**Journal of Health Disparities Research and Practice**
**Volume 6, Issue 2, Summer 2013, pp. 124-136**

School of Community Health Sciences
University of Nevada, Las Vegas

# Do Lifestyle Factors and Socioeconomic Variables Explain Why Black Women Have a Remarkably Higher Body Mass Index (BMI) than White Women in the United States? Findings from the 2010 National Health Interview Survey

Mohammad Siahpush, PhD, University of Nebraska Medical Center
Courtney A. Pinard, PhD, University of Nebraska Medical Center
Gopal K. Singh, PhD, MS, MSc, U.S. Department of Health & Human Services
Melissa Tibbits, PhD, University of Nebraska Medical Center
Raees A Shaikh, MPH, University of Nebraska Medical Center
Amy Yaroch, PhD, University of Nebraska Medical Center

## ABSTRACT

**Objective:** There are marked inequalities in body mass index (BMI), overweight, and obesity across ethnic groups. We sought to examine the extent to which lifestyle factors and socioeconomic variables explain the higher BMI in Black women compared to White women in the United States. **Methods:** We used data from the 2010 National Health Interview Survey (NHIS) and limited the sample to non-Hispanic Black and non-Hispanic White women (n = 9,491). We employed normal regression and compared the association of race with BMI before and after adjusting for lifestyle factors (diet, physical activity, smoking, and drinking) and socioeconomic variables (education, ratio of income to poverty threshold, occupation, and home ownership). Data analysis was performed in 2012. **Results:** The difference between the BMI of Black and White women decreased from 2.91 to 2.17 $Kg/m^2$ (i.e. a decrease of 27.2%) after adjusting for lifestyle factors and socioeconomic variables. Multivariate results also showed that higher consumption of fruit/vegetables and beans, lower consumption of red meat and sugar sweetened beverages, physical activity, smoking, regular drinking, and higher socioeconomic status were associated with lower BMI. **Conclusions:** Lifestyle factors and socioeconomic variables explain about a quarter of the BMI inequality between Black and White women. Thus, interventions that promote healthy eating and physical activity among Blacks as well as social policies that ameliorate socioeconomic inequalities between races might be able to reduce the current BMI inequality between Black and White women.

**Keywords:** Race, Body-Mass Index, BMI, Socio Economics, Life Styles

## INTRODUCTION

Over one-third of the adult population of the United States is obese.[1] Obesity is the second leading cause of preventable death[2] and is linked to increased rates of cardiovascular disease,[3] diabetes,[4] and certain types of cancer.[5] Marked inequalities are reported in body mass index (BMI), overweight, and obesity across sociodemographic groups.[6-8] In particular, the BMI of non-Hispanic Black women has been found to be notably higher than that of non-Hispanic White women. In 2009-2010, the prevalence of age-adjusted overweight and obesity, i.e. BMI>=25 kg/m$^2$, for female adults aged 20 years or older was 82.1% (95% CI: 77.9-85.6%) among non-Hispanic Blacks and 59.5% (95% CI: 55.5-63.3%) among non-Hispanic Whites.[1] Similarly, in 2001-2006, the prevalence of central obesity, measured as a waist circumference of greater than 35 inches in women, was markedly higher in Non-Hispanic Black than Non-Hispanic White women (69.8% versus 52.4%).[7] Such inequalities are not as notable between Non-Hispanic White women and women from other racial/ethnic groups[1,7] and do not exist between Non-Hispanic Black and White males.[1]

Little is known about the specific etiologic reasons for the BMI difference between non-Hispanic Black and non-Hispanic White women. Understanding the possible causes of this inequality can guide appropriate interventions for reducing obesity and disparities in obesity. Several reports have shown that Black women have a lower resting metabolic rate than White women,[9] but there appears to be limited evidence that lower resting metabolic rate is associated with weight gain or can explain any of the observed inequality in BMI.[9,10] We know of no empirical studies that examine the role of behavioral, social, or environmental factors in explaining the BMI difference between non-Hispanic Black and White women. In this article, we examine the extent to which BMI differences between non-Hispanic Black and White women can be explained cross-sectionally by lifestyle factors such as diet, physical activity (PA), smoking, and drinking; and socioeconomic variables such as education, income, occupation, and home ownership. Both lifestyle and socioeconomic variables are associated with BMI and Black/White race, as described below.

