Self-reported and Measured Height and Weight: Impact on Racial/Ethnic Differences in Hypertension

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Objective: We compare estimability of obesity from self-reported and measured height and weight in White, Black, and Hispanic Americans. We also sought to determine the effect of using self-reported and measured height and weight in determining the association of obesity with risk of hypertension in these population groups.

Methods: The 1999–2000 National Health and Nutrition Examination Survey (NHANES 1999–2000) participants' ($n=4789$) self-reported and measured height and weight were used for this study. Logistic regression adjusted for age, blood glucose level, total cholesterol level, smoking status, and exercise status to compare the association of obesity estimated from self-reported and measured height and weight on the prevalence odds of hypertension.

Results: Men tended to overestimate height and weight, and women tended to overestimate height and underestimate weight. Using self-reported values diminished the prevalence of obesity and odds of hypertension, and this effect related to ethnicity and sex. In men, self-report decreased the prevalence of hypertension by 9.1%, 11.8%, and 26.6% in Whites, Blacks, and Hispanics, respectively. The analogous values in women were 11.1%, 22.7%, and 7.7%.

Conclusion: Public health researchers and practitioners who use self-reported height and weight should be aware of the potential for error when using self-reported values to estimate obesity so that they may make better decisions regarding obesity screening and prevention. (*Ethn Dis*. 2008;18:415–420)

Key Words: Height, Weight, Obesity, Race/Ethnicity, Hypertension, High Blood Pressure

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Introduction

The epidemic of obesity along with its social and economic impact among United States (US) adults and children requires good epidemiologic surveillance. While computerized tomography, dual-energy x-ray absorptiometry, and double-labeled water are sometimes used for estimating body fat distribution, they are impractical in large epidemiologic studies. These techniques are arduous and expensive, and some may be hazardous due to the risk of radiation.[1–2] Hence, anthropometric methods are used to calculate body mass index (BMI) based on weight and height as a surrogate marker of generalized obesity.[3–4] Self-reported height and weight are often used in epidemiologic studies because they are inexpensive and easy to obtain.

Although self-reported height and weight are highly correlated with measured values,[5,6] they often lead to systematic and substantial errors in BMI calculation.[7] Indeed, comparisons of self-reported versus measured height and weight in previous studies indicate systematic overestimation of height and underestimation of weight.[5,7,8] Self-reported height and weight often underestimate BMI and, therefore, the prevalence of obesity. Differences between self-reported and measured height and weight have been associated[8] with differences in BMI values of 1–2 kg/m^2.

Many studies have associated systematic biases of BMI derived from self-reported height and weight with sex, age, socioeconomic status, and other population characteristics.[5–8] Because of ethnic differences in perceptions of weight,[9] we hypothesize that self-reported height and weight will differ by ethnicity. Because of the ease of determining height and weight from self-report and the high correlation of BMI with body fat, understanding these differences is critical for developing and defining a constant correction factor for the estimate of obesity from self-reported height and weight.

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The objectives of this study were to describe and compare estimability of obesity from self-reported and measured height and weight and to determine age and sex differences in estimating prevalence of obesity from self-reported and measured height and weight in White, Black, and Hispanic Americans. This study also sought to determine the effect of using self-reported and measured height and weight in determining the association of obesity with the prevalence odds of hypertension in these groups.

Methods

Data Source

The US National Center for Health Statistics (NCHS) provided the 1999–

2000 National Health and Nutrition Examination Survey (NHANES) data that were used in this study. The 1999–2000 NHANES was a cross-sectional survey carried out among the noninstitutionalized US civilian population. Descriptions of the plan and operation of the survey have been described by other investigators.[10–11] Briefly, the 1999–2000 NHANES is the most recent of the health examination surveys carried out by NCHS. The 1999–2000 NHANES was a stratified multistage probability sample based on selection of counties, blocks, households, and persons within households. Approximately 10,000 persons completed the 1999–2000 NHANES.

Measures

In the 1999–2000 NHANES, participants were asked to report their height and weight, and height and weight were also measured independently. Height was measured at standing position with a stadiometer. Weight was measured at a standing position with a Toledo self-zeroing weight scale (Seritex, Carlstadt, New Jersey). Only participants who were identified as non-Hispanic White, non-Hispanic Black, and Hispanic Americans aged 16–85 were included in this investigation. In this study, the term "non-Hispanic" refers to Americans or United States residents of non-Hispanic ethnicity who identify themselves as not having Hispanic cultural heritage, and "Hispanic Americans" refers to Americans of Hispanic cultural heritage.

