age of 15, or for the Aboriginal population who live on reserves in Alberta were also not included. The association between obesity and various health conditions in children and youth is not quantified and the economic costs are unclear, particularly the indirect costs. Canada's population health surveys do not collect data from Aboriginal populations living on reserve, so there is limited ability to ascertain the magnitude of obesity and related health conditions affecting over half of Canada's Aboriginal population. The full *Cost of Obesity in Alberta* report provides descriptions and estimates of the potential magnitude of obesity and associated costs in these populations when available; however, they are not included in the final cost estimates.

Results

In Alberta, the 22 common health conditions analyzed in this report were responsible for approximately 20% of the total healthcare costs in Alberta in 2000. Significant percentages of these 22 conditions can be attributed to obese and overweight BMI status. Overall, the findings of this study reveal that:

- The total costs attributable to obesity in Alberta during the year 2005 totaled $1.27 billion ($2005).

- Indirect costs accounted for 50.5% ($643.8 million, 2005$) of the total costs attributable to overweight and obesity, while direct costs accounted for the remaining 49.5% ($630.1 million, 2005$) of the total costs.

- The highest costs attributable to overweight and obese BMI status were associated with coronary heart disease ($307.1 million, 2005$), osteoarthritis ($167.7 million, 2005$), type 2 diabetes ($161.5 million, 2005$), hypertension ($125.5 million, 2005$), and cancer ($117.8 million, 2005$).

This summary of results will begin with a discussion of the total, direct, and indirect costs of the 22 health conditions (regardless of their association with obesity). Next, the population attributable fractions (PAFs) used to estimate the percentage of the 22 health conditions that was attributable to obesity will be presented. Finally, the total and disease-specific costs attributable to overweight and obese BMI status in Alberta for the year 2005 will be provided. The full *Cost of Obesity in Alberta* report provides a more comprehensive range of results for each specific disease by age, sex, and BMI category, as well as a more detailed breakdown of cost components for each disease. The report can be obtained by contacting the Research and Evaluation Unit of Alberta Health Services' Health Promotion, Disease and Injury Prevention.

Total Costs of All Health Conditions in Alberta, 2000

All health conditions

The total direct and indirect cost of all diseases in Alberta was $18.7 billion in 2000 (2000$).[45] Direct health care costs in Alberta ($9.6 billion), represented 51.2% of the total costs, and indirect costs ($9.1 billion) represented the remaining 48.8% of the total costs.

Obesity-related health conditions

The total direct and indirect cost of the 22 health conditions that may be partially attributable to obesity in Alberta during the year 2000 was $ 3.8 billion (2000$), representing approximately 20% of total costs of all illnesses in Alberta. A percentage of these total costs can be attributed to excess weight (e.g. 36.9% of the total costs of type 2 diabetes can be attributed to obesity):

- The direct costs of these 22 health conditions was $1.5 billion (2000$) or 40% of the total direct and indirect costs for these health conditions.

- The total indirect cost for the 22 health conditions was $2.3 billion (2000$), or 60% of the total direct and indirect costs for the health conditions.

For most health conditions, particularly osteoarthritis, coronary heart disease, and cancer, the majority of associated costs were indirect costs (Figure 6). 86.3% of the costs associated with osteoarthritis and 80.5% of the costs associated with cancer (all 14 sites) were indirect costs. Only for mental health-depression, type 2 diabetes, and hypertension did the direct costs exceed the indirect costs. Direct costs of obesity-related health conditions.

Hospital costs represented the largest share of the direct health care costs, accounting for 34.0% of the total direct health care costs for the obesity-related diseases (Figure 7). Drugs (15.7%), physician care (9.8%), care in other institutions (13.5%), and additional direct costs (18.0%) together represented 57.0% of direct health care costs. The cost of drugs was the highest direct cost for hypertension and asthma, while hospital costs were the highest direct cost for all other health conditions.

Figure 6: Annual direct and indirect costs of health conditions that may be partially attributable to obesity in Alberta (2000$, Millions)

