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The Association of Child and Household Food Insecurity With Childhood Overweight Status

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ABSTRACT

CONTEXT. The prevalence of childhood overweight status is increasing. Some have suggested that childhood overweight is associated with food insecurity, defined as limited or uncertain access to enough nutritious food.

OBJECTIVES. The purpose of this work was to assess the association of household and child food insecurity with childhood overweight status.

METHODS. The National Health and Nutrition Examination Survey 1999–2002 uses a stratified multistaged probability sample and collects a broad array of data from a nationally representative sample of US citizens. All children 3 to 17 years old in this sample are included in these analyses. We measured BMI categorized as at risk for overweight or greater ($\geq 85\%$) or overweight ($\geq 95\%$) and household and child food security/insecurity using the US Food Security Scale.

RESULTS. When compared with children from food-secure households, children from food-insecure households were more likely to demonstrate significant associations with being at risk for overweight or greater in the following demographic categories: 12 to 17 years, girls, white, and in households with income $<100\%$ and >4 times the federal poverty level. Household food insecurity is associated with child overweight status in children aged 12 to 17, girls, and children who live in households with incomes >4 times the federal poverty level. Child food insecurity demonstrated the same associations with being at risk for overweight or greater, as did household food insecurity, but associations were also seen in 3- to 5-year-old children, boys, and Mexican American children. Child food insecurity is significantly associated with child overweight status for children aged 12 to 17, girls, white children, and children in families with income $\leq 100\%$ poverty level. Controlling for ethnicity, gender, age, and family poverty index level, childhood food insecurity is associated with a child being at risk for overweight status or greater, but not overweight status.

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Key Words

food insecurity, child health status, overweight children

Abbreviations

OW—overweight
ARO—at risk for overweight or greater
NHANES—National Health and Nutrition Examination Survey

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CONCLUSIONS. Household and child food insecurity are associated with being at risk for overweight and overweight status among many demographic categories of children. Child food insecurity is independently associated with being at risk for overweight status or greater while controlling for important demographic variables. Future longitudinal research is required to determine whether food insecurity is causally related to child overweight status.

THE INCREASED PREVALENCE of childhood overweight (OW) status (BMI $\geq 95\%$) and at risk for overweight or greater ([ARO] BMI $\geq 85\%$) was initially noted in national surveys in the late 1980s to early 1990s.¹ By the end of 1994, $\sim 11\%$ of children in the United States aged 6 to 19 were overweight compared with $\sim 5\%$ in the 1970s.² This prevalence of overweight children had increased to just more than 15% by 2000³ and 16.5% by the end of 2002.⁴ During this time, the prevalence of overweight status among 2- to 5-year-old children doubled from 5% in the 1970s³ to $>10\%$ in 2002.^{4,5} The highest prevalence of overweight status occurs in black girls aged 6 to 19 years ($\sim 23\%$) and Mexican American boys aged 6 to 19 years ($\sim 25.5\%$).⁴ Even higher prevalence of overweight has been noted in Native American populations.⁶

The severity of overweight status has also increased along with the prevalence. Although the prevalence of overweight status among children aged 2 to 19 years increased by 182% between the early 1970s and 2000, the severity or degree of overweight increased by 247% during this same time.⁷ The metabolic syndrome was found in 4% of all children aged 12 to 19 years by 1994, and $\sim 29\%$ of overweight adolescents had metabolic syndrome.⁸ This striking increase in prevalence and severity of childhood overweight has been called a “pandemic”⁹ and is known to be associated with a broad array of long-term negative health consequences with corresponding economic burden.^{10–12}

Household food insecurity is defined by national experts as limited or uncertain availability of nutritionally adequate and safe foods and limited or uncertain ability to acquire acceptable foods in socially acceptable ways.^{13,14} The most recent national data in 2004 indicated that 11.9% of all households (13.5 million) were food insecure.¹⁵ Of households with children, 17.6% were food insecure at some time during that preceding year. The prevalence of food insecurity is higher in black (23.7%) and Hispanic households (21.7%) than in households of other racial groups. The prevalence is higher in households with incomes below the federal poverty line (36.8%). As measured by the US Food Security Scale, food security is considered a marker for the adequacy and stability of the household food supply over the preceding 12 months for active, healthy living

of all household members.¹³ Eight of the 18 questions in this US Food Security Scale ask specifically about experiences and conditions of children in the household. These 8 child-referred questions have been used to construct a Child Food Security Scale.¹⁶ This measure is conceived as identifying a more severe form of food security than that based on the household. The Child Food Security Scale has not been used to date in published research.

