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Residency and Racial/Ethnic Differences in Weight Status and Lifestyle Behaviors Among US Youth

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Abstract

Purpose—Elevated risk for obesity is found in rural environments and in some minority populations. It is unclear whether living in rural or nonmetropolitan areas and being a minority compound the risk of obesity beyond that of either factor acting alone. Our purpose was to examine adolescent obesity in light of the potential concomitant influences of race/ethnicity, residency, and obesity-related lifestyle behaviors.

Methods—We assessed obesity prevalence, physical activity, consumption of fatty snack foods, and screen time in 8,363 US adolescents based on variation in race/ethnicity and residency. Descriptive, bivariate, and multivariate statistics were used to: (1) calculate race- and residency-based rates of obesity and obesity-related lifestyle behaviors and (2) generate race- and residency-based obesity odds ratios as a function of those same behaviors.

Findings—The results indicated that nonmetropolitan black youth had the highest risk of obesity (26%), rate of consuming fatty snack foods on more than 2 days/week (86%), and rate of spending more than 2 hours/day in screen time (91%) compared to white metropolitan youth. Compared to their metropolitan counterparts, black nonmetropolitan youth had greater odds of being obese if they exercised less than daily (1.71 times), ate fatty snack foods on more than 2 days/week (1.65 times), or spent more than 2 hours/day in screen time (1.64 times).

Conclusions—Race/ethnicity and residency may have a compounding effect on the risk of obesity. Prevention and intervention must be viewed in a socioecological framework that recognizes the importance of culture and community on obesity-related behaviors.

Keywords

adolescent obesity; obesogenic eating; physical activity; racial/ethnic disparity; sedentary behavior

Obesity is a serious public health problem facing the youth of America, with rates having more than tripled in the past 30 years among children aged 12 to 17 years old. Obese

adolescents are at higher risk in their adult years for obesity and associated health problems, such as cardiovascular disease and diabetes.^{1,2} While the rise in obesity may be “leveling off” in some countries including the United States, there continue to be historically high rates of obesity and an urgent need to understand its determinants and potential areas for intervention, particularly for some subpopulations at greatest risk.^{3–5}

Both residency and race/ethnicity are potential risk factors for obesity and cardiovascular disease that have been investigated individually, but rarely in conjunction with each other.^{6–15} However, some reports suggest that rural minorities have the highest rates of reported hypertension and overweight/obesity. Furthermore, nonmetropolitan minorities are the least likely to report meeting the vigorous physical activity recommendations of the Centers for Disease Control and Prevention.¹⁶ A finding of compounded risk has been reported for rural blacks who were at greater odds of having diabetes and hypertension than urban or rural whites or urban blacks.¹⁷

Though these reports relate to rural minority adults, there is evidence that elevated obesity risk is also reflected in rural minority children and adolescents over and above those found for their urban counterparts. Crude prevalence rates for children 10–17 years of age from the National Survey of Children’s Health (NSCH) 2007 indicated that urban children of non-Hispanic black race were more likely to be obese than urban white youth and that obesity risk differences were even greater for their rural counterparts.¹⁸ Thus, it may be that living in rural areas and being a racial/ethnic minority lead to a compounded risk of obesity beyond that of either factor acting alone.

It has been stated that rural racial/ethnic minorities constitute a forgotten population and that priority should be given to routine tracking/monitoring data for this population as an important step toward improving the health and welfare of rural America.¹⁹ Since adult obesity has its roots in child/adolescent obesity and the triad of conditions (obesity, hypertension, and diabetes) have common roots in poor diet, limited exercise, and sedentary activities, we have chosen to examine the prevalence of obesity and these 3 lifestyle behaviors in metropolitan versus nonmetropolitan (hereafter, referred to as metro and nonmetro) US children and adolescents.^{1,2,20–22} Effectively addressing racial/ethnic disparities in obesity requires understanding which factors are more prevalent or intensified in racial/ethnic minorities and how environments of minority children might magnify the effects of factors that lead to obesity.²³ Therefore, the primary objectives of this study were to: (1) examine the potential concomitant influences of race/ethnicity and place of residency (metro/nonmetro) on the prevalence of youth obesity and (2) determine significant differences in selected behavioral variables such as physical activity, consumption of fatty snack foods, and screen time (ie, electronic media) that may be associated with racial/ethnic and residency differences in youth obesity. It was hypothesized that: (1) nonmetro Hispanic and black youth would evidence greater obesity than metro white youth as well as their metro minority counterparts and (2) racial/ethnic differences in the selected lifestyle behaviors align with differences in obesity across race/ethnicity and metro/nonmetro residency.

Methods

The US Health Behavior in School-Aged Children (HBSC) survey, a World Health Organization cross-national study, was conducted in a nationally representative sample of US students in grades 6–10 during the 2005–2006 school years. This study constitutes a secondary data analysis. Sampling used a 3-stage stratified design, with census regions and grades as strata, and school districts as primary sampling units. An oversample of black and Hispanic students was surveyed to provide more accurate population estimates for these students. Procedures were designed to ensure the participants' anonymity. Active or passive parental consent and student assent were obtained depending on the requirements of the local school district. Home-schooled children were not included in this survey. All procedures were approved by the Institutional Review Board of the Eunice Kennedy Shriver National Institute of Child Health and Human Development.

