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Distribution of body weight and height:

Comparison of estimates based on self-reported and observed measures

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SUMMARY The distribution of weight in the adult population aged 20–69 years was examined by comparison of estimates obtained from the 1985 Health Promotion Survey and the 1981 Canada Fitness Survey. The Health Promotion Survey obtained information on self-reported weight and height, and the Canada Fitness Survey utilised measured weight and height. The classification of respondents into weight categories followed the recommendations of the 1973 Fogarty Conference on Obesity. Values of the Quetelet index defined as W/H^2, where W = kilograms and H = metres, were used to define four weight categories: underweight, acceptable weight, overweight, and obese. The comparisons of prevalence estimates of the various weight categories indicate that self-reported weight and height leads to a systematic weight misclassification bias. The implications of this bias for epidemiological studies are discussed and suggestions are offered to handle the bias.

In health surveys anthropometric information relating to weights and height are useful data. Besides being important in their own right, data relating to weight and height may be combined to develop weight classification indices. These indices enable researchers to estimate the prevalence of overweight and obesity in the population and to monitor the secular change in the prevalence of these risk factors.

Recent assessments of the health implications of overweight and obesity have concluded that obesity, defined as excessive storage of energy in the form of fat, has been identified as a risk factor for a wide number of diseases, including hypertension, hypercholerolaemia, adult onset diabetes, coronary heart disease, certain cancers, gout, gall bladder disease, and certain arthritic conditions.[1 2]

Monitoring the prevalence of obesity in populations is thus an important requirement for health promotion programme efforts and for interpreting the change over time of health conditions or outcomes that are known to be associated with obesity.

Most of the surveys that collected anthropometric measurements relating to the Canadian population have employed standardised procedures to measure actual weight and height.[3–6]

Recently, a Canadian survey collected self-reported height and weight data. This invites a comparison of the distribution of weight and the prevalence of overweight and obesity in surveys that rely on self-reported rather than measured anthropometric data.

In this paper I compare estimates of overweight and obesity in the 1981 Canada Fitness Survey and the 1985 Health Promotion Survey. The Canada Fitness Survey collected data on anthropometric measures by using trained technicians and the Health Promotion Survey relied on self-reported measures.

Methods

The estimates of relative weight in this report are derived from the 1981 Canada Fitness Survey and the 1985 Health Promotion Survey.

The sample design of the Canada Fitness Survey is a complex multistage household probability sample. The initial sample consisted of 13 500 households, 88% of which agreed to participate. Within the 11 900 participating households lived 31 000 persons who, on the basis of age alone (7–69 years inclusive), were eligible to participate in some or all of the survey; 77% (23 500) agreed to do so. The fitness tests were designed for everybody between the ages of 7 and 69; 16 000 individuals were tested, representing an overall response rate of 51%.

Anthropometric measurements were obtained in the Canada Fitness Survey by trained technicians using calibrated equipment. Weight was measured with beam balances while subjects wore light clothing. Subjects were standing in stocking feet for height measurements with the head positioned in the Frankfort plane. Gentle traction was applied to achieve stretch stature.

The Health Promotion Survey was conducted by Statistics Canada in June 1985 for the Department of National Health and Welfare. The target population for the survey was all persons 15 years of age and older living in Canada. The survey excluded residents of the Northwest Territories and fulltime residents of institutions. The survey was conducted by telephone.

The Health Promotion Survey employed two different random digit dialling sampling techniques. Within the 10 provinces the survey used the Waksberg method and in the Yukon the method of elimination of non-working banks.

Once a household was reached a selection control form was used to select household members over age 15 at random. One household member was selected. If the selected person was not available at that time, an attempt was made to call back at a convenient time.

The final sample consisted of 10 649 adults aged 15 years and over. The response rate was 81%.

Data on weight and height were collected by self-report. The question relating to height was, "How tall are you without shoes?" Respondents had the option of answering in feet/inches or centimetres. The weight question was "How much do you weigh?" Again, respondents could answer in pounds or kilograms.

Post-stratification procedures were used in both surveys to produce weighted estimates.

There is a possibility of some bias in both surveys. Because the sampling methodology used for the Health Promotion Survey was random digit dialling of telephones, persons living in households that did not have telephone service were excluded from the surveyed population. This accounted for less than 3% of the population. Since households without telephones may be more likely to belong to low income groups and the prevalence of overweight tends to be greater among low-income populations this may lead to slightly conservative estimates of overweight.

