

# Low Family Income and Food Insufficiency in Relation to Overweight in US Children

## Is There a Paradox?

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**Objectives:** To investigate associations between family income, food insufficiency, and being overweight in US children aged 2 to 7 and 8 to 16 years, to discuss mechanisms that may explain these associations, and to propose design and data requirements for further research that could effectively examine this issue.

**Methods:** Data from the Third National Health and Nutrition Examination Survey were analyzed. Children were classified as food insufficient if the family respondents reported that their family sometimes or often did not get enough food to eat. The prevalence of overweight was compared by family income category and food sufficiency status within age-, sex-, and race-ethnic-specific groups. Odds ratios for food insufficiency are reported, adjusted for family income and other potential confounding factors.

**Results:** Among older non-Hispanic white children, chil-

dren in families with low income were significantly more likely to be overweight than children in families with high income. There were no significant differences by family income for younger non-Hispanic white children, non-Hispanic black children, or Mexican American children. After adjusting for confounding variables, there were no differences in overweight by food sufficiency status, except that younger food-insufficient girls were less likely to be overweight, and non-Hispanic white older food-insufficient girls were more likely to be overweight than food-sufficient girls ( $P < .10$ ).

**Conclusion:** Further research to evaluate whether food insecurity causes overweight in American children requires longitudinal quantitative and in-depth qualitative methods.

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**I**N 1995, DIETZ<sup>1</sup> published a case study in *Pediatrics* describing an obese 7-year-old African American girl whose family often ran out of money for food. He introduced the case study by stating, "Both hunger and obesity occur with an increased frequency among poorer populations in the United States. Because obesity connotes excessive energy intake, and hunger reflects an inadequate food supply, the increased prevalence of obesity and hunger in the same population seems paradoxical."<sup>1(p766)</sup> Dietz described the family's situation, in which the first welfare check of the month was spent on rent, leaving no money for food until the second check arrived. Meanwhile, the mother fed the child high-fat foods to assuage her hunger during these periods. Dietz wondered, "does hunger cause obesity?"

Dietz<sup>1</sup> used the term *hunger* in his case study, but the phenomenon he described may be closer to the term *food insecurity*. The US Department of Agriculture defines food insecurity as "limited or uncertain availability of nutritionally adequate and safe

foods or limited or uncertain ability to acquire acceptable food in socially acceptable ways."<sup>2(piii),3</sup> Hunger is "the uneasy or painful sensation caused by a lack of food" or "the recurrent and involuntary lack of access to food."<sup>2(piii),3</sup> The distinction between food insecurity and hunger is one of severity. A family will be categorized as "food insecure" if members are habitually concerned about their food situation or if an adult in the family occasionally goes without food (eg, skips meals). A family will be categorized as "moderately hungry" if an adult in the family goes without food or a child is cutting the size of his or her meals or "not eating enough," but will not be categorized as "severely hungry" unless an adult in the family goes without food for a whole day or a child in the family ever goes without food (skips meals). The US Department of Agriculture estimated that 12% of US households were food insecure, 3.3% were moderately hungry, and 0.8% were severely hungry in 1995.<sup>2</sup>

Another term, *food insufficiency*, was used by the Third National Health and Nu-

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## PARTICIPANTS AND METHODS

Data for children aged 2 to 7 years (n=5200) and 8 to 16 years (n=3996) were analyzed from NHANES III, a cross-sectional representative sample of the US civilian noninstitutionalized, nonhomeless population living in households. The survey was conducted from 1988 to 1994. Mexican Americans and black Americans were oversampled to provide more reliable estimates for these groups. Detailed descriptions of the sample design and operation of the survey have been published elsewhere.<sup>34</sup> Data from NHANES III included medical examination results and interviews conducted with survey participants and proxies who were parents or other relatives or caretakers familiar with the child. All interviews and examinations were conducted using standard protocols.<sup>34</sup>