Dependent Variable

Self-reported age (years and months) and self-reported height and weight were used to calculate BMI-for-age percentiles for each gender using the CDC 2000 growth chart. Weight-status-for-age categories (obese vs nonobese) were created from the BMI-for-age percentiles, with obesity defined as ≥95 percentile in BMI-for-age.²⁴

Independent Variables

Sociodemographic—Sociodemographic variables used in these analyses as independent/control factors or covariates included the following: gender (male, female); age (<12, 12–14, and >14 years of age); race/ethnicity (white, black, Hispanic, and other); metropolitan status (metro and nonmetro); family composition (single parent, 2 parent, and other family constellation); a quality-of-life index (overall physical, emotional, and school functioning on a quartile scale); and the HBSC Family Affluence Scale (FAS; low, mid, high affluence). The quality-of-life index is the mean of subindices (yes = 1, no = 0) that are based on student response to questions regarding emotional status (sad, irritable, hopeless, appetite, sleep, or concentration difficulties); physical functioning (headache, stomachache, backache, bad temper, nervous, or dizzy); and school functioning (positive attitude toward fellow students, acceptance by fellow students, and perception of schoolwork pressure).^{25,26} The FAS has been shown to be a valid indicator of family socioeconomic status (SES) and is well-suited for obtaining this information when surveying adolescents.²⁷ The index is a scale composed of 4 items: whether the family owned a car, van, or truck (no, 1, 2, or more); whether the student has his/her own bedroom (yes, no); how many times the student traveled on vacation with his/her family in the past 12 months (none, once, twice, more than twice); and the number of computers owned by the family (none, 1, 2, more than 2).

Activity and Diet—Lifestyle behaviors included in these analyses as explanatory variables included student reported: (1) days/week of being physically active, (2) days/week of fatty snack food consumption, and (3) hours/day screen time. The reliability and validity of the questions regarding physical activity, food frequency, and screen time have been shown elsewhere.^{28–30}

For the questions on physical activity, an accompanying explanation defined physical activity as any activity that increases the heart rate and produces breathlessness some of the time (eg, running, brisk walking, rollerblading, biking, dancing, skateboarding, swimming, soccer, basketball, football, and surfing). Students reported the number of days (0–7) in the past week that they were physically active for a total of at least 60 minutes per day. Mean days/week of at least 60 minutes of physical activity were calculated for racial/ethnic and metro versus nonmetro comparisons. For prevalence estimates and logistic regression analysis, physical activity was dichotomized into: (1) daily physical activity for at least 60 minutes per day and (2) less than daily physical activity for at least 60 minutes per day based on the American Academy of Pediatrics recommendation for children 11–21 years of age.³¹

Calculation of screen time was based on questions regarding the hours/day usually spent watching television (including videos and DVDs); using a computer for chatting online, Internet, e-mailing, homework, etc., during free time; and playing games on a computer or game console (Playstation, Xbox, GameCube, etc.) during free time. A screen time index for each student was derived by multiplying the number of hours per weekday by 5 for each of the 3 screen-based activities, multiplying the number of hours/day reported for weekends by 2, adding those totals, and dividing by 7 to derive the mean hours/day for the activities combined. For prevalence estimates and logistic regression analysis, screen time was dichotomized into: (1) 2 or less mean hours/day and (2) more than 2 mean hours/day of total screen time (ie, the 3 screen-based activities combined) based on the American Academy of Pediatrics recommendation of limiting total media time to 2 or less hours/day.³²

In contrast to the guidelines described above, nutrition guidelines are considerably more general and focused less on consumption of specific foods and more on broad nutritional categories (eg, carbohydrates, fats, proteins) or nutritional subcategories (eg, grains, lentils, dairy products, fruits/vegetables).³³ The HBSC dietary questions target specific types of foods such as days/week consumption of white bread, brown bread, and cereals (eg, Corn Flakes, Rice Krispies, and Cocoa Krispies); low-fat and whole milk, other milk products (eg, yogurt, chocolate milk, and pudding), cheese; sugar-sweetened soft drinks and sweets (eg, candy and chocolate); fruits and vegetables; and high-calorie fatty snack foods such as french fries and chips (eg, Doritos, Fritos, and potato chips/sticks).

