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A DEMOGRAPHIC ANALYSIS OF METRO/NONMETRO DIFFERENCES IN ADULT NORMAL WEIGHT, OVERWEIGHT, AND OBESITY*

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ABSTRACT

Overweight and obesity prevalence is increasing throughout the United States, and these two health conditions seem to disproportionately affect certain segments of the adult population. To date little research has examined adult differences in normal weight, overweight, and obesity by metropolitan or nonmetropolitan residential status while controlling for important demographic, socioeconomic, behavioral, and health status characteristics. This research helps to fill this gap. We used data from the 2008 Behavioral Risk Factor Surveillance System (BRFSS) to empirically assess predictors of overweight and obesity risk for all adults and then by residential location. Multinomial logistic regression techniques were used to estimate relative risk ratios for an adult being overweight or obese compared with normal weight for all adults and stratified by residential location. Among all adults, a nonmetro weight disadvantage was noted, with nonmetro adults having increased odds of being overweight or obese compared with normal weight. Interestingly, the residence stratified model indicates that race/ethnicity was not as important of a predictor of overweight or obesity for nonmetro residents as it was for metro residents, and far fewer behavioral and health status characteristics determined overweight status for nonmetro adults compared with metro adults; similar associations were noted between these characteristics for obesity status in both metro and nonmetro areas. This research highlights the need for health policies and programs to consider residential location when implementing strategies for weight management and loss for adults in the United States.

The increasing prevalence of obesity in the United States has warranted more and ongoing research, public health programs, and policy debates to address this pervasive health concern. A recent report using National Health and Nutrition Examination Survey (NHANES) data indicates that obesity prevalence has increased from the late 1980s to 2008 for both men and women; however no racial/ethnic differences in obesity status were noted for men while non-Hispanic black and Hispanic women were more likely to be obese than non-Hispanic white

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women (Ogden and Carroll 2010). The prevalence of overweight on the other hand has remained fairly flat over this period, with approximately 34–35 percent of the population being overweight – a substantial proportion of the population. These patterns also vary over space, so that the risk of being obese, and likely overweight as well, are not the same for all areas of the United States (Michimi and Wimberly 2011). Moreover, the high prevalence of overweight combined with the nearly 33 percent of obese adults in the US warrants a close examination to understand the characteristics that place individuals at increased risk of experiencing above normal weight status defined by body mass index (BMI), particularly for residents of rural versus urban areas, since increased BMI is associated with many poor health outcomes.

From a health disparities perspective it is important to examine the individual level characteristics that increase the risk that an individual will be overweight or obese compared with normal weight, because weight status may be an important link in determining differential risk of certain morbidities and increased mortality for vulnerable segments of the population, particularly rural residents. To date, few if any studies have examined both weight status outcomes simultaneously, and no research (to the authors' knowledge) has explicitly examined the role of rural residence in determining weight status for a nationally representative sample of adults in the US. Most research examining obesity focuses on differences by sex, race/ethnicity, socioeconomic status, physical activity, and food consumption; however exploring differences in weight status by residential location to better understand the health needs of an already vulnerable population that has limited access to resources is necessary (Shi and Stevens 2010).

Obesity prevalence is higher in rural than urban areas based on self-reported height and weight data (Eberhardt et al. 2001; Jackson et al. 2005; Kegler et al. 2008; Patterson et al. 2004). Physical inactivity is also more prevalent in rural compared with urban areas (Casey et al. 2008; Centers for Disease Control and Prevention 1998; Martin et al. 2005; Parks et al. 2003; Wilcox et al. 2000). Lower socioeconomic status and less access to health care in rural areas may put rural adults at increased risk of experiencing overweight and obesity and weight related co-morbidities (Casey et al. 2008; Eberhardt et al. 2001). While these characteristics have shown associations with obesity status for rural residents, it is not clear if similar associations will hold for overweight status. This research helps to fill this gap and is guided by the following research questions: 1) are rural residents at increased risk of experiencing overweight and obesity?; and 2) what individual level sociodemographic, behavioral, and health status and health condition variables

influence the risk of being overweight or obese compared with normal weight among rural and urban adults? Previous research suggests a combination of possible explanations for differences in weight status based on rural residence, including cultural, demographic, and environmental influences (Bove and Olson 2006; Larson et al. 2009; Larson and Story 2008; Longacre et al. 2012; Michimi and Wimberly 2010). These explanations help guide the review of literature below that frames this research and interpretation of the findings.

INDIVIDUAL LEVEL CORRELATES OF OVERWEIGHT AND OBESITY

As noted above, obesity prevalence has increased significantly for both children and adults over the past several decades (Ahern et al. 2011; Congdon 2011; Mokdad et al. 2001; Mokdad et al. 2003; Ogden and Carroll 2010; Schwartz et al. 2009). In turn the increased prevalence of obesity has been associated with increased prevalence of several chronic diseases, including diabetes (Narayan et al. 2007), stroke (Curioni et al. 2006), different cancers (Chang et al. 2011) and heart disease (Ingelsson et al. 2007; McAuley et al. 2007; Pearson 2007). Additionally, increased prevalence of obesity has been associated with increased risks of morbidity and premature mortality (Ahern et al. 2011; Field et al. 2001; Must et al. 1999) and higher health care costs for obese individuals (Finkelstein et al. 2005; Finkelstein et al. 2010; Frezza and Wachtel 2009; Richards et al. 2011; Tsai et al. 2011).

Sociodemographic Characteristics and Weight Status

More generally, research has shown that the risk of obesity varies based on a variety of individual sociodemographic characteristics, including sex, age, race/ethnicity, poverty status, educational level, martial status, and residential location (Flegal et al. 2010; Jackson et al. 2005; Kaiser and Baumann 2010; Liu et al. 2008; Patterson et al. 2004). The research literature is mixed on the nature of the association between sex and weight status. Some research notes an overweight and obesity disadvantage for women (Beydoun and Wang 2009; Clarke et al. 2009; Houston et al. 2009), while others note a disadvantage for men (Sparks and Bollinger 2011). Recent NHANES data find that women are more likely to be obese than men, and clear racial/ethnic differences emerge with non-Hispanic Black and Hispanic women much more likely to be obese than non-Hispanic white women (Ogden and Carroll 2010). One explanation for the higher rate of obesity observed for women compared with men relates to how women store fat differently than men (Egger and Swinburn 1997). Differences in obesity status have also been noted by age, with a general increase in the risk of being obese with increasing age. However,

this relationship is likely not completely linear since adults 65 years of age and older experience bone mass loss more than younger adults (Glass et al. 2006; Kaplan et al. 2003). In examining obesity status and race/ethnicity, Non-Hispanic blacks and Hispanics often have a higher prevalence of obesity and overweight compared with non-Hispanic Whites (Ogden and Carroll 2010; Ogden et al. 2006); however this race/ethnicity association with obesity differs by age and sex (Ogden et al. 2007). Rural minorities have been found to have increased risks of being obese compared with rural whites (Patterson et al. 2004).

An obesity disadvantage is noted for adults with lower education levels (Chou et al. 2004; Clarke et al. 2009; Kaplan et al. 2003) and for adults living in poverty (Bennett et al. 2011). Among rural residents, adults are more likely to have lower levels of education, lower levels of income and live in poverty, and report lower levels of physical activity (Adachi-Mejia et al. 2010; Bennett et al. 2011; Carson et al. 2011; Champagne et al. 2004; Fisher 2007; Osuji et al. 2006; Patterson et al. 2004). Higher levels of education may be associated with knowledge of healthy eating and exercise habits, while higher incomes can provide access to healthier, fresh, and whole foods and athletic facilities. However rural residents at all levels of socioeconomic status may face additional barriers to seeking these types of resources than urban residents if distance to food outlets and athletic facilities make their use difficult or prohibitive. The distribution of these sociodemographic characteristics differs between rural and urban areas, which will likely influence the distribution of overweight and obesity in rural versus urban areas.

