Clinical Nutrition & Obesity
Childhood Overweight and Family Income

David S. Freedman, PhD; Cynthia L. Ogden, PhD; Katherine M. Flegal, PhD; Laura Kettel Khan, PhD; Mary K. Serdula, MD; William H. Dietz, MD
Posted 05/03/2007

Abstract

Objective: To examine the relation of family income, expressed relative to the poverty threshold, to the prevalence of childhood overweight, and to determine whether the association differs by race/ethnicity and time period.

Subjects and Methods: Most analyses were based on 2- to 19-year-old participants (n=10,409) in the US National Health and Nutrition Examination Survey (NHANES) from 1999 to 2004. Additional analyses were performed using NHANES data collected from 1971 to 1994 to determine whether family income showed similar associations with childhood overweight (body mass index [BMI] for age ≥ CDC 95th percentile) over this time period.

Results: The relation of family income to childhood overweight differed (P < .001) by race/ethnicity in 1999-2004. As compared with children below the poverty level (annual family income of about $19,200), the odds of overweight among children from families with incomes of 4 or more times the poverty threshold were 0.63 (white children) and 0.51 (Mexican-American children). Among black children, however, overweight was positively associated (odds ratio of 1.12) with family income. Although family income was not associated with childhood overweight in 1971-1974, the observed associations also differed by race/ethnicity in the 1976-1980 and 1988-1994 surveys. Furthermore, the association changed during the past few decades among Mexican-American children (P = .03 for secular trend), but not among white or black children.

Discussion: Although family income is related to childhood overweight, the association varies by race/ethnicity. Additional information on the reasons for these racial/ethnic differences may help in the development of appropriate interventions.

Introduction

A 1989 literature review concluded that the association between family socioeconomic status and childhood overweight in developed countries was inconsistent,[1] with approximately equal numbers of studies reporting positive, negative, or null associations. Furthermore, despite substantial differences in income between black and white participants, the prevalence of childhood overweight varied only slightly between these 2 groups in the 1970s.[2] During the past few decades, however, the prevalence of childhood overweight has tripled,[3] and the prevalence among 6- to 19-year-olds is now more than 50% higher among blacks than among whites.[2-4] It is possible that the relation of socioeconomic status to childhood overweight has also changed during this period.

In an environment that increasingly promotes the development of obesity, it is possible that lower-income families have fewer options for healthy food choices and fewer resources to engage in leisure-time physical activity. For example, sweet and high-fat foods are more affordable than recommended diets based on lean meats, whole grains, and fresh vegetables and fruits.[5] Furthermore, several recent studies have found that socioeconomic status is inversely associated with the prevalence of overweight among white children.[6-15] There appears to be, however, little
association between socioeconomic status and overweight among black and Hispanic children.\cite{6,8,10}

These results among children are fairly consistent with those that have been observed among adults in developed countries. Previously, a consistent inverse association between socioeconomic status and obesity had been observed only among white women,\cite{1} but more recent studies\cite{16,17} suggest that this inverse association may also apply to white men but not to other racial/ethnic groups.

The objectives of the current study were to examine the relationship between family income and the prevalence of childhood overweight using national data collected from 1999 to 2004, and to determine whether this association differs by race/ethnicity. In addition, national data collected from 4 earlier surveys (1971-1974, 1976-1980, 1982-1984, and 1988-1994) were used to determine whether the association has changed during this period.

Methods

Sample

The NHANES is a series of cross-sectional surveys, each of which includes a household interview and physical examination, conducted by the National Center for Health Statistics. Each sample is representative of the US noninstitutionalized civilian population and is independently selected through a multistage process. NHANES became a continuous survey in 1999. Descriptions of the sample design, interviews, and examinations for each NHANES have been published.\cite{18}

Our analyses were based on 2- to 19-year-olds who were examined in NHANES 1999-2004. Race/ethnicity was based on proxy- or self-report and was categorized as non-Hispanic white, non-Hispanic black, or Mexican-American; other categories, such as "other Hispanic," were excluded from the analyses. (We refer to non-Hispanic white children as "white," and non-Hispanic black children as "black.") After excluding pregnant women (n=153) and participants with missing data for weight or height (n=382) or for the poverty-income ratio (n=1004), our final sample size was 10,409.

