Open

International Journal of Obesity (2013) **37**, 461–467

www.nature.com/ijo

ORIGINAL ARTICLE

Temporal changes in bias of body mass index scores based on self-reported height and weight

M Stommel[1] and N Osier[2]

OBJECTIVES: To investigate temporal changes in the bias associated with self-reported (as opposed to measured) body mass index (BMI) and explore the relationship of such bias to changing social attitudes towards obesity.
METHODS: Using data from the National Health and Nutrition Examination Survey covering two time periods, 1988–1994 and 2005–2008, discrepancy scores between self-reported vs measured BMI were generated. Changes in the sensitivity of BMI categories based on self-reports were examined for six weight groups, both for the US adult population as a whole and major demographic groups. Linear regression models were used to examine temporal changes in average bias, as well as attitudes about weight within each weight category and by demographic group.
RESULTS: Between 2005–2008 and 1988–1994, the bias towards underestimation of a person's BMI based on interview responses has declined among obese individuals, a trend evident in virtually all demographic subgroups explored. Conversely, most demographic groups showed little change in the extent of bias among underweight and normal-weight individuals. Although the 2005–2008 survey respondents underestimated their measured BMI more than the 1988–1994 respondents, this shift can be entirely explained by the increased prevalence of obesity in more recent years. In fact, obese individuals in 2005–2008 were less likely to overreport their height and underreport their weight than their counterparts in the 1988–1994. Evidence from responses to questions about ideal weight and desire to lose weight point in the direction of a shift in social attitudes, which may make it easier to 'admit' to greater weight in surveys.
CONCLUSION: Over the past 20 years, the bias in self-reported height and weight has declined leading to more accurate BMI categorizations based on self-report. This change is likely to affect efforts to find correction factors to adjust BMI scores based on self-reported height and weight.

International Journal of Obesity (2013) **37,** 461–467; doi:10.1038/ijo.2012.67; published online 1 May 2012

Keywords: self-reported BMI; measured BMI; bias in self-reports; NHANES; changing attitudes

INTRODUCTION

Recent literature on the feasibility of adjusting for biases in body mass index (BMI) estimates based on self-reported height and weight has focused on two major topics. (1) Some researchers have claimed that adjustments to BMI estimates based on self-reported height and weight cannot eliminate substantial biases in the estimation of health risks associated with elevated BMI levels.[1] Other researchers have reported that risk estimates of morbidity based on self-reported BMI can be quite accurate.[2] (2) A few recent articles have emphasized that biases in self-reported height and weight may and do change over time,[3,4] in part, due to changing social norms and acceptability of overweight and obesity in society.[5,6]

Anthropometric measures of height and weight remain the gold standard for estimating BMI; still, they should not be considered error-free, as no measurement procedure is without error. Moreover, given the increased financial and time requirements associated with anthropometric measurement, the use of self-reported height and weight continues to be widespread in research. To minimize biases resulting from self-report estimates, some researchers have attempted to identify correction factors or formulas that could be applied to help minimize such bias.[2,7] Still, others deny the feasibility of adjusting for biases in self-reported data,[8,9] and have claimed that correction factors might even lead to greater biases in estimates of BMI-related morbidity and mortality risks.[1]

Further complicating the search for correction factors is emerging evidence that biases in self-reporting of height and weight are subject to temporal changes, as attitudes about obesity are changing within society.[3,10] One study[4] presented evidence that compared results from three small Irish surveys spread over 10 years (1998–2007). These researchers report that the discrepancies between BMI scores based on self-reported (vs measured) height and weight have increased over time, with the tendency to underestimate BMI through self-reports rising. Sensitivities for normal-weight persons remained stable, but declined for overweight (from 75.3% in 1998 to 66% in 2007) and for obese persons (from 79.5% in 1998 to 53.4% in 2007). Similarly, other researchers[10] reported that in Canada between 1986–1992 and 2005 biases in self-reported BMI scores increased; this trend was largely the result of greater underreporting of weight among women and overreporting of height among men. However, although the US-based National Health and Nutrition Examination Survey (NHANES) data showed similar, albeit smaller biases, in self-reported height and weight, the discrepancy did not increase between NHANES II (1976–1980) and NHANES

[1]College of Nursing, Michigan State University, East Lansing, MI, USA and [2]School of Nursing University of Pittsburgh, Pittsburgh, PA, USA. Correspondence: Professor M Stommel, College of Nursing, Michigan State University, 424A West Fee Hall, Fee Road, East Lansing, MI 48824, USA.
E-mail: stommel@msu.edu
Received 26 August 2011; revised 1 March 2012; accepted 12 March 2012; published online 1 May 2012

