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Obesity, BMI, and Diet Quality: How does the South Measure Up?

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Abstract

This paper examines regional differences in obesity rates, Body Mass Index (BMI) and dietary quality, using data from the1999-2002 National Health and Nutrition Examination Survey (NHANES), Mobile Examination Center (MEC). For women, BMI and obesity prevalence may be higher in the Deep South states, but the difference is explained by demographic characteristics. Diet quality was found to be lower in the South.

Obesity, BMI, and Diet Quality: How does the South Measure Up?

Having a high body-mass index (BMI) is linked to a variety of negative health consequences, such as increased risk for diabetes, heart disease, and joint stress. While the strong upward trend in rates of obesity and overweight is a national phenomenon, the South appears to have been more affected than other regions. Prevalence estimates of obesity, collected through the CDC's Behavioral Risk Factor Surveillance System (BRFSS), show that in the year 2005, all three states with obesity rates (defined as BMI > 30) over 30 percent were in the South: Louisiana, Mississippi and West Virginia. All other Southern states, with the exception of Delaware, Florida, Maryland and Virginia, had rates of obesity in the range of 25 to 29 percent. No Southern states had rates of obesity below 20 percent. By contrast, in 1990, rates of obesity in Southern states were comparable to those found across the Midwestern states, in the range of 10 to 14% (CDC-BRFSS, 2007).

The heightened risk of poor nutrition and nutrition-related diseases associated with socioeconomic status is well documented (see for example recent articles by Kant and Graubard, 2007, and Loucks et al., 2007). Poverty and food insecurity have been linked to increased likelihood of excess body weight, especially among adult women (Basiotis and Link, 2003; Wardle, 2002; Olson, 1999; Townsend et al., 2001; Wilde and Peterman, 2006). Education, race, and ethnicity have also been found to be factors affecting rates of overweight and obesity (Seo and Torabi, 2006; Schoenborn et al., 2004; Kumanyika, 1999). High levels of poverty, relative to national averages, characterize many Southern states. In 2004, when the national poverty rate was 12.7 percent, rates in several Southern states (e.g. Alabama, Kentucky, Texas, and West Virginia) were over 16 percent, and poverty rates in Mississippi and Louisiana exceeded 19 percent. Data from the 2005, CDC Behavioral Risk Factor Surveillance System show that most Southern states report rates of recommended fruit and vegetables consumption below the national average (which in itself was not high). In addition, many Southern states report a percentage of current smokers above the national average (CDC-BRFSS, 2007). It is therefore not surprising that these same states experience higher than average rates of diabetes and hypertension.

The objective of this paper is to test regional differences in BMI, diet quality and the probability of being obese, with a focus on the South. Data used in the analyses are from the 1999-2002 National Health and Nutrition Examination Survey (NHANES). The NHANES data set provides BMI and a diet recall for a nationally representative sample. The major question of interest is whether differences in the probability of being obese can be explained by the demographic characteristics of the region or whether, even when these factors are controlled, there is still a statistically significant increase in probability that those living in the South will be obese. The link between BMI and diet quality will also be explored.

Data and Methods

This study uses the 1999-2002 National Health and Nutrition Examination Survey (NHANES) survey. Data used for this study were limited to individuals 18 years of age to 60 years of age, who are not pregnant or lactating, and who had body measurements taken at the NHANES Mobile Exam Center (MEC). Geographic information on respondents, including state and census region, is collected in NHANES; however, to protect confidentiality, these data have not been released to the public from the 1999 round onward. The CDC does allow researchers access to unreleased data for valid research purposes, and access to confidential geographic variables (Census region and state) was provided to the researchers following submission of an approved proposal. Certain information, such as the number of respondents in a specific state, cannot be released in publications, but totals for each region may be reported.

Geographical regions in NHANES follow Census region definitions. Census regions for this study are the Northeast, the Midwest, the South, and the West. The Northeast includes Maine, New Hampshire, Vermont, Massachusetts, Rhode Island, Connecticut, New York, New Jersey, and Pennsylvania. The Midwest includes Ohio, Indiana, Illinois, Michigan, Wisconsin, Minnesota, Iowa, Missouri, Kansas, and Nebraska. The West includes Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. The South includes Florida, Georgia, North Carolina, South Carolina, Virginia, West Virginia, Maryland, Washington, D.C., Delaware, Alabama, Kentucky, Mississippi, Tennessee, Arkansas, Louisiana, Oklahoma and Texas. A further division of the Southern region was made, with the "Deep South" defined as: South Carolina, Tennessee, Georgia, Alabama, Mississippi, Louisiana and Arkansas. NHANES data are not collected for all U.S. states; however, confidentiality concerns prohibit release of information on which states are included in the data.

