Self-Reported Body Mass Index and its correlates in Alberta: A portrait from survey and administrative data sources

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Executive Summary

The 1996 National Population Health Survey (NPHS) asks respondents to report their height and weight. From these, an estimate of Body Mass Index (BMI) is calculated. In turn, Health Canada definitions can be used to assign individuals from their BMI into various classes of obesity. These questions were repeated in the 2001 and 2003 Canadian Community Health Survey.

About 37.5% of Albertans over age 20 were classified as overweight in 1996, 10.3% as obese, and 1.6% as morbidly obese. In 2003, the percentages were 39.7% overweight, 14.3% obese, and 3.2% morbidly obese. There is good reason to believe that these figures underestimate the true rates of obesity in the population.

Apparent rates of overweight, obesity, and morbid obesity increase with age until about age 60 after which there is a decline likely due to premature mortality. There are also differences between the sexes and within income groups in these rates.

Survey responses also indicate that self-reported health status declines and self-reported health care utilization increases for obese and morbidly obese individuals. The rate of change appears to accelerate as BMI increases.

Measures of actual health care utilization were derived from linked records maintained by Alberta Health and Wellness for administrative purposes. These appear to confirm that health utilization is higher for obese and morbidly obese individuals for at least three years before and at least 1 year after the survey.

If the incidence of obesity does not change, the number of individuals who are obese is projected to increase in Alberta over the coming decades due to aging of the population. This would translate into poorer population health, and higher health care needs as time goes on.

The report also includes technical discussions of the measurement of childhood obesity, the relationship between obesity and specific chronic diseases, and general cost benefit considerations for interventions in persons with severe obesity.

This report underlines the importance of establishing regular monitoring of obesity, its primary risk factors (diet and level of activity), and the social-environmental factors that influence obesity levels. This will also require resolution of measurement issues as effective obesity measurement for children and youth, and the calibration of self-reported and directly measured BMI.

Acknowledgments

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Table of Contents

List of Figures

List of Tables

Introduction

An Epidemic of Obesity

Obesity has recently been called an epidemic in Canada (CIHI, 2003, 2003b). It is identified as a risk factor for a large number of chronic diseases, and is therefore extremely costly to Canadians and their Health Care system. The causes of obesity are complex, varied, and deeply imbedded in societal norms and behavior (CIHI, 2004; Gilman, 2004). It has been argued that public health agencies and government have a responsibility to transform the current social environment into one that no longer leads to obesity but becomes more health promoting.

The current report presents data from national health surveys and linked provincial administrative databases on obesity trends amongst Albertans and the impact of these trends.

Body Mass Index (BMI) and Obesity

Obesity is not straightforward to measure accurately or reliably. A variety of measurement operations have been proposed. The most complex include densitometry, bioelectrical resistance, dual energy x-ray, and CT/MRI scanning. More often various physical measurements are used. These include hip and waist size and their ratio; and height and weight and their combination into a Body Mass Index (BMI). The BMI is currently the most commonly used measure in evaluations of large numbers of people.

Unfortunately, currently available administrative data do not provide sound estimates of the prevalence of obesity because measured height and weight are not part of data reported electronically to health authorities and provincial government agencies as part of routine health care administration. As a result, the prevalence of obesity is typically estimated from self-reported height and weight gathered in health surveys.

As has long been suspected, there is a difference between self-reported height and weight, and height and weight as measured by a health professional. In a recent study in Prince Edward Island (MacLellan, Taylor, Van Til, & Sweet, 2004), measured height and weight resulted in an estimate of the number of individuals in obesity categories that was 1.84 times higher than when calculated from self-reported height and weight.

The current report presents BMI for Albertans based upon self-reported height and weight from the 1996 National Population Health Survey and the 2001 & 2003 Canadian Community Health Surveys (Statistics Canada, 2004). It also presents information about health utilization from administrative records linked to responses from the National Population Health Survey.

Because this data is from self-report surveys, the prevalence of obesity is underestimated. This will also result in underestimates of other quantities related to levels of obesity. However, the patterns of change in other health measures as BMI increases are less likely to be affected.

Data Sources

National Population Health Survey & Canadian Community Health Survey

The National Population Health Survey (NPHS) is a major longitudinal health survey conducted by Statistics Canada with the support of Health Canada and the provincial health ministries. In 1996, Alberta Health and Wellness commissioned survey responses from an additional cross-sectional sample of individuals in order to examine health status across the province's health regions. In 2000, the Canadian Community Health Survey (CCHS) was initiated by Statistics Canada as an ongoing comprehensive cross-sectional health survey, and the cross-sectional use of the NPHS was discontinued. The CCHS is administered every two years, and the results for the first two administrations became available in 2001 and 2003.

Both the NPHS and the CCHS are comprehensive in scope, and include questions relevant to an examination of obesity and the characteristics of individuals in various BMI classifications.

Comprehensive information about these surveys, including tabulations of results, are available from Statistics Canada's internet site at

http://www.statcan.ca/english/concepts/hs/index.htm

and at

http://www.statcan.ca/english/freepub/82-221-XIE/free.htm

Record linkage

Comparing survey results with administrative records can help to characterize how individuals who suffer from health problems use public health care services. An important feature of the NPHS survey was that individuals were asked to allow provincial ministries to link their survey responses to administrative records, and were invited to provide their health care identification numbers to allow this linkage to occur.

For those individuals who consented, the Physician Services and the Hospital Morbidity files of the Alberta Health Care Insurance Plan were linked to the NPHS survey responses.

The current report presents findings from the NPHS and the linked Alberta Health and Wellness administrative records to characterize the population according to BMI classification in Alberta.

Measures

Table 1 presents the questions used in the 1996 NPHS to elicit height and weight.

Table 2 presents classification schemes for Adult BMI in use at WHO and Health Canada. These do not differ for categorizations based upon BMI. The current report uses the Health Canada (2003) scheme except that it employs an alternative sub-classification of individuals with BMI > 30. Specifically, a category, Morbidly Obese, is formed for those with a BMI over 40, or with a BMI over 35 in the presence of at least one of the following self-reported health disorders: asthma, bronchitis, emphysema, arthritis, high blood pressure heart disease, diabetes, or ulcers[1]. In tables and diagrams this category will generally be labeled as BMI >40.

Table 1 National Population Health Survey Height and Weight Questions

Height/Weight

HTWT-C1	If female & (age >= 15 & age <= 49), go to HTWT-Q1. Otherwise, go to HTWT-Q2.
HTWT-Q1 *HWC6_1*	It is important to know when analyzing health whether or not the person is pregnant. %Are/Is% %you/FNAME% pregnant? 1 YES 2 NO
HTWT-Q2 *HWC6_2HT*	How tall %are/is% %you/FNAME% without shoes on? ___FEET___INCHES OR ___CENTIMETRES
HTWT-Q3 *HWC6_3*	How much %do/does% %you/FNAME% weigh? _____ (ENTER AMOUNT ONLY.) (MIN: 18) (MAX: 575) DK, R (Go to next section)
HTWT-Q4 *HWC6_4*	INTERVIEWER: WAS THAT IN POUNDS OR IN KILOGRAMS? 1 POUNDS *HWC6_3LB* 2 KILOGRAMS *HWC6_3KG*

Reprinted from http://www.statcan.ca/english/concepts/nphs/nphs1.htm

[1] This category was deemed important for the consideration of surgical procedures for obese individuals. It was developed with the help of a medical consultant in consideration of the available data.

Table 2 Health Canada and World Health Organization BMI Classifications

Health Canada Santé Canada

Canada

Table 6: Weight classifications systems

Canada (1988)°	WHO (2000)°°	Canada (2003)
Body Mass Index (BMI)		
Zone A: <20 May be associated with health problems for some people	Underweight <18.5	Underweight <18.5
Zone B: 20 - 25 Good weight for most people	Normal range 18.50-24.99	Normal 18.5-24.9
Zone C: Between 25 and 27 May lead to health problems in some people	Preobese 25.00-29.99	Overweight 25.0-29.9
Zone D: >27 Increasing risk of developing health problems	Obese class I 30.00-34.99	Obese Class I 30.0-34.9
	Obese class II 35.00-39.99	Obese Class II 35.0-39.9
	Obese class III >= 40.00	Obese Class III >= 40.0
Waist to Hip Ratio cut-offs	**Waist Circumference**	
	Increased risk	Increased risk
Male: 1.0 Female: 0.8	M: >= 94 cm* F: >= 80 cm*	M: >= 102 cm (40 in) F: >= 88 cm (35 in)
	Substantially increased risk	
	M: >= 102 cm* F: >= 88 cm*	

Reprinted from http://www.hc-sc.gc.ca/hpfb-dgpsa/onpp-bppn/weight_book_05_table1_e.html

Subjects

The population under study was Albertans aged 12 and over (or aged four to 11 as reported by a parent or proxy). The total sample size was 15,535 for the 1996 NPHS. The total sample aged over 20 was 11,558 for the 2001 CCHS, and 10,776 for the 2003 CCHS.[2]

Linkage between 1996 NPHS responses and Alberta Health and Wellness administrative databases was successful for 6,012 individuals. This is a relatively low rate and casts doubt on the generalizablility of the results[3]. Linkage between the 2001 and 2003 CCHS responses and Alberta Health and Wellness administrative databases was not pursued for this report.

Analyses

The current report does not generally refer to the statistical apparatus required to estimate the certainty with which differences can be asserted, or the precision of estimates. A detailed discussion of these topics is presented in Appendix 1.

All data analyses were conducted using SPSS (v. 12) software. Technical details are presented in footnotes.

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[2] For each survey, the Provincial Share File version was employed. It differs from the Statistics Canada Master File version by excluding individuals who did not consent to share data with the Provincial Ministries. These represent a small proportion of the total sample size, and have been judged by Statistics Canada not to threaten the stability of analyses. All analyses of survey data employed Share File weights generated by Statistics Canada to correct for the effects of the complex sampling procedure and exclusion of subjects.

3 No child less than age 12 was asked for linkage information. Among those aged 12 or over, those less than 40 were less likely and those over 60 more likely to supply linkage information. Those resident in Edmonton or Calgary were more likely to supply linkage information. Individuals who supplied linkage information also reported more disability days and medical consultations. Finally, individuals in the BMI underweight category were considerably less likely to supply linkage information, while individuals in all other categories were slightly more likely to do so. There were slightly more than 130 linked individuals in the lowest frequency category, the morbidly obese category.