The association of dietary intake and BMI and obesity (BMI >= 30) is well-established. For example, higher consumption of red meat and lower consumption of fruit and vegetables are known to be associated with higher BMI levels.[11,12] It has been found that energy intake from trans fats is positively associated and consumption of fiber negatively associated with increases in central obesity.[13] Many studies have shown a relationship between physical activity and BMI and obesity. The number of steps per day has been shown to be negatively associated with BMI and waist circumference,[14] vigorous PA and weight training is associated with a decrease in central obesity,[13] and any PA in general decreases BMI and lowers the probability of being obese.[15] Smoking has also been found to be associated with BMI with current smokers having lower BMI than never smokers, and former smokers having higher BMI than current smokers and never smokers.[16] Several studies have shown a negative relationship between alcohol consumption and BMI.[17-19] The socioeconomic gradient in BMI has been well-documented. Individuals with higher levels of education and income are known to have lower BMI in the general population[6,8,20] and this disparity displays especially among women.[21]

Intakes of vegetables, potassium, calcium, fruits, grain, and milk have been found to be lower among non-Hispanic Black women than their white counterparts.[22,23] Non-Hispanic Black women are reported to be considerably less likely to engage in moderate or vigorous PA[7] and more likely to be inactive.[24] However, they have also been found to be less likely than their White counterparts to smoke[7] or drink alcohol and suffer from alcohol use disorders.[25,26] Further,

it is well-established that non-Hispanic Blacks have lower levels of education and income and are more likely to live in poverty.[7,27]

Given the association of lifestyle and socioeconomic variables with BMI and Black/White race, we would expect that the BMI difference between non-Hispanic Black and White women to be at least partially explained after adjusting for lifestyle and socioeconomic variables. Thus, the aim of this paper was to examine the extent to which this difference is explained by lifestyle factors (diet, PA, smoking, and drinking) and socioeconomic variables (education, ratio of income to poverty threshold, and occupation) among a nationally representative sample in the United States participating in the 2010 National Health Interview Survey (NHIS).

## METHODS

### Data

We derived data from the 2010 NHIS, which was conducted by the National Center for Health Statistics. The NHIS uses a multistage probability sampling design and is representative of the civilian non-institutional population of the US.[28] The household response rate was 79.5% in 2010. All data are based on self-reports, including height and weight information, and obtained via in-home interviews. The sample includes a total of 27,157 persons 18 years of age and older. The subsample of Black or White non-Hispanic women that we used in the current analysis included 11,100 individuals.

### Measurement

The outcome was Body Mass Index (BMI) computed as the ratio of self-reported weight in kilograms to the square of self-reported height in meters. Race distinguished non-Hispanic Blacks from non-Hispanic Whites.

#### *Lifestyle factors:*

*Dietary Behaviors.* Respondents were asked to indicate how often during the past month they consumed any of the following food items: fruit, 100% fruit juice, salad, other vegetables, beans, whole grain bread, brown rice, red meat, processed meat, fried potatoes, candy, cookies, donuts, ice cream, non-diet soda, and fruit drinks. For each respondent, we computed frequency of consumption of each food item per week.

*PA.* Respondents were asked how often they performed "light or moderate leisure-time physical activities for at least 10 minutes that cause only light sweating or a slight to moderate increase in breathing or heart rate" and "vigorous leisure-time physical activities for at least 10 minutes that cause heavy sweating or large increases in breathing or heart rate". They were also asked "About how long do you do these light or moderate leisure-time physical activities [or vigorous physical activities] each time?" From these questions, we computed a variable measuring the length of time of moderate or vigorous PA in minutes per week. We note that "light or moderate" PA as defined in the NHIS is described as "moderate" by the US Department of Health and Human Services[29] and we use the word moderate to refer to light or moderate. Self-reported moderate and vigorous PA among adults has been previously validated against objectively measured (by accelerometer) moderate and vigorous PA.[30] Furthermore, there is no evidence that the agreement of self-reported and measured PA varies by socioeconomic or demographic variables.[30,31]

The survey also included a question about strengthening exercises: "How often do you do leisure-time physical activities specifically designed to strengthen your muscles such as lifting

weights or doing calisthenics." From responses to this question, we computed a variable indicating frequency of performing strengthening exercises per week.

*Smoking*. Respondents were asked "Have you smoked at least 100 cigarettes in your entire life?" Those who replied affirmatively were then asked "Do you now smoke cigarettes every day, some days or not at all?" Based on these questions, we defined smoking status as having three categories: (1) never smokers consisting of those who have not smoked more than a 100 cigarettes in their life; (2) former smokers consisting of those who have smoked more than a 100 cigarettes in their life but do not currently smoke; and (3) current smokers consisting of those who have smoked at least 100 cigarettes in their life and currently smoked every day or some days. Self-reported smoking status based on surveys of the general population has been validated with cotinine and no systematic differentials in underreporting by sociodemographic groups have been observed.[32,33] The validity of self-reported smoking status appears to be similar across racial/ethnic groups when compared with levels of expired carbon monoxide.[34]