Household food insecurity has been associated with lower nutrient intake and lower self-reported general physical and mental health status in adults.^{17–21} Although the results are inconsistent among various studies, there is a suggestion that household food insecurity is associated with obesity in women but not men.^{22–27} Early national surveys measured food insufficiency, a single question that assessed the quantity of food available at the household level but not the quality, uncertainty, or psychological components of food access as measured by the US Food Security Scale.²⁸ Children in households judged to be food insufficient or to have hunger using other brief research measures have been noted to have lower general health status, more physical symptoms, more mental health and behavioral problems, and more academic difficulties.^{29–33} Recent studies that used the full US Food Security Scale found that household food insecurity was associated with poorer general health status and health-related quality of life in the children of these households.^{34,35}

The possible paradoxical association of hunger and food insecurity with childhood obesity was first raised in a case report 10 years ago.³⁶ The author speculated that this association may be because of “an adaptive process to food shortages whereby increasing the consumption of inexpensive energy dense foods results in increasing body mass.” Plausible mechanisms that may explain this association include cheaper cost and overconsumption of energy-dense foods,^{36,37} overeating when foods become available,³⁸ metabolic changes that may permit more efficient use of energy,³⁹ fear of food restriction,⁴⁰ and higher susceptibility to hunger, disinhibition, and environmental cues.⁴¹ A study of grade 5 Hispanic children found that those from the most food insecure households had significant decreases in energy intakes and meat consumption as payday approached.⁴² To date, no empiric data of children has confirmed the association of food insecurity with childhood overweight status in this country.^{27,39,42,43}

Obesity and other chronic conditions follow a socioeconomic gradient in which disease burden is greatest among those with limited economic resources and racial minorities.^{44–48} Because food insecurity and obesity are associated with common socioeconomic factors, it is important to control for these potential confounding variables when examining the association of food insecurity with childhood overweight status.

We used data collected in the 1999–2002 National Health and Nutrition Examination Survey (NHANES).⁴⁹ Using children ages 3 to 17 years in this nationally representative sample, we asked the following research questions: (1) is childhood overweight status associated with household food insecurity and childhood food insecurity; (2) are these associations found in demographic subgroups of children, including age, gender, race, and household poverty status; and (3) does the association between household and child food insecurity with childhood overweight persist after controlling for household poverty, child age, gender, and race?

METHODS

Sample

The NHANES is a series of national examination studies conducted in the United States since 1970. Since 1999, the surveys have been continuous; data have been collected every 2 years from a representative sample of the US population.⁴⁹ The NHANES design is a stratified multistage probability sample of the civilian noninstitutionalized US population. In the basic protocol for these surveys, randomly selected subjects are first interviewed in their homes where information on a broad array of demographic-, diet-, and health-related questions is obtained. In a mobile examination center, body weight and height are measured with standard protocol. This report is based on an analysis of child and household food-security and overweight status (based on BMI percentiles) for US children 3 to 17 years of age in the NHANES 1999–2002. Informed consent was obtained from all of the participants, and the protocol was approved by the Institutional Review Board of the National Center for Health Statistics. The NHANES recommends that analysis be conducted for the combined 1999–2000 and 2001–2002 data sets. The appropriate 4-year sample weights have been calculated and added to the demographic data files to facilitate the combined use of these 2 cycles.