The NHANES surveys are multistage, stratified, area probability samples. Accordingly, appropriate procedures must be used to correct for survey design in all analyses. The public NHANES files include masked strata and primary survey unit (psu) variables. However, because geographic identifiers are used in this study, actual strata and psu variables were provided by the National Center for Health Statistics, Research Data Center, for design corrections.

Race and ethnicity were coded in the NHANES data as Mexican American, Other Hispanic, Non-Hispanic White, Non-Hispanic Black and Other Race - Including Multi-Racial. For this study, Mexican Americans and other Hispanics were combined into one sub-group, Hispanic.

Previous research has found racial differences in BMI and/or metabolism, especially in women (Kimm et al., 2001; Flegal et al., 2002).

The body mass index (BMI) is used as a measure of the individual's weight in relation to height. A BMI of less than 18.5 indicates an underweight individual. A BMI of 18.5 to 24.9 indicates a normal weight individual. A BMI of 25 to 29.9 indicates an overweight individual. Scores of 30 and higher indicate obesity. BMI data included in the NHANES files are from actually body measurements taken at the MEC. For a 5'6" individual, a one unit change in BMI is roughly equal to a change in weight of 6 pounds.

Food security is reported in four levels in NHANES: fully food secure (FFS), marginally food secure (MFS), food insecure without hunger (FIWOH), and food insecure with hunger (FIWH). These categories are based on responses to a food security questionnaire, originally developed by the United States Department of Agriculture, which contains 18 questions concerning behaviors and experiences related to household food security and a method of classifying responses (Bickel et al., 2000). Ten items (household and adult measures) are asked of all respondents. The remaining 8 items are asked only of households with children. Measures of food security for households consisting solely of adults are based on responses to 10 items (adult measure), while measures for households with children may be based on 18 items (household measure). For households without children, the adult measure equals the household measure. For all households included in the NHANES survey, both the adult and household measures of food security are provided.

The NHANES survey contains questions about smoking behavior and alcohol use. In addition, the survey asks respondents to rate their activity level relative to their same-sex, similaraged peers. They may choose from "more active," "less active," or "about the same."

Healthy Eating Index 2005

For the 1999-2002 NHANES, individuals' dietary intakes were collected through an in-person, interviewer-administered 24-h dietary recall method. Research has shown that food intake data based on 1-day dietary recall are reliable measures of usual intakes of population groups (Basiotis et al., 1987). A diet quality index is not included in the NHANES data, but one can be created using the diet recall data.

The Heahlty Eating Index -2005 (HEI-2005) is a measure of overall diet quality that was created by the U.S. Department of Agriculture (Guenther et al., 2007). This index measures the degree to which an individual is following the Dietary Guidelines for Americans 2005, and includes 12 food and nutrient based components. The food based components include amounts of total fruit (includes 100% juice); whole fruit (not juice); total vegetables; dark green and orange vegetables and legumes; total grains; whole grains; milk; meat and beans; and oils. The nutrient based components include intakes of saturated fat; sodium; and calories from solid fat, alcohol, and added sugar (SoFAAS). Information contained in the 24h diet recall files of the NHANES-MEC was used to construct the HEI-2005 by following instructions and SAS code made available from USDA-CNPP (2008). An HEI-2005 score was created only for those participants with complete and reliable dietary data.

Analyses

BMI, obesity, and HEI-2005 were analyzed by region. Men and women were analyzed separately. Both simple analyses (without covariates) and regression analyses were performed.

Based on previous work, age, race/ethnicity, income, and education were included as covariates in the regression analyses of BMI and obesity (see for example, Wilde and Peterman, 2006). In addition, food insecurity status, smoking status, diet quality, energy consumption, alcohol consumption patterns, and self-reported activity level were included as covariates in an alternative model that corrects for more possible confounding factors.