2003–2004. Likewise, a study from Switzerland reported consistent underestimation of obesity using self-reported BMI measures, but did not find a change in the self-report biases between 1977 and 2004.[11]

Beyond apparently contradictory evidence about trends in misreporting, there is the question of how temporal trends in attitudes might affect misreporting of height and weight. Some researchers[10] have argued that the pressures to be thin[12] may have resulted in greater weight discrimination in recent years,[5] thus leading to a greater incentive to downplay one's weight. Yet other researchers,[3] using NHANES data from 2001–2006, found that, compared with estimates from earlier NHANES III surveys, a larger proportion of overweight men and women thought that their weight was 'about right', supporting the notion that 'social norms tend to adjust to average values'.[4] This means that we should expect people to be generally less self-conscious about their weight now, because the prevalence of individuals with BMI values classified as overweight and obese has definitely increased.[13] Researchers, who analyzed data from the 2007 Irish Survey of Lifestyles, Attitudes and Nutrition, found that survey respondents in a given BMI category, who perceived themselves as 'too heavy', tended to overreport their weight and were less likely to exaggerate their height.[6] If these findings were to be confirmed in a larger, more representative study, it would argue that the more sensitive survey respondents are about their weight, the more accurate their self-report measures are going to be, a conclusion for which these researchers did not offer any explanation.

The few studies that have addressed temporal trends in over and underreporting of height and weight in surveys have relied on a few summary statistics like mean differences between self-report and measured BMI for men and women.[10] These studies are limited by the use of very broad BMI categories like normal, overweight and obese, excluding underweight subjects altogether.[4,10] Yet, the literature based on cross-sectional data has shown that biases in self-reporting height and weight are influenced by a number of factors, including sex, age, actual (measured) height and weight, educational status, income, ethnic and racial group membership, smoking status and attitudes towards one's own weight.[2,7,14] Thus, a focus on temporal trends in under- and overreporting of height and weight requires a more detailed analysis, showing to what extent such trends are general or specific to certain population groups.

Finally, any attempt to 'adjust' or 'correct' for biases in self-reported height and weight measures should not be based solely on the ability of the adjusted measure to predict accurately the prevalence of obesity and overweight in society. Rather, such an attempt must also pass the test of minimizing biases in the prediction of BMI-related health and mortality risks.[1,2] In addition, if biases in self-reported height and weight change over time, any kind of adjustment formulas applied to self-report data would have to be reconfigured as well.

This study involved analyses aimed at shedding light on the issue of temporal changes in self-report biases. Specifically, using data from the US NHANES III survey (1988–1994) and more recent (2005–2008) continuous NHANES surveys, we intend to examine: (1) if, and to what extent, biases in self-reported BMI measure have changed among the adult US-resident population during the time interval between these surveys and (2) if changes in self-reports of height and weight are likely to reflect changing attitudes about overweight and obesity in US society.

MATERIALS AND METHODS

The following analysis is based on public use data from the NHANES conducted by the National Center for Health Statistics. The earlier NHANES III data cover the years 1988–1994 and the later continuous NHANES data cover the years 2005–2008. The NHANES surveys are multi-stage probability samples of the non-institutionalized US civilian population. Both self-reported and physical measurements of height and weight are collected for each individual, with the questionnaire preceding the physical examination. Physical examinations take place in mobile examination centers and body measurements are based on the standard protocols.[15] For NHANES III, the overall unweighted response rate for the interview sample was 86%, and for the two continuous 2-year surveys, interview response rates were 80.5% in 2005–2006 and 78.4% in 2007–2008.[16] The NHANES surveys are subject to the Centers for Disease Control National Center for Health Statistics Ethics Review Board to ensure that appropriate human subject protections are provided, in compliance with 45 Code of Federal Regulations, part 46.[17]

The NHANES III sample included 19 618 adults aged $\geqslant 18$ years. Of these, 17 689 (90.2%) had BMI values based on physical measures of height and weight, and 18 258 (93.1%) had BMI values based on self-reported height and weight. For 16 552 (84.4%) adult NHANES III participants, both self-reported and measured BMI indicators were available for analysis. The combined 2005–2008 NHANES sample contained 11 791 adults, of whom 11 126 (94.4%) had BMI values based on physical measures, and for the 11 315 (96.0%) interview respondents, a BMI score based on self-reported height and weight was computed. For 10 700 (90.7%) adults participating in the 2005–2008 NHANES, both self-reported and measured BMI indicators were available for analysis.