### CONCEPTUAL FRAMEWORK

Using past research, a conceptual framework of the factors affecting children's body mass index was created using available variables from NHANES III<sup>35-45</sup> to guide the analyses in this study. This framework is shown in the **Figure**. We postulate that having fewer family resources can lead to food insufficiency, health care risks, or exercise risks that can affect a child's body mass index. Family resources that could be associated with food insufficiency, health care risks, and/or overweight include family income, measured as the poverty-income ratio (PIR), education of the family head, marital status of the family head, family size, and whether the child lives in a metropolitan region. Health care risks include lack of health insurance or a regular source of health care. For older children, exercise risks include increased number of hours spent watching television or lack of physical activity. Past health and nutrition risks can also affect the child's body mass index. These include the child's birth weight, whether the child had birth complications, whether the child was exposed to smoke prenatally, and/or short stature. Hereditary factors can also affect a child's body mass index, which we controlled using parental height and weight.

trition Examination Survey (NHANES III) and is the focus of this article. Food insufficiency was defined as living in a family that "sometimes or often did not get enough food to eat." Through cognitive testing of questionnaire items and comparisons of survey respondents' responses to food-insecurity, hunger, and food-insufficiency questions, it was determined that the NHANES III concept of food insufficiency is more severe than the concept of food insecurity, not as severe as hunger, and closer to the phenomenon of hunger than food insecurity.<sup>4-10</sup> Results from NHANES III found that 4.1% of the population was food insufficient between 1988 and 1994.

There is some evidence that food insecurity, but not hunger, the more severe form of food deprivation, is associated with obesity in adult women. In a sample of rural white Upstate New York women, the prevalence of obesity was significantly higher in food-insecure women than in food-secure women, but the

## OVERWEIGHT

For these analyses, we defined overweight by cutoff values derived from the Centers for Disease Control and Prevention's growth chart data linking the adult criterion for overweight to the corresponding centile for children, as described by Kuzmarski et al.<sup>46</sup> The cutoffs used to determine overweight were sex and half-year age specific. We used the 85th percentile of weight for height as a cutoff, which expert panels defined as *risk of overweight* rather than overweight.<sup>47,48</sup> We used this outcome measure for these analyses because the prevalence of "overweight" based on the 95th percentile was too low for us to be able to confidently estimate associations. We repeated our analyses using the cutoffs from Cole et al,<sup>49</sup> and found essentially the same results as reported herein.

### SOCIODEMOGRAPHIC AND FAMILY/CHILD RESOURCES

For each child in the survey, information about sex, age, race-ethnicity (non-Hispanic white, non-Hispanic black, or Mexican American), metropolitan or nonmetropolitan region of residence, family size, family income, employment status and education of the family head, health insurance status, and whether the child had a regular source of health care was provided by a responsible adult living in the home. The "family head" was a person who owned or rented the home in which the child lived. Total family income for the previous 12 months was reported for categories ranging from "less than \$1000" to "\$80000 and over," in \$1000 increments below \$19999, in \$5000 increments between \$20000 and \$49999, and in \$10000 increments between \$50000 and \$79999. The PIR was then calculated by comparing the midpoint of the category and the child's family size to the federal poverty line.<sup>50</sup> These analyses used 3 poverty status categories: low income, a PIR less than or equal to 130% of the poverty line, which is the federal cutoff for eligibility for the Food Stamp Program; middle income (>130%-300% of the poverty line); and high income (>300% of the poverty line). Children were defined as insured if they were covered during the last

prevalence among hungry women was similar to the prevalence among the food secure.<sup>11,12</sup> Similarly, in an analysis of national data,<sup>13</sup> food-insecure women, but not men, were more likely to be overweight than were food-secure women. However, in another analysis of national data,<sup>14</sup> food-insufficient diabetic adults were twice as likely to be obese as were food-sufficient diabetic adults. In the only study<sup>15</sup> on this topic conducted with children, to our knowledge, hungry, but not food-insecure, Mexican American preschool-aged children were significantly less likely to be overweight than food-secure children.