Health Behaviors, Health Status, and Weight Status

Beyond these socioeconomic characteristics, weight status is also influenced by individual behaviors. Smoking status presents a complicated association with weight status, because smoking is associated with lower BMI but is also associated with several chronic health conditions and elevated mortality risks (Gruber and Frakes 2006; Keenan 2009; Nonnemaker et al. 2009). An interesting association is also noted between alcohol consumption and obesity. In a review of numerous studies, Sayon-Orea and colleagues (2011) note that heavy alcohol consumption was linked to increased obesity, but moderate consumption, particularly wine consumption, was protective against obesity. Lastly, current exercise and increased physical activity have an inverse association with obesity (Lahti-Koski et al. 2002), while sedentary lifestyles are associated with increased obesity risks (Lahti-Koski et al. 2002).

If cultural, demographic, and environmental (conceived of here as residential location) characteristics influence the health and health behaviors of rural residents, then adults living in rural areas may be placed at higher risk of experiencing overweight and obesity since rural adults often have higher concentrations of characteristics associated with above normal weight status. Since few population-based studies have examined associations between individual level characteristics and overweight, particularly for rural residents, it is not clear if similar associations noted between these variables and obesity will be found for overweight status. This research helps to fill this gap by simultaneously estimating the risk of being overweight or obese for each of these characteristics and then stratifying the analysis to focus on adults by residential location. Based on the review of literature above, four hypotheses were tested. First, we hypothesized that rural (nonmetro) adults would be more likely to be overweight and obese than adults in metro areas based on the distribution of sociodemographic, health behaviors, and health status characteristics between rural and urban areas. Second, we hypothesized that an increased risk of being overweight or obese would persist for nonmetro adults with the addition of controls to account for sociodemographic characteristics, health behaviors, and health status and health conditions compared with metro residents. Third, when only examining the nonmetro sample, it was hypothesized that the SES-weight status association would not be as strong as for the entire adult sample or for only metro residents. Fourth, we hypothesized that activity limitations would be stronger in predicting the risk that an individual was overweight or obese compared with normal weight among nonmetro adults compared with all adults, because physical inactivity is more prevalent in rural areas. The data and methods necessary to address this research problem and these hypotheses are detailed below.

DATA AND METHODS

Behavioral Risk Factor Surveillance System (BRFSS)

For this analysis data from the 2008 Behavioral Risk Factor Surveillance System (BRFSS) were used. The BRFSS is a continuing cross-sectional survey targeting the civilian, non-institutionalized population 18 years of age and older for all states and territories of the US. The data collection effort is administrated by the Centers of Disease Control and Prevention, in cooperation with state health departments, as an annual telephone survey (Centers for Disease Control and Prevention 2008). Pregnant women were excluded from this analysis due to the impact of pregnancy on weight gain and increases in BMI. Therefore, the results

are generalizeable to the non-institutionalized, non-pregnant adult population 18 years of age and older in the US in 2008.

Measures

The key variable of interest in this analysis was weight status. Weight status was measured by a computed BMI value contained in the BRFSS. This value was calculated from reported weight and height, so that each respondent's BMI value was equal to the individual's weight in kilograms divided by height in meters squared. A weight status variable with three categories was created indicating whether the respondent was: 1) normal weight, with a BMI of less than 25 (reference); 2) overweight, with a BMI between 25 and less than 30; 3) or whether the respondent was obese, with a BMI of greater or equal to 30.

The second variable of interest was nonmetropolitan status. Nonmetropolitan status was defined using the Metropolitan Status Code provided in the BRFSS. Respondents who did not reside in a metropolitan statistical area (MSA) were coded as 1 to indicate nonmetro status, while respondents who lived in the center city of an MSA, outside the center city of an MSA but inside the county containing the center city, inside a suburban county of the MSA or in an MSA that has no center city were assigned a value of 0 to indicate metro status.

Demographic characteristics of the respondents were measured with three variables: race/ethnicity; sex; and current age. To measure race/ethnicity, we used the constructed variable available in the BRFSS that accounts for Hispanic ancestry and created four race/ethnicity categories: non-Hispanic white (reference); non-Hispanic black; non-Hispanic other races; and Hispanic. Each respondent was asked his or her age at the time of the interview. An imputed age value was available in the data that replaced missing values to this question in the post-stratification process and did not alter the age distribution of the sample. Six age categories were generated from this variable to test the non-linearity of age and obesity status, including 18-24 years of age (reference), 25-34 years of age, 35-44 years of age, 45-54 years of age, 55-64 years of age and 65 years of age or older. Six measures of socioeconomic characteristics were included in the analysis: education; current employment status; whether the respondent's household income was less than $25,000; current marital status; current health care coverage status; and whether the respondent stated that medical costs were too high to see a doctor. The highest level of education completed by each respondent was coded into three categories: less than a high school education; a high school diploma; and some college education or more (reference). Current employment status was ascertained from a

question that asked the respondent if they were currently employed and was measured as a dichotomous variable. Responses of currently employed for wages or self-employed were coded 1, and responses of out of work for more than 1 year, out of work for less than 1 year, a homemaker, a student, retired, or unable to work were coded as 0. To measure income we used the income category variable provided in the dataset. Respondents whose annual household income from all sources was less than $25,000 were coded as 1, whereas those respondents with an annual household income of $25,000 or more were coded as 0. This value was used based on the poverty threshold for a family of four, so this dichotomous variable proxies whether a household lives below the poverty threshold or not. While several different responses were given to the question regarding the respondent's current marital status, we constructed a dichotomous variable from responses to this question to indicate whether the respondent was currently married (including being a member of an unmarried couple, reference) or not (including never married, divorced, separated, or widowed). To determine their current health care coverage status, respondents were asked whether they had "any kind of health care coverage including health insurance, prepaid plans such as HMOs or government plans such as Medicare" (Centers for Disease Control and Prevention 2008). If the respondent answered yes, the response was coded as 1, which means that the respondent had some kind of health care coverage (reference). If the respondent answered no, do not know/unsure, or the respondent refused to answer, the response was coded as 0. The question whether there had been "a time in the past 12 months when you needed to see a doctor but could not because of cost" was used to create a dichotomous variable indicating whether high medical costs prevented a respondent from seeing a doctor (Centers for Disease Control and Prevention 2008). If the response to this question was yes, the variable was coded as 1, meaning that there had been a time in the past year where the respondent could not consult a doctor due to high medical costs (reference). If the answer were no, do not know/unsure, or the respondent refused to answer, the response was coded as 0.

Besides using socioeconomic characteristics to ascertain associations with obesity status, we also included behavioral characteristics, as well as current health status and medical conditions. Health behaviors were measured with three variables including: current smoking status; exercise during the past 30 days; and alcohol consumption. A respondent could have stated they were a current smoker, a former smoker, or that they had never smoked (reference). During the interview, respondents were asked if they had participated in leisure time activities or exercised during the past 30 days other than those activities that were a part of

their normal job duties. A dummy variable was created to indicate if the respondent had exercised during the past 30 days (reference) or not. Alcohol consumption was assessed by whether the respondent stated that he/she had consumed any alcoholic beverage in the past 30 days. A dummy variable was created, which indicated whether the respondent had a drink in the past 30 days (reference) or not.

Health status and medical conditions were measured with seven variables: self-reported health; whether the respondent had ever been told that he/she had asthma; stroke; heart attack; diabetes; angina or coronary heart disease; and whether the respondent had any activity limitations. Each respondent was asked how they would evaluate their health in general and were offered five response options: excellent, very good, good, fair, and poor. If the respondent indicated their health was fair or poor, the variable were coded as 1 for poor health (reference); if the respondent chose any other response option or refused to answer the question a value of 0 was assigned. Dummy variables were created for several medical conditions: whether the respondent had been told he/she had asthma; diabetes; whether he/she had been diagnosed with a stroke; heart attack; and angina or coronary heart disease. The dummy variables were coded as 1 if the respondent answered that he/she had been told by a doctor that he/she had this condition, otherwise a value of 0 was assigned. Finally a question asked in the BRFSS assesses potential activity limitations. If a respondent answered yes to the question, "are you limited in any way in any activities because of physical, mental, or emotional problems?," they were assigned a value of 1 for the dummy variable measuring activity limitations (Centers for Disease Control and Prevention 2008).