The weight history section of the NHANES interview schedule contains the following two questions, which remained unchanged over the course of the surveys included in this analysis: (1) 'How tall are you without shoes?' (this question could be answered by the respondent in terms of feet and inches or in meters and centimeters) and (2) 'How much do you weigh without clothes or shoes?' (this question could be answered in terms of pounds or kilograms). Weight, height and BMI discrepancy scores were computed as the difference of the self-report measure minus the physical measurement score for each individual; mean discrepancy scores refer to the average amount of discrepancy in height, weight and BMI among individuals within a specified group of interest.

The analysis employed weighted cross-classification tables, weighted linear regression models and locally weighted polynomial regression using Cleveland's tricube weighting function and employing a linear model within the local window, with a bandwidth ($=$ one half of local window) of six BMI units for the purpose of smoothing scatterplots.[18] Sensitivity in the cross-classification tables was defined as the percent of members of a given BMI category, classified on the basis of the measured BMI, who occupied the same BMI category classified on the basis of self-reported BMI ($=$ true positives). Relative risks (RRs) are computed as ratios of two probabilities, comparing the probability of 'wanting to lose weight' or 'attempting to lose weight' in the later (NHANES 2005–2008) and earlier (NHANES 1988–1994) surveys. All statistical analyses were carried out with STATA 11.1 software,[19] using the 'svy' command to incorporate information on the appropriate weights, primary sampling units and strata for correct variance estimation. For both the NHANES III and 2005–2008 NHANES surveys, we employed the final weights for the examination sample. For the continuous NHANES, the pooled weights for the 2005–2006 and the 2007–2008 surveys were divided by two to obtain estimates corresponding to the total US-resident population during 2005–2008.

RESULTS

Mean self-reported BMI scores (in $kg\,m^{-2}$) did not differ significantly ($P > 0.61$) between respondents with (26.85) and without (27.03) a measured BMI score; however, mean measured BMI scores were significantly ($P < 0.01$) lower for respondents who answered self-reported weight and height questions on the survey (27.46) compared with those who did not answer these self-reported questions (28.44).

Table 1 shows population estimates of the sensitivities, or percents of true positives, for six commonly employed BMI categories as outlined in 1998 by the National Institutes of Health and the National Heart Lung and Blood Institute.[20] Between 1988–1994 and 2005–2008, there was a slight decline in sensitivities for underweight (60.3 to 58.9%) and normal-weight (90.9 to 90.0%) persons; virtually no change for overweight persons (78.6% vs 78.7%), and substantial improvements in the proportion of true positives for obese persons (60.1 to 68.9%

Table 1. Comparison of Cross-classification of measured BMI (kg m^{-2}) and self-reported BMI for standard BMI categories: column % and s.e. in ()[a]

Self-reported BMI	*Measured BMI*					
	Underweight *<18.5*	*Normal weight* *18.5<25*	*Overweight* *25<30*	*Obesity I* *30<35*	*Obesity II* *35<40*	*Obesity III* *40+*
NHANES III 1988–1994						
<18.5	60.3 (3.7)	2.3 (0.3)	0.0 (0.1)	0.0 (0.1)	0.0 (0.0)	0.0 (0.0)
18.5<25	39.1 (3.8)	90.9 (0.4)	18.3 (0.6)	1.2 (0.4)	0.3 (0.2)	0.0 (0.0)
25<30	0.1 (0.1)	6.7 (0.5)	78.6 (0.7)	36.6 (2.1)	3.9 (0.6)	1.5 (0.9)
30<35	0.5 (0.5)	0.0 (0.1)	3.0 (0.3)	60.1 (2.0)	41.2 (2.4)	9.3 (2.1)
35<40	0.0 (0.0)	0.0 (0.1)	0.1 (0.1)	2.2 (0.4)	51.8 (2.4)	34.8 (3.9)
40+	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.1 (0.1)	2.9 (0.8)	54.4 (4.1)
		$n=16\,552$; Population size = 177 544 872				
NHANES 2005–2008						
<18.5	58.9 (3.4)	1.7 (0.3)	0.1 (0.1)	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)
18.5<25	41.1 (3.4)	90.0 (0.7)	16.6 (0.8)	1.1 (0.2)	0.1 (0.0)	0.0 (0.0)
25<30	0.0 (0.0)	8.3 (0.6)	78.7 (0.8)	27.1 (1.1)	3.1 (0.7)	0.8 (0.4)
30<35	0.0 (0.0)	0.0 (0.0)	4.5 (0.4)	68.9 (1.0)	38.8 (1.3)	2.7 (0.9)
35<40	0.0 (0.0)	0.0 (0.0)	0.1 (0.1)	2.5 (0.4)	55.5 (1.8)	25.0 (2.1)
40+	0.0 (0.0)	0.0 (0.0)	0.0 (0.0)	0.1 (0.1)	3.7	71.7 (2.6)
		$n=10\,700$; Population size = 204 730 330				