*Alcohol Consumption.* Alcohol consumption was categorized into six groups: (1) Never drinker defined by the consumption of less than 12 drinks in lifetime; (2) former drinker defined by the consumption of 12 or more drinks in lifetime but none in the past year; (3) current infrequent drinker defined by the consumption of 12 or more drinks in lifetime and between one to 11 drinks in the past year; (4) current light drinker defined by the consumption of 12 or more drinks in lifetime and less than or equal to three drinks per week in the past year; (5) current moderate drinker defined by the consumption of 12 or more drinks in lifetime, and greater than three drinks and up to 14 drinks per week in the past year among males, or greater than three and up to seven drinks per week in the past year among women; (6) current heavy drinker defined by 12 or more drinks in lifetime, and greater than 14 drinks per week in the past year among males, and greater than seven drinks per week in past year among women.

***Socioeconomic variables:***

*Educational attainment* was grouped into 0-8, 9-11, 12, 13-15, and >=16 years. *Family poverty status* was measured as the ratio of total family income from all sources before taxes to the 2010 poverty threshold.[35] *Occupation* was classified into the following categories: (1) professional and managerial occupations; (2) sales/clerical and technical support occupations; (3) service; (4) craft and repair; (5) other occupation; (6) unemployed; and (7) not in the labor force.

**Statistical analysis**

In all analyses, we have taken into account sampling weights, stratification, and primary sampling units. Cases with missing values for any of the study variables, except poverty status, were excluded from the analysis. Missing values for poverty status (14% in Blacks and 17% in Whites) were included as a distinct category. The sample used in all analyses included 9,491 individuals, 2,188 non-Hispanic Black and 7,303 non-Hispanic White women.

In order to examine the extent to which lifestyle and socioeconomic variables explained the BMI difference in non-Hispanic Black and White women, we used normal regression and first estimated the age-adjusted effect of Black/white race on BMI. We then estimated a second model where lifestyle variables were added. Finally, we estimated a third model which included both lifestyle and socioeconomic variables. The attenuation of the effect of Black/White race on BMI from the first model to the third model gives an indication of the extent to which lifestyle factors and socioeconomic variables explain BMI differentials between non-Hispanic Black and White women. Because BMI is slightly skewed to the right, we performed additional analyses using the logarithmic transformation and found no appreciable difference in the effect of covariates on BMI. Stata SE version 12 was used in all analyses.[36]

## RESULTS

Table 1 provides descriptive statistics for variables used in the analysis. Compared to non-Hispanic White women, non-Hispanic Black women were younger and appeared to consume less fruit/vegetables, whole grain bread, red meat, and sweets, and more processed meat, fried potatoes, and sugar sweetened beverages. Compared to White respondents, Black respondents engaged in substantially less moderate/vigorous PA, strengthening exercise, smoking, and current drinking. Non-Hispanic Black women had markedly lower socioeconomic status than their White counterparts. Similarly, a notably higher percentage of Blacks were unemployed and lived in rental housing.

**Table 1. Sample characteristics and mean BMI across categories of each covariates (n=9491; 2,188 Blacks and 7,303 Whites)**

| Covariates | % in sample or mean (SD)[a] | | Mean BMI[b] | *p*-value[c] |
|---|---|---|---|---|
| | Blacks | Whites | | |
| Race | | | | <0.001 |
| Black | - | - | 30.02 | |
| White | - | - | 26.94 | |
| Age | | | | <0.001 |
| 18-24 | 15.35 | 11.28 | 24.98 | |
| 24-44 | 38.08 | 31.63 | 27.38 | |
| 45-65 | 33.48 | 36.51 | 28.33 | |
| 65+ | 13.09 | 20.58 | 27.24 | |
| *Lifestyle factors (diet, physical activity, smoking, and drinking)*[d] | | | | |
| Fruits and vegetables[e] | 17.79(17.49) | 17.94(11.13) | 27.85/26.98 | <0.001 |
| Beans | 1.11(2.47) | 1.07(1.63) | 27.51/27.29 | <0.001 |
| Whole grain bread | 3.58(5.90) | 3.96(3.86) | 27.64/27.16 | 0.047 |
| Brown rice | 0.72(2.23) | 0.71(1.42) | 27.94/26.84 | 0.004 |
| Red meat | 2.41(3.60) | 2.49(2.27) | 26.95/28.08 | <0.001 |
| Processed meat | 1.68(3.01) | 1.41(1.81) | 27.01/28.17 | <0.001 |
| Fried potatoes | 1.56(3.54) | 1.13(1.72) | 27.00/27.86 | 0.062 |
| Sweets[f] | 5.81(10.39) | 6.10(5.84) | 27.60/27.22 | 0.284 |
| Sugar sweetened beverages[g] | 6.04(10.84) | 3.14(6.34) | 27.06/27.80 | <0.001 |
| Moderate/vigorous physical activity | 136.72(368.93) | 201.12(321.98) | 28.35/26.40 | <0.001 |
| Strengthening exercise | 0.63(2.11) | 0.95(2.19) | 27.96/25.77 | <0.001 |
| Smoking status | | | | <0.001 |
| Current smoker | 17.45 | 19.70 | 27.04 | |
| Former smoker | 10.64 | 21.55 | 28.03 | |
| Never smoker | 71.91 | 58.75 | 27.33 | |
| Alcohol consumption | | | <0.001 | |
| Former drinker | 14.78 | 14.10 | 29.46 | |
| Current infrequent drinker | 18.11 | 17.05 | 28.63 | |
| Current light drinker | 23.16 | 33.16 | 26.63 | |
| Current moderate drinker | 5.54 | 10.96 | 25.65 | |
| Current heavy drinker | 3.92 | 6.11 | 25.84 | |