Some analyses also examined possible differences between Mexican-American children born in the United States and those born in Mexico. About 21% of Mexican-American children, but less than 4% of white and black children, were born outside the United States.

Family Income

During the household interview, respondents were asked to report the total (annual) income for themselves and for other members of their family. (A family was defined as 2 or more related people who resided together.) Respondents who did not answer were asked (1) whether the family income was below or above $20,000, and (2) to select 1 of 11 income categories (ranging from < $5000 to ≥ $75,000). The National Center for Health Statistics used the midpoint of each income category to calculate the poverty-income ratio.

This ratio divides family income by the poverty threshold and was used as the indicator of socioeconomic status in the analyses. The poverty thresholds are adjusted for family size and are updated annually for inflation. In 2002, for example, the average poverty thresholds were $19,307 for a family of 4 and $22,831 for a family of 5.\cite{19} (Thresholds also vary slightly according to the number of children vs adults in a family.) A poverty-income ratio below 1 indicates that the family is below the poverty threshold. In NHANES 1999-2004, levels of the poverty-income ratio above 5 were recoded as 5; this corresponds to an income of about $96,000 for a family of 4.
Because the poverty-income ratio reflects family income relative to the poverty threshold, we refer to it as the "income ratio." Table 1 shows the sample sizes in NHANES 1999-2004 within categories of the income ratio and by race/ethnicity, sex, and age. Because only 24 of the Mexican-American children who were born in Mexico were from families with income ratios above 3.0, they were grouped with children having income ratios of 2.0-2.9 in some analyses.

**Anthropometry**

In each survey, height and weight were obtained using standardized techniques and calibrated equipment, and BMI was calculated from these measurements as weight (kg) divided by (height [m])². Sex-specific BMI-for-age percentiles and z-scores were calculated from the CDC Growth Charts [20,21] and overweight was defined as a BMI-for-age ≥ CDC 95th percentile [22,23]. We also considered children with a BMI-for-age ≥ 99th percentile (as calculated from the parameters for skewness, central tendency, and dispersion in the growth charts) to be "very overweight" [24]. In NHANES 1999-2004, the prevalence of overweight was 15.6% (standard error [SE]=1.0%) and the prevalence of very overweight was 3.9% (SE=0.3%).

In contrast to these percentile cut points, adult cut points for obesity are based on absolute BMI levels. We therefore classified 12 participants who had a BMI-for-age < 95th percentile but a BMI ≥ 30 kg/m² as overweight [22], and 16 persons who had a BMI-for-age < 99th percentile but a BMI ≥ 40 kg/m² as very overweight. These 28 participants were 17 years of age or older.

**Multiple NHANES Surveys**

To determine whether the relation of family income to childhood overweight has changed over time, we examined cross-sectional associations and secular trends in NHANES I (1971-1975), NHANES II (1976-1980), Hispanic HANES (1982-1984), and NHANES III (1988-1994). In contrast to the national studies, Hispanic HANES included Mexican-American children from only 5 southwestern states.

**Statistical Analyses**

Data were analyzed using R (version 2.2.1) with the "survey package" [25,26] and many of the results were compared with those obtained in SUDAAN. All analyses used sample weights, and statistical significance was assessed in analyses that accounted for the complex sampling design. We examined the prevalence of childhood overweight across income ratio categories, as well as by race/ethnicity, sex, and age. Because associations with overweight may be nonlinear [12], we used loess to examine trends; this nonparametric smoothing technique is based on a weighted regression analysis of neighboring data [27,28].

Logistic regression was used to examine the associations after adjusting for race/ethnicity, sex, and age. Age was modeled using restricted cubic splines in these analyses, and the income ratio was modeled either as a categorical (5 levels) or linear variable. Odds ratios (ORs) for a 1-unit difference in the income ratio or within categories of the income ratio were also calculated in analyses stratified by race, sex, and age. Interaction (product) terms were used to determine whether the association differed by race/ethnicity and other covariates.