Abbreviations: BMI, body mass index; NHANES, National Health and Nutrition Examination Survey. *Source:* NHANESs, 1988–1994, 2005–2008. National Center for Health Statistics, CDC. Underlined percentages refer to sensitivity: the percent of respondents in the measured BMI categories, who are assigned to the same BMI category based on their self-reported BMI scores due to rounding, not all columns sum to 100%. Mantel–Haenszel estimate of average odds ratio in sensitivity difference between 2005–2008 and 1988–1994 controlling for measured BMI categories: 1.13, $P<0.001$. [a]Measured BMI was calculated using physical measurements of height and weight; self-reported BMI was calculated using self-reported height and weight.

among those with a BMI in the 'obesity I' category, 51.8 to 55.5% in the 'obesity II' category and 54.4 to 71.7% for 'obesity III'). In other words, in the years 2005–2008, interview responses concerning height and weight were less likely to result in a downward bias of BMI classifications among the obese US residents, when compared with 1988–1994 responses.

As the data in Table 2 show, this trend towards more accurate reporting of height and weight among obese persons can be observed among virtually all population groups in 2005–2008: it occurred among non-Hispanic Whites, non-Hispanic Blacks, Mexican-Americans and other minorities, among men and women and among all age groups, but particularly among the younger (<45 years of age) and older (65+ years). At the same time, for most population groups, there is little change in the accuracy of BMI classifications for overweight, normal-weight and even underweight persons.

Nonetheless, as the mean discrepancies between self-reported and measured BMI scores show (Table 3): for the 2005–2008 US-resident population as a whole, self-reported BMI scores underestimate true BMI scores by a slightly larger amount than those associated with the 1988–1994 population (-0.64 in 2005–2008 vs -0.56 in 1988–1994, $P<0.031$). However, this apparent decline in accuracy for the total sample is entirely explained by the upward shift of the actual population BMI distribution during this time period.[13] As has been well documented,[7] people with higher BMI values tend to overreport their height (mostly among men and the elderly of both sexes) and underreport their weight (particularly among younger women), resulting in greater discrepancies of self-reported and measured BMI among individuals in higher BMI categories. However, although this pattern still holds, Figures 1 and 2, employing smoothed scatterplots,[18] show that overweight and obese people in 2005–2008 were less prone, compared with those in 1988–1994, to underreport their weight and overreport their height. The tendency to understate one's weight by more than two pounds has declined among the adult US residents whose actual BMI exceeds 27 kg m^{-2}, while overstating one's height by more than one inch has become less common for people with a BMI <38 kg m^{-2}. The net effect of these trends has been that average discrepancies between self-reported and measured BMI scores are now smaller within each given BMI category than in the late 80s and early 90s (Table 3).

In Table 4, responses to three questions probing respondents' attitudes towards their weight status are displayed. When asked if they considered themselves overweight, underweight or about the right weight, the overall population percentages show a slight shift towards more 'overweight' responses in 2005–2008 (compared with 1988–1994). However, an analysis separating out responses by BMI categories shows a shift towards greater acceptance of one's weight as normal over time. For instance, among the overweight US residents, 38.7% thought of themselves as weighing 'about right' in 2005–2008, up from 32.8% in the earlier period (1988–1994). In fact, even among the obese (BMI 30<35 kg m^{-2}) participants in 2005–2008, 12.9% thought of themselves as having an 'about right' weight (vs 9.7% in 1988–1994). A similar trend is observable in the responses to the question inquiring whether the survey respondent would 'like to weigh more, less or stay about the same.' In 2005–2008, overall 64.8% of the adult US residents asserted that they wanted to weigh less, compared with 60.6% in 1988–1994. That translates into an unadjusted RR of 1.07 ($P<0.001$). However, after adjusting for the six BMI categories, the RR declines to 0.95 ($P<0.001$) and to 0.91 ($P<0.001$) using the continuous BMI adjustment, which takes into account all the individual differences in BMI. In other words, persons with the same BMI scores in 2005–2008, as in 1988–1994, are less likely to want to lose weight. The NHANES respondents were also asked to indicate, if they had attempted to lose weight during the 12 months prior to the interview. The overall (unadjusted) RR of trying to lose weight was 0.93 ($P<0.001$); that is to say: in 2005–2008, there were relatively fewer US residents trying to lose weight (37.5%) than in 1988–1994 (40.3%), despite the fact that average BMI in the US population increased from 26.4 to 28.4 kg m^{-2} ($P<0.001$). Thus, after adjusting for the BMI, the RR of trying to lose weight declines to 0.85 ($P<0.001$) between the two survey sequences.