| Covariates | % in sample or mean (SD)[a] | | Mean BMI[b] | *p*-value[c] |
|---|---|---|---|---|
| | Blacks | Whites | | |
| *Socioeconomic variables (education, poverty, occupation, and home ownership)* | | | | |
| Education (years of schooling completed) | | | | <0.001 |
| 0-8 | 2.79 | 2.07 | 28.41 | |
| 9-11 | 11.83 | 5.50 | 27.96 | |
| 12 | 30.98 | 27.45 | 28.08 | |
| 13-15 | 35.72 | 33.53 | 27.82 | |
| 16+ | 18.70 | 31.44 | 26.11 | |
| Poverty status (Ratio of family income to poverty threshold) | | | | <0.001 |
| <100% | 25.99 | 9.39 | 28.43 | |
| 100-199% | 20.41 | 14.13 | 28.66 | |
| 200-299% | 15.22 | 13.75 | 27.49 | |
| 300-399% | 9.96 | 11.72 | 27.72 | |
| 400-499% | 4.16 | 9.04 | 27.36 | |
| 500%+ | 10.59 | 24.91 | 26.43 | |
| No income information | 13.67 | 17.06 | 26.64 | |
| Occupation | | | | <0.001 |
| Professional/managerial | 12.48 | 19.88 | 27.11 | |
| Sales/clerical | 25.67 | 24.54 | 27.51 | |
| Service | 11.44 | 8.36 | 26.88 | |
| Craft and repair | 2.63 | 1.98 | 28.23 | |
| Laborers | 1.38 | 0.99 | 28.56 | |
| Other | 1.20 | 0.41 | 26.59 | |
| Unemployed | 11.14 | 4.30 | 28.07 | |
| Not in the labor force | 34.07 | 39.53 | 27.47 | |
| Home ownership | | | | <0.001 |
| Renter | 51.00 | 23.05 | 27.86 | |
| Owners/purchaser | 49.00 | 76.95 | 27.25 | |

[a] For continuous variables (i.e., frequency of consuming each food item per week, minutes of moderate/vigorous physical activity per week, and frequency of strengthening exercises per week), the mean and standard deviation of BMI is reported.

[b] For continuous variables, the mean BMI for the category at or below the median and the category above the median, separated by a slash, are reported.

[c] *p*-value for the bivariate association of BMI and each covariate.

[d] The food item variables indicate frequency of consumption per week. The moderate/vigorous physical activity represents minutes per week. The strengthening exercises variable indicates frequency per week.

[e] This food category includes fruit, 100% fruit juice, salad, and other vegetables.

[f] This food category includes candy, cookie, donut, and ice cream.

[g] This food category includes non-diet soda and fruit drink.

Table 1 also includes statistics pertaining to the bivariate relationship between BMI and covariates. Mean BMI of Black respondents was 30 kg/m$^2$ and that of White respondents was 26.9 kg/m$^2$. BMI generally increased with age. Higher consumption of fruit and vegetables, beans, brown rice and lower consumption of red meat, processed meat, and sugar sweetened beverages were associated with lower BMI ($p$<0.001 for all associations, except for brown rice where $p$=0.004). Higher levels of moderate/vigorous PA, higher frequency of strengthening exercises, smoking, and current regular drinking were associated with lower BMI ($p$<0.001 for all associations). The bivariate results also showed that higher socioeconomic status was associated with lower BMI (p<0.001 for all associations). Those with the highest years of

education had the lowest BMI. Higher ratio of income to poverty threshold, and being a home owner/purchaser was associated with lower BMI. White collar occupation (i.e. professional/managerial, sales/clerical, and service) had the lowest BMI and laborers had the highest.