Other variables from NHANES that were used for this study included diastolic blood pressure (DBP), systolic blood pressure (SBP), fasting blood glucose level, total cholesterol level, smoking status, and exercise status. In the survey, three and sometimes four blood pressure measurements were taken on all eligible individuals with a mercury sphygmomanometer. The average of three readings was used for this analysis, and hypertension was defined as DBP $>$90 mm Hg, SBP $>$140 mm Hg, or current treatment with prescribed antihypertensive medication.[12] The laboratory methods used for blood collection and analysis are published in the NHANES Laboratory/Medical Technologists Procedures Manual.[13] Briefly, blood samples were collected, processed, stored at -20°C, and shipped to the laboratory for analysis.[13] Fasting blood glucose was measured by a modified hexokinase enzymatic method.[14] Cholesterol was measured enzymatically in serum or plasma in a series of coupled reactions that hydrolyzed cholesteryl esters and oxidized the 3-OH group of cholesterol.[14]

Smoking and exercise were assessed by self-report. Smoking was categorized as current smoker or nonsmokers. Exercise status was evaluated with the question "Have been engaged in vigorous physical activity in the past 30 days?" Respondents who answered yes were classified as being engaged in exercise.

In this study, only the participants with complete information on height, weight, blood pressure, smoking, exercise, and laboratory values were eligible for this analysis. No significant differences were observed between eligible and excluded subjects in terms of these variables.

Statistical Analysis

We used SAS (SAS Institute, Inc, Cary, NC) for Windows and SUDAAN (RTI International, Research Triangle Park, NC) in this analysis. To account for unequal probabilities of selection, oversampling, and nonresponse, appropriate sample weight were used for the analyses. Standard errors were estimated by using the SUDAAN statistical program method.[15]

Racial/ethnic differences in self-reported and measured height, weight, and BMI were assessed by one-way analysis of variance, and the Tukey post hoc method was used for pairwise comparisons. Obesity was defined as BMI $\geq$30 kg/m^2. Prevalence of obesity was assessed across ethnic, sex, and age groups (16–19, 20–39. 40–59, and 60–85 years).

Logistic regression analysis[16] was used to determine the association of obesity estimated from self-reported and measured height and weight on the prevalence odds of hypertension in Whites, Blacks, and Hispanics. In the regression model, hypertension (dependent variable) was defined as SBP $>$140 mm Hg or DBP $>$90 mm Hg, and obesity defined by self-reported or measured height and weight was used as the independent variable. Statistical adjustment was made for age, blood glucose level, total cholesterol level, smoking status, and exercise status. Prevalence odds ratios from logistic regression models were used to estimate risk of hypertension associated with obesity.

RESULTS

A total of 2164 Whites, 1098 Blacks, and 1527 Hispanics were eligible for this investigation. White men and women were older than their Black and Hispanic counterparts ($P<.01$) (Table 1). According to both self-reported and measured values, White men were taller and heavier than Black and Hispanic men ($P<.01$). Black women had the highest BMI of any subgroup, both in self-report and measured values ($P<.01$).

Overall, height was overestimated by self-report in White, Black, and Hispanic men and women. Weight was also overestimated in White, Black, and Hispanic men but underestimated in White, Black, and Hispanic women. Ethnic differences with respect to overestimated height in men and women, and underestimated weight in women was significant ($P<.01$).In males, self-report was associated with overestimated height of 1.70 cm, .70 cm and .71 cm in Whites, Blacks and Hispanic Amer-

