The Unequal Impact of Food Insecurity on Cognitive and Behavioral Outcomes Among 5-Year-Old Urban Children

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ABSTRACT

Objective: To examine the associations of food insecurity with children's cognitive and behavioral outcomes using quantile regression.

Design: Secondary analysis of the Fragile Families and Child Wellbeing Study dataset.

Participants: A total of 2,046 children aged 5 years.

Main Outcome Measures: Child behavioral outcomes were measured using externalizing (aggressive) and internalizing (emotional) behavior problems. Child cognitive outcomes were measured using the Peabody Vocabulary test and the Woodcock-Johnson letter-word identification test. Food insecurity was measured using the US Department of Agriculture's Food Security Module.

Analysis: Unconditional quantile regressions were employed. Statistical significance was set at $P \leq .05$.

Results: Negative associations between food insecurity and child behavior problems (externalizing and internalizing) were largest for children with the most behavior problems. For Peabody Vocabulary scores, the negative association with food insecurity was statistically significant only for children in the top half of the distribution (≥ 50 th percentile). The analysis found mixed evidence of an association between food insecurity and the Woodcock-Johnson letter-word identification test. These associations were similar for boys and girls.

Conclusions and Implications: Because children's cognitive skills and behavioral problems have long-lasting implications and effects later in life, reducing the risk of food insecurity might particularly benefit children with greater externalizing and internalizing behavior problems.

Key Words: child behavior problems, child cognitive outcomes, food insecurity, quantile regression (*J Nutr Educ Behav.* 2018;50:687–694.)

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INTRODUCTION

Food security is the ability to access enough food for a healthy and active life.¹ In the US, the risk of food insecurity varies by ethnicity, race, age, and socioeconomic status.^{1–3} For example, food insecurity is more prevalent in the following households: African American, Hispanic, those with children (especially young children), those with children and a single parent, and low-income.¹ Despite record high participation in federal food assistance

programs and private charities over the past several years,^{1,3,4} food insecurity continues to be a persistent concern facing the nation. In 2016, over 41.2 million Americans lived in food-insecure households, including 12.9 million children.¹ Children represent a particularly vulnerable population because of the potential long-term negative consequences of food insecurity.^{5,6}

Theories on child physiological development suggest that food insecurity can affect child development negatively through undernutrition and

micronutrient deficiencies such as those in iron and zinc.^{7,8} These nutritional deficiencies have been found to lead to adverse development of the brain and its functioning in children.^{9–11} This can result in poor cognitive functioning (eg, practiced structural approaches)¹² and physiological (eg, anemia, low energy, and stunted growth),^{2–4} behavioral (eg, self-control),¹³ and emotional (eg, interpersonal relations) problems in children.^{14,15} However, most of the empirical evidence on the negative consequences of food insecurity used cross-sectional data and there is more limited empirical evidence on the long-term negative outcomes resulting from food insecurity.

Most studies on the consequences of food insecurity focused on the average effect, which assumes that all children are similarly affected by food insecurity. However, evidence shows that the negative impacts of food insecurity on child cognitive outcomes and social skills are larger for girls,

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which suggests that children may be affected differently by food insecurity.¹⁶ These negative impacts of food insecurity could potentially be larger for demographic groups (such as more disadvantaged children) that are at higher risk for experiencing food insecurity. For example, food insecurity could have greater adverse impacts on brain development in more disadvantaged children, leading to poorer cognitive and behavioral outcomes. A greater understanding about how food insecurity affects children differently is necessary to respond adequately to the issue. This study used data from the Fragile Families and Child Wellbeing Study (FFCWS), a sample of children born to mostly low-income urban mothers, to examine associations between food insecurity and child cognitive outcomes and behavioral problems at different score percentiles using quantile regression. The FFCWS dataset is well-suited for this because of its focus on disadvantaged families.