Statistical Approach

BRFSS includes weight variables that account for the complex sample design of the data and adjust for probability of selection of respondents, subgroup disproportionate selection, and unit non-response. To adjust for complex survey design, we used the SURVEY procedures in SAS 9.2 for descriptive statistics and the svy commands in STATA 10.1 for constructing multinomial regression models. First, we estimated chi-squared tests of significance for differences in all characteristics just detailed by nonmetro status. In addition, we estimated differences by weight status (normal weight, overweight and obese) using the same procedure.

Next, we constructed a multinomial regression model using a three-category dependent variable specifying the respondents as either normal weight, overweight or obese for all non-institutionalized, non-pregnant adults in the US. This statistical

model estimates the probability that someone is obese versus normal weight while simultaneously estimating the probability of someone being overweight versus normal weight, controlling for all other variables in the model and adjusting for the complex survey design of the data. We present relative risk ratios, confidence intervals, as well as levels of significance for all the variables included in the model. Lastly, we stratified the sample by residential location and estimated the same multinomial model for metro and nonmetro adults separately. Additionally we tested for the possibility of multicollinearity among variables included in these analyses, and the values of the variance inflation factor for each independent variable indicated that multicollinearity was not present in the multivariable models.

Limitations

First, the analysis presented here is only based on cross sectional data. As such, we are unable to establish causality or establish the causal direction of some associations tested. We are mindful of this limitation when interpreting results from the multiple variable models, particularly for variables of health behaviors such as smoking, alcohol consumption, and activity limitations. Discerning the causal ordering of these variables and the outcome of interest is impossible. Second, data used to construct the dependent variable was based on self-reported height and weight data, and both measures run the risk of being misreported in survey data (Gorber et al. 2007; Krul et al. 2010). However our estimates of normal weight, overweight, and obesity are very similar to other national estimates (National Center for Health Statistics 2009; Ogden and Carroll 2010), so we feel comfortable that we are capturing the weight status of the population. Lastly, the 2008 BRFSS does not collect data on food consumption patterns, which may lend an important additional set of sociodemographic and behavioral variables to the analysis. However we feel that the comprehensive set of variables used in these models contribute to our understanding of weight status for adults in the United States by thoroughly including measures likely to influence the risk of being overweight or obese.

RESULTS

Characteristics of BRFSS 2008 Adult Population by Metropolitan Status

Significant differences were found between adults living in metropolitan and nonmetropolitan areas based on bivariate tests of all variables included in this analysis, except sex and an asthma diagnosis (Table 1). In metro areas 40.5 percent

TABLE 1. WEIGHTED PERCENTAGES OF WEIGHT STATUS, DEMOGRAPHIC, SOCIOECONOMIC, BEHAVIORAL AND HEALTH CHARACTERISTICS AMONG ADULTS BY METROPOLITAN STATUS WITH ADJUSTMENTS FOR SURVEY DESIGN, BRFSS 2008, N=406,747

VARIABLES	METRO AREAS	NONMETRO AREAS	RAO-SCOTT χ^2	SIG.
Weight status.			245.6	<.0001
Normal weight (BMI < 25).	40.5	36.3		
Overweight (25 ≥ BMI < 30).	34.7	34.6		
Obese (BMI ≥ 30).	24.7	29.1		
Sex.			3.8	0.051
Male.	48.8	48.1		
Female.	51.2	51.9		
Race/ethnicity.			2029.7	<.0001
Non-Hispanic White.	66.2	82.5	2054.2	<.0001
Non-Hispanic Black.	10.7	6.5	382.7	<.0001
Hispanic.	15.9	6.2	868.6	<.0001
Non-Hispanic other races.	7.3	4.8	174.0	<.0001
Age.			253.6	<.0001
18-24.	12.5	11.5	7.9	<.005
25-34.	18.5	16.8	31.8	<.0001
35-44.	19.3	17.1	70.1	<.0001
45-54.	19.2	19.1	0.2	0.622
55-64.	14.2	16.1	97.8	<.0001
65 Years of age or older.	16.2	19.4	278.3	<.0001
Educational level.			1031.8	<.0001
Less than high school.	10.9	13.1	72.5	<.0001
High school diploma.	27.4	37.0	874.9	<.0001
Some college or more.	61.6	49.8	1146.7	<.0001
Employment status.			95.7	<.0001
Employed.	60.4	57.1		
Not employed.	39.6	42.9		
Income.			315.9	<.0001
Less than $25,000.	21.2	26.6		
Greater equal $25,000.	78.8	73.4		
Marital status.			30.1	<.0001
Married.	63.6	65.5		
Not married.	36.4	34.5		
Health care coverage status.			63.5	<.0001
Covered	84.8	82.4		
Not covered	15.2	17.6		

Table 1. (*Continued*)

Variables	Metro Areas	Nonmetro Areas	Rao-Scott χ^2	Sig.
Medical costs too high to see doctor.			42.4	<.0001
Yes.	13.7	15.5		
No.	86.3	84.5		
Current smoking status.			361.4	<.0001
Current smoker.	17.9	22.4	235.3	<.0001
Former smoker.	24.1	25.5	24.7	<.0001
Never smoked.	57.9	52.1	291.3	<.0001
Had alcoholic drink in past 30 days.			609.2	<.0001
Yes.	53.0	44.4		
No.	47.0	55.6		
Exercised during past 30 days.			224.8	<.0001
Yes.	75.5	71.0		
No.	24.5	29.0		
Self-reported health.			235.8	<.0001
Good health.	84.6	80.8		
Poor health.	15.4	19.2		
Ever diagnosed with asthma.			0.5	0.465
Yes.	13.4	13.6		
No.	86.6	86.4		
Ever diagnosed with stroke.			102.4	<.0001
Yes.	2.5	3.4		
No.	97.5	96.6		
Ever diagnosed with diabetes.			63.9	<.0001
Yes.	9.5	10.9		
No.	90.5	89.1		
Ever diagnosed with heart attack.			194.7	<.0001
Yes.	4.0	5.6		
No.	96.0	94.4		
Ever diagnosed with angina or coronary heart disease.			121.2	<.0001
Yes.	4.1	5.4		
No.	95.9	94.6		
Activity limitations.			241.0	<.0001
Yes.	19.5	23.6		
No.	80.5	76.4		

of adults were normal weight, and 24.7 percent of adults were obese; while in nonmetropolitan areas 36.3 percent of adults were normal weight and 29 percent were considered obese. Approximately 35 percent of adults in metro and nonmetro areas were overweight. In terms of socioeconomic characteristics, adults in metro areas were more likely to have some college education or more and were more likely

to be currently employed than adults living in nonmetro areas. Lower incomes were more common among nonmetro adults compared with metro adults. Most of the adults were currently married, although nonmetropolitan residents were more likely to be married. Respondents in nonmetropolitan areas were more likely to have no health care coverage, and nonmetro residents were also more likely to state that medical costs were too high to see a doctor. Metro area respondents were more likely to have never smoked compared with nonmetro area respondents; alternatively adults residing in nonmetropolitan areas were more likely to be current or former smokers compared with their metropolitan counterparts. While approximately 53 percent of metro area adults stated they had an alcoholic drink in the past 30 days, 55.6 percent of nonmetro adults stated they did not consume any alcohol in the reference period. It could also be seen that most of the respondents both in metro and nonmetro areas had exercised in the last 30 days and reported to be in good health, however the values were lower for nonmetro adults. Specific morbidity conditions and activity limitations were more common among nonmetro adults.

Characteristics of BRFSS 2008 Adult Population by Weight Status

Like the previous bivariate analysis, chi-square tests of differences were also performed by weight status. Significant differences in weight status – normal weight, overweight, and obese – were found for all variables in the analysis (Table 2). Men were more likely to be both overweight and obese compared with women, while women were most likely to be normal weight. Race/ethnicity differences were also noted, with non-Hispanic black adults most likely to be overweight or obese, and Hispanic adults the least likely to be either overweight or obese. Overweight and obesity increased with age.