Table 2 provides the results of the regression of BMI on Black/White race, lifestyle factors, and socioeconomic variables in women. Model 1 shows that the age-adjusted mean of BMI was 2.98 kg/m$^2$ greater in Blacks than in Whites. Model 2 shows that after controlling for lifestyle factors, the difference in the adjusted mean of BMI between Blacks and Whites was attenuated to 2.61 kg/m$^2$. We also examined an alternative Model 2 where socioeconomic variables, instead of lifestyle factors, were added to Model 1. In this alternative model, the BMI difference between Blacks and Whites was 2.47 kg/m$^2$. Finally, in Model 3 both lifestyle and socioeconomic variables were simultaneously added to the equation. The difference in the adjusted mean of BMI between non-Hispanic Black and non-Hispanic White women was further reduced to 2.17 kg/m$^2$, which represented a reduction of 27.2% from the age-adjusted difference in Model 1.

**Table 2. Regression of BMI on race, lifestyle factors, and socioeconomic variables[a] (n=9,491; 2,188 Blacks and 7,303 Whites)**

| Covariates | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | $\hat{\beta}$ | *p*-value | $\hat{\beta}$ | *p*-value | $\hat{\beta}$ | *p*-value |
| Race | | <0.001 | | <0.001 | | <0.001 |
| Black | 2.98 | | 2.61 | | 2.21 | |
| White | 0 | | 0 | | 0 | |
| *Lifestyle factors (diet, physical activity, smoking, and drinking)*[b] | | | | | | |
| Fruit and vegetables | | | -0.02 | <0.001 | -0.02 | <0.001 |
| Beans | | | -0.08 | 0.054 | -0.10 | 0.009 |
| Whole grain bread | | | 0.02 | 0.350 | 0.01 | 0.375 |
| Brown rice | | | -0.07 | 0.230 | -0.06 | 0.298 |
| Red meat | | | 0.18 | <0.001 | 0.16 | <0.001 |
| Processed meat | | | 0.03 | 0.385 | 0.04 | 0.306 |
| Fried potatoes | | | 0.01 | 0.797 | 0.02 | 0.514 |
| Sweets | | | -0.03 | 0.025 | -0.02 | 0.060 |
| Sugar sweetened beverages | | | 0.03 | 0.015 | 0.03 | 0.012 |
| Moderate vigorous physical activity | | | -0.01 | <0.001 | -0.01 | <0.001 |
| Strengthening exercise | | | -0.15 | <0.001 | -0.13 | <0.001 |
| Smoking status | | | | <0.001 | | 0.001 |
| Current smokers | | | 0 | | 0 | |
| Former smoker | | | 1.56 | | 1.96 | |
| Never smokers | | | 0.58 | | 1.23 | |
| Alcohol consumption | | | | <0.001 | | <0.001 |
| Never | | | 0 | | 0 | |
| Former | | | 1.75 | | 1.51 | |
| Infrequent | | | 1.20 | | 1.01 | |
| Light | | | -0.33 | | -0.26 | |
| Moderate | | | -1.42 | | -1.27 | |
| Heavy | | | -1.30 | | -1.09 | |

**Table 2. continued**

| Covariates | Model 1 | | Model 2 | | Model 3 | |
|---|---|---|---|---|---|---|
| | $\hat{\beta}$ | *p*-value | $\hat{\beta}$ | *p*-value | $\hat{\beta}$ | *p*-value |
| *Socioeconomic variables (education, poverty, occupation, and home ownership)* | | | | | | |
| Education (years of schooling completed) | | | | | | <0.001 |
| 0-8 | | | | | 0 | |
| 9-11 | | | | | 0.59 | |
| 12 | | | | | 1.28 | |
| 13-15 | | | | | 1.13 | |
| 16+ | | | | | 1.38 | |
| Poverty status (Ratio of family income to poverty threshold) | | | | | | <0.001 |
| <100% | | | | | 0 | |
| 100-199% | | | | | 1.14 | |
| 200-299% | | | | | 1.50 | |
| 300-399% | | | | | 0.56 | |
| 400-499% | | | | | 0.66 | |
| 500%+ | | | | | 0.72 | |
| No income information | | | | | -0.20 | |
| Occupation | | | | | | <0.001 |
| Professional/managerial | | | | | 0 | |
| Sales/clerical | | | | | -0.42 | |
| Service | | | | | -0.91 | |
| Craft and repair | | | | | -0.77 | |
| Laborers | | | | | 0.63 | |
| Other | | | | | -1.29 | |
| Unemployed | | | | | 0.14 | |
| Not in the labor force | | | | | -0.64 | |
| Adjusted $R^2$ | 0.052 | | 0.079 | | 0.110 | |

[a] Model 1 adjusts for race and age. Model 2 adjusts for race, age, and lifestyle factors. Model 3 adjusts for race, age, lifestyle factors, and socioeconomic variables.
[b] The food item variables indicate frequency of consumption per week. The moderate/vigorous physical activity represents minutes per week. The strengthening exercises variable indicates frequency per week.