Measures

Overweight Calculation

The NHANES body measurement component procedures are outlined in the NHANES Anthropometry Procedures Manual (www.cdc.gov/nchs/data/nhanes/bm.pdf). The body measurement component was performed in a specially equipped room in a mobile examination center. A health technician assisted by a trained recorder gathered all of the data. For weight and standing height, data were captured electronically from the measuring instruments to minimize potential data entry errors. BMI was calculated from measures of height and weight (kg/m^2). BMI percentiles were calculated by age in months and gender according to the Centers for Disease Control and Prevention reference.⁵⁰ These calculations were per-

formed by the NHANES and released in the data set. ARO is defined as $\text{BMI} \geq 85\%$, and OW is defined as $\text{BMI} \geq 95\%$ for gender and age.⁵¹

Household Food-Security Status

Household food security was evaluated using the 18-question US Food Security Scale.^{13,52} This instrument was administered to 1 adult in a household. Using standard scoring methods, households were placed into 2 categories: food secure or food insecure, which included families who were food insecure with or without hunger.

Child Food Security

Eight of the 18 questions in the US Food Security Scale refer specifically to children. Affirmative responses to ≥ 2 of these 8 child-referenced questions were used to categorize the child as food insecure.¹⁶

Statistical Analyses

All of the analyses were performed according to NHANES analytic guidelines.⁵³ The household and child food-security status categories were calculated and released in the NHANES data sets. Variables used in the analysis available in the NHANES data set include child age (3–5, 6–8, 9–11, and 12–17 years), poverty index (0–1, >1–2, >2–3, >3–4, and >4–5), gender, and race (non-Hispanic white, non-Hispanic black, Mexican American, and other). Poverty index of 0 to 1 included families whose household incomes were $\leq 100\%$ of the poverty level, poverty index of 1 to 2 included families of income from 100% to 200% of the poverty level, and so forth.

All of the statistical analyses were conducted by using SAS 9.0 for Windows (SAS Institute, Inc, Cary, NC) and SUDAAN (Research Triangle Institute, Research Triangle Park, NC). All of the estimates were weighted by using the 4-year sample weights (WTMEC4YR). The sample weights account for the unequal probabilities of selection resulting from the complex sample design, survey nonresponse, and the planned oversampling of selected population subgroups. SEs were estimated with SUDAAN using the Taylor series linearization.

Comparisons of categorical variables were performed by χ^2 analyses, using weighted percentages. The association of household food insecurity and child food insecurity with ARO status and OW status was determined for the entire sample and stratified by child age, gender, race, and poverty index. Logistic-regression analyses were conducted with ARO and OW status as the dependent variables and child food-security and household food-security status as the independent variables. Covariates included were child age, race, gender, and household poverty index.

RESULTS

A total of 6995 children from aged 3 to 17 years was available for analyses. A description of this sample by age, family poverty index, gender, and race is depicted in Table 1. Almost 20% of the children in the sample were aged 3 to 5 years, and 40% were 12 to 17 years. Just less than one fourth were categorized as 0 to 1 on the poverty index, and 22% were categorized as >4 on the poverty index. A total of 50.8% were boys, 60.8% were white, 15% were black, and 11.9% were Mexican American. The prevalence of household food insecurity in these households with children was 17%. The prevalence of child food insecurity was 11.2%. The BMI of ~15% of the children was $\geq 85\%$ and $< 95\%$, and another 15.3% were $\geq 95\%$, indicating a distribution skewed to the right. Almost 30% (29.8%) were ARO.

Table 2 shows the prevalence of child OW status by food-security status (child and household) according to child age and gender. Children who live in food-insecure households or who were child food insecure were significantly more likely to be ARO ($P < .01$) and OW ($P < .01$). Children who were normal weight were more likely to live in food-secure households (67.4% vs 61.5%; $P \leq .01$) and were more likely to be child food

secure (67.4% vs 58.4%; $P \leq .01$; data not shown in Table 2).