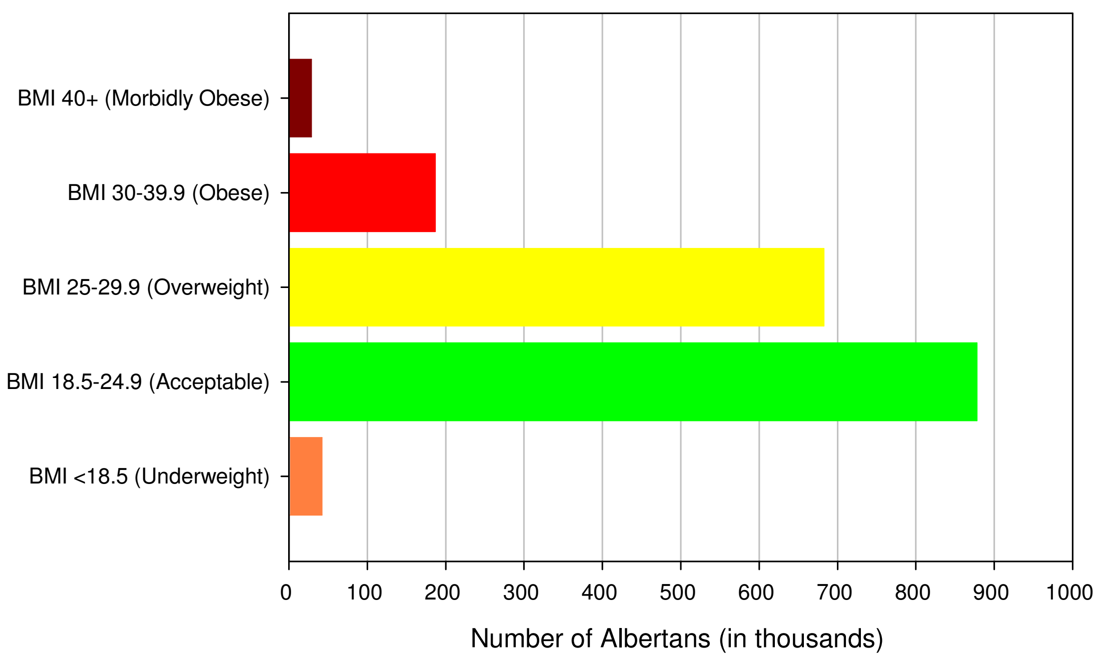
Results

Prevalence by BMI Classification

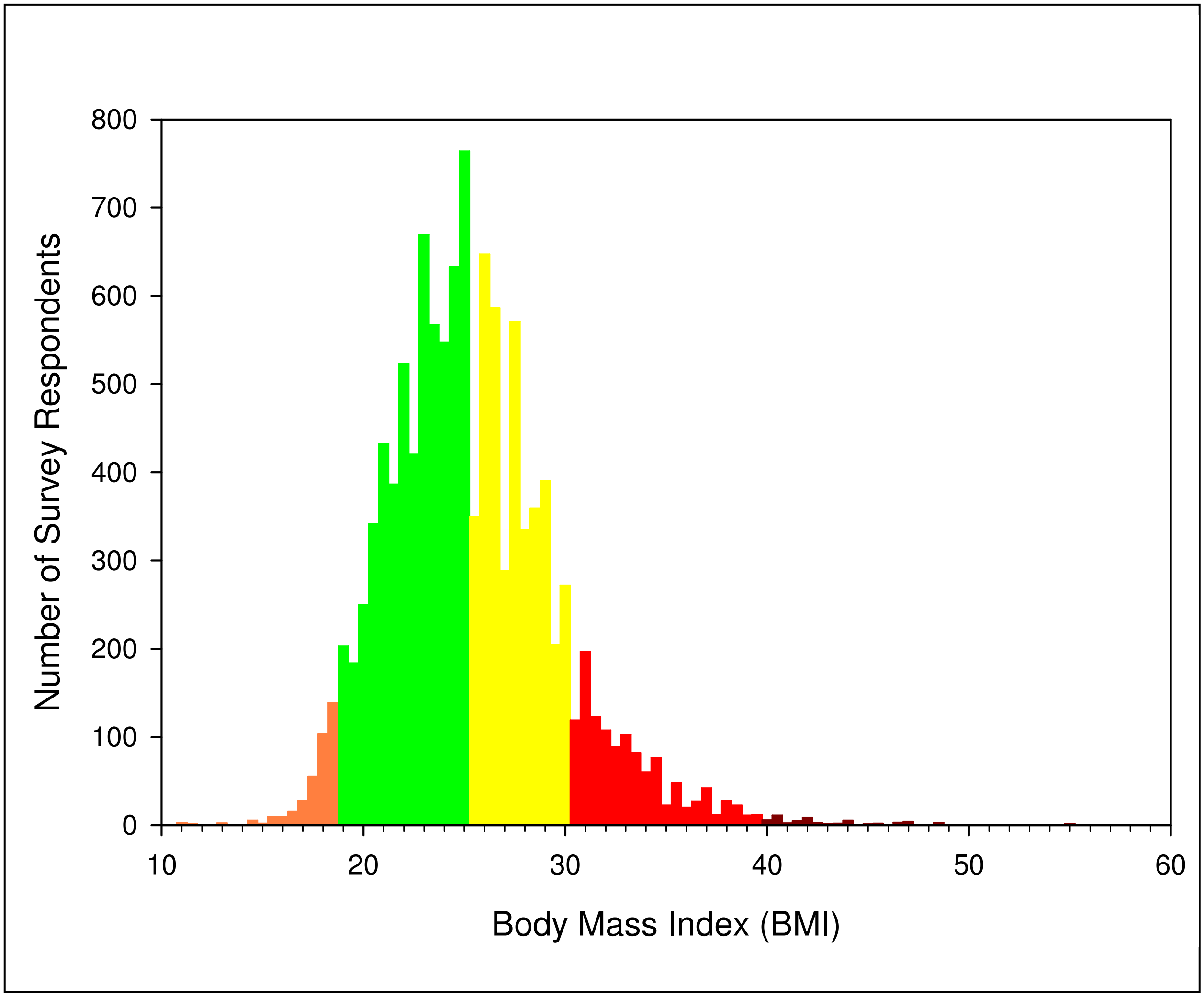
The number of individuals aged twelve or over in Alberta in various BMI categories in 1996 can be estimated[4]. Health Canada does not regard the BMI Classification system, and especially the labels for the categories, to be an accurate reflection of obesity among youth. Appendix 2 presents a detailed consideration of childhood obesity. Table 3 presents the estimated number of individuals in each of the BMI classification groups age 20 or over in 1996. The third panel gives more detailed information about the BMI distribution among the actual survey respondents.

Table 3 Estimated population by BMI Classification

BMI Category	Estimated population 20+ Years of age	Percentage
BMI < 18.5 (Underweight)	42,384	2.3%
BMI 18.5-24.9 (Acceptable)	877,888	48.3%
BMI 25-29.9 (Overweight)	682,804	37.5%
BMI 30-39.9 (Obese)	186,980	10.3%
Morbidly Obese	28,474	1.6%
Total	1,818,529	100%



[4] The NPHS survey weights were post-stratified to the 1996 Census Populations.



Age-sex prevalence

Using the NPHS data, age specific prevalence was calculated for each sex separately for the BMI classification. These are presented in figures 1 and 2.[5]. At each age, these figures show the changing proportions[6] of individuals in each of the BMI categories.

[5] Data were smoothed by fitting a localized regression procedure (cubic spline with multiple knots). After smoothing, the estimates were standardized to total 1.0 and presented as stacked area charts.
[6] Percentages can be obtained by multiplying these proportions by 100.

Figure 1 BMI Classification by age for males

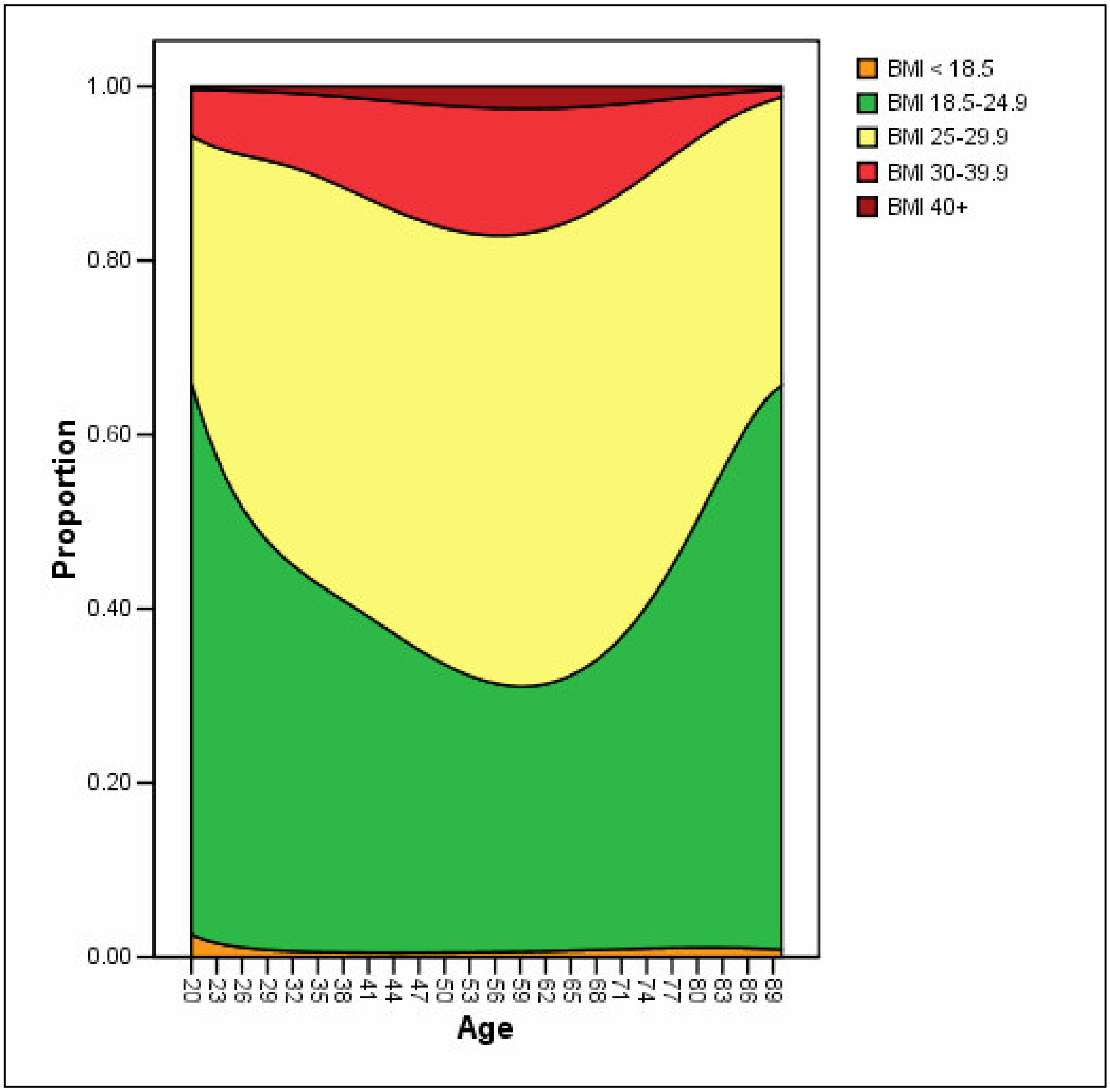
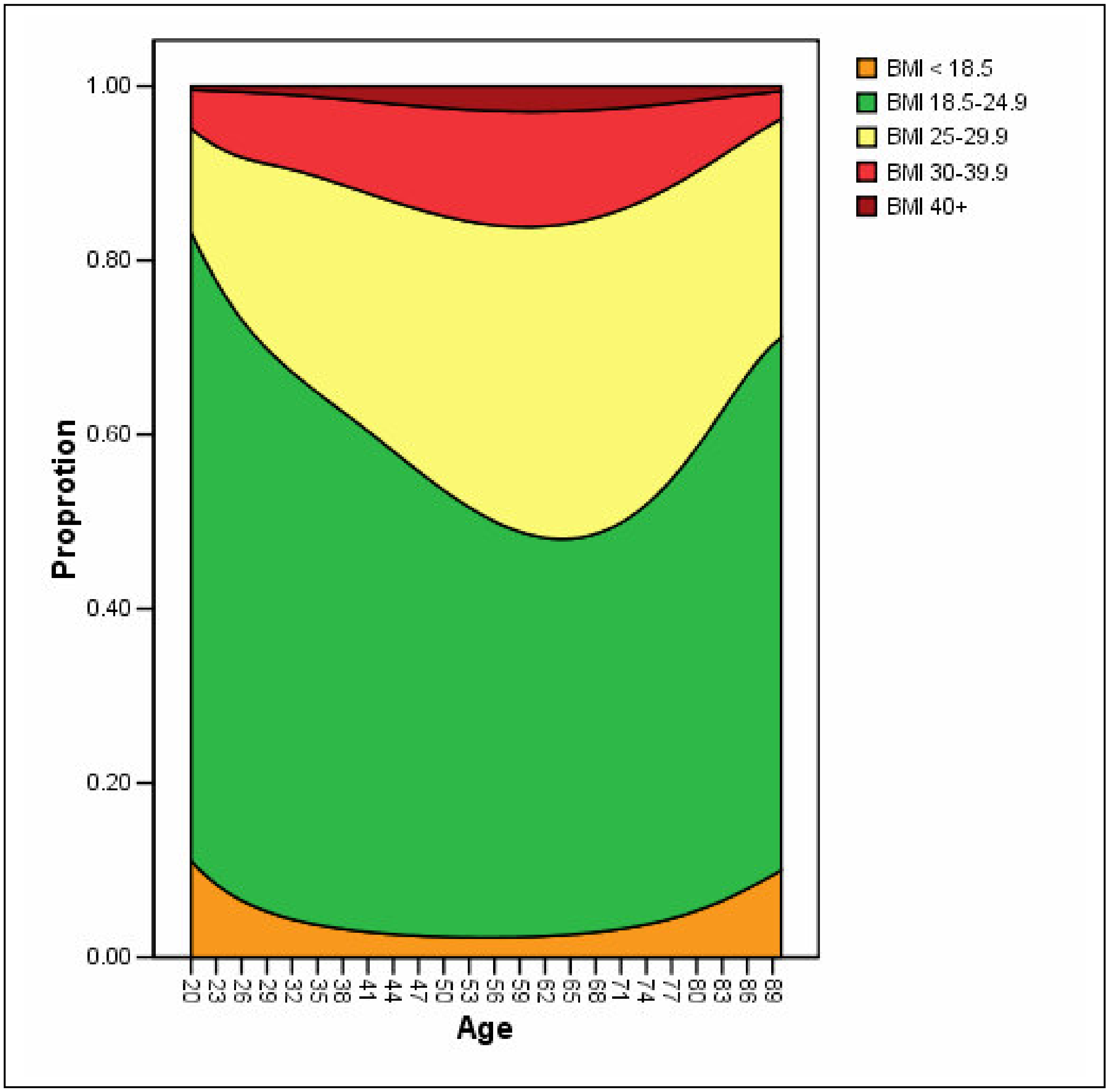