METHODS

Participants

The FFCWS, a longitudinal study, sampled about 5,000 couples and their children born between 1998 and 2000 in 20 large urban cities with a population > 200,000 in the US. By design, the study oversampled unmarried mothers because they are at higher risk for living in poverty and later facing potential separation from the father than are mothers from more traditional families.¹⁷ Review by the institutional review board was not required for this secondary analysis of the FFCWS dataset.¹⁸

Over the course of the study, both parents were interviewed at regular intervals. This study used data from the fourth wave of interviews (when the child was about age 5 years); the caregiver (usually the mother) also participated in an in-home survey that collected information on the child's cognitive and emotional development and overall health, the home environment, food insecurity, and the child's behaviors, among other data.

Survey Instruments

The FFCWS researchers measured children's cognitive outcomes using 2

instruments: the Peabody Picture Vocabulary Test–Revised, a measurement of children's receptive vocabulary capabilities for standard English and academic readiness¹⁹; and the Woodcock–Johnson Test of Achievement letter–word identification subtest, a measure of cognitive development.²⁰

Children's behavioral outcomes were measured using the Child Behavior Checklist for Ages 1.5–5.²¹ This checklist is a widely used instrument to assess children's behavioral and emotional (externalizing and internalizing) behaviors. For each item, mothers reported how often a specific behavior of the child was true (0 = not true, 1 = sometimes true, and 2 = often or very true). Externalizing behaviors are directed toward others (eg, aggressive behaviors) and internalizing behaviors are negative emotions directed toward the self.²² The externalizing behaviors measure included 25 items (Cronbach α = .85) and the internalizing behaviors measure included 17 items (α = .73). Examples of items included in the externalizing behavior scale were whether the child argued a lot, bullied, was disobedient, or destroyed things. Examples of items included in the internalizing behavior scale were whether the child worried, sulked a lot, was shy, or refused to talk.²¹ These cognitive outcomes and behavioral problems measures were standardized with a mean of 0 and SD of 1 to simplify the interpretation of associations.

Food insecurity was assessed at the household level using an 18-item scale instrument from the US Department of Agriculture.²³ The survey asked questions by order of severity of food insecurity; households that responded affirmatively to ≥ 3 items were classified as food insecure.²³

Control Variables

Several control variables were included in this study that could potentially confound associations between food insecurity and child academic outcomes. Binary variables were constructed to indicate the mother's race/ethnicity (white, black, Hispanic, or other race), low birth weight, maternal education (less than high school, high school, some college,

or college graduate and beyond), the mother's relationship with the father (married, cohabitating, nonresident, or separated), whether the mother had a new romantic partner, the mother's employment status (employed or not), whether the mother smoked during pregnancy, parental history of drug and alcohol abuse, whether the mother was an immigrant, and whether the mother received benefits from the *Supplemental Nutrition Assistance Program* at the time of the interview. Although the researchers controlled for the mother's race/ethnicity and had information on the father's race/ethnicity, there was no direct information on the race/ethnicity of the child. It is possible for some children that their race differed from the mother's and/or father's. Additional control variables included household income as a proportion of the federal poverty guidelines, mother's age when the child was born, the number of children in the home, whether the child was in poor or fair health, and whether the child had asthma.

A measure of maternal depression using the Composite Diagnostic Interview–Short Form was included.²⁴ Mothers were considered to be depressed if they reported feeling depressed or unable to enjoy normally pleasurable activities and had ≥ 3 of 7 additional symptoms, such as having trouble sleeping or feeling worthless. The analysis also controlled for social support, material hardship, parenting stress, and parents' relationship quality. For social support, mothers reported whether they could count on someone to: loan them \$200, loan them \$1,000, provide a temporary place to live, and help with emergency child care. The material hardship measure counted the number of financial hardships experienced by the mother, such as falling behind on rent or mortgage payments, or whether the electricity was turned off because of missed payments.^{25,26} Parenting stress was an average of 4 statements ranging from 1 to 4 (strongly disagree to strongly agree): (1) *Being a parent is harder than I thought it would be*, (2) *I feel trapped by my responsibilities as a parent*, (3) *Taking care of my child is more work than pleasure*, and (4) *I often feel tired from raising a family*.^{27,28} Parents'

relationship quality was rated by mothers on a scale of 1 to 5 (poor to excellent).^{29,30}