Furthermore, adjusted results in Model 3 show that a higher frequency of consumption of fruits and vegetables ($p<0.001$) and beans ($p=0.009$) was associated with lower BMI, and a higher frequency of consumption of red meat ($p<0.001$) and sugar sweetened beverages ($p=0.012$) was associated with higher BMI. More moderate/vigorous PA ($p<0.001$) and strengthening exercises ($p<0.001$), being a smoker ($p=0.001$), and being a regular drinker ($p<0.001$) were associated with lower BMI, as was the case in the bivariate results. The adjusted effect of education, ratio of income to poverty threshold, and occupation was similar to bivariate findings, which indicate that higher SES is associated with lower BMI ($p<0.001$ for all associations). Home ownership was not associated with BMI.

## DISCUSSION

Using national data, we estimated that about 27.2% of the difference between the BMI of non-Hispanic Black and White women in the United States can be attributed to lifestyle factors such as diet, PA, smoking, and drinking and socioeconomic variables such as education, income, and occupation. Consistent with previous literature, our results showed that higher consumption of fruit/vegetables, lower consumption of red meat,[11,12] more PA,[13,14] smoking,[16] regular drinking,[17] and higher socioeconomic status were associated with lower BMI.[6,8,20,21]

A major strength of our study was the use of a large nationally representative sample with a high response rate and a data collection based on in-person home interviews. Our study had some possible limitations, predominantly in relation to the measurement of variables, which were all self-reported. People who are overweight or obese are more likely than others to underestimate their weight and overestimate their height.[37] Thus, given that non-Hispanic Black women have a higher objectively measured BMI than non-Hispanic White women,[1] it might be argued that the self-reported BMI difference observed in this study may actually be an underestimation of the actual difference. However, non-Hispanic Black women are more likely than non-Hispanic White women to report a larger ideal body type,[38] indicate that their partners prefer larger bodies,[38] and be less influenced by thin images on television.[39] This implies that non-Hispanic Black women are less likely to underreport their weight than what otherwise would be expected. In effect, there may be little difference in the underestimation of BMI based on reported weight and height between the two groups. Previous research also provides no evidence of differential underreporting of weight by race/ethnicity or socioeconomic status.[8] Furthermore, because the focus of this research was not on point estimates of BMI but on the association of Black/White race with BMI, uniform underestimation across races is not likely to affect estimates of the regression coefficients.

In order to assess dietary behaviors, we used screener measures rather than more comprehensive diet assessment such as 24-hour dietary recalls. Screener measures, which record the frequency of intake of a limited number of food groups, tend to underestimate dietary intake.[40] Furthermore, there is evidence that obese people underreport their dietary intake and the underreporting maybe the greatest for high carbohydrate and high fat foods.[41] Finally, information on the amount of consumption of each food item was not available. Not only the type of food but also the amount consumed can contribute to the total intake of calories and variations in BMI and this was not assessed.

Our measure of PA only relates to activity performed during leisure time. It is likely that some individuals perform notable amounts of PA at their jobs. By including broad occupational categories in our analyses, to some extent we have controlled for work-related PA.

Due to possible random and systematic measurement error, we might have underestimated the contribution of lifestyle factors and socioeconomic variables to BMI difference in non-Hispanic Black and White women. However, even with the best possible measures, it is likely that a substantial amount of the observed BMI difference would remain unexplained by lifestyle factors and socioeconomic variables. Future research should address the contribution of other important predictors of BMI. The effect of psychosocial correlates of obesity such as stress, major life events, and discrimination need to be investigated. Research should also examine the effect on race differences in BMI of obesogenic factors at the community, environment and policy levels such as availability of healthy foods, access to PA facilities, food prices, and policies creating environments that promote physical activities and healthy eating.

## CONCLUSION

We have unraveled some of the possible causes of the BMI inequality between non-Hispanic Black and White women. We have shown that lifestyle and socioeconomic factors account for about a quarter of this inequality. The study highlights the continued need for the development of culturally appropriate interventions involving promotion of healthful eating and increased PA at multiple levels (e.g., individual, environment, and policy) to tackle the enigmatic problem of obesity that disproportionately affects Black women. While developing targeted or tailored interventions, we can also concurrently explore social policies that ameliorate socioeconomic inequalities between the races and thereby can help reduce the current BMI inequality among non-Hispanic Black and White women. From this perspective, social policies should be regarded as health policies.

