

Diet, Physical Activity, and Sedentary Behaviors as Risk Factors for Childhood Obesity: An Urban and Rural Comparison

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At the Heart of Health Policy

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Executive Summary

Nearly 20% of the U.S. population resides in non-metropolitan areas, yet our knowledge about the prevalence of obesity in rural America is very limited. Previous research by the South Carolina Rural Health Research Center found that rural children, paradoxically, were both more likely to be overweight or obese and more likely to be physically active than urban children. That initial work was based on parent-reported information from the 2003 National Survey of Children's Health, which did not include information about children's diets. The current report expands on prior work by using information from the 1999-2006 National Health and Nutrition Examination Surveys (NHANES), which included both height and weight measurements by trained NHANES examiners and detailed diet information obtained from parents and children.

Using the 2000 Body Mass Index (BMI) charts from the Centers for Disease Control and Prevention as a reference, children whose gender- and age-specific BMI values were at or above the 95th percentile of the reference population were categorized as *obese*. Those children with BMI values at or above the 85th percentile of the CDC reference population were classified as being either *overweight or obese*. For simplicity, we used the term *overweight* to represent this group. Residence was measured at the census tract level using the Rural-Urban Commuting Area (RUCA) definition, with "urban" defined as RUCA codes between 1 and 3 and "rural" defined as RUCA codes between 4 and 10. To provide guidance for potential interventions, we also examined obesity-related behaviors (i.e., diet, physical activity and sedentary behavior) as risk factors for childhood obesity. Key findings of the report are as follows:

The prevalence of overweight and obesity is higher among rural children than urban children

- In 1999-2006, 30.9% of US children aged 2-19 years old were overweight and 15.9% of them were obese. A greater proportion of rural children were overweight (35.5%) than those living in urban areas (29.5%). Similarly, the overall prevalence of obesity was higher among rural than urban children (18.5% vs. 15.2%).

- The prevalence of overweight and obesity was higher among black and Hispanic children than white children. Among whites, rural children had significantly higher rates of overweight and obesity than their urban counterparts. Among blacks and Hispanics, rural children had significantly higher rates of overweight, but not obesity, than their urban peers. Rural black children had the highest prevalence of overweight (41.6%) and obesity (26.2%) among all children.

Differences in obesity-related behaviors

Because diet and activity recommendations and measurement of these behaviors vary with the age of the child, our findings are organized by age group:

Pre-school aged children (2 to 5 years old)

We did not observe differences in the prevalence of obesity among rural versus urban pre-school aged children. However, we found differences in obesity-related behaviors that could lead to the development of obesity later in life:

- Two to five year old children in rural areas consumed significantly more fat than children in urban areas (62.7 g versus 56.9 g per day).
- Rural children in the two to five year age group consumed more sweetened beverages than urban children, with 13.5% of rural children, versus 7.9% urban children, consuming more than 24 ounces of sweetened beverages per day on average.
- About one of four US children, aged 2 to 5 years old (24.4%) did not report levels of physical activity sufficient to meet physical activity guidelines (≥ 5 bouts of exercise per week). There were no significant differences by urban or rural residence among these children.
- At least three out of five US children aged two to five years old spent two hours or more per day on sedentary activities such as watching TV or videos, using a computer, or playing computer games (63.6%). Rural girls aged 2 to 5 were less likely to exceed screen time guidelines than their urban counterparts (52.0% rural vs. 63.7% urban).

Other than this, no significant differences between urban and rural two to five year old children were found.

Elementary school-aged children (6 to 11 years old)

We did not find that rural children in the 6 – 11 age group were more likely to be overweight than their urban peers. As with younger children, however, we did note differences in diet and activity that may have implications for weight as the children grow older:

- Six to eleven year old rural children consumed more fat on average than urban children (80.3 g versus 73.2 g per day). We did not observe any other substantive differences in dietary intake in school-aged children.
- Approximately 24.7% of US children aged 6 to 11 years old did not report enough physical activity to meet physical activity recommendations. Rural children were less likely to fail to meet physical activity guidelines than urban children (19.6% versus 26.2%), with most of the difference coming among rural girls. Rural girls were less likely to fail to meet physical activity guidelines than urban girls (16.5% versus 31.5%), but failure to engage in physical activity was similar among rural and urban boys in this age group (19.2% and 20.9%, respectively).
- Seventy-two percent of US children aged 6 to 11 years old spent two hours or more per day on sedentary activities. There were no significant differences between urban and rural children, in either boys or girls.

Adolescents (12 to 19 years old)

Rural adolescent girls were more likely to be overweight than adolescents in urban areas (38.0% versus 30.1%, respectively), while rural and urban boys were similar (31.1% versus 31.9%, respectively). Minor differences in diet and exercise were found across this age group:

- Adolescents in both rural and urban areas had poorer dietary quality than younger children. In general, diet quality did not vary by residence. Rural and urban adolescents had similar fat consumption. Minor differences were present:

- Rural adolescents were more likely than their urban peers to report eating two or more cup equivalents of fruit.
- Rural adolescent girls consumed slightly less fiber than urban girls (11.2 g versus 12.3 g).
- Approximately 21.2% of US adolescents reported no vigorous physical activity (VPA) in the past 30 days, while 11.6% reported no participation in vigorous or moderate-to-vigorous physical activity (MVPA) in the past 30 days. Among all adolescents and adolescent boys, the likelihood of participation in VPA and MVPA did not differ by residence. Within girls, rural adolescents were more likely to be in the highest terciles of VPA and MVPA category than their urban counterparts.
- A higher proportion of adolescents (74.2%) reported 2 or more hours of sedentary activities than among younger children (68.9%, 2 to 11 year old). Sedentary behaviors did not vary by residence in this age group.

Obesity-related behaviors: Not yet a full explanation for differences

We used multivariable analyses to ascertain the degree to which specific behaviors captured in the NHANES survey might contribute to overweight among children.

- While unadjusted analysis did not find differences in the prevalence of overweight among children age 2 – 11 years, after adjusting for socio-demographic characteristics, health, and obesity-related behavioral factors, rural children were more likely to be overweight than urban children (AOR: 1.4, 95% CI: 1.1-1.7). Differences based on residence were found for both boys (AOR: 1.4, 95% CI: 1.0, 1.9) and girls (AOR: 1.3, 95% CI: 1.0, 1.7) after controlling for all covariates. Diet, physical activity and sedentary behaviors were not significantly associated with overweight in 2 to 11 year old children.
- Rural adolescents (12 – 19) were more likely to be overweight in unadjusted analysis, a relationship that remained when indicators of socio-demographic status were held equal (AOR: 1.3, 95% CI: 1.0-1.6). After further controlling for diet, physical activity and

sedentary behaviors, the difference in overweight among rural and urban children was still significant among all adolescents and among girls. There was no significant difference in overweight among rural and urban adolescent boys. The principal significant findings are noted below:

- Among children aged 12-19 years old, every 5 g increase in total fiber was associated with 10% reduction in the odds of being overweight (95% CI: 0.8, 0.9).
- Spending more than 2 hours in screen activities was associated with 50% increase in the odds of being overweight compared to children who spent less than 2 hours in screen activities (AOR: 1.5, 95% CI: 1.3-1.8).

Recommendations for reducing obesity among rural children

For children aged 2-11 years old, programs and policies that seek to reduce the amount of sedentary behavior, particularly television viewing, and grams of fat and sweetened beverages that children consume on a regular basis, might lead to long term benefits for children living in rural areas in terms of obesity prevention.

For children aged 12-19 years old, programs and policies with a focus on encouraging participating in vigorous physical activity, less sedentary behaviors, and higher fiber intake would be beneficial in reducing rural differences in overweight.

Because obesity tracks from childhood to adulthood and obese adults suffer adverse social and health consequences due to obesity, it is very important to develop policies and programs aimed at reducing the gap in childhood obesity between rural and urban children. At the end of the report, we suggest some relatively simple policy and program targets that can help rural communities address the relatively high prevalence of childhood obesity and prevent the consequences of obesity.

Chapter 1: Introduction

The prevalence of childhood obesity (defined as age- and sex-specific body mass index (BMI) at or above 95th percentile) has risen dramatically in the United States, with the greatest increases in prevalence among non-Hispanic black and Mexican American adolescents during the past three decades.¹⁻³ Obese children, especially adolescents, are at greater risk for becoming obese adults.⁴ As the prevalence of childhood obesity increases, so too will its associated consequences, including type 2 diabetes mellitus, hypertension, obstructive sleep apnea, poor quality of life, and increased morbidity and mortality in adulthood.⁵⁻⁶ Policy-makers have ranked obesity as a critical public health threat for the 21st century.¹

Nearly 20% of the U.S. population resides in non-metropolitan areas.⁷ Few studies have examined the prevalence of obesity among rural children. Regional and local data suggest that obesity is more prevalent in rural children and adolescents than their metropolitan counterparts.⁷ The recent SCRHRC report, *Overweight and Physical Inactivity among Rural Children Aged 10 – 17*, has provided the first national and state-specific estimates of obesity for rural children.⁸ Using parent-reported weight and height from the 2003 National Survey of Children's Health, we found that obesity was more prevalent among rural (16.5%) than urban children (14.3%). After adjusting for socio-demographic characteristics and physical activity, rural children still had 13% higher odds of being obese than urban children. Minorities, children from families with lower socioeconomic status, and children living in the South were particularly at risk,⁹ paralleling results from similar research.¹⁰ Paradoxically, however, rural children were *less* likely to fail to meet physical activity recommendations than urban children.

It was not clear why living in a rural area was linked to an increased risk of being obese. Rural settings may be “obesogenic,” favoring decreased energy expenditure and increased energy intake. Although our previous findings did not support physical activity alone as the most likely cause of increased obesity prevalence,⁹ other research has linked dietary-fat intake and physical activity, along with other factors such as distance to recreational facilities, crime safety, and sedentary behaviors, to adult obesity in rural communities.¹¹ Fewer grocery outlets

and increased costs of fruits and vegetables may also make rural settings more “obeseogenic.”¹² However, the evidence linking obesity-related behaviors (i.e., diet intake, physical activity, sedentary behaviors) with childhood obesity among rural children is limited, although this model has been explored among adults in rural settings.¹¹

To improve on prior work, we re-examined the prevalence of obesity by urban and rural residence using measured weight and height rather than the parent-reported information used in our previous study. We also examined obesity-related behaviors as risk factors for childhood obesity. By documenting the differences in obesity-related behaviors by urban and rural residence and by examining their associations with childhood obesity, we can explore whether rural settings are more “obeseogenic.” We implemented our research using the data from the 1999-2006 National Health and Nutrition Examination Survey (NHANES). Unlike telephone and mail-based surveys, the NHANES conducts thorough physical examinations of a representative sample of the US civilian, non-institutionalized population, generating accurate measurement of height and weight in children. The detailed, objective data provided by the NHANES allows a more careful specification of the relative importance of obesity-related behaviors in childhood, and examination of how these relationships vary by age, sex, and residence. This information will be useful for health planners or researchers designing intervention programs targeted to specific types of children at risk.

In the report that follows, we examine obesity and potential contributors to obesity, including diet, physical activity, and sedentary behavior, among rural and urban children.

Chapter 2: Overweight and Obesity Among Children

Characteristics of Rural and Urban Children

Across the US, 22.6% of children aged 2 to 19 years old lived in rural counties in 1999-2006 (See Table B-1, Appendix B, for estimates). Rural children were similar in age, sex, reported health status, health insurance status, and in-school status to their urban peers. Important differences included a higher proportion of white children in rural than in urban areas (76.5% vs. 55.9%; $p < 0.05$). Rural children were also more likely than their urban peers to live in poor families (below 130% federal poverty level; 36.8% versus 30.4%; $p < 0.05$) or to have parents with less than a college education (56.9% versus 45.7%; $p < 0.05$). Table A-1 (Appendix A) presents unweighted sample size by age, gender, and urban / rural residence.

Prevalence of overweight status by residence and age

In 1999-2006, 30.9% of all US children aged 2-19 years old were overweight or obese. Proportionately more rural children were overweight (35.5%) than those living in urban areas (29.5%; Table B-2; $p < 0.05$). Overweight status was more prevalent among both rural boys (37.3% vs. 30.2%; $p < 0.05$) and rural girls (33.7% vs. 28.8%; $p < 0.05$) compared to urban children. The proportion of children who were overweight increased with age among both rural and urban children. Differences between urban and rural children were large enough to reach statistical significance in the 12 to 19 age

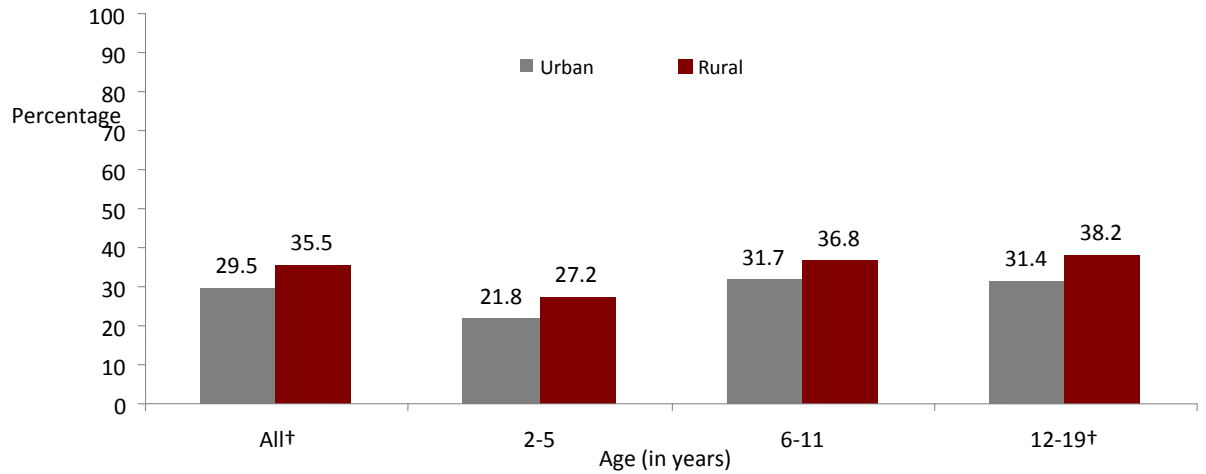
How we defined *overweight* and *obese*:

Children were considered overweight or obese if their body mass index (BMI) was at or above the 85th percentile for age and gender according to growth charts from the National Center for Health Statistics (NCHS). For simplicity, these children are labeled "overweight."

Children were considered obese if their BMI was at or above the 95th percentile on NCHS charts.

group (See Figure 1 and Table B-2). Urban and rural differences were also found among girls in the 12 to 19 age group, among whom 38.0% of rural girls, versus 30.1% of urban girls, were overweight.

Figure 1. Percent of US children who are overweight by residence and age

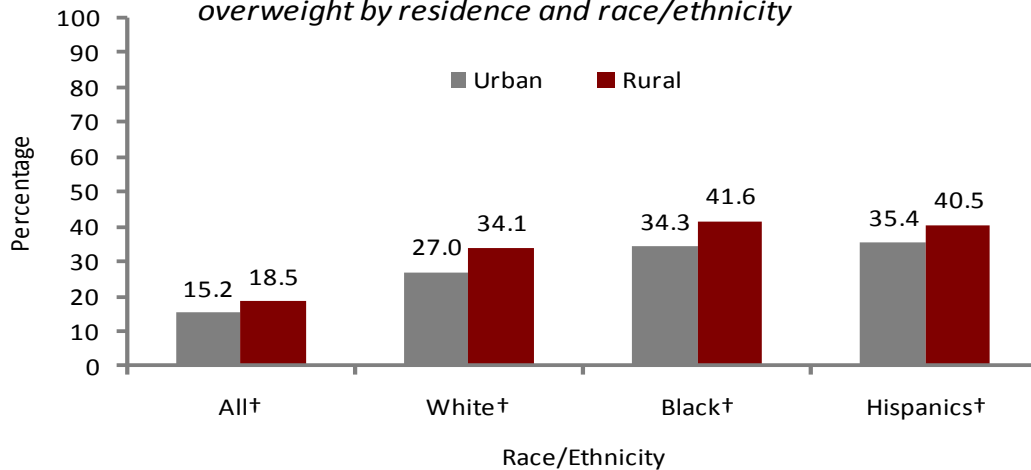


Data Source: 1999-2006 NHANES

Prevalence of overweight status by residence and race / ethnicity

Rural children of all major racial/ethnic groups were more likely to be overweight than were similar urban children. Estimates are not provided for children of other non-Hispanic race/ethnicity due to small sample sizes among rural children. Thus, compared to urban white children, rural white children had significantly higher rates of overweight (34.1% vs. 27.0%, $p < 0.05$). Similarly, rural black children had significantly higher rates of overweight (41.6% vs. 34.3%, $p < 0.05$) than urban black children, and rural Hispanic children when compared to urban Hispanic children (40.5 % vs. 35.4%; $p < 0.05$). Rural black children had the highest prevalence of overweight (41.6%) among all children (See Table B-4 and Figure 2).