Statistical Analyses

The researchers used a difference of means *t* test to test whether differences in the descriptive statistics were significant by gender (Table 1). Whereas previous studies used regression-based models to estimate the average association between food insecurity and child academic outcomes, this analysis used unconditional quantile regression. Quantile regression can model associations between independent and dependent variables at different points of the distribution of a continuous variable rather than just the mean.³¹ Quantile regression can be useful in identifying linear and nonlinear associations between cognitive and behavioral outcomes and food insecurity. In addition, it can be informative about the distribution of important risk factors that explain food-insecure households. Using the FFCWS, which surveyed a majority of disadvantaged families, quantile regression can give useful insight into the multifaceted issue of food insecurity and its effects on young children. The quantile regressions estimated the associations between food insecurity and child academic outcomes at the 10th, 25th, 50th, 75th, and 90th percentiles with robust SEs. The sample size included 2,046 children and their mothers for the behavioral outcomes and 1,684 children for the cognitive outcomes. Some variables with missing values were imputed using multiple imputation by chained equations to preserve these observations.³² Because the results were similar using the nonimputed data, only the results using imputation were reported. $P < .05$ was considered to indicate statistical significance. All analyses were conducted using Stata (version 14, StataCorp LP, College Station, TX).

RESULTS

Participant Demographics

Table 1 presents descriptive statistics for the sample by the child's gender. About 19% of children in this sample lived in food-insecure households. The characteristics reflect the oversampling

of nonmarital births. For example, close to three quarters of mothers were African American or Hispanic, close to two thirds of mothers had at most a high school degree, and more than half of mothers were separated from the child's father. A *t* test of differences of means showed that most of the differences in the average characteristics between boys and girls in this sample were statistically significant at $P < .05$. On average, girls had fewer behavior problems, scored higher on tests, and were less likely to be in poor health or to have asthma problems.

Table 2 presents estimates of the association between household food insecurity and externalizing behaviors, internalizing behaviors, Peabody vocabulary, and Woodcock-Johnson letter-word identification by percentile (10th, 25th, 50th, 75th, and 90th). Table 2 shows the fully adjusted models (unadjusted models not shown and available upon request), which included all of the control variables listed in Table 1. The coefficient reported for each quantile and outcome is that of food insecurity. They are β values and are interpreted in the same way as in ordinary least squares regression. For externalizing and internalizing behaviors, children in the lowest percentiles had fewer behavior problems than did those in the highest percentiles. Household food insecurity was associated with more behavior problems (both externalizing and internalizing) and the negative association was largest for children with the most behavior problems (in the highest percentiles of behavior problems). For example, household food insecurity increased externalizing behavior problems by 0.32 SD for children in the 90th percentile (high behavior problems) whereas it increased externalizing behavior problems by 0.02 SD (not statistically significant) for children in the 10th percentile (low behavior problems).

Cognitive and Behavioral Results

For the Peabody Vocabulary test, household food insecurity was associated with lower scores only for children between the 50th and 90th percentiles. Household food insecurity did not have a statistically signifi-

cant association for children with lower scores (10th and 25th percentiles). For the Woodcock-Johnson letter-word identification assessment, household food insecurity was associated with lower scores only for children in the 10th percentile. These estimates showed that the negative association between household food insecurity and child outcomes varied by percentile and outcome and was not uniform among students.