The Canada Fitness Survey may also have had a bias toward lower prevalence estimates of overweight and obesity. If persons who were less physically fit opted to not participate in the fitness testing the prevalence of obesity may be decreased, as persons who are less physically active are more likely to be obese.

The age range of the surveyed populations in the two surveys differed. I have confined comparisons of the distribution of weight to the 20–69 age range.

A classification system proposed by Bray was used to define four relative weight groups: underweight, acceptable weight, overweight, and obese.[7] The weight for height values recommended by Bray correspond to the ranges of desirable weight from the lower limit of the small body frame to the upper limit of the large body frame as shown in the 1959 Metropolitan Life Insurance Company tables.[8] Quetelet index values for weights appropriate for a given height were used to assign the desirable weight range to the weight classification categories.

The Quetelet index values for men were as follows: underweight $<20{\cdot}1$, acceptable weight $20{\cdot}1$ to $<25{\cdot}1$, overweight $25{\cdot}1$ to <30, and obese $\geqslant 30$. The corresponding values for women were $<18{\cdot}7$, $18{\cdot}7$ to $<23{\cdot}8$, $23{\cdot}8$ to $<28{\cdot}6$ and $\geqslant 28{\cdot}6$.

A two tailed t test with a critical value at the 0·05 level of significance was used to test differences between sample means. The standard errors associated with the estimates from each survey were adjusted to take into account the fact that the surveys were not simple random samples.

Results

Table 1 compares estimates of weight, height, and the Quetelet index in the two surveys. The means, standard deviations, and the 95% confidence interval on the true difference between independent sample means are presented. As a general rule, where the confidence interval includes the value 0, the difference between sample means is not statistically significant at the 5% level.

Comparisons of mean weight estimates among males indicate that there were no significant differences between sample means with the exception of males aged 60–69. In that age group, observed data produced estimates that were 3·8 kg higher than estimates based on self-reported weight.

Among all women, observed weight data yielded mean weight estimates that were 0·6 kg higher than estimates based on self-reported data. However, differences were statistically significant only in the 20–69, 30–39, and 40–49 age groups. The differences between means in the latter two groups were 1·8 and 1·5 kg.

There is evidence of a systematic tendency of self-reported data to produce slightly higher estimates of height. Among males the mean difference ranged from 1·8 to 3·2 cm; males below age 50 tended to have the largest mean differences in height. Among women the discrepancy between means based on observed compared to self-reported height ranged from 0·8 to 4·4 cm. After age 40, the mean difference in height between samples increased with age. All of the differences in mean height for corresponding age/sex groups between the two surveys were statistically significant.

Table 1 *Comparison of selected anthropometric measures based on observed data* and self-reported data†*

