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ARTICLE

Household Food Insecurity and Overweight Status in Young School Children: Results From the Early Childhood Longitudinal Study

Donald Rose, PhD, J. Nicholas Bodor, MPH

School of Public Health and Tropical Medicine, Tulane University, New Orleans, Louisiana

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ABSTRACT

OBJECTIVE. Recent work on the determinants of obesity has shown a positive association between household food insecurity and overweight status in adult women, yet research exploring this issue in children has been inconclusive. In this study we examine the association between food insecurity and overweight status in young school children by using a large, nationally representative sample.

METHODS. Data from the Early Childhood Longitudinal Study-Kindergarten Cohort (ECLS-K) were analyzed. Replicate heights and weights were measured on kindergarten children ($N = 16\,889$) in the spring of 1999. Children with a body mass index ≥95th percentile of their gender-specific BMI-for-age chart were considered overweight. Food-insecurity status was assessed by using the full 18-question US Department of Agriculture Household Food Security Scale. Multivariate logistic regression was used to assess the relationship between overweight and food-insecurity status while controlling for potential demographic, socioeconomic, and behavioral confounders.

RESULTS. Overall, 11.2% of the girls and 11.8% of the boys were overweight. Children from food-insecure households were 20% less likely to be overweight than their food-secure counterparts. Similar results on the food-insecurity/overweight link were found across a range of different models and expressions for key variables. Positive predictors of overweight status included low physical activity, television watching for >2 hours/day, high birth weight, black or Latino ethnicity, and low income.

CONCLUSIONS. There are strong arguments for reducing food insecurity among households with young children. This research suggests that these arguments would be based on reasons other than a potential link to obesity. Low activity levels and excessive television watching, however, were strongly related to overweight status, a finding that supports continued efforts to intervene in these areas.

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Key Words
food insecurity, hunger, overweight, obesity, children, ECLS-K

Abbreviations
NHANES—National Health and Nutrition Examination Survey
ECLS-K—Early Childhood Longitudinal Study-Kindergarten Cohort
PSU—primary sampling unit
CDC—Centers for Disease Control and Prevention
USDA—US Department of Agriculture
PIR—poverty index ratio
OR—odds ratio

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Address correspondence to Donald Rose, PhD, School of Public Health and Tropical Medicine, Tulane University, 1440 Canal St, Suite 2301, New Orleans, LA 70112. E-mail: diego@tulane.edu

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OBESITY IS THE most pressing nutritional problem in the United States. There is strong evidence of increased risk of poor health outcomes such as cardiovascular disease, diabetes, and cancer as a result of this condition.[1,2] Moreover, the prevalence of the condition is on the rise; now close to two thirds of the US adult population is overweight or obese.[3,4] Sherry and Dietz[5] argue that the problem is of no less concern among children because of evidence of significant health consequences associated with overweight during childhood. The latest evidence also confirms dramatically increasing trends in the prevalence of overweight in this group.[4,6]

Although there is little controversy about the proximal determinants of overweight status (ie, an imbalance between energy intake and expenditure), there is considerable complexity in the framework of distal factors that give rise to this imbalance. An emerging area of research is concerned with the relationship between household food insecurity and obesity. The initial hypothesis was developed by Dietz[7] and was based on a case study, published in *Pediatrics*, of a 7-year-old black girl. Although it may seem like a paradox, several mechanisms could explain this relationship. Food insecurity could lead to an overweight status if individuals overcompensate for periods when food is scarce so that overall intake is greater. For example, Fisher and Birch[8] have reported that middle-class children respond to parental restriction of particular foods by increasing their intake of these foods when given the opportunity. In their research on a low-income population, Wilde and Ranney[9] observed that food expenditures and energy intake spike shortly after food stamps are received. Weight cycling could also make the body more efficient in using dietary energy and thus, over the long-run, lead to an increased weight.[10] Finally, energy-dense foods are often less expensive, and so those in food-insecure households who cannot afford to eat balanced meals or must rely on a few kinds of low-cost foods may have an overall greater energy intake.[11]

Various studies have explored the food-insecurity/weight-status relationship empirically. Women in upstate New York from households with a milder form of food insecurity were more overweight (as assessed by mean body mass index [BMI]) than women from either the more seriously food-insecure or food-secure households.[12,13] Townsend et al[14] found a positive association between household food insecurity and overweight status in a nationally representative sample of adult women from the 1994–1996 Continuing Survey of Food Intake by Individuals. Adams et al[15] also found a positive association among women in the 1998–1999 California Women's Health Survey.

