Sex and Ethnic Differences in Validity of Self-reported Adult Height, Weight and Body Mass Index

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Objectives: Describe self-reported and measured height, weight, and body mass index (BMI) stratified by sex and ethnicity in the United States, explore ethnic variations in the likelihood of under-reporting BMI, and investigate pathways linking race/ethnicity to the underassessment of BMI.

Design: An observational study.

Setting: The entire United States.

Patients or Participants: Data were from the 2007–2008 National Health and Nutrition Examination Survey, a nationally representative sample of non-institutionalized civilian Americans.

Main Outcome: Objectively measured and subjectively reported BMI.

Measures: Independent variables include race/ethnicity (non-Hispanic Whites, non-Hispanic Blacks, Hispanics, and others), sex, age groups (age 20–29, 30–49, 50–69, and ≥70), marital status (currently married vs other marital categories), education (less than high school, high school graduate or equivalent, some college, college graduate or above), and poverty income ratio (PIR).

Results: This study confirmed that the use of reported BMI led to underestimates of the population prevalence of overweight and obesity due to the general tendency towards over-reporting height and under-reporting weight. Women were more likely than men to under-report BMI. And Whites were more likely than Blacks and Hispanics to under-report BMI. Other factors positively associated with higher likelihood of under-reporting of BMI included overweight and obese weight status, aged ≥60 years, and college education. Among women, family income was an additional positive covariate.

Conclusions: The results from this study underscore the need for frequently monitoring ethnic differences in validity of reported BMI and highlight the care which needs to be taken in making comparisons across sociodemographic groups based on reported BMI. (*Ethn Dis.* 2012;22(1):72–78)

Key Words: BMI, Validity, Self-reported, Measurement, Sex, Ethnicity

Introduction

National statistics have shown the prevalence of obesity has been persistently high in the United States.[1] Evidence is also abundant indicating large obesity disparities across major sociodemographic groups in the United States, with higher obesity rates found in Hispanics and Blacks compared to Asian and White Americans and in socioeconomically disadvantaged groups vs privileged groups across the life course.[2]

While little doubt has been cast on these reported trends, the majority of studies on obesity are reliant on self-reported body mass index (BMI), to measure body composition, which is inevitably subject to response bias. It has been frequently reported that adult weight and BMI are underestimated by self-reported measures,[3] but nuanced group differences in response bias of height and weight are less documented.[4] Accuracy of self-reported weight and height could vary by groups according to different norms and understandings regarding body weight.[5] Demographic differences or similarities in the validity of self-reported BMI have been found to have an impact on observed racial/ethnic differences in hypertension[6] and acute myocardial infarction,[7] biasing our understanding of racial/ethnic disparities in health. However, literature specifically examining whether and how validity of self-reported BMI differs across sociodemographic groups remains sparse.

There are two main sources of reporting errors in height and weight. One is an honest mistake due to lack of recent measurement at home or by health care providers. Disadvantaged groups and older individuals may have a stronger tendency than their respective counterparts for such errors caused by recall bias and lack of information.[8,9] The other reason is purposeful under- or over-reporting height and weight that is often related to social desirability. Groups who are faced with stronger social pressure on ideal body images are more likely to exhibit such response bias. In this sense, White women likely have a stronger conscious tendency towards under-reporting BMI due to the desire for a lean body.

Ethnic variation in accuracy of BMI measures based on self-reported weight and height in the United States has not been fully studied.[10] Published studies have generated mixed evidence.[4,9,11–13] Many of these studies used data from the National Health and Nutrition Examination Survey (NHANES) of various waves collected in different years. The NHANES is arguably the best source of investigating validity of self-reported BMI in the United States given that it collects both measured and reported height and weight and that it is a series of nationally representative cross-sectional sample of Americans. An earlier study using data from the Second NHANES of 1976–1980 reported no Black-White differences in reporting bias.[12] A study using the Third NHANES of 1988–1994 also found no Black-White differences but much lower sensitivity of self-reported BMI for Mexican American women compared to White women.[9] However