	Height (cm)					*Weight (kg)*					*Quetelet index (weight/height²)*				
Age	*Observed*		*Self-reported*		*Difference between means*	*Observed*		*Self-reported*		*Difference between means*	*Observed*		*Self-reported*		*Difference between means*
(years)	$\bar{x}$	*SD*	$\bar{x}$	*SD*	*95% CI*	$\bar{x}$	*SD*	$\bar{x}$	*SD*	*95% CI*	$\bar{x}$	*SD*	$\bar{x}$	*SD*	*95% CI*
Males															
20–69	174·1	7·0	176·5	7·0	(−2·7, −2·1)	76·7	12·1	76·7	11·6	(−0·5, 0·5)	25·3	3·6	24·6	3·3	(0·5, 0·9)
20–29	175·8	6·8	178·1	6·5	(−2·8, −1·8)	73·9	11·3	74·6	10·3	(−1·6, 0·2)	23·9	3·3	23·5	3·0	(0·1, 0·7)
30–39	174·8	6·7	177·0	6·8	(−2·8, −1·6)	77·1	12·4	77·1	12·1	(−1·0, 1·0)	25·2	3·6	24·6	3·3	(0·3, 0·9)
40–49	173·6	7·4	176·8	6·9	(−4·0, −2·4)	78·8	12·9	80·1	12·0	(−2·7, 0·1)	26·1	3·6	25·6	3·2	(0·1, 0·9)
50–59	172·9	6·4	174·8	6·6	(−2·7, −1·1)	78·3	11·2	77·9	11·2	(−1·0, 1·8)	26·2	3·3	25·4	3·3	(0·4, 1·2)
60–69	171·2	6·4	173·0	7·7	(−2·8, −0·8)	78·1	11·9	74·3	12·1	(2·1, 5·5)	26·6	3·6	24·8	3·5	(1·3, 2·3)
Females															
20–69	160·7	6·6	162·4	7·0	(−2·0, −1·4)	61·5	11·1	60·9	10·9	(0·2, 1·1)	23·8	4·3	23·1	3·9	(0·5, 0·9)
20–29	162·0	6·4	163·1	7·3	(−1·6, −0·6)	57·2	8·8	57·8	9·8	(−1·4, 0·2)	21·8	3·2	21·7	3·2	(−0·2, 0·4)
30–39	161·4	6·3	162·2	6·9	(−1·3, −0·3)	61·2	11·3	59·4	10·7	(1·0, 2·6)	23·5	4·0	22·5	3·7	(0·7, 1·3)
40–49	160·9	6·5	161·8	7·0	(−1·4, −0·4)	63·7	11·9	62·2	10·8	(0·3, 2·7)	24·6	4·4	23·7	3·8	(0·5, 1·3)
50–59	159·7	6·4	162·6	6·6	(−3·6, −2·2)	65·2	11·2	64·8	10·9	(−0·8, 1·6)	25·6	4·4	24·5	4·5	(0·6, 1·6)
60–69	157·6	6·4	162·0	7·1	(−5·2, −3·6)	64·0	10·8	63·8	11·4	(−1·2, 1·6)	25·8	4·2	24·3	4·1	(1·0, 2·0)

*Observed data, 1981, Canada Fitness Survey.
†Self-reported data, 1985, Canada Health Promotion Survey.

Mean Quetelet index values based on observed data were generally higher than those based on self-reported data. All comparisons, with the exception of females aged 20–29, were statistically significant.

Tables 2 and 3 compare the distribution of the population by age and sex into weight classification categories in each survey. The overall pattern of overweight and obesity prevalence by age and sex in the two surveys is similar to that noted in other national surveys.[1 9] In both surveys, the prevalence of obesity is greater among women than among men, and the prevalence of overweight is higher among men than among women. Among both men and women the prevalence of overweight and obesity increases with age.

Although the surveys produced similar age/sex patterns in the prevalence of overweight and obesity, there is evidence of a systematic bias towards the underweight, acceptable weight end of the weight classification continuum in the 1985 survey. The net effect of the bias for males is a reduction in the prevalence of obesity and overweight, a large increase

Table 2 *Distribution of men by body weight classification, age and type of anthropometric data*

Age group by type of survey data	*Sample n*	*% Underweight (<20·1)*	*% Acceptable (20·1<25·1)*	*% Overweight (25·1<30)*	*% Obese (≥30)*
Total: 20–69					
Observed	5077	5·3	46·8	38·5	9·4
Self-reported	3908	6·1	56·5	31·3	6·1
20–29					
Observed	1648	8·6	61·3	25·1	5·1
Self-reported	1178	9·5	69·1	18·6	2·9
30–39					
Observed	1415	5·5	48·5	37·2	8·8
Self-reported	1173	4·4	60·7	29·6	5·4
40–49					
Observed	898	3·6	37·9	46·5	12·0
Self-reported	639	2·1	49·6	39·7	8·7
50–59					
Observed	656	2·8	37·1	47·9	12·2
Self-reported	488	3·7	45·1	42·6	8·6
60–69					
Observed	460	1·9	32·1	51·8	14·2
Self-reported	428	11·1	42·2	38·5	8·3

Row percents may not add up to exactly 100% due to rounding.