Figure 2 BMI Classification by age for females

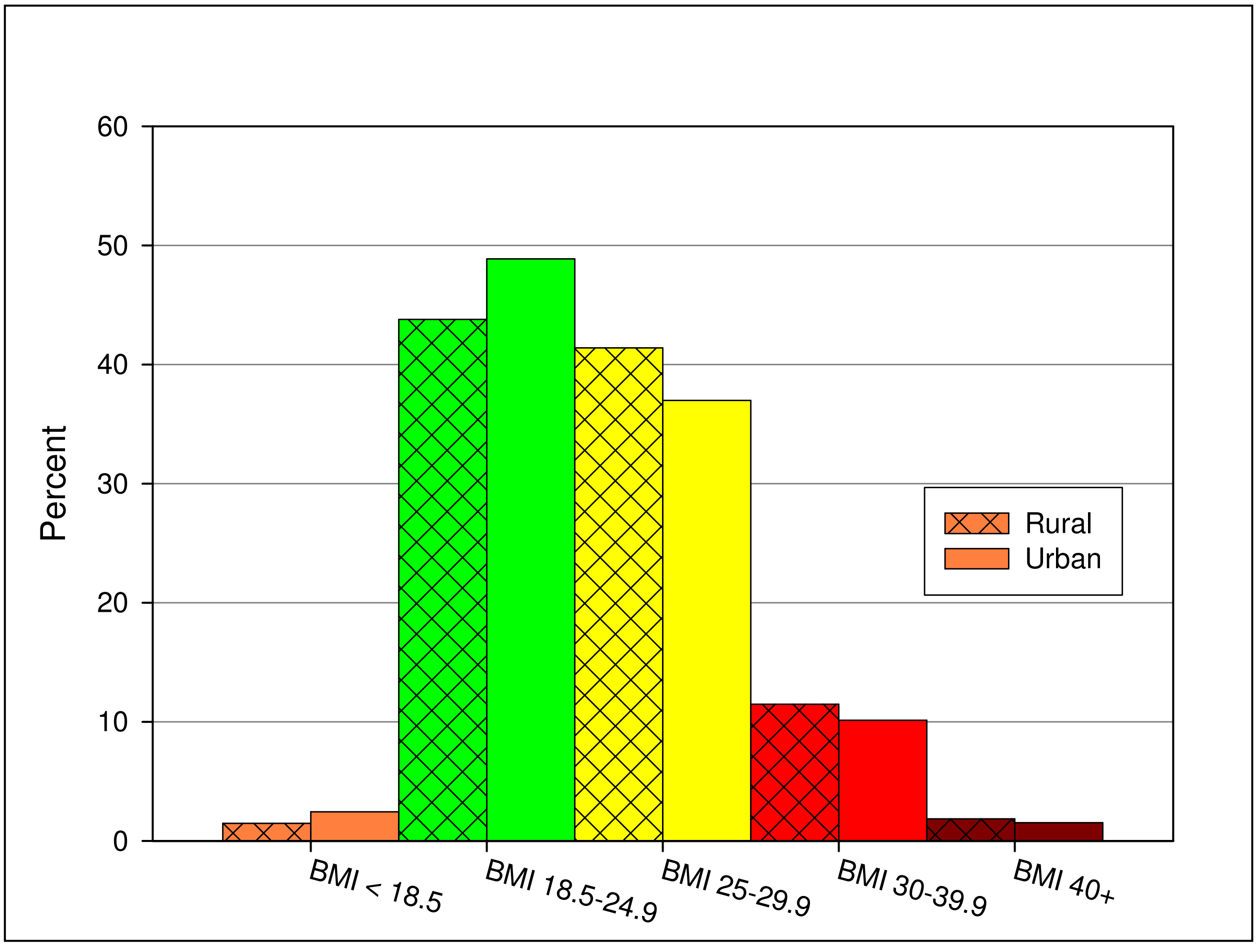


The prevalence of individuals in the overweight (BMI 25-29.9) and obesity categories (BMI 30-39.9, BMI 40+) as a proportion of the total increases markedly with age in both sexes at least until the early to mid sixties. At greater ages, there is a relative decline likely due largely to the increased tendency for individuals in these categories to die prematurely (Fontaine, Redden, Wang, Westfall, & Allison, 2003; Katzmarzyk, Janssen, & Ardem, 2003; Peeters, Barendregt, Willekens, Mackenbach, Mamun, & Bonneaux, 2003). A comparison of the figures shows that females are less likely to be overweight (BMI 25-29.9) than males, though they have similar rates of obesity (BMI 30-39.9) and morbid obesity (BMI 40+).

Prevalence by urban-rural residence, by income level, and by education

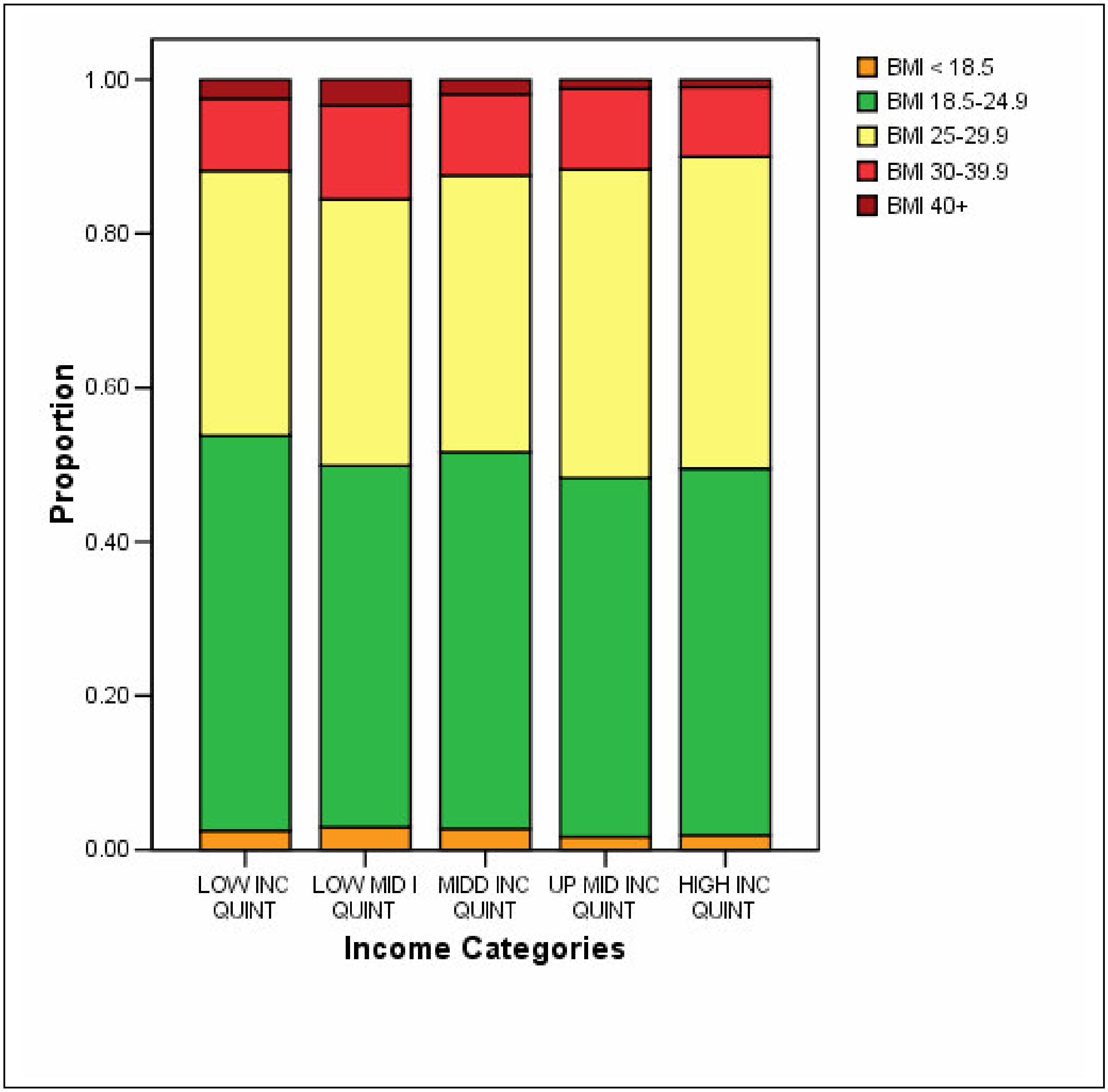
Prevalence estimates were calculated for place of residence. It appears that the entire BMI distribution has been shifted towards greater BMI in the rural population. This results in a larger percentage of individuals in the overweight (BMI 25-29.9) and obese (BMI 30-39.9, BMI 40+) ranges among rural residents.

