Obesity and Related Health Behaviors Among Urban and Rural Children in the United States: Data from the National Health and Nutrition Examination Survey 2003–2004 and 2005–2006

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Received March 1, 2010; revisions received November 29, 2010; accepted December 8, 2010

Objective To assess rates of overweight/obesity and related health behaviors among rural and urban children using data from the National Health and Nutrition Examination Survey (NHANES). **Methods** Data were drawn from the 2003–2004 and 2005–2006 NHANES surveys regarding demographic characteristics, weight status, dietary behaviors and physical activity behaviors. **Results** Significantly more rural children were found to be obese than urban children. Health behavior differences to explain this differential obesity rate were primarily not significant, but multivariate analyses indicate that for rural children meeting physical activity recommendations is protective and engaging in more than 2 hr/day of electronic entertainment promotes obesity. **Conclusions** There are modifiable health behavior differences between rural and urban children which may account for the significantly higher obesity rates among rural children.

Key words nutrition; obesity; public health.

Introduction

Pediatric overweight is often cited as the most pressing health problem among today's children (Robinson, 2008). Obesity is considered an important pediatric health issue because child weight status is directly related to adult health status, independent of adult weight status (Dietz, 1998). In other words, if an individual is overweight as a child, even if they lose weight prior to adulthood, being overweight as a child can result in many negative health outcomes such as diabetes, heart disease, orthopedic issues, and sleep difficulties (Must & Strauss, 1999). Children who are overweight or obese are also likely to remain obese as adults (Guo et al., 2000) and have increased rates of psychosocial problems, such as poor quality of life (Zeller, Roehrig, Modi, Daniels, & Inge, 2006), poor body image (Israel & Ivanova, 2002), and social problems (Janssen, Craig, Boyce, & Pickett, 2004). Recent economic data indicate that overweight/obesity costs the U.S. healthcare system over $100 billion dollars annually (Overweight and obesity for professionals: Economic consequences, 2009).

In June 2007, the Expert Committee on Pediatric Obesity changed terminology, such that children with a Body Mass Index (BMI) at or between the 85th and 94th percentiles are now considered ''overweight,'' and children with a BMI percentile at or above the 95th are now considered ''obese'' (Barlow & The Expert Committee, 2007). Recent data indicate that prevalence of pediatric overweight and obesity continue to rise both in the United States and around the world (World Health Organization Obesity and Overweight Fact Sheet, 2010).

There are certain groups of children who are more likely to have difficulties with pediatric overweight, including African American teenage girls, Hispanic teenage boys, and children whose parents are obese (Winkleby,

Journal of Pediatric Psychology 36(6) pp. 669–676, 2011
doi:10.1093/jpepsy/jsq117
Advance Access publication January 11, 2011

Robinson, Sundquist, & Kraemer, 1999). Some data also indicate that living in a rural community increases one's risk of overweight or obesity. For example, Davy Harrell, Stewart, & King (2004) conducted a study of body weight status, dietary habits, and physical activity levels among middle-school children in rural Mississippi (Davy et al., 2004). Data from 205 children indicate 54% had a BMI over the 85th percentile, they consumed 34% of their calories from fat (30% or fewer are recommended), and engaged in approximately 9,000 steps per day (10,000 or more steps are recommended). Unfortunately, no matched urban group was included making comparison between urban and rural children difficult. In a similar study with 54 Appalachian Kentucky elementary school children, another group found that 33% of rural children had a BMI over the 85th percentile, they consumed 36% of their calories from fat and engaged in over 3 hr of screen time (TV/video/computer play) on average per day (Crooks, 2000). It is problematic to draw conclusions from such a small sample from a single rural region. However, similar results have been found for African American children from rural South Carolina (Felton et al., 1998), and for fourth grade children from rural central Iowa (Gustafson-Larson & Terry, 1992). Although these studies are consistent, they lack a nationally representative sample of urban and rural children obtained simultaneously which would allow for assessment of the relationship between overweight/obesity, health behaviors and rural/urban status. Such national studies have been conducted with adults and consistently indicate that overweight (Jackson, Doescher, Jerant, & Hart, 2005; Patterson, Moore, Probst, & Shinogle, 2004) and overweight-related health behaviors (i.e., excess calories, decreased physical activity; Martin et al., 2005) are more common among rural adults than urban adults.