Table 2. Comparison of population estimates of sensitivity values (%)[a] associated with measured BMI (kg m^{-2}) categories between NHANES III and the continuous NHANES 2005–2008 within demographic groups

	Measured BMI Categories					
	Underweight *<18.5*	*Normal weight* *18.5<25*	*Overweight* *25<30*	*Obese I* *30<35*	*Obesity II* *35+*	*Obesity III* *40+*
Men						
NHANES 1988–1994	54.2	87.7	84.5	63.8	53.5	53.8
NHANES 2005–2008	46.8	86.5	81.5	72.3	57.6	69.6
Women						
NHANES 1988–1994	62.2	93.5	70.2	56.5	50.9	54.7
NHANES 2005–2008	65.3	92.6	74.9	65.1	54.2	72.9
Race/ethnicity						
NH Whites						
NHANES 1988–1994	67.2	92.0	79.6	60.1	52.9	52.0
NHANES 2005–2008	61.9	91.1	79.6	69.6	56.4	71.1
NH Blacks						
NHANES 1988–1994	49.2	87.6	78.1	60.7	46.7	63.4
NHANES 2005–2008	46.5	87.2	79.2	69.0	60.5	75.0
Mexican-Americans						
NHANES 1988–1994	49.2	84.6	75.6	60.8	42.1	71.2
NHANES 2005–2008	47.9	82.1	75.3	64.2	50.4	72.0
Others						
NHANES 1988–1994	28.8	87.5	70.4	58.4	58.3	22.6
NHANES 2005–2008	54.1	89.0	74.7	67.7	41.0	60.7
Age groups						
18–44 years						
NHANES 1988–1994	56.4	90.6	79.1	60.4	49.6	58.0
NHANES 2005–2008	54.9	90.1	77.8	67.1	54.2	71.8
45–64 years						
NHANES 1988–1994	63.7	91.4	82.2	65.7	59.9	49.1
NHANES 2005–2008	55.0	89.4	80.6	72.5	57.4	73.7
65+ years						
NHANES 1988–1994	75.8	91.9	71.8	49.2	40.3	52.2
NHANES 2005–2008	85.9	90.5	77.7	65.3	54.8	63.1
Age-sex groups						
Men, 18–44 years						
NHANES 1988–1994	54.6	86.9	85.5	66.6	50.5	58.7
NHANES 2005–2008	49.8	85.6	80.7	71.5	56.0	72.8
Men, 45–64 years						
NHANES 1988–1994	38.3	88.3	86.3	68.0	66.2	48.2
NHANES 2005–2008	39.8	87.3	83.4	74.9	60.4	69.5
Men 65+ years						
NHANES 1988–1994	63.4	91.5	77.8	47.8	35.0	25.4
NHANES 2005–2008	56.7	88.3	79.4	67.0	54.2	48.2
Women, 18–44						
NHANES 1988–1994	57.0	93.6	68.2	54.2	49.1	57.7
NHANES 2005–2008	57.2	93.8	73.4	62.0	53.3	71.1
Women, 45–64 years						
NHANES 1988–1994	69.9	94.0	76.7	63.5	56.9	49.3
NHANES 2005–2008	67.8	90.7	76.3	69.4	55.1	75.6
Women, 65+ years						
NHANES 1988–1994	80.4	92.2	65.8	50.4	42.8	50.8
NHANES 2005–2008	95.2	91.7	75.9	63.8	55.3	68.7

Abbreviations: BMI, body mass index; NHANES, National Health and Nutrition Examination Survey. [a]Percentages refer to sensitivity: the percent of respondents in the measured BMI categories, who are assigned to the same BMI category based on their self-reported BMI scores.