Several mechanisms have been proposed by which food insecurity could cause obesity. First, food-insecure individuals may be overweight because they can only afford to consume cheaper foods, which tend to be energy (calorie) dense and could result in the person consuming excessive energy and gaining weight.<sup>16-19</sup> Second, periods without enough food could cause individu-

month by private health insurance, military health care insurance, or Medicaid, and if the coverage paid for “more than accidents.”

#### FOOD INSUFFICIENCY

A child was classified as “food insufficient” if the respondent to the family questionnaire reported that the family either “sometimes” or “often” did not get enough food to eat.

#### EXERCISE RISK

Data on exercise risks were available for 8- to 16-year-old children only. These included the number of hours spent watching television in the previous day and the number of hours spent per week playing or exercising enough to make the child “sweat or breathe hard.”

#### PAST HEALTH AND NUTRITION RISK

For children aged 2 to 7 years, information was collected on the presence of birth complications, birth weight, and any prenatal smoke exposure. We used measured height (collected for all children) as a measure of past health and nutrition status.

#### STATISTICAL METHODS

Data for children aged 2 to 7 and 8 to 16 years were analyzed for each race-ethnic group. These age groups were chosen because certain data were available for one or the other age group and because creating more than 2 age groups would have resulted in sample sizes too small for adequate analyses. Children categorized as “other” race-ethnicity were excluded from the analyses. Pregnant teen-aged girls and those who reported having had at least one full-term birth were also excluded.

Race-ethnic groups were examined separately for 2 reasons. First, there are cultural differences in food patterns between Mexican Americans, non-Hispanic black Americans, and non-Hispanic white Americans.<sup>51-54</sup> Second, a

previous analysis<sup>55</sup> of adults in NHANES III has shown that overweight is strongly related to income only for non-Hispanic white women.

Sample weights were created for the NHANES III data to take into account the oversampling of certain groups, such as black Americans and Mexican Americans, and of nonresponse. For these analyses, NHANES III-weighted data were analyzed using the *svy* commands available in Stata statistical software.<sup>56</sup> These commands use the weights and survey cluster design to calculate accurate point estimates and variances.

For prevalence estimates and means, missing data were excluded from the analyses. Logistic regression models were created to test for significant differences by family income after adjusting for age.

Logistic regression models were also created to test the hypothesis that food insufficiency is associated with overweight, independent of other potential confounding factors. Control variables included those variables shown in the Figure and previously described. The PIR was entered as a continuous variable. For the logistic regression analyses, all missing data except for food insufficiency status were imputed using the *impute* command in Stata statistical software, which uses regression equations to fill in missing values based on other nonmissing data in the child’s record. Variables included in these regression equations were chosen separately for each imputed variable using backward stepwise regression to screen for associated variables. For dichotomous variables, the *impute* command was used to predict a probability, and a random value was selected based on this probability. The number of missing values imputed ranged from 0 children with missing data for whether the child had a regular source of health care to 463 children aged 2 to 7 years and 334 children aged 8 to 16 years with missing data for their family’s PIR. Regression results were not sensitive to the inclusion of imputed values.

Sample sizes for each prevalence estimate are shown in **Table 1** and **Table 2**. Sample sizes for some groups were small, eg, there were only 17 non-Hispanic white 8- to 16-year-old food-insufficient girls.

als to overeat when there is enough food, resulting in increased energy intake overall, which would then cause a gain in weight.<sup>20-27</sup> Third, fluctuations in eating habits could result in the body becoming a more efficient user of energy, meaning that the individual could increase in weight without eating more calories; these fluctuations may not cause lasting changes in resting energy expenditure.<sup>28-33</sup>

With this background in mind, we used data from NHANES III to investigate whether there is an association between family income and overweight, and between food insufficiency and overweight, in US children. Specifically, we answer 2 questions: (1) Is there a paradox? That is, does an increased prevalence of food insufficiency and overweight coexist in the population of US children living in families with low income? (2) Is food insufficiency independently associated with overweight, controlling for known confounders?