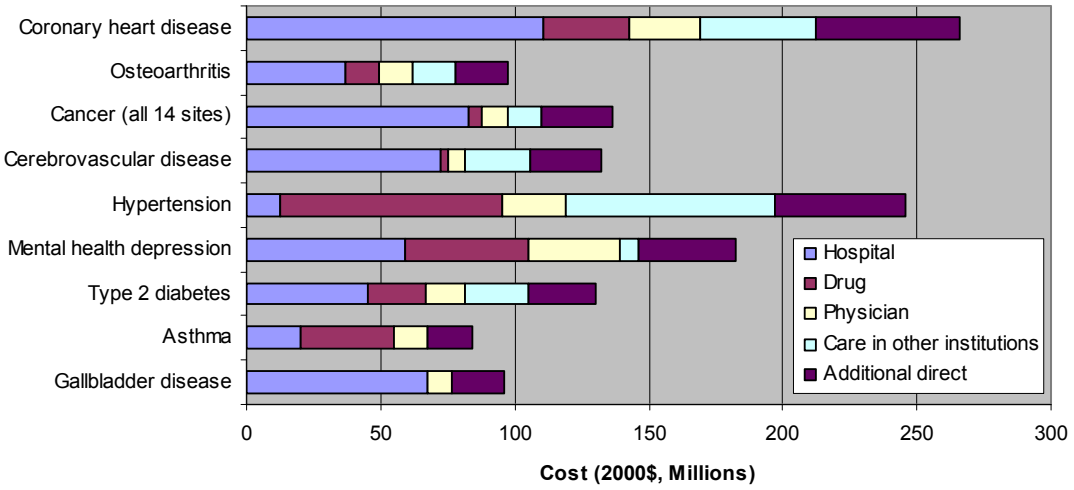
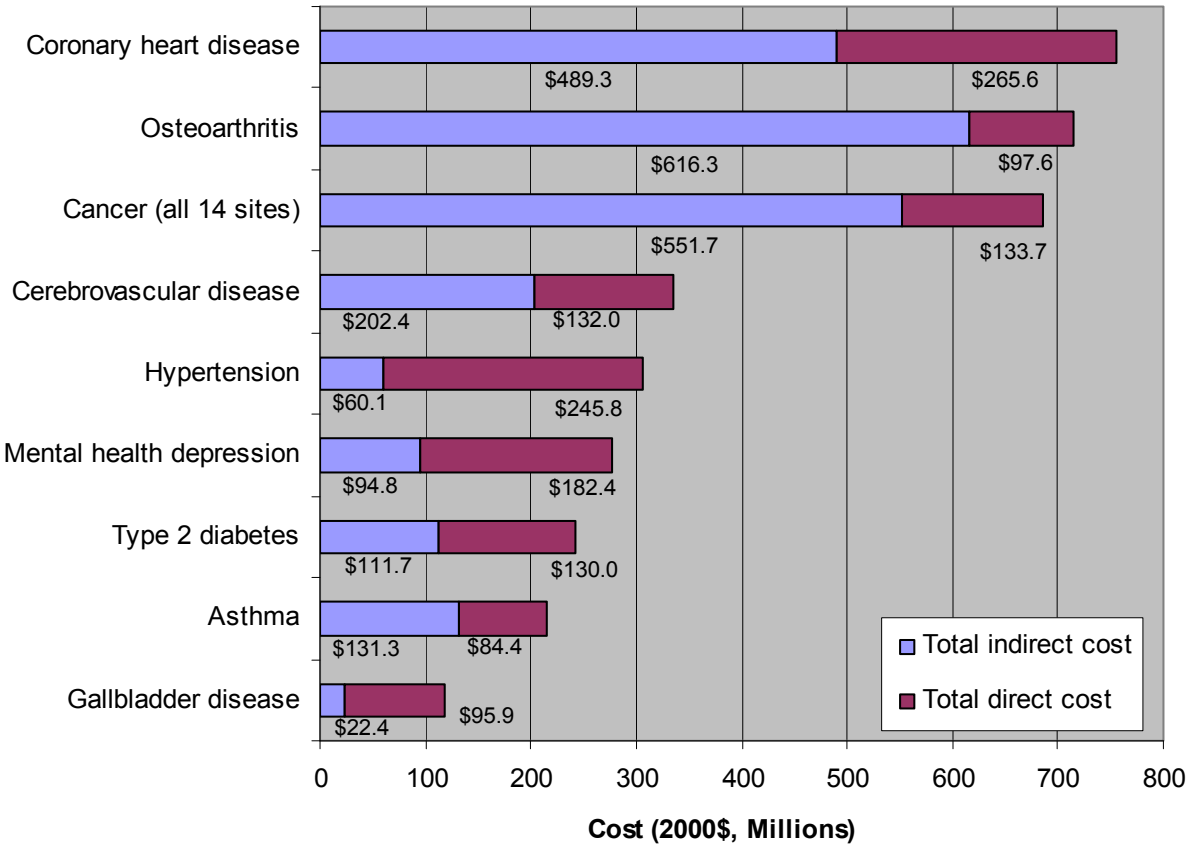


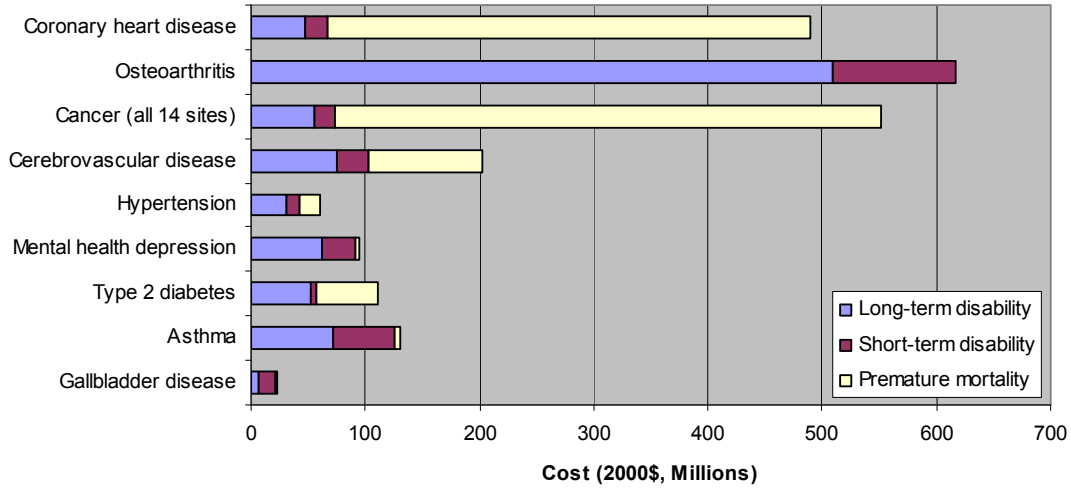
Figure 7: Distribution of annual direct costs of health conditions partially attributable to obesity in Alberta (2000$, Millions)