Figure 2. Percent of U.S. children aged 2-19 who are overweight by residence and race/ethnicity



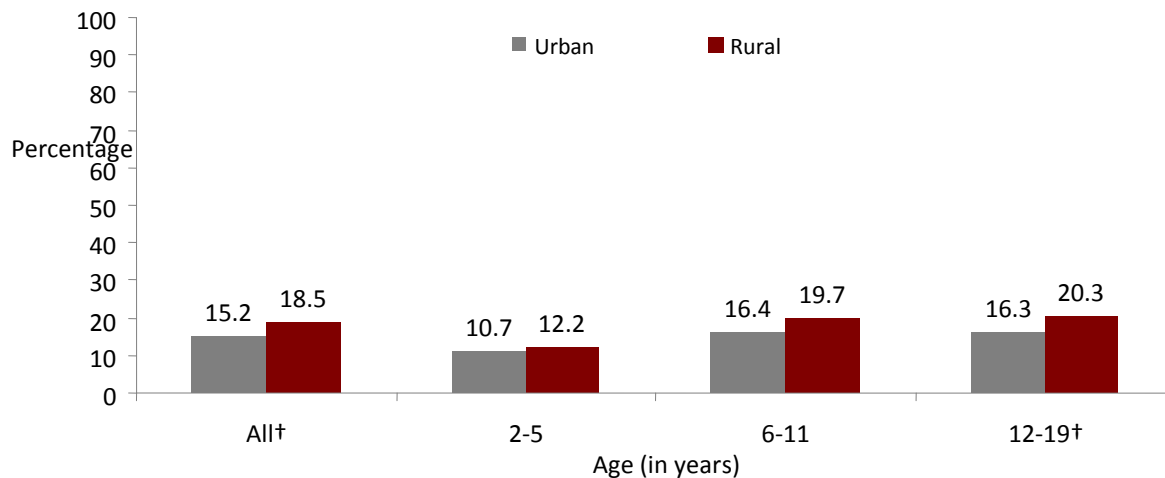
Data Source: 1999-2006 NHANES

†P-value < 0.05

Prevalence of obesity by residence and age

Overall, 15.9% of US children aged 2-19 years old were obese during 1999 through 2006 (See Table B-3 and Figure 3). The overall prevalence of obesity was higher among rural than among urban children (18.5% vs. 15.2%; $p < 0.05$). When examined within age groups, rural children differed statistically from their urban peers only among children aged 12 – 19, as shown in Figure 3.

Figure 3. Percent of US children who are obese by residence and age



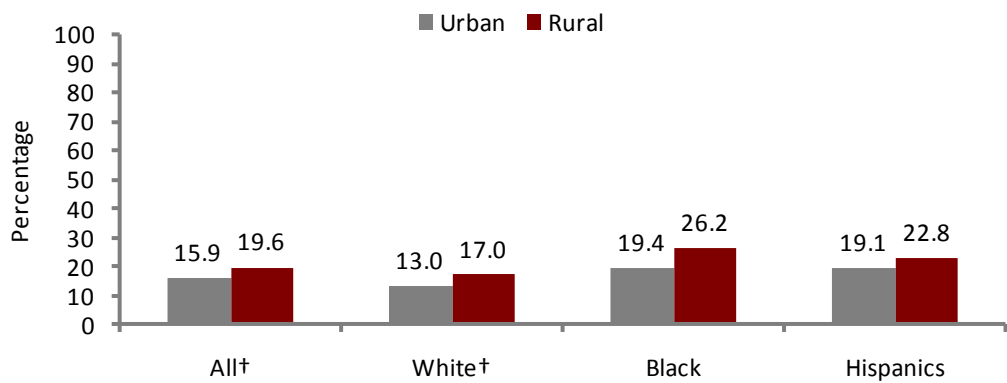
Data Source: 1999-2006 NHANES

†P-value < 0.05

Prevalence of obesity by residence and race / ethnicity

White rural children were more likely than white urban children to be obese (17.0% vs. 13.0%, $p < 0.05$). The prevalence of obesity did not vary significantly by residence among blacks, Hispanics and other race groups. Rural black children had the highest overall prevalence of obesity (26.2%) among all racial groups (See Table B-4 and Figure 4).

Figure 4. Percent of U.S. children aged 2-19 who are obese by residence and race/ethnicity



Data Source: 1999-2006 NHANES

Race/Ethnicity

†P-value < 0.05

Summary

When all ages are considered (2 – 19), rural children are more likely to be overweight and obese. This finding applies to white, black, and Hispanic children. Rural children did not differ significantly from urban children in the 2 – 5 and 6 – 11 year age groups. Rural teens (12 – 19), however, were more likely to be both overweight and obese than urban teens. Rural black and Hispanic children are at higher risk for overweight and obesity than rural white children.

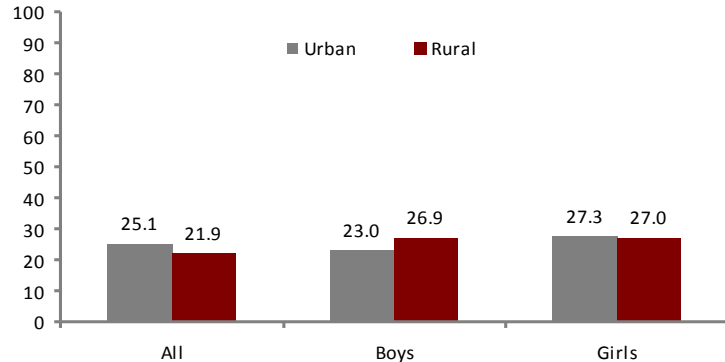
Chapter 3: Physical Activity and Sedentary Behaviors

Physical activity

Physical activity among pre-school and elementary school aged children

In 1999-2006, one in four US children aged 2 to 5 years old was not physically active, that is, they did not engage in play or exercise hard enough to make them sweat or breathe hard for 5 or more times per week and thus did not meet physical activity guidelines (24.4%; see Table B-5). Among children aged 2 to 5 years old, a greater proportion of girls than boys failed to meet the physical activity recommendation (27.2% vs. 21.6%, $p < 0.05$). There were no significant differences in reported physical activity between rural and urban children in this age group (see Figure 5).

Figure 5. Percent of children 2-5 years who do not meet physically activity recommendation, by sex and residence



Data Source: 1999-2006 NHANES

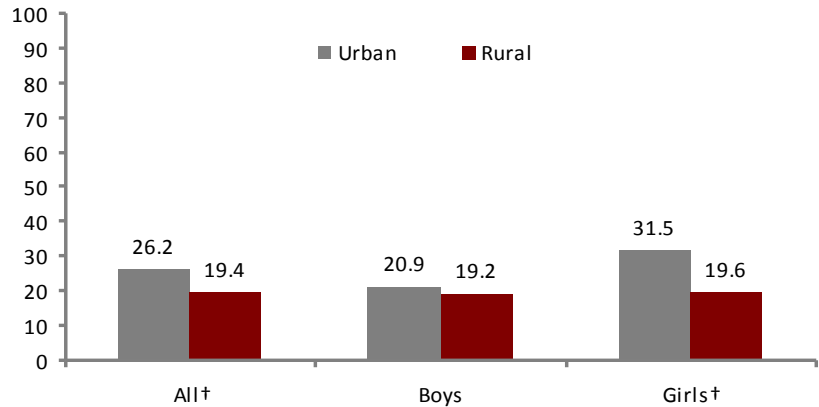
†P-value <0.05

How physical activity was measured:

- Among children ages 2 – 11 years, physical activity assessment was based on questions asking how many times per week children played or exercised hard enough to make them sweat or breathe hard. Children must engage in physical activity five or more times per week to meet CDC recommendations.
- Among children 12 – 19, respondents were asked the frequency and duration of each type of physical activity they participated in over the past 30 days. This information was used to calculate metabolic equivalents for vigorous physical activity (VPA) and moderate to vigorous physical activity (MVPA; details in Appendix). Children were sorted into four groups: no physical activity, and the bottom, middle and top third for reported VPA or MVPA.

Among children aged 6 to 11 years old, 24.7% reported insufficient physical activity to meet recommendations. Rural children were less likely than urban children to fail to meet physical activity guidelines (19.4% versus 26.2%; $p < 0.05$, see Table B-6 and Figure 6). Rural girls aged 6 to 11 years old were more likely to meet physical activity guidelines than urban girls of the same age (19.6% versus 31.5%; $p < 0.05$). Physical activity levels did not vary significantly by residence among six to eleven year old boys (Figure 6).

Figure 6. Percent of children 6-11 years who do not meet physically activity recommendation, by sex and residence



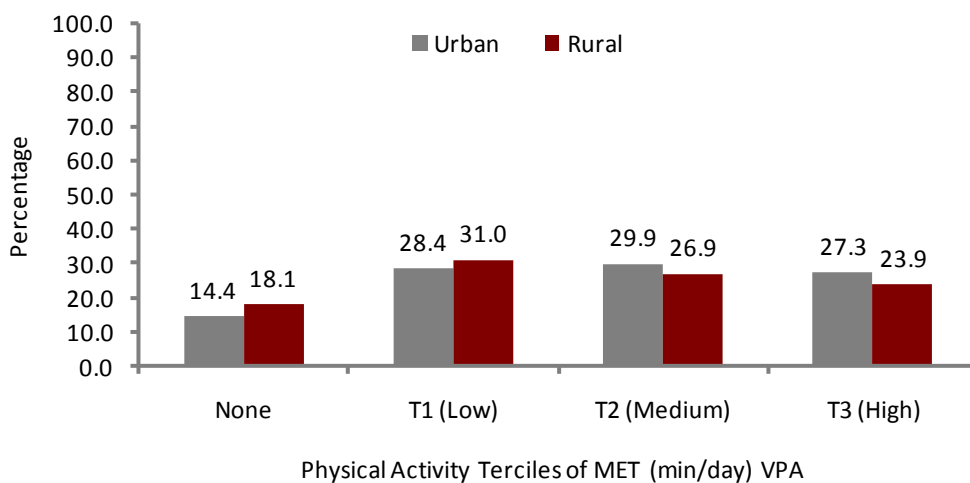
Data Source: 1999-2006 NHANES

† p -value < 0.05

Physical activity among adolescent children

Among adolescents aged 12 to 19 years old, 21.2% reported no vigorous physical activity (VPA) in the past 30 days while 11.6% reported no participation in vigorous or moderate-to-vigorous physical activity (MVPA) in the past 30 days. There were no significant differences between rural and urban adolescents as a whole or between rural and urban adolescent boys. However, rural adolescent girls were more active than their urban counterparts, with more rural than urban girls falling into the highest tercile for vigorous physical activity (30.3% versus 23.3%) and for moderate to vigorous physical activity (35.8% versus 27.9%) (See Table B-7 and Figures 7a and 7b).

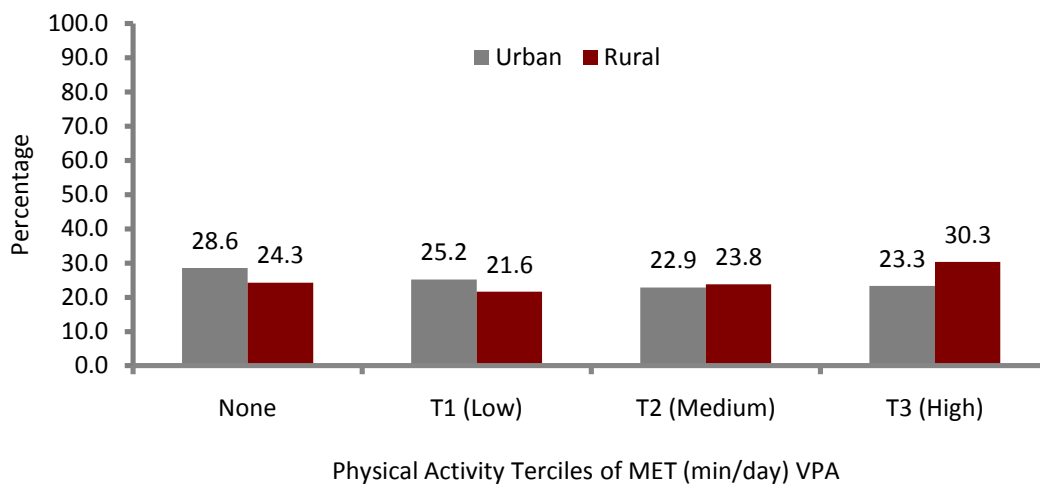
Figure 7a. Percent of U.S. boys aged 12-19 years old and corresponding physical activity terciles, by residence



Data Source: 1999-2006 NHANES

†P-value<0.05

Figure 7b. Percent of U.S. girls aged 12-19 years old and corresponding physical activity terciles, by residence†



Data Source: 1999-2006 NHANES

†P-value<0.05

In addition to overall activity levels, we also examined exercise specific behaviors among adolescents. Urban adolescents were more likely to report commuting to school or doing errands by walking or biking than were rural adolescents (47.4% versus 38.5%, $p < 0.05$; Table B-7). The proportion of children reporting strength exercises was higher among boys than girls (67.7% versus 53.3%, $p < 0.05$), but there were no differences based on residence (Table B-7).

Sedentary behaviors

A majority of children in both rural and urban settings spend more time in sedentary activity than recommended by national guidelines, with participation in sedentary behaviors increasing significantly between pre-school and elementary school ages.

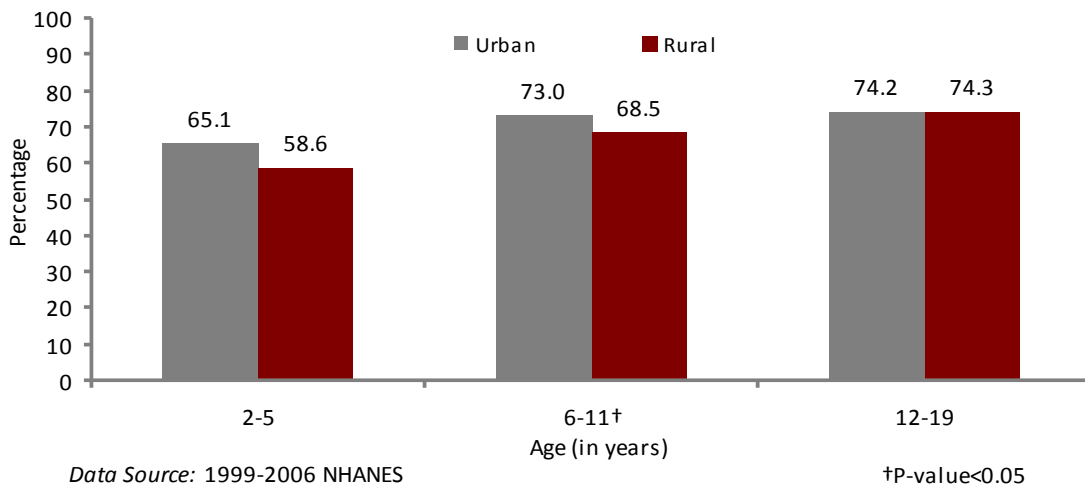
Overall, 63.6% of US children aged 2 to 5 years old spent two hours or more per day on sedentary activities such as watching TV or videos, using a computer, or playing computer games (Table B-5), with no significant differences between urban and rural children. While urban and rural boys did not differ, relatively fewer rural girls aged 2 to 5 exceeded screen time guidelines than their urban counterparts (52.0% rural vs. 63.7% urban, $p < 0.05$; Table B-5).

Among children aged 6 to 11 years old, 72.0% spent two hours or more per day on sedentary activities, again with no significant differences between urban and rural children in both boys and girls (Table B-6). The rate of sedentary behavior was significantly greater among 6 - 11 than among 2-5 year old children. Among adolescents, 74.2% reported spending more than two hours per day in sedentary behaviors, with no difference between urban and rural children (Table B-7). Sedentary behavior among adolescents was not significantly higher than among 6 – 11 year old children (See Figure 8).

How sedentary behavior was measured:

Some activities, such as television viewing, reading, working at a computer, talking with friends or on the telephone, or driving a car, do not require a person to expend any more energy than they would at rest. The NHANES asked children how much time they spent watching TV or videos, using a computer, or playing computer games. We refer to these activities collectively as sedentary behaviors or screen time. National guidelines recommend no more than two hours per day of screen time for children (see Appendix for details).

Figure 8. Percent of US children who spent two hours or more per day on sedentary activities by residence and age



Physical activity and sedentary behaviors in minority children

In general, there were few differences in physical activity associated with race/ethnicity among children aged 2 to 11 years old. Because sample sizes are smaller when looking at children within racial/ethnic groups, we could not create separate estimates for pre-school and elementary school age children. Hispanic children were slightly less likely to fail to meet physical activity recommendations than white children (Table B-8). Rural white children were less likely to fail to meet physical activity recommendations than urban white children. When stratifying by gender within white children, only rural white girls were less likely to fail to meet physical activity recommendations than urban white girls (21.9% versus 30.7%).

Black children were markedly more likely to exceed screen time guidelines than white children (81.8% vs. 65.3%). Similar racial differences were observed among boys and girls aged 2 to 11 years old. No urban/rural differences were observed in sedentary activities among children in this age group (Table B-8).

Among adolescents aged 12-19 years old, black children (25.6%) and Hispanic children (27.5%) were more likely to report no participation in vigorous physical activity than white children (17.9%, p-value<0.05, See Table B-9). These racial differences were consistent among boys and girls; there were no differences based on residence. Similarly, black adolescents were

more likely to exceed screen time guidelines (≥ 2 hours/day) than white adolescents (80.7% vs. 74.1%). Participation in sedentary behavior was similar for rural and urban adolescents.