Somewhat of an education gradient was noted based on weight status. Low-income adults were more likely to be obese than their non-poor counterparts. More married adults were either overweight or obese than their non-married counterparts. Obese adults were more likely to report that medical costs were too high to see a doctor than to report medical costs were not too high, while the reverse pattern was observed for overweight adults. Current smokers were more likely to be normal weight compared with overweight or obese; a similar pattern holds for never smokers. Former smokers were more likely to be overweight. Overweight respondents were more likely to have consumed an alcoholic beverage in the past 30 days, while obese respondents were more likely to have not consumed alcohol. Respondents were more likely to be obese if they had not exercised in the

TABLE 2. WEIGHTED PERCENTAGES OF METROPOLITAN RESIDENCE, DEMOGRAPHIC, SOCIOECONOMIC, BEHAVIORAL AND HEALTH CHARACTERISTICS AMONG ADULTS BY WEIGHT STATUS WITH ADJUSTMENTS FOR SURVEY DESIGN, BRFSS 2008, N=406,747

VARIABLES	NORMAL BMI < 25	OVERWEIGHT 25 ≥ BMI < 30	OBESE BMI ≥ 30	RAO-SCOTT χ^2	SIG.
Metropolitan status				245.6	<.0001
Metro areas	40.5	34.7	24.7		
Nonmetro areas	36.3	34.6	29.1		
Sex				2844.8	<.0001
Male	31.1	42.0	27.0		
Female	48.0	27.8	24.2		
Race/Ethnicity				581.6	<.0001
Non-Hispanic White	40.6	34.9	24.7	91.0	<.0001
Non-Hispanic Black	30.3	34.3	35.4	506.7	<.0001
Hispanic	49.1	32.0	18.9	13.4	0.001
Non-Hispanic other races	37.9	35.1	27.0	209.4	<.0001
Age				2110.5	<.0001
18-24	57.8	25.1	17.1	752.4	<.0001
25-34	42.1	33.1	24.8	33.6	<.0001
35-44	36.9	35.6	27.5	88.3	<.0001
45-54	34.8	36.1	29.1	318.1	<.0001
55-64	31.7	37.7	30.5	721.9	<.0001
65 years of age or older	39.9	38.2	22.0	296.1	<.0001
Educational level				181.8	<.0001
Less than high school	39.0	32.4	28.6	43.4	<.0001
High school diploma	38.1	34.0	27.9	108.1	<.0001
Some college or more	40.7	35.5	23.8	198.0	<.0001
Employment status				257.2	<.0001
Employed	37.8	36.4	25.8		
Not employed	42.7	32.2	25.1		
Income				197.8	<.0001
< $25,000	38.1	32.4	29.6		
≥ $25,000	40.2	35.4	24.4		

Table 2. (*Continued*)

VARIABLES	NORMAL BMI < 25	OVERWEIGHT 25 ≥ BMI < 30	OBESE BMI ≥ 30	RAO-SCOTT χ^2	SIG.
Marital status.				455.2	<.0001
Married.	37.2	36.9	25.8		
Not married.	44.3	30.7	25.0		
Health care coverage status.				54.5	<.0001
Covered.	39.3	35.3	25.3		
Not covered.	42.1	31.4	26.6		
Medical costs too high to see doctor.				173.8	<.0001
Yes.	38.3	31.0	30.7		
No.	40.0	35.3	24.7		
Current smoking status.				554.0	<.0001
Current smoker.	42.4	33.4	24.3	55.2	<.0001
Former smoker.	33.1	38.0	28.8	635.5	<.0001
Never smoked.	41.7	33.7	24.5	197.3	<.0001
Had alcoholic drink in past 30 days.				387.3	<.0001
Yes.	39.6	37.2	23.1		
No.	39.9	32.0	28.1		
Exercised during past 30 days.				849.9	<.0001
Yes.	41.2	35.8	23.1		
No.	35.6	31.6	32.8		
Self-reported health.				1477.1	<.0001
Good health.	41.3	35.5	23.2		
Poor health.	31.9	30.4	37.7		
Ever diagnosed with asthma.				404.8	<.0001
Yes.	40.4	35.2	24.4		
No.	35.5	31.6	33.0		
Ever diagnosed with stroke.				86.0	<.0001
Yes.	34.1	34.9	31.0		
No.	39.9	34.7	25.4		
Ever diagnosed with diabetes.				3962.3	<.0001
Yes.	20.5	30.8	48.6		
No.	14.8	35.1	23.6		
Ever diagnosed with heart attack.				381.1	<.0001
Yes.	29.0	37.1	33.9		
No.	40.2	34.6	25.2		
Ever diagnosed with angina or coronary heart disease.				469.7	<.0001
Yes.	28.0	37.1	34.9		
No.	40.3	34.6	25.1		
Activity limitations.				1503.3	<.0001
Yes.	32.2	32.3	35.5		
No.	41.7	35.3	23.0		

past 30 days. It is also interesting more overweight adults reported exercising in the past 30 days as opposed to not exercising. Adults reporting poor health were more likely to be obese than either normal weight or overweight. Adults with certain health conditions, including diabetes, heart attack, or angina or coronary heart disease, were much more likely to be obese compared with normal weight or overweight. Adults with activity limitations were more likely to be overweight and obese than adults without activity limitations.

Multinomial Regression Results for All Adults

A positive, significant association between nonmetropolitan status and both overweight and obese status was noted in the multinomial regression model presented in the first two columns in Table 3, holding all demographic, socioeconomic, behavioral, and health characteristics constant. Stated differently, adults in nonmetropolitan areas had 14.5% higher relative risk of being overweight and approximately 30% higher relative risk of being obese compared to being normal weight, once controls for demographic, socioeconomic, behavioral measures and health status and medical conditions were held constant. The risk of being overweight or obese among nonmetropolitan residents did not change much when these variables were added, as the relative risk of being overweight was 1.11 (95%CI=1.07-1.15) and obese was 1.31 (95%CI=1.27-1.36) with only nonmetro status in the model.

Being female, of non-Hispanic other race, a current smoker, reporting to have poor health, as well as having been diagnosed with asthma were protective factors for the relative risk of being overweight compared with normal weight. All other covariates increased the relative risk of being overweight, except for having less than high school education, having exercised in the past 30 days, or having ever been diagnosed with a stroke or a heart attack, which were not statistically significant. For the risk of being obese compared with normal weight, being female, of non-Hispanic other race, being a current smoker, having had an alcoholic drink, having exercised in the past 30 days, and having been diagnosed with asthma or stroke were protective factors. All other covariates except for having less than high school education and having been diagnosed with a heart attack resulted in increased relative risk of being obese compared with normal weight. Note that having been diagnosed with diabetes had by far the largest effect on the relative risk of being obese compared with normal weight; respondents with a diabetes diagnosis were 247% more likely to be obese compared with normal weight.