Despite the apparent agreement of studies on adult women, no clear pattern has emerged when considering the food-insecurity/overweight link in children. In a study of Mexican American children aged 3 to 6 years, Kaiser et al,[16] did not find statistically significant differences in children's weight-for-height status across household food-insecurity groups. Another study of Hispanic children found that those in the food-insecure group had lower BMIs than the food-secure group.[17] Jones et al[18] analyzed nationally representative data on 5- to 12-year-old children from low-income households in the Child Development Supplement of the 1997 Panel Study of Income Dynamics. They found that children from food-insecure households were less likely to be at risk of overweight than those from food-secure households. Alaimo et al[19] analyzed nationally representative data from the 1988–1994 National Health and Nutrition Examination Survey (NHANES). Using multivariate models to control for potential confounders, they found that non-Hispanic white girls aged 8 to 16 years from food-insufficient households were more likely to be at risk of overweight than their counterparts from food-sufficient households. However, they did not find significantly positive associations in any of the other age-gender-ethnic groups of children who were studied and, in fact, found a negative association between food insufficiency and weight status (among 2- to 7-year-old white girls). They considered the possibility that this could be a result of small sample sizes because of their need to split the total sample into 8 age-gender-ethnic groups. Both the Panel Study of Income Dynamics and NHANES analyzed risk of overweight (≥85th percentile of BMI for age) rather than an overweight status (≥95th percentile). Presumably, this was because of small sample sizes; Alaimo et al[19] indicate that prevalences of overweight were too low to confidently estimate associations. Townsend (M. Townsend, PhD, verbal communication, 2003) has also suggested that a small sample size might explain why they did not find a significant relationship between food insecurity and overweight status among children when using Continuing Survey of Food Intake by Individuals data. In sum, the question of the food-insecurity/overweight relationship in children is unresolved, perhaps because of limitations of previous data sets.

Our objective in this article is to test the hypothesis of positive association between household food insecurity and overweight status in children. To do this we analyzed data from the Department of Education's Early Childhood Longitudinal Study-Kindergarten Cohort (ECLS-K). This survey has various advantages over previous data sets used to assess this hypothesis. It is based on a large, nationally representative sample of children from a narrow age range. In addition, the ECLS-K used the latest methods for assessing household food security and obtained direct replicate measures of height and weight on children.

METHODS

Study Sample

Data for the analysis presented here come from the ECLS-K, which is being conducted by the Department of Education to provide information on children's status at entry into kindergarten and on their progression through school on a number of educational outcomes.[20,21] The nationally representative sample consists of a cohort of children who entered kindergarten in the fall of 1998.

The ECLS-K used a multistage probability design in which the primary sampling units (PSUs) were geographic areas that consisted of counties or groups of counties. Schools were the second-stage units that were sampled within these PSUs, and students were the final-stage units selected within schools. Details of the sampling procedures have been published previously.[20]

Various types of information have been collected on the children at 4 different times in the first 2 years of the study (ie, during the fall [1998; wave 1] and spring [1999; wave 2] of the children's kindergarten year and in the fall [1999; wave 3] and spring [2000; wave 4] of their year in first grade). Because information on both household food insecurity and children's heights and weights was collected in spring 1999, we focus our analysis on data from that time period (ie, wave 2). Our main analytic sample (N = 16 889) consists of all individuals with complete information on the variables described below. We also describe results of the analyses that examined the relationship of food insecurity to children's weight gain from wave 2 to wave 4. Because of drop-offs from wave 2 to wave 4, this is a smaller sample; there are 12 890 individuals with complete data for these additional analyses.