Figure 3 BMI Distributions by Urban-Rural Status



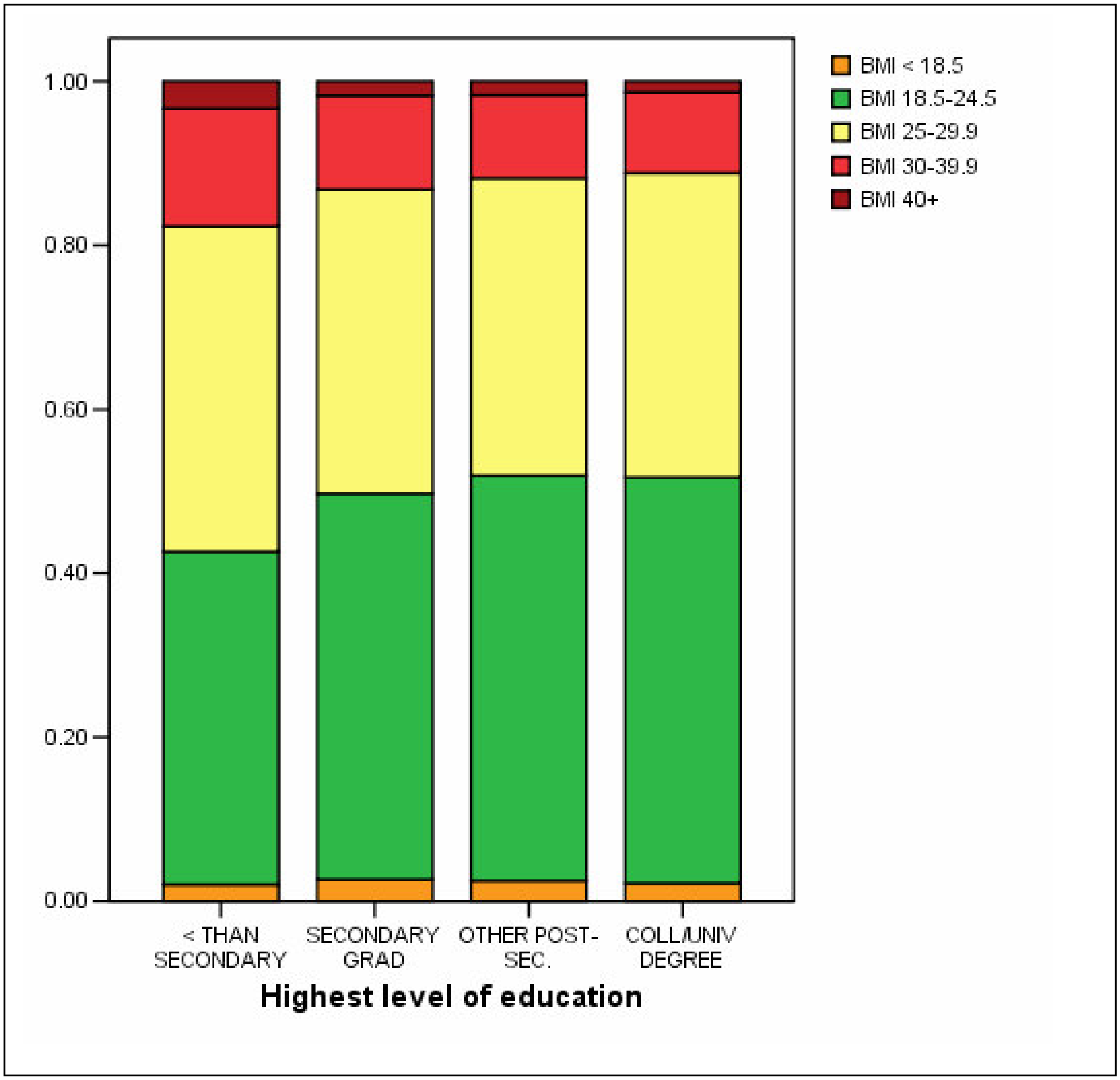
Distributions were calculated for five self-reported family income quintiles. Figure 4 presents the income-specific BMI distributions. Examination reveals that higher incomes are associated with being overweight (BMI 25-29.9), and lower incomes (especially the lower middle quintile) have a larger proportion of both obese (BMI 30-39.9, BMI 40+) and underweight (BMI < 18.5) individuals.

Figure 4 BMI classification by income quintile



Distributions were calculated for four self-reported education attainment levels. Figure 5 presents the education specific BMI distributions. Examination shows that individuals without secondary graduation have higher levels of overweight (BMI 25-29.9), obesity (BMI 30-39.9), and morbid obesity (BMI 40+). Differences between other educational groups do not attain conventional levels of statistical significance.

Figure 5 BMI classification by education level

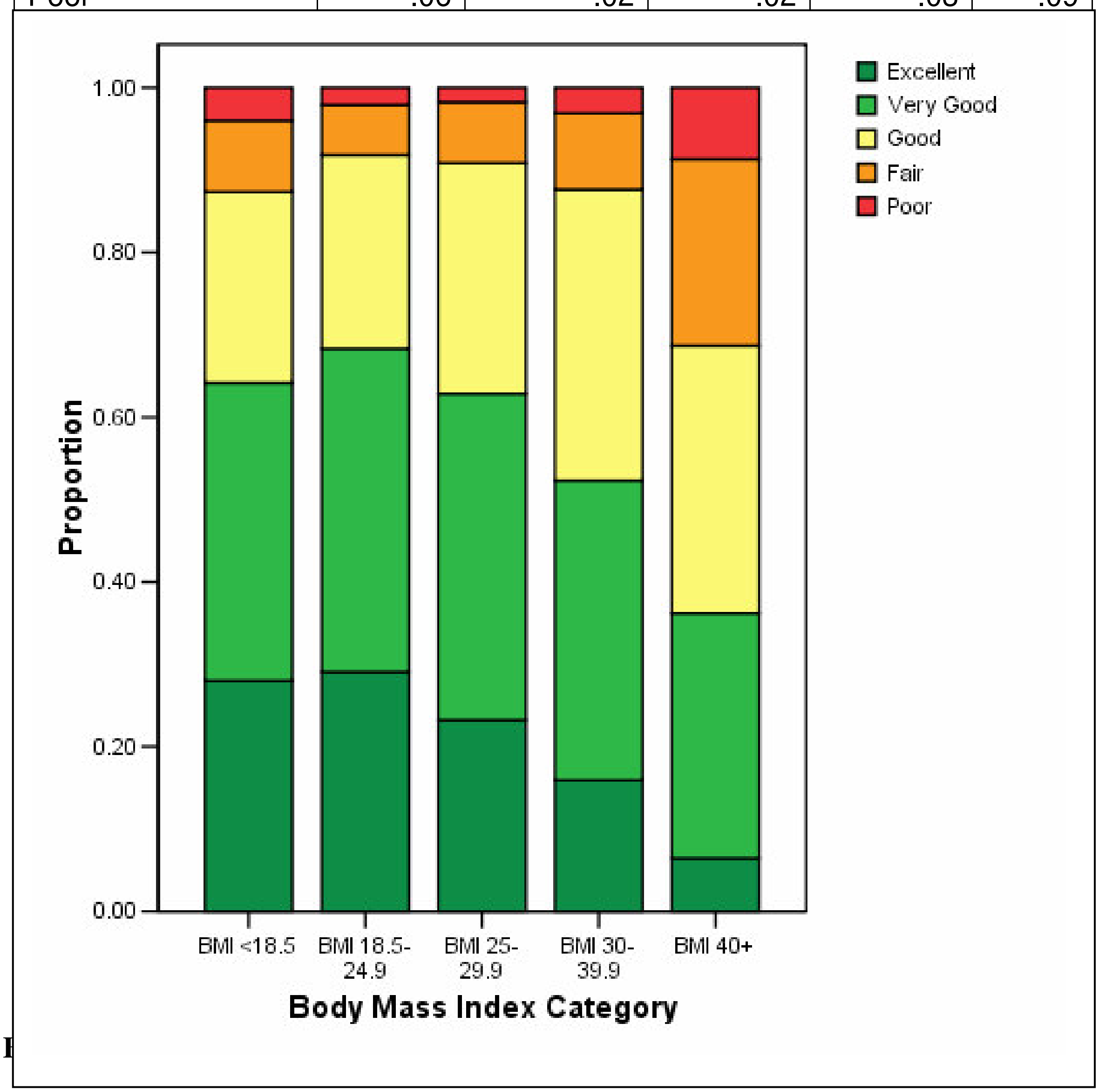


Health status by BMI classification

In this section, self reported health status variables, risk adjusted for age and sex, are presented by BMI Category. The general pattern shows progressively poorer health status through the categories overweight (BMI 25-29.9), obese (BMI 30-39.9), and morbidly obese (BMI 40+). The underweight category (BMI < 18.5) also has poorer health status, but typically to a lesser extent.

Table 4 Proportion of each BMI group in each self-reported health group

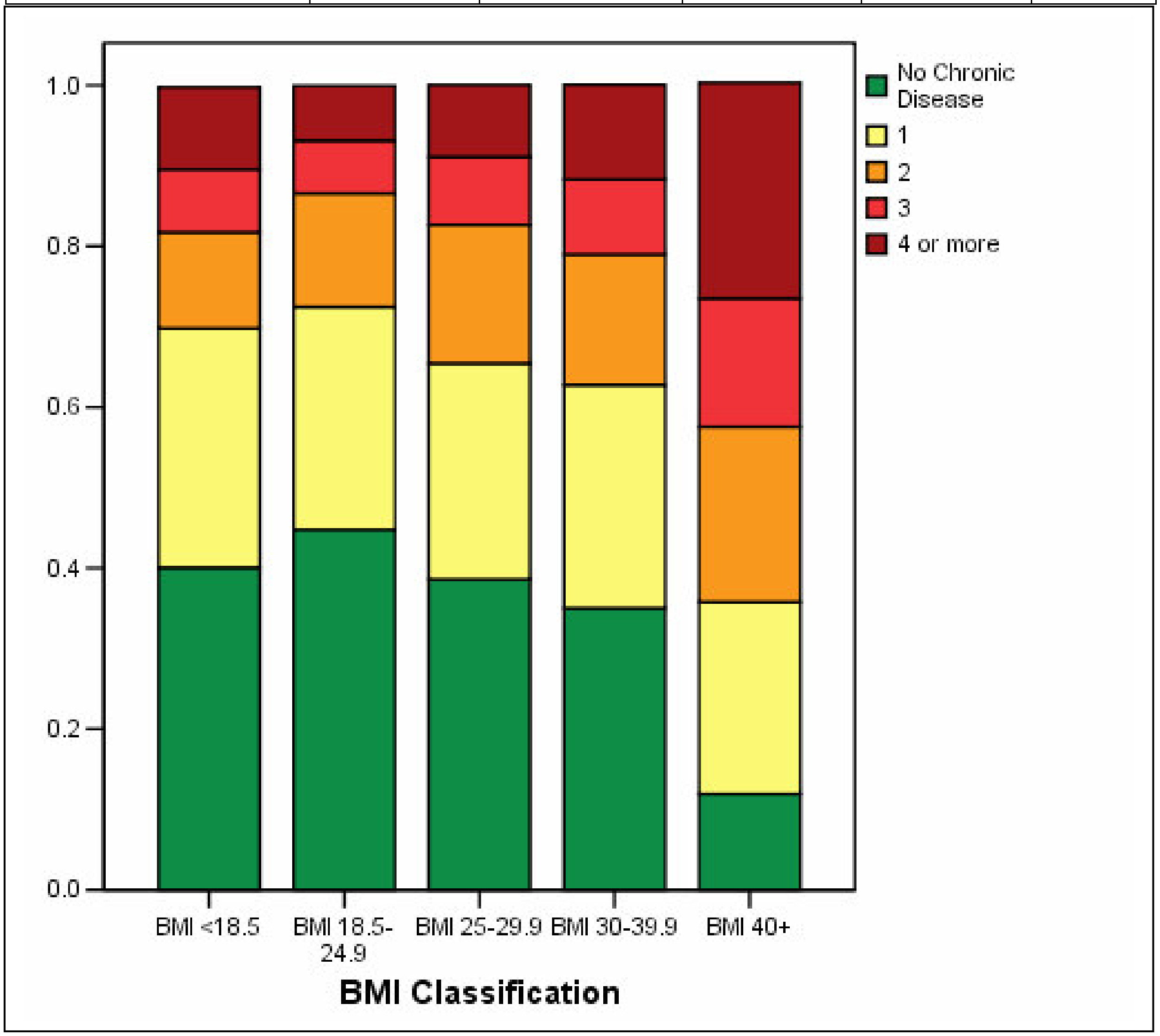
	BMI Classification				
Self Reported Health	BMI < 18.5	BMI 18.5-24.9	BMI 25-29.9	BMI 30-39.9	BMI 40+
Excellent	.32	.30	.23	.16	.07
Very Good	.31	.39	.40	.36	.30
Good	.21	.23	.28	.35	.32
Fair	.10	.06	.07	.09	.22
Poor	.06	.02	.02	.03	.09



The probability of reporting having been diagnosed with one or more chronic conditions is presented in Table 6[7]. A detailed analysis involving the relationships with specific chronic diseases is reported in Appendix 3.