TABLE 3. RELATIVE RISK RATIOS OF WEIGHT STATUS AND OTHER INDIVIDUAL COVARIATES AMONG ADULTS USING MULTINOMIAL REGRESSION WITH DESIGN EFFECTS, BRFSS 2008, N=406,747

	OVERWEIGHT		OBESE	
	RRR (95% CI) N=142,059		RRR (95% CI) N= 106,983	
Nonmetropolitan status (1=yes).	1.15***	(1.11-1.18)	1.30***	(1.25-1.35)
Female (1=yes).....	0.42***	(0 .41-0.43)	0.54***	(0.52-0.56)
Race/Ethnicity (ref=Non-Hispanic White)				
Non-Hispanic Black.	1.53***	(1.43-1.63)	1.94***	(1.82-2.07)
Hispanic.	1.26***	(1.17-1.35)	1.19***	(1.10-1.29)
Non-Hispanic other races.	0.78***	(0.72-0.84)	0.61***	(0.56-0.66)
Age (ref=18-24)				
25-34.	1.69***	(1.55-1.85)	1.89***	(1.71-2.09)
35-44.	2.05***	(1.89-2.24)	2.27***	(2.07-2.50)
45-54.	2.20***	(2.02-2.38)	2.25***	(2.05-2.47)
55-64.	2.54***	(2.34-2.76)	2.29***	(2.09-2.52)
65 or older.	2.22***	(2.05-2.41)	1.24**	(1.13-1.36)
Educational level (ref=Some college or more)				
Less than high school.	0.98	(0.92-1.05)	1.05	(0.98-1.13)
High school diploma.	1.09***	(1.05-1.13)	1.21***	(1.16-1.26)
Currently employed (1=yes).....	1.20***	(1.15-1.25)	1.29***	(1.23-1.35)
Income less than $25,000 (1=yes). .	1.13***	(1.07-1.19)	1.14***	(1.08-1.20)
Currently married (1=yes).	1.19***	(1.14-1.23)	1.12***	(1.08-1.17)
Current health care coverage status (1=yes).	1.14***	(1.07-1.21)	1.11**	(1.03-1.18)
Medical costs too high to see doctor (1=yes).	1.06*	(1.00-1.13)	1.14***	(1.07-1.21)
Current smoking status (ref= Never smoked)				
Current smoker.	0.87***	(0.83-0.91)	0.75***	(0.71-0.79)
Former smoker.....	1.13***	(1.09-1.17)	1.22***	(1.17-1.27)
Had alcoholic drink in past 30 days (1=yes).	1.07***	(1.03-1.11)	0.91***	(0.87-0.94)
Exercised during past 30 days (1=yes).	0.99	(0.95-1.03)	0.73***	(0.70-0.76)
Poor self-reported health (1=yes)...	0.93*	(0.89-0.98)	1.24***	(1.17-1.31)
Ever diagnosed with asthma (1=yes).	0.87***	(0.82-0.91)	0.67***	(0.64-0.71)
Ever diagnosed with stroke (1=yes).	0.96	(0.89-1.04)	0.82***	(0.75-0.90)
Ever diagnosed with diabetes (1=yes).	1.54***	(1.45-1.62)	3.47***	(3.29-3.67)

TABLE 3. (*CONTINUED*)

	Overweight		Obese	
	RRR (95% CI)		RRR (95% CI)	
Ever diagnosed with heart attack (1=yes).	1.02	(0.95-1.10)	1.02	(0.94-1.11)
Ever diagnosed with angina or coronary heart disease (1=yes).	1.13**	(1.04-1.22)	1.22***	(1.12-1.33)
Has activity limitations (1=yes).....	1.15***	(1.10-1.20)	1.58***	(1.51-1.65)

Residence Stratified Multinomial Regression Results

Since clear differences in weight status were noted by metro-nonmetro status and most variables in this analysis also varied by residential status, we stratified the analysis and estimated the same multinomial model for metro and nonmetro adults separately. Most variables operate similarly between the metro sample and the full adult sample. Differences are largely noted between metro and nonmetro areas based on race/ethnicity for both overweight and obesity status, and for several measures of health behaviors and health status in determining overweight status for nonmetro adults. No differences were noted in the relative risk of being overweight or obese compared with normal weight for Hispanic or non-Hispanic other race adults compared with non-Hispanic whites in nonmetro areas. Among metro adults an overweight and obesity status disadvantage was noted for Hispanics compared with non-Hispanic whites, while a normal weight advantage is noted in metro areas for non-Hispanic other race adults compared with non-Hispanic whites. Only non-Hispanic black adults had a higher relative risk of being overweight or obese compared with non-Hispanic whites in nonmetro areas. While the variables operated in a similar way between metro and nonmetro areas, the size of effects for socioeconomic status, measured by educational level, current employment status, and income, on weight status were not as strong for nonmetro compared with metro adults. Additionally medical coverage and costs more strongly influenced weight status, particularly obesity versus normal weight, for nonmetro adults.

Several health status and medical condition variables were significant in determining overweight status for metro adults; however only having a diagnosis of diabetes and angina or coronary heart disease significantly increased the relative risk that a nonmetro adult would be overweight compared with normal weight. Activity limitations had no significant association with overweight status compared with normal weight for nonmetro adults, while activity limitations significantly increased the relative risk that a metro adult would be overweight compared with normal weight.

TABLE 4. RELATIVE RISK RATIOS OF WEIGHT STATUS AND OTHER INDIVIDUAL COVARIATES AMONG ADULTS USING MULTINOMIAL REGRESSION WITH DESIGN EFFECTS STRATIFIED BY METRO/NONMETRO STATUS, BRFSS 2008

	OVERWEIGHT				OBESE			
	Nonmetro Residents		Metro Residents		Nonmetro Residents		Metro Residents	
	RRR (95% CI) N=48,242		RRR (95% CI) N=93,817		RRR (95% CI) N=38,585		RRR (95% CI) N=68,398	
Female (1=yes)	0.44***	(0.41-0.46)	0.42***	(0.40-0.43)	0.58***	(0.54-0.61)	0.53***	(0.50-0.55)
Race/Ethnicity (ref=Non-Hispanic White)								
Non-Hispanic Black.	1.37***	(1.20-1.57)	1.55***	(1.44-1.66)	1.83***	(1.61-2.08)	1.94***	(1.81-2.09)
Hispanic.	1.02	(0.86-1.21)	1.28***	(1.19-1.38)	0.99	(0.82-1.19)	1.21***	(1.11-1.31)
Non-Hispanic other races.	1.06	(0.92-1.22)	0.75***	(0.69-0.82)	1.09	(0.95-1.25)	0.56***	(0.51-0.61)
Age (ref=18-24)								
25-34.	1.86***	(1.59-2.17)	1.66***	(1.50-1.84)	1.83***	(1.53-2.18)	1.91***	(1.70-2.15)
35-44.	2.09***	(1.80-2.43)	2.05***	(1.87-2.26)	2.19***	(1.85-2.59)	2.30***	(2.06-2.57)
45-54.	2.36***	(2.04-2.73)	2.17***	(1.97-2.38)	2.15***	(1.83-2.54)	2.29***	(2.05-2.55)
55-64.	2.37***	(2.06-2.74)	2.59***	(2.35-2.84)	1.90***	(1.60-2.24)	2.40***	(2.15-2.67)
65 or Older.	2.11***	(1.89-2.53)	2.22***	(2.02-2.44)	1.07	(0.91-1.27)	1.28***	(1.15-1.43)
Educational level (ref=Some college or more)								
Less than high school.	1.02	(0.92-1.14)	0.97	(0.89-1.06)	0.98	(0.87-1.10)	1.08	(0.99-1.18)
High school diploma.	1.08*	(1.02-1.15)	1.09***	(1.04-1.14)	1.14***	(1.07-1.22)	1.23***	(1.17-1.29)
Employed (1=yes).	1.14***	(1.06-1.22)	1.21***	(1.15-1.27)	1.25***	(1.15-1.35)	1.29***	(1.23-1.36)
Income less than $25,000 (1=yes).	1.11**	(1.03-1.20)	1.14***	(1.07-1.20)	1.15**	(1.06-1.25)	1.14***	(1.07-1.21)
Currently married (1=yes).	1.26***	(1.18-1.35)	1.17***	(1.12-1.22)	1.25***	(1.16-1.34)	1.10***	(1.05-1.15)
Current health care coverage status (1=yes).	1.22***	(1.11-1.34)	1.12**	(1.04-1.20)	1.13*	(1.02-1.26)	1.10*	(1.02-1.19)
Medical costs too high to see doctor (1=yes).	1.09	(0.99-1.20)	1.06	(0.99-1.14)	1.25***	(1.13-1.38)	1.12**	(1.04-1.20)

TABLE 4. (*CONTINUED*)