Table 3. Mean discrepancy scores between self-reported and measured BMI (kg m^{-2}) based on NHANES 1988–1994 and NHANES 2005–2008 by BMI categories (population estimates)

	Mean	*95% CI*		*Mean difference: 88/94-05/08*	P-*value*
Unadjusted					
NHANES 1988–1994	−0.564	−0.615	−0.513		
NHANES 2005–2008	−0.644	−0.694	−0.593	0.080	<0.031
BMI <18.5					
NHANES 1988–1994	0.747	0.565	0.930		
NHANES 2005–2008	0.538	0.375	0.700	0.210	<0.092
BMI 18.5<25					
NHANES 1988–1994	−0.065	−0.120	−0.010		
NHANES 2005–2008	0.000	−0.063	0.063	−0.065	<0.126
BMI 25<30					
NHANES 1988–1994	−0.618	−0.669	−0.566		
NHANES 2005–2008	−0.588	−0.657	−0.519	−0.030	<0.493
BMI 30<35					
NHANES 1988–1994	−1.267	−1.414	−1.121		
NHANES 2005–2008	−1.018	−1.105	−0.931	−0.249	<0.001
BMI 35<40					
NHANES 1988–1994	−1.791	−2.033	−1.549		
NHANES 2005–2008	−1.604	−1.767	−1.441	−0.186	<0.208
BMI 40+					
NHANES 1988–1994	−3.487	−3.999	−2.974		
NHANES 2005–2008	−2.258	−2.610	−1.905	−1.229	<0.001

Abbreviations: BMI, body mass index; CI, confidence interval; NHANES, National Health and Nutrition Examination Survey.

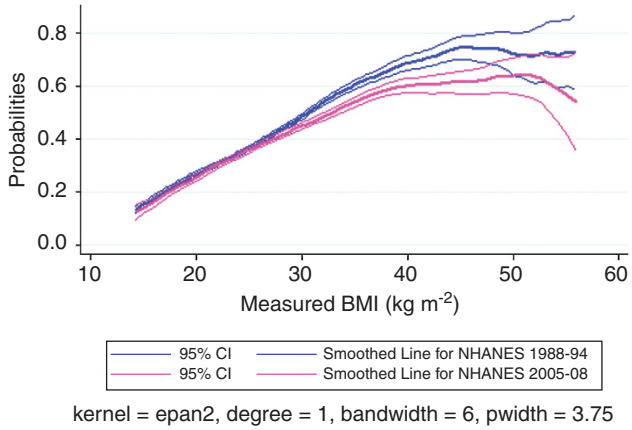

Figure 1. Probability of understating weight by two pounds or more.

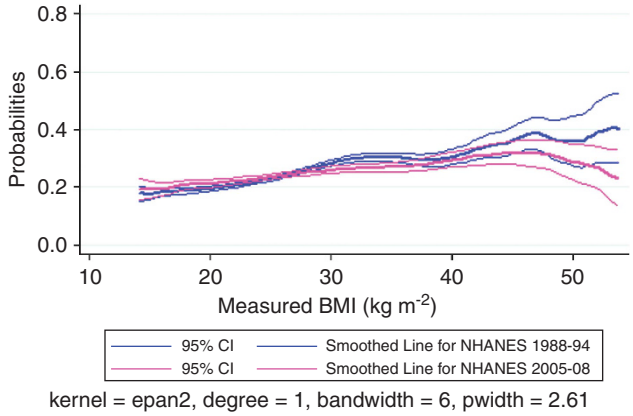

Figure 2. Probability of overstating height by one inch or more.

DISCUSSION

The evidence presented here, based on multi-year NHANES surveys, points to an increased acceptance of overweight and obesity status among adult US residents during the recent two decades. Among the obese adults, understating self-reported weight has become (on average) less severe, while overstating one's height has become less common in two of the three obesity categories. The net result is that the BMI classifications based on self-reported height and weight have become more accurate among overweight and obese people, whereas the accuracy remains about the same for underweight and normal-weight people. These trends were consistent in all the major demographic categories based on race/ethnicity, age and gender. The evidence also supports the hypothesis that these changes in self-reporting of height and weight reflect a growing national acceptance of higher BMI values as 'normal'. In particular, the adult US residents with measured BMI levels above underweight (18.5+) have become less likely to view themselves as overweight and more likely to think of themselves as having a weight that is 'just about right'. Consistent with these findings, fewer overweight and obese US residents have wanted to lose weight in more recent years or actually tried to lose it. The findings of this study appear to be inconsistent with those from an Irish study,[4] which suggested that BMI estimates based on self-reported height and weight have resulted in greater underestimates of measured BMI values among the Irish overweight and obese survey respondents between 1998 and 2007. However, two of the samples employed in that study[4] are extremely small (n (1998) = 208 and n (2002) = 331), have low response rates (<40%) and consist of self-selected respondents. It is difficult to accept that their data accurately reflect changes in the adult Irish population as a whole. Another analysis,[10] based on the data from the Canadian Heart Health Surveys (1986–1992) and the Canadian Community Health Survey (2005), showed that the mean underestimation of BMI values computed from self-reported (vs measured) height and weight increased from −0.8 to −1.1 among the Canadian adults aged 18–74 years. Using the NHANES III (1988–1994) and an NHANES survey from 2003 to 2004, the same authors[10] did not find any changes in the mean underestimation of the self-reported BMI measure among the US-resident adults aged 18–74 years. These findings are not inconsistent with the results presented here. Notably, the aforementioned study was limited by the fact that the researchers did not control for the fact that both the US- and Canadian- resident population