For several reasons, it was hypothesized that these latter foods (french fries and chips) were the likeliest of those surveyed in HBSC 2005–2006 to be associated with obesity and possible racial/ethnic variation in consumption and were therefore included in the analyses. It has been documented that 45% of the calories in these foods are derived from fat, which has more than twice the number of calories per gram compared to carbohydrates and proteins.³³ Adolescents 12–18 years of age and those at risk for obesity or obese are the most likely to consume these “energy-dense vegetables.”³⁴ In addition, a recent study indicated french fries and chips had the largest positive independent association with weight changes per serving per day compared to other foods, including desserts and sweetened beverages.³⁵ For this analysis, the days/week of consuming each of the foods was added together and an average derived for comparison across racial/ethnic and metro versus nonmetro categories in the same manner as physical activity and screen time. For prevalence estimates and logistic regression analysis, fatty snack food consumption was dichotomized

into: (1) 2 or less days/week and (2) more than 2 days/week. Lacking a specific recommended nutritional guideline other than to limit consumption of these foods, this cut point was chosen so as to ensure a minimum cell size for testing differences (~30).³⁶

Residency—The HBSC student survey was anonymous; therefore, home addresses of respondents could not be used to provide information about individual respondents' neighborhoods. Consequently, metro status was determined based on the location of the school, which was used as a proxy for the home neighborhoods of all students at that school. The metro status variable was based on the National Center for Education Statistics (NCES) Common Core Data coding system. A dichotomized metro statistical area versus nonmetro statistical area contrast was used because it was the only consistent residency contrast across the NCES and the more commonly used Rural Urban Commuting Area (RUCA) codes.

Analysis Plan

Descriptive statistics were generated for race/ethnicity, gender, age, family affluence, family composition, and overall functioning to examine the sample distribution across residency status (Table 1). Statistical comparisons (chi-square) were made for crude obesity prevalence as a function of metro versus nonmetro status and sociodemographic factors (Table 2). Age- and covariate-adjusted prevalence of less than daily physical activity, more than 2 days/week of fatty snack food consumption, and more than 2 hours/day of screen time were obtained as predicted marginals via separate logistic regression models (Table 3). Covariate adjustment included the variables family composition, family affluence, gender, and overall physical, emotional, and school functioning in addition to age. Chi-square tests were conducted to determine overall differences in obesity and lifestyle behavior prevalences as a function of race/ethnicity and metro status. Bonferroni-adjusted *P* levels were used to judge significance following the aforementioned tests. Race-stratified logistic regression analyses were performed to obtain odds ratios for obesity in racial/ethnic subpopulations residing in nonmetro versus metro areas as a function of less than daily physical activity, more than 2 days/week of fatty snack food consumption, and more than 2 hours/day of screen time, adjusting for all sociodemographic factors as well as lifestyle variables (Table 4). Various measures of multicollinearity among the independent variables were within acceptable limits (VIF <1.2, Condition Index <1.7, and *r* <0.30). The SU-DAAN 10.0.1 software tool (RTI International, Research Triangle Park, North Carolina) was used to adjust for the survey design including stratification, clustering, and weighting.

Results

Of the 9,227 adolescents who completed the US 2005–2006 HBSC survey (response rate = 87%), 49.2% were boys and 50.8% were girls (mean age = 14.1 years), 40.2% were white, 19.1% were black, 27.6% were Hispanic, and 13.0% were of other races (Table 1); While age and race differed somewhat across nonmetro versus metro residency in the overall 2005–2006 HBSC sample, the 2 subsamples were comparable with respect to gender, family affluence, family composition, and overall student functioning. For this analysis, 864 (8.9%) were excluded due to missing weight/height data resulting in a total usable sample of 8,363

cases. For this sample, family composition in addition to age and race/ethnicity distributions differed between the metro and nonmetro sub-samples.

Crude Rates

While crude obesity prevalence in the total 2005–2006 sample did not differ significantly based on metro versus nonmetro residency, significant variation was generally noted in the sample as a whole and/or within metro and nonmetro subsamples based on race, gender, age, family affluence, family composition, and overall functioning (Table 2). The exceptions were a lack of significant difference in obesity as a function of age in the metro ($P = .05$) and nonmetro ($P = .41$) subsamples or family affluence in the nonmetro ($P = .05$) subsample after Bonferroni adjustment for post hoc testing. Crude rates of less than daily physical activity, more than 2 days/week of fatty snack food consumption, and more than 2 hours/day of screen time did not differ on the basis of metro versus nonmetro residency (data not shown).

Age- and Covariate-Adjusted Obesity and Lifestyle Behavior Prevalences

Table 3 presents comparisons of age- and covariate-adjusted obesity prevalence and lifestyle behavior prevalences by race-ethnicity and metro versus nonmetro status. Included are P values for the results of chi-square tests to determine differences as a function of race/ethnicity and metropolitan status. For tests that proved significant, 6 post hoc tests (Bonferroni-adjusted $P < .008$) were conducted to compare rates for the following subpopulations: white metro versus black metro, white metro versus black nonmetro, black metro versus black nonmetro, white metro versus Hispanic metro, white metro versus Hispanic nonmetro, and Hispanic metro versus Hispanic nonmetro. The purpose of these particular post hoc comparisons was to test our hypotheses that: (1) nonmetro Hispanic and black youth would evidence greater obesity than metro white youth as well as their metro minority counterparts and (2) racial/ethnic differences in the selected lifestyle behaviors would align with differences in obesity across race/ethnicity and metro/nonmetro residency.