We used data from 5 NHANES studies (1971-1975 to 1999-2004) to determine whether the associations were similar across studies. Within each survey, predictor variables in the regression models included race/ethnicity, sex, age, income ratio (linear), and the income ratio multiplied by race/ethnicity product term. (Because our analyses of Hispanic HANES were limited to Mexican-Americans, a possible interaction was not examined.) We also examined the survey multiplied by income ratio interaction term within each race/ethnicity (after combining the surveys into a single
dataset) to determine whether the relation of income to overweight had changed over time. In these analyses, the first year of the 5 surveys was used as the "survey date."

**Results**

Levels of various characteristics among the 2- to 19-year-olds in NHANES 1999-2004 are shown in Table 2. As compared with white children, black and Mexican-American children had higher levels of BMI-for-age, a higher prevalence of overweight, and were almost twice as likely to be very overweight (3% vs 5% to 6%). Large differences were also seen in the income ratio, with the median level more than 2-fold higher among white families than among black and Mexican-American families. (For a family of 4, these values correspond to median family incomes of about $51,000 for white families vs $22,000 to $24,000 for black and Mexican-American families in 2004.) In addition, whereas 16% of white families had a family income that was below the poverty threshold, 40% to 43% of black and Mexican-American families were below this threshold.

Overall, the prevalence of childhood overweight in families below the poverty threshold (income ratio < 1.0) was 3% higher than in families above this threshold, and the prevalence of childhood overweight by levels of the income ratio is shown in Table 3. Across the 5 categories of family income, the prevalence of overweight varied from 18% (income ratio < 1.0) to 12% (≥ 4.0). (The prevalence of very overweight varied from 5% to 2%; data not shown.) The relation of the income ratio to overweight differed across race/ethnic groups (P = .003 as assessed by a product term), but not by sex or age.

As seen in the bottom of Table 3 and in Figure 1 (middle panel), the income ratio was inversely associated with the prevalence of overweight among white and Mexican-American children, but the association was positive among black children. Among white children, the prevalence of overweight varied from 17% (income ratio < 1.0) to 11% (income ratio ≥ 4), and among Mexican-American children, the prevalence varied from 22% to 12%. (However, the association among Mexican-American children was not monotonic, with the prevalence of overweight decreasing only at income ratios above 4.0.) Among black children, in contrast, the income ratio increased from 18% to 27% (3.0-3.9). Additional analyses of Mexican-American children, stratified by country of birth, indicated that within each income ratio category, the prevalence of overweight was at least 3% higher among those born in the United States than among those born in Mexico.
Figure 1 shows smoothed levels of BMI-for-age (left panel), as well as the prevalence of overweight (middle panel) and very overweight (right panel), by the income ratio. In general, the trends for the BMI-for-age paralleled those for overweight, with inverse associations among white and Mexican-American participants, but a positive association among black participants. These smoothed levels also suggest that the association between the income ratio and BMI-for-age among white children was strongest at income ratios above 2, whereas the association was strongest at income ratios below 3 among black children. Although inverse associations were also seen with very overweight (right panel) among white and Mexican-American children, there was little association among black children. Additional analyses indicated that the positive association between income and overweight among black children was largely attributable to BMI-for-age levels between the 95th and 99th percentiles.
These associations were not altered by controlling for sex and age. Table 4 shows the results of logistic regression models, within each race/ethnicity group, that treated the income ratio as either a continuous variable (left columns) or contrasted income ratios of 4.0 and above with those below 1.0 (right columns). Each 1-unit difference in the income ratio decreased the odds of overweight by 0.90 ($P = .01$) among white children and by 0.92 ($P = .09$) among Mexican-American children but increased the odds by 1.05 ($P = .02$) among black children. Categorical analyses indicated that among white participants, the odds of overweight for a child in a family with an income ratio of $\geq 4$ was about one third lower (OR=0.63) than for a child with an income ratio below 1; the comparable OR among Mexican-American children was 0.51 ($P = .002$).

An examination of the age multiplied by income product term within each race/ethnicity group indicated that these associations significantly varied by age only among Mexican-American children ($P = .02$). As indicated in the age-stratified analyses in Table 4, 2- to 5-year-old Mexican-American children showed the strongest association between family income and childhood overweight, with an OR of 0.74 for each 1-unit difference in income. Although the association did not significantly differ between boys and girls in any race/ethnicity group, the positive association among black children was most evident among girls (categorical ORs of 1.25 for girls and 0.98 for boys).