Indirect costs of obesity-related health conditions

Overall, the highest indirect cost of health conditions partially attributable to obesity was for premature mortality, at approximately $1.08 billion or 47.5% of the total indirect cost for the diseases (Figure 8). Short-term disability ($284.8 million) and long-term disability ($912.2 million) represented approximately 12.5% and 40.0% of indirect costs, respectively. Indirect costs show more variation, reflecting the severity of the condition and the impact of each condition on mortality. Premature mortality represented the highest indirect cost for coronary heart disease ($423.2 million), cancer ($477.6 million), cerebrovascular disease ($99.1 million), and type 2 diabetes ($55.6 million). The costs associated with short-term disability were the highest indirect cost of gallbladder disease ($14.6 million), while the costs of long-term disability represented the highest indirect cost of osteoarthritis ($509.8 million), hypertension ($30.9 million), mental health/depression ($61.7 million), and asthma ($72.0 million).

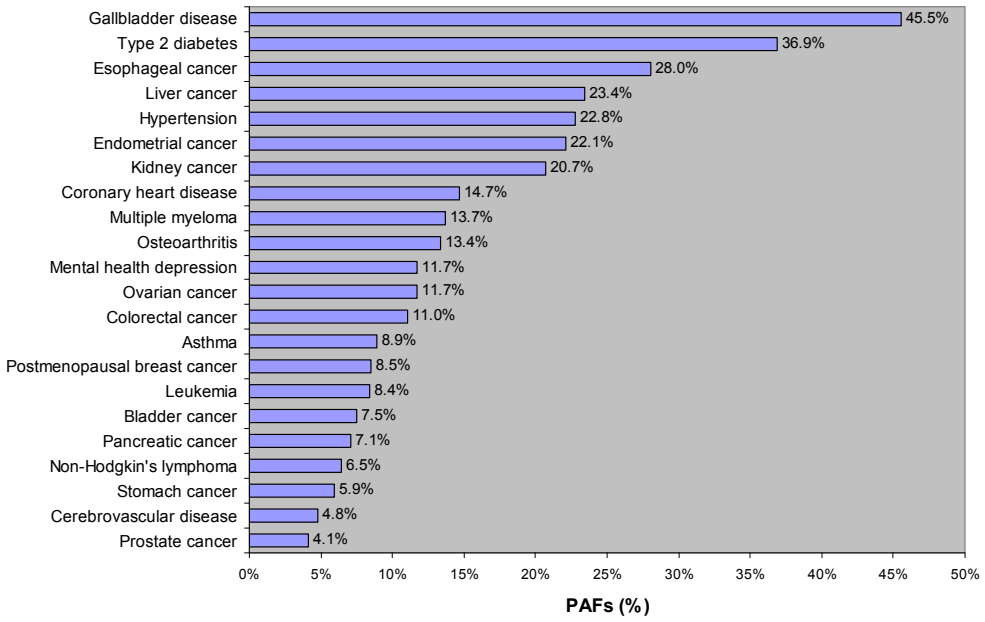
Figure 8: Distribution of annual indirect costs of health conditions partially attributable to obesity in Alberta (2000$, Millions)



Population Attributable Fractions for Disease Prevalence and Mortality

Figure 9 illustrates the Population Attributable Fractions (PAFs) for the prevalence of the 22 health conditions that was attributed to excess weight among Canadians over 15 years of age in 2004-2005. Overall, gallbladder disease (45.5%) and type 2 diabetes (36.9%) were most attributable to total obesity, followed by esophageal cancer (28.0%), liver cancer (23.4%), hypertension (22.8%), and endometrial cancer (22.1%).

Figure 9: Specific health conditions (%) attributable to obesity (BMI≥30) for the population aged ≥15 years, Canada, 2004-2005



Variation by Sex

Among males and females, the health conditions that were most attributed to obesity were gallbladder disease (67.3% in males, 38.3% in females) and type 2 diabetes (41.2% in males, 32.0% in females). Esophageal cancer (30.4%), liver cancer (28.2%), and kidney cancer (25.6%) were the next highest obesity-attributable health conditions among males. In contrast, hypertension (22.8%), endometrial cancer (22.1%), and esophageal cancer (19.3%) were the next highest obesity-attributable health conditions in females.

In general, men had higher percentages of illnesses that were attributable to obesity than females, with the exception of depression, asthma, leukemia, non-Hodgkin's lymphoma, pancreatic cancer, and cerebrovascular disease, which were higher among females. The percentage of hypertension attributable to obesity was identical for both sexes.