Rural Healthy People 2010 suggests that there may be ''cultural'' and ''structural'' limitations specific to rural areas that may impact the prevalence of overweight/obesity (Tai-Seale & Chandler, 2003). ''Cultural'' tendencies implicated include higher dietary fat and calorie consumption in rural areas, lower rates of exercise, higher rates of screen time (TV, video, and computer play), and lack of adequate health education. The ''structural'' causes include lack of nutrition education, poor access to nutritionists, limited resources, and fewer outlets for exercise. Demographic factors also play a role. Rural individuals are typically poorer and have less education than their urban counterparts, two factors that have been shown to be positively associated with higher rates of overweight.

Despite these compelling data, to date, there have been no national studies of the rates of pediatric overweight/obesity and related health behaviors with rural and urban children. The objective of the current study was to assess overweight/obesity and overweight/obesity-related health behaviors among rural and urban children using data from the National Health and Nutrition Examination Survey (NHANES). NHANES is a national survey conducted biannually to provide a snapshot of the health and nutrition of the U.S. population. As such, it is an ideal source of data given the objective of the current study. Based upon previous data, we hypothesize that children in rural areas will have higher rates of overweight and obesity, will have different dietary composition, and will have lower rates of physical activity when compared with urban children.

Methods

Data for this analysis were drawn from the 2003–2004 and 2005–2006 NHANES. The NHANES is an ongoing survey of the general U.S. population conducted by the National Center for Health Statistics within the Centers for Disease Control and Prevention. NHANES participants undergo a survey as well as a medical examination that includes blood work and measured height and weight. Responses to questions were obtained directly from those aged 16 years or older; all others were obtained from the parent or guardian.

We used two cycles of NHANES data to ensure adequate sample sizes for analysis, for a total of 7,882 participants aged 2–18 years. We then used the weights, strata, and primary sampling units provided by the NHANES data to weigh the data to provide representative estimates of the U.S. population at large, resulting in a weighted sample size of 138,345,314.

Variable Definitions

Overweight/Obesity

The main variable of interest, weight status, was defined according to the CDCs age- and gender-specific percentile ranks for BMI. Three measures were used in this analysis; *overweight* was defined as an age and gender BMI equal to or greater than the 85th and below the 95th percentile; *obese* was defined as an age and gender specific BMI equal to or above the 95th percentile; *overweight/obese* was defined as an age and gender BMI greater than the 85th percentile.

Residence

Each participant's county of residence's rural status was classified according to its urban influence code (UIC), established by the USDA (Economic Research Service). These codes are drawn from the 2005 Area Resource file, which maintains information regarding the characteristics of the 3,142 counties in the United States (DHHS, Area

Resource File, 2008). If UIC Codes were 1 or 2, then the county was coded as Urban while all other UIC codes (3–12—known as ''nonmetropolitan codes'' by the USDA Economic Research Service) were classified as Rural (Liu, Bennett, Harun, & Probst, 2008).

Physical Activity

The CDC recommends that children and adolescents aged 6–17 years should participate in at least 60 min of activity per day, and vigorous activity several days per week (Centers for Disease Control & Prevention, 2009). The NHANES questions are not structured, however, to determine if the participants met these recommendations. Therefore, for children aged 2–11 years, we classified those who answered the question ''How many times per week does ____ play or exercise enough to make {him/her} sweat and breathe hard?'' as three or more times to be in compliance with the recommendations. For those aged 12–18 years old, we utilized the Physical Activity Individual Activities data file. This survey component asked participants to choose from a list of activities those they participate in on a regular basis, the number of times they performed the activity during the past 30 days, and the average number of minutes each activity is performed per session. These responses were summed by participant and averaged over the 30 day period to obtain an estimate of daily activity level. Those who averaged 60 min of activity per day, based upon these responses, were classified as meeting the physical activity recommendations.