Table 5 Proportion of each BMI group reporting chronic diseases

	BMI Classification				
Number of Chronic Diseases	BMI < 18.5	BMI 18.5-24.9	BMI 25-29.9	BMI 30-39.9	BMI 40+
0	.40	.45	.39	.35	.12
1	.30	.28	.27	.28	.24
2	.12	.14	.17	.16	.22
3	.08	.07	.08	.09	.16
4 or more	.10	.07	.09	.12	.27



[7] The list of Chronic Diseases in the 1996 NPHS Survey is available at http://www.statcan.ca/english/concepts/hs/index.htm

The probability of being diagnosed with Clinical Depression in an examination by a psychiatrist can be estimated from the Composite International Diagnostic Interview (CIDI) endorsed by the World Health Organization and included on the NPHS. Morbid obesity (BMI 40+) is associated with a dramatic increase in the probability of being diagnosed with clinic depression.

Table 6 Probability of suffering clinical depression by BMI group

	BMI Classification				
	BMI < 18.5	BMI 18.5-24.9	BMI 25-29.9	BMI 30-39.9	BMI 40+
Probability of Depression	.05	.06	.06	.06	.13

Table 7 Proportion reporting long-term disabilities or handicaps by BMI group

	BMI Classification				
	BMI < 18.5	BMI 18.5-24.9	BMI 25-29.9	BMI 30-39.9	BMI 40+
Has long-term disabilities or handicaps	.22	.12	.13	.17	.31

Table 8 Disability days in the past two weeks by BMI group

	BMI Classification				
	BMI < 18.5	BMI 18.5-24.9	BMI 25-29.9	BMI 30-39.9	BMI 40+
Disability days	1.30	.91	.97	1.10	2.37
Probability of at least 1 Disability day	.18	.14	.16	.17	.29

Measures of both long term and short term disabilities in Tables 7 and 8 show the expected pattern of progressively poorer health status through the categories overweight (BMI 25-29.9), obese (BMI 30-39.9), and especially morbidly obese (BMI 40+). The underweight category (BMI < 18.5) also has poorer health status.

Health utilization by BMI classification

Here, self-reported health utilization variables are presented according to the BMI classification. For these variables, no risk adjustment has been applied. All of these variables show a gradation with levels of obesity, and underweight (BMI < 18.5) individuals also show increased utilization.

Table 9 Self reported Health Utilization by BMI Category

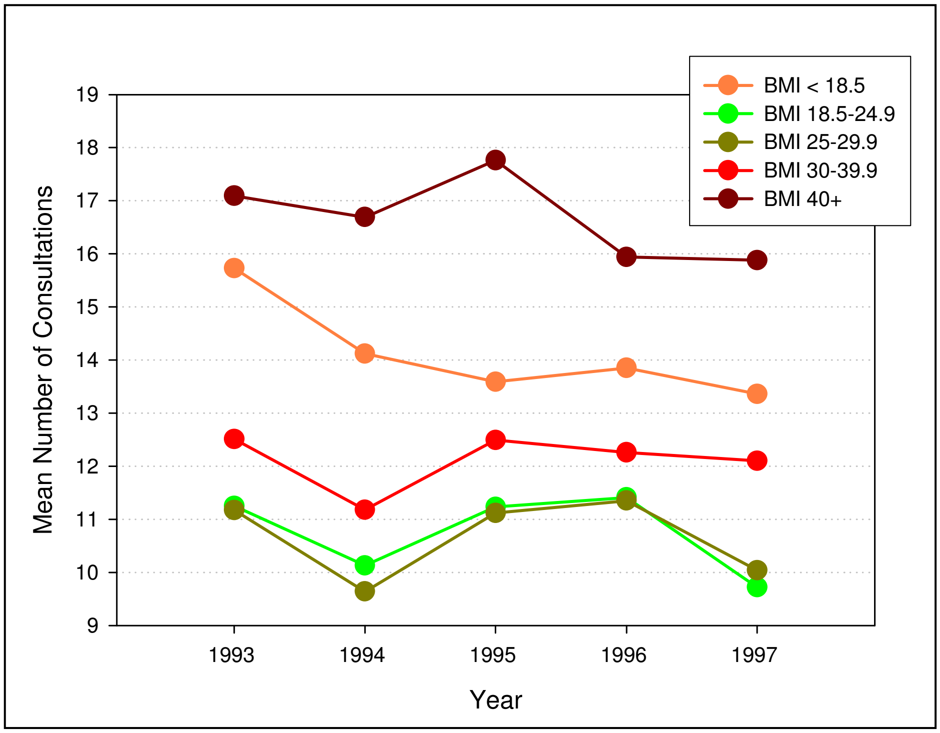
	BMI Classification				
	BMI < 18.5	BMI 18.5-24.9	BMI 25-29.9	BMI 30-39.9	BMI 40+
Proportion hospitalized	.14	.07	.08	.08	.14
Consultations with a medical professional	5.03	4.14	4.13	5.08	9.66
Proportion reporting. unmet needs	.13	.08	.08	.09	.13
Proportion seeking alternative care	.10	.10	.08	.08	.09
Proportion attending a self help group	.03	.03	.03	.03	.07

Administrative records by BMI Classification

In this section, results are presented for the linkage between the NPHS and administrative records. Despite the fact that the number of individuals that could be linked for this analysis is only 39 per cent of the respondents, the picture presented by this data is consistent. Thus obesity (BMI 30-39.9) and morbid obesity (BMI 40+) is associated with increased health utilization, as is being underweight (BMI < 18.5). These associations existed before the date of the survey, and appear to persist after the survey.

Figure 6 shows the average number of medical consultations from administrative records for each year from 1992 to 1997. While these numbers appear to be substantially larger than those reported in the survey, this is likely due to the fact that a visit to a medical laboratory is counted as a consultation in the administrative records, but is unlikely to be so recalled by individuals in a health survey context.

Figure 6 Consultations with health professionals by BMI Classification



Figures 7 and 8 show the number of hospitalizations and the total number of hospital days according to administrative records.

Figure 7 Number of hospitalizations by BMI Classification

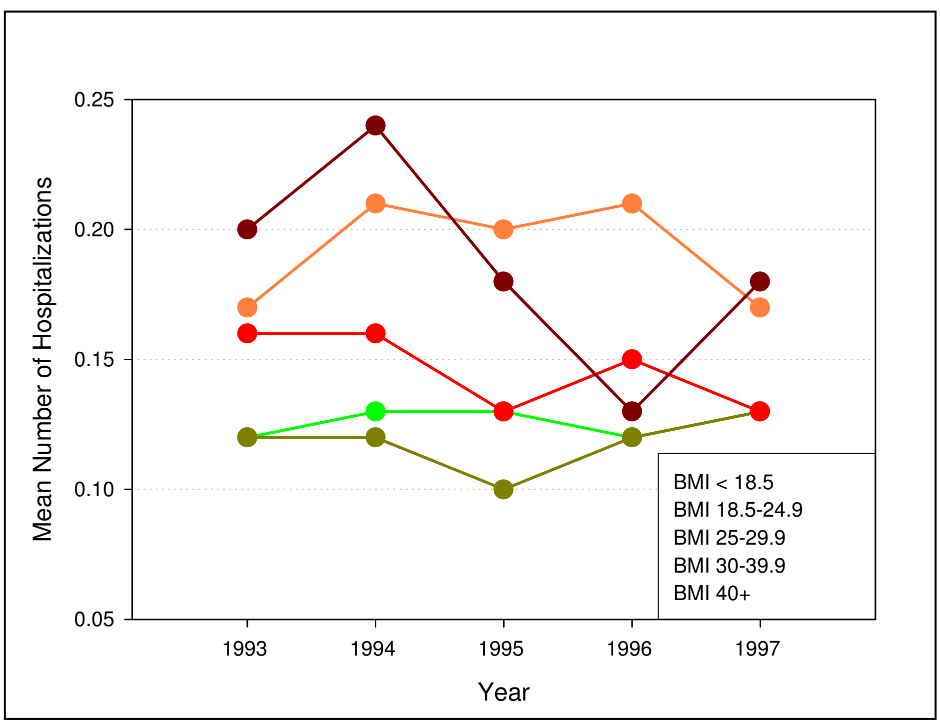
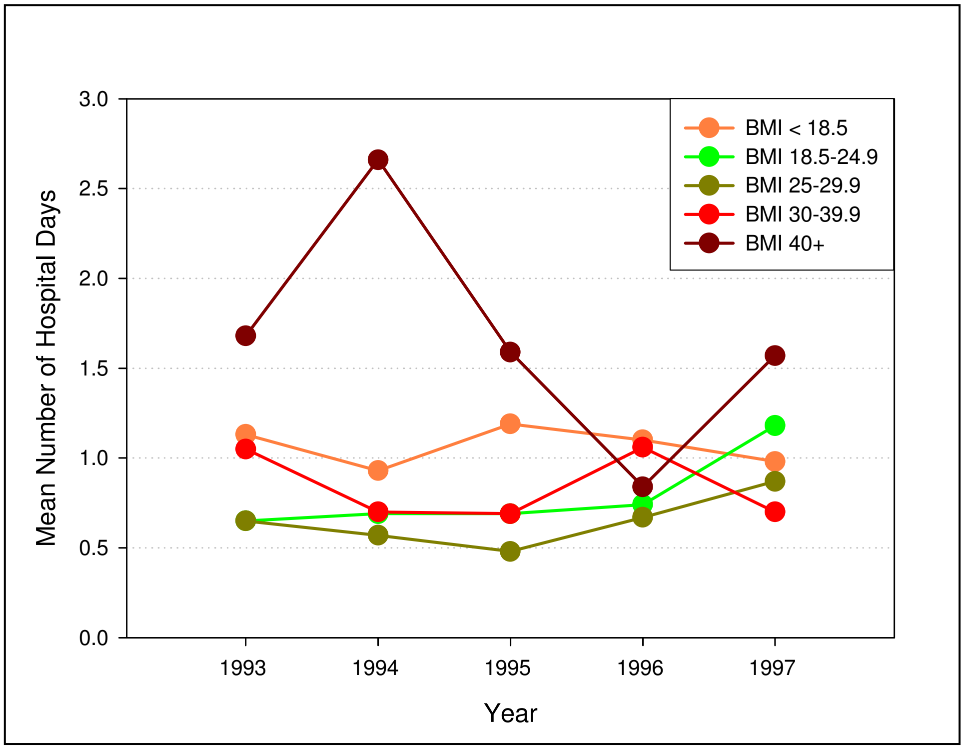