	OVERWEIGHT				OBESE			
	Nonmetro Residents		Metro Residents		Nonmetro Residents		Metro Residents	
	RRR (95% CI) N=48,242		RRR (95% CI) N=93,817		RRR (95% CI) N=38,585		RRR (95% CI) N=68,398	
Current smoking status (ref= Never smoked)								
Current smoker.	0.81***	(0.75-0.87)	0.89***	(0.84-0.94)	0.59***	(0.54-0.64)	0.79***	(0.74-0.84)
Former smoker.	1.17***	(1.10-1.24)	1.12***	(1.07-1.16)	1.23***	(1.15-1.32)	1.21***	(1.16-1.27)
Had Alcoholic Drink In Past 30 Days (1=yes).	1.04	(0.98-1.10)	1.08***	(1.03-1.12)	0.90**	(0.84-0.96)	0.91***	(0.87-0.95)
Exercised During Past 30 Days (1=yes).	0.97	(0.91-1.04)	0.99	(0.94-1.04)	0.76***	(0.71-0.81)	0.72***	(0.69-0.76)
Poor Self-Reported Health (1=yes).	0.93	(0.86-1.01)	0.94*	(0.88-1.00)	1.22***	(1.12-1.34)	1.24***	(1.17-1.33)
Ever Diagnosed with Asthma (1=yes).	0.98	(0.90-1.07)	0.84***	(0.80-0.89)	0.79***	(0.72-0.86)	0.65***	(0.61-0.69)
Ever Diagnosed with Stroke (1=yes).	1.00	(0.89-1.12)	0.95	(0.87-1.05)	0.85*	(0.75-0.97)	0.81***	(0.73-0.90)
Ever Diagnosed with Diabetes (1=yes).	1.51***	(1.38-1.65)	1.54***	(1.44-1.65)	3.48***	(3.19-3.81)	3.47***	(3.25-3.70)
Ever Diagnosed with Heart Attack (1=yes).	0.96	(0.85-1.08)	1.05	(0.95-1.15)	1.00	(0.88-1.13)	1.04	(0.94-1.14)
Ever Diagnosed with Angina or Coronary Heart Disease (1=yes).	1.17*	(1.03-1.32)	1.12*	(1.02-1.22)	1.19**	(1.04-1.36)	1.23***	(1.11-1.36)
Has Activity Limitations (1=yes).	1.06	(0.99-1.13)	1.17***	(1.12-1.23)	1.48***	(1.37-1.59)	1.61***	(1.52-1.69)

DISCUSSION

Several findings deserve some discussion as they relate to the hypotheses posed in this research. Weight status varied significantly based on residential location and supports the first hypothesis tested. More nonmetro adults were obese than their metro counterparts, which supports existing research (Eberhardt et al. 2001; Jackson et al. 2005; Kegler et al. 2008; Patterson et al. 2004); however it is interesting that similar proportions of adults were overweight in both metro and nonmetro areas. Roughly 34.5 percent of adults were overweight, and this is similar to information reported using NHANES data over the same period for adults (Ogden and Carroll 2010). Overall more adults in nonmetro areas experience above normal weight status (roughly 64 percent of all adults) than their metro counterparts. This raises questions about the overall health needs of the nonmetro population, because nonmetro adults were more likely to report poorer health profiles and higher prevalence of activity limitations compared with their metro counterparts. The composition of nonmetro areas as demonstrated in the bivariate analyses likely influences the higher prevalence of above normal weight status for nonmetro adults in the US.

The relative risk of a nonmetro adults being overweight or obese compared with normal weight were significantly higher than for metro adults. This association persisted, and remained fairly consistent with the inclusion of all variables in the model, including sociodemographic characteristics, health behaviors, health status and health condition variables. This lends support for the second hypothesis. Like previous research, clear racial/ethnic, sex, and age disparities were noted based on overweight and obesity status. Since few studies have examined these three weight status categories simultaneously, it is interesting that the magnitudes of associations were very similar in predicting the relative risk that an adult would be either overweight or obese compared with normal weight in the full adult sample. Moreover, the socioeconomic measures operated similarly in determining whether an adult was overweight or obese compared with normal weight. The one difference noted that was different from what was anticipated was that no association was observed between exercising in the past 30 days and being overweight compared with normal weight; however, a protective effect of exercising was found for obesity status. Again it is important to note that with the inclusion of all variables in the full adult sample, nonmetro adults had a 15 percent higher relative risk of being overweight and 30 percent higher relative risk of being obese versus normal weight compared with adults in metro areas.

To test the third and fourth hypotheses, the sample was stratified by residential location and similar multinomial regression models were estimated for metro and nonmetro adults. Some support was found for hypothesis three in that the SES-weight status association was not as strong among the nonmetro sample compared with the metro sample, particularly for overweight status. More work is needed to understand the SES-weight status relationship in nonmetro areas that addresses access to resources, such as healthy and fresh food, recreational facilities, and medical clinics offering weight management counseling, as one potential intervening mechanism, since these resources differ between rural and urban areas (Bove and Olson 2006; Hosler 2009; Larson and Fleishman 2003; Michimi and Wimberly 2010).

Among the full adult sample, activity limitations increased the risk that an adult would be overweight or obese compared with normal weight. However, activity limitations only increased the risk that a nonmetro adult would be obese compared with normal weight or a metro adult would be overweight or obese compared with normal weight, while no significant difference was noted between whether a nonmetro adult was overweight compared with normal weight if they had an activity limitation. Similarly, exercise in the past 30 days had no significant association with overweight versus normal weight status for metro or nonmetro adults, while it was protective against obesity for both metro and nonmetro adults. This gives some support for the fourth hypothesis tested in this research but raises additional questions. Since physical inactivity is higher in rural compared with urban areas as noted here and in other research (Casey et al. 2008; Kegler et al. 2008; Martin et al. 2005; Parks et al. 2003; Wilcox et al. 2000), examining how physical inactivity influences activity limitations and its role in determining weight status will be important for future research. What remains less clear is the direction of influence between obesity status, physical activity, and activity limitations. Longitudinal data and methods are needed to assess these relationships.

Lastly, differences in weight status were not noted based on race/ethnicity for nonmetro adults as were witnessed for metro adults. Only nonmetro non-Hispanic blacks had an increased risk of being overweight or obese versus normal weight compared with nonmetro non-Hispanic whites. This differs from the work of Patterson et al. (2004) that found increased odds of obesity for rural non-Hispanic blacks and Hispanics compared with rural non-Hispanic whites using data from the National Health Interview Survey in 1998. Changes in the composition of minority populations in nonmetro areas from this study to that cited may partly account for these differences, but more work is needed to document racial/ethnic differences in

weight status by residential location, particularly as the minority population of nonmetro areas becomes more diverse.

As stated earlier, previous research has suggested that a combination of cultural, sociodemographic, and environmental factors likely influence the differences in weight status noted between rural and urban adults. Results presented here would help to support the argument that lower socioeconomic status and less access to health care in rural areas may put rural adults at increased risk of obesity and obesity related co-morbidities (Casey et al. 2008; Eberhardt et al. 2001) as well as experiencing overweight, although some associations are weaker or not significant with this weight category. Distance to resources (such as healthy and affordable whole, fresh foods, recreational and exercise facilities, and medical clinics) and transportation barriers in rural areas may present obstacles to maintaining a healthy weight for rural residents (Hermstad et al. 2010; Pucher and Renne 2005). Both sedentary lifestyles and physical inactivity are likely to present additional barriers to healthy weights for rural residents (Chen et al. 2009; Eaton et al. 1994). Resources and social support networks are also likely to influence patterns of overweight and obesity in rural areas (Hermstad et al. 2010). Therefore public health campaigns and programs geared to weight management in rural areas must consider these complex set of factors that put certain individuals at risk of being overweight and obese based on residential location. Results from this research give us a first step in understanding the individual correlates of weight status that includes normal weight, overweight, and obese adults in both metro and nonmetro areas using nationally representative data.

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REFERENCES

Adachi-Mejia, Anna M., Keith M. Drake, Todd A. MacKenzie, Linda Titus-Ernstoff, Meghan R. Longacre, Kristy M. Hendricks, Michael L. Beach, and Madeline A. Dalton. 2010. "Perceived Intrinsic Barriers to Physical Activity Among Rural Mothers." *Journal of Womens Health* 19:2197–202.