Children aged 3 to 5 years and boys who live in food-insecure households did not demonstrate a higher prevalence of ARO than their counterparts in food-secure households. However, the 3- to 5-year-old children and boys who were child food insecure had a significantly higher prevalence of ARO. Teens aged 12 to 17 years and girls had significantly higher prevalence of ARO, whether child food insecure or household food insecure. The prevalence of ARO for children aged 6 to 8 and 9 to 11 years was not higher for either household food insecurity or child food insecurity, although all demonstrated trends of higher prevalence of ARO when food insecure.

Similar results were found with child OW status. Children aged 12 to 17 years and girls demonstrated a higher prevalence of OW for both child and household insecurity. Boys had a higher prevalence of OW status for child food insecurity only. This association of OW status with food insecurity was not found in any other age group, although the trend in all of the age groups was for higher prevalence of OW in the food insecure.

Table 3 depicts the prevalence of child OW status by food-security status (child and household) according to child race and household poverty index. The association of food insecurity and childhood ARO differs for black, white, and Mexican American children. Among white children, ARO is significantly higher for both the child food insecurity and household food insecurity group. Among black children, there is virtually no difference in prevalence of ARO in either the child food insecurity group or household food insecurity group. Mexican American children have a significantly higher prevalence of ARO for child food insecurity but not household food insecurity. A higher prevalence of child OW status was found only in white children who were child food insecure but not household food insecure. The prevalence of OW status was not higher for black or Mexican American children whether child or household food insecure.

Children who live in households at $\leq 100\%$ of the federal poverty level had significantly higher prevalence of ARO, whether child food insecure or household food insecure. There was no difference in the prevalence of ARO based on child or household food insecurity status in children from households with a poverty index from 1 to 4 (101%–400% of poverty level). There was a significantly higher prevalence of ARO in children with a poverty index > 4 who live in households that were food insecure. A higher prevalence of child OW status was found only for children in households at $\leq 100\%$ of the federal poverty level who were child food insecure and children who live in households with poverty indices > 4 who were household food insecure.

The results of the logistic regression of childhood food

TABLE 1 Demographics, Food-Security, and Weight Status in NHANES 1999–2002 Children Aged 3 to 17 Years

Total (N = 6995)	% Total (Weighted)
Age, y	
3–5	19.1
6–8	21.4
9–11	19.5
12–17	40.0
Poverty index	
0–1	23.4
>1–2	25.3
>2–3	16.6
>3–4	12.6
>4–5	22.1
Gender	
Male	50.8
Female	49.2
Race	
Non-Hispanic white	60.8
Non-Hispanic black	15.0
Mexican American	11.9
Other	12.3
Household food security	
Food secure	83.0
Food insecure	17.0
Child food security	
Food secure	88.8
Food insecure	11.2
Child weight status	
Underweight (BMI < P5)	3.6
Normal (P5 \geq BMI < P85)	66.6
At risk for overweight (BMI P \geq P85 < P95)	14.5
OW (BMI \geq P95)	15.3

P5 indicates 5th percentile; P85, 85th percentile; P95, 95th percentile.

TABLE 2 Overweight Status According to Food-Security Status for Child Age Group and Gender

Variable	ARO				OW			
	Child Food-Security Status		Household Food-Security Status		Child Food-Security Status		Household Food-Security Status	
	FS	FI	FS	FI	FS	FI	FS	FI
Age, y								
3–5	21.6	36.9 ^a	22.6	24.8	10.4	19.2	10.8	13.1
6–8	29.3	42.2	29.4	37.0	14.6	21.7	14.5	19.4
9–11	32.3	37.6	31.6	39.8	16.0	22.5	15.8	21.8
12–17	30.1	38.3 ^b	29.7	37.6 ^b	15.6	20.8 ^b	15.5	20.1 ^b
Gender								
Male	29.7	40.7 ^a	30.4	33.5	15.4	23.0 ^b	15.8	18.5
Female	27.8	36.6 ^b	27.0	38.2 ^a	13.6	18.8 ^a	13.2	19.7 ^a
Total	28.8	38.8 ^a	28.7	35.7 ^a	14.5	21.1 ^a	14.5	19.0 ^a

FS indicates food secure; FI, food insecure.