Table 3 *Distribution of women by body weight classification, age and type of anthropometric data*

Age group by type of survey data	*Sample n*	*% Underweight (<18·7)*	*% Acceptable (18·7<23·8)*	*% Overweight (23·8<28·6)*	*% Obese (≥28·6)*
Total: 20–69					
Observed	5834	5·2	54·2	28·5	12·1
Self-reported	5333	8·0	55·3	28·6	8·1
20–29					
Observed	1860	10·8	69·1	16·4	3·7
Self-reported	1618	13·9	64·6	18·1	3·4
30–39					
Observed	1596	4·3	61·9	24·7	9·1
Self-reported	1507	8·1	63·8	21·5	6·6
40–49					
Observed	1007	3·6	46·7	33·7	16·0
Self-reported	800	3·9	52·9	33·1	10·1
50–59					
Observed	826	1·5	38·4	40·3	19·7
Self-reported	700	3·3	40·2	45·1	11·4
60–69					
Observed	545	1·0	35·8	40·9	22·2
Self-reported	708	6·0	41·2	38·7	14·1

Row percents may not add up to exactly 100% due to rounding.

in the proportion of males who have an acceptable weight, and a small increase in the prevalence of underweight.

Among women the effect of the bias is a reduction in the prevalence of obesity, little or no change in the prevalence of overweight or acceptable weight, and an increase in the prevalence of underweight.

Discussion

The issue of the reliability and validity of relative weight estimates that are based on self-reported rather than measured data is important for both methodological and epidemiological reasons. If self-reported anthropometric data yield reasonable estimates of weight status it would decrease the cost of conducting surveys. From an epidemiological perspective, comparability in the estimates derived from self-reported data to estimates obtained from measured data would assist in the interpretation of the relative risk associated with overweight and obesity.

Ideally, one would wish to compare estimates of weight classification categories that are based on self-reported and measured data for persons within the same survey. Because the comparisons in this paper are based on two separate surveys the analysis should be viewed as a partial assessment.

A number of studies have compared the accuracy of self-reported anthropometric data. Wing *et al* reported that women under-reported their weight more than men, and that men below the median weight tended to over-report their weight.[10] A study by Palta *et al* concluded that self-reported height and weight differed from the measured quantities in systematic ways. Height was generally overstated by an average of 1·3% in men and 0·6% in women. Weight was under-reported by 1·6% in men and 3·1% in women. Stewart concluded that although there was evidence of a response bias in self-reported weight and height "the overall impression obtained . . . is that self-reported weight and height are remarkably accurate indicators of actual weight and height".[12] Stunkard argues that self-reported weight is so accurate among Americans, even obese ones, that it may be possible to carry out valid studies of weight status by questionnaire and perhaps even by telephone interviews.[13]

These assessments of the potential bias in relative weight based on self-reported weight and height are somewhat more optimistic than the comparisons in the present paper would suggest. Small differences in mean anthropometric measures have the potential to lead to sizable differences in the prevalence of overweight or underweight in the population. None of the previous studies considered the impact of the relatively small differences between self-reported and observed anthropometric data on the distribution of the population into weight classification categories. In response to the argument that the four year interval between the Canada Fitness Survey and the Health Promotion Survey could account for some of the variance in the prevalence estimates one can argue that the prevalence estimates of overweight and obesity in the 1971 Nutrition Canada Survey and the 1981 Canada Fitness Survey were very similar.[14] A similar pattern of change for the US population was noted by Abraham.[15] Since there have been only small changes in the prevalence of overweight and obesity over the past decade, the observed differences between estimates in the Canada Fitness Survey and the Health Promotion Survey are probably attributable to the methodological differences in the two surveys.

If systematic bias in the self report of anthropometric data leads to underestimates of the prevalence of obesity in the population it may also introduce a misclassification bias that can have a variety of effects when the association between weight and morbidity is being examined. According to Fleiss, misclassification bias "can turn a truly positive association into one that is less strongly positive or even apparently negative or even apparently positive; and one that is nil into one that is strong. These facts contradict the long standing, but erroneous impression that errors of misclassification tend only to reduce the magnitude of association".[16]

The implications of this for surveys that rely on self-reported weight and height are twofold. Firstly, estimates of obesity based on self-reported measures should be regarded as underestimates. Secondly, researchers might consider methods of adjusting self-reported data for bias. In some cases it is possible to assess the reliability and validity of estimates by collecting measured and self-reported data for a subsample of the surveyed population.[17] In others, it may be possible to use estimates from surveys that employ measured data to obtain correction factors to discipline the data.

Before embarking on such adjustment procedures it might be judicious to compare the levels of relative risk and measures of association implied by measured and self-reported data where common data elements are available in surveys.

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