Overweight Status

All measurements in the ECLS-K were conducted by field teams that consisted of a supervisor and 3 assessors.[20] People who had experience with other quantitative survey research projects, the majority of whom were retired teachers, former educators, or people who were experienced in conducting assessments or in working in schools or with school-aged children, were selected as field staff. Field teams received both in-home training, including videos documenting direct child-assessment procedures, and 1 week of intensive group training. For each child during each wave of data collection, height was measured twice by using a Shorr (Olney, MD) measuring board, and weight was measured twice by using a digital scale.[20] Values were averaged from the 2 measurements and used to calculate BMI as weight divided by height squared (kg/m^2). BMI-for-age percentiles were assigned to each child for each wave on the basis of that child's average height and weight measurement, their age at the time of measurement, and their gender. These assignments were made by using publicly available computer algorithms for the Centers for Disease Control and Prevention (CDC) 2000 growth charts.[22] Following CDC guidelines, children with a BMI that was ≥95th percentile of their gender-specific BMI-for-age chart were considered overweight. In addition to this overweight indicator, we created a dichotomous variable that indicated children who had a BMI >85th percentile of BMI for age. This combined into 1 group children who were either overweight or "at risk of overweight," a CDC term for children with a BMI ≥85th percentile and <95th percentile of their BMI-for-age chart.

We also developed a dichotomous variable to indicate a high weight gain between waves 2 and 4. Because there are no currently accepted reference standards for what is excessive weight gain among children, we developed a measure, in consultation with the CDC, that is based on statistical grounds and simply indicates when a gain in BMI from wave 2 to wave 4 was in the top 15% of the distribution of this variable for children from specific age-gender groups.

Food-Insecurity Status

All 18 questions from the US Department of Agriculture Household Food Security Scale[23] were included in the ECLS-K wave 2 household questionnaire. On the basis of their answers to these questions, households were classified into 1 of 3 groups: food secure, food insecure without hunger, and food insecure with hunger. Because the percentage of households in the latter category was very low, we conducted most of our analyses with a dichotomous variable, which simply indicated whether the household was food insecure (ie, either with or without hunger) or food secure. We did, however, check to determine if our findings using the simple dichotomous variable held for other expressions of the food-security variable. We tested models with 2 indicator variables (1 that indicated food insecurity without hunger and 1 that indicated food insecurity with hunger), because the more moderate version of food insecurity has been associated with overweight in women.[12–14] There has been some research indicating that the food-security measure is not equivalent for households with and without children.[24] Because all households in the ECLS-K include children, we also tested a model using a specific indicator for child food insecurity (formed from the 8 questions that ask specifically about children) and one with 2 indicators for child food insecurity with and without hunger.

Statistical Analysis

We conducted bivariate analyses to test for associations between household food-security status and demographic, socioeconomic, and behavioral variables using the χ^2 statistic and a significance level with a P value of

$<.05$. χ^2 statistics were also used to test for differences in overweight prevalence rates between children from food-insecure and food-secure households. These tests were made for each gender-race/ethnicity group. Differences in BMI were assessed by using simple *t* tests.

Weight status is known to be affected by a number of biological and socioeconomic factors. To control for potentially confounding variables, we developed multivariate logistic-regression models. The dependent variable in our models was a dichotomous indicator of overweight status. Independent variables included our measure of household food insecurity and the variables described below.

At the individual level, we included variables on the gender and age of the child (in months). We included 4 dichotomous variables indicating their race/ethnicity (ie, black, Latino, Asian American, or other), with white children being the reference group. We also included interaction terms for gender and the 4 race/ethnicity indicators. Birth weight of the child was obtained from the household respondent, usually the mother. Because birth weight is known to affect child growth and development, we included 2 dummy variables in our regression models indicating either a low ($<$2.5 kg) or high ($>$4.0 kg) birth weight.

We included a number of variables describing the socioeconomic conditions of the household, because it is known that overweight prevalence varies by socioeconomic status. Each household's reported annual income was divided by the federal poverty threshold for households of its size. This poverty index ratio (PIR) then was used to create 4 dichotomous variables indicating whether the household was in poverty (PIR $<$ 1.0); had an income that was low, qualifying the household for various food-assistance programs, but above the poverty threshold (1.0 $\leq$ PIR $<$ 1.85); had a PIR between 1.85 and 3.0; or had a PIR between 3.0 and 5.0. Households with a PIR of $>$5.0 were the reference group. We included information on maternal schooling, specifically 2 dummy variables indicating whether the mother had not finished high school or whether she had graduated college, with high school graduates as the reference group. We represented urbanization with 2 dummy variables indicating whether the household lived in a rural area/small town or in an urban fringe area/large town, with those living in the central city as the reference group. We also included 3 dichotomous variables indicating region of the country (south, midwest, and west), with those in the northeast being the reference group.