Table 1. Characteristics of study population

Variable	MALE White	MALE Black	MALE HA	MALE *P* value	FEMALE White	FEMALE Black	FEMALE HA	FEMALE *P* value
n	1061	527	729		1103	571	798	
Age (y)	$49.8^a \pm .66$	$39.4^b \pm .87$	$38.8^b \pm .75$	<.001	$47.5^a \pm .65$	$40.9^b \pm .83$	$37.8^c \pm .68$	<.001
Self-reported								
Height (m)	$177.9^a \pm .23$	$176.5^b \pm .36$	$170.3^c \pm .27$	<.001	$163.4^a \pm .21$	$163.6^b \pm .31$	$158.7^c \pm .27$	<.001
Weight (kg)	$85.4^a \pm .54$	$84.1^a \pm 86$	$78.9^b \pm .54$	<.001	$70.3^a \pm .51$	$79.3^b \pm .94$	$68.1^c \pm .53$	<.001
BMI (kg/m^2)	$26.9^a \pm .46$	$27.1^a \pm .24$	$27.2^{3a} \pm .19$	.520	$26.3^a \pm .18$	$29.6^b \pm .34$	$27.1^c \pm .21$	<.001
Measured								
Height (cm)	$176.2^a \pm .23$	$175.8^a \pm .33$	$169.6^b \pm .24$	<.001	$162.4^a \pm .20$	$163.0^a \pm .27$	$157.2^b \pm .23$	<.001
Weight (kg)	$85.1^a \pm .57$	$83.4^a \pm .96$	$78.5^b \pm .63$	<.001	$71.9^a \pm .54$	$81.0^b \pm .99$	$68.8^c \pm 57$	<.001
BMI (kg/m^2)	$27.4^a \pm .16$	$26.9^a \pm .28$	$27.2^{1a} \pm .20$	.262	$27.2^a \pm .19$	$30.4^b \pm .35$	$27.8^c \pm .22$	<.001
Difference (*): (measured minus self-reported value)								
*Height	$-1.70^a \pm .08$	$-.70^b \pm .17$	$-.71^b \pm .17$	< .001	$-1.00^a \pm .09$	$-.60^b \pm .17$	$-1.50^c \pm .17$	<.001
*Weight	$-.30^a \pm .11$	$-.70^a \pm .26$	$-.40^a \pm .18$	.140	$1.60^a \pm .13$	$1.70^a \pm .29$	$.70^b \pm .16$	<.001
*BMI	$.50^a \pm .04$	$-.20^b \pm .01$	$-.01^b \pm .002$	<.001	$.90^a \pm .05$	$.80^a \pm .13$	$.70^a \pm .50$	.115

HA, Hispanic American; Values are means ± standard errors; *P* value compares variable differences across ethnic groups and was assessed by one-way analysis of variance (ANOVA); Values with different superscripts (**a–c**) differ significantly ($P<.05$) across race/ethnicity in pair-wise (Tukey's posthoc method) comparisons; Negative values indicate overestimation, and positive values indicate underestimation of self-reported values.

icans, respectively. The corresponding values in females were 1.0 cm, .60 cm, and 1.50 cm. In females, self-report was associated with 1.60 kg, 1.70 kg, and .70 kg reduced weight in Whites, Blacks, and Hispanic Americans, respectively. Differences between measured and self-reported height and weight were associated with reduced BMI of .90 kg/m^2, .80 kg/m^2 and .70 kg/m^2 in White, Black and Hispanic American females, respectively ($P<.01$).

To determine the effect of racial/ethnic differences in self-reporting of height and weight on the prevalence of obesity, overall and sex- and race/ethnic-specific prevalences of obesity were compared across age categories (Table 2). There was no statistically significant racial/ethnic differences between prevalence of obesity estimated using self-reported and measured height and weight in the 16–19 year-old White males and White females. The prevalences of overall obesity in White, Black and Hispanic American males using self-reported height and weight were 23%, 24.6% and 23.9%, respectively. The corresponding values using measured height and weight were 25.3%, 25.2% and 25.1%. In females, the prevalences of obesity in Whites, Blacks and Hispanic Americans using self-reported height and weight were 22.8%, 40.8% and 27.1%. The corresponding values using measured height and weight were 25.3%, 44.5% and 32.1%. In males and females, the greatest variability between self-reported and measured prevalence of obesity was in men aged 20–39 and women aged 60–85.