Figure 8 Number of hospital days by BMI Classification

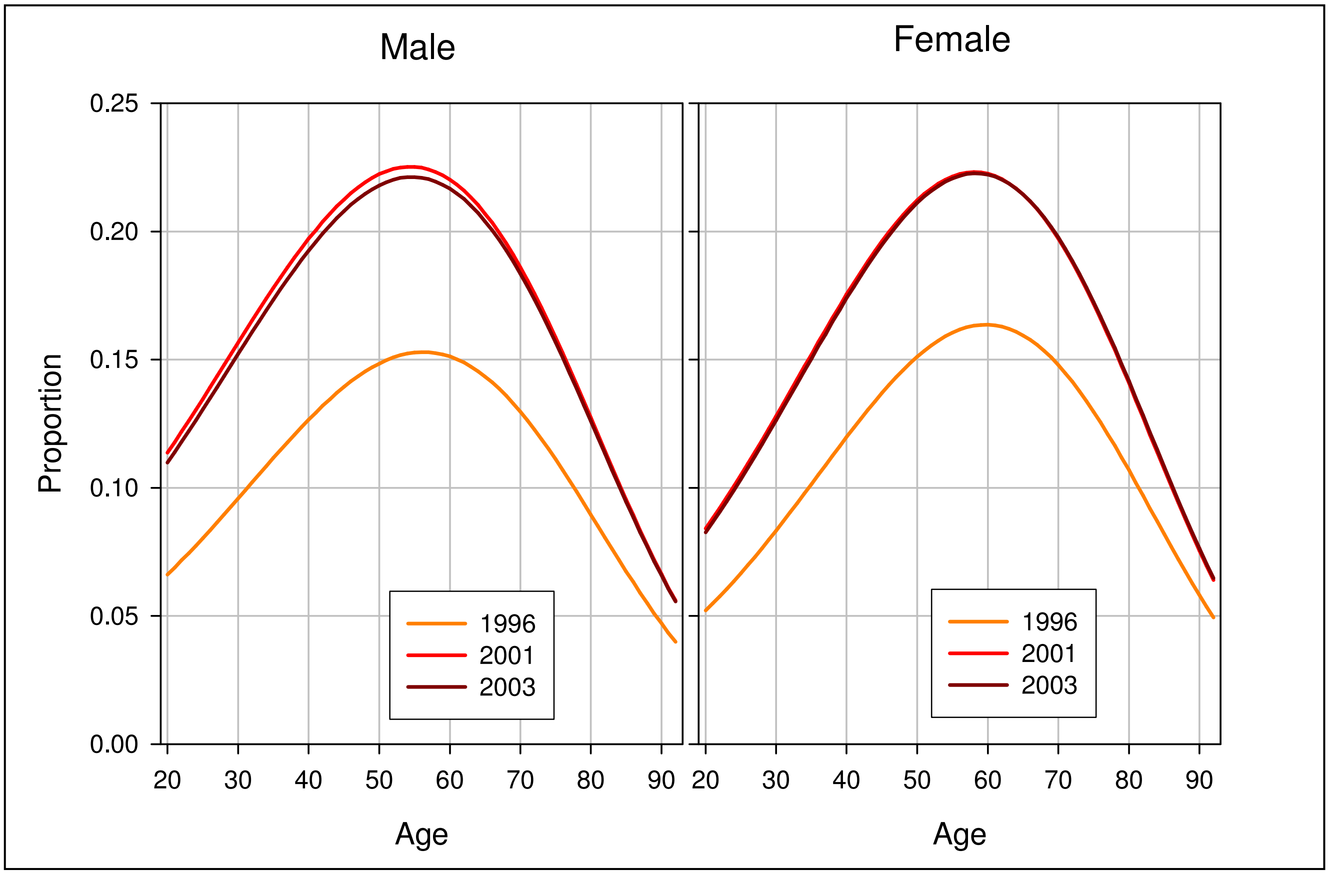


In almost all cases, the gradation in health utilization is as expected: individuals with morbid obesity requiring greater levels of utilization than those with obesity and with the obese having higher levels than the overweight or those with acceptable weights. As well the underweight have elevated levels. The greater fluctuation in the rates associated with morbid obesity are likely due to the relatively small number of these individuals in the linked sample.

Stability of prevalence estimates for BMI Classification

The Canadian Community Health Survey (CCHS) asked survey participants for self-reported height and weight in the first cycle in 2000 and 2001 and again in the second cycle in 2002 and 2003. Self-reported BMI was calculated for individuals over age 20. Age-sex specific prevalences for individuals in the categories BMI 29.9+ (Obese and Morbidly Obese) and for individuals in the categories BMI 40+ or BMI 35+ with co-morbidity (Morbidly Obese) for the 1996 NPHS and 2001 and 2003 CCHS samples were calculated. A regression model was fit to these data[8]. The model predicted age sex prevalences are presented in figures 9 and 10.

Figure 9 Prevalence of Self-Reported BMI > 29.9 (Obese and Morbidly Obese), Alberta , 1996, 2001, 2003



Obesity rates for both males and females have increased dramatically since 1996. Unfortunately, because these are self-report data, it is uncertain whether this increase represents a real increase in BMI, or an increasing tendency to accurately report height and weight between 1996 and later surveys. The fact that there is no difference between 2001 and 2003 does make the latter possibility more plausible. There are other difficult-to-explain increases in the rates of health status measures between the 1996 NPHS and the later CCHS surveys, notably an increase in the apparent probability of depression in Alberta (Schopflocher, 2003)[9]. These

[8] A logistic regression with a cubic spline age component, a sex factor, a factor for the year of survey, and all two-way interactions was fit to weighted data. Effects described below were statistically significant at $p<0.05$.
[9] One speculation would be that these increases have been influenced by the increased importance that health and health care has taken in the national consciousness over the past decade.

changes may become better understood when large samples of physical measures become available[10].

A close examination of figure 9 also shows that while overall rates of obesity are comparable between the sexes in each of the survey years, females are consistently less likely to be obese at younger ages, and more likely to be obese at older ages.

Figure 10 Prevalence of Self-Reported BMI 40+ or BMI > 35 with co-morbidity (Morbid Obesity), Alberta, 1996, 2001, 2003

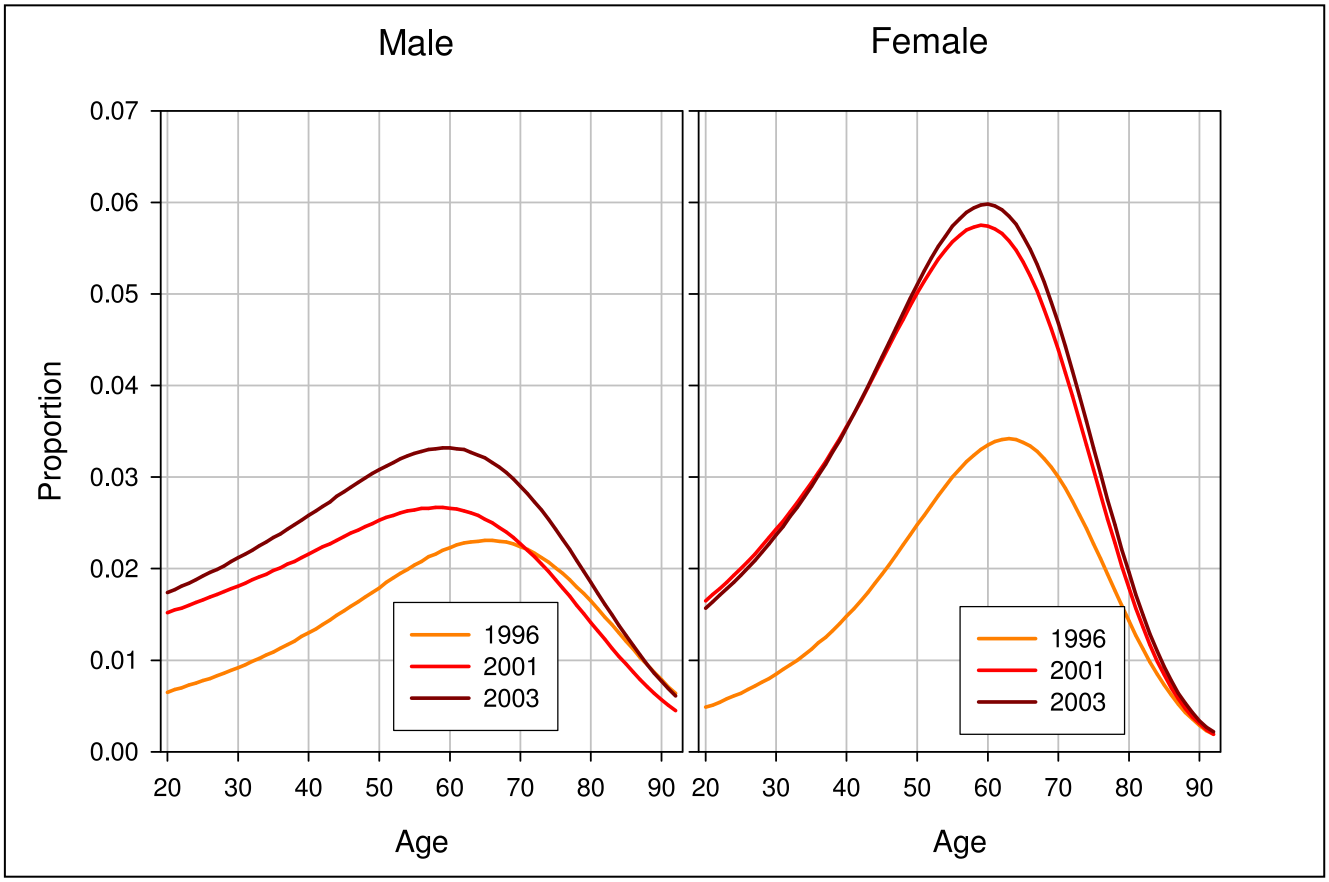


Figure 10 shows the prevalence of morbid obesity in males and females as assessed by self-reported height and weight in the three surveys. Immediately apparent is the difference between males and females who have more than 50% higher rates in every assessment. It is also clear that the rates are higher at each successive survey, though not significantly so for females between 2001 and 2003. A third aspect of these figures is that the peak prevalence rates have shifted

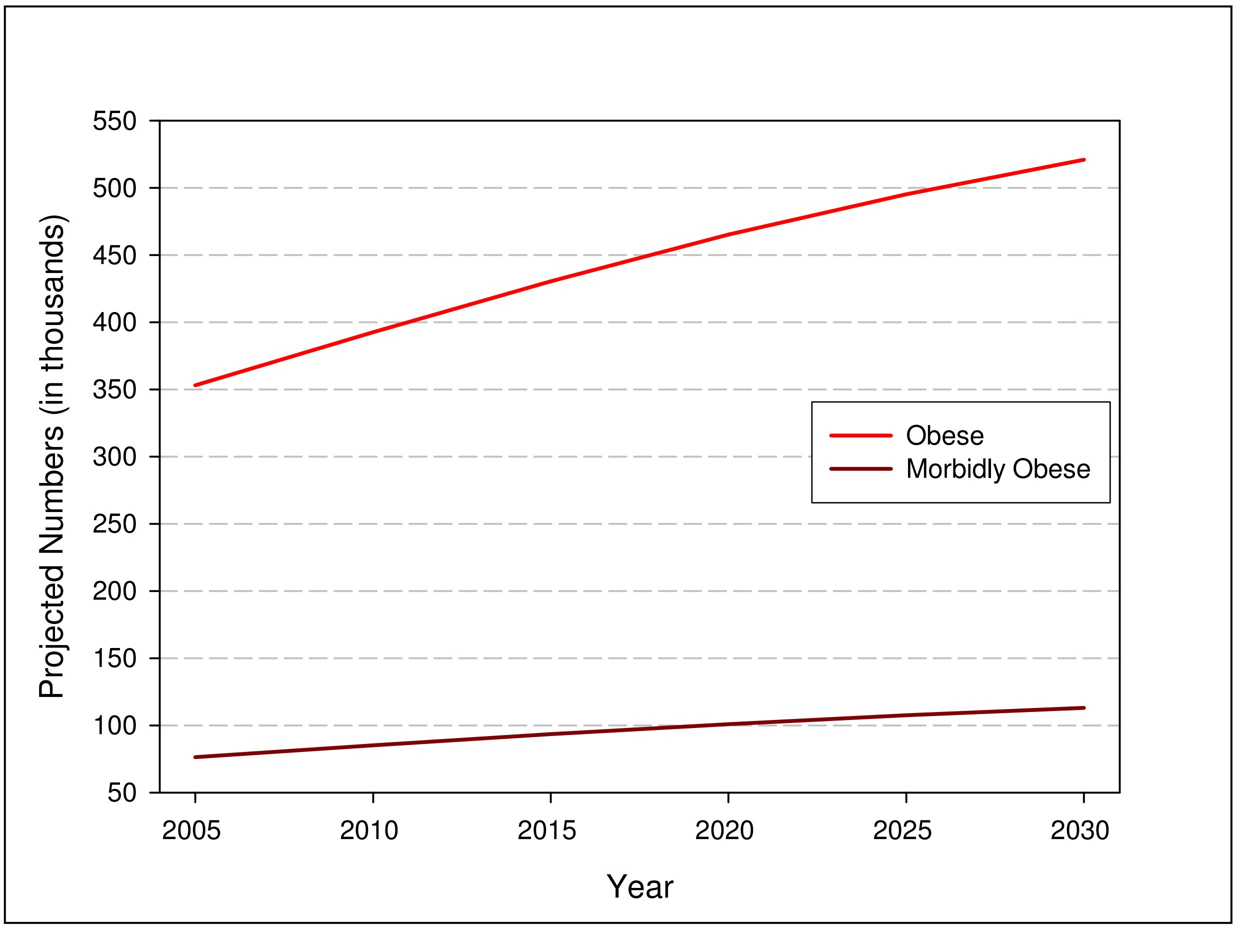
[10] Statistics Canada has collected measured height and weight as part of the CCHS Cycle 2.2 on a sample of Canadians, and a Physical Measures survey will collect more extensive data in 2006-2007.

downwards in age in the CCHS surveys compared to the 1996 NPHS survey. This shift is more prominent in males.