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other studies using the same data found the odds of underestimating BMI was actually greater among non-Hispanic White adults compared to Mexican and African American adults.[11,13] And findings from more recent continuous 2001–2006 NHANES data showed that ethnic/racial background was not a significant covariate of the difference between self-reported and measured BMI.[4] These empirical discrepancies may be due to differences in survey design (eg, oversampling of certain minority groups) and/or in analytical approach adopted in the analysis (eg, continuous difference between reported and measured values or categorical weight status were used as outcome variables); alternatively, they may reflect real temporal differences across groups in cultural sensitivities about being overweight. Therefore, the trend in ethnic variation in validity of self-reported BMI needs to be investigated periodically.[14] This information is not only necessary to accurately estimate ethnic differences in prevalence rates of overweight and obesity but also is useful in risk estimates in etiological studies of health disparities associated with ethnicity and weight status.

Using most recent data from the 2007–2008 NHANES, this study describes self-reported and measured height, weight, and BMI stratified by sex and ethnicity in the United States, explores ethnic variation in the likelihood of underassessment of BMI, and investigates pathways linking race/ethnicity to underassessment of BMI. The extant research has revealed age, marital status, education, and income are relevant sociodemographic factors influencing response bias in BMI.[4] Because these factors are all systematically associated with race/ethnicity,[15] they are likely to play a certain role in contributing to ethnic variation in validity of self-reported BMI. In addition, we also include objectively measured BMI as a predictor of response bias given evidence that individuals with excess weight tend to under-report weight and BMI significantly more than those with normal weight.[12,16]

This study describes self-reported and measured height, weight, and BMI stratified by sex and ethnicity in the United States, explores ethnic variation in the likelihood of underassessment of BMI, and investigates pathways linking race/ethnicity to underassessment of BMI.

DATA AND METHODS

For these analyses, we used data from the continuous 2007–2008 NHANES, which was conducted by the National Center for Health Statistics, as the most recently released data from a series of cross-sectional, nationally representative, multi-stage probability samples of the non-institutionalized US civilian population beginning in 1960. In 2007–2008, the sample consisted of 8,082 men and women aged ≥20 years; of whom 73.4% (n=5935) were interviewed and 70.6% (n=5707) were both interviewed and examined. Pregnant women (n=57) and participants missing measured weight or height variables (n=95) or missing reported weight or height measures (n=205) or other covariates (n=7) were excluded from the analyses. Missing values in poverty income ratio were filled with predictive values of ordinary least squares regression model on age, sex, marital status, education and household income. This study used data for 2,672 adult men and 2,671 non-pregnant adult women from the continuous NHANES 2007–2008. Both physical measurement and self-reported height and weight information were used in our analyses and differences of self-reported and measured BMI measures were computed. For descriptive purposes, weight status was categorized into underweight (BMI<18), normal weight (BMI≥18 and BMI<25), overweight (BMI≥25 and BMI<30 kg/m^2), and obese (BMI≥30). Because we are mainly concerned with the underassessment problem of BMI, a dichotomous variable was constructed to indicate whether the respondent under-reported BMI (self-reported BMI<measured BMI). This variable was treated as our outcome variable in the following sex-stratified logistic regression analysis.

Six sociodemographic factors were explored, including race/ethnicity (non-Hispanic Whites, non-Hispanic Blacks, Hispanics, others), sex, age groups (20–39, 40–59, ≥60), marital status (currently married vs other marital categories), education (less than high school graduate, high school graduate or equivalent, some college, college graduate or above), and poverty income ratio, which is a ratio of annual family income versus federal poverty line for the corresponding family size. The other racial/ethnic category included Asian Americans, Native Hawaiians, Pacific Islanders, those who identified as other race or multiple races. Although the tables include the other race group, it is not discussed in the text because of heterogeneity.

