RACE/ETHNIC AND SEX DIFFERENTIALS IN BODY MASS AMONG US ADULTS

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Current research incompletely documents race/ethnic and sex disparities in body mass, especially at the national level. Data from the 2000 National Health Interview Survey, Sample Adult File, are used to examine overall and sex-specific disparities in body mass for non-Hispanic Whites, non-Hispanic Blacks, Native Americans, Asian Americans, Puerto Ricans, Mexican Americans, and Cuban Americans. Two complementary multivariate regression techniques, ordinary least squares and multinomial logistic, are employed to control for important confounding factors. We found significantly higher body masses for non-Hispanic Blacks, Native Americans, Puerto Ricans, and Mexican Americans, compared to non-Hispanic Whites. Among very obese individuals, these relationships were more pronounced for females. Given the known health consequences associated with overweight and obesity, and recent trends toward increasing body mass in the United States, these findings underscore the need for public health policies that target specific subpopulations, in order to close the wide disparities in body mass in the United States. (*Ethn Dis*. 2004;14:389–398.)

Key Words: Race/Ethnicity, Sex, Body Mass, Obesity

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INTRODUCTION

The prevalence of overweight and obesity among US adults has steadily increased over the last 4 decades, and represents a major public health concern. From 1976 to 1999, the percentage of overweight adults increased from 48% to 61%, while rates of obese adults increased from 15% to 27%.[1] These rapid increases lead some scholars to term obesity an epidemic, and to lobby for national objectives designed to reduce the prevalence of overweight and obesity for both sexes, and among all race/ethnic groups.[2,3] However, despite the significant ramifications for health and well-being, and disproportionately high levels of obesity among non-Hispanic Blacks, Hispanics, and Native Americans, few national studies have examined disparities in body mass across detailed race/ethnic groups, by sex.[4,5] Therefore, this article provides a current examination of race/ethnic and sex differences in body mass, while accounting for confounding factors.

Studies consistently find that non-Hispanic Blacks are significantly heavier than non-Hispanic Whites.[6–9] Further, non-Hispanic Black male and female body mass distributions differ. Although the percentages of overweight non-Hispanic Black males and females are almost identical, obesity is much higher among females.[6,9] Recent estimates suggest that the prevalence of obesity for non-Hispanic Black females is 80% greater than for non-Hispanic Black males.[2]

Native Americans are an important, but understudied, population within the United States, and may possess higher obesity levels than all other race/ethnic groups, including non-Hispanic Blacks. Most Native Americans are overweight or obese, but these levels vary by region, Native American subpopulation, and sex.[10–12] Generally, overweight and obesity is slightly higher among Native American women than men. For example, researchers studying small regional samples of the Pima Indians of Arizona reported that 78% of males and 87% of females are overweight or obese.[10] National level analyses of adult Native Americans conducted in 1987 revealed that 34% of males and 40% of females were overweight or obese.[13] Although those rates are low by today's standards, they were considerably higher than the rest of the US adult population at that time. Nevertheless, several methodological issues limit the accuracy of current estimates of overweight and obesity among Native Americans. First, roughly half of the Native Americans in the United States live on reservations, and are often excluded from national surveys of health.[14] Second, small regional samples show wide variation in body mass, depending on the area studied. Third, much published research categorizes overweight and obesity differently, which obfuscates comparisons across studies.[3] In short, there is sparse information on body mass for Native Americans at the national level, particularly compared to other groups.

Among US adults, Hispanics usually exhibit higher levels of overweight and obesity than non-Hispanic Whites, but slightly lower levels than non-Hispanic Blacks.[6,9,15–18] Recent data, however, suggest that greater percentages of Hispanic males are overweight than non-Hispanic Whites or Blacks.[6,9] Studies using data from the Established Population for Epidemiologic Studies of the Elderly, the Hispanic Health and Nutrition Examination Survey, and the San Antonio Heart Study, have documented important body mass disparities for Hispanics.

Studies consistently find that non-Hispanic Blacks are significantly heavier than non-Hispanic Whites.[6–9]

In general, Mexican Americans have the highest body masses of any Hispanic subpopulation, including Cuban Americans and Puerto Ricans.[19,20] But sex differences among Hispanics remain unclear; although research suggests that Hispanic females have higher overall body masses than Hispanic males, other data show the reverse.[6,9,19] Further research is clearly warranted to examine current levels of body mass for Hispanic males and females.

Asian Americans typically have lower body masses than those found among the average US adult population.[9,21] Lauderdale and Rathouz examined adults, aged 18 to 59, and found moderately lower levels of overweight, and significantly lower levels of obesity among Asian Americans, when compared to non-Hispanic Whites and Blacks.[22] Whereas overweight and obesity rates among Asian Americans for both sexes are low, the rates are generally lower among Asian American females than males.[22,23]

This article addresses 3 major limitations of prior research. First, much of the previous research that described trends in body mass did not control for other risk factors,[1,6–10,12,17,19,20,22,24] including social, economic, and behavioral characteristics.[2,25–31] Second, few studies used recent, nationally representative data to compare body mass disparities among detailed race/ethnic groups.[10,12,17,19,20,22,23] Third, few reports examined race/ethnic and sex disparities at different points in the body mass distribution. Accordingly, this article examines race/ethnic and sex inequities in body mass, while controlling for confounding factors that influence body mass. We used data that is representative of the non-institutionalized US adult population for the year 2000 to examine body mass disparities among non-Hispanic Whites, non-Hispanic Blacks, Native Americans, Asian Americans, Puerto Ricans, Mexican Americans, and Cuban Americans, by sex. Finally, examining distributional differences among detailed race/ethnic and sex groups was central to our analyses.