Why behavior matters: Associations of physical activity and sedentary behaviors with overweight or obesity

Does meeting the physical activity guidelines or not exceeding screen time guidelines reduce the urban / rural disparity in the prevalence of obesity among children aged 2 to 11?

Among children aged 2 to 11, the percentage who were overweight or obese did not vary significantly by whether the child met physical activity guidelines (29.0% among children who met guidelines versus 29.6% among those who did not; Table B-10). However, the prevalence of overweight was significantly higher among physically active rural boys aged 2-11 (36.7%) than among similar urban boys (28.2%; Table B-10). While this finding seems contrary to our understanding of obesity (i.e., being active should prevent obesity), it could be that the total intensity of physical activity is lower among rural children, within the broad category of meeting physical activity guidelines, so that more time spent in activity doesn't mean more energy expenditure. Alternatively, it could be that other aspects of rurality, such as dietary patterns might be relatively more important in understanding obesity in rural boys.

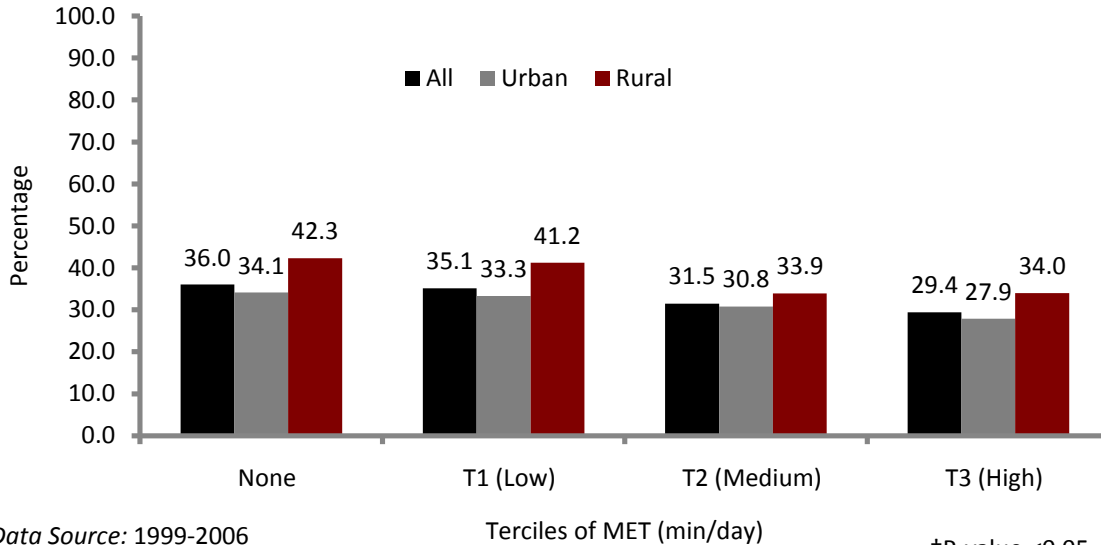
Among children aged 2 to 11, exceeding screen time guidelines (that is, more than two hours per day) was significantly associated with overweight and obesity status. Among all children aged 2 to 11, 30.5% of those who exceeded guidelines were overweight, versus 26.0% of those with less time in this behavior (Table B-10). Spending two or more hours in sedentary activities was similarly associated with obesity, with 16% of sedentary children being obese and 12.1 % of non-sedentary children being obese. Exceeding screen time guidelines was significantly associated with overweight and obesity among girls in this age group, but not among boys. With one exception (boys 2-11), there were no differences between urban and rural children within the categories of exceeding screen time guidelines; that is, the effects of sedentary behavior were similar for children regardless of whether they live in a rural or urban area. The single exception was among boys who exceeded screen time guidelines, among

whom a higher proportion of rural boys were overweight than among urban boys (37.6% versus 29.5%, $p < 0.05$; Table B-10). This might be due to rural boys having a much higher number of hours spent in screen activities than urban boys or that rural children are more likely to be overweight than urban children.

Does participation in physical activity or not exceeding screen time guidelines reduce the disparity between rural and urban adolescents aged 12-19 in the prevalence of overweight or obesity?

Participation in VPA or MVPA was significantly associated with lower prevalence of overweight among all children aged 12-19 years old (Table B-11, Figure 9). As anticipated, the proportion of children who were overweight was lowest among those in the highest tertiles of VPA and MVPA. This relationship was consistent among boys and girls for both overweight and obesity outcomes.

Figure 9. Percent of overweight or obesity by physical activity among U.S. children 12-19 years old, by residence†



Data Source: 1999-2006

Within specific physical activity categories, the proportion of rural children who were overweight was generally similar to that among urban children. Rural children were more likely to be overweight than urban children in some categories of VPA and MVPA, such as all children and boys reporting no VPA, lowest tertile vigorously active girls, lowest tertile moderate to

vigorously active children and girls (Table B-11). Rural children were also similar to urban children in the proportion who were obese within each activity category. Again, when rural children differed from urban children, it was because rural children were more likely to be obese (such as boys reporting no VPA; children in the medium tercile in MVPA; Table B-12).

Sedentary behavior (screen time in excess of two hours per day) was positively associated with weight among all children, boys and girls in the 12 to 19 year old age group ($p < 0.05$; Tables B-11, B-12). If they reported spending ≥ 2 hours in screen time per day, a significantly higher percentage of overweight was observed among rural children (all, boys, girls) than urban children ($p < 0.05$; Table B-11) and higher percentage of obesity among rural children (all, boys) than urban children ($p < 0.05$, Table B-12). Again, while the relationship between activity level and overweight or obesity was similar among rural and urban children, the rates of overweight and / or obesity were generally higher among rural children.

Does commuting by bike or walking reduce the disparities in the prevalence of overweight or obesity among adolescents?

Commuting by walking or biking was not significantly related to overweight or obesity among all children aged 12 – 19 (Tables B-11, B-12). Among children who did not report active commuting, rural children were more likely to be overweight or obese than their urban counterparts (38.7% versus 30.4% among all children; 41.2% versus 30.1% among boys, $p < 0.05$; not significant among girls, Table B-11). Among girls who do walk or bike to school or to run errands, the prevalence of overweight was higher among rural girls than among urban girls (40.4% versus 29.7%, $p < 0.05$; Table B-11). The prevalence of obesity was higher among rural children and rural boys than urban children if they reported no commuting by walking and biking (Table B-12).

Does strength exercise reduce the disparity in prevalence of overweight or obesity between rural and urban adolescents?

The proportion of children who were overweight or obese was greater among children who did not report any strength exercise (all children and among girls; Tables B-11, B-12).

Strength exercise was not associated with weight status among boys. As was the case with commuting activity, we observed significant differences between rural and urban children in several categories, all of which showed a higher prevalence of overweight among rural children (all, among those who did and did not report strength exercise, boys who did not report strength exercise, and among girls who did strength exercises) (Table B-11). In terms of obesity outcome, among those who reported strength exercise, rural children had a significantly higher proportion of obesity than urban children ($p < 0.05$; Table B-12). These urban / rural differences within categories are consistent with the higher prevalence of overweight and obesity among rural children in general.

Summary

Rural children were not markedly less active than urban children and, in some age groups (all children, and girls aged 6-11 and 12-19), rural children were more active. Nonetheless, the prevalence of overweight and obesity is higher among rural children, even in some cases within the “good” categories (high activity, low sedentary behavior). The explanation of residential differences must lie in a different set of factors, thus, we explore diet.

Chapter 4: Diet and Dietary Quality

Given that rural children are generally as physically active as their urban counterparts, and in some cases, more physically active, activity levels alone must not be responsible for the higher rates of overweight and obesity found in rural children. Thus, we used the detailed diet recall information collected by NHANES to examine rural children's diet. The measures used are summarized in the box at right and described in detail in the Appendix. Because dietary recommendations vary by age and behaviors vary by gender, we present all dietary information stratified by age and gender.

Pre-school aged children (2-5 year olds)

On average, 2 to 5 year old children were reported to consume 1,632 kcals per day (Table B-13). Boys consumed about 130 kcals more than girls (1,698 vs. 1,567 kcals). The Dietary Guidelines for Americans recommends that 2 to 3 year olds consume about 1,000-1,400 kcals per day and that 4 to 8 year olds consume 1,000 to 2,000 per day, depending on their activity levels.¹³ Thus, average energy intake for pre-school age children seems adequate to support an active lifestyle during this period of rapid growth. Rural and urban children did not differ significantly in total calorie intake (1,687 kcals vs. 1,617 kcals).

Pre-school aged children consumed an average of 58 grams of fat per day, consistent with recommendations from the Dietary Guidelines that no more than 35% of total energy come from fat (about 38 to 77 grams of fat, depending on age and activity level). Pre-school-aged children living in rural areas consumed more fat than children living in urban areas (62.7 g v. 56.9 g, $p < 0.05$), with rural boys having the highest consumption of fat (Table B-13).

Overall dietary quality as measured by the Healthy Eating Index was low among children aged 2 to 5. The average child had a score of 51.3 out of a possible 100 points on the score.

We used eight measures to assess quantity and quality of children's diets. These were:

- Total calorie intake (kcal)
- Fat intake (grams)
- Fiber intake (grams)
- Consumption of sweetened beverages
- Consumption of fruit
- Consumption of vegetables
- Healthy Eating Index score (see appendix)

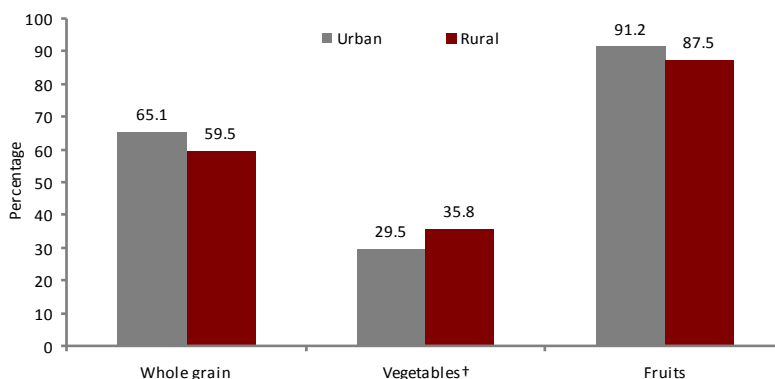
Boys and girls were similar and we did not observe significant differences by rural and urban residence.

Pre-school-aged children should consume about 14 g of fiber per 1000 kcals, or 14 to 28 grams per day from a variety of foods including vegetables, fruits and whole grains. Pre-school-aged children were not consuming sufficient fiber (10.6 g on average) in either rural or urban areas (Table B-13). We did not note any differences among rural and urban children or boys or girls. Looking at specific fiber-rich food groups, pre-school aged children were not consuming sufficient fruits, vegetable or

whole grains. Almost seventy percent of pre-schoolers were noted to have eaten *no* vegetables on the day of reporting. Rural children were more likely than urban children to report at least some vegetable intake (35.8% versus 29.5%,

$p < 0.05$), with most of this difference being explained by greater intake in rural girls than urban girls (Table B-13, Figure 10). Only 22.6% of children consume recommended amounts of fruits, that is, two or more cup-equivalents per day, with no significant differences by residence. Whole grain intake was more prevalent, with 63.9% of children reporting at least some whole grain intake, with no differences by rural or urban residence.

Figure 10. Percent of US children aged 2-5 years who reported consuming at least some whole grains, vegetables and fruits by residence



Data Source: 1999-2006 NHANES

† p -value < 0.05

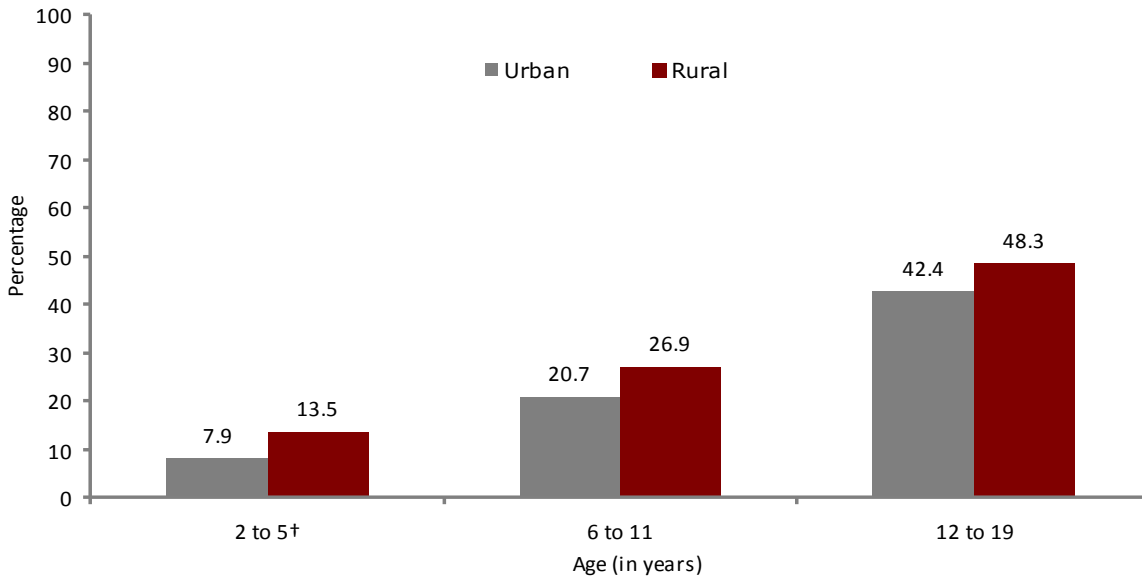
What counts as a cup of fruit?

The new USDA Food Guide Pyramid uses common measurements to recommend amounts of foods to eat. Fruits are measured in cups. As a reference, $\frac{1}{2}$ of a large apple, a whole large banana, a large orange, or about 8 strawberries are all one cup-equivalent.

Calorically-sweetened beverages, such as sodas, fruit drinks, and drink mixes are considered discretionary calories. Sweetened beverage consumption in young children can lead to children substituting beverages for much needed nutrient-rich foods and beverages to

sustain rapid growth. Overall, about 60% of all 2 to 5 year old children were consuming less than 8 ounces of calorically sweetened beverages. About 31% of all 2 to 5 year olds were consuming between 8 and 24 ounces of sweetened beverages. Approximately 9% of all 2 to 5 year olds were consuming more than 24 ounces of sweetened beverages (not including sweetened milks). We found that overall, urban children are consuming less sweetened beverages than rural children, with only 7.9% of urban 2 to 5 year olds (versus 13.5% rural children) consuming more than 24 ounces of sweetened beverages per day on average ($p < 0.05$). This difference is most pronounced among 2 to 5 year old girls, where 63.6% of rural girls consume less than 8 ounces versus 52.8% of urban girls ($p < 0.05$) (table B-13 and Figure 11). In Figure 11, the percentage of children in each age group that consumed more than 24 ounces of sweetened beverages is presented by place of residence. Among 2 to 5 year olds, significantly more rural children are consuming more than 24 ounces of sweetened beverages on the previous day.

Figure 11. Percent of US children aged 2-19 years who reported consuming more than 24-ounces of sweetened beverages the previous day by age and residence



Data Source: 1999-2006 NHANES

†P-value < 0.05

Elementary school-aged children (6 to 11 years)

Across the US, children aged 6 to 11 years averaged about 2,000 kilocalories of energy consumption per day in 1999 – 2006, with no significant differences between urban and rural children (Table B-14). Among school aged children, boys reported higher kcal intake than girls (2,145 versus 1,891 kcal, $p < 0.05$), but there were not significant differences between rural and urban boys or girls in energy intake. These average intakes would support the growth and activity of active school aged children but would be higher than recommended for children who are sedentary or only moderately active.¹³ Rural children consumed more fat on average than urban children (80.3 g vs. 73.2 g, $p < 0.05$). The greatest differences in fat intake were between rural and urban girls (75.3 g vs. 69.0 g, $p < 0.05$). Interestingly, these higher fat intakes did not translate into significantly higher total energy intakes, suggesting that rural girls may be eating less of other macronutrients (protein and carbohydrate).

Overall dietary quality is slightly lower in school-aged children than in preschool aged children, according to the Healthy Eating Index scores ($p < 0.05$). While younger children had an average HEI score of 51.3, the average among all 6 to 11 year old children was 47.8. We did not observe significantly different HEI scores between rural and urban children aged 6 to 11.

Like pre-school aged children, 6 to 11 year olds were not consuming sufficient fiber during 1999-2006. All children reported consuming about 13 g of fiber per day on average, with no differences by urban or rural residence (Table B-14). Looking at specific fiber-rich food groups, elementary school aged children, like preschool children, were not consuming sufficient fruits, vegetable or whole grains. About 58% of 6 to 11 year old children reported consuming at least some whole grains on the previous day. About 38% of 6 to 11 year olds reported consuming at least some vegetables on the previous day. About 15% of these children reported consuming the recommended two cups or more of fruit. We did not observe any significant differences by residence or gender in whole grain, fruit or vegetable intake of 6 to 11 year olds.