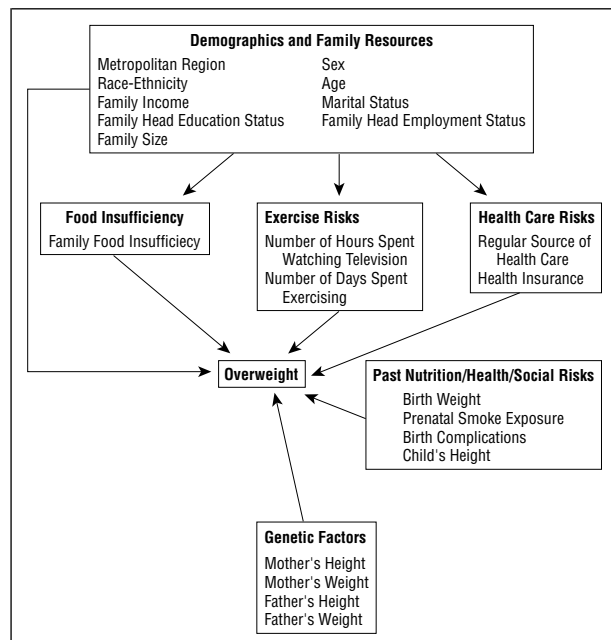
We present results from our analyses, and discuss design and data requirements for further research that could effectively examine this issue.

## RESULTS

### DOES AN INCREASED PREVALENCE OF FOOD INSUFFICIENCY AND RISK OF OVERWEIGHT COEXIST IN US CHILDREN LIVING IN FAMILIES WITH LOW INCOME?

To answer this question, we begin first by looking at the prevalence of food insufficiency in the United States by income category. Among 2- to 7-year-old children, the prevalence of food insufficiency is 15.8% in the low-income population, 1.8% in the middle-income population, and 0.3% in the high-income population; for 8- to 16-year-old children, the corresponding figures are 16.4%,

2.4%, and 0%. There are similar trends among the race-ethnic groups. Hence, an increased prevalence of food insufficiency exists in the low-income population.



Theoretical model of relationships between family resources, food insufficiency, exercise risks, health care risks, past nutrition/health/social risks, genetic factors, and overweight: Third National Health and Nutrition Examination Survey, 1988 to 1994.

Turning to the question of overweight, for 2- to 7-year-old girls and boys, there were no statistically significant differences in overweight by income category for any of the race-ethnic groups (Table 1). For 8- to 16-year-old girls and boys, only non-Hispanic white children showed significant differences among family income category; low- and middle-income non-Hispanic white boys had a significantly higher prevalence of overweight than did high-income non-Hispanic white boys, and low- and middle-income non-Hispanic white girls had a significantly higher prevalence of overweight than did high-income non-Hispanic white girls. Therefore, an increased prevalence of food insufficiency and overweight coexists only among low-income older non-Hispanic white children in the United States.

### IS FOOD INSUFFICIENCY ASSOCIATED WITH OVERWEIGHT, CONTROLLING FOR KNOWN CONFOUNDERS?

Table 2 shows prevalence estimates of overweight by age, sex, and race-ethnicity for food-sufficient vs food-insufficient children. There were no consistent trends in the relationship between overweight and food insufficiency status.

The results of the logistic regression analyses testing for statistical differences in overweight between food-sufficient and food-insufficient children are shown in **Table 3**. Results are shown for all 2- to 7-year-old

**Table 1. Prevalence of Overweight by Race-Ethnicity, Age, Sex, and Family Income: NHANES III, 1988-1994\***

Participants	Age Group, y					
	2-7			8-16		
	Sample Size	% Overweight	SE	Sample Size	% Overweight	SE
Non-Hispanic						
White boys						
Low income	155	17.3	3.7	102	34.0†	4.5
Middle income	353	16.6	1.9	236	29.7‡	3.2
High income	223	13.8	3.3	169	20.6	4.0
White girls						
Low income	172	16.4	2.8	122	29.8†	4.4
Middle income	338	20.1	3.3	244	26.1†	3.6
High income	238	19.3	3.1	184	16.1	2.8
Black boys						
Low income	513	18.7	1.9	388	23.1	2.4
Middle income	229	15.9	2.4	230	27.2	2.2
High income	71	19.3	4.3	74	28.0	6.1
Black girls						
Low income	487	21.7	2.0	393	30.6	3.2
Middle income	258	20.8	3.5	204	32.5	3.2
High income	61	15.4	3.6	73	42.6	7.1
Mexican American						
Boys						
Low income	539	29.5	2.3	389	32.8	2.0
Middle income	230	25.9	3.2	184	37.4	5.0
High income	50	37.5	9.4	50	30.6	11.3
Girls						
Low income	581	26.5	2.6	389	30.0	4.5
Middle income	241	19.2	4.0	192	38.3	5.1
High income	51	23.7	8.4	61	25.1	6.6