METHODS

We employed the 2000 National Health Interview Survey (NHIS), Sample Adult File (SAF), to examine race/ethnic and sex differences in body mass. The NHIS-SAF is a current, nationally representative survey of non-institutionalized adults aged 18 years and older, and is a central data set used to examine national trends in illness and disability, and to track progress toward achieving national health objectives. It collects detailed information on race/ethnicity and social, health, economic, and behavioral factors. Further, this data set oversamples Blacks and Hispanics, and includes Native Americans living on reservations within its sampling frame, thereby ensuring adequate samples of individuals across race/ethnic groups.[32,33] We dropped 6.1% of the cases due to missing values for key variables, leaving 28,998 individuals for our analyses. To determine whether results were sensitive to these sample exclusions, we compared statistical models that first included, then excluded dummy variables for those with missing data on key variables, and found no substantive differences (results not shown).

We examined race/ethnic and sex differences in body mass, controlling for sociodemographic,[6,7,24,28,29] socioeconomic,[27,30] and behavioral factors.[2,31] Race/ethnicity includes 19,913 non-Hispanic Whites (referent), 4,207 non-Hispanic Blacks, 156 Native Americans (including American Indians and Alaska Natives), 790 Asian Americans, 528 Puerto Ricans, 3,077 Mexican Americans, and 327 Cuban Americans. Sex was coded as male or female (referent). We measured age in 5-year increments, and included an age-squared term, because older individuals tend to have higher body masses, perhaps due to more sedentary lifestyles or spinal compression.[25,26] Marital status included currently married (referent), previously married, or never married individuals. Region included Midwest (referent), Northeast, South, or West.

Family income was measured dichotomously, as less than or equal to $20,000 per year (referent), or greater than $20,000 per year. We used this measure of family income because it includes substantially fewer missing values than the more detailed income variable. Education was coded categorically as more than a high school degree (referent), high school degree, or less than a high school degree. Employment status included those who were employed (referent), unemployed, or not in the labor force.

Finally, we controlled for health behaviors that are associated with body mass and race/ethnicity. Smoking status controlled for never (referent), current, and former smokers. We included a dichotomous variable that indicated whether the respondent biked or walked daily. Vigorous weekly activity captured whether individuals exercised for at least 10 minutes once or less per week (referent), twice per week, 3 times per week, 4 or more times per week, or were unable to exercise.

We assessed body mass with the Body Mass Index (BMI), calculated according to convention, as weight in kilograms/height in meters^2.[34,35] We used BMI as a continuous variable in regression analysis, and then categorized it according to World Health Organization standards as underweight ($BMI<18.5$), normal weight ($18.5\leq BMI<25.0$), overweight ($25.0\leq BMI<30.0$), obese class I ($30.0\leq BMI<35.0$), obese class

Table 1. Percentages for race/ethnicity and sex, by BMI categories, US adults, 2000

	Underweight (*N*=658)	Normal Weight (*N*=11,719)	Overweight (*N*=10,195)	Obese Class I (*N*=4,221)	Obese Class II (*N*=1,414)	Obese Class III (*N*=791)	Average BMI
Panel A. Full Sample (*N*=28,998)							
Non-Hispanic							
White	2.3	42.3	35.2	13.7	4.5	2.1	26.3
Black	1.3	32.3	36.4	18.1	7.0	4.9	28.3
Native American	0.3	22.4	36.3	24.2	11.6	5.2	29.2
Asian American	7.2	60.6	25.6	5.1	0.6	0.9	23.4
Hispanic							
Puerto Rican	1.5	37.6	32.2	18.3	6.5	3.9	27.5
Mexican American	1.2	33.8	39.7	17.2	5.8	2.3	27.5
Cuban American	1.4	33.9	44.5	15.4	3.0	1.8	27.0
Sex							
Males	1.1	34.5	43.3	15.2	4.4	1.6	27.0
Females	3.4	47.1	27.8	13.3	5.1	3.2	26.5
Panel B. Males (*N*=12,704)							
Non-Hispanic							
White	1.0	34.1	43.8	15.2	4.3	1.5	26.9
Black	0.7	33.9	41.1	17.1	4.9	2.4	27.4
Native American	0.0	17.6	41.1	20.4	14.1	6.8	29.4
Asian American	3.8	57.1	33.1	4.6	0.6	0.8	24.1
Hispanic							
Puerto Rican	1.3	34.6	35.5	21.1	6.4	1.3	27.0
Mexican American	0.5	30.0	46.0	16.1	5.5	2.0	27.6
Cuban American	1.5	27.7	50.6	17.6	1.6	1.0	27.3
Panel C. Females (*N*=16,294)							
Non-Hispanic							
White	3.6	50.2	26.9	12.1	4.6	2.7	25.9
Black	1.8	31.0	32.6	19.0	8.8	6.9	28.9
Native American	0.7	27.5	31.2	28.2	9.0	3.5	29.1
Asian American	10.7	64.3	17.9	5.7	0.6	0.9	22.9
Hispanic							
Puerto Rican	1.7	39.9	29.7	16.2	6.7	5.9	27.8
Mexican American	1.8	37.8	33.3	18.3	6.1	2.7	27.4
Cuban American	1.4	38.8	39.6	13.6	4.1	2.4	26.8
Total	2.3	40.4	35.2	14.6	4.9	2.7	26.7

Source: Derived from National Health Interview Survey 2000 (NCHS 2002).