Figure 2 shows the (lowess) smoothed prevalence of overweight by family income, race/ethnicity, and age group. Among both white and black children, the prevalence of overweight was higher among the 2 older age groups, but the patterns were fairly similar at all ages. Among Mexican-American children, however, the prevalence of overweight among 2- to 5-year-olds varied from about 18% to 5% across income ratio levels, whereas the prevalence among 6- to 11-year-olds varied only slightly across levels of the income ratio.
Figure 2.

Smoothed prevalence of overweight by race/ethnicity and age group. The 3 panels show data for white (left panel), black (middle panel), and Mexican-American (right panel) children. Weighted data were smoothed using lowess.

We then examined whether the relation of family income to childhood overweight also varied by race/ethnicity during earlier time periods (Table 5). From 1971-1975 to 1999-2004, the prevalence of overweight approximately tripled among white and black children and doubled among Mexican-American children (1982-1984 to 1999-2004). In addition, the median income ratio of white and black families increased by about 20% from 1971 to 1999.

Although there was no association between the income ratio and childhood overweight in NHANES I (ORs of 0.98 and 1.01), ORs among white children were less than 1.0 in subsequent studies and were statistically significant in NHANES III and NHANES 1999-2004. In contrast, the OR among black children was slightly greater than 1.0 in each study but was statistically
significant only in NHANES 1999-2004. Although none of the linear associations among Mexican-
American participants were statistically significant, the direction of the association was positive in
Hispanic HANES and NHANES III but negative in NHANES 1999-2004. As assessed by product
terms (race/ethnicity multiplied by income), the association differed significantly by race/ethnicity
in NHANES II, III, and 1999-2004. Additional analyses, based on combining data from the 5
surveys, indicated that the relation of family income to childhood overweight varied over time only
among Mexican-American children ($P = .03$).

Discussion

We found that the relation of family income to childhood overweight varied substantially by
income was inversely related to levels of BMI-for-age and to the prevalence of overweight and
very overweight. Conversely, among black children, family income was positively associated with
levels of BMI-for-age and overweight. Furthermore, these associations were not attributable
solely to the influence of poverty. Among white children, for example, the prevalence of
overweight was fairly constant (about 16%) between income ratios of 0 and 3 and then decreased
to about 11% among children of families with income ratios of 4 or higher.

Although a 1989 review\[1\] concluded that there was little evidence that the socioeconomic status
of the family was associated with childhood overweight, more recent studies\[6-15\] are in agreement
with many of our findings. Among 9- to 10-year-old girls in the Growth and Health Study,\[6\] for
example, the prevalence of overweight decreased by about 50% across categories of parental
education and income among white children, whereas no trend was seen among black children.
Data from NHANES III (1988-1994)\[8\] and the National Longitudinal Study of Adolescent Health
(1996)\[10\] also showed that family income was inversely associated with overweight among white,
but not black, children. We also found that there was little association between family income and
childhood overweight among black children before 1999 (Table 5).

The relation of family socioeconomic status to overweight among Mexican-American children has
not been as well studied. Although Gordon-Larsen and colleagues\[10\] found an inverse association
among Hispanic girls (but not boys), others have found no association with overweight (based on
the CDC 85th percentile of BMI-for-age).\[8\] We found an inverse association between childhood
overweight and family income among both Mexican-American boys and girls in NHANES 1999-
2004, but associations tended to be positive in earlier studies (Table 5). Although child fatness
has traditionally been viewed as a sign of good health in Mexican culture,\[29\] this attitude may not
exist among Mexican-Americans who have resided in the United States for many years. The
particularly strong (inverse) association between family income and overweight that we observed
among 2- to 5-year-olds may reflect changes in health perceptions among Mexican-American
parents with greater financial resources.