Previous research shows that food insecurity and body weight are positively associated among women, with mildly food insecure women more likely to be overweight than normal weight women. (See for example Olson, 1999; Townsend et al., 2001; Adams, Grummer-Strawn, and Chavez, 2003; or Bosiotis and Link, 2003). For men, the relationship is less clear (Wilde and Peterman, 2006). The mechanism that links food insecurity to increased risk of obesity and overweight is not well understood, but some previous work sheds light on the subject. In what may have been the first research paper to address this issue, Dietz (1995), using a case study framework, speculated that low income and food insecurity could be related to obesity if weight gain were an adaptive response to periodic food shortages. Drewnowski and Specter (2004) provided further rationale for this argument. Block et al. (2004) found that environmental factors, such as higher numbers of fast food restaurants in low-income neighborhoods, may also contribute to increased obesity among the poor.

Smoking has been found to increase resting energy expenditures and thus to have a negative effect on obesity and overweight (Akbartabartoori, Lean, and Hankey, 2005; Kimm et al., 2001; Pinkowish,1999). Some recent research in economics has linked the rising rates of obesity in the United States, at least in part, to lower rates of smoking (Chou, Grossman, and Saffer, 2004). For this study, based on responses to the questions about cigarette smoking, respondents were classified as current smokers, former smokers or never smokers. Although the NHANES survey also contains questions about use of other tobacco products, the data for these variables have large amounts of missing data (other than that accounted for by a skip pattern). Hence, for this study, we focused exclusively on cigarette smoking.

Recent work by Breslow and Smothers (2005) has shown a relationship between alcohol consumption and obesity, with those who drink small amounts frequently less likely to be obese, while those who consume large amounts on each drinking occasion more likely to be obese. NHANES data contain information on drinking patterns that can be used to develop variables for frequency of alcohol consumption as well as number of drinks per occasion. Alcohol questions are only asked of respondents 20 years of age or older, so analyses with alcohol pattern variables as covariates will be restricted to those age 20 to 60, rather than 18 to 60 as in other analyses.

Results

Mean BMI, mean HEI-2005, and percentage of respondents who are obese, by region, are reported in Table 1. (In all cases, corrections for survey weights in NHANES have been applied.) The lowest regional BMI for women, along with the lowest obesity rate, occurs in the Northeast, with a mean BMI of 27.7 and a 29.1% obesity rate. For men, the lowest mean BMI and obesity rate occurs in the South, with a mean BMI of 27.4 and a 24.4% obesity rate. There is no significant difference in mean BMI or the probability of obesity across the four Census regions, either for men or women. (Significance tests were conducted to account for survey design factors.)

For both men and women, the highest mean HEI-2005 occurs in the West, 52.4 for women and 49.4 for men. For diet quality, significant differences were found across the four Census regions. For women, the South has a significantly lower diet quality than either the West (rho =

0.0004) or the Northeast (rho = 0.0707). For men, in both the South (rho = 0.0080) and the Midwest (rho = 0.0009) diet quality is significantly worse than in the West.

Lack of significant difference for the South in terms of obesity and BMI was not expected, given the results from the BRFSS reports (CDC, 2007). Two possible explanations for the lack of significance were explored. The BRFSS data are self-reported. Hence, it is possible that respondents in the Southern region reported relatively heavier weights (or shorter heights) than respondents in the other Census regions compared to their actual heights and weights. In addition to measurements, the NHANES data include self-reported heights and weights. Accordingly, to test the possibility of different regional biases in self-reports, the self-reported heights and weights were used to construct a BMI measure. The difference between this measure and the actual BMI, based on measurements, was then calculated. The mean difference was about 0.4 units, with respondents typically under-reporting weight or over-reporting height. However, no significant difference in reporting error was found across regions.

Another possibility for the difference between our results and the BRFSS reports is that the Census region of the South includes a number of states, such as Florida and Virginia, which do not have higher than average rates of obesity. Accordingly, the South was split into two regions, the Deep South (see above) and the "other South." The other South included all states in the Southern Census region not included in the Deep South.

For the Deep South mean BMI for women was 29.2, which was significantly different from the other South (rho = 0.0184) and from the Western region (rho = 0.0770). The probability of obesity for women was correspondingly higher in the Deep South than in the other South (rho = 0.0455) and the West (rho = 0.0907). For men, there were no significant differences in BMI or the probability of obesity for the Deep South compared to other regions. In terms of HEI-2005, both the Deep South and the other South were significantly lower than the Western region. For men, both the Deep South and the other South were significantly lower than both the Western region and the Northeast.