About 22% of six to eleven year old children, on average, reported consuming more than 24 ounces of calorically sweetened beverages per day. Proportionately more rural children reported consuming 24 or more ounces than urban children (26.9% v. 20.7%), but the

difference was not statistically significantly different. About 1/3 of the sample of 6 to 11 year old children report drinking less than 8 ounces of sweetened beverages (38.6%). Girls are more likely to report less than 8 ounces of sweetened beverages than boys (42.1% vs. 35.1%, $p < 0.05$, Table B-14).

Adolescents (ages 12 to 19)

Children aged 12 to 19 experience rapid growth and development and have greater dietary needs than at almost any other time in life. Children of this age are also becoming aware of body image as a part of self, and expectations for beauty and thinness are heightened. Often dietary intake is mis-represented by adolescents in their efforts to report socially desirable intake patterns; this is especially true of adolescent girls concerned with thinness.¹⁴⁻¹⁵ Thus, we note that reported dietary data may be distorted in this age group. However, there is no reason to believe that body image issues or the social desirability of food consumption patterns varies by urban versus rural residence.

Across the whole US, adolescent boys reported an average total energy intake of 2,661 kcals per day, while girls reported 1,969 kcals per day ($p < 0.05$; Table B-15). The dietary guidelines for Americans recommend that adolescent boys consume between 1,800 and 3,200 kcals per day depending on age and activity level, and that girls consume between 1,600 and 2,400 kcals per day. The high average intakes reported by boys and girls would support the growth and development of active adolescents but exceed the energy needs of sedentary adolescents. We did not observe differences in rural and urban adolescents' total caloric intake.

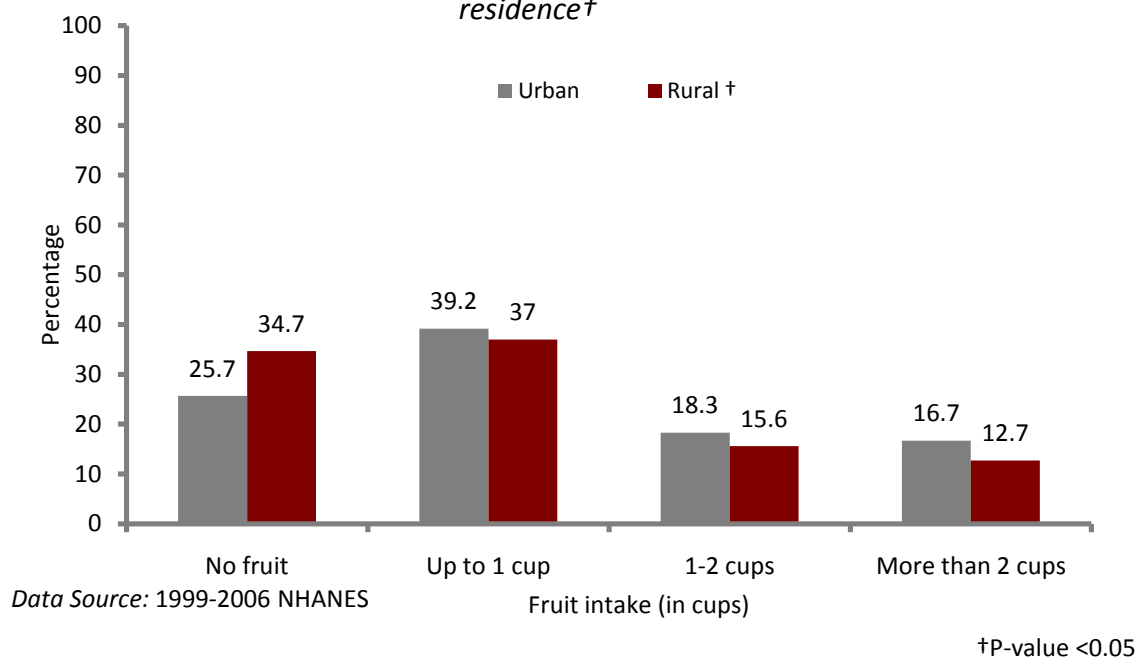
Overall, adolescents reported a level of fat intake consistent with dietary guidelines, consuming about 85 grams of fat (Table B-15). We did not observe differences in fat intake by rural and urban residence. Consistent with their higher total energy intake, boys reported consuming considerably more fat than girls in each residence category. Overall dietary quality, as measured by the HEI score, was lower among adolescents than the other two age groups (school age children, $p < 0.05$; pre-school age children, $p < 0.05$). With average HEI score of 46.5. We found a slightly higher HEI score in urban adolescents (1.3 points) than in rural, with most

of the difference being explained by a slightly higher HEI in urban girls (47.3 v. 45.7). Pre-school aged children who are overweight ($\geq 85^{\text{th}}$ percentile for BMI) consumed more energy, fat and less fiber than children below the 85^{th} percentile. In general, we did not find that rural pre-school aged children consumed any more or less calories than urban pre-school aged children (Table B-16). However, among pre-schoolers who were overweight, we found that girls living in rural areas consumed significantly more fat than girls in urban areas (70.9 grams vs. 55.4 grams, $p<0.05$). Among preschoolers that were not overweight, we found that girls in rural areas had significantly lower dietary quality (HEI) than girls living in urban areas (48 vs. 52, $p<0.05$). We found no significant differences between rural and urban boys.

Adolescents reported consuming inadequate amounts of dietary fiber (13.7 g per day for all children; see Table B-15). Rural girls reported a small but significantly different intake than urban girls (11.2 vs. 12.3, $p<0.05$). Only 45.4% of all adolescents reported that they had consumed any whole grains the previous day, and only 50.8% of adolescents reported that they had consumed at least some vegetables the previous day. There were no differences by place of residence. About 16% of all adolescents reported eating the recommended two cups of fruit. Significantly more rural children than urban children reported consuming fruit ($p<0.05$) (Figure 12).

Forty-three percent of adolescents report consuming more than 24 ounces of calorically sweetened beverages on average. There is a trend toward high consumption among rural children, but the differences are not significantly different. About 50% of all adolescent boys reported consuming more than 24 ounces of sweetened beverages while 36.8% of girls reported this high level of consumption ($p<0.05$).

Figure 12. Fruit intake among US children aged 12-19 years by residence†



Are dietary behaviors different among overweight rural children?

In this section, we compare the total energy, fat, fiber and Healthy Eating Index scores between children that are at or below and above the 85th percentile for BMI, living in rural and urban areas of the United States.

Pre-school aged children who are overweight ($\geq 85^{\text{th}}$ percentile for BMI) consumed more energy, fat and less fiber than children below the 85th percentile. In general, we did not find that rural pre-school aged children consumed any more or less calories than urban pre-school aged children (Table B-16). However, among pre-schoolers who were overweight, we found that girls living in rural areas consumed significantly more fat than girls in urban areas (70.9 grams vs. 55.4 grams, $p < 0.05$). Among preschoolers that were not overweight, we found that girls in rural areas had significantly lower dietary quality (HEI) than girls living in urban areas (48 vs. 52, $p < 0.05$). We found no significant differences between rural and urban boys.

School-aged children (6 to 11 year olds) show similar dietary intake to younger children, but consume more, as would be expected. Consistent with younger children, overweight school aged children consume more energy, fat and fiber than normal weight children (data not

shown in table). We found that rural overweight girls consumed significantly more fat (77 g vs. 68 g, $p < 0.05$, Table B-17) than urban overweight girls. Otherwise, we saw no significant differences between rural and urban school-aged children's dietary intake.

Adolescents in this sample show the greatest urban and rural differences in dietary intake. Among girls, we observed significant urban and rural differences in normal weight girls in fiber intake ($p < 0.05$). Specifically, rural girls reported consuming less total fiber (~ 1g on average, $p < 0.05$). We did not observe significant urban and rural differences in overweight girls. Among boys, we did not observe differences in rural and urban boys dietary intake among normal weight boys. They reported consuming large amounts of calories, fat, with relatively low dietary quality, regardless of location (~2700 kcals per day, 101 g of fat, and HEI score of 44 to 46, on average). Overweight boys did differ by location, so that rural overweight boys reported consuming more calories (2580 vs. 2378, $p < 0.05$), more fat (95 g vs. 85 g., $p < 0.05$), and marginally less fiber (12 g vs. 14 g, $0.05 < p < 0.1$).

Chapter 5: Risk Factors for Overweight Among Rural Children

To better understand the risk factors associated with childhood obesity, we ran multiple logistic regression models with weight status (overweight or obesity versus normal weight) as our outcomes and urban or rural residence as our main independent variable of interest. We ran incremental models by adding socio-demographic, health, health care, and obesity-related behavioral variables such as diet, physical activity and sedentary behaviors sequentially. Because the results for obesity are very similar to those for overweight status, only overweight models are presented here.

We first examined factors associated with overweight among children aged 2-11 years old. In a simple comparison, rural children were more likely to be overweight than their urban peers (Odds Ratio (OR): 1.3, 95% CI: 1.0-1.7; Table B-19, model 1). After adjusting for differences in demographic, socioeconomic, and health-related conditions between rural and urban children, rural children continued to be significantly more likely to be overweight (AOR: 1.4, 95% CI: 1.1-1.8; Table B-19, model 2). Adjusting for obesity-related behaviors (diet, physical activity, or sedentary behaviors) did not reduce the risk for overweight among rural children, which remained above their urban peers (Table B-19, models 3-8). In models that took into consideration the child's demographic, socioeconomic and health status, no obesity-related behaviors were significant predictors of overweight status. In analyses stratified by gender, we found no significant differences between rural and urban girls. Among boys aged 2-11 years old, regardless of any adjustments, rural boys always had 1.4 times higher odds of being overweight than urban boys (OR 1.4; 95% CI: 1.0-1.9; Table B-19).

We next examined factors associated with overweight among children aged 12-19 years old. Without adjusting for other characteristics, rural children had significantly higher odds of being overweight than urban children (unadjusted OR: 1.3, 95% CI: 1.0-1.6, Table B-20). The association remained statistically significant after adjusting for socio-demographic characteristics of the child, his/her participation in vigorous physical activity, sedentary behaviors, and diet variables (Table B-20, Models 2-8). This suggests that differences in

overweight status among children aged 12-19 were not explained by these factors. Spending 2 or more hours per day in sedentary activities was associated with 50% increase in the odds of being overweight compared to children who spent less than 2 hours per day in screen activities (OR 1.5, 95% CI: 1.3-1.8; Table B-20, model 8). A 5-gram increase in fiber intake was associated with significantly (10%) lower odds of overweight among adolescents aged 12-19 years old (95% CI: 0.8-0.9). This suggests that sedentary behaviors and fiber intake are independent risk factors for overweight status among children aged 12-19.

Among adolescent boys, there is no significant difference in overweight status by urban and rural residence. However, among adolescent girls aged 12-19, rural girls had significantly higher odds of being overweight than urban girls (unadjusted OR: 1.4, 95% CI: 1.1-1.8, Table B-20) and this difference remained statistically significant after adjusting for socio-demographic and obesity-related behaviors. Sedentary behaviors and total fiber intake are significant risk factors for overweight status among adolescent girls. Among adolescent boys, only sedentary behaviors is a significant risk factor for overweight status.

Chapter 6: Conclusions and Policy Implications

Summary of main results

Overweight and obesity were more prevalent among rural children, primarily among adolescents. While there were no differences in total calorie intake by residence, rural children had a higher fat intake (preschool-aged children, school-aged children) and higher level of sweetened beverage intake (preschool-aged children) than urban children. Adolescents had poorer dietary quality than younger children. Rural adolescent girls consumed less fiber than urban adolescent girls.

A majority of US children (range: 64-74% depending on age and gender) reported spending more than two hours per day on sedentary behaviors such as watching TV or videos, using a computer, or playing computer games. Differences between rural and urban children were not consistent. Some rural children, specifically school-aged children and adolescent girls, were more physically active than their urban counterparts. However, rural preschool aged children were more likely to exceed screen time guidelines than their urban counterparts.

Among children aged 2-11 and adolescents aged 12-19 years, after adjusting for socio-demographic, health, and obesity-related behavioral factors, rural disparity in the prevalence of overweight persisted or did not change if there was no significant difference (i.e, among girls 2-11 years old and boys 12-19 years old). This suggests that obesity-related behaviors do not contribute to contemporaneous overweight status, although it is possible that the continuation of such behaviors over time results in subsequent disparities. Among adolescents aged 12-19 years, spending 2 hours or more per day on sedentary behaviors and lower fiber intake were associated with the increased odds of overweight.

Program and policy implications

Policies and programs are needed to reduce the gap between rural and urban children's risk of obesity because obesity tracks from childhood to adulthood,¹⁶ thus, a higher prevalence of obesity in rural children can have lifelong implications for rural communities. The prevention

of excess obesity is of crucial importance for protecting rural quality of life and population health. Rural areas can reduce obesity and its negative consequences through addressing diet and activity patterns in children.

For preschoolers and school-aged children (ages 2-11 years old), policies and programs to prevent childhood obesity in rural areas should focus on the behaviors that lead to obesity—excessive sedentary behavior particularly television viewing, and grams of fat and sweetened beverages that children consume on a regular basis. First, parenting education efforts can focus on how to redirect children into other activities and structure screen time into an overall active lifestyle. Second, rural families with young children need access to high quality, affordable and safe child care, and opportunities for safe free play, preferably out of doors. Some communities have instituted policies that increase access to active play, such as leaving school playgrounds open and available to children after school hours, or installing walking and biking trails for children. Third, rural families need access to foods that will reduce the total intake of fat. For instance, policies that encourage food retailers to provide lean meats, low-fat dairy products and quality fruits and vegetables, and educate consumers about the benefits of low fat products for children, could help to reduce home consumption of fat. Behavior-based educational programs that assist families in developing cooking and parenting skills to reduce total fat in the diet could lead to the small changes in children’s diets needed to reduce the prevalence of obesity. Finally, in schools and other care settings, children can be offered lower fat alternatives through already established school meals programs. Sweetened beverages represent discretionary calories in the diet, and should not be accessible to children in care or school settings. Studies have shown that policies and programs that regulate the availability of foods such as sweetened beverages can reduce consumption of these low-nutrient beverages.¹⁷

For adolescents aged 12-19 years old, programs and policies directed at reducing the higher prevalence of overweight and obesity among rural children should focus on increasing their participation in physical activity, particularly vigorous activities, reducing the amount of sedentary behavior, particularly television viewing, and promoting healthy diets with higher

fiber intake, lower fat and sweetened beverage consumption. Programs and policies mentioned for younger children can also apply for this age group.

Additional place-specific research is needed to understand why children in rural areas have a higher prevalence of obesity. Of particular importance are studies that examine the social ecology of obesity. For example, limited studies have examined how environmental factors (access to healthy food, sports facilities, playgrounds, safe walking trails etc.) differ by rural and urban areas and how it influences the children's diet, physical activity and sedentary behaviors and their weight status. Expansion of research into the needs of children will help reduce the burden of ill-health for the next generation.

Appendix A: Design, Data and Methods

Study design

A cross-sectional study

Data source

Our research used data from the 1999-2006 continuous National Health and Nutrition Examination Survey (NHANES). NHANES is an ongoing, nationally representative study conducted by the National Center for Health Statistics (NCHS). NHANES uses a complex, stratified, multistage probability sampling procedure designed to provide prevalence estimates describing the health and nutritional status of the civilian, non-institutionalized US population. To allow for accurate estimates for sub-groups, NHANES oversampled blacks, Hispanics, adolescents, elderly, and pregnant women. Data from NHANES have provided the basis for national references for such measurements as height and weight and have been used in many epidemiological studies which have helped to develop sound public health policy, direct and design health programs and services, and expand the health knowledge for the Nation.¹⁸

The NHANES reaches about 5,000 persons each year in counties all across the United States. Fifteen of these counties are visited annually. Households are selected randomly within each county. The NHANES team first conducted health interviews and then invited the respondents to complete physical examinations and laboratory measurements in mobile examination centers (MEC). Over the 8 year period from 1999-2006, the home interview response rate was 81% and 95% of respondents interviewed at home had a follow-up examination in the MEC. All questions asked in the home and MEC were available in Spanish.

Assisted interviews were completed with children younger than 16 years old for demographic questions. Children were asked to provide their own data assisted by an adult household member (referred to as the assistant). For physical activity questionnaires, proxy respondents answered all questions for 2-11 years olds, while those aged 12-19 followed the adult self-report protocol. For diet questionnaires, proxy interviews were conducted for survey

participants less than six years of age. Interviews for children between 6 and 8 years of age were conducted with proxies, but the child must be present to assist the proxy during the interview. Assisted interviews were conducted with children aged 9 to 11 years old. The preferred proxy/assistant is the person most knowledgeable about what the children ate the day before the interview.

The sample sizes (unweighted observations) for the data used in the present report are shown below, sorted by age, gender, residence and race (Table A-1). The small sample sizes in several of the rural age groups, coupled with the relatively small proportion of minority race/ethnicity children who live in rural counties, restricted the extent to which the analysis could address race-based differences within the rural population. In particular, only limited estimates are offered for “non-Hispanic other” children. In specific tabulations such as physical activity (Tables B-8 and B-9), in which the number of observations for rural “other” children is small, estimates are limited to white, black and Hispanic children.