II ($35.0 \leq BMI < 40.0$), and obese class III ($BMI \geq 40.0$). Body mass index (BMI) is routinely used as an indicator of body mass because it can be easily collected in interviews, can be self-reported with a great deal of accuracy, is a valuable indicator of health and well-being, and shows persistent associations with morbidity and mortality.[25,26,36,37]

This article establishes average race/ethnic and sex disparities in body mass, after accounting for various mediating factors, and then examines disparities among very obese individuals. We used ordinary least squares (OLS) regression to estimate average differences in continuous BMI among males and females, and among the race/ethnic groups, while controlling for social, economic, and behavioral risk factors, which allowed us to parsimoniously examine the extent to which various covariates account for race/ethnic and sex differences in body mass.

Because average differences between groups may mask discrepancies in body mass among obese individuals, we also used multinomial logistic (MNL) regression to estimate the relationships for males and females, and among race/ethnic groups, at various levels of the BMI categories listed above. Unlike OLS, MNL regression does not assume that the dependent variable is normally distributed, and is not limited to presenting solely average differences; rather, it examines disparities in body mass across multiple categories.[38] That is, because race/ethnic and sex disparities in body mass may be largest among the obese, and those differences may not be constant across groups, MNL regression al-

Table 2. Unstandardized OLS regression coefficients of covariates and BMI, US adults, 2000

	Model 1		Model 2*		Models (Males)		Model 4 (Females)	
	b	95% CI	b	95% CI	b	95% CI	b	95% CI
Race-ethnicity								
Non-Hispanic								
White	ref		ref		ref		ref	
Black	1.93	1.70, 216	1.76	1.52, 2.01	0.53	0.19, 0.87	2.72	2.37, 3.06
Native American	3.13	2.08, 4.18	2.86	1.78, 3.94	2.85	1.35, 4.34	3.03	1.50, 4.56
Asian American	−2.70	−3.06, −2.34	−2.67	−3.05, −2.29	−2.60	−3.13, −2.08	−2.79	−3.30, −2.29
Hispanic								
Puerto Rican	1.29	0.63, 1.95	1.16	0.49, 1.83	0.47	−0.71, 1.64	1.66	0.94, 2.39
Mexican American	1.35	1.10, 1.60	0.90	0.62, 1.18	0.74	0.35, 1.14	1.10	0.70, 1.50
Cuban American	0.32	−0.41, 1.04	0.18	−0.57, 0.92	−0.11	−0.97, 0.75	0.47	−1.00, 1.94
Sociodemographic controls								
Sex (1=male)	0.80	0.65, 0.94	0.94	0.80, 1.09	—	—	—	—
Age (5 year increments)	1.06	0.98, 1.14	1.08	1.00, 1.17	0.94	0.82, 1.06	1.20	1.09, 1.31
Age (5 year increments) squared	−0.07	−0.08, −0.06	−0.08	−0.09, −0.07	−0.08	−0.09, −0.07	−0.09	−0.10, −0.08
Marital status								
Currently married			ref		ref		ref	
Previously married			0.10	−0.07, 0.26	−0.37	−0.61, −0.13	0.27	0.04, 0.50
Never married			−0.08	−0.30, 0.14	−0.79	−1.09, −0.50	0.47	0.14, 0.80
Region								
Midwest			ref		ref		ref	
Northeast			−0.43	−0.66, −0.21	−0.35	−0.64, −0.06	−0.57	−0.87, −0.26
South			−0.27	−0.47, −0.07	−0.06	−0.31, 0.19	−0.50	−0.78, −0.22
West			−0.27	−0.52, −0.02	−0.26	−0.55, 0.02	−0.29	−0.65, 0.07
Socioeconomic controls								
Family income (1=>$20,000)			−0.33	−0.52, −0.15	0.10	−0.14, 0.34	−0.55	−0.81, −0.29
Education								
More than high school			ref		ref		ref	
High school degree			0.54	0.37, 0.71	0.37	0.15, 0.60	0.70	0.45, 0.95
Less than high school			0.72	0.49, 0.95	0.15	−0.17, 0.46	1.26	0.94, 1.58
Employment status								
Employed			ref		ref		ref	
Unemployed			0.18	−0.12, 0.48	0.06	−0.31, 0.44	0.46	0.05, 0.87
Not in labor force			0.28	0.06, 0.49	0.35	−0.02, 0.71	0.37	0.10, 0.64
Behavioral controls								
Smoking status								
Never			ref		ref		ref	
Current			−1.07	−1.26, −0.87	−0.98	−1.21, −0.75	−1.05	−1.34, −0.76
Former			0.44	0.26, 0.63	0.54	0.29, 0.80	0.53	0.27, 0.79
Bikes or walks (1=yes)			−0.59	−0.80, −0.38	−0.49	−0.76, −0.22	−0.61	−0.89, −0.32