^a $P \leq .01$.^b $P \leq .05$.**TABLE 3** OW Status According to Food-Security Status for Child Race and Household Poverty Index

Variable	ARO				OW			
	Child Food-Security Status		Household Food-Security Status		Child Food-Security Status		Household Food-Security Status	
	FS	FI	FS	FI	FS	FI	FS	FI
Race								
White	25.8	37.2 ^a	25.8	32.5 ^a	12.2	20.3 ^a	12.3	16.7
Black	33.4	35.0	33.7	33.6	18.7	17.5	18.9	12.7
Mexican American	36.3	42.2 ^a	37.0	39.4	20.9	23.0	21.2	22.0
Poverty index								
0–1	29.8	39.3 ^a	29.9	36.5 ^a	16.5	22.3 ^a	16.7	20.7
1–2	31.5	37.6	32.6	31.2	16.1	17.0	16.4	15.2
2–3	30.4	34.0	29.5	42.3	15.0	15.1	14.9	15.3
3–4	26.7	24.1	26.8	21.9	12.2	23.4	12.3	20.7
4	25.1	54.8	24.9	55.4 ^b	13.1	29.5	12.9	35.7 ^a

FS indicates food secure; FI, food insecure; poverty index 0 to 1, family income $\leq 100\%$ federal poverty level; 1 to 2, family income 100% to 200% federal poverty level, and so forth.^a $P \leq .05$.^b $P \leq .01$.

insecurity on child ARO status, controlling for child race, gender, age, and household poverty index, are presented in Table 4. Independent of these demographic variables, child food-security status is significantly associated with child ARO (adjusted odds ratio = 1.32; 95% confidence interval: 1.03–1.69; $P = .03$). In similar logistic-regression analyses, child food-security status was not independently associated with child OW status. Also, in similar analyses, household food-security status was not independently associated with either ARO or child OW status.

DISCUSSION

In this large nationally representative sample of children aged 3 to 17 years old, both household and child food insecurity are significantly associated with children being ARO (BMI $\geq 85\%$). Child food insecurity is significantly associated with ARO for children aged 3 to 5 and 12 to 17 years, boys and girls, white and Mexican American (but not black), and children in families with income $\leq 100\%$ poverty level. Child food insecurity is

TABLE 4 Risk of Child ARO Status and Child Food Insecurity (Controlling for Covariates)

Predictor	AOR (95% CI)	P
Child FI (vs FS)	1.32 (1.03–1.69)	.03
Ethnicity (vs white)		
Black	1.30 (1.02–1.67)	.01
Mexican American	1.53 (1.18–2.00)	
Other	1.39 (1.01–1.91)	
Gender, female (vs male)	0.89 (0.75–1.06)	.19
Age, y		
9–11	1.57 (1.22–2.01)	
12–17	1.50 (1.17–1.93)	
PIR (vs ≤ 1)		.57
>1–2	1.10 (0.86–1.41)	
>2–3	1.07 (0.85–1.36)	
>3–4	0.90 (0.68–1.18)	
>4–5	0.86 (0.69–1.08)	

AOR indicates adjusted odds ratio; CI, confidence interval; FI, food insecurity; FS, food security; PIR, poverty index ratio.

significantly associated with OW for children aged 12 to 17 years, girls, white children, and children in families with income $\leq 100\%$ poverty level. Household food in-

security is associated with ARO in children 12 to 17 years, girls, white children, and household poverty 0%–100% and 400%–500% times the federal poverty level. Household food security is associated with child OW status in children aged 12 to 17 years, girls, and children who live in households with incomes >4 times the federal poverty level. Controlling for ethnicity, gender, age, and family poverty index, childhood food insecurity is independently associated with ARO but not OW. Household food insecurity was not independently associated with ARO or OW after controlling for these demographic variables.