Measures

Urban and rural residence. Residence is defined using the Rural-Urban Commuting Area (RUCA) definition developed by the University of Washington’s Rural Health Research Center and the USDA Economic Research Service (ERS). The RUCA categories are based on the size of settlements and towns as delineated by the Census Bureau and the functional relationships between places as measured by track-level work-commuting data.¹⁹ Public use data files for NHANES do not have census track data. Thus, we accessed this protected data through the Research Data Center at the National Center for Health Statistics. There are 10 major RUCA classifications²⁰ and we further defined urban as RUCA codes between 1 and 3 and rural areas as RUCA codes between 4 and 10.

Table A-1. Unweighted sample size of US children and adolescents by sex, age, race or ethnicity, and residence, 1999-2006 NHANES

		All	Race or Ethnicity of Child:			
			Non-Hispanic White	Non-Hispanic Black	Hispanic	NH others
Both genders	Total	15,479	4,171	4,807	5,783	718
	2-5 years	2,985	906	813	1,097	169
	6-11 years	3,975	1,057	1,272	1,456	190
	12-19 years	8,519	2,208	2,722	3,230	359
Urban	Total	12,863	2,987	4,310	4,968	598
	2-5 years	2,467	624	742	968	133
	6-11 years	3,355	764	1,158	1,264	169
	12-19 years	7,041	1,599	2,410	2,736	296
Rural	Total	2,616	1,184	497	815	120
	2-5 years	518	282	71	129	36
	6-11 years	620	293	114	192	--
	12-19 years	1,478	609	312	494	63
Boys	Total	7,803	2,107	2,465	2,886	345
	2-5 years	1,486	466	400	539	81
	6-11 years	1,959	514	636	720	89
	12-19 years	4,358	1,127	1,429	1,627	175
Urban	Total	6,524	1,515	2,238	2,494	277
	2-5 years	1,221	320	367	474	60
	6-11 years	1,654	365	581	632	76
	12-19 years	3,649	830	1,290	1,388	141
Rural	Total	1,279	592	227	392	68
	2-5 years	265	146	33	65	--
	6-11 years	305	149	55	88	--
	12-19 years	709	297	139	239	34
Girls	Total	7,676	2,064	2,342	2,897	373
	2-5 years	1,499	440	413	558	88
	6-11 years	2,016	543	636	736	101
	12-19 years	4,161	1,081	1,293	1,603	184
Urban	Total	6,339	1,472	2,072	2,474	321
	2-5 years	1,246	304	375	494	73
	6-11 years	1,701	399	577	632	93
	12-19 years	3,392	769	1,120	1,348	155
Rural	Total	1,337	592	270	423	52
	2-5 years	253	136	38	64	--
	6-11 years	315	144	59	104	--
	12-19 years	769	312	173	255	29

-- Numbers were not presented due to sample size < 30. NH: non-hispanic

Anthropometric measures. Height and weight measurements were taken by trained examiners at the MEC. Digital scales and stadiometers that automatically transmit data into

databases were used to increase accuracy. These measurements were used along with the respondent's age and gender to calculate their body mass index (BMI), calculated as weight in kilograms divided by the square of height measured in meters (kg/m^2). Because of differences in children's development by gender and age during childhood, obesity and overweight were defined based on the sex-specific BMI for age growth charts from the CDC.²¹ Children whose BMI-for-age and -gender is in the 85th percentile or greater have been classified as overweight (included obese children). Children whose BMI-for-age and -gender is in the 95th percentile or greater have been classified as obese.

Physical activity measures. In NHANES, physical activity status is obtained differently for children less than 12 years of age compared to children 12 years of age or greater. As a result, all analysis was stratified by age group.

- For children less than 12 years of age, physical activity was obtained by asking the number of times per week the child played or exercised hard enough to make them sweat or breathe hard. In the analysis, children were considered inactive if they reported this level of activity less than 5 days per week and active if they reported 5 or more activity days per week.
- For children 12 years of age or greater, answers to questions regarding participation in moderate to vigorous physical activity (MVPA) were used to calculate metabolic equivalents (METs) per day. Respondents were asked to report the frequency and duration of each type of physical activity they participated in over the past 30 days. A MET was assigned to all activities reported by the respondents. The product of the number of times an activity was performed, the duration (in minutes) of the activity and the MET value was divided by 30 to determine the average MET minutes per day for a specific activity.²² To obtain MET minutes of vigorous physical activity (VPA), activities with a MET value of 6 or more were totaled. In our analyses, we created gender-specific terciles for VPA and MVPA MET minutes per day among those who reported VPA and MVPA activities. Thus, the recoded VPA and MVPA MET minutes variables have four

categories (0 MET minutes/day, tertiles of VPA or MVPA). We also analyzed these two variables in a dichotomous fashion (no VPA vs. VPA; no MVPA vs. MVPA).

Table A-2. Cut-off points for gender-specific tertiles for VPA and MVPA (in MET minutes) for children aged 12-19, 1999-2006

	<u>VPA</u>		<u>MVPA</u>	
	Boys	Girls	Boys	Girls
T1 (Low)	2.0	2.0	1.0	1.3
T2 (Medium)	170.7	92.0	144.0	145.0
T3 (High)	≥ 526.0	≥ 298.0	≥ 450.0	≥ 449.7

Sedentary behaviors. NHANES collected information on sedentary behaviors such as hours sitting and watching TV or videos, using a computer, or playing computer games. The answer options ranged from less than 1 hour to 5 hours or more per day with one-hour increments. In the 1999-2002 surveys, respondents greater than 15 years of age were asked one question for television and computer use while separate questions for computer and television use were used for NHANES 2003-2006 for this age group. In all years, subjects greater than 15 years of age were asked about their typical use over the past 30 days. For children aged 15 years or less, the computer and television use was asked about the day prior to the interview in 1999-2000, while it was about their typical day daily use over the past 30 days for the 2001-2006 NHANES. Based on the information provided, we created the total number of hours per day that the child spent in television and computer use. Using national guidelines,²³⁻²⁴ we defined excessive total screen time as ≥ 2 hours of screen time per day.

Diet intake and dietary behaviors. Across the 1999 – 2006 period, trained diet technicians from NHANES obtained detailed dietary intake information during the MEC visit, including the types and amounts of *all* foods and beverages consumed (excluding plain drinking water) in the period of 24 hours prior to the visit. Beginning in 2003, NHANES has started to use 2-day 24-hour dietary recalls. In this report, only 1-day (NHANES 1999-2002) or first-day

24-hour dietary recall data (NHANES 2003-2006) were used, to maintain equivalence in the measure across time. Prior studies have concluded that 24-hour recalls provide adequate validity and reliability.²⁵⁻²⁷ Table A-3 below summarizes proxy and assisted interviews for 24-hour diet recall data collection in NHANES

Table A-3. Table of proxy and assisted interviews for 24-hour recalls in NHANES

Child's Age, years	Interview	Adult Present	Child Present
<6	Proxy	Yes	No
6-8	Proxy/Assistant	Yes	Yes
9-11	Child/Assistant	Yes	Yes
≥12	Child	No	Yes

In our research, both a summary measure of diet quality and individual dietary factors were used to assess diet. The revised Healthy Eating Index (HEI-2005), developed and revised by the U.S. Department of Agriculture's (USDA) Center for Nutrition Policy and Promotion (CNPP), was used to assess compliance to federal dietary guidance.²⁸ HEI-2005 consists of 12 components, which represent all of the major food groups in MyPyramid (total fruits, total vegetables, milk, meat and beans) plus 8 additional components of whole fruit, dark green and orange vegetables and legumes, whole grains, oils, saturated fat, sodium, and calories from solid fat, alcohol, and added sugar (SoFAAS). Each component represents a different aspect of a healthful diet based on the 2005 Dietary Guidelines for Americans. The overall HEI score has a maximum value of 100. This index has been applied to NHANES data in previous research.²⁹⁻³¹ Using data from the NHANES 2001-2002, CNPP researchers concluded that HEI-2005 has satisfactory psychometric properties and validity and the individual components provide additional insight to that of the summary score.²⁸ In this report, the HEI score was used as a continuous variable.

While HEI score examines the quality of diet, it does not capture overconsumption of kilocalories. Previous intervention and observational studies have shown that energy intake

and percentage of energy from fat and fiber are the most important dietary factors in the development of obesity.³²⁻³³ In this report, we also present average energy (kcal), fat(g), fiber (g) and information on some key food groupings, such as calorically-sweetened beverages, fruits, vegetables and whole grains. Due to low consumption of certain foods, some analyses group diet into “any” versus “no” consumption:

- Calorically-Sweetened Beverages: Sweetened beverage consumption is categorized in this report as 0-8 ounces, 9-23 ounces, and 24 or more ounces.
- Fruits include both whole fruits and fruit juices and are categorized as no fruit intake, 0.1-1 cups, 1.1-1.9 cups, and 2 or more cups of fruit or fruit juice.
- Vegetables and Whole Grains: We dichotomized children’s diets based on whether they reported eating at least some vegetables or whole grains versus none.

Race / ethnicity of children was classified as Hispanic, non-Hispanic white, non-Hispanic black, and non-Hispanic other. The last category includes all other races as well as multiracial children. Because of the low number of non-white children living in rural counties, only aggregate analyses differentiate between urban and rural children by race/ethnicity.

Other covariates. In all adjusted analyses, we considered the following factors as potential confounders of the main associations of interest. They are child's age, gender, perceived health status, household poverty level, reference person’s education, region, health insurance status, and whether or not the child attends school.

- Perceived health status was assessed by asking the respondent how they would classify their health. The categories included were excellent, very good, good, fair, and poor. For the analysis, the variable was categorized as good/fair/poor, very good, and excellent.
- Household poverty level was determined using the poverty income ratio (PIR) which is a ratio of the family income to the family’s appropriate poverty threshold determined by the U.S. census bureau. This variable was categorized as <130% of the federal poverty level (FPL), 131-185% FPL, 186-250% FPL, and >250% FPL.

- Reference person's education was categorized as <12 years of education, 12 years of education, and >12 years of education. Reference person is defined as the first household member, 18 years of age or older, listed on the screener household member roster who owns or rents the residence where the respondent lives.
- Region was defined according to the U.S. Census Bureau classification using state FIPS codes.³⁴ The four regions are "Northeast" (States 9, 23, 25, 33, 34, 36, 42, 44, and 50), "Midwest" (States 17, 18, 19, 20, 26, 27, 29, 31, 38, 39, 46, and 55), "South" (1, 5, 10, 11, 12, 13, 21, 22, 24, 28, 37, 40, 45, 47, 48, 51, and 54), and "West" (2, 4, 6, 8, 15, 16, 30, 32, 35, 41, 49, 53, and 56).
- Health insurance status was determined by asking the respondent whether or not they were covered by some kind of health care plan. This variable was classified as yes or no.
- School attendance status was obtained by asking if the respondent attends school during the school year. This variable was also classified as yes or no.

Analytical samples

To obtain sufficient numbers of children for accurate estimation, we pooled eight years of data from the 1999-2006 NHANES, restricting to children and adolescents aged 2-19 years (n=17,807). Children were then excluded from the analysis for the following reasons: 1) did not complete the examination portion of the survey (673, 3.8%); 2) were pregnant (177, 1.0 %) at the interview; 3) did not have a reliable 24 hour dietary recall (1,155, 6.5%); 4) did not have information on overweight or obesity classification (319, 1.8%); or 5) did not have a value for Health Eating Index score (4, 0.02%). The remaining number of respondents available for analysis was 15,479.

Statistical analyses

Statistical analyses were conducted using SAS-Callable SUDAAN, to account for the weighted sampling structure and complex survey design of NHANES. Sample weights account for differential non-response, non-coverage, and planned oversampling of certain groups.

NHANES analytic guidelines were followed to calculate the appropriate 8-year sample weights.

³⁵ Because the sample size was limited to respondents with an MEC visit, all analyses conducted used the MEC weight. To calculate the 8-year MEC weight for the 1999-2000 and 2001-2002 surveys the 4-year MEC weight was multiplied by $\frac{1}{2}$. To calculate the 8-year MEC weight for the 2003-2004 and 2005-2006 surveys the 2-year MEC weight was multiplied by $\frac{1}{4}$.

For descriptive statistics, the χ^2 test was used for categorical variables and the t-test was used for continuous variables. Considering that obesity prevalence and obesity-related risk factors vary by age groups (2-11 and 12-19) and gender and the questions related to physical activity and sedentary behaviors in NHANES differed by age groups, we conducted stratified analyses by age groups (2-11, 12-19) and gender. Whenever possible, we also conducted gender-specific analyses. Logistic regression was used to model the dependant variable overweight/obesity. Models for obesity or overweight outcomes were further adjusted for possible confounders, including obesity-related behaviors (i.e., physical activity, sedentary behaviors, diet intake) and socio-demographic factors. The obesity-related risk factors were added into models in sequential models in order to gain better understanding about the independent effects of each factor.

Accuracy of Study Results

Overall, NHANES has excellent data quality, particularly in relation to other types of national surveys. First, NHANES collected objectively measured weight and height for all study participants aged 2 or older. This is a major strength of this study. Second, the dietary information included in this report was drawn from the multiple pass twenty-four hour recall which is the state-of-the-art in dietary data collection methods and is regarded as the best approach available for estimating population level dietary trends.³⁶ Third, NHANES has collected rich information on the physical activities for children aged 12 years old or older including both moderate-to-vigorous and vigorous physical activities, which are far more comprehensive than other national surveys. Last but not the least, with the access to the census tract information through the Research Data Center at the National Center for Health

Statistics, we were able to use the Rural-Urban Commuting Area (RUCA) definition, a highly regarded definition with research quality, to define our residence variable.

However, as other studies, NHANES data are not perfect in every aspect. For example, proxy interviews were conducted to collect physical activity questions (2-11 years old) and diet (< 6 years old). Assisted interviews were conducted with survey participants 6 to 11 years of age. For older children aged 12-19 years old, adult self-report protocol was used for both physical activity and diet questionnaires. As we know, all recall methods suffer from limitations related to memory, social desirability and quality of nutrition data matched to the recalls. Children aged 12 to 19 experience rapid growth and development and have greater dietary needs than almost any other time in life. Children of this age are also becoming aware of body image as a part of self and expectations for beauty and thinness are heightened. Often dietary intake is mis-represented by adolescents in their efforts to report socially desirable intake patterns; this is especially true of adolescent girls concerned with thinness.¹⁴⁻¹⁵ Thus, we note that reported dietary data may be distorted in this age group. However, there is no reason to believe that body image issues or the social desirability of food consumption patterns varies by urban versus rural residence.

Appendix B: Background Tables

Table B-1. Characteristics of US Children aged 2-19 years old, by Urban/Rural residence, NHANES 1999-2006

Characteristics	Unweighted N	Weighted % (SE)	Urban % (SE)*	Rural % (SE)*	P-value**
Total (weighted %)	15,479 (100.0)		12,863 (77.4)	2,616 (22.6)	
Age (years)					.53
2-5	2,985	20.0 (0.5)	20.1 (0.6)	19.7 (0.7)	
6-11	3,975	33.6 (0.7)	34.0 (0.7)	32.4 (1.5)	
12-19	8,519	46.4 (0.7)	45.9 (0.8)	47.9 (1.7)	
Sex					.53
Female	7,676	49.0 (0.5)	49.2 (0.6)	48.4 (1.2)	
Male	7,803	51.0 (0.5)	50.8 (0.6)	51.6 (1.2)	
Race / Ethnicity					.0005
Hispanic	5,783	18.4 (1.4)	20.6 (1.4)	10.8 (2.9)	
Non-Hispanic White	4,171	60.6 (1.7)	55.9 (1.8)	76.5 (3.2)	
Non-Hispanic Black	4,807	14.4 (1.2)	16.6 (1.3)	6.9 (1.8)	
Non-Hispanic Other	718	6.7 (0.6)	6.9 (0.5)	5.9 (1.8)	
Child's health					.63
Good/fair/poor	5,105	25.2 (0.7)	24.8 (0.7)	26.6 (1.7)	
Very good	3,990	27.0 (0.5)	27.0 (0.7)	26.9 (1.0)	
Excellent	6,379	47.8 (0.8)	48.2 (0.9)	46.5 (1.7)	
Missing	5				
Child's health insurance status					.16
Yes	12,458	86.8 (0.7)	87.4 (0.7)	84.9 (1.6)	
No	2,838	13.2 (0.7)	12.6 (0.7)	15.1 (1.6)	
Missing	183				
Child's in-school status (4-19)					.29
Yes, in school	11,397	82.6 (0.7)	83.0 (0.7)	81.5 (1.4)	
No, not in school	2,448	17.4 (0.7)	17.0 (0.7)	18.5 (1.4)	
Missing	4				

Household poverty status					.002
≤130% FPL***	6,338	32.3 (1.2)	30.9 (1.3)	36.8 (2.7)	
131-185% FPL	1,910	11.6 (0.6)	10.9 (0.7)	13.7 (1.1)	
186-250% FPL	1,546	11.6 (0.6)	11.0 (0.6)	13.5 (1.4)	
≥ 251% FPL	4,599	44.6 (1.4)	47.2 (1.6)	35.9 (2.6)	
Missing	1,086				
Reference person's education					.001
< 12 years	5,300	22.1 (0.9)	22.3 (0.8)	21.6 (2.8)	
= 12 years	3,610	25.9 (0.9)	23.4 (0.9)	34.3 (2.1)	
> 12 years	5,922	51.9 (1.2)	54.3 (1.2)	44.0 (2.6)	
Missing	647				
Region					.63
Northeast	2,171	16.3 (2.3)	17.4 (2.7)	12.3 (5.4)	
Midwest	2,794	22.4 (3.4)	20.5 (3.0)	28.8 (10.3)	
South	6,039	36.4 (2.8)	35.1 (3.4)	40.7 (7.0)	
West	4,475	24.9 (3.6)	26.9 (3.6)	18.2 (8.5)	
Year of survey					.42
1999-2000	3,764	22.7 (1.1)	23.8 (23.8)	19.1 (7.9)	
2001-2002	4,067	26.8 (1.5)	27.8 (1.5)	23.6 (4.2)	
2003-2004	3,706	25.0 (1.4)	25.3 (1.5)	24.1 (5.7)	
2005-2006	3,942	25.4 (1.5)	23.1 (1.9)	33.2 (5.9)	

Percentages weighted to reflect population. ** P-values from chi-square tests of independence.