Dietary intake

Dietary intake was defined using the mean estimated daily intake in seven categories; fruits/vegetables, sugar-sweetened beverages, milk products, fried foods, meat, added fats, and desserts/sweets. Parents were asked to report the number of items consumed in a typical day by their child. These answers were then aggregated and estimated daily frequencies were computed.

Socioeconomic status

Socioeconomic status was defined using the federal poverty level percentage, grouped by each NHANES year's tertile, to provide low-, middle-, and high-socioeconomic status designations.

Electronic entertainment

Electronic entertainment was defined as more than 2 hr spent, per day, watching television, using computers, or playing video games for entertainment purposes. Other variables utilized in the analysis included age, race, gender, and the presence of any physical limitations that would affect activity levels.

Analytic Plan

The proportion of participants who were overweight/obese was calculated, subset by the variables detailed above. These proportions were further subset by residence (rural vs. urban), with differences tested using chi-squared. The bivariate analyses indicated potential interactions between race, gender, and age, which were included in the multivariate logistic models. The multivariate logistic models used obesity status as the dependent variable, while controlling for race, gender, age group (2–11 vs. 12–18 years), socioeconomic status, physical activity, dietary intake, use of electronic entertainment, and physical activity limitations. We conducted two sets of multivariable logistic regression models to determine the factors related to obesity among rural and urban populations. The initial models utilized a dichotomous obesity indicator variable for the dependent variable, and included all of the above intendment variables. This model was performed on two subpopulations; rural only and urban only. The final models were also subset to the two subpopulations (rural only and urban only), and only included those independent variables that that were significant in the full model at $p < .10$. All analyses were conducted using SAS-Callable SUDAAN (Proc Crosstab, Proc Descript, and Proc Multilog) to take into account the complex sampling structure of the NHANES data.

Results

A total of 7,882 unweighted subjects in this analysis represented more than 138 million weighted, nationally representative individuals. Overall, nearly 16% lived in rural areas, and the sample was predominately White (See Table I for demographic information). Rural residents differed significantly from urban residents on most key demographic characteristics (gender, race, age, and SES; see Table I).

The unadjusted analyses indicate that overall, 33.1% of the sample was overweight/obese; 15.4% were overweight while 17.7% were obese (see Table II). Breaking the sample down by rural/urban status, 39.0% of the rural children were over the 85th percentile, whereas 32.0% of the urban children were over the 85th percentile. This difference did not reach statistical significance. Looking at categories of overweight versus obese, significantly more rural children were obese (21.8%) compared to urban children (16.9%). Other factors significantly associated with weight status included gender, race, age, and socioeconomic status.

Table I. *Demographic Information*

	All *N* (%)	Rural 1,028	Urban 6,854	*p*-value, Urban versus Rural
All	7,882 (100.0)	15.8	84.2	
Gender				0.01*
Male	3,908 (51.0)	54.1	50.4	
Female	3,974 (49.0)	45.9	49.6	
Race				0.04*
White	2,116 (60.2)	77.2	57.1	
African American	2,587 (14.8)	10.3	15.7	
Hispanic	2,769 (17.8)	9.5	19.4	
Other	410 (7.1)	3.2	7.8	
Age group (years)				0.22
2–9	3,267 (45.4)	43.3	45.8	
10–18	4,615 (54.6)	56.7	54.2	
Socioeconomic status				0.03*
Low	3,497 (33.4)	39.3	32.3	
Middle	2,296 (32.9)	36.9	32.1	
High	1,990 (33.7)	23.8	35.6	

*$p < .05$.

Table II. *Demographic Factors by Rural/Urban Status and Obesity Status*

	BMI > 85th	Overweight	Obese
All (%)	2,794 (33.1)	1,232 (15.4)	1,562 (17.7)
Residence			
Rural	39.0	17.3	21.8*
Urban	32.0	15.0	16.9
Gender			
Male	33.8	15.2	18.6*
Female	32.3	15.6	16.8
Race			
White	31.9*	15.7*	16.2*
African American	36.7	15.0	21.8
Hispanic	38.5	16.0	22.5
Other	21.5	11.9	9.6
Age group (years)			
2–9	27.3*	12.6*	14.7*
10–18	37.9	17.7	20.1
Socioeconomic status			
Low	35.5*	15.6*	19.8*
Middle	35.5	16.6	18.9
High	28.2	14.2	14.0

*Within-group differences significant, $p < .05$.