Table 2 provides the parameter estimates for the regression model with BMI as the dependent variable and age, income, education level, and race/ethnicity as covariates. (Models were run in SAS, PROC SURVEYREG, with corrections for weights and survey design.) The income variable in the model is household income as a ratio to the corresponding poverty level for the household. It is top-coded at 5 in the released data. The education variable is a dummy variable coded as 1 for individuals with less than a high school degree, 0 otherwise. Age is a continuous variable measured in years. The variables Black and Hispanic are also dummy variables, based on race/ethnicity responses. They are mutually exclusive categories in NHANES, representing the primary race/ethnicity identification of the respondent.

Once demographic variables are included in the models, no significant regional effects were found for either men or women. For both men and women, age was a significant factor affecting BMI. For women, but not men, income was negatively associated with BMI. A women moving from the poverty level to twice the poverty level, would be expected to have about a 0.6 unit drop in BMI, or approximately 4 pounds on a 5'6" person. Being black or Hispanic was positively associated with BMI for women, but not for men. For women, being black was associated with over a 3 unit increase in BMI, or approximately 18 pounds for a 5'6" individual, while being Hispanic was associated with slightly less than a 1 unit increase in BMI.

Table 3 presents results for the regression models with additional covariates for "lifestyle factors". (Models were run in SAS, PROC SURVEYREG, with corrections for weights and survey design.) The variable "low activity" is a dummy variable with the value of 1 if a respondent reported less physical activity than same-age, same-sex peers, 0 otherwise. "High activity" is a dummy variable coding for those who reported more activity than their peers. The variable for drinking alcohol is a dummy variable with a value of 1for those who drank at least 12 alcoholic drinks in the last year (threshold is set by NHANES), 0 otherwise. The frequency of drinking is the typical number of times per week that respondents reported drinking alcohol (set to 0 for non-drinkers). The number of drinks is the typical number of drinks per drinking occasion. Energy is kilocalories consumed on the day of the 24h diet recall.

As with the previous regression, no differences across regions were found. In addition to the demographic covariates found to have a significant association with BMI for women , several lifestyle factors were also found to be associated with BMI for women, including smoking status, diet quality as measured by the HEI-2005, self-reported activity level, and alcohol consumption patterns. Diet quality, as measured by the HEI-2005, was significantly and negatively associated with BMI; however the effect was small. A 24 unit increase in diet quality would be associated with about a 1 unit decrease in BMI.

The results for self-reported physical activity level were relatively large for women. Going from low to high activity would be associated with over 5 units in BMI. Caution in interpreting these results is needed as causality cannot be established with cross-sectional data and it is possible that higher body weight may interfere with physical functioning.

Being a current cigarette smoker was associated with almost a 2 unit decrease in BMI in women, which is not surprising given the known metabolic effect of smoking. The results for alcohol consumption are similar to those found by Breslow and Smothers (2005). Drinking small amounts of alcohol frequently is associated with a lower BMI, while "binge drinking" is associated with a higher BMI. Food security and energy consumption were not significantly associated with BMI in this model framework.

Results for men were similar to those for women in terms of the impact of cigarette smoking and alcohol consumption patterns. Although diet quality was significant for men, the effect was smaller than for women. For men, a 53-point increase in HEI-2005 would be required to see a 1 unit drop in BMI. For men, being food insecure without hunger (FIWOH) was associated with lower BMI.

The models reported in tables 2 and 3 were also fit to a logistic model with obesity (0-1) as the dependent variable. (Models were run in PROC SURVEYLOGISTIC in SAS with corrections for weights and survey design). Not surprisingly, the results were very similar to those found with the continuous variable, BMI, as the dependent variable. Because the models with BMI as the dependent variable are much easier to interpret, the logistic models are not reported in this paper, but are available on request.

Discussion and Conclusions

When obesity rates and BMI are analyzed across the four Census regions, the South as a region is not significantly "fatter" than the rest of the U.S. When the Deep South is broken out of the Southern region, however, there is a significant increase in mean BMI for women compared to the Northeast region and also the rest of the South. When demographic factors are controlled, however, the significance disappears. Low-income women and black women have significantly higher BMI than higher-income women and white women. The South is a region with lower than average income and a higher than average minority population; hence, these factors most likely are at the root of the reportedly higher than average rates of obesity for many deep Southern States.

Diet quality for both men and women, as measured by the HEI-2005, was significantly lower in the entire Southern Census region than in the Western Census region, which reported the highest diet quality. The difference was about 5 points for women and 4 for men. Although poor diet quality is associated with higher BMI, the effect is small. A 5 point decrease in diet quality would result in about a 0.20 increase in BMI, or a little over a pound on a 5'6" individual.