*** FPL: federal poverty level

Table B-2. Proportion of US children who are overweight or obese, by gender, age and residence, 1999-2006 (n = 15,479)

	Percentage (s.e.)			
	All (2-19 years)	2-5 years	6-11 years	12-19 years
All	30.9 (0.8)	23.0 (1.1)	32.8 (1.4)	32.9 (1.0)
Urban	29.5 (0.7)	21.8 (1.2)	31.7 (1.4)	31.4 (0.9)
Rural	35.5 (2.1)**	27.2 (2.7)\$	36.8 (4.0)	38.2 (2.3)**
Males				
All	31.9 (1.0)	23.7 (1.6)	33.8 (1.7)	33.9 (1.2)
Urban	30.2 (1.0)	22.7 (1.8)	31.5 (1.7)	32.5 (1.3)
Rural	37.3 (2.4)*	27.1 (3.2)	41.6 (4.7)\$	38.3 (2.7)
Females				
All	29.9 (0.9)	22.3 (1.4)	31.7 (1.8)	32.0 (1.2)
Urban	28.8 (0.8)	20.8 (1.5)	31.9 (1.8)	30.1 (1.0)
Rural	33.7 (2.4)*	27.2 (3.9)	31.1 (4.3)	38.0 (3.0)*

s.e. = standard error

\$ 0.05 < p < 0.1, *p < 0.05, **p < 0.01, ***p < 0.001,

Table B-3. Proportion of US children who are obese, by gender, age and residence, 1999-2006 (n = 15,479)

	Percentage (s.e.)			
	All (2-19 years)	2-5 years	6-11 years	12-19 years
All	15.9 (0.6)	11.0 (0.9)	17.1 (0.9)	17.2 (0.8)
Urban	15.2 (16.1)	10.7 (0.9)	16.4 (1.0)	16.3 (0.8)
Rural	18.5 (1.2)*	12.2 (1.9)	19.7 (1.8)	20.3 (1.5)*
Males				
All	16.8 (0.7)	11.3 (1.1)	18.3 (1.1)	18.0 (0.9)
Urban	15.9 (0.7)	11.4 (1.3)	17.0 (1.3)	17.1 (1.0)
Rural	19.6 (1.4)*	11.1 (1.8)	22.5 (2.7)	21.1 (1.8)*
Females				
All	15.0 (0.7)	10.7 (1.1)	15.9 (1.1)	16.4 (1.0)
Urban	14.4 (0.7)	10.0 (1.2)	15.7 (1.3)	15.4 (1.0)
Rural	17.3 (1.5)\$	13.3 (2.9)	16.3 (2.2)	19.6 (2.3)\$

s.e. = standard error

\$ 0.05 < p < 0.1, *p < 0.05, **p < 0.01, ***p < 0.001

Table B-4. Proportion of US children aged 2-19 years old who are overweight or obese by race / ethnicity and residence, 1999-2006 (n = 15,479)

	Percentage (s.e.)				
	All	Whites	Blacks	Hispanics	Others
Percent overweight or obese					
All	30.9 (0.8)	29.0 (1.2)	35.1 (0.8)	36.1 (0.9)	24.9 (2.4)
Urban	29.5 (0.7)	27.0 (1.2)	34.3 (0.9)	35.4 (1.0)	21.5 (2.2)
Rural	35.5 (2.1)*	34.1 (2.7)*	41.6 (1.5)**	40.5 (1.8)*	38.9 (5.9)
Percent obese					
All	15.9 (0.6)	14.2 (0.9)	20.2 (0.7)	19.6 (0.8)	12.6 (1.7)
Urban	15.2 (0.6)	13.0 (0.9)	19.4 (0.6)	19.1 (0.8)	10.5 (1.4)
Rural	18.5 (1.2)*	17.0 (1.6)*	26.2 (2.4)	22.8 (2.6)	20.8 (3.8)

s.e. = standard error

*p <0.05, **p <0.01, ***p<0.001

Table B-5. Physical activity and sedentary behaviors among US children aged 2-5 years old, by sex and residence, 1999-2006

	All children		
	All	Urban	Rural
Unweighted sample sizes	2,972	2,455	517
% (s.e.) not meeting physical activity recommendation (< 5 times/week)	24.4 (1.2)	25.1 (1.2)	21.9 (3.6)
% (s.e.) exceeding screen time guidelines (≥ 2 hours/day)	63.6 (1.3)	65.1 (1.4)	58.6 (3.1)
	Boys		
Unweighted sample sizes	1,482	1,218	264
% (s.e.) not meeting physical activity recommendation (< 5 times/week)	21.6 (1.5)	23.0 (1.7)	26.9 (3.4)
% (s.e.) exceeding screen time guidelines (≥ 2 hours/day)	66.2 (2.0)	66.5 (2.3)	65.1 (3.5)
	Girls		
Unweighted sample sizes	1,490	1,237	253
% (s.e.) not meeting physical activity recommendation (< 5 times/week)	27.2 (1.4)	27.3 (1.4)	27.0 (4.1)
% (s.e.) exceeding screen time guidelines (≥ 2 hours/day)	61.1 (1.7)	63.7 (1.7)	52.0 (4.1)*

s.e. = standard error

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B-6. Physical activity and sedentary behaviors among US children aged 6-11 years old, by sex and residence, 1999-2006

	All children		
	All	Urban	Rural
Unweighted sample sizes	3,961	3,341	620
% (s.e.) not meeting physical activity recommendation (< 5 times/week)	24.7 (1.0)	26.2 (1.1)	19.4 (1.8)**
% (s.e.) exceeding screen time guidelines (≥ 2 hours/day)	72.0 (1.3)	73.0 (1.3)	68.5 (4.5)
	Boys		
Unweighted sample sizes	1,952	1,647	305
% (s.e.) not meeting physical activity recommendation (< 5 times/week)	20.5 (1.1)	20.9 (1.4)	19.2 (2.4)
% (s.e.) exceeding screen time guidelines (≥ 2 hours/day)	74.4 (2.0)	74.6 (1.9)	73.7 (6.0)
	Girls		
Unweighted sample sizes	2,009	1,694	315
% (s.e.) not meeting physical activity recommendation (< 5 times/week)	29.1 (1.4)	31.5 (1.5)	19.6 (2.6)***
% (s.e.) exceeding screen time guidelines (≥ 2 hours/day)	69.5 (1.6)	71.3 (1.7)	62.4 (5.1)

s.e. = standard error

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table B-7. Physical activity and sedentary behaviors among US children aged 12-19 years old, by sex and residence, 1999-2006

	Percentage (s.e.)														
	All children					Males					Females				
	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural
Unweighted sample sizes	8,519	7,041	1,478	4,358	3,649	709	4,161	3,392	769						
Terciles of MET min/day VPA															
None	21.2 (0.8)	21.2 (0.8)	21.2 (2.1)	15.2 (0.9)	14.4 (0.8)	18.1 (2.7)	27.5 (1.1)	28.6 (1.4)	24.3 (2.3)						
T1 (Low)	26.2 (0.8)	26.5 (0.9)	25.4 (1.7)	29.0 (1.1)	28.4 (1.2)	31.0 (2.3)	24.4 (1.1)	25.2 (1.2)	21.6 (2.4)						
T2 (Medium)	26.8 (0.7)	26.8 (0.8)	27.0 (1.8)	29.2 (0.8)	29.9 (0.9)	26.9 (2.4)	23.1 (0.9)	22.9 (1.0)	23.8 (1.8)						
T3 (High)	25.8 (0.8)	25.6 (0.8)	26.5 (1.8)	26.6 (1.1)	27.3 (1.1)	23.9 (2.5)	25.0 (0.9)	23.3 (1.0)	30.3 (2.4)*						
Terciles of MET min/day in MVPA															
None	11.6 (0.5)	11.7 (0.6)	11.4 (1.4)	8.7 (0.7)	8.7 (0.7)	8.5 (1.7)	14.7 (0.7)	14.9 (1.0)	14.3 (1.6)						
T1 (Low)	28.7 (0.8)	29.4 (0.9)	26.4 (1.6)	30.1 (1.1)	29.3 (1.2)	32.8 (2.6)	27.2 (1.0)	28.1 (1.0)	24.1 (2.1)						
T2 (Medium)	29.8 (0.7)	29.6 (0.8)	30.5 (1.7)	30.8 (1.1)	31.0 (1.2)	30.1 (2.8)	28.3 (0.9)	29.1 (1.0)	25.8 (1.9)						
T3 (High)	29.8 (0.9)	29.2 (0.9)	31.7 (2.2)	30.4 (1.1)	30.9 (1.1)	28.6 (2.9)	29.8 (1.0)	27.9 (1.1)	35.8 (2.2)*						
% Commuting by walking / biking	45.3 (1.4)	47.4 (1.5)	38.5 (2.2)**	47.8 (1.7)	50.0 (1.7)	40.7 (2.3)*	42.6 (1.7)	44.6 (1.9)	36.3 (3.4)*						
% Strength exercise	60.7 (1.1)	61.8 (1.1)	57.2 (2.8)	67.7 (1.3)	68.9 (1.3)	63.6 (3.3)	53.3 (1.5)	54.2 (1.5)	50.7 (3.2)						
% exceeding screen time guidelines (≥ 2 hours/day)	74.2 (0.9)	74.2 (1.3)	74.3 (1.6)	76.5 (1.1)	77.3 (1.5)	74.0 (2.1)	71.8 (1.4)	70.9 (1.7)	74.6 (2.8)						

s.e. = standard error; MET = Metabolic equivalents. VPA: vigorous physical activity. MVPA: moderate-to-vigorous physical activity.

*p <0.05, **p <0.01, ***p<0.001

Table B-8. Physical activity and sedentary behaviors among US children aged 2-11 years old, by race and residence, 1999-2006

	White			Black			Hispanic		
	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural
Unweighted sample sizes	1,995	1,381	574	2,076	1,891	185	2,554	2,223	321
Physical activity less than 5 times/week	24.8 (1.2)†	27.0 (1.3)†	19.5 (2.1)**	23.1 (1.6)	23.1 (1.6)	22.7 (3.8)	23.9 (1.3)†	23.7 (1.3)	25.3 (2.7)
Screen time of 2 or more hours/day	65.3 (1.5)\$	66.1 (1.5)	63.4 (3.9)	81.8 (0.9)\$	81.6 (0.9)	84.4 (3.3)	69.5 (1.5)	70.0 (1.5)	66.1 (4.5)
Boys									
Unweighted sample sizes	976	682	294	1,033	945	88	1,255	1,102	153
Physical activity less than 5 times/week	21.5 (1.6)	25.3 (1.9)	17.5 (2.2)	19.5 (1.8)	19.0 (1.8)	24.5 (4.1)§	19.4 (1.7)	19.3 (1.9)	20.6 (3.2)
Screen time of 2 or more hours/day	68.2 (2.2)†	64.8 (1.9)	55.8 (4.4)	83.4 (1.3)†	83.3 (1.3)	84.4 (4.0)	70.9 (1.7)	69.0 (2.3)	62.2 (3.5)
Girls									
Unweighted sample sizes	979	699	280	1043	946	97	1,289	1,121	168
Physical activity less than 5 times/week	28.3 (1.5)	30.7 (1.7)	21.9 (3.0)**	26.7 (2.0)	27.4 (2.1)	21.2 (5.4)§	28.3 (1.8)	28.1 (1.8)	29.4 (4.3)
Screen time of 2 or more hours/day	62.3 (1.8)\$	67.3 (2.1)	70.0 (5.3)	80.2 (1.3)\$	79.8 (1.3)	84.4 (5.5)	68.2 (2.1)	71.0 (1.7)	70.7 (5.9)

SE = standard error; MET = Metabolic equivalents. VPA: vigorous physical activity. MVPA: moderate-to-vigorous physical activity.

*p <0.05, **p <0.01, ***p<0.001, for rural – urban comparisons.

† p-value< 0.05 comparing white children to children of other race/ethnicity.

§ Unreliable estimate due to sample size less than 30.

Table B-9. Physical activity and sedentary behaviors among US children aged 12-19 years old, by race and residence, 1999-2006

	Whites			Blacks			Hispanics		
	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural
	Unweighted sample sizes	1,647	1,149	498	2,080	1,822	258	2,291	1,949
% (s.e.) no VPA	17.9 (1.1)\$#	17.6 (1.3)	18.6 (2.0)	25.6 (1.1)\$	26.0 (1.1)	22.8 (3.9)	27.5 (1.1)#	27.4 (1.2)	27.8 (2.2)
% (s.e.) exceeding screen time guidelines (≥ 2 hours/day)	74.1 (1.4)\$	73.7 (2.0)	75.0 (2.0)	80.7 (1.0)\$	79.9 (1.1)	86.3 (2.3)	74.4 (1.5)	74.6 (1.5)	73.3 (5.1)
Boys									
Unweighted sample sizes	831	593	238	1,075	966	109	1,145	981	164
% (s.e.) no VPA	13.6 (1.1)\$#	12.7 (1.2)	16.1 (2.6)	14.6 (1.1)\$	15.4 (1.1)	7.7 (2.5)*§	18.6 (1.2)#	18.3 (1.4)	20.3 (2.3)
% (s.e.) exceeding screen time guidelines (≥ 2 hours/day)	76.9 (1.7)	77.7 (2.4)	74.9 (2.3)	81.1 (1.3)	80.6 (1.3)	84.7 (2.2)	76.5 (1.8)	76.6 (1.8)	75.5 (5.2)
Girls									
Unweighted sample sizes	816	556	260	1,005	856	149	1,146	968	178
% (s.e.) no VPA	22.5 (1.5)\$#	23.1 (2.0)	21.2 (2.6)	37.1 (1.7)\$	37.6 (1.6)	34.1 (6.0)	36.5 (1.9)#	36.7 (2.2)	35.2 (3.3)
% (s.e.) exceeding screen time guidelines (≥ 2 hours/day)	71.0 (1.9)\$	69.1 (2.4)	75.1 (3.4)	80.4 (1.5)\$	79.0 (1.5)	87.5 (4.3)	72.2 (2.2)	72.4 (2.3)	71.2 (6.6)

s.e. = standard error; MET = Metabolic equivalents. VPA: vigorous physical activity. MVPA: moderate-to-vigorous physical activity.

*p <0.05, **p <0.01, ***p <0.001. . \$ p-value < 0.05 to compare the whites and blacks. # p-value < 0.05 to compare the whites and Hispanics.

§ Unreliable estimate due to sample size less than 30.