Table 2. Continued

	Model 1		Model 2*		Models (Males)		Model 4 (Females)	
	b	95% CI	b	95% CI	b	95% CI	b	95% CI
Vigorous weekly activity								
Unable			1.06	0.41, 1.71	0.67	−0.28, 1.61	1.27	0.44, 2.09
Once or less			ref		ref		ref	
Twice			−0.51	−0.78, −0.24	−0.35	−0.68, −0.03	−0.72	−1.17, −0.27
Three times			−0.87	−1.10, −0.64	−0.41	−0.72, −0.09	−1.31	−1.65, −0.96
Four or more times			−0.88	−1.06, −0.70	−0.47	−0.71, −0.23	−1.39	−1.67, −1.10
Constant	23.06	22.82, 23.29	23.90	23.56, 24.24	25.33	24.90, 25.77	23.40	22.90, 23.89
R-Square	0.06		0.08		0.08		0.10	

Source: Derived from National Health Interview Survey 2000 (NCHS 2002). OLS=ordinary least squares.
* (F=38.55; df_1=26, df_2=29.312; P<.001).

lowed us to more flexibly estimate inequalities at various body mass levels. We compared levels of body mass to normal weight individuals and have presented our results in the form of relative risk ratios. Because the 2000 NHIS-SAF used a clustered, stratified, unequal probability sampling frame, we employed Stata 8.0 software to ensure that our estimated coefficients and confidence intervals were unbiased and efficient.[39] All estimates were weighted to reflect the US civilian noninstitutionalized population aged 18 years and older.

RESULTS

Table 1 presents percentage of distributions of body mass for the race/ethnic groups, first for the full sample, then separately by sex. Several important patterns emerged. First, for all race/ethnic groups except Asian Americans, the majority of individuals were overweight or obese. Second, many of the race/ethnic groups had different body mass distributions. For example, whereas 14% of non-Hispanic Whites were in obese class I, 18% of non-Hispanic Blacks, and 24% of Native Americans were in obese class I. Conversely, greater proportions of Asian Americans were underweight, compared to any other group, with very small proportions in the most obese categories. Finally, important sex differences were observed across groups. For the full sample, compared to males, more females were underweight and normal weight, but more females also appeared in obese classes II and III.

Panels B and C demonstrate that some of the largest race/ethnic disparities occurred within the sex groups at the most extreme levels of obesity. Panel B shows that 7% of Native American males, but only 2% of non-Hispanic White males, and 1% of Cuban American males, were in obese class III. Similarly, Panel C indicates that 7% of non-Hispanic Black females, and 6% of

Table 3. Relative risk ratios (rrr) for race/ethnicity and sex, US adults, 2000*

	Underweight vs Normal Weight		Overweight vs Normal Weight		Obese Class I vs Normal Weight		Obese Class II or III vs Normal Weight	
	rrr	95% CI	rrr	95% CI	rrr	95% CI	rrr	95% CI
Panel A. Full Sample (*N* = 28,998)								
Non-Hispanic								
White	ref		ref		ref		ref	
Black	0.54	0.38, 0.79	1.60	1.44, 1.76	1.90	1.69, 2.13	2.23	1.90, 2.62
Native American	0.23	0.03, 1.72	2.14	1.32, 3.47	3.38	1.89, 6.02	4.27	2.40, 7.59
Asian American	2.48	1.71, 3.61	0.50	0.40, 0.61	0.26	0.17, 0.40	0.15	0.08, 0.30
Hispanic								
Puerto Rican	0.59	0.26, 1.33	1.21	0.93, 1.58	1.69	1.22, 2.35	1.80	1.19, 2.71
Mexican American	0.53	0.35, 0.81	1.54	1.36, 1.76	1.52	1.29, 1.78	1.33	1.06, 1.65
Cuban American	0.68	0.22, 2.10	1.57	1.24, 1.98	1.28	0.77, 2.13	0.82	0.42, 1.58
Sex (1 = male)	0.42	0.32, 0.54	2.30	2.16, 2.45	1.73	1.58, 1.89	1.15	1.03, 1.28
Panel B. Males (*N* = 12,704)								
Non-Hispanic								
White	ref		ref		ref		ref	
Black	0.48	0.23, 1.00	1.09	0.95, 1.25	1.26	1.03, 1.55	1.28	0.97, 1.69
Native American	0.01	0.00, 0.01	2.13	1.08, 4.20	2.82	1.28, 6.22	6.74	2.82, 16.09
Asian American	2.57	1.31, 5.02	0.45	0.34, 0.59	0.19	0.10, 0.33	0.15	0.05, 0.48
Hispanic								
Puerto Rican	0.81	0.18, 3.62	0.93	0.62, 1.40	1.53	0.84, 2.77	1.48	0.62, 3.49
Mexican American	0.52	0.20, 1.37	1.43	1.17, 1.75	1.30	1.01, 1.68	1.50	1.07, 2.12
Cuban American	1.40	0.19, 10.27	1.48	1.00, 2.20	1.37	0.80, 2.35	0.51	0.16, 1.59
Panel C. Female (*N* = 16,294)								
Non-Hispanic								
White	ref		ref		ref		ref	
Black	0.66	0.44, 1.00	2.15	1.89, 2.44	2.47	2.12, 2.88	3.04	2.51, 3.70
Native American	0.30	0.04, 2.32	2.31	1.23, 4.34	4.34	1.97, 9.58	2.67	1.19, 5.96
Asian American	2.57	1.65, 4.01	0.54	0.40, 0.71	0.36	0.21, 0.61	0.15	0.07, 0.34
Hispanic								
Puerto Rican	0.55	0.21, 1.48	1.51	1.09, 2.11	1.77	1.19, 2.63	1.97	1.32, 2.95
Mexican American	0.56	0.35, 0.90	1.72	1.46, 2.03	1.78	1.45, 2.19	1.24	0.92, 1.66
Cuban American	0.48	0.16, 1.47	1.68	1.18, 2.40	1.22	0.59, 2.52	1.04	0.34, 3.15

Source: Derived from National Health Interview Survey 2000 (NCHS 2002).