Although we do not have direct measures of the children's dietary intake or physical activity level, a number of variables on the ECLS-K data set have been shown by previous research to be associated with either diet quality or overweight status. For example, household food patterns, such as consumption of dinner with the family, has been associated with an improved dietary quality.[25] Other studies have documented the importance of breakfast for overweight status.[26] Thus, we included dummy variables indicating whether the family ate breakfast together a majority of days each week (ie, $\geq$4 days/week), and we also included 1 for the evening meal.

Previous research has shown that parental perception of their child's activity level relative to other children is associated with the child's overweight status.[27] Thus, we included variables that could proxy for the physical activity level of the child. One was a dichotomous variable indicating that the parent considered their child to be less physically active than other children of their child's age during structured activities at school. A second variable indicated that their child was less physically active than other children during their free time. A third indicated that their child got less aerobic exercise on a consistent basis than other children of the same age. Finally, television watching has been associated with overweight status.[28] We included a dummy variable to indicate that the child, on average, watched $>$2 hours per day of television.

We performed all analyses with the appropriate statistical weights that were supplied with the ECLS-K data set; because the ECLS-K is based on a clustered sample design, variance estimates used for hypothesis testing can be understated if they are generated from standard statistical software. Thus, we used the WesVar statistical package,[29] which uses replication techniques to estimate variances from survey data with complex sample designs. We used the paired-jackknife replication method under WesVar, because the ECLS-K design sampled 2 PSUs from each of the strata.

RESULTS

Basic demographic, social, and economic characteristics of the children in the analytic sample are displayed in the first data column of Table 1, and the breakdown of these characteristics by food-security status is shown in the second and third columns. The sample was mostly evenly split between boys and girls, with an average age of ~6 years. Black and Latino children made up ~16% and 19% of the total sample, respectively. Overall, ~9% of the children lived in households that were food insecure. In perusing the food-secure and -insecure columns, one can see differences in the racial/ethnic group makeup; white children comprised a smaller percentage of the food insecure than they did of the food secure, whereas the opposite was true of black and Latino children. There were also sizable differences, although certainly expected, in income distribution. Food-secure children were approximately evenly divided across the 5 income groups, whereas ~85% of the food-insecure children were below 185% of the poverty threshold. Food-insecure children seemed to be more inactive than

TABLE 1 **Characteristics of the Analytic Sample According to Household Food-Security Status: ECLS-K, Spring 1999**

Variable	All Children (*n* = 16 889)	Food Secure (*n* = 15 409)[a]	Food Insecure (*n* = 1480)[a]
Mean age, mo	74.7	74.7	74.8
Gender, % male	51.4	51.5	50.4
Race/ethnicity, %			
White	58.8	60.9	37.0
Black	15.5	14.8	22.5
Latino	18.6	17.3	32.2
Asian American	2.7	2.7	2.3
Other	4.4	4.3	6.0
Birth weight, %			
Low (<2.5 kg)	8.0	7.7	11.0
High (>4.0 kg)	11.4	11.4	10.9
Maternal education, %			
Less than high school graduate	14.3	12.7	30.6
High school graduate	63.6	63.4	65.6
College graduate	22.1	23.9	3.9
PIR, %			
<1.00	21.0	17.7	53.5
1.00–1.85	21.5	20.5	32.0
1.85–3.00	19.9	20.8	11.0
3.00–5.00	23.7	25.8	2.9
≥5.00	13.9	15.2	0.7
Region, %			
Northeast	18.0	18.5	13.2
Midwest	23.0	23.3	20.6
South	37.4	37.3	38.3
West	21.5	20.8	27.8
Urbanization, %			
Central city	47.1	47.4	45.0
Urban fringe	31.6	31.1	35.7
Rural	21.3	21.5	19.4
Family meal patterns, %			
Eat breakfast together ≥4 d/wk	56.8	58.0	44.3
Eat dinner together ≥4 d/wk	86.8	87.1	84.0
Child activity patterns, %			
Less physically active in structured activities	4.3	4.0	7.2
Less physically active in free time	4.9	4.7	6.5
Less aerobic exercise	8.3	7.9	12.7
Watches television >2 h/d	41.2	39.8	54.1

[a] All demographic, socioeconomic, and behavioral variables shown here are significantly associated with household food-security status ($P < .05$) except age, gender, and urbanization.

food-secure children; they watched more television and were rated by their parents as being less active than other children their age in structured activities, in free time, and in aerobic exercise.