Table B-10. Prevalence of overweight or obesity, by physical activity and sedentary behaviors among US children aged 2-11 years old, by sex and residence, 1999-2006

Characteristics	Percentage (s.e.)											
	All children				Boys				Girls			
	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural
Percent overweight or obese												
Meeting physical activity recommendation (≥ 5 times/week)												
< 5 times/week	29.6 (1.8)	28.8 (1.9)	32.9 (5.0)	29.9 (2.5)	28.6 (2.7)	35.4 (7.4)	29.3 (2.3)	29.0 (2.4)	30.7 (5.8)	29.3 (2.3)	29.0 (2.4)	30.7 (5.8)
≥ 5 times/week	29.0 (1.1)	27.7 (1.0)	33.2 (3.1)	30.2 (1.3)	28.2 (1.4)	36.7 (3.4)*	27.6 (1.4)	27.2 (1.6)	29.2 (3.6)	27.6 (1.4)	27.2 (1.6)	29.2 (3.6)
Exceeding screen time guidelines (≥ 2 hours/day)												
< 2 hours/day	26.0 (1.6)	25.0 (1.6)	29.0 (4.7)	27.0 (2.7)	25.1 (2.4)	33.1 (7.9)	25.2 (1.8)	25.0 (1.9)	25.8 (3.8)	25.2 (1.8)	25.0 (1.9)	25.8 (3.8)
≥ 2 hours/day	30.5 (1.1)**	29.3 (1.0)	35.3 (3.5)	31.3 (1.3)	29.5 (1.4)	37.6 (3.3)*	29.6 (1.3)**	29.0 (1.2)	32.3 (4.6)	29.6 (1.3)**	29.0 (1.2)	32.3 (4.6)
Percent obese												
Meeting physical activity recommendation (≥ 5 times/week)												
< 5 times/week	16.3 (1.3)	16.3 (1.5)	16.6 (2.7)	18.3 (1.9)	18.0 (2.0)	19.1 (4.4)	14.9 (1.6)	15.0 (1.8)	14.4 (3.1)	14.9 (1.6)	15.0 (1.8)	14.4 (3.1)
≥ 5 times/week	14.3 (0.7)	13.5 (0.7)	16.9 (2.0)	15.1 (0.9)	14.1 (0.9)	18.2 (2.5)	13.4 (0.9)	12.9 (0.9)	15.4 (2.2)	13.4 (0.9)	12.9 (0.9)	15.4 (2.2)
Exceeding screen time guidelines (≥ 2 hours/day)												
< 2 hours/day	12.1 (1.0)	11.9 (1.2)	12.7 (2.5)	13.7 (1.5)	13.3 (1.9)	15.1 (3.2)	10.7 (1.2)	10.7 (1.3)	10.8 (2.9)	10.7 (1.2)	10.7 (1.3)	10.8 (2.9)
≥ 2 hours/day	16.0 (0.8)**	15.2 (0.8)	19.0 (1.9)	16.4 (0.9)	15.5 (1.1)	19.5 (2.3)	15.5(1.0)**	14.9 (1.0)	18.2 (3.0)	15.5(1.0)**	14.9 (1.0)	18.2 (3.0)

s.e. = standard error

*p <0.05, **p <0.01, ***p<0.001

Table B-11. Prevalence of overweight or obesity by physical activity and sedentary behaviors among US children aged 12-19 years old, by sex and residence, 1999-2006 NHANES

Characteristics	Percentage (s.e.)											
	All Children					Girls						
	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural	All		
Percent overweight or obese												
Tertiles of MET-min/day spending on vigorous physical activities												
None	36.0 (1.7)	34.1 (1.7)	42.3 (3.9)*	40.1 (2.9)	36.4 (2.8)	49.8 (6.1)*	33.6 (1.9)	32.8 (1.9)	36.6 (4.5)	33.6 (1.9)	32.8 (1.9)	36.6 (4.5)
T1 (Low)	35.1 (1.6)	33.3 (1.7)	41.2 (3.7)	36.7 (2.0)	36.4 (2.3)	37.4 (3.7)	34.2 (2.6)	29.7 (2.7)	50.6 (6.4)**	34.2 (2.6)	29.7 (2.7)	50.6 (6.4)**
T2 (Medium)	31.5 (1.3)	30.8 (1.6)	33.9 (2.9)	30.2 (2.0)	30.5 (2.0)	29.2 (5.5)	32.5 (2.4)	31.3 (2.7)	36.0 (4.3)	32.5 (2.4)	31.3 (2.7)	36.0 (4.3)
T3 (High)	29.4 (1.6)**	27.9 (1.6)	34.0 (3.7)	30.3 (2.4)**	28.5 (2.4)	37.5 (5.2)	27.9 (1.9)*	26.8 (2.2)	30.4 (4.8)	27.9 (1.9)*	26.8 (2.2)	30.4 (4.8)
Tertiles of MET-min/day spending on moderate-to-vigorous physical activities												
None	35.4 (1.9)	34.2 (2.1)	39.3 (4.6)	38.6 (3.8)	38.2 (3.8)	40.3 (8.9)	33.3 (2.4)	31.7 (2.4)	38.8 (5.7)	33.3 (2.4)	31.7 (2.4)	38.8 (5.7)
T1 (Low)	36.7 (1.5)	34.7 (1.5)	43.9 (3.8)*	37.6 (1.9)	36.4 (2.1)	41.3 (4.7)	36.6 (2.1)	34.0 (2.3)	45.9 (5.1)*	36.6 (2.1)	34.0 (2.3)	45.9 (5.1)*
T2 (Medium)	31.3 (1.3)	30.0 (1.5)	35.2 (2.4)	31.7 (2.2)	30.6 (2.3)	35.5 (5.2)	29.6 (1.9)	28.0 (1.8)	35.1 (5.2)	29.6 (1.9)	28.0 (1.8)	35.1 (5.2)
T3 (High)	29.9 (1.5)**	28.3 (1.3)	34.6 (3.8)	30.2 (2.3)*	28.9 (2.2)	35.0 (4.9)	29.7 (2.0)*	28.0 (2.1)	34.0 (4.9)	29.7 (2.0)*	28.0 (2.1)	34.0 (4.9)
Commuted by walking / biking												
Yes	33.2 (1.2)	32.5 (1.4)	36.2 (2.7)	34.4 (1.7)	34.8 (1.9)	32.5 (3.8)	31.9 (1.6)	29.7 (1.6)	40.4 (4.5)*	31.9 (1.6)	29.7 (1.6)	40.4 (4.5)*
No	32.6 (1.1)	30.4 (0.9)	38.7 (2.9)*	33.0 (1.5)	30.1 (1.5)	41.2 (4.2)*	32.2 (1.4)	30.6 (1.4)	36.4 (3.4)	32.2 (1.4)	30.6 (1.4)	36.4 (3.4)
Strength exercise												
Yes	31.4 (1.2)	30.0 (1.2)	36.2 (2.7)*	32.7 (1.4)	32.0 (1.5)	35.2 (3.4)	29.7 (1.6)	27.4 (1.6)	37.4 (3.7)**	29.7 (1.6)	27.4 (1.6)	37.4 (3.7)**
No	35.2 (1.2)*	33.6 (1.1)	39.9 (2.8)*	35.8 (1.9)	33.7 (1.9)	41.8 (3.6)*	32.1 (1.2)*	30.2 (1.1)	37.9 (2.9)	32.1 (1.2)*	30.2 (1.1)	37.9 (2.9)
Exceeding screen time guidelines (≥ 2 hours/day)												
< 2 hours/day	26.2 (1.4)	25.6 (1.6)	28.3 (3.0)	27.0 (1.9)	27.2 (2.1)	26.3 (4.6)	25.5 (1.9)	24.2 (1.8)	30.3 (3.9)	25.5 (1.9)	24.2 (1.8)	30.3 (3.9)
≥ 2 hours/day	35.2 (1.0)**	33.4 (0.9)	41.1 (2.9)**	35.8 (1.4)**	34.1 (1.4)	41.7 (3.5)*	34.6 (1.4)**	32.7 (1.4)	40.5 (3.5)*	34.6 (1.4)**	32.7 (1.4)	40.5 (3.5)*

P-value: * p < 0.05, ** p < 0.01, *** p < 0.001

Table B-12. Prevalence of obesity by physical activity and sedentary behaviors among US children aged 12-19 years old, by sex and residence, 1999-2006 NHANES

Characteristics	Percentage (s.e.)														
	All Children					Boys					Girls				
	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural
Percent obese															
Teriles of MET-min/day spending on vigorous physical activities															
None	20.8 (1.2)	19.6 (1.3)	24.5 (3.4)	21.7 (2.4)	17.7 (2.2)	32.4 (6.5)*	20.2 (1.5)	20.7 (1.6)	18.5 (3.1)						
T1 (Low)	19.4 (1.4)	18.6 (1.4)	22.0 (3.5)	22.1 (1.7)	21.5 (1.9)	23.9 (3.04)	15.9 (1.9)	13.4 (1.7)	25.3 (5.5)						
T2 (Medium)	14.1 (1.2)	13.0 (1.3)	17.5 (2.4)	13.7 (1.3)	14.6 (1.6)	10.2 (2.1)	14.7 (1.7)	13.3 (1.9)	18.7 (3.6)						
T3 (High)	15.4 (1.2)**	14.8 (1.4)	17.3 (2.2)	15.8 (1.7)***	15.2 (1.7)	18.0 (3.7)	14.7 (1.6)*	13.5 (1.9)	17.8 (3.2)						
Teriles of MET-min/day spending on moderate-to-vigorous physical activities															
None	20.4 (1.3)	19.7 (1.7)	23.0 (3.9)	21.5 (3.1)	18.6 (2.6)	31.5 (10.3)	19.8 (1.8)	20.3 (2.1)	17.9 (3.6)						
T1 (Low)	20.3 (1.3)	19.4 (1.2)	23.7 (3.1)	22.1 (1.7)	20.9 (1.7)	25.6 (4.2)	18.4 (1.7)	17.6 (1.8)	21.3 (4.2)						
T2 (Medium)	15.0 (1.1)	13.6 (1.2)	19.6 (1.9)**	15.8 (1.5)	15.4 (1.7)	17.2 (3.3)	14.3 (1.2)	12.6 (1.3)	20.4 (3.4)						
T3 (High)	15.2 (1.1)***	14.7 (1.3)	16.5 (2.2)	15.1 (1.5)**	15.1 (1.6)	15.1 (2.9)	15.0 (1.5)*	13.5 (1.7)	18.7 (2.9)						
Commuted by walking/biking															
Yes	17.4 (0.9)	17.0 (1.2)	19.3 (2.1)	18.0 (1.4)	18.4 (1.6)	16.1 (2.1)	16.8 (1.3)	15.2 (1.2)	23.0 (4.4)						
No	17.0 (0.9)	15.7 (1.0)	20.6 (1.9)*	17.9 (1.2)	15.9 (1.3)	23.6 (2.9)**	16.1 (1.3)	15.5 (1.5)	17.7 (2.6)						
Strength exercise															
Yes	15.8 (0.9)	14.9 (1.0)	19.1 (1.5)*	17.4 (1.1)	16.5 (1.2)	20.5 (2.2)	13.7 (1.1)	12.6 (1.3)	17.3 (2.0)						
No	19.4 (1.0)**	18.6 (0.9)	21.4 (2.7)	19.2 (1.5)	18.7 (1.7)	20.6 (2.9)	19.5 (1.3)***	18.6 (1.4)	22.1 (3.5)						
Exceeding screen time guidelines (≥ 2 hours/day)															
< 2 hours/day	12.7 (1.1)	12.5 (1.2)	13.0 (2.3)	12.6 (1.4)	13.5 (1.6)	10.1 (3.6)	12.7 (1.4)	11.7 (1.3)	16.0 (3.2)						
≥ 2 hours/day	18.8 (0.9)***	17.6 (0.9)	22.6 (1.8)*	19.6 (1.1)***	18.3 (1.2)	24.3 (2.1)**	17.9 (1.2)**	16.9 (1.2)	20.9 (2.5)						

P-value: * p < 0.05, ** p < 0.01, *** p < 0.001

Table B-13. Dietary characteristics of US children aged 2-5, by sex and residence, 1999 – 2006.

	All children				Males			Females		
	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural	
Unweighted sample sizes	2,985	2,467	518	1,486	1,221	265	1,499	1,246	253	
Total Energy(kcal)	1,632	1,617	1,687	1,698	1,691	1,722	1,567	1,543	1,652	
Total Fat (g)	58.2	56.9	62.7**	60.6	59.5	64.1*	55.8	54.2	61.4*	
Total Fiber (g)	10.6	10.7	10.4	10.9	11.0	10.6	10.3	10.4	10.1	
Healthy Eating Index	51.3	51.8	49.7*	51.4	51.8	50.3	51.2	51.8	49.1	
Consumed any vegetables (%)	30.9	29.5	35.8*	32.3	31.3	36.0	29.4	27.7	35.6*	
Fruit consumption (%)										
No fruit	9.6	8.8	12.5	9.6	8.9	11.9	9.7	8.7	13.0 §	
0-1 cups	39.1	39.1	39.1	39.0	38.9	39.3	39.2	39.2	39.0	
1-1.9 cups	28.7	28.4	29.5	26.7	26.6	27.0	30.6	30.3	32.0	
2 cups or more	22.6	23.7	18.9	24.7	25.5	21.8	20.5	21.8	16.0 §	
Consumed any whole grains	63.9	65.1	59.5	65.1	66.9	59.1	62.6	63.4	59.8	
Sweetened beverages										
0 to 8 ounces	59.4	60.8	54.6	57.6	56.3	58.0	61.2	52.8	63.6	
9 to 23 ounces	31.4	31.3	31.9	31.7	31.6	31.7	31.1	32.3	30.8	
24 or more ounces	9.2	7.9	13.5*	10.7	12.1	10.3	7.6	14.9	5.6** §	

P-value: *p <0.05, ** p<0.01, ***p<0.001 § Unreliable estimate due to sample size less than 30.

Table B-14. Dietary characteristics of US children aged 6-11, by sex and residence, 1999 – 2006.

	All children				Males			Females		
	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural	
Unweighted sample sizes	3,975	3,355	620	1,959	1,654	305	2,016	1,701	315	
Total Energy(kcal)	2,021	1,994	2,116	2,145	2,116	2,241	1,891	1,872	1,969	
Total Fat (g)	74.8	73.2	80.3*	79.1	77.5	84.6	70.3	69.0	75.3*	
Total Fiber (g)	12.6	12.5	12.6	13.2	13.1	13.3	11.9	12.0	11.8	
Healthy Eating Index	47.8	48.1	46.7	47.6	48	46.5	47.9	48.2	46.9	
Consumed any vegetables	38.4	38.6	37.7	38.3	38.9	36.2	38.5	38.2	39.6	
Fruit consumption (%)										
No fruit	16.3	16	17.4	18.3	17.7	20.5	14.1	14.2	13.7 §	
0-1 cups	47.5	46.6	50.9	45.8	44.6	49.5	49.3	48.5	52.6	
1-1.9 cups	21.0	21.6	19.2	20.5	21.5	17.3	21.6	21.7	21.4	
2 cups or more	15.2	15.9	12.5	15.4	16.2	12.7	14.9	15.6	12.2 §	
Consumed any whole grains	57.7	58.6	54.5	58.9	59.5	57.3	56.5	57.8	51.3	
Sweetened beverages										
0 to 8 ounces	38.6	40.1	33.2	35.1	36.8	29.6	42.1	43.3	37.4	
9 to 23 ounces	39.4	39.3	39.9	38.7	39.2	37.2	40.1	39.3	43.1	
24 or more ounces	22.0	20.7	26.9	26.1	24.0	33.3	17.8	17.3	19.5	

P-value: *p <0.05, ** p<0.01, ***p<0.001 § Unreliable estimate due to sample size less than 30.

Table B-15. Diet and diet quality among US children aged 12-19 years old, by sex and residence, 1999-2006

	All children						Males			Females		
	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural	All	Urban	Rural
Unweighted sample sizes	8,519	7,041	1,478	4,358	3,649	709	4,161	3,392	769			
Total Energy (kcal)	2,325	2,323	2,333	2,661	2,646	2,713	1,969	1,976	1,946			
Total Fat (g)	85.4	85.1	86.5	97.1	96.6	98.9	73.0	72.7	73.9			
Total Fiber (g)	13.7	13.9	13.0	15.3	15.4	14.8	12.1	12.3	11.2**			
Healthy Eating Index	46.5	46.8	45.5*	46.1	46.4	45.3	47.0	47.3	45.7*			
Consumed any vegetables	50.8	51.0	50.4	54.0	54.1	53.3	47.5	47.6	47.4			
Fruit consumption (%)												
No fruit	27.8	25.7	34.7	30.9	28.6	38.9	24.5	22.7	30.5			
0-1 cups	38.7	39.2	37.0	35.5	36.4	32.4	42.1	42.2	41.6			
1-1.9 cups	17.7	18.3	15.6	17.2	17.8	15.2	18.2	18.9	15.9			
2 cups or more	15.8	16.7	12.7**	16.3	17.2	13.5*	15.2	16.2	11.9*			
Consumed any whole grains	45.4	45.4	45.3	45.3	45.6	44.1	45.5	45.2	46.5			
Sweetened beverages												
0 to 8 ounces	24.3	25.3	21.1	20.2	21.1	17.2	28.7	29.8	25.1			
9 to 23 ounces	31.9	32.3	30.6	29.5	29.7	28.8	34.5	35.2	32.4			
24 or more ounces	43.8	42.4	48.3	50.3	49.2	54.0	36.8	35.0	42.6			

*p <0.05, **p <0.01, ***p <0.001

Table B – 16. Dietary Intake of Selected Nutrients and Foods among 2 – 5 year olds, by weight status and residence, 1999-2006 NHANES.