* These models control for sex, age, marital status, region, family income, education, employment status, smoking status, whether bikes or walks, and weekly vigorous activity.

Puerto Rican females, but only 3% of non-Hispanic White females, were in obese class III.

Table 2 presents unstandardized OLS regression coefficients, examining whether social, economic, and behavioral factors accounted for average disparities in body mass among detailed race/ethnic and sex groups. Model 1 regresses BMI on race/ethnicity, sex, and age, finding marked disparities. Compared to non-Hispanic Whites, non-Hispanic Blacks, Native Americans, Puerto Ricans, and Mexican Americans, exhibited significantly higher body mass. However, compared to non-Hispanic Whites, Cuban Americans had statistically similar body mass, and only Asian Americans averaged a significantly lower body mass.

Model 2 shows that sociodemographic, economic, and behavioral factors partially eliminated race/ethnic differences in body mass, although large disparities remained. Compared to non-Hispanic Whites, non-Hispanic Blacks, Native Americans, Puerto Ricans, and Mexican Americans still had significantly higher body masses, ranging from almost 3 BMI points higher among Native Americans, to less than one BMI point higher for Mexican Americans. As in Model 1, compared to non-Hispanic Whites, Cuban Americans revealed no statistically significant difference, and Asian Americans averaged a 2.7 BMI unit lower body mass.

Models 3 and 4 present the sex-specific effects of the covariates among the different race/ethnic groups. Disparities in body mass between non-Hispanic Whites and non-Hispanic Blacks and Puerto Ricans were largely due to female differences. For example, non-Hispanic Black females were 2.7 BMI units heavi-

er than non-Hispanic White females, although non-Hispanic Black males were only 0.5 BMI units heavier than non-Hispanic White males. A similar, less pronounced, pattern held for Puerto Ricans; other patterns were consistent for males and females. Indeed, compared to non-Hispanic Whites, Native American males and females were considerably heavier, and Asian American males and females had considerably lower BMIs. Because these results may understate race/ethnic and sex disparities in body mass among moderately or very obese individuals, we turned to multinomial regression.

Table 3 presents relative risk ratios (rrr) for MNL regression models that regress the body mass categories on race/ethnicity and the other covariates, first for the entire sample, and then by sex. Normal weight was the comparison group for all other body mass categories, and we combined obese classes II and III, due to small numbers of cases for some race/ethnic groups. Although all models controlled for the full array of social, economic, and behavioral factors presented in Table 2, for parsimony, we have presented only the rrr for race/ethnicity and sex.

Panel A presents the results for the full sample, indicating that, relative to normal weight individuals, all the race/ethnic groups, except for Asian Americans, were generally more likely to be overweight or obese, compared to non-Hispanic Whites. Although Table 2 found no differences in average body mass between non-Hispanic Whites and Cuban Americans, the OLS models obscured their differences. Table 3 reveals that relative to normal weight individuals, Cuban Americans were almost 60% more likely to be overweight than non-Hispanic Whites. However, relative to normal weight individuals, Cuban Americans and non-Hispanic Whites had statistically similar odds of being obese.

Many race/ethnic differences persisted into the most obese categories. Relative to normal weight individuals, non-Hispanic Blacks were 2.2 times, Native Americans were 4.3 times, Puerto Ricans were 1.8 times, and Mexican Americans were 1.3 times, as likely as non-Hispanic Whites to be in obese classes II or III. Alternately, relative to normal weight individuals, Asian Americans were 2.5 times as likely to be underweight, 50% less likely to be overweight, and 85% less likely to be in obese classes II or III, compared to non-Hispanic Whites. However, sex differences in the distribution of body mass may have confounded these relationships; overall, males were less likely to be underweight, and more likely to be overweight or obese, compared to females, relative to normal weight individuals.

Panel B examines the relationships between race/ethnicity and body mass for males, and the net of social, economic, and behavioral factors. Race/ethnic disparities in body mass among males are somewhat attenuated when compared to inequities in the overall population. For example, relative to normal weight males, non-Hispanic Black males and Puerto Rican males are statistically no more likely than non-Hispanic White males to be in obese classes II or III, a significant shift from the relationships found for the full sample. But other differences persist; relative to normal weight males, and compared to non-Hispanic White males, Native American males are 6.7 times as likely, and Mexican American males are 1.5 times as likely, to be in obese classes II or III. Further, body mass disparities that advantaged Asian Americans, relative to non-Hispanic Whites, remained for males.

Although race/ethnic disparities in body mass were somewhat muted among males, females exhibited persistent differences (Panel C). For example, relative to normal weight females, compared to non-Hispanic White females, non-Hispanic Black females were 3.0 times as likely, Native American females were 2.7 times as likely, and Puerto Rican females were 2.0 times as likely, to be in obese classes II or III, net of social, economic, and behavioral factors. Indeed, compared to non-Hispanic White females, all race/ethnic groups, other than Asian Americans, are more likely to be overweight or obese, an important difference from the patterns that typified males.