Significant differences in estimated age-adjusted obesity rates (predicted marginals) were noted as a function of race/ethnicity and metro/nonmetro status (upper section Table 3) after adjustment for multiple tests. The estimated difference in obesity prevalence rates between white and black metro adolescents was -0.07 or 7 percentage points ($P = .0012$, blacks significantly higher than whites), -0.15 or 15 percentage points between white metro and black nonmetro adolescents ($P < .0001$, blacks significantly higher than whites), and 0.09 or 9 percentage points between black nonmetro and black metro adolescents ($P = .006$, black nonmetro significantly higher than black metro). In addition, estimated obesity rate differences were -0.08 or 8 percentage points between white and Hispanic metro adolescents ($P = .0001$, Hispanics higher than whites) and the same amount between white metro and Hispanic nonmetro adolescents ($P = .0019$).

Overall, chi-square tests for age-adjusted lifestyle behavior rates (middle section Table 3) for all 3 behaviors (less than daily physical activity, >2 days/week of fatty snack food consumption, and >2 hours/day of screen time) as a function of race/ethnicity and metro/nonmetro status were each statistically significant ($P > .05$). Post hoc testing (Bonferroni-

adjusted) indicated that the estimated difference in the rate of less than daily physical activity was -0.08 or 8 percentage points between white and Hispanic metro adolescents ($P = .0003$, Hispanic more likely than white). The estimated difference in the rate of eating fatty snack foods on more than 2 days/week was -0.13 or 13 percentage points between white and black metro adolescents ($P < .0001$, black more likely than white) and -0.18 or 18 percentage points between white metro and black nonmetro adolescents ($P < .0001$, black nonmetro more likely than white metro). White metro adolescents were also less likely to engage in more than 2 hours/day of screen time than black metro adolescents (-0.13 or 13 percentage points; $P = .0001$), black nonmetro adolescents (-0.11 or 11 percentage points; $P = .0001$), and Hispanic metro adolescents (-0.05 or 5 percentage points; $P = .0062$).

Scant differences were found for the covariate-adjusted obesity and lifestyle behavior prevalences compared to the age-adjusted rates. After adjusting for all covariates, black metro adolescents were no longer significantly different in obesity prevalence compared to white metro adolescents, and Hispanic metro adolescents were no longer different in physical activity levels from white metro adolescents.

Obesity as a Function of Lifestyle Behaviors

Significant odds of obesity as a function of nonmetro versus metro residence and lifestyle behaviors are shown in race-stratified logistic regression models, adjusted for sociodemographic factors and lifestyle behaviors (Table 4). Significant odds of increased obesity were consistently found for black adolescents in nonmetro versus metro areas based on variation in levels of physical activity, fatty snack food consumption, and screen time. Higher levels of screen time and fatty snack food consumption and lower levels of physical activity were each associated with higher odds of obesity among black adolescents in non-metro versus metro areas. The odds of obesity in non-metro black adolescents who exercised less than daily for 60 minutes per day were approximately 70% higher than metro blacks who also did not exercise daily for at least 60 minutes, with other lifestyle (ie, fatty snack food consumption, screen time) and sociodemographic variables being held constant. Nonmetro black adolescents who consumed fatty snack foods more than 2 days/week had 65% greater odds of being obese than their metro counterparts. Similarly, nonmetro black adolescents with more than 2 hours/day of screen time had approximately 65% greater odds of being obese than black adolescents in metro areas with more than 2 hours/day screen time. The same type of nonmetro versus metro differences were not obtained for white and Hispanic adolescents or adolescents of other race/ethnicities.

Discussion

We have shown that differences exist in obesity prevalence across youth of varying race/ethnicity living in non-metro versus metro environments. Differences in rates of consuming fatty snack foods and screen time, but not physical activity, generally aligned with the obesity rates in black adolescents. Among nonmetro black youth in particular, covariate-adjusted analyses (Table 3) indicated greater obesity prevalence compared to their metro black counterparts and, to an even greater extent, metro white youth. Directly comparable analyses are not available; however, 2 sources for nationally representative data on obesity

in age groups comparable to our study population are the NSCH and the National Health and Nutrition Examination Survey (NHANES). Relative to the former (NSCH), one racial/ethnic by rural/urban analysis (equivalent to our metro vs nonmetro categorization) reported overall higher parent-reported obesity (in 2008 referred to as overweight) rates than the self-reported rates presented here, but with similar patterns of racial/ethnic variation.¹⁸ That is, the lowest rates in both rural and urban settings were associated with white youth and youth of “other” races while higher rates were associated with Hispanic and black youth, with a markedly high rate (nearly identical to that found here) among black youth in rural areas. That study reported on physical activity for rural versus urban populations and for the different racial/ethnic subpopulations; however, an analysis similar to our residency $\times$ race/ethnicity analysis was not included. It was determined that, overall, rural 10- to 17-year olds were less active than their urban counterparts, but only Hispanic youth were more physically inactive than white youth.