Prevalence projections for obesity

The age-sex prevalence rates calculated from the 2003 CCHS were applied to population projections previously prepared by Health Surveillance (Alberta Health and Wellness, 2000). The number of individuals 20 years of age and over projected to be obese (BMI 30 - 39.9), and morbidly obese (BMI 40+) is shown in figure 11. These projections assume that the incidence of obesity will remain constant, and that it is well represented by the data from the CCHS in 2003.

Figure 11 Expected number of individuals morbidly obese, or obese in Alberta



There will be a large increase in the number of individuals who are obese, or morbidly obese in Alberta in the absence of a change in the incidence rates for obesity. In fact this increase would be about 60 per cent in the next 25 years. Part of the increase is due to a population increase in Alberta, and part of the increase will come from the aging of the population.

Conclusion

These data derived from the Alberta sample of the National Population Health Survey (NPHS) and the Canadian Community Health Survey (CCHS) provide estimates of the prevalence of obesity in Alberta, and some of the consequences of obesity.

Rate of obesity

In 1996, 37.5% of Albertans over age 20 were classified as overweight, 10.3% as obese, and 1.6% as morbidly obese. In 2003, these had risen to 39.7% overweight, 14.3% obese, and 3.2% morbidly obese.

Obesity, age and income

The proportion of individuals in the overweight, obese, and morbidly obese categories increases in prevalence with age up to about age 60. This relationship is found in both males and females. The proportion of individuals in the obese and morbidly obese categories also increases in the lower income classes.

Obesity and health status

A large number of health status and health utilization measures from the NPHS confirm that there is a gradient such that obesity and morbid obesity leads to decreasing health status. Underweight individuals also had decreased health status.

Obesity and chronic diseases

Respondents to the NPHS also reported the presence of a number of chronic illnesses. Increasing levels of obesity are associated with an increased number of chronic disease.

Obesity and utilization of health services

Self-reported health utilization also shows an increase with increasing levels of obesity. Record linkage to administrative records confirm this gradient in health utilization measures, and shows that the gradient exists for at least four years prior to the survey, and at least one year after the survey.

Projected changes in the number of overweight, obese, and morbidly obese individuals

The number of individuals who are overweight, obese, or morbidly obese will increase dramatically in Alberta over the coming decades due to the aging of the population, even if the prevalence of obesity does not change, unless health promotion programs can be initiated that have an immediate and profound effect.

The information presented here underlines the importance of establishing regular monitoring of obesity, its primary risk factors (diet and level of activity), and social-environmental factors that influence obesity levels (Plotnikoff, RC, Bercovitz, K, Loucaides, CA, 2004; Raine, 2004). To effectively achieve this goal will also require resolution of many of the measurement issues noted here such as effective obesity measurement for children and youth, and the calibration of self-reported and directly measured BMI.

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Appendix 1: A note on statistical comparisons

The current report does not contain reference to the statistical apparatus required to estimate the certainty with which differences can be asserted, or the precision of surrounding estimates. There are a number of reasons for this:

1. The statistical apparatus most often applied (i.e. involving 'hypothesis testing' and so-called "p-values") presumes that it is most important to avoid asserting a difference if none exists (i.e. avoid a "type I error"). In most public health situations, adherence to the 'precautionary principle' suggests that it is much more important in general not to assert no difference when one does exist (i.e. avoid a "type II error").

2. The statistical apparatus most often applied notes the difficulties surrounding making a very large number of comparisons, but does not provide any easily used mechanism to make such an activity less risky.

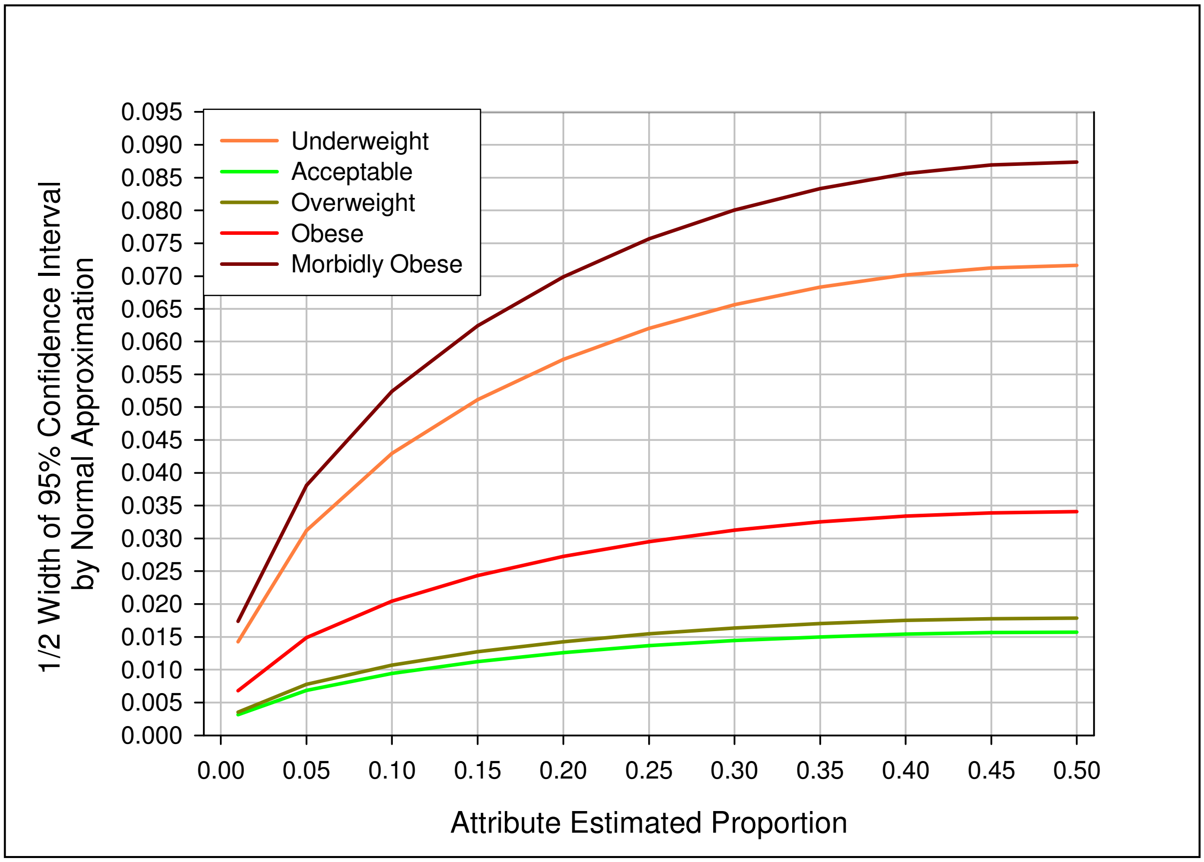
3. Both of these challenges suggest that an approach focused on the precision of estimates (i.e. confidence intervals) would be preferable. This is also consistent with the generally descriptive and exploratory nature of analyses. That is, 'Indicator Measurement' has a very different set of purposes than does measurement for the purpose of scientific research. (In general, scientific research will be very much concerned with making attributions of cause and effect, and for this purpose the statistical apparatus most often applied has much more justification).

4. Furthermore, it is often the case that the most important information available from broad scale analyses such as the ones presented here involve patterns and their similarity and trends and their similarity (i.e. covariance or second moment structures), and do not depend upon precise estimates of indicator levels (i.e. means or first moment structures) This would also suggest that precision estimates may be important to allowing a judgment of how similar two or more patterns might be. However, in complex graphics, these are often very difficult to present usefully.

Figure 12 shows approximate 95% confidence half widths for binary variables as expressed within each of the BMI categories discussed here[11].

[11] A normal approximation to a Poisson distribution is a very good approximation until the rates become very extreme. But because the data is derived from a complex survey, standard formulae are not accurate. Statistics Canada recommends a computer intensive bootstrap procedure for research reports. In other situations, an approximate design effect can be calculated and applied to the standard formula. Here, a general design effect of 1.2 has been applied.

Figure 12 Confidence Interval (95%) half widths for proportions within BMI Categories



Note: for Proportions above 0.5, use (1-proportion)

The figure's primary features include:

1. Estimates at the extremes of the BMI distribution (Table 3) (i.e. underweight, obese, and morbidly obese) contain fewer persons, and can therefore be estimated with less precision than those at the centre of the distributions where there are more persons.

2. Extreme proportions can be estimated more accurately than less extreme ones. (It should be noted, however, that the approximation in the figure breaks down at very high or very low proportions.)

Consider as an example of the use of this figure, the approximate 95% Confidence Intervals for the data from table 7 from the text (reproduced below)

Proportion reporting long-term disabilities or handicaps by BMI group

	BMI Classification				
	BMI < 18.5	BMI 18.5-24.9	BMI 25-29.9	BMI 30-39.9	BMI 40+
Has long-term disabilities or handicaps	.22	.12	.13	.17	.31

For the individuals, with BMI < 18.5, the proportion with long-term disabilities is 0.22. From figure 12, find the horizontal axis at 0.22, locate the orange curve representing 'underweight' at that point, and read the 95% Confidence Interval half-width from the vertical axis at this point. It is 0.06.Therefore the 95% confidence interval can be expressed as 0.22-0.06 to 0.22 +0.06 or 0.16 to 0.28. Using a similar process, the 95% Confidence Interval for the proportion with long-term disabilities among individuals with BMI of 25 to 29.9 is 0.12 to 0.14 (0.13-0.01 to 0.13+0.01).

Appendix 2: Childhood Obesity

It is not surprising that the apparent increase in the prevalence of obesity in adults has turned attention towards obesity in children. Unfortunately, BMI-based classification systems used for adults are not generally appropriate for use with children (Health Canada, 2004).

An international effort to develop categories of obesity for children and youth based upon BMI measurement has been mounted (Cole, Bellizi, Flegal & Dietz, 2000). It has been evaluated in population studies in Canada, one involving self-reported height and weight (Willms, Tremblay, & Katzmarzyk, 2003), and one involving measured height and weight (Canning, Courage, & Frizzell, 2004).

The tables and figures below extend the work on self-reported height and weight. Table 10 shows that the measures from the 1996 NPHS are slightly higher than the Canadian figures from the NLSCY[12].