Elevated disparities in body mass were the most pronounced among non-Hispanic Blacks, Native Americans, Puerto Ricans, and Mexican Americans, and this variance may partially account for significant differences in morbidity and mortality across groups.[30,40]

DISCUSSION

We documented substantial body mass differences by race/ethnicity and sex, even after adjusting for other risk factors, with a large, current, nationally representative data set. Elevated disparities in body mass were the most pronounced among non-Hispanic Blacks, Native Americans, Puerto Ricans, and Mexican Americans, and this variance may partially account for significant differences in morbidity and mortality across groups.[30,40] Importantly, these elevated disparities are relative to non-Hispanic Whites, a group in which more than half the individuals are overweight or obese (Table 1).

Further, race/ethnic disparities in body mass vary across BMI categories. For example, Cuban Americans were

more likely to be overweight than non-Hispanic Whites, although both groups have comparable levels of obesity, relative to normal weight individuals. Differences between non-Hispanic Whites and non-Hispanic Blacks, Native Americans, Puerto Ricans, and Mexican Americans persisted into the most obese levels. Although most groups were disadvantaged relative to non-Hispanic Whites, Asian Americans consistently maintained lower body masses.[9,22,23]

Race/ethnic disparities in body mass varied not only by category, but also by sex. Compared to non-Hispanic Whites, non-Hispanic Blacks were generally heavier, a relationship driven by obese non-Hispanic Black females. For both sexes, Mexican Americans and Native Americans were more often overweight or obese than were non-Hispanic Whites. Among Puerto Ricans, however, females were more likely to be overweight or obese, whereas males possessd statistically similar body masses to non-Hispanic Whites. Large disparities persisted, despite extensive controls for confounding factors, indicating that other, unmeasured social, biological, or cultural differences exist across these groups.[41–44] Indeed, norms pertaining to ideal body type may explain race/ethnic differences in body mass, at least among females.[45] Some research has found that obesity is less ostracized among non-Hispanic Black and Mexican American females, than among non-Hispanic White females.[41,42] And compared to obese non-Hispanic White women, obese non-Hispanic Black women were more than twice as likely to be satisfied with their weight.[43]

Traditional comparisons between non-Hispanic Whites, non-Hispanic Blacks, and Hispanics may understate race/ethnic disparities in the United States.[6–8,24] For instance, Native Americans are consistently heavier than non-Hispanic Whites for both sexes.[10–13] Although our data contained a limited number of Native American cases, this relationship was stable, and generally overshadowed non-Hispanic Black and Hispanic disparities, indicating a major level of health disadvantage. Conversely, Asian American males and females persistently exhibit lower body masses than non-Hispanic Whites. Although some race/ethnic subpopulations are numerically small, their health and mortality risks may deviate substantially from those found among the numerically largest race/ethnic groups in the country and call for additional data collection and analyses.[14,46]

Ordinary least squares (OLS) regression and MNL regression illuminate race/ethnic and sex disparities in body mass. Ordinary least squares (OLS) models are advantageous because they reveal average race/ethnic differences in BMI units.[47] For example, using the information provided in Table 2 Model 2, compared to non-Hispanic Whites with an average height of 1.67 meters (or 5′6″, the average height in the full sample), comparable non-Hispanic Blacks are 5.0 kilograms (about 11 pounds) heavier, and Native Americans are 8.0 kilograms (about 18 pounds) heavier ($kg = BMI \times m^2$). But other comparisons show even more pronounced differences: compared to Asian Americans who are 1.67 meters tall, non-Hispanic Blacks of the same height are 12.4 kilograms (27 pounds) heavier, and Native Americans of the same height are 15.4 kilograms (almost 34 pounds) heavier. Conversely, MNL regression more aptly deals with asymmetric distributions.[38] Indeed, race/ethnic disparities in body mass are not constant at all levels of BMI; compared to normal weight individuals, non-Hispanic Blacks were 2.2 times and Native Americans were 4.3 times as likely as non-Hispanic Whites to be in obese classes II or III. Future work must employ the appropriate analytical techniques to more fully understand race/ethnic and sex differences in body mass.

Some scholars suggest that body mass measures and body fat indicators should be different for various race/ethnic groups.[17,21,23,48–51] It is essential, however, to establish national trends across groups in order to better understand and combat rising levels of overweight and obesity. Establishing such large-scale trends requires an effective and efficient measure; BMI qualifies as such a measure.[25,26,36,37] Further, researchers must not overlook the detrimental outcomes of being overweight or obese for all individuals. Elevated rates of obesity lead to increasing morbidity and mortality by contributing to heart disease, high blood pressure, gallbladder disease, respiratory problems, complications from diabetes, osteoarthritis, functional disability, cancer, and roughly 300,000 excess deaths per year in the United States.[6–8,11,15,24–26,28,29,36,52–56] Further, if body mass continues to increase, and smoking rates continue to decline in the United States, then obesity related healthcare costs may soon surpass those of smoking.[57] Future research must focus on variations in disease and mortality at different levels of BMI for detailed race/ethnic and sex groups.

Race/ethnic and sex disparities in body mass endure net of social, economic, and behavioral differences, and foreshadow growing race/ethnic inequality in health care, morbidity, and mortality in the United States. Public health policies must actively educate diverse groups about the health risks of overweight and obesity, perhaps by promoting physical and dietary education, and advocating that households spend fewer hours watching television, or engaging in other sedentary activities.[58,59] Further, doctors and other healthcare professionals must provide individuals with both encouragement and effective strategies to maintain normal weights, or, if overweight, to return to normal weight.[60,61] Otherwise, if current trends continue, not only will race/ethnic disparities in health and well-being likely widen, overall health and well-being of all race/ethnic and sex subpopulations may also deteriorate. Therefore, future policy and research should identify and

account for the cultural, behavioral, social, and economic factors that contribute to race/ethnic and sex disparities in body mass, while at the same time striving to reduce overweight and obesity among all groups.