Analyses were then conducted to learn more about specific health behavior differences that may be associated with weight status for rural and urban children. For these analyses, initial modeling revealed healthy and overweight (not obese) children had no differences between rural and urban areas regarding specific health behaviors, so those groups were collapsed and the groups analyzed were: (a) obese versus and (b) healthy weight and overweight (groups collapsed). Activity variables (Table III) included meeting physical activity guidelines and more than 2 hr/day using electronic entertainment were not significantly different between rural and urban children. When these were broken down by obese (BMI > 95th) versus nonobese, however, we found that significantly more nonobese children met physical activity guidelines as compared to obese children, both in urban (67.4 vs. 62.4, $p < .05$) and rural (67.1 vs. 57.4, $p < .05$) areas. The same held true for the use of electronic entertainment, in that significantly more obese children used electronic entertainment for more than 2 hr/day as compared to non-obese children, both in urban (67.6 vs. 62.2, $p < .05$) and rural (69.0 vs. 63.1, $p < .05$) areas.

Regarding dietary variables, there were no urban–rural differences in mean intakes of any of the dietary intake categories (Table III). Overall, both urban and rural obese children were more likely to drink more sugar-sweetened beverages. Urban obese children consumed more meat and desserts on a daily basis than nonobese urban children, and among urban children obese were less likely to consume sweets than nonobese.

The multivariate analysis showed, after controlling for the independent variables, few factors remained significant predictors of obesity, and that the factors differed for rural children compared to urban children (See Table IV). Among rural children, the significant factors related to obesity included race (African American children were more likely to be overweight than White children), meeting physical activity recommendations [Odds Ratio (OR) = 0.70, 95% CI 0.49–0.99], and electronic entertainment use greater than 2 hr/day (OR = 1.42, 95% CI 1.04–1.95). Among urban children, the factors significantly related to obesity included race (again, with African American children were more likely to be obese than White children), age (children less than 10 years old were less likely to be obese), socioeconomic status (those in families with middle incomes were more likely to be obese than those with high incomes), and dietary intake (more average daily consumption of meat and sugar-sweetened beverages was associated with being obese).

Conclusions

This study sought to examine the rate of overweight and obesity among rural and urban children, and to determine which specific health behaviors contributed to any existing differences. We found that rural children were significantly

Table III. *Activity-Related Health Behaviors by Rural/Urban Status and Obesity Status*

	Urban			Rural		
	All	BMI < 95th	BMI ≥ 95th	All	BMI < 95th	BMI ≥ 95th
Obesity-related behaviors						
Physical activity recommendations						
Met	66.5	67.4*	62.4	65.0	67.1*	57.4
Did not meet	33.5	32.6	37.6	35.0	32.9	44.6
Electronic entertainment						
>2 hr/day	63.1	62.2*	67.6	64.4	63.1*	69.0
<2 hr/day	36.9	37.8	32.4	35.6	38.9	31.0
Dietary intake						
Fruit/vegetables	5.34	5.30	5.50	5.21	5.13	5.48
Sugar-sweetened beverages	1.51	1.43*	1.91	1.54	1.44*	1.89
Milk	1.27	1.28	1.18	1.59	1.64**	1.41
Fried foods	0.79	0.79	0.79	0.85	0.83	0.90
Meats	1.66	1.64**	1.75	1.81	1.76	1.99
Added fats	1.33	1.34	1.31	1.42	1.39	1.53
Desserts/sweets	1.31	1.33**	1.2	1.45	1.48	1.34

*Significantly different from obese group (BMI ≥ 95th), $p < .05$; no urban/rural differences were significant at $p < .05$.

more likely to be obese than urban children—a finding that has consistently been found in regional rural obesity studies (Crooks, 2000; Davy et al., 2004; Felton et al., 1998; Gustafson-Larson & Terry, 1992), and in other national studies with adults (Jackson et al., 2005; Martin et al., 2005; Patterson et al., 2004). Nearly 22% of rural children in our sample were classified as obese, compared to only 17% of urban children. In terms of treatment options, this finding is especially problematic, given that so many rural areas are designated as healthcare provider shortage areas as well (Health Resources Services Administration, n.d.). If there are more children in rural areas in need of treatment, how are we to get empirically supported programs out to them? There have been some novel uses of technology such as interactive televideo (Davis et al., 2011) and other outreach programs (Janicke et al., 2010) that may be helpful, but this is definitely an area in need of further attention.