Of the health conditions that occur in both sexes, the differences in percentage of illness attributable to obesity between men and women were greatest for:

- Gallbladder disease - 29 percentage points higher among males than females;
- Liver cancer – 15.1 percentage points higher among males than females;
- Esophageal cancer -11.1 percentage points higher among males than females; and,
- Stomach cancer - 10.0 percentage points higher among males than females

Variation by Age

Overall, the percentage of health conditions that were attributable to obesity decreased with age. The highest percentage of disease attributable to obesity occurred in the 35-64 year old age group for most health conditions, including type 2 diabetes (43.5%), coronary heart disease (30.7%), cerebrovascular disease (13.4%), hypertension (32.5%), and mental health/depression (13.3%). For each of these conditions, the percentage of illness attributable to obesity was lowest in the oldest age group (ages 65 years and older). The highest percentage of osteoarthritis attributable to obesity occurred among individuals aged 15-34 years and decreased with age, reaching 7.4% among individuals aged 65 years and older. The decreasing percentage of illness

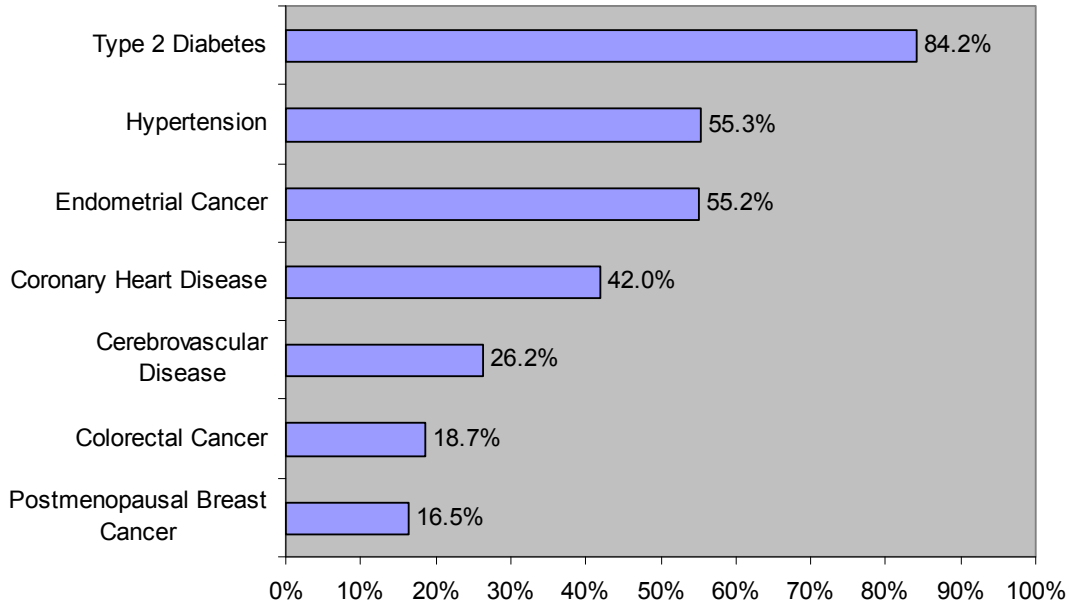
attributable to obesity that occurs with increasing age is largely explained by the fact that disease risk is higher in older age groups, but is less due to specific risk factors like obesity. The percentage of asthma attributable to obesity increased with age, and asthma was the only disease to have the highest attributable percentage (14.2%) among people aged 65 years and older.

There were relatively few cases of gallbladder disease compared to other illnesses. Therefore, the age-specific distribution was assessed for ages <55 years and ≥55 years and are not strictly comparable with the age groups used for other health conditions. 57.3% of gallbladder disease among individuals younger than 55 years and 28.5% of gallbladder disease among individuals aged 55 years and older age group was attributable to obesity.

Premature mortality

PAFs for premature mortality were only available for seven of the diseases (Figure 10). Premature mortality costs for the other diseases were based on the PAF for all-cause mortality as estimated by the World Health Organization global burden of disease study, which was 10.0%.[46] Type 2 diabetes had the highest mortality-specific PAF, with 84.2% of premature mortality attributable to overweight and obesity. Premature mortality from hypertension and endometrial cancer is also strongly associated with obesity, with 55.3% of mortality associated with hypertension and 55.2% of mortality associated with endometrial cancer being attributable to overweight and obesity. Colorectal cancer and postmenopausal breast cancer have multi-factorial risks related to mortality, therefore the obesity-attributable premature mortality associated with these conditions is moderate (18.7% and 16.5%, respectively)

Figure 10: Premature mortality (%) from selected diseases attributable to overweight and obesity (BMI≥25) for the population aged ≥30 years, WHO America-A sub region (Canada, United States and Cuba) [47]