At income ratios below 3, the prevalence of overweight was higher among Mexican-American
children born in the United States than in Mexico (Table 3), further emphasizing the role of
acculturation in the development of overweight. (Very few Mexican-American children born in
Mexico had family income ratios above 3.) Other investigators have found higher BMI levels
among second-generation Mexican-American adults than among those born in Mexico,\[30\] and the
prevalence of obesity among Hispanic immigrants converges toward the prevalence among those
born in the United States as their length of residence increases.\[31,32\]

In agreement with our results, a recent analysis by Wang and Zhang\[15\] also concluded that the
relation of family income to childhood overweight differed by race in NHANES 1999-2002, with
the association positive among black participants. Some findings, however, differ between the 2
analyses. For example, Wang and Zhang\[15\] concluded that the inverse association between
family income and childhood overweight was limited to white girls, but we also found inverse
associations among white boys and Mexican-American children. There are several possible
reasons for these differences; the current study: (1) included more recent (2003-2004) data; (2)
treated family income as a continuous variable and as a 5-level (rather than 3-level) categorical
variable; and (3) statistically assessed race, sex, and age differences in the association between
family income and childhood overweight. In addition, the use of tertiles of annual income by Wang
and Zhang[15] likely resulted in a large number of children from families with modest incomes to be
included in the "high" (income ratio ≥ 3.14) socioeconomic status group; this cut point
corresponds to an annual income of $60,131 for a family of 4.

The recent secular increases in obesity likely result from the interaction of various biological and
social factors in an environment that provides an overabundance of high-calorie foods with fewer
opportunities for physical activity.[33,34] Although the mechanisms are uncertain, family
socioeconomic status could influence various aspects of energy intake and expenditure through
its effects on material circumstances, behaviors, and knowledge.[35-37] Consumers with limited
resources may also select energy-dense diets that are high in refined grains, as well as having
added sugars and fats, as an effective way to save money.[5,38] In addition, a recent report[14] found
that differences in the relation of family income to overweight between older and younger
adolescents may, in part, be due to physical activity, sweetened beverage consumption, and
skipping breakfast. Lower-income families also have fewer resources to engage in voluntary
energy expenditure, and it is possible that the recent decreases in physical education in public
schools would most strongly affect children from lower-income families. However, the contrasting
relations that we observed between family income and overweight by race/ethnicity suggest that
the interaction of these factors is complex.

Although the sex difference in the relation of family income to childhood overweight was not
statistically significant, the positive association among black children was most evident among
girls ( Table 4 ). This finding may partly reflect a combination of (1) increases in food quantity with
higher incomes,[11,12] and (2) differences in cultural and social views of body size. Black
adolescents experience less social pressure about their weight, tend to be more satisfied with
their bodies, and have less negative attitudes about overweight than white adolescents.[39,40]
Some data also indicate that as compared with white girls, black girls have a higher mean energy
intake,[41] spend more time watching television,[42] are more likely to eat food while watching
television and doing homework,[43] and experience larger decreases in physical activity levels
during adolescence.[44]

Several limitations of the current analyses should be considered. Some, but not all,
investigators[13,16,45] have found that the prevalence of overweight is related differently to levels of
education and income, but data on parental education were not available in NHANES 1999-2004.
Although information on family income was missing for about 8% of the eligible children,
additional analyses indicated that the prevalence of childhood overweight was almost identical
among children who had information on the income ratio (16%) and those who did not (15%). It
should also be realized that the US poverty thresholds are adjusted for price changes but not for
changes in the general income or consumption of the population[46] and do not account for in-kind
benefits (eg, food stamps), regional variation in housing costs, or the cost of earning income (eg,
child care costs).

Our results indicate that there is a cross-sectional association between socioeconomic status and
childhood overweight, but the association differs by race/ethnicity. Longitudinal studies are
needed to examine the relation of family socioeconomic status to BMI changes from childhood to
early adulthood. Potential explanations for the difference in the relation of socioeconomic status
to childhood overweight by race/ethnicity, as well as for the secular trend among Mexican-
American children, should be examined so that appropriate interventions can be designed.
Table 1. Unweighted Sample Sizes of 2- to 19-year-old Children in NHANES 1999-2004 by Categories of Income Ratio and Other Characteristics