Mean BMI and overweight prevalence by gender, race/ethnicity, and food-security status are displayed in Table 2. Overall, 11.2% of girls and 11.8% of boys were overweight. There were some minor variations in BMI by food-insecurity status, but none of them were statistically significant. There seemed to be some larger differences in overweight prevalence by food-insecurity status, particularly for Asian and Latino children, but because of relatively large standard errors, these differences were not statistically significant. Overall, minority children, especially Latino boys (18.4% prevalence) and black girls (14.3%), were more likely to be overweight than white boys (10.0%) and girls (9.5%).

The results of our main logistic-regression model are presented in Table 3. The coefficient on the food-insecurity variable was significant and negative, and the odds ratio (OR) of being overweight was 0.80; this indicates that after controlling for other possible confounders, children from food-insecure households were 20% less likely to be overweight. Holding other factors constant, black and Latino children were more likely to be overweight. High birth weight children were more likely to be overweight than the reference group, whereas low birth weight children were less likely. Maternal education was inversely associated with overweight status; that is, children from a household whose mother had a college education were significantly less likely to be overweight. Household income was also negatively associated with overweight status. We chose the reference group to be children whose households were at the high

TABLE 2 Mean BMI and Overweight Prevalence According to Gender, Race/Ethnicity, and Food-Security Status: ECLS-K, Spring 1999

	Mean BMI (SE)			Overweight Prevalence, % (SE)		
	All Children	Food Secure	Food Insecure	All Children	Food Secure	Food Insecure
Girls	16.4 (0.03)	16.4 (0.03)	16.5 (0.10)	11.2 (0.43)	11.2 (0.46)	11.8 (1.14)
White	16.2 (0.04)	16.2 (0.04)	16.4 (0.14)	9.5 (0.52)	9.5 (0.53)	9.2 (1.62)
Black	16.6 (0.08)	16.7 (0.10)	16.6 (0.21)	14.3 (1.13)	14.2 (1.29)	15.2 (2.50)
Latino	16.7 (0.07)	16.7 (0.07)	16.6 (0.19)	13.8 (1.02)	14.1 (1.10)	12.5 (2.22)
Asian American	16.0 (0.17)	16.0 (0.18)	16.7 (0.39)	8.1 (1.83)	8.3 (1.93)	5.4 (3.30)
Other	16.6 (0.17)	16.6 (0.16)	16.7 (0.49)	13.9 (2.07)	13.9 (2.17)	13.8 (4.55)
Boys	16.5 (0.03)	16.5 (0.03)	16.6 (0.10)	11.8 (0.41)	11.7 (0.42)	13.7 (1.39)
White	16.3 (0.04)	16.3 (0.03)	16.2 (0.13)	10.0 (0.50)	10.0 (0.51)	8.9 (1.81)
Black	16.4 (0.06)	16.5 (0.07)	16.3 (0.14)	10.2 (0.90)	10.3 (0.90)	9.7 (2.90)
Latino	17.0 (0.07)	16.9 (0.07)	17.2 (0.22)	18.4 (1.06)	18.0 (1.00)	20.7 (2.75)
Asian American	16.4 (0.14)	16.4 (0.15)	16.3 (0.34)	14.8 (1.68)	15.2 (1.80)	10.9 (4.77)
Other	16.6 (0.15)	16.6 (0.14)	16.6 (0.31)	13.1 (1.58)	12.7 (1.51)	16.0 (5.71)

There were no significant differences ($P < .05$) between food-insecure and -secure children in either BMI or overweight prevalence for any of the gender-race/ethnicity groupings.

end of the income distribution (ie, those with incomes >5 times the poverty level). Relative to them, children from the other lower-income groups were all more likely to be overweight, although this was statistically significant in only the second- and third-lowest income groups. Variables indicating less physical activity were all positively and significantly associated with overweight status, whereas variables indicating that a majority of meals per week were consumed together with the family were negatively and significantly associated with overweight status.