Few of the major health behaviors that were measured in the study demonstrated any significant differences between rural and urban children that would account for the differential obesity rates. The two groups of children had similar rates of meeting physical activity recommendations, similar rates of electronic entertainment use, and similar rates of consumption of sugar-sweetened beverages. It is important to note, however, that there are more methodologically rigorous assessment methods available (i.e., physical activity monitors, 24 hr dietary recalls) that may be more sensitive than the self-report measures used by NHANES. Other studies utilizing these rigorous assessment methods among smaller samples have found health behavior differences among urban and rural children (Davis et al., 2008).

The current data do show that there are health behavior differences between obese and nonobese children in the expected direction. For example, nonobese children were significantly more likely to meet physical activity guidelines, and significantly less likely to engage in more than 2 hr of electronic entertainment. Regarding dietary variables, obese children consumed significantly more sugar-sweetened beverages than nonobese children. Like adult findings (Davies et al., 2000), our data do indicate that drinking milk had a protective effect, but this only reached statistical significance for rural children, possibly due to their slightly higher milk consumption.

One surprising finding was that urban children who were not obese consumed significantly more sweets than urban children who were obese. Interestingly, this same pattern of higher sweets consumption among the nonobese was observed for rural children as well, but did not reach statistical significance. Looking at the methodology for the NHANES survey, dietary information is based upon parent report. There is some literature to suggest that weight status of underreporters is significantly higher than that of plausible reporters (Ventura, Loken, Mitchell, Smickilas-Wright, & Birch, 2006) suggesting that our results could be due to underreporting. Further research is needed to clarify this issue.

The multivariate models showed that for rural children obesity was highly related to race (African American), not

Table IV. *Multivariate Analyses Results: Odds of being Obese, Rural and Urban Children, by Selected Characteristics*

	Rural			Urban		
	β est. (*SE*)	ORs (95% CI)	*p-value*	β est. (*SE*)	ORs (95% CI)	*p-value*
Gender						
Male	0.29 (0.23)	1.33 (0.84–2.11)	0.21	0.10 (0.09)	1.11(0.92–1.34)	0.28
Female	–	–	–	–	–	–
Race						
White	–	–	–	–	–	–
African American	0.42 (0.21)	1.53 (0.99–2.32)	0.04	0.30 (0.13)	1.35 (1.03–1.77)	0.03
Hispanic	−0.09 (0.34)	0.91 (0.46–1.83)	0.79	0.25 (0.18)	1.29 (0.90–1.85)	0.16
Other	−0.94 (0.54)	0.39 (0.13–1.18)	0.09	−0.62 (0.22)	0.54 (0.34–0.85)	0.01
Physical limitations						
No	–	–	–	–	–	–
Yes	0.78 (0.54)	2.19 (0.73–6.60)	0.16	0.50 (0.21)	1.66 (1.09–2.52)	0.02
Age group						
2–9 years	−0.09 (0.17)	0.91 (0.65–1.28)	0.59	−0.32 (0.1)	0.73 (0.59–0.90)	0.0048
10–18 years	–	–	–	–	–	–
Socioeconomic status						
Low	0.20 (0.42)	1.22 (0.52–2.88)	0.63	0.22 (0.18)	1.25 (0.87–1.79)	0.22
Middle	0.18 (0.36)	1.19 (0.58–2.46)	0.62	0.39 (0.17)	1.48 (1.05–2.08)	0.03
High	–	–	–	–	–	–
Physical activity recommendations						
Met	−0.36 (0.17)	0.70 (0.49–0.99)	0.05	–	–	–
Did not meet	–	–	–	–	–	–
Electronic entertainment						
>2 hr/day	0.35 (0.15)	1.42 (1.04–1.95)	0.03	–	–	–
<2 hr/day	–	–	–	–	–	–
Mean servings per day						
Sugar-sweetened beverages	–	–	–	0.10 (0.02)	1.10 (1.05–1.15)	0.01
Meat	–	–	–	0.05 (0.03)	1.06 (0.99–1.12)	0.05
Desserts/sweets	−0.06 (0.11)	0.94 (0.76–1.17)	0.58	−0.17 (0.05)	0.85 (0.76–0.94)	0.01