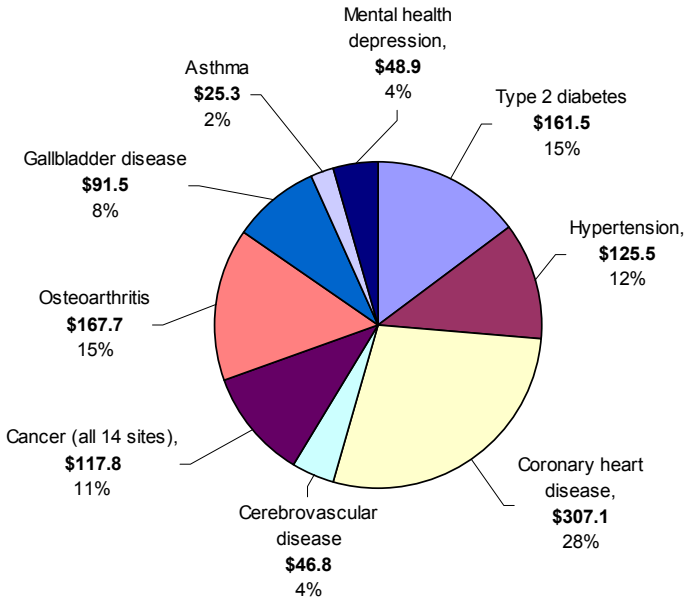
Costs Attributable to Overweight and Obesity in Alberta

In 2005, the total direct and indirect costs of illnesses that were attributable to obesity in Alberta were $1.27 billion (2005$). This cost represents 28.0% of the total direct and indirect costs of the 22 specific health conditions analyzed in this study and 5.6% of the total direct and indirect costs for all health conditions in Alberta (when all costs are inflated to 2005$).

Health Conditions

Coronary heart disease ($307.1 million) had the highest direct and indirect costs attributable to overweight and obese BMI status in Alberta in 2000 (with the costs inflated to 2005 dollars) (Figure 11). Osteoarthritis ($167.7 million), type 2 diabetes ($161.5 million), hypertension ($125.5 million), and the 14 cancer sites ($117.5 million) had the highest obesity-attributable costs after coronary heart disease. Among the 14 cancer sites, colorectal cancer ($31.6 million), postmenopausal breast cancer ($14.5 million), and leukemia ($11.0 million) had the highest costs attributable to overweight and obesity in Alberta.

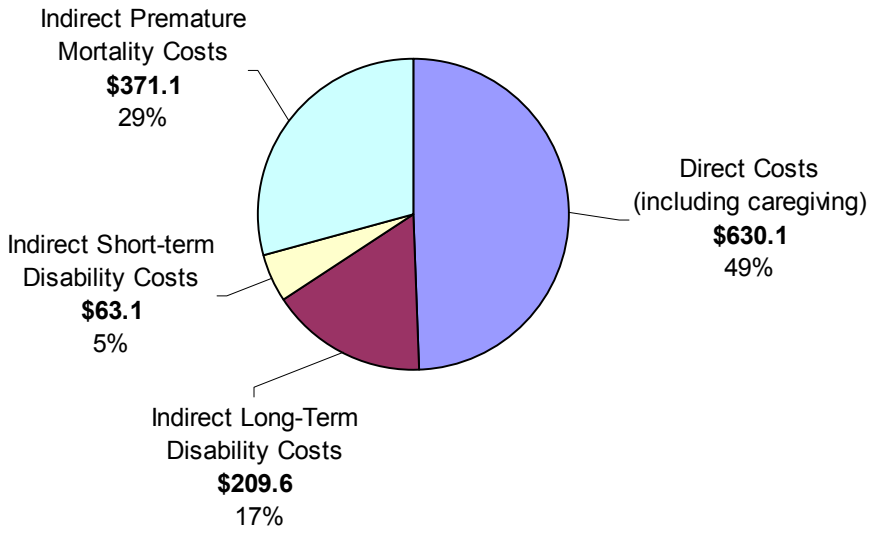
Figure 11: Total annual costs (2005$, Millions) attributable to overweight and obese BMI status in Alberta, by health condition



Direct and indirect costs

In 2005, the direct health care cost attributable to overweight and obesity was $630.1 million, or 49.5% of the total cost of overweight and obesity (Figure 12). These direct costs included $448.3 million in overweight and obesity-attributable costs of the 22 health conditions, and $181.8 million in obesity-attributable costs for caregiving that could not be assigned to specific health conditions. The indirect cost attributable to overweight and obesity was $643.8 million, representing 50.5% of the total cost of overweight and obesity. This included $63.1 million in short-term disability costs, $209.6 million in long-term disability costs, and $371.1 million in premature mortality costs attributable to overweight and obesity.

Figure 12: Total annual cost (2005$ Millions) and distribution of direct and indirect costs attributable to overweight and obese BMI status in Alberta