In developing this model, we tested a number of possible interaction terms. We found that there were significant interactions between the gender of the child and his or her race/ethnicity, which reflects findings that can be seen in Table 2. For example, Latino boys were more likely to be overweight than Latino girls, whereas the opposite was true for black boys and girls. We also found that there was a significant interaction between household food-security status and maternal education. The coefficient on this variable was positive and significant. Combining coefficients from both food-insecurity terms, we found that food-insecure children whose mothers were college graduates were close to 2.8 times more likely to be overweight (result are not shown in the table). Although this is a somewhat dramatic result, it applies to a very small minority of children. Only 4% of children from food-insecure households had a mother who graduated college.

We tested a wide range of alternative models to determine how robust the finding of an inverse association between food insecurity and overweight prevalence was by comparing adjusted ORs for different models. To focus on the 96% of the food-insecure sample whose mothers were not college graduates, in Table 4 we present ORs from our alternative models for this larger group of children. The USDA has developed thresholds for "food insecurity without hunger" and "food insecurity with hunger." We ran a model that was identical to our main model except it included indicators for children from households from both of these groups, and both were negatively (but not statistically significantly) associated with overweight. ORs for these groups were approximately the same as our Table 3 results. Researchers at the USDA and elsewhere have developed separate food-security scales for households with children and for households with just adults.[23,24] Thus, we estimated a model identical to our main model, except that it used child food insecurity as the key independent variable, and another one that used 2 indicators for child food insecurity and child hunger. Coefficients for all of these terms were negative, and the ORs were all <1. We also estimated several models in which we changed the expression of the dependent variable. In 1 model, we used a dependent variable that classified children into 2 groups by using the 85th percentile of the BMI-for-age chart as a cut point (instead of the 95th percentile, as in the rest of our work). The CDC considers children with a BMI between the 85th and 95th percentile as being "at risk of overweight." Again, the food-insecurity coefficient was negative, and the OR was <1. We also estimated a linear-regression model by using the continuous expression of BMI as a dependent variable and obtained a negative coefficient on the food-insecurity variable. Finally, we estimated 2 models that exploited the longitudinal nature of the ECLS-K. In one model we tried to predict the probability of overweight in wave 4 (spring 2000) with food-insecurity information from wave 2 (spring 1999). In the second model we tried to predict a high weight gain (>85th percentile of the change in BMI distribution) from wave 2 to wave 4. In both models, food insecurity was negatively associated with the dependent variable, particularly strongly so in the weight-gain model, with an OR of 0.73.

TABLE 3 **Logistic-Regression Results on the Relationship Between Overweight Status (Dependent Variable) and Food Insecurity and Other Socioeconomic Characteristics: ECLS-K, Spring 1999**

	OR	95% CI	*P*
Food insecure	0.80	0.66 to 0.98	.027
Male	0.98	0.85 to 1.14	.831
Age	1.00	0.98 to 1.01	.645
Race/ethnicity			
Black	1.39	1.08 to 1.79	.011
Latino	1.10	1.10 to 1.66	.004
Asian	0.86	0.53 to 1.38	.523
Other	1.38	0.97 to 1.98	.072
Gender-race/ethnicity interactions			
Male × black	0.68	0.48 to 0.95	.026
Male × Latino	1.36	1.09 to 1.69	.006
Male × Asian	2.08	1.21 to 3.56	.008
Male × other	0.95	0.64 to 1.42	.802
Birth weight			
High birth weight	1.85	1.61 to 2.12	.000
Low birth weight	0.63	0.52 to 0.77	.000
Maternal schooling			
Less than high school graduate	1.09	0.88 to 1.35	.404
College graduate	0.68	0.56 to 0.81	.000
College graduate × food insecure	3.47	1.60 to 7.52	.002
PIR			
PIR $<$ 1.00	1.20	0.94 to 1.54	.143
1.00 $\leq$ PIR $\leq$ 1.85	1.35	1.11 to 1.65	.003
1.85 $\leq$ PIR $\leq$ 3.00	1.27	1.02 to 1.58	.031
3.00 $\leq$ PIR $\leq$ 5.00	1.08	0.87 to 1.35	.484
Region			
Midwest	0.82	0.66 to 1.01	.064
South	0.85	0.72 to 1.00	.057
West	0.80	0.66 to 0.98	.031
Urbanization			
Urban fringe	0.88	0.75 to 1.04	.120
Rural	1.08	0.89 to 1.32	.411
Physical activity			
Less active, structured	1.49	1.14 to 1.94	.004
Less active, free time	1.48	1.12 to 1.97	.007
Less aerobic exercise	1.40	1.19 to 1.66	.000
Watches television $>$2 h/d	1.24	1.12 to 1.38	.000
Family meal patterns			
Breakfast together $\geq$4 d	0.86	0.76 to 0.96	.011
Dinner together $\geq$4 d	0.87	0.76 to 1.00	.046