Another analysis using a nationally representative dataset (NHANES 2003–2004 and 2005–2006) reported on a wider age range than the one reported here.³⁷ That analysis reported on a similar set of obesity-related behaviors as well as obesity as a function of rural versus urban status, but it did not present those behaviors in the context of a residency $\times$ race/ethnicity analysis. While we found black youth in both metro and nonmetro areas had higher adjusted and unadjusted risk of obesity than white youth, the NHANES analysis indicated black youth had greater odds of being obese compared to white youth in urban, but not rural areas. Differences such as methods of data collection and analysis may account for the lack of agreement. Similar to our findings, however, the NHANES study found no overall urban-rural differences in mean intake of fried foods and frequency of meeting physical activity recommendations or electronic media use.

The relative patterns of some lifestyle behaviors cited here may provide some insight into the corresponding patterns of obesity prevalence reported in this study, at least for black youth (Table 3). Compared to white metro youth, metro black youth exhibited higher covariate-adjusted rates of fatty snack food consumption and screen time, possibly accounting at least to some extent for statistically higher concomitant rates of obesity. Black non-metro youth, though not statistically higher in the rate of fatty snack food consumption and screen time compared to their black metro counterparts, did evidence greater differences compared to white metro youth than did the black metro youth. Such differences may have led to obesity rates that were trending higher than the already elevated rates of their metro counterparts. In contrast, youth of “other” races had levels of obesity prevalence that were statistically similar to white youth (metro and nonmetro) possibly because they had no differences in lifestyle behavioral risk factors compared to white youth. Furthermore, the odds ratios obtained from multiple logistic regression analyses (adjusting for not only all covariates, but also lifestyle behaviors) indicated that for black youth the higher risk of obesity may be equally modifiable by reducing fatty snack food and screen time as well as increasing physical activity to recommended levels. In the case of black youth, it appeared that greater numbers and degree of risk factors co-occurred with higher rates of obesity prevalence and each may be modifiable sources of reducing obesity for black youth. A puzzling and difficult finding to explain was that while nonmetro Hispanic youth evidenced higher obesity rates than white metro youth, rates of physical activity, fatty snack food

consumption, and screen time were similar. This is a possible indication of a greater degree of variability in the Hispanic population or the influence of factors not included in this analysis.

The findings presented here suggest the importance of investigating how these 3 lifestyle behaviors interact in various cultures and environments to determine what will constitute the most effective strategies for prevention and treatment. Cultural and racial/ethnic differences (independent from sociodemographics such as region of residency, income, educational status, and household composition as shown here and elsewhere) may have influences on habits and beliefs about healthy weight and body image ideals that may contribute to the differences in observed obesity levels and may necessitate culturally relevant treatment approaches.^{38–41} The recommendations of the National Institutes of Health's Working Group on Future Research Directions in Childhood Obesity Prevention and Treatment include: (1) testing the effects of having single and multiple behavioral targets (eg, dietary interventions with and without modifications of physical activity and/or sedentary behavior), (2) investigating multilevel interventions targeting minority and low-income populations (eg, culturally appropriate ways to reach Latino, black, Native American, Asian, and Pacific Islanders), and (3) identifying environmental and policy determinants of weight gain.⁴²

Future studies into the determinants of the disparities observed in this study will most certainly require determining how race/ethnicity and residency might interact to compound obesity prevalences in multilevel studies. One factor not often considered is residential segregation. While controlling for neighborhood SES is important, it has been suggested that residential segregation may be a stronger determinant of health disparities given that such segregation explains variance in health differences after neighborhood SES is taken into account.⁴³ Recent data indicate that while residential segregation has been somewhat reduced in metropolitan areas since the 1990s, historical patterns of residential neighborhood segregation are now being reproduced in nonmetropolitan areas.⁴⁴ Although most immigrant groups have experienced some residential segregation in the United States, current measures indicate that blacks experience the highest levels of residential segregation.^{45,46} Though studies are limited, 2 studies based on nationally representative data have found significant associations between BMI and segregation.^{47,48} Ignoring contextual differences conditioned by residential segregation may lead to misestimation of the effect of other factors mediated by neighborhoods.^{49,50}

Being overweight may be viewed as a cultural norm and more socially acceptable in areas of high black concentration, leading to higher obesity rates. A closely circumscribed community may ingrain negative habits, but it can also be the strongest resource for mutual support to its members in the service of driving changed attitudes and behaviors. Influential community leaders such as church leaders have been engaged to assist in implementing community-based weight loss and physical activity intervention centered on black women in church groups.⁵¹ For adolescents, a comprehensive community-based program may involve different emphases such as sports activities, dances, healthy food cooking classes, etc. However, such efforts must be accompanied by strong efforts on the part of community leaders to alter the landscape of the community (eg, by attracting food retailers to locate in or offer healthier food and beverage choices to underserved areas) and to form coalitions or

partnerships aimed at environmental and policy changes promoting active living and healthy eating.⁵²

Schools can be effective partners in a multilevel integrated effort to combat youth obesity by developing an environment that is conducive to healthful eating and physical activity.⁵³ Many schools, especially secondary schools and schools in rural areas, allow students to buy “competitive foods” (foods sold outside of federally reimbursed school meals). Some studies have related the availability of “energy-dense” foods to students’ high intake of total calories, soft drinks, total fat and saturated fat, and lower intake of fruits and vegetables.⁵⁴ A “whole school approach” (ie, children, parents, and all staff including food services) as adopted in combating tobacco use among youth would serve to exemplify healthy practice.⁵³ However, further work needs to be done regarding effective school-based approaches to obesity prevention.⁵¹