Ahern, M., C. Brown, and S. Dukas. 2011. "A National Study of the Association Between Food Environments and County-Level Health Outcomes." *Journal of Rural Health* 27:367–79.

Bennett, K. J., J. C. Probst, and C. Pumkam. 2011. "Obesity among Working Age Adults: The Role of County-level Persistent Poverty in Rural Disparities." *Health & Place* 17:1174–81.

Beydoun, M. A. and Y. F. Wang. 2009. "Gender-ethnic Disparity in BMI and Waist Circumference Distribution Shifts in US Adults." *Obesity* 17:169–76.

Bove, Caron F. and Christine M. Olson. 2006. "Obesity in Low-income Rural Women: Qualitative Insights about Physical Activity and Eating Patterns." *Women and Health* 44:57–78.

Carson, Valerie, Ronald J. Iannotti, William Pickett, and Ian Janssen. 2011. "Urban and Rural Differences in Sedentary Behavior among American and Canadian Youth." *Health & Place* 17:920–8.

Casey, A. A., M. Elliott, K. Glanz, D. Haire-Joshu, S. L. Lovegreen, B. E. Saelens, J. F. Sallis, and R. C. Brownson. 2008. "Impact of the Food Environment and Physical Activity Environment on Behaviors and Weight Status in Rural Us Communities." *Preventive Medicine* 47:600–4.

Centers for Disease Control and Prevention. 1998. "Self-reported Physical Inactivity by Degree of Urbanization–United States, 1996." *MMWR. Morbidity and Mortality Weekly Report* 47:1097–100.

_____. 2008. *Behavioral Risk Factor Surveillance System Survey Data.* Atlanta, Georgia: U.S. Department of Health and Human Services, Centers for Disease Control and Prevention.

Champagne, C. M., M. L. Bogle, B. B. McGee, K. Yadrick, H. R. Allen, T. R. Kramer, P. Simpson, J. Gossett, J. Weber, and Inter Lower Mississippi Delta Nutr. 2004. "Dietary Intake in the Lower Mississippi Delta Region: Results from the Foods of our Delta Study." *Journal of the American Dietetic Association* 104:199–207.

Chang, Shine, Louise C. Masse, Richard P. Moser, Kevin W. Dodd, Facundo Arganaraz, Bernard F. Fuemmeler, and Ahmedin Jemal. 2011. "State Ranks of

Incident Cancer Burden Due to Overweight and Obesity in the United States, 2003 (vol 16, pg 1636, 2008)." *Obesity* 19:2288–90.

Chen, Y., D. C. Rennie, and J. A. Dosman. 2009. "Changing Prevalence of Obesity in a Rural Community Between 1977 and 2003: a Multiple Cross-sectional Study." *Public Health* 123:15–9.

Chou, S. Y., M. Grossman, and H. Saffer. 2004. "An Economic Analysis of Adult Obesity: Results from the Behavioral Risk Factor Surveillance System." *Journal of Health Economics* 23:565–87.

Clarke, P., P. M. O'Malley, L. D. Johnston, and J. E. Schulenberg. 2009. "Social Disparities in BMI Trajectories Across Adulthood by Gender, Race/ethnicity and Lifetime Socio-economic Position: 1986–2004." *International Journal of Epidemiology* 38:499–509.

Congdon, Peter. 2011. "A Multilevel Model for Comorbid Outcomes: Obesity and Diabetes in the US." *International Journal of Environmental Research and Public Health* 7:333–52.

Curioni, C., C. Andre, and R. Veras. 2006. "Weight Reduction for Primary Prevention of Stroke in Adults with Overweight or Obesity." *Cochrane Database of Systematic Reviews* 4.

Eaton, C. B., A. N. Nafziger, D. S. Strogatz, and T. A. Pearson. 1994. "Self-reported Physical-Activity in a Rural County – A New York County Health Census." *American Journal of Public Health* 84:29–32.

Eberhardt, M., D. Ingram, D. Makuc, E. Pamuk, V. Freid, S. Harper, C. Schoenborn, and H. Xia. 2001. "Urban and Rural Health Chartbook. Health, United States, 2001." Hyattsville, MD.

Egger, G. and B. Swinburn. 1997. "An 'Ecological' Approach to the Obesity Pandemic." *British Medical Journal* 315:477–80.

Field, A. E., E. H. Coakley, J. L. Spadano, N. Laird, W. H. Dietz, E. Rimm, and G. A. Colditz. 2001. "Impact of Overweight on the Risk of Developing Common Chronic Diseases During a 10-year Period." *Archives of Internal Medicine* 161:1581–6.

Finkelstein, E., I. C. Fiebelkorn, and G. J. Wang. 2005. "The Costs of Obesity among Full-time Employees." *American Journal of Health Promotion* 20:45–51.

Finkelstein, Eric A., Marco da Costa DiBonaventura, Somali M. Burgess, and Brent C. Hale. 2010. "The Costs of Obesity in the Workplace." *Journal of Occupational and Environmental Medicine* 52:971–6.

Fisher, Monica. 2007. "Why Is US Poverty Higher in Nonmetropolitan than in Metropolitan Areas?" *Growth and Change* 38:56–76.

Flegal, Katherine M., Margaret D. Carroll, Cynthia L. Ogden, and Lester R. Curtin. 2010. "Prevalence and Trends in Obesity Among US Adults, 1999–2008." *JAMA-Journal of the American Medical Association* 303:235–41.

Frezza, Eldo E. and Mitchell S. Wachtel. 2009. "The Economic Impact of Morbid Obesity." *Surgical Endoscopy and Other Interventional Techniques* 23:677–9.

Glass, T. A., M. D. Rasmussen, and B. S. Schwartz. 2006. "Neighborhoods and Obesity in Older Adults – The Baltimore Memory Study." *American Journal of Preventive Medicine* 31:455–63.

Gorber, S. C., M. Tremblay, D. Moher, and B. Gorber. 2007. "Diagnostic in Obesity Comorbidities – A Comparison of Direct Vs. Self-report Measures for Assessing Height, Weight and Body Mass Index: a Systematic Review." *Obesity Reviews* 8:307–26.

Gruber, J. and M. Frakes. 2006. "Does Falling Smoking Lead to Rising Obesity?" *Journal of Health Economics* 25:183–97.

Hermstad, A. K., D. W. Swan, M. C. Kegler, J. K. Barnette, and K. Glanz. 2010. "Individual and Environmental Correlates of Dietary Fat Intake in Rural Communities: A Structural Equation Model Analysis." *Social Science & Medicine* 71:93–101.

Hosler, Akiko S. 2009. "Retail Food Availability, Obesity, and Cigarette Smoking in Rural Communities." *Journal of Rural Health* 25:203–10.

Houston, D. K., J. Cai, and J. Stevens. 2009. "Overweight and Obesity in Young and Middle Age and Early Retirement: The ARIC Study." *Obesity* 17:143–9.

Ingelsson, E., L. M. Sullivan, C. S. Fox, J. M. Murabito, E. J. Benjamin, J. F. Polak, J. B. Meigs, M. J. Keyes, C. J. O'Donnell, T. J. Wang, R. B. D'Agostino, P. A. Wolf, and R. S. Vasan. 2007. "Burden and Prognostic Importance of Subclinical Cardiovascular Disease in Overweight and Obese Individuals." *Circulation* 116:375–84.

Jackson, J. E., M. P. Doescher, A. F. Jerant, and L. G. Hart. 2005. "A National Study of Obesity Prevalence and Trends by Type of Rural County." *Journal of Rural Health* 21:140–8.

Kaiser, Betty L. and Linda C. Baumann. 2010. "Perspectives on Healthy Behaviors Among Low-Income Latino and Non-Latino Adults in Two Rural Counties." *Public Health Nursing* 27:528–36.