Table 10 Overweight and Obesity for Children age 7 to 13 based on Self-reported Height and Weight, Canada, and Alberta, 1996

Proportions	Overweight	Obese	Overweight	Obese
	1996 NLSCY Canada (Willms et al, 2003)	1996 NLSCY Canada (Willms et al, 2003)	1996 NPHS Alberta	1996 NPHS Alberta
Female	26	9	29	12
Male	33	10	34	12

Overweight and obesity measures based upon Cole et al 2000 classification system

Table 11 Over weight and Obesity for youth and young adults ages 12 to 30 based on Self-Reported Height and Weight, Alberta 1996, 2001, 2003

	Overweight			Obese		
	NPHS 1996	CCHS 2001	CCHS 2003	NPHS 1996	CCHS 2001	CCHS 2003
Female	14.0	18.8	21.3	3.6	5.1	4.8
Male	22.8	29.2	31.9	5.2	7.7	8.3

Overweight and obesity measures based upon Cole et al 2000 classification system

[12] The NPHS figures are apparently much greater than the Alberta figures from the NLSCY, though Willms et al, 2003, did not directly report Alberta figures. This might be accounted for, in part, by the fact that the NLSCY included some direct measurement, and all informants were 'the person most knowledgeable about the child', whereas with the NPHS, children of age 12 and 13 often answered for themselves.

Table 11 shows the comparisons between the 1996 NPHS and 2001 and 2003 CCHS data. Note that these comparisons are for a different age range since the CCHS does not include young children within its sample. It appears from these figures that overweight and obesity rates under this classification system have increased in the recent past. As was noted with the adult data, this may be due in part to changes in BMI and in part to changes in the accuracy with which height and weight are reported.

Figures 13 and 14 below present the data as smoothed age-sex specific rates for all three surveys.

Figure 13 Over weight for children, youth and young adults based on Self-Reported Height and Weight, Alberta 1996, 2001, 2003

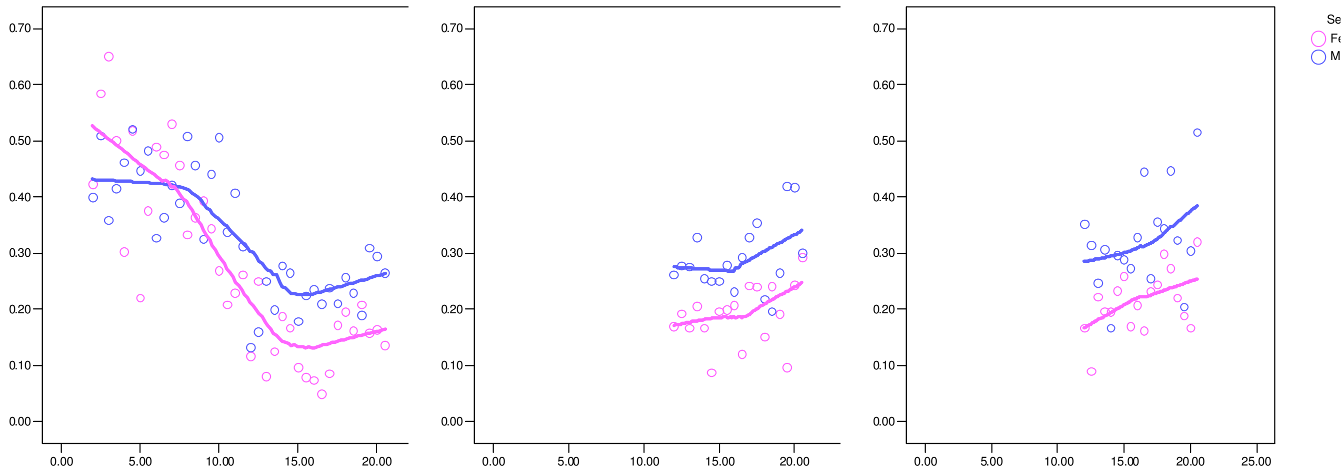
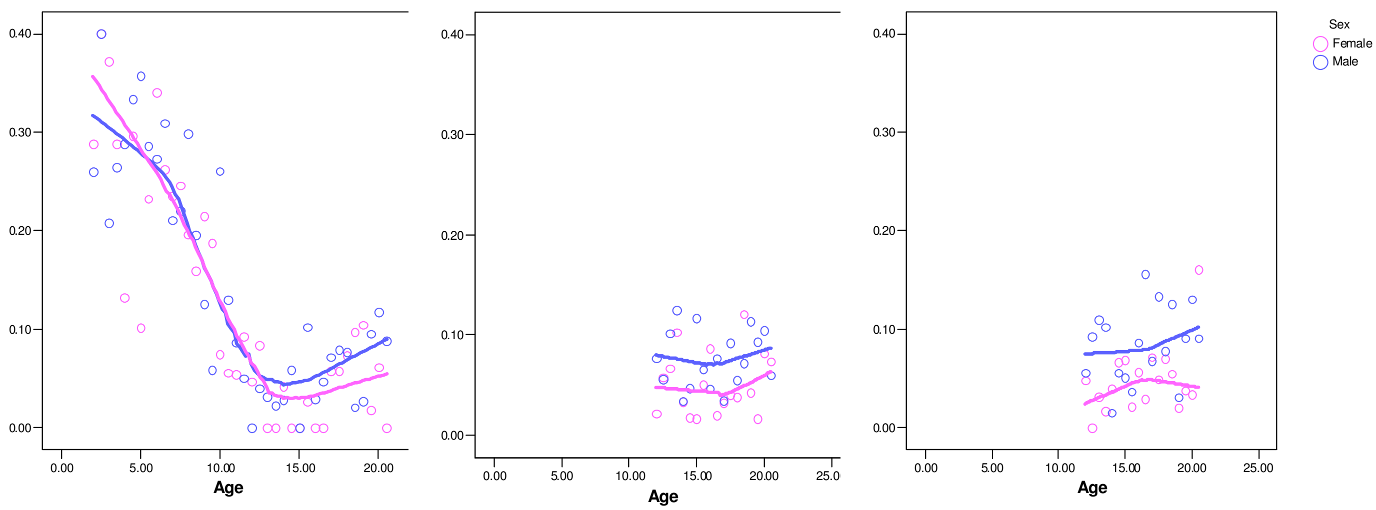


Figure 14 Obesity for children, youth and young adults based on Self-Reported Height and Weight, Alberta 1996, 2001, 2003



The trends across survey, where they can be compared, are quite consistent. For ages 12 to 20, male overweight and obesity rates are greater than female rates, and increase slightly with age. The gap between the sexes is greater in the overweight category. This data is consistent with the adult data, and offers support to the classification system (Cole et al, 2000).

The data for children below age 12 for the 1996 NPHS survey show that the rates do not seem to differ dramatically between the sexes. Echoing the findings of Willms et al 2003, however, they do appear to decline dramatically with age. It is Willms et al's contention that this speaks to a deficiency in the measurement operations for children below age 12 (Cole et al, 2000).

Appendix 3: Relationship of Particular Chronic Diseases to BMI

The BMI classification was employed to examine the associations between particular chronic diseases and obesity. There are a number of complications to this analysis:

1. The NPHS asked questions about only a selection of chronic diseases. Some of these are not generally associated with obesity.
2. The NPHS allowed the individual to register all chronic diseases from which they suffered. This complicates analysis because a decision needs to be taken as to whether to ignore or attempt to model the effects of co-morbidity.

The current analysis attempted to control for (or model) the effects of co-morbidity, so that the resulting estimates should be thought to refer to *individuals suffering from that single chronic disease alone.* The presence of two or more chronic diseases might increase the odds of being obese to a greater degree than might have been expected by combining the results given here.

The base analysis was a sequence of logistic regressions. First, the obesity and morbid obesity categories were combined for a single analysis. Then a separate analysis was conducted within this category of obesity to examine the elevated risk induced by being morbidly obese as opposed to merely obese.

Table 12 shows the statistically significant odds ratios resulting from each of these analyses. The first column of ratios reports the changed odds that an individual would belong to the obese category if they reported having that chronic disease. Individuals reporting cancer have lower odds of being obese possibly because some cancers cause weight loss. The second column shows the increased odds that an obese person reporting a chronic disease will be morbidly obese. It is notable that for those chronic diseases with increased odds, the ratios are substantially higher that an obese person will be morbidly obese, than it was that a person with the disease would be obese. This indicates a substantially increased risk associated with these diseases[13].

[13] It should also be noted that heart disease is not present in this list of chronic diseases. One speculation as to why this counter intuitive finding may have arisen is that a) many individuals with heart disease are unaware of it until they suffer an episode, and b) obese individuals may be less likely to survive such an episode.

Table 12 Odds Ratios for the associations between Obesity and Chronic Diseases

	Obese or Morbidly Obese	Morbidly Obese Compared to Obese
Asthma	1.3	3.2
Arthritis	1.6	3.0
Low Back Pain (Excl. Arthritis)		1.5
High Blood Pressure	2.2	3.0
Diabetes	1.9	
Epilepsy	2.4	
Cancer	0.6	
Thyroid Condition	1.5	

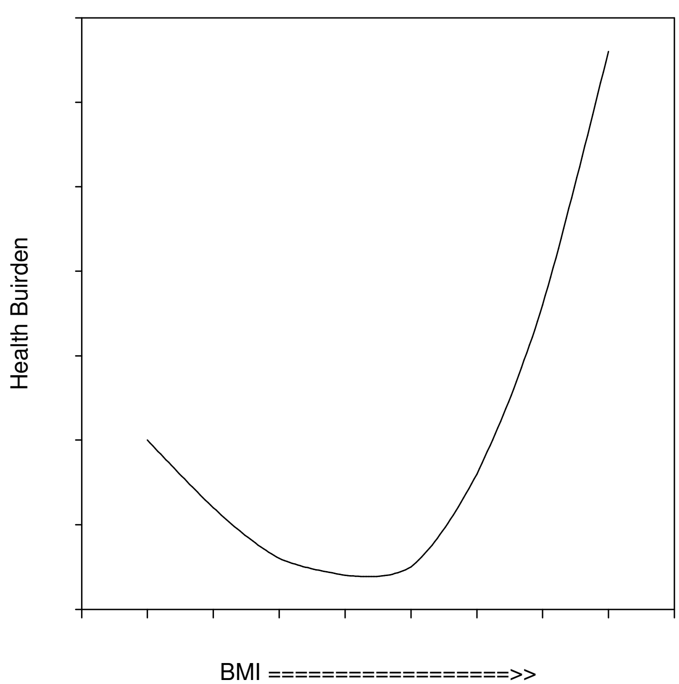
Note: All tabled Odds ratios statistically significant at $p<0.05$

Appendix 4 A note about Morbid Obesity

Persons falling into the classification of Morbidly Obese are most frequently the ones who engage in surgical or other radical procedures to attempt to reverse their obesity. New procedures will need to be evaluated, and the cost-benefit of these procedures for individuals in the morbidly obese category will need to be considered. For purposes of cost-benefit analysis, the information presented in this report can be most succinctly summarized as follows:

1. The rapid decline in the prevalence of morbid obesity after the age of 60 strongly reflects the fact that the morbidly obese have high mortality rates (Fontaine, Redden, Wang, Westfall, & Allison, 2003; Katzmarzyk, Janssen, & Ardem, 2003; Peeters, Barendregt, Willekens, Mackenbach, Mamun, & Bonneaux, 2003).

2. The general shape of the gradient in health status measures and health utilization measures is that obese individuals have poorer health status and greater health utilization. For the morbidly obese, these measures are markedly more extreme. This strongly suggests that as BMI goes up, the burden of obesity goes up, at an accelerating rate.



The major implication is that it will be very critical to the success of any cost benefit analysis to carefully determine the category of individuals who might qualify for any intervention.