The effect of age on self-reported height, weight, and BMI were compared across racial/ethnic groups (Table 3). Height was overestimated in all age groups. The greatest discrepancies between self-reported and measured height were observed in men and women in the oldest age group. Self-reported weight was underestimated in women of all age and ethnic groups and

Table 2. Age-specific prevalences (%) of obesity computed from self-reported (SR) and measured (M) height and weight in males and females

	MALE								FEMALE							
	White		Black		HA				White		Black		HA			
Age group	SR	M	SR	M	SR	M	P1	P2	SR	M	SR	M	SR	M	P1	P2
16–19	9.2	10.3	16.4	20.0*	16.3	18.2	<.05	<.01	9.3	10.2	22.7	25.1*	14.4	18.3*	<.01	<.01
20–39	21.2	37.8*	28.1	42.4*	28.0	33.1*	<.05	<.01	22.9	25.2*	42.1	44.0*	32.6	35.8*	<.01	<.01
40–59	30.0	31.1*	30.2	34.6*	29.2	30.6*	<.05	<.01	30.0	32.4	50.1	54.2*	42.2	45.8	<.01	<.01
60–85	23.4	26.3*	26.4	29.1*	28.4	29.3	<.01	<.01	27.2	32.5*	47.1	52.3*	37.4	42.7*	<.01	<.01
Overall	23.4	25.3*	24.6	25.2*	23.9*	25.1*	<.05	<.01	22.8	25.3*	40.8	44.5*	27.1	32.1*	<.01	<.01

HA, Hispanic American; P1, *P* value from chi-square comparing prevalence of obesity from self-reported (SR) height and weight across race/ethnicity; P2, *P* value from chi-square comparing prevalence of obesity from measured (M) height and weight across race/ethnicity.
* statistically significant differences between self-reported and measured prevalences using chi-square tests.

overestimated in men of all age and ethnic groups, except in Black men aged 16–19 and 40–59. The greatest discrepancies between self-reported and measured weight were observed in the young adult Whites (2.43 kg), middle-aged Blacks (2.36 kg), and middle-aged Hispanic Americans (1.22 kg).

Overall, in both men and women, obesity estimated from self-reported height and weight was associated with lower prevalence odds ratio of hypertension than obesity estimated from measured height and weight in the three racial/ethnic groups (Table 4). In men, the highest relative difference in prevalence odds ratio of hypertension due to differences between self-reported and measured height and weight was observed in Hispanic men (26.6%). In women, the highest relative difference was in Black women (22.7%).

DISCUSSION

Although the differences between self-reported and measured height and weight have been investigated,[17–24] we are unaware of any studies that describe the differences with respect to risk for hypertension by ethnicity. Although some studies examined the discrepancy between self-reported and measured height and weight, none have been conducted in ethnically diverse populations. Also to our knowledge, no other studies have examined the impact of self-reported height and weight on the risk of hypertension among an ethnically diverse population. NHANES data is the best available data since the sampling scheme is representative and national in scope. The training program and quality control measures that were instituted in NHANES provide an added level of credibility to the data.

A good prevalence estimate of obesity in a specified population is a requisite for effective, early, and prompt identification of patients needing treatment. Thus, anthropometric measures that are relatively accurate and acceptable need to be developed. Measured height and weight are generally used for obesity estimates because they satisfy the above criteria. However, they can be expensive in population studies because measurement tools must be transported and calibrated and technicians must be trained. Hence, self-reported height and weight are used because they are highly correlated with measured values. However, epidemiologic studies show that self-reported weight is often 4–6 kg

Table 3. Age- and sex-specific differences between self-reported and measured height and weight and associated body mass index

	MALE				FEMALE			
	White	Black	HA	*P* value	White	Black	HA	*P* value
				16–19 year olds				
Height	−1.44	−.20	−.31	.002	−1.11	−.24	−1.26	.020
Weight	−.19	.78	−.01	.331	.61	1.31	.84	.692
BMI	.32	.19	.05	.566	.55	.55	.47	.642
				20–39 year olds				
Height	−.73	−.12	−.15	.012	−.48	−.12	−1.01	.007
Weight	−.14	−.93	−.65	.202	2.43	1.87	1.22	.033
BMI	.17	.06	−.22	.054	1.04	.54	.80	.075
				40–59 year olds				
Height	−1.13	−.66	−.44	.251	−.14	−.26	−1.30	.025
Weight	−.25	1.28	−.15	.043	1.58	2.36	.69	.008
BMI	.27	−.24	−.05	.113	.65	.96	.52	.444
				60–85 year olds				
Height	−2.76	−1.40	−1.94	<.001	−2.06	−2.05	−2.41	.592
Weight	−.33	−1.83	−1.02	<.001	1.03	.64	.49	.002
BMI	.73	−.22	.24	<.001	1.08	−.96	.60	.073