The strengths of this study include: (1) the use of a nationally representative sample of US adolescents; (2) the inclusion of several obesity-related indices that take into account multiple measures of physical activity, consuming fatty snack foods, and screen time; and (3) the combined effects of race/ethnicity and place of residency on the prevalence of obesity and patterns of behaviors that influence weight gain. However, some limitations must be noted. The cross-sectional nature of the data imposes limits on the ability to discern any causal relationship between obesity and the various related behaviors (ie, physical activity, snack food consumption, and screen time) included in this analysis. Additionally, a dichotomized metropolitan versus nonmetropolitan status variable is only a rough approximation of urban/rural status and using school as a proxy for neighborhood has limitations, particularly in light of school busing. Future research would benefit from prospective, longitudinal data collection and delineation of finer urban/rural gradations (eg, including micropolitan and remote rural categories) based on RUCA codes.

Finally, estimates of obesity are based on self-reported age, heights, and weights for the computation of BMI for age. The accuracy of adolescent self-report of height and weight for assessment of overweight status has been questioned. Among adolescents in general, weight is under-reported by both males and females and overweight or obese black youth may be more likely than other race/ethnicities to under-report.^{54,55} While this would potentially mean that the findings reported here underestimated the prevalence of obesity, it would only serve to reinforce the conclusion that special attention should be given to treating minority youth and those residing in areas that have fewer resources to combat the especially steep rise in youth obesity in these subpopulations. While anthropomorphic measurement and direct observation are the preferred method of obtaining body mass index measurements, the wide variety of relevant variables available in this survey make it a valuable contribution to the perspective on weight status, race/ethnicity, and residency.

The implications to be wrought from the above discussion, in addition to the considerable body of literature on obesity, are that race/ethnicity and place of residency (ie, environment) may have a compounding effect on obesity prevalence, but that the dynamic interaction among these and other factors may be characterized by considerable complexity. Attempts to alter individual behaviors must incorporate the broader social and environmental context

as influences on individual behavior patterns. However, challenges in synthesizing research and designing multilevel interventions (individual, family, community, state and local policy) lie ahead as no clear consensus on effective policy or programmatic strategies currently exists.^{56–58} Emphasis should be placed on community-based research and intervention to identify key behavioral, cultural, policy, and environmental determinants of rising youth obesity and to find effective and sustainable policy and environmental solutions, with a special focus on the populations and communities at highest risk.⁵⁰ A public health framework of “cultural competence” and avoidance of a “one-size-fits-all” approach will be required to address the sociocultural variation in attitudes and behaviors as well as historical, physical, economic, and policy environments in which various subpopulations operate.^{23,59,60}

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Table 1

Sample Characteristics by Selected Sociodemographic Factors Among US Youth in Grades 6–10 in Metropolitan Versus Nonmetropolitan Areas: Health Behaviors in School-Aged Children, 2005–2006

Sociodemographic Characteristics	Total			Metropolitan			Nonmetropolitan			P
	N	Weighted %	SE	N	Weighted %	SE	N	Weighted %	SE	
Total	9,227			6,564	71.7	3.85	2,663	28.4	3.85	
Race/ethnicity										<.01
White	3,974	40.2	2.85	2,500	36.6	3.17	1,474	49.1	5.73	
Black	1,824	19.1	2.32	1,439	22.3	2.93	385	11.3	2.40	
Hispanic	2,339	27.6	2.37	1,917	30.6	2.69	422	20.2	4.55	
Other	1,021	13.0	1.39	658	10.5	0.65	363	19.4	4.29	
Gender										n.s.
Male	4,456	49.2	0.85	3,149	49.2	1.00	1,307	49.0	1.57	
Female	4,742	50.8	0.85	3,390	50.8	1.00	1,352	51.0	1.57	
Age										<.05
<12	989	8.4	0.87	811	9.9	1.30	178	4.4	1.37	
12–14	4,060	40.0	2.32	2,825	38.5	3.21	1,235	44.0	5.31	
>14	4,052	51.6	2.56	2,840	51.6	3.70	1,212	51.6	5.55	
FAS										n.s.
Low	2,475	27.6	1.32	1,825	28.8	1.60	650	24.6	2.26	
Medium	4,485	48.7	0.87	3,138	47.8	0.98	1,347	50.9	1.75	
High	2,173	23.7	1.27	1,529	23.5	1.42	644	24.5	2.70	
Family composition										n.s.
Single parent	2,432	26.4	1.16	1,779	27.4	1.48	653	24.1	1.52	
Two parent	6,308	68.4	1.42	4,448	67.6	1.80	1,860	70.4	1.94	
Other	487	5.2	0.44	337	5.1	0.55	150	5.6	0.76	
Overall functioning, quality of life										n.s.
1st quartile—lowest	2,282	24.2	0.94	1,605	24.7	1.18	677	23.1	1.43	
2nd quartile	2,297	25.6	0.60	1,653	25.4	0.71	644	26.3	1.12	
3rd quartile	2,282	25.0	0.62	1,612	25.0	0.73	670	24.9	1.15	
4th quartile—highest	2,297	25.2	0.95	1,636	24.9	1.14	661	25.8	1.75	

SE, standard error; n.s., not significant; FAS, Family Affluence Scale.