Statistical Analysis

For under-reporting of BMI, a dichotomous outcome, logistic regression analyses with identical configurations were separately performed for men and women. Model 1 is the baseline model with only race/ethnicity included treating Whites as the reference group. Model 2 to Model 6 are nested models subsequently adding marital status,

Table 1. Sample statistics

	Total		Whites		Blacks		Hispanics		Others	
	Male	Female	Male	Female	Male	Female	Male	Female	Male	Female
Objectively measured height, cm	176.05	162.37	177.44	163.21	176.73	163.42	170.35	157.38	171.35	159.29
Subjectively reported height, cm	177.46	163.21	179.03	163.94	178.09	164.11	171.24	158.94	172.01	160.33
Difference in means between measured and self-reported height, cm	−1.41	−.84	−1.59	−.73	−1.36	−.69	−.89	−1.56	−.66	−1.04
Objectively measured weight, kg	88.49	75.29	90.12	74.89	89.59	83.92	84.60	73.05	76.79	65.66
Subjectively reported weight, kg	88.50	73.91	90.08	73.39	90.23	82.18	84.51	72.46	76.39	65.10
Difference in means between measured and self-reported weight, kg	−.01	1.38	.04	1.50	−.64	1.74	.09	.59	.40	.56
Objectively measured BMI, kg/m^2	28.49	28.53	28.58	28.09	28.65	31.37	29.02	29.51	26.11	25.88
Subjectively reported BMI, kg/m^2	28.05	27.74	28.06	27.29	28.42	30.49	28.73	28.72	25.83	25.35
Difference in means between measured and self-reported BMI, kg/m^2	.44	.79	.52	.80	.23	.88	.29	.79	.28	.53
Age										
Age group 20–39	36.05%	34.05%	31.65%	30.95%	40.55%	38.52%	53.68%	47.13%	40.89%	37.68%
Age group 40–59	42.43%	41.19%	43.33%	41.17%	43.48%	42.37%	36.00%	38.17%	44.15%	45.14%
Age group ≥60	21.52%	24.77%	25.02%	27.87%	15.97%	19.10%	10.32%	14.70%	14.96%	17.18%
Currently married	59.63%	54.12%	62.35%	58.15%	41.43%	28.50%	54.51%	49.86%	69.65%	67.30%
Education										
Less than high school graduate	20.71%	18.61%	14.94%	13.91%	28.09%	27.11%	46.81%	41.07%	18.34%	14.76%
High school graduate or equivalent	26.42%	24.91%	27.32%	26.25%	27.43%	23.11%	24.13%	19.93%	19.48%	21.44%
Some college	26.83%	31.33%	28.58%	32.80%	28.87%	29.98%	19.19%	25.42%	20.05%	27.18%
College graduate or above	26.05%	25.15%	29.16%	27.04%	15.61%	19.81%	9.87%	13.57%	42.12%	36.62%
Poverty income ratio[a]	3.16	2.98	3.44	3.21	2.68	2.43	2.18	2.08	2.89	3.05
Sample size	2,672	2,671	1,323	1,256	544	576	686	743	119	96

[a] Ratio of annual family income versus federal poverty line for the corresponding family size.

overweight and obese categories, age groups, education, and poverty income ratio to the previous model. The NHANES sampling design was corrected in all the regression models. The statistical software STATA version 11.0 was used in the analyses. Survey commands were employed for both descriptive statistics and analytical models.

RESULTS

Table 1 presents sex-specific descriptive statistics for the total sample as well as for specific racial/ethnic groups on self-reported and measured height, weight, and BMI measures, reporting errors in the three variables (ie, difference in means of measured vs self-reported values), and sociodemographic variables including age, marital status, education and poverty income ratio. Based on both reported and measured BMI across sex, Whites have the lowest average BMI. Among women, Blacks have higher average BMI than Hispanics; and among men, Hispanics' average BMI is higher than Blacks. Both men (+1.41cm) and women (+.84cm) overestimate their heights, which is the case for all the groups. However, White and Black men exhibit greater magnitude of over-reporting than women, whereas the sex pattern is reversed for Hispanics. As to weight, except for Black men who overestimate their weight, all other sex by ethnic groups underestimate weight ranging from .04kg among White men to 1.74kg among Black women. Because of over-reporting height and under-reporting weight tendencies, reported BMI is consistently lower than measured BMI across the groups. Women's under-reporting error in BMI is greater than men's. Blacks are the group that shows the largest sex gap in BMI with women having the largest under-reporting error and men the least (due to their over-reporting weight) across the groups. Group differences in sociodemographic variables are apparent. Non-Hispanic Whites are the oldest, followed by non-Hispanic Blacks, with Hispanics the youngest. Whites are also the most likely to be married, followed by Hispanics and then Blacks. In terms of both education and income, Whites appear most advantaged, followed by Blacks, with Hispanics most disadvantaged.