	Boys						Girls					
	< 85 th percentile		≥ 85 th percentile		< 85 th percentile		≥ 85 th percentile		< 85 th percentile		≥ 85 th percentile	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Nutrient, mean (se)												
Total energy intake (kcal)	1664 (25)	1674 (67)	1759 (40)	1980 (117)	1523 (23)	1570 (56)	1618 (49)	1870 (123)				
Total fat intake (g)	58.5 (1.1)	62.7 (3.1)	63.3 (1.8)	71.6 (5.9)	53.9 (1.1)	57.8 (3.0)	55.4 (2.1)	70.9 (5.6)*				
Total fiber intake (g)	10.9 (0.2)	9.7 (0.6)	11.2 (0.4)	12.7 (1.1)	10.1 (0.2)	9.7 (0.6)	11.3 (0.6)	11.2 (1.0)				
Individual HEI score	49.2 (1.2)	51.6 (0.4)	51.3 (1.8)	52.0 (1.0)	52.0 (0.6)	48.4 (1.4)*	51.0 (0.8)	51.0 (2.1)				
Selected Foods, % (se)												
<i>Sweetened Beverages</i>												
0 to 8 ounces	59.1 (2.5)	59.2 (3.3)	54.2 (3.9)	48.4 (6.5)	65.4 (2.4)	49.3 (5.5)	57.0 (3.2)	62.2 (7.1)				
9 to 23 ounces	31.3 (2.2)	29.5 (2.9)	33.2 (4.1)	37.1 (8.0) §	29.3 (2.2)	33.9 (5.4)	36.8 (3.2)	27.9 (6.7) §				
24 or more ounces	9.7 (1.3)	11.2 (2.6)	12.5 (2.5)	14.5 (6.0) §	5.4 (0.8)	16.8 (2.8)**	6.2 (1.7)	9.9 (3.8) §				
<i>Fruit consumption (%)</i>												
No fruit	8.5 (1.2)	13.6 (3.5)	10.2 (2.7)	7.3 (4.5) §	7.9 (1.4)	14.5 (3.6)	12.0 (3.4)	11.3 (2.6)				
0-1 cups	38.8 (2.3)	38.9 (3.3)	39.3 (4.3)	40.4 (7.5)	40 (2.4)	36.6 (4.2)	36.4 (4.3)	38.8 (3.2)				
1-1.9 cups	26.4 (2.2)	27.8 (3.4)	27.4 (3.6)	24.9 (6.8)	30.1 (1.9)	33.3 (4.0)	30.8 (3.9)	30.2 (2.7)				
2 cups or more	26.2 (1.8)	19.7 (3.1)	23.1 (2.9)	27.4 (5.9)	22.0 (2.0)	15.6 (3.2)	20.8 (3.0)	19.7 (2.4) §				
<i>Vegetables</i>												
% reporting at least 1 bite	31.5 (2.2)	34.6 (4.0)	30.7 (3.4)	39.7 (6.8)	26.0 (2.2)	32.3 (3.7)	34.1 (4.4)	44.4 (6.4)				
<i>Whole grains</i>												
% reporting at least 1 bite	67.5 (2.2)	55.7 (3.7)**	64.8 (3.4)	68.4 (7.6)	64.0 (2.2)	59.4 (5.0)	60.8 (4.1)	61.1 (6.1)				

*p < 0.05, **p < 0.01, ***p < 0.0001 § Unreliable estimate due to sample size less than 30.

Table B – 17. Dietary Intake of Selected Nutrients and Foods among 6–11 year olds, by weight status and residence, 1999-2006 NHANES.

	Boys						Girls					
	< 85 th percentile		≥ 85 th percentile		< 85 th percentile		≥ 85 th percentile		< 85 th percentile		≥ 85 th percentile	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Nutrients, mean (se)												
Total energy intake (kcal)	2077 (32)	2118 (67)	2201 (44)	2414 (149)	1878 (24)	1954 (80)	1858 (31.6)	2002 (81)				
Total fat intake (g)	75.5 (1.3)	78.0 (3.1)	81.9 (1.7)	93.8 (8.2)	69.3 (1.1)	74.3 (3.3)	68.2 (1.6)	77.5 (3.7)*				
Total fiber intake (g)	13.0 (0.2)	13.4 (0.7)	13.4 (0.3)	13.2 (0.5)	12.0 (0.2)	11.6 (0.5)	11.9 (0.3)	12.1 (0.5)				
Individual HEI score	46.3 (1.4)	47.9 (0.5)	45.4 (1.9)	48.2 (0.7)	48.1 (0.5)	46.7 (1.0)	48.5 (0.6)	47.4 (1.1)				
Selected Foods, % (se)												
<i>Sweetened Beverages</i>												
0 to 8 ounces	39.0 (2.3)	31.0 (3.8)	31.9 (2.6)	27.6 (5.1)	43.2 (1.8)	39.5 (4.6)	43.6 (2.4)	32.8 (5.5)				
9 to 23 ounces	39.2 (2.0)	39.7 (5.3)	39.3 (2.9)	33.7 (4.5)	39.8 (1.9)	43.6 (5.5)	38.3 (2.3)	42.1 (7.3)				
24 or more ounces	21.8 (1.7)	29.4 (5.5)	28.8 (2.4)	38.7 (8.0)	17.0 (1.7)	16.9 (3.8)	18.1 (1.8)	25.1 (5.2)				
<i>Fruit consumption (%)</i>												
No fruit	16.5 (1.7)	16.9 (2.9)	20.2 (2.2)	25.5 (5.8)	13.9 (1.4)	10.9 (3.4)	15.0 (2.1)	20.0 (4.6)				
0-1 cups	45.4 (2.2)	52.2 (3.8)	42.9 (3.2)	45.7 (4.3)	49.5 (2.5)	54.2 (4.0)	46.3 (3.1)	49.2 (5.1)				
1-1.9 cups	22.6 (2.0)	19.8 (4.2)	18.9 (2.4)	13.8 (3.0) §	21.8 (1.8)	20.3 (3.7)	21.4 (2.3)	23.8 (3.8)				
2 cups	15.4 (1.2)	11.1 (3.2)	18.0 (2.4)	15.0 (4.9) §	14.8(1.6)	14.6(2.9)	17.4 (2.2)	6.9 (3.2) §				
<i>Vegetables</i>												
% reporting at least 1 bite	35.5 (2.4)	37.0 (3.8)	46.4 (2.7)	35.0 (4.5)*	36.4 (2.4)	37.4 (3.7)	42.1 (3.1)	44.5 (4.6)				
<i>Whole grains</i>												
% reporting at least 1 bite	60.0 (2.2)	57.5 (5.1)	58.3 (2.8)	57.0 (5.4)	59.4 (2.2)	52.3 (5.81)	54.2 (2.97)	49.0 (5.15)				

*p <0.05, **p <0.01, ***p<0.0001 § Unreliable estimate due to sample size less than 30.

Table B – 18. Dietary Intake of Selected Nutrients and Foods among 12–19 year olds, by weight status and residence, 1999–2006 NHANES.

	Boys				Girls			
	< 85 th percentile		≥ 85 th percentile		< 85 th percentile		≥ 85 th percentile	
	Urban	Rural	Urban	Rural	Urban	Rural	Urban	Rural
Nutrients, mean (se)								
Total energy intake (kcal)	2775 (35)	2796 (75)	2378 (45)	2580 (81)*	2032 (26)	1992 (44)	1847 (32)	1871 (66)
Total fat intake (g)	101.9 (1.5)	101.0 (3.2)	85.6 (1.8)	95.4 (3.2)*	74.3 (1.1)	76.7 (2.2)	69.0 (1.3)	69.3 (3.3)
Total fiber intake (g)	16.1 (0.3)	16.2 (0.6)	13.9 (0.4)	12.5 (0.7)	12.9 (0.1)	11.6 (0.4)*	11.0 (0.2)	10.5 (0.4)
Individual HEI score	44.7 (1.0)	46.6 (0.3)	44.0 (1.2)	46.3 (0.3)	47.9 (0.4)	46.1 (0.8)	46.0 (0.4)	45.1 (0.6)
Selected Foods, % (se)								
<i>Sweetened Beverages</i>								
0 to 8 ounces	21.0 (1.3)	17.6 (2.4)	21.5 (1.3)	16.7 (3.4)	31.0 (2.1)	26.6 (2.1)	26.9 (1.9)	22.5 (4.4)
9 to 23 ounces	30.2 (1.2)	25.8 (2.9)	28.6 (1.8)	33.6 (3.8)	34.9 (1.4)	32.7 (2.8)	35.8 (1.8)	31.9 (2.8)
24 or more ounces	48.8 (1.6)	56.6 (3.7)	50.0 (1.8)	49.8 (3.9)	34.0 (1.6)	40.7 (2.8)	37.3 (1.9)	45.7 (3.4)
<i>Fruit consumption (%)</i>								
No fruit	28.0 (1.3)	34.6 (3.7)	45.8 (1.8)	33.9 (1.6)	20.1(1.5)	30.6 (2.7)	28.7 (1.9)	30.4 (3.6)
0-1 cups	36.4 (1.2)	36.1 (3.0)	26.5 (1.4)	33.9 (1.4)	43.0 (1.4)	41.1 (3.9)	40.4 (2.0)	42.5 (4.2)
1-1.9 cups	17.2 (1.0)	15.7 (2.4)	14.3 (1.5)	17.8 (1.2)	19.6 (1.3)	16.2 (1.9)	17.1 (1.8)	15.5 (2.5)
2 cups	18.4 (1.1)	13.5 (2.3)	13.3 (1.1)	14.3 (1.1)***	17.3 (1.4)	12.2 (1.9)*	13.8 (1.6)	11.5 (2.2) §
<i>Vegetables</i>								
% reporting at least 1 bite	55.4 (1.5)	55.0 (3.7)	51.5 (2.1)	50.7 (3.5)	49.2 (1.2)	46.1 (2.8)	43.8 (2.5)	49.6 (4.6)
<i>Whole grains</i>								
% reporting at least 1 bite	48.4 (1.4)	47.9 (4.4)	39.8 (1.9)	37.9 (3.7)	48.2 (1.6)	52.1 (3.2)	38.2 (2.0)	37.4 (4.3)

*p < 0.05, **p < 0.01, ***p < 0.0001 § Unreliable estimate due to sample size less than 30.

Table B-19. Factors associated with overweight status (BMI ≥ 85th percentile) among US children aged 2-11, 1999-2006 NHANES (N=6,565).

Models	Odds ratios (95% confidence intervals)					
	Rural (vs. urban)	Weekly exercise for ≥ 5 times / week	Screen time ≥ 2 hrs/day	Total energy intake (per 500 kcal change)	Total fat (per 5 g change)	Total fiber (per 5 g change)
1: crude	1.3 (1.0, 1.7)					
2: model 1 + sociodemographic factors*	1.4 (1.1, 1.8)					
3: model 2 + PA	1.4 (1.1, 1.8)	1.0 (0.8,1.2)				
4: model 2 + SED	1.4 (1.1, 1.8)		1.1 (0.9, 1.3)			
5: model 2 + diet	1.4 (1.0, 1.7)			1.1 (0.9,1.2)	1.0 (0.9,1.0)	1.0 (0.9,1.1)
6: model 2 + PA + SED	1.4 (1.1, 1.8)	1.0 (0.8,1.2)	1.1 (0.9,1.3)			
7: model 2 + PA + diet	1.4 (1.1, 1.7)	1.0 (0.8,1.2)		1.1 (0.9,1.2)	1.0 (0.9,1.0)	1.0 (0.9,1.1)
8: model 2 + PA + diet + SED	1.4 (1.1, 1.7)	1.0 (0.8,1.2)	1.1 (0.9,1.3)	1.1 (0.9,1.2)	1.0 (0.9,1.0)	1.0 (0.9,1.1)
Boys aged 2-11 years (N=3,246)						
1: crude	1.4 (1.0, 1.9)					
2: Model 1 + sociodemographic factors*	1.5 (1.1, 2.0)					
3: Model 2 + PA	1.5 (1.1, 2.0)	1.0 (0.8,1.3)				
4: Model 2 + SED	1.5 (1.1, 2.0)		1.2 (0.9, 1.5)			
5: Model 2 + diet	1.4 (1.0, 1.9)			1.1 (0.9,1.3)	1.0 (0.9,1.1)	0.9 (0.8,1.1)
6: Model 2 + PA + SED	1.5 (1.0, 2.0)	1.0 (0.8,1.4)	1.2 (0.9,1.6)			
7: Model 2 + PA + diet	1.4 (1.0, 1.9)	1.1 (0.8,1.3)		1.1 (0.9, 1.3)	1.0 (0.9, 1.1)	0.9 (0.8,1.0)
8: Model 2 + PA + diet +SED	1.4 (1.0, 1.9)	1.0 (0.8,1.3)	1.2 (0.9,1.6)	1.1 (0.9, 1.3)	1.0 (0.9, 1.1)	0.9 (0.8,1.0)
Girls aged 2-11 years (N=3,319)						
1: crude	1.2 (0.8, 1.6)					
2: Model 1 + sociodemographic factors*	1.3 (0.9, 1.7)					
3: Model 2 + PA	1.3 (0.9, 1.7)	0.9 (0.7,1.2)				
4: Model 2 + SED	1.3 (1.0, 1.7)		1.0 (0.8, 1.3)			
5: Model 2 + diet	1.3 (0.9, 1.7)			1.1 (0.9,1.3)	1.0 (0.9,1.1)	1.0 (0.9,1.2)
6: Model 2 + PA + SED	1.3 (0.9, 1.7)	0.9 (0.7,1.2)	1.0 (0.8,1.3)			
7: Model 2 + PA + diet	1.3 (0.9, 1.7)	0.9 (0.7,1.2)		1.1 (0.9,1.3)	1.0 (0.9,1.1)	1.0 (0.9,1.2)
8: Model 2 + PA + diet +SED	1.3 (1.0, 1.7)	0.9 (0.7,1.2)	1.1 (0.8,1.3)	1.1 (0.9,1.3)	1.0 (0.9,1.1)	1.1 (0.9,1.2)

PA = physical activity, SED = sedentary behaviors, diet: measured by three variables such as total energy intake, total fat, total fiber intake.

* The model adjusted for urban/rural residence, child's age, race/ethnicity, perceived health, health insurance status, reference person's education, region, and survey year.

Table B-20. Factors associated with overweight status (BMI \geq 85th percentile) among US children aged 12-19, 1999-2006 NHANES (N=7,717).

Models	Odds ratios (95% confidence intervals)					
	Rural (vs. urban)	Participation in vigorous physical activity	Screen time \geq 2 hrs/day	Total energy intake (per 500 kcal change)	Total fat (per 5 g change)	Total fiber (per 5 g change)
1: crude	1.3 (1.0, 1.6)					
2: model 1 + sociodemographic factors*	1.3 (1.0, 1.6)					
3: model 2 + PA	1.3 (1.0, 1.6)	1.1 (0.9,1.4)				
4: model 2 + SED	1.3 (1.0, 1.6)		1.5 (1.3,1.8)			
5: model 2 + diet	1.3 (1.0, 1.6)			0.9 (0.8,1.0)	1.0 (1.0,1.0)	0.9 (0.8,0.9)
6: model 2 + PA + SED	1.3 (1.0, 1.6)	1.1 (0.9,1.3)	1.5 (1.3,1.8)			
7: model 2 + PA + diet	1.3 (1.0, 1.6)	1.1 (0.9,1.3)		0.9 (0.8,1.0)	1.0 (1.0,1.0)	0.9 (0.8,0.9)
8: model 2 + PA + diet + SED	1.3 (1.0, 1.6)	1.1 (0.9,1.3)	1.5 (1.3,1.8)	0.9 (0.8,1.0)	1.0 (0.9,1.0)	0.9 (0.8,0.9)
Boys aged 12-19 years (N=3,947)						
1: crude	1.2 (0.9, 1.6)					
2: Model 1 + sociodemographic factors*	1.2 (0.9, 1.6)					
3: Model 2 + PA	1.2 (0.9, 1.6)	1.3 (1.0,1.7)				
4: Model 2 + SED	1.2 (0.9, 1.6)		1.6 (1.2,1.9)			
5: Model 2 + diet	1.2 (0.9, 1.6)			0.9 (0.8,1.0)	1.0 (0.9,1.0)	0.9 (0.8,1.0)
6: Model 2 + PA + SED	1.2 (0.9, 1.6)	1.3 (0.9,1.7)	1.5 (1.2,1.9)			
7: Model 2 + PA + diet	1.2 (0.9, 1.6)	1.3 (0.9,1.7)		0.9 (0.8,1.0)	1.0 (0.9,1.0)	0.9 (0.8,1.0)
8: Model 2 + PA + diet +SED	1.2 (0.9, 1.6)	1.2 (0.9,1.7)	1.5 (1.2,1.9)	0.9 (0.8,1.0)	1.0 (0.9,1.0)	0.9 (0.8,1.0)
Girls aged 12-19 years (N=3,770)						
1: crude	1.4 (1.1, 1.8)					
2: Model 1 + sociodemographic factors*	1.4 (1.1, 1.9)					
3: Model 2 + PA	1.4 (1.1, 1.9)	1.0 (0.8,1.3)				
4: Model 2 + SED	1.4 (1.1, 1.9)		1.5 (1.1,1.9)			
5: Model 2 + diet	1.4 (1.1, 1.9)			0.9 (0.8,1.1)	1.0 (0.9,1.0)	0.8 (0.7,0.9)
6: Model 2 + PA + SED	1.4 (1.1, 1.9)	1.0 (0.8,1.3)	1.5 (1.1,1.9)			
7: Model 2 + PA + diet	1.4 (1.1, 1.9)	1.0 (0.8,1.3)		0.9 (0.8,1.0)	1.0 (0.9,1.0)	0.8 (0.7,0.9)
8: Model 2 + PA + diet +SED	1.4 (1.0, 1.8)	1.0 (0.7,1.2)	1.4 (1.1,1.8)	0.9 (0.8,1.0)	1.0 (0.9,1.0)	0.8 (0.7,0.9)

VPA = vigorous physical activity, PA = physical activity, SED = sedentary behaviors, diet: measured by three variables such as total energy intake, total fat, total fiber intake.

* The model adjusted for urban/rural residence, child's age, race/ethnicity, perceived health, health insurance status, reference person's education, region, and survey year.

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