Table 4. Comparison of 1988/84 and 2005/08 attitudes towards weight status by BMI categories (%)

	Do you consider yourself?			P-*value*[a]
	Underweight	*About right*	*Overweight*	
Unadjusted				
NHANES 1988–1994	5.8	41.5	52.6	
NHANES 2005–2008	5.0	39.3	55.7	<0.003
Measured BMI (kg m^{-2})				
<18.5				
NHANES 1988–1994	50.0	50.0	0.0	
NHANES 2005–2008	56.6	41.8	1.6	<0.047
18.5<25				
NHANES 1988–1994	9.7	64.7	25.6	
NHANES 2005–2008	10.2	71.2	18.6	<0.001
25<30				
NHANES 1988–1994	0.6	32.8	66.6	
NHANES 2005–2008	1.1	38.7	60.2	<0.001
BMI 30<35				
NHANES 1988–1994	0.5	9.7	89.7	
NHANES 2005–2008	0.4	12.9	86.7	<0.041
BMI 35<40				
NHANES 1988–1994	0.0	2.9	97.1	
NHANES 2005–2008	0.4	4.4	95.2	<0.107
BMI 40+				
NHANES 1988–1994	0.1	2.3	97.6	
NHANES 2005–2008	0.1	2.2	97.7	>0.915
	Would you like to weigh less, more, or stay about the same?			
	Less	*Same*	*More*	
Unadjusted				
NHANES 1988–1994	60.6	31.5	8.0	
NHANES 2005–2008	64.8	28.0	7.2	<0.001

Abbreviations: BMI, body mass index; NHANES, National Health and Nutrition Examination Survey. [a]Design-based Pearson's Chi-square test.

had become heavier during these years. In fact, for given BMI levels, we see a decline in underreporting weight among women and overreporting height among men. One study from Switzerland,[11] covering surveys between 1977 and 2002, found neither a deterioration nor an improvement in the survey respondents' self-reports of height and weight; but this study also failed to control for the increased average weight of the Swiss residents.

The present study is not without limitations. It is important to keep in mind that the NHANES surveys are representative of the US-resident population, excluding institutionalized individuals who account for 2% of the population. The progressively decreasing response rates for the NHANES surveys analyzed (from 86% in 1988–1994 to 80.5% in 2005–2006 and 78.4% in 2007–2008[16]) may have contributed to biases in the temporal comparisons, if nonrespondents differed from respondents in some unrecognized way. Similarly, in an analysis focusing on discrepancies between self-reported and measured BMI scores, individuals were excluded, if they had missing data on either the self-reported or the measured height or weight data. Yet the percentage of respondents, for whom measured BMI values were unavailable, rose from 1% in 1988–1994 to almost 5% in 2005–2008, whereas the percentage of respondents neglecting or refusing to report their height or weight in the survey declined slightly from 3.4 to 2.5%. Given the relatively small sample sizes of the NHANES surveys, the cross-classification of self-reported and measured BMI in the extreme categories, underweight and obesity III produced estimates with large s.e., limiting our confidence in these findings. Finally, it should not be forgotten that respondents to the NHANES surveys do know in advance that their height and weight will be measured, possibly resulting in a bias towards more accurate reporting than one would find in a survey-only situation.

Beyond the fact that the findings reported here are consistent with sociological theory concerning social norms and their adjustments over time,[21] they also provide a challenge to those who have attempted to 'adjust' or 'correct for' misrepresentations of height and weight in surveys.[2,10] To the extent that attitudes and social norms concerning weight and obesity change over time, one would have to assume that adjustment or correction formulas must change their parameters over time as well. To what degree changes in correction formulas are necessary and how accurate are risk estimates associated with corrected BMI measures based on self-reported height and weight will be taken up in a future paper.

CONFLICT OF INTEREST

The authors declare no conflict of interest.