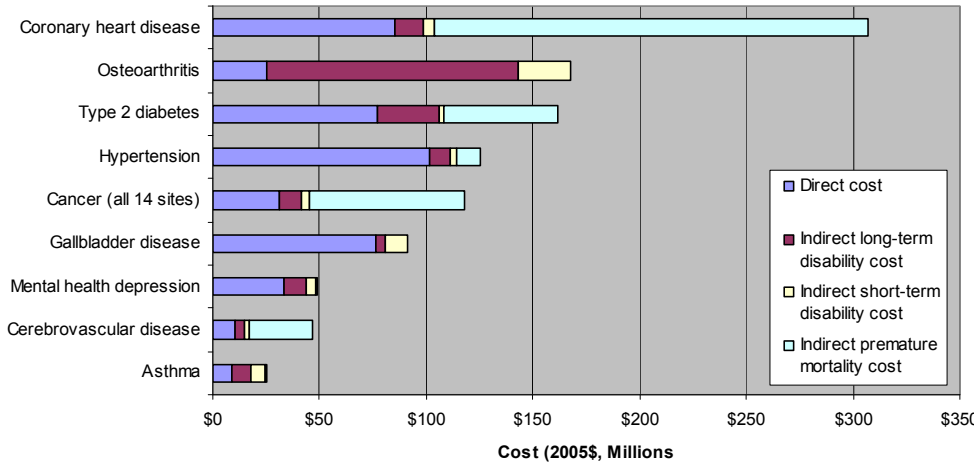


Direct and indirect costs attributable to overweight and obese BMI status, by health condition

Direct costs made up the highest percentage of costs attributable to excess weight for hypertension ($101.5 million, 80.9%), type 2 diabetes ($76.9 million, 47.6%), gallbladder disease ($76.5 million, 83.6%), and mental health/depression ($33.3 million, 68.1%)

(Figure 13). Indirect premature mortality incurred the highest percentage of obesity-attributable costs for coronary heart disease ($203.3 million, 66.2%), all cancer sites combined ($72.5 million, 61.6%), and cerebrovascular disease (29.7 million, 63.5%). The highest obesity-attributable costs associated with osteoarthritis were indirect long-term disability costs were the highest obesity-attributable costs of both osteoarthritis ($117.8 million, 70.2%) and asthma ($9.1 million, 36.2%).

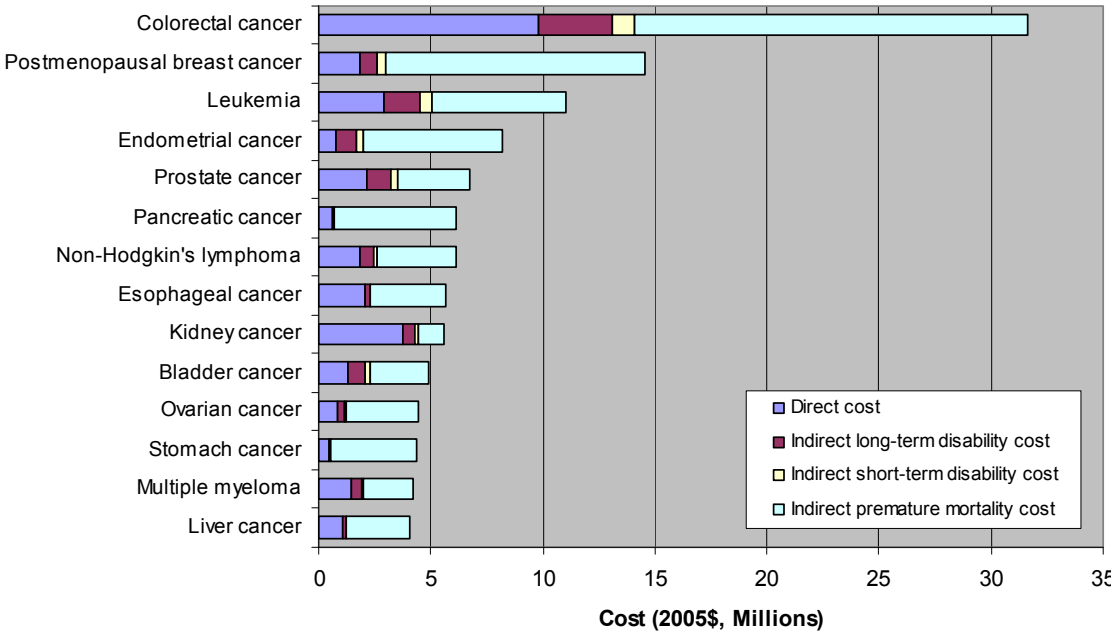
Figure 13: Annual direct and indirect costs attributable to overweight and obese BMI status among Albertans aged ≥15 years, by health condition (2005$ Millions)



Direct and indirect costs attributable to overweight and obese BMI status, by cancer site

Direct costs represent the highest percentage of obesity-attributable costs for kidney cancer; however, for all other cancer sites, the cost of premature mortality makes up the highest percentage of costs attributable to excess weight (Figure 14). $31.6 million of the total cost of colorectal cancer can be attributed to obesity and overweight BMI status. This is more than double the $14.8 million obesity-attributable costs of postmenopausal breast cancer, which has the second highest obesity-attributable costs of all cancer sites. Leukemia had the next highest costs attributable to an overweight or obese BMI status, at $11.0 million. Given that colorectal cancer and breast cancer are among the top 3 incident cancers in Alberta, and that the population is aging, it is likely that the costs associated with these types of cancer will be even higher in the future. Preventing or reducing obesity could produce substantial reductions in the costs associated with these common cancers.