<table>
<thead>
<tr>
<th></th>
<th>Income Ratio</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt; 1.0</td>
</tr>
<tr>
<td>Overall (n=10,409)</td>
<td>3578</td>
</tr>
<tr>
<td><strong>Race</strong></td>
<td></td>
</tr>
<tr>
<td>Whites (n=3144)</td>
<td>561</td>
</tr>
<tr>
<td>Blacks (n=3577)</td>
<td>1510</td>
</tr>
<tr>
<td>Mexican-Americans&lt;sup&gt;b&lt;/sup&gt; (n=3688)</td>
<td>1507</td>
</tr>
<tr>
<td>Born in US (n=2899)</td>
<td>1051</td>
</tr>
<tr>
<td>Born in Mexico (n=780)</td>
<td>449</td>
</tr>
<tr>
<td><strong>Sex</strong></td>
<td></td>
</tr>
<tr>
<td>Boys (n=5267)</td>
<td>1825</td>
</tr>
<tr>
<td>Girls (n=5142)</td>
<td>1753</td>
</tr>
<tr>
<td><strong>Age Group (years)</strong></td>
<td></td>
</tr>
<tr>
<td>2-5.9 (n=1968)</td>
<td>769</td>
</tr>
<tr>
<td>6-11.9 (n=2729)</td>
<td>957</td>
</tr>
<tr>
<td>12-19.9 (n=5712)</td>
<td>1852</td>
</tr>
</tbody>
</table>

<sup>a</sup>Values of the income ratio > 5 were recoded as 5.

<sup>b</sup>Nine Mexican-American children were not born in the United States or in Mexico.
Table 2. Mean Levels of Various Characteristics by Race/Ethnicity, NHANES 1999-2004

<table>
<thead>
<tr>
<th></th>
<th>Whites</th>
<th>Blacks</th>
<th>Mexican-Americans</th>
</tr>
</thead>
<tbody>
<tr>
<td>N</td>
<td>3144</td>
<td>3577</td>
<td>3688</td>
</tr>
<tr>
<td>Female (%)</td>
<td>48%</td>
<td>49%</td>
<td>49%</td>
</tr>
<tr>
<td>Age (years)</td>
<td>11.1</td>
<td>10.8</td>
<td>10.4</td>
</tr>
<tr>
<td><strong>BMI-for-age</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Z-score*</td>
<td>0.38</td>
<td>0.53</td>
<td>0.59</td>
</tr>
<tr>
<td>Percentile (median)*</td>
<td>65</td>
<td>71</td>
<td>73</td>
</tr>
<tr>
<td>Overweight (%)**</td>
<td>14%</td>
<td>19%</td>
<td>20%</td>
</tr>
<tr>
<td>Very overweight (%)**</td>
<td>3%</td>
<td>6%</td>
<td>5%</td>
</tr>
<tr>
<td><strong>Income ratio</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median*</td>
<td>2.6</td>
<td>1.2</td>
<td>1.2</td>
</tr>
<tr>
<td>Income ratio &lt; 1 (%)*</td>
<td>16%</td>
<td>43%</td>
<td>40%</td>
</tr>
<tr>
<td>Income ratio ≥ 5 (%)*</td>
<td>17%</td>
<td>6%</td>
<td>4%</td>
</tr>
<tr>
<td>Missing information (%)**</td>
<td>5%</td>
<td>10%</td>
<td>9%</td>
</tr>
</tbody>
</table>

*Overweight was defined as a BMI-for-age ≥ 95th percentile or a BMI ≥ 30 kg/m².

**Very overweight was defined as a BMI-for-age ≥ 99th percentile or a BMI ≥ 40 kg/m².

The median family income for a family of 4 (2 adults and 2 children) can be obtained by multiplying the median income ratio by $19,157 (the poverty threshold for this family).

Percent of otherwise eligible children who were missing information on the income ratio.

*P < .001 for difference across the 3 racial/ethnic groups as assessed by linear or logistic regression models that controlled for sex and age. The null hypothesis is that the 3 means (or proportions) are equal.
Table 3. Prevalence of Overweight by Income Ratio and Other Characteristics, NHANES 1999-2004