Kaplan, M. S., N. Huguet, J. T. Newsom, B. H. McFarland, and J. Lindsay. 2003. "Prevalence and Correlates of Overweight and Obesity among Older Adults: Findings from the Canadian National Population Health Survey." *Journals of Gerontology Series A-Biological Sciences and Medical Sciences* 58:1018–30.

Keenan, P. S. 2009. "Smoking and Weight Change After New Health Diagnoses in Older Adults." *Archives of Internal Medicine* 169:237–42.

Kegler, M. C., C. Escoffery, I. Alcantara, D. Ballard, and K. Glanz. 2008. "A Qualitative Examination of Home and Neighborhood Environments for Obesity Prevention in Rural Adults." *International Journal of Behavioral Nutrition and Physical Activity* 5.

Krul, Arno J., Hein A. M. Daanen, and Hyegjoo Choi. 2010. "Self-reported and Measured Weight, Height and Body Mass Index (BMI) in Italy, the Netherlands and North America." *European Journal of Public Health*:1–6.

Lahti-Koski, M., P. Pietinen, M. Heliovaara, and E. Vartiainen. 2002. "Associations of Body Mass Index and Obesity with Physical Activity, Food Choices, Alcohol Intake, and Smoking in the 1982–1997 FINRISK Studies." *American Journal of Clinical Nutrition* 75:809–17.

Larson, N. I., M. T. Story, and M. C. Nelson. 2009. "Neighborhood Environments Disparities in Access to Healthy Foods in the US." *American Journal of Preventive Medicine* 36:74–81.

Larson, Nicole and Mary Story. 2008. "The Adolescent Obesity Epidemic: Why, How Long, and What to Do about It." *Adolescent Medicine: State of the Art Reviews* 19:357–79, vii.

Larson, S. L. and J. A. Fleishman. 2003. "Rural-urban Differences in Usual Source of Care and Ambulatory Service Use – Analyses of National Data Using Urban Influence Codes." *Medical Care* 41:65–74.

Liu, Jihong, Kevin J. Bennett, Nusrat Harun, and Janice C. Probst. 2008. "Urban-rural Differences in Overweight Status and Physical Inactivity among Us Children Aged 10-17 Years." *Journal of Rural Health* 24:407–15.

Longacre, M. R., K. M. Drake, T. A. MacKenzie, L. Gibson, P. Owens, L. J. Titus, M. L. Beach, and M. A. Dalton. 2012. "Fast-Food Environments and Family Fast-Food Intake in Nonmetropolitan Areas." *American Journal of Preventive Medicine* 42:579–87.

Martin, S. L., G. J. Kirkner, K. Mayo, C. E. Matthews, J. L. Durstine, and J. R. Hebert. 2005. "Urban, Rural, and Regional Variations in Physical Activity." *Journal of Rural Health* 21:239–44.

McAuley, P., J. Myers, J. Abella, and V. Froelicher. 2007. "Body Mass, Fitness and Survival in Veteran Patients: Another Obesity Paradox?" *American Journal of Medicine* 120:518–24.

Michimi, Akihiko and Michael C. Wimberly. 2010. "Associations of Supermarket Accessibility with Obesity and Fruit and Vegetable Consumption in the Conterminous United States." *International Journal of Health Geographics* 9.

_____. 2011. "Spatial Patterns of Obesity and Associated Risk Factors in the Conterminous U.S." *American Journal of Preventive Medicine* 39:E1–12.

Mokdad, A. H., B. A. Bowman, E. S. Ford, F. Vinicor, J. S. Marks, and J. P. Koplan. 2001. "The Continuing Epidemics of Obesity and Diabetes in the United States." *JAMA-Journal of the American Medical Association* 286:1195–200.

Mokdad, A. H., E. S. Ford, B. A. Bowman, W. H. Dietz, F. Vinicor, V. S. Bales, and J. S. Marks. 2003. "Prevalence of Obesity, Diabetes, and Obesity-related Health Risk Factors, 2001." *JAMA-Journal of the American Medical Association* 289:76–9.

Must, A., J. Spadano, E. H. Coakley, A. E. Field, G. Colditz, and W. H. Dietz. 1999. "The Disease Burden Associated with Overweight and Obesity." *JAMA-Journal of the American Medical Association* 282:1523–9.

Narayan, K. M. V., J. P. Boyle, T. J. Thompson, E. W. Gregg, and D. F. Williamson. 2007. "Effect of BMI on Lifetime Risk for Diabetes in the US." *Diabetes Care* 30:1562–6.

National Center for Health Statistics. 2009. *Health, United States, 2008 with Chartbook*. Hyattsville, MD: U.S. Department of Health and Human Services.

Nonnemaker, J., E. Finkelstein, M. Engelen, T. Hoerger, and M. Farrelly. 2009. "Have Efforts to Reduce Smoking Really Contributed to the Obesity Epidemic?" *Economic Inquiry* 47:366–76.

Ogden, C. and M.D. Carroll. 2010. "Prevalence of Overweight, Obesity, and Extreme Obesity among Adults: United States, Trends 1960–1962 through 2007–2008." National Center for Health Statistics.

Ogden, C. L., M. D. Carroll, L. R. Curtin, M. A. McDowell, C. J. Tabak, and K. M. Flegal. 2006. "Prevalence of Overweight and Obesity in the United States, 1999–2004." *JAMA-Journal of the American Medical Association* 295:1549–55.

Ogden, C.L., M.D. Carroll, M.A. McDowell, and K.M. Flegal. 2007. "Obesity Among Adults in the United States—No Statistically Significant Change Since 2003–2004." NCHS.

Osuji, Thearis, Sarah Lovegreen, Michael Elliott, and Ross C. Brownson. 2006. "Barriers to Physical Activity among Women in the Rural Midwest." *Women and Health* 44:41–55.

Parks, S. E., R. A. Housemann, and R. C. Brownson. 2003. "Differential Correlates of Physical Activity in Urban and Rural Adults of Various Socioeconomic

Backgrounds in the United States." *Journal of Epidemiology and Community Health* 57:29–35.

Patterson, P. D., C. G. Moore, J. C. Probst, and J. A. Shinogle. 2004. "Obesity and Physical Inactivity in Rural America." *Journal of Rural Health* 20:151–9.

Pearson, T.A. 2007. "The Prevention of Cardiovascular Disease: Have We Really Made Progress?" *Health Affairs* 26:49–60.

Pucher, J. and J. L. Renne. 2005. "Rural Mobility and Mode Choice: Evidence from the 2001 National Household Travel Survey." *Transportation* 32:165–86.

Richards, Nathan G., Alec C. Beekley, and David S. Tichansky. 2011. "The Economic Costs of Obesity and the Impact of Bariatric Surgery." *Surgical Clinics of North America* 91:1173–.

Sayon-Orea, C., M. A. Martinez-Gonzalez, and M. Bes-Rastrollo. 2011. "Alcohol Consumption and Body Weight: A Systematic Review." *Nutrition Reviews* 69:419–31.

Schwartz, Frank, Anirundth Ruhil, Sharon Denham, Jay Shubrook, Chris Simpson, and Sara L. Boyd. 2009. "High Self-Reported Prevalence of Diabetes Mellitus, Heart Disease, and Stroke in 11 Counties of Rural Appalachian Ohio." *Journal of Rural Health* 25:226–30.

Shi, L. and G.D. Stevens. 2010. *Vulnerable Populations in the United States*. San Fransisco: Jossey-Bass.

Sparks, P. Johnelle and Mary Bollinger. 2011. "A Demographic Profile of Obesity in the Adult and Veteran US Populations in 2008." *Population Research and Policy Review* 30:211–33.

Tsai, A. G., D. F. Williamson, and H. A. Glick. 2011. "Direct Medical Cost of Overweight and Obesity in the USA: A Quantitative Systematic Review." *Obesity Reviews* 12:50–61.

Wilcox, S., C. Castro, A. C. King, R. Housemann, and R. C. Brownson. 2000. "Determinants of Leisure Time Physical Activity in Rural Compared with Urban Older and Ethnically Diverse Women in the United States." *Journal of Epidemiology and Community Health* 54:667–72.