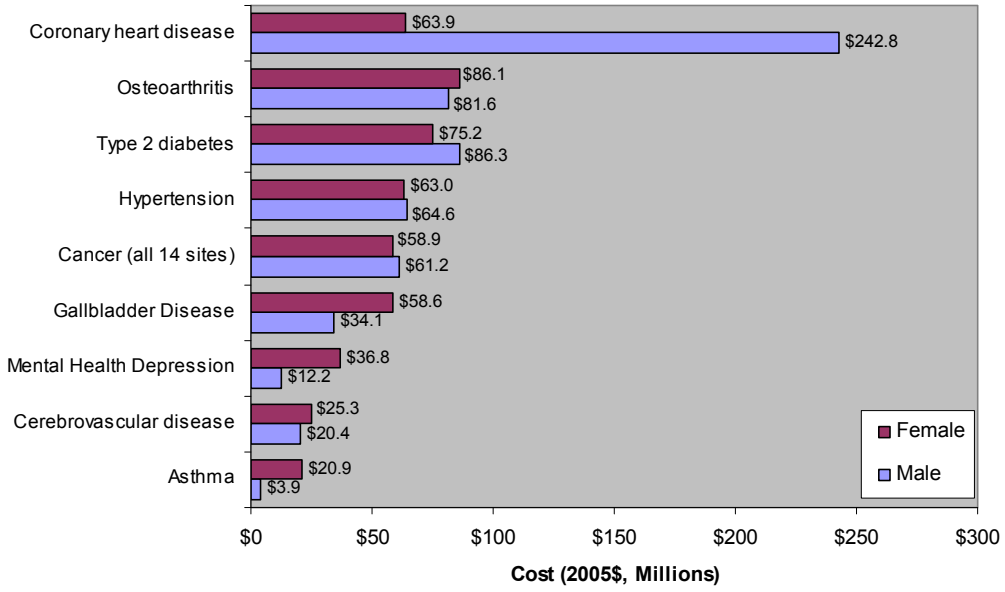
Figure 14: Annual direct and indirect costs attributable to overweight and obese BMI status among Albertans aged ≥15 years, by cancer site (2005$ Millions)



Costs attributable to obese and overweight BMI status, by sex

Overall, the costs attributable to overweight and obesity were greater among males (55.4% of total costs, $607.2 million, $2005) than females (44.6% of total costs, $488.7 million, $2005). This difference is largely due to the high obesity-attributable cost of coronary heart disease in males relative to females ($242.8 million in males compared to $63.9 million in females, $2005). With the exception of coronary heart disease and type 2 diabetes, females have higher costs attributable to excess weight for most of the other health conditions. The obesity-attributable costs of all cancer sites combined and hypertension were similar among males and females.

Figure 15: Annual costs of overweight and obese BMI status among Albertans aged ≥15 years, by sex ($2005 Millions)



Key Findings of the Cost of Obesity in Alberta Report

This study estimated the costs attributable to overweight and obese BMI status for the year 2005 in Alberta using data on the prevalence of obesity and 22 health conditions that are associated with obesity and the costs associated with each of these health conditions.

There were $1.27 billion (2005$) in direct and indirect costs attributable to overweight and obese BMI status in Alberta in 2005. This represents 5.6% of the total direct and indirect costs for all healthcare expenditures in Alberta, and 28.0% of the total costs associated with the 22 specific health conditions that were partially attributable to overweight and obesity and analyzed in this study.

Indirect costs of short and long term disability and premature mortality accounted for 50.5% ($643.5 million) of the total costs attributable to overweight and obesity. Direct costs represented 49.5 % ($630.1 million) of the total costs attributable to overweight and obesity.

Of the 22 diseases analyzed, coronary heart disease ($307.1 million) had the highest direct and indirect costs attributable to overweight and obesity in Alberta in 2005. Osteoarthritis (167.7 million), type 2 diabetes ($161.5 million), hypertension ($125.5 million), and the 14 cancer sites combined ($117.8 million) had the top 5 attributable costs, respectively. The potential for cost savings is greatest for conditions that have a high percentage of illness attributable to obesity, such as type 2 diabetes (36.9% attributable to obesity) and conditions that affect a large part of the population and have high associated costs, such as coronary heart disease (total costs of $754.9 million). In contrast, for conditions like breast cancer, which is only 8.5% attributable to obesity, the potential cost savings are lower.

The estimated costs attributable to overweight and obesity in the Alberta population represent a considerable economic and social cost not only to the Alberta health care system, but also (i) to the province's private enterprises and businesses through lost production, (ii) to individuals through out-of-pocket, care giving, and unpaid costs, and (iii) to society as a whole through the total costs of a population living with less than optimal health. If only a portion of the costs of illness attributable to overweight and

obesity could be reduced, the result would be less spending on illness and a healthier population in general.

Applications of These Findings in Alberta

The findings of this study reveal that 60.9% of Albertan adults are either overweight or obese, and that excess weight contributes $1.27 billion ($2005) per year in direct and indirect health care costs within the province. This dollar figure represents the potential savings to Alberta if interventions could bring everyone in Alberta to a healthy weight. While bringing everyone to a healthy weight may be unrealistic, this research can help to identify segments of the population who would benefit most from targeted interventions and where potential cost savings are highest. These findings can be used to inform future health policy, programming and research.