ACKNOWLEDGEMENTS

We thank the Michigan State University College of Nursing Research Office for their support.

REFERENCES

1 Keith S, Fontaine K, Pajewski N, Mehta T, Allison D. Use of self-reported height and weight biases the body mass index-mortality association. *Int J Obes (Lond)* 2011; **35**: 401–408.
2 Stommel M, Schoenborn C. Accuracy and usefulness of BMI measures based on self-reported weight and height: findings from the NHANES and NHIS 2001-2006. *BMC Public Health* 2009; **9**: 421–430.
3 Merrill R, Richardson J. Validity of self-reported height, weight, and body mass index: findings from the National Health and Nutrition Examination Survey, 2001–2006. *Prev Chronic Dis* 2009; **6**: A121–A130.
4 Shiely F, Perry I, Lutomski J, Harrington J, Kelleher C, McGee H *et al.* Temporal trends in misclassification patterns of measured and self-report based body mass index categories- findings from three population surveys in Ireland. *BMC Public Health* 2010; **10**: 560–572.
5 Andreyeva T, Puhl R, Brownell K. Changes in perceived weight discrimination among Americans, 1995–1996 through 2004–2006. *Obesity* 2008; **16**: 1129–1134.
6 Brestoff J, Perry I, Van den Broeck J. Challenging the role of social norms regarding body weight as an explanation for weight, height, and BMI misreporting biases: development and application of a new approach to examining misreporting and misclassification bias in surveys. *BMC Public Health* 2011; **11**: 331–358.

7 Gorber S, Tremblay M, Moher D, Gorber B. A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. *Obes Rev* 2007; **8**: 307–326.
8 Kuczmarski M, Kuczmarski R, Najjar M. Effects of age on validity of self-reported height, weight, and body mass index: findings from the third National Health and Nutrition Examination Survey, 1988-1994. *J Am Diet Assoc* 2001; **101**: 28–34.
9 Lawlor D, Bedford C, Taylor M, Ebrahim S. Agreement between measured and self-reported weight in older women, results from the British Women's Heart and Health Study. *Age Aging* 2002; **31**: 169–174.
10 Gorber S, Tremblay M. The bias in self-reported obesity from 1976-2005: A Canada-US comparison. *Obesity* 2010; **18**: 354–361.
11 Faeh D, Marques-Vidal P, Chiolero A, Bopp M. Obesity in Switzerland: do estimates depend on how body mass index has been assessed. *Swiss Med Wkly* 2008; **138**: 204–210.
12 Katzmarzyk P, Davis C. Thinness and body shape of playboy centerfolds from 1978 to 1998. *Int J Obes Relat Metab Disord* 2001; **25**: 590–592.
13 Ogden C, Carroll M, Curtin L, McDowell M, Tabak C, Flegal K. Prevalence of overweight and obesity in the United States, 1999-2004. *JAMA* 2006; **295**: 1549–1555.
14 Park J, Mitrou P, Keogh R, Luben R, Wareham N, Khaw K. Effects of body size and sociodemographic characteristics on differences between self-reported and measured anthropometric data in middle-aged men and women: the EPIC-Norfolk study. *Eur J Clin Nutr* 2011; **65**: 357–367.
15 National Health and Nutrition Examination Survey. *2005–2006 Data Documentation, Codebook, and Frequencies Body Measurements (BMX_D)*. CDC/National Center for Health Statistics: Hyattsville, MD, 2007. Available from: http://www.cdc.gov/nchs/nhanes/nhanes2005-2006/BMX_D.htm.
16 National Health and Nutrition Examination Survey. *NHANES Response Rates and CPS Totals*. CDC/National Center for Health Statistics: Hyattsville, MD 2010; Cited on 17 August 2011 (1 screen). Available from: http://www.cdc.gov/nchs/nhanes/response_rates_cps.htm.
17 US Department of Health and Human Services. *Code of Federal Regulations, Title 45*. Available from: http://www.hhs.gov/ohrp/humansubjects/guidance/45cfr46.html.
18 Cleveland W. Robust locally weighted regression and smoothing scatterplots. *J Am Statist Assoc* 1979; **74**: 829–836.
19 StatCorp. Stata Statistical Software: Release 11 2009. College Station, TX.
20 National Institutes of Health/National Heart Lung and Blood Institute. Clinical guidelines on the identification, evaluation, and treatment of overweight and obesity in adults–The evidence report. *Obes Res* 1998; **6**(Suppl 2): 51S–209S.
21 Etile F. Social norms, ideal body weight, and food attitudes. *Health Econ* 2007; **16**: 945–966.