## ACKNOWLEDGEMENTS

**Funding:** This work was not funded by any grants, sponsorships and financial or material source of support.

**Conflict of Interest Statement:** We, hereby acknowledge that none of the authors or their institutions' have financial or personal relationships or affiliations that could influence (or bias) our decisions, work, or manuscript. We confirm that this conflict of interest disclosure information is accurate and complete.

## REFERENCES

(1) Flegal KM, Carroll MD, Kit BK, Ogden CL. Prevalence of obesity and trends in the distribution of body mass index among US adults, 1999-2010. JAMA 2012 Feb 1;307(5):491-497.

(2) Mokdad AH, Marks JS, Stroup DF, Gerberding JL. Actual causes of death in the United States, 2000. JAMA 2004 Mar 10;291(10):1238-1245.

(3) Lavie CJ, Milani RV, Ventura HO. Obesity and cardiovascular disease: risk factor, paradox, and impact of weight loss. J Am Coll Cardiol 2009 May 26;53(21):1925-1932.

(4) Gregg EW, Cheng YJ, Narayan KM, Thompson TJ, Williamson DF. The relative contributions of different levels of overweight and obesity to the increased prevalence of diabetes in the United States: 1976-2004. Prev Med 2007 Nov;45(5):348-352.

(5) Renehan AG, Tyson M, Egger M, Heller RF, Zwahlen M. Body-mass index and incidence of cancer: a systematic review and meta-analysis of prospective observational studies. Lancet 2008 Feb 16;371(9612):569-578.

(6) Singh GK, Siahpush M, Hiatt RA, Timsina LR. Dramatic increases in obesity and overweight prevalence and body mass index among ethnic-immigrant and social class groups in the United States, 1976–2008. J Community Health 2011;36(1):94-110.

(7) Karlamangla AS, Merkin SS, Crimmins EM, Seeman TE. Socioeconomic and ethnic disparities in cardiovascular risk in the United States, 2001-2006. Ann Epidemiol 2010 Aug;20(8):617-628.

(8) Clarke P, O'Malley PM, Johnston LD, Schulenberg JE. Social disparities in BMI trajectories across adulthood by gender, race/ethnicity and lifetime socio-economic position: 1986-2004. Int J Epidemiol 2009 Apr;38(2):499-509.

(9) Sharp TA, Bell ML, Grunwald GK, Schmitz KH, Sidney S, Lewis CE, et al. Differences in resting metabolic rate between white and African-American young adults. Obesity 2002;10(8):726-732.

(10) Luke A, Dugas L, Kramer H. Ethnicity, energy expenditure and obesity: are the observed black/white differences meaningful? Current Opinion in Endocrinology , Diabetes and Obesity ( Formerly : Current Opinion in Endocrinology and Diabetes ) 2007;14(5):370-373-373.

(11) Heo M, Kim R, Wylie-Rosett J, Allison D, Heymsfield S, Faith M. Inverse Association between Fruit and Vegetable Intake and BMI even after Controlling for Demographic, Socioeconomic and Lifestyle Factors. Obesity Facts 2011;4(6).

(12) Wang Y, Beydoun M. Meat consumption is associated with obesity and central obesity among US adults. Int J Obes 2009;33(6):621-628.

(13) Koh-Banerjee P, Chu NF, Spiegelman D, Rosner B, Colditz G, Willett W, et al. Prospective study of the association of changes in dietary intake, physical activity, alcohol consumption, and smoking with 9-y gain in waist circumference among 16 587 US men. Am J Clin Nutr 2003 Oct;78(4):719-727.

(14) Dwyer T, Hosmer D, Hosmer T, Venn AJ, Blizzard CL, Granger RH, et al. The inverse relationship between number of steps per day and obesity in a population-based sample: the AusDiab study. Int J Obes (Lond) 2007 May;31(5):797-804.

(15) Martinez-Gonzalez MA, Martinez JA, Hu FB, Gibney MJ, Kearney J. Physical inactivity, sedentary lifestyle and obesity in the European Union. Int J Obes Relat Metab Disord 1999 Nov;23(11):1192-1201.

(16) Travier N, Agudo A, May AM, Gonzalez C, Luan J, Wareham NJ, et al. Longitudinal changes in weight in relation to smoking cessation in participants of the EPIC-PANACEA study. Prev Med 2011.

(17) Lahti-Koski M, Pietinen P, Heliovaara M, Vartiainen E. Associations of body mass index and obesity with physical activity, food choices, alcohol intake, and smoking in the 1982-1997 FINRISK Studies. Am J Clin Nutr 2002 May;75(5):809-817.

(18) Williamson DF, Forman MR, Binkin NJ, Gentry EM, Remington PL, Trowbridge FL. Alcohol and body weight in United States adults. Am J Public Health 1987 Oct;77(10):1324-1330.