Our results indicate that activity level appears to have important effects on BMI, and yet a measure of activity level is seldom included among the control variables in models of BMI. Further, economic studies often group men and women together in analyzing BMI or likelihood of obesity (see for example Chen, Yen, and Eastwood, 2007), while biologically based fields normally separate men and women (see for example Wilde and Petermen, 2007). Results here support the practice of stratifying by gender, as responses to key variables were not the same for men and women.

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Table 1. Mean BMI, Obesity, and Healthy Eating Index-2005, by Region, NHANES, 1999-2002.

	Women			Men		
	Mean BMI	Obesity	HEI-2005	Mean BMI	Obesity	HEI-2005
U.S.	28.0	32.40%	50.2	27.6	25.90%	47.3
Northeast	27.7	29.10%	52.2	27.9	24.50%	48.7
MidWest	28.7	35.50%	50.0	27.9	26.50%	45.9
West	27.9	31.70%	52.4	27.8	27.50%	49.4
South	27.9	32.70%	48.1	27.4	24.40%	46.3
Deep South*	29.2	39.30%	47.2	27.6	24.10%	45.1
Observations						
U.S.	3052	3052	2952	3424	3424	3268
Northeast	474	474	470	501	501	496
MidWest	465	465	463	514	514	507
West	879	879	863	936	936	922
South	1170	1170	1156	1353	1353	1343
Deep South*	387	387	375	416	416	399

*South Carolina, Tennessee, Georgia, Alabama, Mississippi, Lousiana, Arkansas
Analyses conducted for adults, 18 to 60 years old, not pregnant or lactating.

Table 2. BMI with Demographic Covariates, NHANES, 1999-2002.

	Women		Men	
	Parameter	Std Error	Parameter	Std Error
Intercept	23.870 *	1.012	24.471 *	0.724
Deep South	0.900	0.977	0.415	0.659
Other South	-0.274	0.773	-0.094	0.677
Midwest	1.243	0.848	0.290	0.705
West	0.489	0.795	0.270	0.691
Age	0.125 *	0.014	0.087 *	0.012
Income	-0.563 *	0.094	-0.058	0.118
Low Education	0.100	0.456	-0.291	0.440
Black	3.184 *	0.556	-0.289	0.358
Hispanic	0.985 *	0.357	-0.077	0.364
R-square	*0.078*		*0.033*	
N	*2695*		*3018*	

Analyses conducted for adults, 18 to 60 years old, not pregnant or lactating. * = significance at the 5% level. ** at the 10% level.

Table 3. BMI with Demographic and Lifestyle Covariates, NHANES, 1999-2002.

	Women		Men	
	Parameter	Std Error	Parameter	Std Error
Intercept	25.468 *	1.250	26.308 *	1.150
Deep South	0.286	0.739	0.521	0.649
Other South	-0.772	0.836	-0.403	0.710
Midwest	0.401	0.761	0.396	0.696
West	0.238	0.692	0.029	0.667
Age	0.145 *	0.015	0.091 *	0.011
Income	-0.358 *	0.106	0.082	0.098
Low Education	0.179	0.600	-0.430	0.412
Black	3.375 *	0.592	-0.062	0.404
Hispanic	0.761 **	0.380	0.178	0.376
Current Smoker	-1.976 *	0.423	-1.229 *	0.333
Former Smoker	0.616	0.514	0.685	0.412
HEI-2005	-0.042 *	0.011	-0.019 **	0.010
Energy (KCAL)	0.0002	0.000	0.0001	0.000
Low Activity	2.888 *	0.553	2.500 *	0.458
High Activity	-2.518 *	0.384	-1.604 *	0.227
MFS	0.616	0.556	1.124	0.784
FIWOH	0.955	0.713	-1.212 **	0.624
FIWH	-0.989	0.745	0.210	0.867
Drinks Alcohol	-1.313 *	0.642	-1.366 *	0.567
Number of Drinks	0.415 *	0.110	0.074 *	0.020
Frequency of Drinks	-0.385 *	0.117	-0.194 *	0.062
R-square	*0.198*		*0.135*	
N	*1934*		*2060*	

Analyses conducted for adults, 20 to 60 years old, not pregnant or lactating. * = significance at the 5% level. ** at the 10% level.