Previous studies in this country using small convenience samples with limited demographic variation^{42,43} or older national surveys including NHANES III have not found an association between household food insecurity (insufficiency) and child ARO or OW status.^{27,39,54,55} These negative results may be because of small sample size with limited statistical power or homogeneous demographic make-up of these convenience samples. Earlier national surveys used data collected several years ago, from 1988–1994 for NHANES III. At that time, the prevalence of child OW status was lower, perhaps diminishing the likelihood of an association between food insecurity and child OW status. The prevalence of ARO (BMI $\geq 85\%$) in this sample is $\sim 30\%$, and $>40\%$ in some food-insecure subcategories, a striking finding.

The availability of the current NHANES data provided the opportunity to advance this literature with the use of the more recent national data and the Child Food Security Scale. The Child Food Security Scale is perceived as measuring a more severe degree of food insecurity as compared with the full household food-security measure, because this measure reflects a decrease in quality or quantity of food directly available to children. The prevalence of 11.2% child food insecurity has not been reported previously. This more severe measure of food insecurity was associated with ARO and OW in several demographic categories, most striking in children aged 12 to 17 years, white children, girls, and those from families with incomes below the federal poverty index. The household food insecurity measure was associated with child ARO and OW in several but fewer demographic subgroups. In addition, only the childhood food insecurity measure predicted ARO while controlling for the array of demographic characteristics. One can reasonably assume that these differences relate to an association of childhood ARO status with the more extreme degree of food insecurity measured by the child scoring method.

The lack of relationship between child food insecurity and household food insecurity and ARO and OW in black children is of interest. For black children, the prevalence of ARO and OW is the same regardless of food-security status. The prevalence of ARO was 35% among child food insecure versus 33.4% among child food se-

cure. The prevalence of OW was 17.5% among child food insecure versus 18.7% for child food secure. One can only speculate why there is no relationship in the black children with very high prevalence of ARO, OW, and food insecurity. This difference between races might relate to variation in food availability or dietary habits not related to food-security status. There is a suggestion that black children in general receive a higher percent of energy from fat.^{56,57} Perhaps food insecurity does not affect this higher fat energy intake. In a study that used NHANES III (1998–1994), no association was found between ARO (BMI $\geq 85\%$) in children who lived in food-insufficient households (using the single question as noted earlier), after controlling for confounding variables.³⁹ Among various demographic categories, only older non-Hispanic white girls from low income families demonstrated a significant association between household food insufficiency and child ARO status. The association of ARO in children with food-insecure households with family income >4 times the poverty index is also of interest. Perhaps in these relatively economically advantaged families, food insecurity may represent very poor meal planning in which children consume easily accessible energy-dense foods. It is also possible that this association is spurious, perhaps related to small sample size. Only 13 families in this higher income level were household food insecure, and 6 of those were Mexican American. In this sample, Mexican American children have the highest prevalence of ARO and OW. Future research in other large samples is required to verify these findings.

Given the cross-sectional data available in the NHANES, these data do not allow for a conclusion regarding causality between food insecurity status and child ARO and OW status. It is conceptually plausible that food-insecure status would result in lower intake of healthy foods and nutrients and perhaps greater intake of unhealthy obesigenic foods, which may ultimately contribute to poorer child health and nutrition status.⁵⁸ Families of limited income have no flexible financial resources to deal with unexpected changes in monthly expenses.⁵⁹ Families with restricted and diminished income may, thus, ration food, regulate frequency of meals, and/or use low-cost energy-dense foods at times of financial constraints, perhaps particularly at the end of the month when monthly financial resources may be depleted.⁶⁰

CONCLUSIONS

Household food insecurity and childhood insecurity are associated with ARO status and OW status in many demographic categories of children, particularly in teens, girls, white children, and those from families below the poverty level. Childhood food insecurity is independently associated with ARO status in children, while controlling for family poverty level, child age, race, and

gender. Future longitudinal research with larger samples will be required to determine whether food insecurity is a part of the causal pathway of childhood OW, what precise mechanisms account in the causal relationships, and whether interventions can improve the prevalence of food insecurity and its association with children ARO status. Given the increasing prevalence of both childhood OW status and household food insecurity, our data suggest that both clinicians and child health policy experts should work toward achieving food security for all families.

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