Table 2 presents odds ratios from logistic regressions of under-reporting BMI for men. In the baseline model, Blacks and Hispanics are both less likely than Whites to under-report BMI, a pattern consistent with descriptive results presented in Table 1. Marital status is not a significant covariate (Model 2). Overweight and obese weight categories are both significant,

Table 2. Odds ratio of sociodemographic factors on the likelihood of under-reporting BMI for men

	(1)	(2)	(3)	(4)	(5)	(6)
Blacks	.72[c]	.73[c]	.72[c]	.75[b]	.82[a]	.83[a]
	(.58–.89)	(.59–.89)	(.57–.90)	(.59–.94)	(.67–1.01)	(.68–1.02)
Hispanics	.76[b]	.76[b]	.69[b]	.73[a]	.90	.92
	(.58–.99)	(.58–.99)	(.50–.96)	(.52–1.01)	(.64–1.28)	(.65–1.31)
Others	.76	.76	.98	1.02	1.01	1.03
	(.47–1.22)	(.47–1.22)	(.57–1.66)	(.60–1.75)	(.59–1.73)	(.60–1.77)
Currently married		1.05				
		(.85–1.30)				
Overweight			2.50[c]	2.54[c]	2.48[c]	2.47[c]
			(1.98–3.15)	(2.00–3.22)	(1.96–3.14)	(1.96–3.11)
Obese			1.79[c]	1.78[c]	1.82[c]	1.82[c]
			(1.43–2.24)	(1.44–2.20)	(1.50–2.19)	(1.51–2.19)
Age 40–59				.81	.81	.80[a]
				(.61–1.06)	(.62–1.06)	(.61–1.04)
Age ≥60				1.69[c]	1.78[c]	1.78[c]
				(1.25–2.29)	(1.33–2.39)	(1.32–2.39)
High school graduates					1.58[b]	1.55[b]
					(1.07–2.32)	(1.04–2.29)
Some college					1.82[b]	1.76[b]
					(1.16–2.87)	(1.11–2.79)
College graduates or above					2.05[c]	1.95[c]
					(1.61–2.61)	(1.54–2.46)
PIR[d]						1.03
						(.96–1.10)

N=2,672; 95% confidence intervals in parentheses; reference group Whites; see text for model descriptions.
[a] Significant at 10%.
[b] Significant at 5%
[c] Significant at 1%.
[d] Ratio of annual family income over federal poverty line normalized on family size.

positively associated with the odds of under-reporting BMI and renders the Hispanic effect a small increase (+9.2%; Models 2–3). So measured weight is actually a suppressor of the Hispanic effect. There is a small reduction of the race/ethnicity effects when age group is added (−4.2% for Blacks and −5.8% for Hispanics; Models 3–4) and more notable reductions when education is added (−9.3% for Blacks and −23.3% for Hispanics; Models 4–5). The oldest age group and higher education are clearly associated with higher odds of under-reporting BMI. Poverty income ratio is not a significant covariate and does not render any further reduction in the race/ethnicity effects.

Table 3 presents odds ratios from logistic regressions of under-reporting BMI for women. Although the effect direction remains the same as for men, neither Blacks nor Hispanics is a significant covariate in the baseline model. However, when overweight and obese weight categories are added, which are significant and positive covariates themselves, the effects of Blacks and Hispanics are much strengthened and become statistically significant (+15.7% for Blacks and +12.4% for Hispanics; Models 2–3). There is not much reduction of the race/ethnicity effects when age group is added (−2.7% for Blacks and −5.1% for Hispanics; Models 3–4) and slightly more notable reductions when education is added (−3.9% for Blacks and −7.3% for Hispanics; Models 4–5). As what was found for men, the oldest age group is associated with greater odds of under-reporting BMI. However, the education effect is less clear for women although the direction of the effect is still positive. Meanwhile, poverty income ratio is a significant and positive covariate net of education although it does not offer much explanation for the ethnicity effects (Models 5–6).