CI indicates confidence interval.

DISCUSSION

We set out to test the association between household food insecurity and child overweight status. The ECLS-K provides a large sample of children of approximately the same age with measured heights and weights and the full 18-item USDA Food Security Scale. Our main finding was that household food insecurity, when modeled with appropriate controls, is not associated with a higher prevalence of overweight among young school children and, if anything, seems to be inversely associated with weight status.

This finding gives added strength to a conclusion that is emerging from a number of studies on child weight status in the presence of household food insecurity. Several studies on Latino children in California have found either no association between food insecurity and weight status[16,30] or a negative association.[17] Jones et al[18] found a lower prevalence of risk of overweight among children from food-insecure households than from food-secure households. Alaimo et al,[19] using nationally representative NHANES data, found a negative association with younger white girls, a positive association with older white girls, and no association with the 6 other age-gender-ethnic groups that they explored. Sherry et al[31] studied this issue by using pediatric surveillance data in 6 WIC (Supplemental Nutrition Program for Women, Infants, and Children) clinics in Arizona and also found no association. Although this handful of studies used different measures of food insecurity and overweight status, the conclusions were relatively similar.

A number of authors have argued that the lack of positive findings may have been the result of either a small sample size or a specific population group. Others could be concerned that the food-insecurity measure was based on a dated or incomplete instrument, that is, the earlier Cornell/Radimer scale,[32] the NHANES food-insufficiency questions,[19] or a 4-question threshold subscale of the full USDA 18-item measure that has been used in a pilot nutritional-surveillance system.[31] Our findings come from an analysis of a large nationally representative cohort of young schoolchildren; thus, sample size is not a concern in our study. We also analyzed models with a food-insecurity measure based on, at the time of this writing, the most up-to-date set of questions for assessing this condition.

We believe that our findings are relatively robust, because we found similar results across a range of different models. We analyzed dichotomous (food secure, insecure) and trichotomous (food secure, insecure without hunger, insecure with hunger) expressions of the food-security variable and also used dichotomous and trichotomous expressions for child food insecurity, a newer measure of the condition that has been suggested for use in households with children. We also analyzed models with different expressions of the dependent variable by using "risk of overweight" as an indicator in 1 model and simply BMI, in continuous form, in another. In none of these tests was there a positive association between food insecurity and overweight status. All of these models were based on a cross-sectional analysis of data that were collected in the spring of the child's kindergarten year. It should be noted that parents reported on household status in the 12 months prior to the interview, so a food-insecure condition would have, in effect, preceded the child's weight status. Still, we tested whether food insecurity in the spring of 1999 was predictive of overweight status 1 year later and found that it was not. We also tested whether household food insecurity in 1999 was predictive of a high weight gain over the next year and found an inverse association.