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REFERENCES

1. Pastor PN, Makuc DM, Reuben C, Xia H. *Chartbook on Trends in the Health of Americans. Health, United States, 2002.* Hyattsville, Md: National Center for Health Statistics; 2002.
2. US Department of Health and Human Services. *Healthy People 2010.* Washington, DC: US Dept of Health and Human Services; 2000.
3. Story M, Evans M, Fabsitz RR, Clay TE, Holy Rock B, Broussard B. The epidemic of obesity in American Indian communities and the need for childhood obesity-prevention programs. *Am J Clin Nutr.* 1999;69:747S–754S.
4. US Department of Health and Human Services. *Report of the Secretary's Task Force on Black and Minority Health.* Washington, DC: US Government Printing Office; 1985.
5. Flegal KM, Carroll MD, Kuczmarski RJ, Johnson CL. Overweight and obesity in the United States: prevalence and trends, 1960–1994. *Int J Obes Relat Metab Disord.* 1998; 22:39–47.
6. Flegal KM, Carroll MD, Ogden CL, Johnson CL. Prevalence and trends in obesity among US adults. *JAMA.* 2002;288:1723–1727.
7. Durazo-Arvizu RA, McGee DL, Cooper RS, Liao Y, Luke A. Mortality and optimal body mass in a sample of the US population. *Am J Epidemiol.* 1998;147:739–749.
8. Mokdad AH, Ford ES, Bowman BA, et al. Prevalence of obesity, diabetes, and obesity-related health risk factors, 2001. *JAMA.* 2003; 289:76–79.
9. Schoenborn CA, Adams PF, Barnes PM. *Body Weight Status of Adults: United States, 1997–1998.* Hyattsville, Md: National Center for Health Statistics; 2002. Advance Data from Vital and Health Statistics, No. 330.
10. Knowler WC, Pettitt DJ, Saad MF, et al. Obesity in the Pima Indians: its magnitude and relationship with diabetes. *Am J Clin Nutr.* 1991;53:1543S–1551S.
11. Hanson RL, McCance DR, Jacobsson LT, et al. The u-shaped association between body mass index and mortality: relationship with weight gain in a Native American population. *J Clin Epidemiol.* 1995;48:903–916.
12. Gordon DL, Cook CB, Scheer WD, et al. Diabetes and obesity in the Louisiana Coushatta Indians. *Ethn Dis.* 1999;9:48–58.
13. Broussard BA, Johnson A, Himes JH, et al. Prevalence of obesity in American Indians and Alaska Natives. *Am J Clin Nutr.* 1991;53: 1535S–1542S.
14. Broussard BA, Sugarman JR, Bachman-Carter K, et al. Toward comprehensive obesity prevention programs in Native American communities. *Obes Res.* 1995;3:289S–297S.
15. Ostir GV, Markides KS, Freeman DH, Goodwin JS. Obesity and health conditions in elderly Mexican Americans: the Hispanic EPESE. *Ethn Dis.* 2000;10:31–38.
16. Hazuda HP, Haffner SM, Stern MP, Eifler CW. Effects of acculturation and socioeconomic status on obesity and diabetes in Mexican Americans. *Am J Epidemiol.* 1988;128: 1289–1301.
17. Stern MP, Patterson JK, Mitchell BD, Haffner SM, Hazuda HP. Overweight and mortality in Mexican Americans. *Int J Obes.* 1990;14:623–629.
18. Sundquist J, Winkleby M. Country of birth, acculturation status and abdominal obesity in a national sample of Mexican-American women and men. *Int J Epidemiol.* 2000;29: 470–477.
19. Khan LK, Sobal J, Martorell R. Acculturation, socioeconomic status, and obesity in Mexican Americans, Cuban Americans, and Puerto Ricans. *Int J Obes Relat Metab Disord.* 1997;21:91–96.
20. Nichaman MZ, Garcia G. Obesity in Hispanic Americans. *Diabetes Care.* 1991;14: 691–694.
21. Deurenberg P, Deurenberg-Yap M, Guricci S. Asians are different from Caucasians and from each other in their body mass index/body fat percent relationship. *Obes Rev.* 2002;3:141–146.
22. Lauderdale DS, Rathouz PJ. Body mass index in a US national sample of Asian Americans: effects of nativity, years since immigration, and socioeconomic status. *Int J Obes Relat Metab Disord.* 2000;24:1188–1194.
23. Yanai M, Kon A, Kumasaka K, Kawano K. Body mass index variations by age and sex, and prevalence of overweight in Japanese adults. *Int J Obes.* 1997;21:484–488.
24. Calle EE, Thun MJ, Petrelli JM, Rodriguez C, Heath CW Jr. Body mass index and mortality in a prospective cohort of US adults. *N Engl J Med.* 1999;341:1097–1105.
25. Himes CL. Obesity, disease, and functional limitation in later life. *Demography.* 2000;37: 73–82.
26. Krueger PM, Rogers RG, Hummer RA, Boardman JD. Body mass, smoking, and overall and cause specific mortality among older US adults. *Res Aging.* In press.
27. Rogers RG. Living and dying in the USA: sociodemographic determinants of death among Blacks and Whites. *Demography.* 1992;29:287–303.
28. Dorn JM, Schisterman EF, Winklestein W Jr, Trevisan M. Body mass index and mortality in a general population sample of men and women: the Buffalo study. *Am J Epidemiol.* 1997;48:919–931.
29. Gordon T, Doyle JT. Weight and mortality in men: the Albany study. *Int J Epidemiol.* 1988;17:77–81.
30. Rogers RG, Hummer RA, Nam CB. *Living and Dying in the USA: Behavioral, Health, and Social Differentials of Adult Mortality.* London: Academic Press; 2000.
31. Garrison RJ, Feinleib M, Castelli WP, McNamara PM. Cigarette smoking as a confounder of the relationship between relative weight and long-term mortality: the Framingham Heart Study. *JAMA.* 1983;249:2199–2203.
32. National Center for Health Statistics. *National Health Interview Survey, 2000* [computer file]. 2nd ICPSR version. Hyattsville, Md: US Dept of Health and Human Services, National Center for Health Statistics; 2002.
33. National Center for Health Statistics. National Health Interview Survey: research for the 1995–2004 redesign. *Vital Health Stat.* 1999.
34. World Health Organization. Physical status: the use and interpretation of anthropometry. *World Health Organ Tech Rep Ser.* Geneva: World Health Organization; 1995:854.
35. World Health Organization. *Obesity: Preventing and Managing the Global Epidemic.* Geneva: World Health Organization; 1997.
36. Rogers RG, Hummer RA, Krueger PM. The effect of obesity on overall, circulatory disease, and diabetes-specific mortality. *J Biosoc Sci.* 2003;35:107–129.
37. Stewart AL. The reliablity and validity of self-reported weight and height. *J Chronic Dis.* 1982;35:295–302.
38. Menard S. *Logistic Regression.* Thousand Oaks, Calif: Sage; 1995.
39. StataCorp. *Stata Statistical Software: Release 8.0.* College Station, Tex: Stata Corporation; 2003.
40. Hummer RA, Reindl M, Rogers RG. Race/ethnic disparities in health and mortality among the US elderly population. Book chapter prepared for the National Research Council; 2003.
41. Hebl MR, Heatherton TF. The stigma of obesity in women: the difference is Black and White. *Pers Soc Psychol Bull.* 1998;24:417–426.
42. Flynn KJ, Fitzgibbon M. Body images and obesity risk among Black females: a review of