DISCUSSION

As one of the leading preventable causes of death in the United States,[17] obesity trends need to be consistently monitored in representative national surveys. Due to financial and logistic constraints, many surveys on body weight are reliant on self-reported height and weight despite evidence on under-assessment of BMI based on self-reported values. Although high correlations between reported and measured BMI have been routinely observed,[3,12] many authors have cautioned that using reported BMI in prevalence and etiological studies may incur systematic bias.[6] It is also important to regularly

Table 3. Odds ratio of sociodemographic factors on the likelihood of under-reporting BMI for women

	(1)	(2)	(3)	(4)	(5)	(6)
Blacks	.89	.89	.75[b]	.77[a]	.80[a]	.83
	(.70–1.14)	(.68–1.18)	(.57–.98)	(.59–1.02)	(.62–1.03)	(.63–1.09)
Hispanics	.89	.89	.78[b]	.82[a]	.88	.92
	(.74–1.06)	(.75–1.06)	(.64–.94)	(.66–1.01)	(.73–1.06)	(.76–1.12)
Others	1.00	1.00	1.20	1.24	1.26	1.28
	(.57–1.77)	(.58–1.74)	(.65–2.20)	(.67–2.29)	(.68–2.33)	(.70–2.34)
Currently married		1.01				
		(.74–1.38)				
Overweight			2.04[c]	1.99[c]	2.01[c]	2.02[c]
			(1.61–2.59)	(1.57–2.53)	(1.59–2.55)	(1.61–2.54)
Obese			1.36[c]	1.39[c]	1.39[c]	1.40[c]
			(1.10–1.67)	(1.13–1.70)	(1.13–1.72)	(1.13–1.73)
Age 40–59				.96	.99	.95
				(.78–1.18)	(.81–1.21)	(.79–1.14)
Age ≥60				1.44[c]	1.53[c]	1.51[c]
				(1.20–1.72)	(1.31–1.80)	(1.29–1.78)
High school graduates					1.16	1.12
					(.81–1.67)	(.77–1.61)
Some college					1.48[b]	1.38[a]
					(1.07–2.05)	(.96–1.99)
College graduates or above					1.24	1.10
					(.84–1.83)	(.71–1.70)
PIR[d]						1.07[a]
						(.99–1.15)

N=2,671; 95% confidence intervals in parentheses; reference group Whites; see text for model descriptions.
[a] Significant at 10%.
[b] Significant at 5%
[c] Significant at 1%.
[d] Ratio of annual family income over federal poverty line normalized on family size.

assess ethnic differences in BMI reporting errors given ethnic differences in perceptions of weight and body image,[6,14] differential access to health care and health information,[18] and disparities in a wide range of health outcomes.[19]

Consistent with previous findings from industrialized societies,[4,7–10] this study confirmed that the use of reported BMI leads to underestimates of the population prevalence of overweight and obesity due to the general tendency towards over-reporting height and under-reporting weight. That said, the magnitude of under-reporting across all sex-ethnic groups is generally small ranging from .23 kg/m^2 among Black men to .88 kg/m^2 among Black women, all within the 1 BMI unit range. In addition, consistent with the studies using previous NHANES and other data,[6,9,12,20,21] high correlations between measured and reported BMI were observed (data not shown). It should be noted that the under-reporting of weight and BMI tends to be smaller in the NHANES than in other studies,[12] possibly because participants are aware that the questionnaire survey is followed up by the examination.[9] So the under-reporting of BMI based on NHANES data provides a conservative estimate of BMI reporting errors.