Although a review of interventions to reduce and prevent obesity was beyond the scope of this current study, it is clear from this study that these interventions are necessary and could result in significant reductions in the prevalence of chronic diseases and their associated costs. At a basic level, weight gain occurs over time when the amount of energy consumed is consistently greater than the amount of energy expended through metabolism and daily physical activity. Although individuals make choices about their dietary behaviours and physical activity levels, the root causes of overweight and obesity are much more complex and numerous. Research suggests environmental, behavioural, social, cultural and genetic factors all contribute to the development of overweight and obesity.[48] Examples of these factors include modern lifestyles, work environments, urban design and obesogenic (obesity-producing) environments, transportation systems, food production systems, technological developments, and economic growth itself.[49]

Given the complexity of obesity, prevention and reduction interventions will require cooperation across all sectors of society and levels of government. In addition to education and awareness-raising strategies, social, economic, physical and environmental determinants must be addressed to create environments that are supportive of healthy choices.[50] The results of this study can be used to justify obesity prevention and reduction policies and programs, and motivate health policy decision makers to act on this issue. Furthermore, these results are useful for targeting obesity

interventions towards segments of the population where obesity-attributable costs are highest, therefore optimizing the potential cost savings associated with interventions.

The report can also serve as baseline evidence to measure progress over time with respect to obesity prevention and reduction interventions targeting Albertan adults and specific segments of the province's population. Completing future studies of obesity-related costs, and comparing the results of future studies with the costs established in this current work will assist health policy and program analysts in quantifying net benefits of programs and policies intended to reduce excess weight in the population.

Future Areas for Investigation

The process of determining the costs attributable to obesity identified areas where future research would be highly valuable:

- This report does not consider the potential costs of interventions intended to help the population achieve healthy weights. Understanding the costs and effectiveness of such interventions is a necessary next step in dealing with the high rates of obesity in the population, and will enable the completion of return on investment (ROI) analyses.

- As previously indicated, the costs of obesity in Aboriginal populations and children could not be included. Opportunities to examine the cost of obesity in each of these populations and other special populations to obtain a more accurate estimate of the total costs of obesity in Alberta should be explored.

- This report identifies many areas where data limitations made it impossible to complete the cost calculations with the highest degree of accuracy. Areas for improvement in data availability and quality include: More recent data on cost of illnesses, disease prevalence (including those diseases attributable to obesity that could not be included in this report), directly-measured obesity prevalence (as opposed to self-reported), determination of PAFs for premature mortality for a broader range of diseases, and obesity-attributable costs that could not be included in this study. While improvements in data availability could increase the precision of future obesity cost estimates, this study has improved upon past costing estimates by using directly-measured BMI data rather than self-reported data, estimating costs for a broader range of health conditions, and including cost breakdowns by age, sex, and obesity classes.

- The costs attributable to obesity were higher in certain segments of the population. Further academic and applied research is necessary to determine the most effective obesity prevention and reduction initiatives for target populations, as identified in this report:

- Albertan males have a combined prevalence of overweight and obesity of 68.8% (Figure 3) and incur 55% of the total obesity-attributable costs in Alberta. Interventions that effectively prevent and reduce obesity in adult males could produce substantial reductions in Alberta's healthcare costs.

- Between the ages of 25 and 54, the percentage of Albertan adults who have higher than normal BMI increases by over 20% (Figure 4). The highest percentages of obesity-attributable diseases were found among adults age 36-65 years, indicating that the reduction of excess weight among this population could substantially reduce the prevalence of the 22 health conditions and their associated costs. Interventions are needed to prevent the weight gain that occurs after the age of 25, as well as to reduce excess weight among middle-aged adults.

Conclusion

The increasing prevalence of obesity over the last several decades represents a significant public health concern in Alberta and other developed countries. Obesity is associated with an increased risk of multiple chronic diseases and adverse health outcomes, such as cardiovascular diseases, type 2 diabetes, numerous types of cancers, and other illnesses. This high prevalence of obesity translates into an economic burden of $1.27 billion (2005$) within the province of Alberta, as estimated by this report. As such, there is a high need for population-level interventions that will effectively prevent and reduce excess weight among Albertans.

The findings of this report can provide justification for such interventions (policies and programs), and can help to motivate political decision makers to invest in policies that support the achievement and maintenance of healthy weights, and identify priority target populations for such interventions. Additionally, the report will be useful in evaluating the economic impact of obesity reduction strategies implemented in the future. Despite current knowledge gaps and limitations, the *Cost of Obesity in Alberta* report greatly improves upon past cost of obesity reports and represents the most accurate and up to date determination of obesity costs in Alberta.

The Cost of Obesity in Alberta Report

The full *Cost of Obesity in Alberta* report provides an extensive review of obesity definitions, obesity prevalence and trends in Alberta, and the findings of the literature review undertaken to identify the 22 chronic health conditions that were partially attributable to excess body weight in the population.

The report also delivers a comprehensive overview of the methodology used to determine population attributable risk factors (PAFs), the direct and indirect costs associated with each disease, and the percentages of total costs attributable to obesity. Furthermore, the full report presents more detailed findings regarding the obesity-attributable direct and indirect costs of individual diseases, and across age, sex, and BMI categories.

The full report can be obtained by contacting the Research and Evaluation Unit of Alberta Health Services' Health Promotion, Disease and Injury Prevention.

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