<table>
<thead>
<tr>
<th>Income Ratio</th>
<th>&lt; 1.0&lt;sup&gt;a&lt;/sup&gt;</th>
<th>1.0-1.9</th>
<th>2.0-2.9</th>
<th>3.0-3.9</th>
<th>≥ 4</th>
</tr>
</thead>
<tbody>
<tr>
<td>Overall</td>
<td>18%</td>
<td>16%</td>
<td>16%</td>
<td>16%</td>
<td>12%</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>18%</td>
<td>17%</td>
<td>17%</td>
<td>15%</td>
<td>12%</td>
</tr>
<tr>
<td>Girls</td>
<td>18%</td>
<td>15%</td>
<td>15%</td>
<td>17%</td>
<td>11%</td>
</tr>
<tr>
<td>Age Group (years)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-5.9</td>
<td>11%</td>
<td>15%</td>
<td>9%</td>
<td>8%&lt;sup&gt;b&lt;/sup&gt;</td>
<td>8%&lt;sup&gt;b&lt;/sup&gt;</td>
</tr>
<tr>
<td>6-11.9</td>
<td>21%</td>
<td>16%</td>
<td>18%</td>
<td>16%</td>
<td>14%</td>
</tr>
<tr>
<td>12-19.9</td>
<td>20%</td>
<td>17%</td>
<td>19%</td>
<td>18%</td>
<td>12%</td>
</tr>
<tr>
<td>Race/Ethnicity</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>White</td>
<td>17%</td>
<td>15%</td>
<td>15%</td>
<td>14%</td>
<td>11%</td>
</tr>
<tr>
<td>Black</td>
<td>18%</td>
<td>19%</td>
<td>17%</td>
<td>27%</td>
<td>21%</td>
</tr>
<tr>
<td>Mexican-American</td>
<td>22%</td>
<td>18%</td>
<td>21%</td>
<td>21%</td>
<td>12%</td>
</tr>
<tr>
<td>Born in US</td>
<td>24%</td>
<td>19%</td>
<td>21%</td>
<td>22%</td>
<td>12%</td>
</tr>
<tr>
<td>Born in Mexico</td>
<td>17%</td>
<td>16%</td>
<td>16%&lt;sup&gt;b,c&lt;/sup&gt;</td>
<td>---</td>
<td>---</td>
</tr>
</tbody>
</table>

<sup>a</sup>Families with an income ratio < 1.0 are below the poverty threshold.

<sup>b</sup>Did not meet standard of statistical reliability and precision. Relative SE was between 30% and 40%.

<sup>c</sup>Includes 24 Mexican-American children born in Mexico with income ratios ≥ 3.
Table 4. Associations Between Income Ratio and Childhood Overweight, by Race/Ethnicity, Age Group, and Sex, as Assessed in Logistic Regression, NHANES 1999-2004

<table>
<thead>
<tr>
<th></th>
<th>Estimated Odds Ratios Between Income Ratio and Overweight&lt;sup&gt;a&lt;/sup&gt;</th>
<th>Categorical: Income Ratio of ≥4 vs &lt;1&lt;sup&gt;c&lt;/sup&gt;</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Linear: 1-Unit Difference in Income Ratio&lt;sup&gt;b&lt;/sup&gt;</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Whites</td>
<td>Blacks</td>
</tr>
<tr>
<td>Overall</td>
<td>0.90* (0.84, 0.98)</td>
<td>1.05* (1.01, 1.10)</td>
</tr>
<tr>
<td>Age Group (years)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>2-5.9</td>
<td>0.88 (0.73,1.06)</td>
<td>0.98 (0.81, 1.19)</td>
</tr>
<tr>
<td>6-11.9</td>
<td>0.90 (0.77,1.06)</td>
<td>1.11 (0.99, 1.24)</td>
</tr>
<tr>
<td>12-19.9</td>
<td>0.91 (0.82, 1.00)</td>
<td>1.04 (0.98, 1.10)</td>
</tr>
<tr>
<td>Sex</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Boys</td>
<td>0.89* (0.80,1.00)</td>
<td>1.02 (0.92, 1.12)</td>
</tr>
<tr>
<td>Girls</td>
<td>0.92 (0.83,1.01)</td>
<td>1.08 (0.98, 1.19)</td>
</tr>
</tbody>
</table>

<sup>a</sup>All analyses controlled for age (modeled using restricted cubic splines) and sex.

<sup>b</sup>Linear odds ratios (ORs; 95% confidence intervals) were calculated in models that treated the income ratio as a continuous variable.

<sup>c</sup>Categorical ORs were calculated from models that treated the income ratio as a 5-level categorical variable (as in Table 3). The null hypothesis is that the ORs for the 5 income categories are all equal to 1.0.