(19) Ruf T, Nagel G, Altenburg HP, Miller A, Thorand B. Food and nutrient intake,

anthropometric measurements and smoking according to alcohol consumption in the EPIC Heidelberg study. Annals of nutrition and metabolism 2005;49(1):16-25.

(20) Mokdad AH, Bowman BA, Ford ES, Vinicor F, Marks JS, Koplan JP. The continuing epidemics of obesity and diabetes in the United States. JAMA 2001 Sep 12;286(10):1195-1200.

(21) Rundle A, Field S, Park Y, Freeman L, Weiss CC, Neckerman K. Personal and neighborhood socioeconomic status and indices of neighborhood walk-ability predict body mass index in New York City. Soc Sci Med 2008 Dec;67(12):1951-1958.

(22) Kant AK, Graubard BI, Kumanyika SK. Trends in black-white differentials in dietary intakes of U.S. adults, 1971-2002. Am J Prev Med 2007 Apr;32(4):264-272.

(23) Kirkpatrick SI, Dodd KW, Reedy J, Krebs-Smith SM. Income and Race/Ethnicity Are Associated with Adherence to Food-Based Dietary Guidance among US Adults and Children. Journal of the Academy of Nutrition and Dietetics 2012;112(5):624-635. e6.

(24) Marshall SJ, Jones DA, Ainsworth BE, Reis JP, Levy SS, Macera CA. Race/ethnicity, social class, and leisure-time physical inactivity. Medicine & Science in Sports & Exercise 2007;39(1):44.

(25) Keyes KM, Liu XC, Cerda M. The role of race/ethnicity in alcohol-attributable injury in the United States. Epidemiol Rev 2012 Jan;34(1):89-102.

(26) Hasin DS, Stinson FS, Ogburn E, Grant BF. Prevalence, correlates, disability, and comorbidity of DSM-IV alcohol abuse and dependence in the United States: results from the National Epidemiologic Survey on Alcohol and Related Conditions. Arch Gen Psychiatry 2007 Jul;64(7):830-842.

(27) Eisner , M . D ., Blanc , P . D ., Omachi , T . A ., Yelin , E . H ., Sidney S, Katz , P . P ., et al. Socioeconomic status, race and COPD health outcomes. J Epidemiol Community Health 2011;65(1):26-34-34.

(28) National Center for Health Statistics, Centers for Disease Control and Prevention. National Health Interview Survey. 2012; Available at: http://www.cdc.gov/nchs/nhis.htm. Accessed July 2012.

(29) US Department of Health and Human Services. 2008 physical activity guidelines for Americans. 2008; Available at: www.health.gov/paguidelines, 2012.

(30) Slootmaker SM, Schuit AJ, Chinapaw MJM, Seidell JC, Van Mechelen W. Disagreement in physical activity assessed by accelerometer and self-report in subgroups of age, gender, education and weight status. International Journal of Behavioral Nutrition and Physical Activity 2009;6(1):17.

(31) Rauh MJ, Hovell MF, Hofstetter CR, Sallis JF, Gleghorn A. Reliability and validity of self-

reported physical activity in Latinos. Int J Epidemiol 1992;21(5):966-71.

(32) Vartiainen E, Seppala T, Lillsunde P, Puska P. Validation of self reported smoking by serum cotinine measurement in a community-based study. J Epidemiol Community Health 2002;56:167-170.

(33) Graham H, Owen L. Are there socioeconomic differentials in under-reporting of smoking in pregnancy? Tob Control 2003;12:434-436.

(34) Wills TA, Cleary SD. The validity of self-reports of smoking: analyses by race/ethnicity in a school sample of urban adolescents. Am J Public Health 1997 Jan;87(1):56-61.

(35) DeNavas-Walt C, Proctor BD, Smith JC. Income, Poverty, and Health Insurance Coverage in the United States: 2010. 2011.

(36) Stata C. Stata Statistical Software: Release 12, Special Edition. 2011.

(37) Rowland ML. Self-reported weight and height. Am J Clin Nutr 1990;52(6):1125-1133.

(38) Roberts A, Cash TF, Feingold A, Johnson BT. Are black-white differences in females' body dissatisfaction decreasing? A meta-analytic review. J Consult Clin Psychol 2006 Dec;74(6):1121-1131.

(39) Botta RA. The mirror of television: A comparison of Black and White adolescents' body image. J Commun 2000;50(3):144-159.

(40) Spencer EH, Elon LK, Hertzberg VS, Stein AD, Frank E. Validation of a brief diet survey instrument among medical students. J Am Diet Assoc 2005 May;105(5):802-806.

(41) Heitmann BL, Lissner L. Dietary underreporting by obese individuals--is it specific or non-specific? BMJ 1995 Oct 14;311(7011):986-989.