Chi-square tests were used to test differences. $P < .05$.

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Table 2

Crude Obesity Rates as a Function of Selected Covariates Among US Youth in Grades 6–10 in Metropolitan Versus Nonmetropolitan Areas: Health Behaviors in School-Aged Children, 2005–2006

Covariates	Obesity Prevalence ^d								p
	Metropolitan				Nonmetropolitan				
	N	Weighted %	SE		N	Weighted %	SE		
Total	823		13.7	0.65	354		13.5	1.30	n.s.
Race/ethnicity									<.001
White	238		9.7	0.90	157		9.0	1.24	
Black	215		16.4	1.61	84		26.1	2.59	
Hispanic	291		17.7	1.03	71		18.3	2.61	
Other	79		12.2	1.52	42		12.8	2.72	
Gender									<.001
Male	451		15.2	0.82	207		16.0	1.64	
Female	374		12.2	0.84	149		11.0	1.46	
Age									<.05
<12	113		17.7	1.59	27		17.9	4.64	
12–14	339		13.4	0.96	143		12.4	1.31	
>14	358		13.0	0.92	180		13.6	1.89	
FAS									<.001
Low	289		19.5	1.29	110		15.5	2.20	
Medium	397		13.1	0.88	190		14.9	1.62	
High	135		8.6	0.88	53		8.8	2.15	
Family composition									<.001
Single parent	266		17.8	1.38	110		17.0	2.04	
Two parent	513		11.9	0.80	212		11.4	1.19	
Other	46		16.4	2.94	34		25.3	3.90	
Overall functioning, quality of life									<.001
1st quartile—lowest functioning	281		18.0	1.45	127		19.6	2.52	
2nd quartile	249		15.4	1.45	103		16.2	2.22	
3rd quartile	172		12.7	1.10	68		10.0	1.67	

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Covariates	Obesity Prevalence ^a					
	Metropolitan			Nonmetropolitan		
	N	Weighted %	SE	N	Weighted %	p
4th quartile—highest functioning	119	8.7	0.87	58	9.0	1.58

SE, standard error; n.s., not significant; FAS, Family Affluence Scale.

^a Obesity was defined as 95 BMI-for-age percentile based on CDC's 2000 growth charts for males and females.

Chi-square tests were used to test differences. *P* < .05.

Table 3

Age- and Covariate-Adjusted Rates of Obesity, Physical Activity, Fatty Snack Food Consumption, and Screen Time Based on Race/Ethnicity and Metropolitan Versus Nonmetropolitan Residency Among US Youth in Grades 6–10: Health Behaviors in School-Aged Children, 2005

Lifestyle Behaviors	Metro White	Metro Black	Metro Hispanic	Metro Other	Nonmetro White	Nonmetro Black	Nonmetro Hispanic	Nonmetro Other	Overall <i>P</i>
Age-adjusted obesity (% , SE)	9.6 (0.09)	16.0 (1.66) ^a	17.4 (1.02) ^a	12.2 (1.53)	9.0 (1.27)	25.6 (2.68) ^{a,b}	17.7 (2.45) ^a	12.9 (2.72)	<.001
Covariate-adjusted obesity (% , SE)	10.5 (0.09)	15.1 (1.58)	16.3 (1.05) ^a	11.7 (1.50)	9.7 (1.21)	24.1 (2.65) ^{a,b}	17.1 (2.44) ^a	13.2 (2.69)	<.001
Age-adjusted lifestyle behavior prevalences									
Physical activity (% , SE)									
Less than daily	59.8 (1.92)	63.9 (1.18)	67.7 (1.47) ^a	68.0 (2.65)	61.1 (5.55)	64.1 (3.88)	64.0 (4.38)	62.7 (4.10)	<.001
Fatty snack food consumption (% , SE)									
More than 2 days/week	67.5 (1.30)	80.2 (2.04) ^a	67.6 (1.43)	63.3 (3.10)	66.9 (2.34)	85.7 (1.98) ^a	66.3 (3.32)	68.2 (3.40)	<.001
Screen time (% , SE)									
More than 2 hours/day	79.7 (1.69)	92.4 (1.25) ^a	84.6 (0.86) ^a	86.1 (2.19)	79.8 (1.85)	91.2 (1.57) ^a	82.6 (1.99)	83.8 (1.89)	<.001
Covariate-adjusted lifestyle behavior prevalences									
Physical activity (% , SE)									
Less than daily	61.6 (1.77)	63.6 (1.30)	66.0 (1.54)	67.8 (2.70)	62.3 (4.86)	62.6 (3.97)	62.5 (4.41)	62.0 (3.71)	<.001
Fatty snack food consumption (% , SE)									
More than 2 days/week	68.6 (1.31)	79.5 (2.07) ^a	66.7 (1.57)	63.3 (3.13)	68.0 (2.08)	84.9 (2.10) ^a	65.4 (3.32)	67.6 (3.46)	<.001
Screen time (% , SE)									
More than 2 hours/day	79.3 (1.65)	92.7 (1.20) ^a	84.8 (0.83) ^a	86.0 (2.24)	79.7 (1.83)	91.4 (1.54) ^a	82.6 (1.79)	83.7 (1.77)	<.001

SE, standard error.