TABLE 4 **The Relationship Between Overweight Status and Food Insecurity in Alternative Models: ECLS-K**

Model Description	AOR	95% CI
Dependent variable: overweight status in spring 1999		
Main model (see Table 3)	0.80	0.66 to 0.98
Separate indicators for food insecurity and hunger		
Food insecurity	0.81	0.64 to 1.01
Hunger	0.79	0.55 to 1.13
Child food-insecurity indicator	0.88	0.70 to 1.10
Separate child food-insecurity indicators		
Child food insecurity	0.89	0.70 to 1.14
Child hunger	0.65	0.30 to 1.40
Main model run separately by gender		
Girls	0.78	0.60 to 1.00
Boys	0.83	0.63 to 1.09
Alternate dependent variables		
Risk of overweight as dependent variable[a]	0.86	0.75 to 0.98
Overweight in spring 2000 (wave 4) as dependent variable	0.89	0.72 to 1.11
High weight gain from waves 2–4 as dependent variable	0.73	0.57 to 0.93
BMI as dependent variable[b]	−0.145	−0.303 to 0.012

AOR indicates ORs adjusted for all the independent variables presented in Table 3; CI, confidence interval.

[a] Dichotomous variable combining overweight children (BMI ≥95th percentile of BMI for age) and children at risk of overweight (BMI ≥85th and <95th percentile) into 1 group and comparing them to children with BMIs <85th percentile.

[b] ORs are not calculated for continuous dependent variables. The results presented for the linear-regression model are the parameter estimate on the food-insecurity variable and the 95% confidence interval around that estimate. The negative coefficient implies an inverse relationship between food insecurity and BMI.

How do we explain our finding that food insecurity is not positively associated with overweight status in children, given the opposite results seen in previous literature on adult women? One explanation may be that in households with food insecurity, young children are protected, so that they would be last to be affected by food shortages. Ethnographic research in upstate New York first suggested this as a possibility.[32] Research using the nationally representative 1989–1991 Continuing Survey of Food Intake by Individuals also seems to confirm this.[33,34] In this earlier study, there were no differences in nutrient intake of preschoolers from food-sufficient and -insufficient households, yet for the rest of the members from those same households, many nutrients were consumed in significantly lower amounts. A second possibility is that the means by which food insecurity affects weight status (eg, increased metabolic efficiency resulting from weight cycling) may take years to develop, or is simply more applicable in adults, when linear growth has been completed.

A potential limitation of this research is that our food-insecurity variable is correlated with the error terms in our regression equations; unobserved factors, or omitted variables, which affect both food insecurity and overweight status, could bias our estimates. However, to limit this potential bias, we attempted to include all relevant and available independent variables in these regressions. We included economic variables such as income status in these regressions, because it is reasonable to assume that they could have an effect on overweight status that is independent of food insecurity. For example, household income, which is measured on an annual basis in the ECLS-K, directly influences food choices[35] and can shape longer-term dietary habits that persist even during temporary bouts of food insecurity. In any case, omitting the income variables from our regressions had very little impact on our results. However, there are other potentially important, but unobserved, factors. Not only are food-insecure households more likely to have low incomes, they are more likely to be in unsafe neighborhoods, which would discourage the children from playing outdoors. Certainly lower activity levels resulting from staying inside more often could cause higher overweight rates. Thus, we tried a model that included variables that proxy for the child's activity level. Controlling for this set of confounders had the expected effect and made the coefficient on the food-insecurity variable even more negative. In these models, we also controlled for food-eating patterns of the households, because previous research indicated the importance of eating together as a family for diet quality and health outcomes.

If for most young children food insecurity is not associated with overweight status, the nation's most serious nutrition problem, does it mean that we should stop paying attention to food insecurity? Certainly not. In addition to concerns for equity of access to food, there are strong arguments for reducing food insecurity based on society's interest in improving the productivity of its next generation. A growing literature focused on children has found that food insecurity or hunger is associated with negative academic outcomes and poor psychosocial functioning at school,[36,37] adverse health outcomes,[38–40] and poor mental health.[38,41] It may mean, however, that food insecurity is less relevant for those whose main concern is to address the child-obesity problem.

Contrary to the findings on food insecurity, child inactivity variables were all positively associated with overweight status. These variables included 3 indicators based on parental assessment of their child's relative activity level during structured activities at school and during free time and for overall aerobic exercise, as well as a fourth indicator based on time spent watching television. The magnitudes of these relationships were relatively large. For example, after controlling for other variables, children who were less active during free time were 50% more likely to be overweight than other children their age. For those whose main concern is to address the overweight problem in children, our research suggests that increasing physical activity and reducing television watching are more fruitful areas for intervention.

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