Note: Rural and urban models were restricted to variables with $p < .10$ in full model (not shown here).

meeting physical activity recommendations, and use of electronic entertainment for more than 2 hr/day. This indicates that among rural children activity and the lack thereof may be key in combating obesity in children. However, among urban children, obesity was related to race (African American), age (children less than 10 years of age were less likely to be overweight/obese), socioeconomic status (high-income children were less likely to be overweight/obese), and higher dietary intake (specifically regarding meats and sugar-sweetened beverages). Therefore, among urban children physical activity and sedentary activity variables may be less important shifting the focus to dietary interventions possibly focusing on meats and sugar-sweetened beverages.

This study is an improvement over previous studies because we used NHANES data, which provides a nationally representative sample of rural and urban children. Also, NHANES physically measures a child's height and weight to calculate BMI; other studies have used data sets that depended upon parental report for height and weight (Tai-Seale & Chandler, 2003). The results, however, are similar enough to lend credence to the previous work, and to bolster the evidence of a rural difference in obesity prevalence among children.

Our study has several limitations. Although we pooled two waves of NHANES data, we were still limited by relatively small rural sample sizes that reduced our ability to detect significant differences among groups and factors. Also, many of the health behaviors (such as physical activity data) depended upon respondent recall and estimation, and are subject to recall bias. We chose to use the frequency measures of dietary intake rather than dietary recall information, despite it being present for a majority of the children in the sample, due to the nature in which the recall data were collected. For those aged 6 years and under, a proxy (usually a parent or guardian) recalled the

child's dietary info; for those aged 6–11 years, the recall was facilitated; and for those aged 12 years and over, the recall was performed with the child, independently. Previous research has indicated that these types of source differences can significantly affect outcome (Savage, Mitchell, Smiciklas-Wright, Symons Downs, & Birch, 2008; Huang, Howarth, Lin, Roberts, & Mcrory, 2004). The data used are also quite dated, being from 2003 to 2006 and we also chose to collapse several categories of rural (UIC codes 3–12) in our analyses, which has been done previously but does not allow for assessment of the nuances of different levels of rurality. Finally, combining the physical activity data for children aged 2–11 years of age with the data for children aged 12–18 years despite the different methodology used with each age group is a limitation.

The current study provides evidence that rural children and adolescents are at higher risk for obesity than their urban counterparts. The results also demonstrate that it is not living in a rural area in and of itself that leads to this increased prevalence. Rather, the factors that differ between urban and rural residents, such as socioeconomic status, and prevalence of physical limitations, contribute significantly to the weight differences. These findings support the notion that interventions aimed at improving these factors are needed in rural areas to combat the significantly higher rates of pediatric obesity.

The current study also raises several areas in need of further study. First, our study did not find any significant health behavior differences between rural and urban children. Using stronger methodology (such as three 24-hr dietary recalls, 7-day activity monitor counts) and a more appropriately powered sample, may allow the sensitivity and statistical power to detect any differences that exist. Second, the finding that drinking milk had a protective effect, but only for rural children, bears further study, as does the finding that urban children who were not obese consumed more sweets than urban children who were obese. Finally, our multivariate findings that physical activity variables may be more important for rural children and dietary variables may be more important for urban children have direct implications for the development of treatment interventions targeting pediatric obesity among rural and urban children.

Acknowledgments

The authors would like to thank Robert Krasowski and Dr Peter Meyer of the National Center for Health Statistics for their assistance with data analysis.

Funding

National Institutes of Health (K23 DK068221 to A.D.).

Conflicts of interest: None declared.

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