Chi-square tests were used to test differences.

Bonferroni post hoc adjustment, $P < .008$.

Logistic regression was used to produce age- and covariate-adjusted rates.

Covariate adjustment for gender, family composition, family affluence, and overall functioning in addition to age.

^a Significantly different from white metropolitan adolescents.

^b Significantly different from black metropolitan adolescents.

Table 4

Fully Adjusted Prevalence and Odds Ratios for Race-Stratified Obesity Among US Adolescents as a Function of Health Behaviors and Nonmetropolitan Versus Metropolitan Residency: Health Behaviors in School-Aged Children, 2005–2006

	White			Black			Hispanic			Other		
	Adjusted Prevalence % (SE)	Adjusted Odds Ratio (95% CI)	Adjusted Prevalence % (SE)	Adjusted Odds Ratio (95% CI)	Adjusted Prevalence % (SE)	Adjusted Odds Ratio (95% CI)	Adjusted Prevalence % (SE)	Adjusted Odds Ratio (95% CI)	Adjusted Prevalence % (SE)	Adjusted Odds Ratio (95% CI)	Adjusted Prevalence % (SE)	Adjusted Odds Ratio (95% CI)
Physical activity												
Nonmetro, less than daily	8.5 (1.44)	0.77 (0.50–1.19)	25.1 (3.21)	1.71 (1.15–2.54)*	17.4 (3.16)	0.81 (0.50–1.31)	15.8 (4.00)	1.33 (0.67–2.66)				
Nonmetro, daily	9.5 (2.33)	0.86 (0.49–1.53)	23.3 (6.48)	1.56 (0.72–3.37)	17.2 (5.23)	0.80 (0.36–1.78)	6.6 (3.11)	0.48 (0.17–1.41)				
Metro, less than daily (reference)	10.7 (1.12)	1.00	16.6 (1.60)	1.00	20.5 (1.54)	1.00	12.5 (1.93)	1.00				
Metro, daily	8.0 (1.03)	0.72 (0.52–0.98)	15.0 (2.66)	0.88 (0.56–1.38)	11.9 (1.55)	0.51 (0.35–0.73)*	9.6 (2.11)	0.74 (0.41–1.31)				
Fatty snack food consumption												
Nonmetro, more than 2 days/week	7.8 (1.40)	0.91 (0.58–1.43)	24.0 (3.18)	1.65 (1.10–2.49)*	15.9 (2.31)	1.01 (0.68–1.50)	12.7 (3.44)	1.08 (0.52–2.22)				
Nonmetro, 2 or less days/week	11.5 (2.29)	1.42 (0.85–1.46)	27.3 (9.22)	1.99 (0.73–5.39)	21.2 (5.52)	1.46 (0.70–3.02)	12.6 (4.26)	1.06 (0.43–2.61)				
Metro, more than 2 days/week (reference)	8.5 (0.97)	1.00	16.3 (1.76)	1.00	15.8 (1.20)	1.00	12.0 (2.00)	1.00				
Metro, 2 or less days/week	12.7 (1.43)	1.60 (1.16–2.22)*	15.1 (3.49)	0.91 (0.48–1.73)	21.8 (2.55)	1.52 (1.04–2.21)*	10.7 (2.49)	0.88 (0.45–1.73)				
Screen time												
Nonmetro, more than 2 hours/week	9.1 (1.25)	0.84 (0.59–1.21)	23.8 (3.51)	1.64 (1.05–2.57)*	17.2 (2.67)	0.88 (0.57–1.34)	12.4 (2.97)	1.06 (0.56–2.00)				
Nonmetro, 2 or less hours/week	7.7 (2.26)	0.70 (0.36–1.37)	30.9 (10.5)	2.39 (0.86–6.65)	17.3 (4.03)	0.88 (0.49–1.60)	14.8 (4.69)	1.33 (0.59–2.99)				
Metro, more than 2 hours/week (reference)	10.6 (1.03)	1.00	16.3 (1.60)	1.00	19.1 (1.26)	1.00	11.8 (1.58)	1.00				
Metro, 2 or less hours/week	6.0 (1.22)	0.53 (0.33–0.85)*	13.4 (3.90)	0.79 (0.38–1.62)	10.3 (2.79)	0.47 (0.24–0.91)*	9.3 (5.14)	0.76 (0.21–2.73)				

SE, standard error; CI, confidence interval.

* Statistically significant at $P > .05$.

Adjusted for gender, family affluence, age, family composition, overall functioning, and lifestyle variables.

Race-stratified logistic regression was used to determine odds ratios and produce predicted marginals.