*P < .05; **P < .01.
Table 5. Relation of Income Ratio to Childhood Overweight in Various NHANES Surveys

<table>
<thead>
<tr>
<th>NHANES Surveya</th>
<th>I</th>
<th>II</th>
<th>Hispanic</th>
<th>III</th>
<th>Continuous</th>
</tr>
</thead>
<tbody>
<tr>
<td>Years</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1971-1975</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1976-1980</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1982-1984</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1988-1994</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1999-2004</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>N</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whites</td>
<td>4779</td>
<td>5237</td>
<td>----</td>
<td>2815</td>
<td>3144</td>
</tr>
<tr>
<td>Blacks</td>
<td>1657</td>
<td>1141</td>
<td>----</td>
<td>3345</td>
<td>3577</td>
</tr>
<tr>
<td>Mexican-Americans</td>
<td>----b</td>
<td>----b</td>
<td>3212</td>
<td>3285</td>
<td>3688</td>
</tr>
<tr>
<td>Overweight (%)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whites</td>
<td>5%</td>
<td>5%</td>
<td>10%</td>
<td>14%</td>
<td></td>
</tr>
<tr>
<td>Blacks</td>
<td>6%</td>
<td>8%</td>
<td>12%</td>
<td>19%</td>
<td></td>
</tr>
<tr>
<td>Mexican-Americans</td>
<td>9%</td>
<td>14%</td>
<td>20%</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Median Income Ratio</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whites</td>
<td>2.2</td>
<td>2.2</td>
<td>2.5</td>
<td>2.6</td>
<td></td>
</tr>
<tr>
<td>Blacks</td>
<td>1.0</td>
<td>1.1</td>
<td>1.1</td>
<td>1.2</td>
<td></td>
</tr>
<tr>
<td>Mexican-Americans</td>
<td>1.3</td>
<td>1.1</td>
<td>1.2</td>
<td></td>
<td></td>
</tr>
<tr>
<td>OR (1-unit difference)c</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Whites</td>
<td>0.98</td>
<td>0.87</td>
<td>0.81**</td>
<td>0.90*</td>
<td></td>
</tr>
<tr>
<td>Blacks</td>
<td>1.01</td>
<td>1.42</td>
<td>1.04</td>
<td>1.05*</td>
<td></td>
</tr>
<tr>
<td>Mexican-Americans</td>
<td>1.05</td>
<td>1.11</td>
<td>0.92</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Race H income ratio interaction (P value)</td>
<td>.75</td>
<td>.02</td>
<td>---</td>
<td>.002</td>
<td>&lt; .001</td>
</tr>
</tbody>
</table>

*Each survey was independently designed, and there was no intended overlap in the samples.

Because of the small number of Mexican-Americans in NHANES I and II, they are excluded from the analyses.

The income ratio was treated as a continuous variable.

*P < .05; **P < .01
References


2001;155:360-365. Abstract

Funding Information

The research in this article was funded by the US Centers for Disease Control and Prevention.

Disclaimer

The findings and conclusions in this report are those of the authors and do not necessarily represent those of CDC.

David S. Freedman, PhD, Division of Nutrition and Physical Activity, Centers for Disease Control and Prevention, Atlanta, Georgia
Cynthia L. Ogden, PhD, National Center for Health Statistics, Centers for Disease Control and Prevention, Hyattsville, Maryland
Katherine M. Flegal, PhD, National Center for Health Statistics, Centers for Disease Control and Prevention, Hyattsville, Maryland
Laura Kettel Khan, PhD, Division of Nutrition and Physical Activity, Centers for Disease Control and Prevention, Atlanta, Georgia
Mary K. Serdula, MD, Division of Nutrition and Physical Activity, Centers for Disease Control and Prevention, Atlanta, Georgia
William H. Dietz, MD, Division of Nutrition and Physical Activity, Centers for Disease Control and Prevention, Atlanta, Georgia

Disclosure: David S. Freedman, PhD, has disclosed no relevant financial relationships.
Disclosure: Cynthia L. Ogden, PhD, has disclosed no relevant financial relationships.
Disclosure: Katherine M. Flegal, PhD, has disclosed no relevant financial relationships.
Disclosure: Laura Kettel Khan, PhD, has disclosed no relevant financial relationships.
Disclosure: Mary K. Serdula, MD, has disclosed no relevant financial relationships.
Disclosure: William H. Dietz, MD, has disclosed no relevant financial relationships.