\*NHANES III indicates the Third National Health and Nutrition Examination Survey.

†Significantly different ( $P < .05$ ) from high income, after adjusting for age.

‡Significantly different ( $P < .10$ ) from high income, after adjusting for age.

**Table 2. Prevalence of Overweight by Race-Ethnicity, Age, Sex, and Family Food Insufficiency Status: NHANES III, 1988-1994\***

Participants	Age Group, y					
	2-7			8-16		
	Sample Size	% Overweight	SE	Sample Size	% Overweight	SE
Non-Hispanic						
White boys						
Food insufficient	17	19.1	14.2	20	19.3	10.2
Food sufficient	739	16.0	1.4	505	27.8	2.2
White girls						
Food insufficient	36	7.5	3.9	17	41.3	12.7
Food sufficient	746	19.6	1.8	549	23.0	2.5
Black boys						
Food insufficient	97	19.4	6.0	77	24.9	5.7
Food sufficient	783	17.6	1.3	662	24.9	1.5
Black girls						
Food insufficient	89	15.4	4.0	81	27.7	6.2
Food sufficient	776	21.5	1.8	645	33.8	2.2
Mexican American						
Boys						
Food insufficient	164	30.8	3.9	136	35.7	4.3
Food sufficient	750	28.3	1.9	581	34.8	2.1
Girls						
Food insufficient	190	30.9	4.6	121	23.1	4.5
Food sufficient	811	23.7	2.7	597	32.7	3.7

\*NHANES III indicates the Third National Health and Nutrition Examination Survey.

**Table 3. Logistic Regression for Overweight 2- to 7- and 8- to 16-Year-Old Children: NHANES III, 1988-1994\***

Food Sufficiency Status	Age Group, y							
	2-7 (All Children)†		8-16					
			Non-Hispanic Children‡				Mexican American Children§	
	Boys	Girls	White	Black	White	Black	Boys	Girls
Food insufficient	0.91 (0.55-1.51)	0.64 (0.38-1.08)	0.35 (0.05-2.22)	3.55 (0.82-15.40)	1.10 (0.50-2.40)	0.90 (0.47-1.71)	1.33 (0.74-2.39)	0.70 (0.36-1.34)
Food sufficient	1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00

\*Data are given as odds ratio (95% confidence interval). NHANES III indicates the Third National Health and Nutrition Examination Survey.

†Odds ratios are adjusted for child's height, child's birth weight, mother's height and weight, father's height and weight, age squared, poverty-income ratio, household size, family head educational status, family head employment status, family head marital status, metropolitan location, health insurance coverage, regular source of health care, smoke exposure during pregnancy, and birth complications.

‡Odds ratios are adjusted for child's height, child's birth weight, mother's height and weight, father's height and weight, age squared, poverty-income ratio, household size, family head educational status, family head employment status, family head marital status, metropolitan location, health insurance coverage, regular source of health care, hours of television viewed per day, and hours spent exercising.

§Odds ratios are also adjusted for language of the interview.

||Referent.

boys and girls, but results for 8- to 16-year-old boys and girls are displayed by race-ethnic group because of significant interactions found between race-ethnic group and PIR and between race-ethnic group and food insufficiency status. Only 2 notable differences by food sufficiency status were found after adjusting for potential confounding factors: food-insufficient 2- to 7-year-old girls were 1.6 times less likely to be overweight than were food-sufficient girls, and non-Hispanic white 8- to 16-year-old food-insufficient girls were 3.5 times more likely to be overweight than were food-sufficient girls ( $P < .10$ ).