HA, Hispanic American; Height, weight and BMI values are in cm, kg, and kg/m^2, respectively and represent differences between measured and self-reported values; negative values indicate overestimation, and positive values indicate underestimation by self reported anthropometrics; *P* value compares variable differences across ethnic groups

Table 4. Relative differences in the association of obesity with prevalence odds of hypertension using self-reported and measured height and weight in White, Black, and Hispanic Americans

	Self-reported		Measured		Relative difference
	POR	95% CI	POR	95% CI	(%)
MALES					
White	2.10	1.50–3.31	2.29	1.54–3.41	9.1
Black	1.87	1.44–1.99	2.09	1.66–2.44	11.8
HA	1.88	1.09–3.24	2.38	1.38–4.09	26.6
FEMALES					
White	1.44	1.08–2.38	1.60	1.01–2.53	11.1
Black	1.32	1.07–2.51	1.62	1.19–2.51	22.7
HA	2.21	1.25–3.91	2.38	1.36–4.19	7.7

HA, Hispanic American; POR, prevalence odds ratio, CI, confidence intervals are from age, blood glucose, total cholesterol, current smoking and exercise-adjusted logistic regression

lower than measured weight, which results in lower prevalence estimates for obesity.[5,7,8]

The results of this study are consistent with those of a study that used the 1988–1994 NHANES data.[25] Overall, height was overestimated and weight was underestimated by self-reported measures. Self-reported height was overestimated more in White men than in Black and Hispanic men. In women, height was much more overestimated in Hispanics, while weight was more underestimated in Blacks. In this study, self-reported height and weight were biased toward lower prevalences of obesity. Overall, self-reported height and weight were associated with significantly decreased prevalence of obesity in Hispanic American women compared with other groups.

In this study the degree of linear correlation between self-reported and measured height ranged from a low of .78 in Hispanic women to a high of .93 in White men. The degree of linear correlation between self-reported and measured weight ranged from .95 in Black and Hispanic women to .97 in White men. The high correlation between self-reported and measured height and weight reported in this study are consistent with those of other studies.[26–30] The reasons for the higher differences between self-reported height and weight with measured values among the group aged 60–85 are not clear but may be due to decrease in height from kyphosis[31] or diminution of bone mineral density in elderly persons.[31] Elderly persons loose an average of .16 cm per year in height due to the aging process.[32,33]

Despite the high degree of correlation between self-reported and measured height and weight, obesity that was estimated from self-report was associated with lowered odds of hypertension in men and women. The results from this study underscore the need for corrections to large-scale epidemiologic studies that rely solely on self-reported values. The discrepancy between self-reported and measured variables is most significant among Black women and Hispanic men. In this study, the effect of self-reported height and weight on the decreased prevalence of obesity in all age categories has implications with regard to prevention efforts for obesity. Furthermore, across all age groups, self-reported and measured weight and BMI differed more for women than for men.

Healthcare providers need to target women for screening and counseling for obesity in all age groups and pay particular attention to women who may perceive themselves in the normal range of BMI when they actually are above the BMI cutpoint for obesity. The underestimation of obesity prevalence from self-reported data compared with measured data highlights the need to conduct epidemiologic surveillance with measured BMI to obtain a more accurate prevalence of obesity.

Obesity estimated from self-reported height and weight was associated with lower prevalence odds of hypertension than was obesity estimated from measured height and weight in all three ethnic groups studied. We must determine whether errors due to self-reporting height and weight are random or systematic, or whether sex, ethnic, cultural, or social factors might help explain these differences. Social and cultural factors that may affect self-report of height and weight include language barriers, lack of access to health care and measurement instruments, and satisfaction about one's own weight and height. Indeed, non-White women are less likely to perceive themselves as overweight and are more satisfied with body size than are White women.[34,35] An earlier study showed that overweight Hispanic women (31%) were more likely to underestimate their weight than were White women (14%).[36]

The results of this study provide evidence that practitioners should rely on BMI derived from measured height and weight. Further studies are needed to determine if the observed effect of self-reported and measured height and weight on the odds of hypertension is applicable to other obesity-related diseases. Public health researchers and practitioners who use self-reported height and weight should be aware of the "error" of self-reported values so that they may make better decisions regarding obesity screening and prevention.

The results of this study provide evidence that practitioners should rely on BMI derived from measured height and weight.

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