the literature. *Ann Behav Med.* 1998;20:13–24.
43. Stevens J, Kumanyika SK, Keil JE. Attitudes towards body size and dieting: differences between elderly Black and White women. *Am J Public Health.* 1994;84:1322–1325.
44. Kumanyika SK. Obesity in African Americans: biobehavioral consequences of culture. *Ethn Dis.* 1998;8:93–96.
45. Furnham A, Alibhai N. Cross-cultural differences in the perception of female body shapes. *Psychol Med.* 1983;13:829–837.
46. Hayward MD, Heron M. Racial inequality in active life among adult Americans. *Demography.* 1999;36:77–91.
47. Berry WD, Feldman S. *Multiple Regression in Practice.* Thousand Oaks, Calif: Sage; 1985.
48. Kumanyika S. The minority factor in the obesity epidemic. *Ethn Dis.* 2002;12:316–319.
49. Lopez LM, Masse B. Comparison of body mass indexes and cutoff points for estimating the prevalence of overweight in Hispanic women. *J Am Diet Assoc.* 1992;92:1343–1347.
50. Deurenberg P, Yap M, van Staveren WA. Body mass index and percent body fat: a meta analysis among different ethnic groups. *Int J Obes Relat Metab Disord.* 2003;27:287–288.
51. Stevens J, Nowicki EM. Body mass index and mortality in Asian populations: implications for obesity cut-points. *Nutr Rev.* 2003;61:104–107.
52. Allison DB, Fontaine KR, Manson JE, Stevens J, VanItallie TB. Annual deaths attributable to obesity in the United States. *JAMA.* 1999;282:1530–1538.
53. McGinnis M, Foege WH. Actual causes of death in the United States. *JAMA.* 1993;270:2207–2212.
54. Calle EE, Rodriguez C, Walker-Thurmond K, Thun MJ. Overweight, obesity, and mortality from cancer in a prospectively studied cohort of US adults. *N Engl J Med.* 2003;348:1625–1638.
55. Must A, Spadano J, Coakley EH, Field AE, Colditz G, Dietz WH. The disease burden associated with overweight and obesity. *JAMA.* 1999;282:1523–1529.
56. Young TK. Diabetes mellitus among Native Americans in Canada and the United States: an epidemiological review. *Am J Hum Biol.* 1993;5:399–414.
57. Sturm R. The effects of obesity, smoking, and drinking on medical problems and costs. *Health Affairs.* 2002;21:247–253.
58. Dowda M, Ainsworth BE, Addy CL, Saunders R, Riner W. Correlates of physical activity among US young adults, 18 to 30 years of age, from NHANES III. *Ann Behav Med.* 2003;26:15–23.
59. Proctor MH, Moore LL, Gao D, et al. Television viewing and change in body fat from preschool to early adolescence: the Framingham Children's Study. *Int J Obes Relat Metab Disord.* 2003;27:827–833.
60. Galuska DA, Will JC, Serdula MK, Ford ES. Are healthcare professionals advising obese patients to lose weight? *JAMA.* 1999;282:1576–1578.
61. Kaplan D. Promoting weight loss in the obese patient. *Patient Care.* 2000;34:204–218.

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