### COMMENT

The results of this study demonstrate that a population-level paradox of increased prevalence of overweight and food insufficiency occurs only in low-income older non-Hispanic white children in the United States, but not in younger non-Hispanic white children, non-Hispanic black children, or Mexican American children. Other studies of the relationship between income and overweight also show mixed results. In their review of 144 studies conducted before 1989, Sobal and Stunkard<sup>38</sup> concluded that

there was a clear relationship between obesity and socioeconomic status in women in the United States; poorer women were more likely to be overweight. However, results of studies of men and children were mixed, with some finding a direct relationship (poorer men and children are more likely to be overweight), some finding an indirect relationship (poorer men and children are less likely to be overweight), and some finding no relationship.

The logistic regression analyses indicate that food insufficiency is positively associated with overweight only in older non-Hispanic white girls. Therefore, according to these analyses, food insufficiency is a potential explanation for a paradox of increased prevalence of overweight in children living in families with low income only for older non-Hispanic white girls.

We emphasize that this is a potential explanation for several reasons. There are several limitations of the NHANES III data and, therefore, this study, for looking at the relationship between food insufficiency and overweight in children. First, because it was necessary to divide the sample into age, sex, and race-ethnic groups, sample sizes for some subgroups were small. Small samples limit the power to detect significant differences between groups and can also result in finding spurious relationships. These small sample sizes also necessitated combining children of differing ages in whom associations between food insufficiency and overweight might be different (eg, food-insufficient 8- to 10-year-old children may have different eating patterns than food-insufficient adolescents).

Another shortcoming of this study is the lack of information about potential fluctuations in family food availability in the NHANES III data. The concept of "food insufficiency," measured by NHANES III, is closer to the concept of "hunger" than of "food insecurity." It is unknown if children who live in food-insufficient families exhibit the fluctuations in food intake postulated to cause overweight. It could be that children who live in food-insufficient families experience a more severe form of food deprivation.

Difficulty in interpretation is compounded by the fact that food insufficiency, as measured by the NHANES III, is a family measure and assigns the same value to adults and children in the family. Testing of the postulated mechanisms requires a measure that allows one to treat adults and children within the same family differently because eating patterns could be different for different members of the family.

Additional research with cross-sectional data is unlikely to yield insight into the potential relationship between food insecurity and overweight. The elucidation of these relationships will require retrospective longitudinal studies that allow one to study temporal sequences of events. Future studies will also benefit from more qualitative research approaches. They should explore several issues, including the food insecurity and hunger status of each member of the child's family, an in-depth understanding of the meaning and patterns of food deprivation that each individual in food-insecure and hungry families exhibits, and an understanding that different food-insecure and hungry families (eg, those of dif-

### What This Study Adds

It is commonly thought that there is a higher prevalence of food deprivation and overweight among US children in low-income compared with middle- and high-income families, and that this represents a paradox. Hence, researchers have asked the following: Does food deprivation cause overweight? However, to our knowledge, there have been no national studies that have examined if this paradox exists in all race-ethnic groups in the United States, or if there is an association between food insufficiency and overweight in children.

An increased prevalence of overweight and food insufficiency existed only in older (aged 8-16 years), non-Hispanic white, low-income children in the United States; all younger children (aged 2-7 years) and non-Hispanic black and Mexican American children showed no differences in the prevalence of overweight by family income. After adjusting for confounding variables, food insufficiency was not positively associated with overweight except in older, non-Hispanic white girls. Thus, there is epidemiological evidence for the paradox only in one race-ethnic and age group of the US child population.

ferent race-ethnic or family composition) may have different ways of coping with their situation that will hinder generalizations.

Finally, it is worth noting that childhood food insufficiency, food insecurity, and hunger are associated with serious health, academic, and psychological problems for children.<sup>57-59</sup> Regardless of whether these phenomena are associated with overweight, achieving food security for all US families should be a critical component of child health policy.

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