Despite the modest degree of discrepancy in BMI reporting in general, sex and ethnic differences in deviations of the reported BMI values from measured BMI values were observed and predictors of accuracy of reported BMI measures were identified, indicating the need for nuanced analyses to refine our knowledge about group differences in validity of adult self-reported BMI. Predictors of likelihood of under-reporting of BMI were overweight and obese weight status, female sex, being White, aged ≥60, and college education. For women, poverty income ratio was an additional predictor positively associated with the tendency towards under-reporting BMI. Indeed, as previously pointed out,[13] report biases in BMI may be particularly significant in subgroups such as elderly and heaviest individuals where accuracy is of prime concern.

The finding that Whites are more likely to under-report BMI compared to Blacks and Hispanics is noteworthy. The present study used the most recent NHANES data to revisit the validity issue of reported BMI and provides consistent evidence that Whites have stronger tendency of under-reporting BMI compared to Blacks and Hispanics regardless of sex. This result is consistent with some studies[6,11,13] but not others[3,12] that have used data from

different waves of NHANES. Two reasons are possible for this empirical discrepancy. One regards analytical approach. Earlier NHANES studies[3,12] did not oversample minorities making it less feasible or reliable to study these groups. In some studies, discrepancy in BMI was measured as a continuous variable subtracting measured BMI from reported BMI,[4,9] whereas others[13] and the present study used categorical outcomes which may detect stepwise rather than linear effects of racial/ethnic influences on BMI reporting bias. In the same vein, although reported and measured BMI values appear highly correlated, sensitivity and specificity analyses, which are based on categories of weight status, revealed substantial bias undetectable by linear analyses.[9,12] Another possible reason underlying different results reported using NHANES data of various waves is that the widespread obesity epidemic has led to much heightened awareness of the overweight problem, making it a more socially sensitive issue. Whites may feel stronger social pressure towards conforming to norms of the ideal body images, namely lean body composition. Compared to Blacks and Hispanics, Whites have been found to be more accurately aware of their weight problems controlling for their objective weight.[14,22,23] This ethnic difference may be due to cultural factors[24,25] and/or lack of information as Blacks and Hispanics may be less equipped to either do a home-based scale measure of weight or get objective measures from a medical examiner. If the ethnic difference in the underreporting bias found in this study is real, then the reported higher prevalence rates of overweight and obesity among Blacks and Hispanics relative to Whites would have been somewhat overestimated. Disparities associated with weight status and the related complications may be less severe than what we thought, especially among women.

Another unique feature of this study was to have explored sociodemographic pathways linking race/ethnicity to BMI reporting bias. We found education played the most salient role in contributing to lower likelihoods of underreporting BMI among Blacks and Hispanics and income only mattered for women but not for men. It has been proposed in the health stratification literature that education was a more important socioeconomic factor than income linked to lifestyles partly because of its strong impact on health information and perceptions.[26] Arguably, the finding that ethnic differences in educational attainment explains, to some extent, the ethnic variation in response bias of BMI lends indirect support to this notion. Why income matters more for women than for men remains elusive and needs further investigation.

This study has some limitations. First, Asians, Pacific Islanders, and Native Americans were excluded from the analyses due to data constraints. This is an important drawback in the health disparity by race/ethnicity literature. Second, there are omitted variables that were not examined in this study. For example, attitudes toward overweight in a person's social networks may be an important factor of response bias;[27] unfortunately, this information is not available. Third, as abovementioned, NHANES tends to produce less report bias compared to reported BMI based on other telephone (eg, Behavioral Risk Factor Surveillance System) or home surveys (eg, National Health Interview Survey).[10] The reported discrepancy estimates should be interpreted with caution. And fourth, the statistical power of this study is relatively limited due to limited sample size of the most recent two-period continuous NHANES survey.

CONCLUSION

All the eight sex by racial/ethnic groups examined in this study underreported BMI; the amount of the underreporting was greatest among Black women and least among Black men; and the underreporting bias was more severe among women than among men. For both men and women, personal attributes such as race/ethnicity, age, sex, education and weight status were important factors of report bias in BMI. Among women, family income was an additional positive predictor. Whites' stronger tendency towards under-reporting BMI was partly but not entirely attributable to their higher levels of education. The results from this study underscore the need for frequently monitoring of ethnic differences in validity of reported BMI and highlight the care which needs to be taken in making comparisons across sociodemographic groups based on reported BMI.

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