The same models were reestimated by gender (Table 3). For boys, household food insecurity was associated with externalizing behavior problems for those in the 50th and 75th percentiles. Food insecurity was associated with greater internalizing behavior problems in all percentiles. The association was more than twice as large for those in the 90th percentile than for those in the 10th and 25th percentiles. Food insecurity was associated with a lower Peabody vocabulary score only for those in the 75th percentile. The association between food insecurity and Woodcock-Johnson letter-word identification scores was not statistically significant.

For girls, associations between food insecurity and child academic and behavioral outcomes followed a similar pattern as for boys. Food insecurity was associated with externalizing behavior problems and the association was larger for girls in the higher percentiles. Similarly, food insecurity was associated with internalizing behavior problems and the association was larger for the higher percentiles. On the other hand, food insecurity was associated with a lower Peabody vocabulary score only for girls in the 75th and 90th percentiles, which meant that it affected only girls with higher scores. There was no statistically significant association between food insecurity and Woodcock-Johnson letter-word identification scores by gender.

DISCUSSION

This study used quantile regression to examine how food insecurity affects child cognitive and behavioral outcomes at different points within the distribution; it also examined these associations by gender. The study found that food insecurity was associated

Table 1. Descriptive Statistics of Fragile Families and Child Wellbeing Study Sample

Variable	Full sample (% or Mean)	Boy (% or Mean)	Girl (% or Mean)
Child outcomes			
Externalizing behaviors	9.6	10.0	9.1**
Internalizing behaviors	4.3	4.4	4.3
Peabody Picture Vocabulary Test	86.2	85.0	87.5**
Woodcock–Johnson letter–word identification	99.9	97.9	102.1**
Food-insecure household	19.2	19.7	18.6**
Mother's race			
White	22.5	23.2	21.7**
Black	52.6	52.9	52.4
Hispanic	21.6	20.4	22.9**
Other	3.3	3.6	3.0**
Mother's education			
Less than high school	31.2	29.8	32.7**
High school degree	31.6	33.1	29.9**
Some college	26.0	25.4	26.6**
College graduate	11.2	11.7	10.7**
Mother's relationship with father			
Married	28.9	29.1	28.7
Cohabiting	12.8	11.6	14.0**
Nonresident	3.7	2.8	4.6**
Separated	54.6	56.5	52.7**
Mother has a new romantic partner	28.6	30.1	26.9**
Mother's relationship quality with father	3.3	3.3	3.2
Mother is an immigrant	10.5	10.3	10.7
Number of children	2.6	2.6	2.6
Mother is employed	59.3	58.2	60.4**
Mother's age at birth of child, y	25.2	25.1	25.2*
Household income to poverty ratio	1.9	1.9	1.9
Parental history of drug or alcohol abuse	23.7	24.0	23.2*
Maternal smoking history during pregnancy	20.2	18.7	21.8**
Low birth weight	10.0	9.0	11.1**
Mother receives food stamp benefits	45.2	46.0	44.3**
Mother is depressed	17.1	17.6	16.5**
Social support	3.2	3.2	3.2*
Material hardship	1.1	1.1	1.1
Parenting stress	2.2	2.2	2.2**
Child is in poor health	11.3	13.6	8.7**
Child has asthma problems	8.2	10.6	5.6**
Sample size		1,069	977

* $P < .05$. ** $P < .01$.Note: t tests for differences in means were used to test differences between gender characteristics.

Table 2. Quantile Regressions of Associations Between Household Food Insecurity and Child Cognitive and Behavioral Outcomes

Variable	Percentile score				
	10th	25th	50th	75th	90th
Externalizing behaviors	0.02 (−0.05 to 0.10)	0.24** (0.12 to 0.36)	0.27** (0.15 to 0.39)	0.28** (0.10 to 0.46)	0.32** (0.08 to 0.57)
Internalizing behaviors	0.28** (0.22 to 0.33)	0.25** (0.15 to 0.35)	0.39** (0.26 to 0.52)	0.43** (0.26 to 0.61)	0.44** (0.25 to 0.63)
Peabody Vocabulary	−0.01 (−0.20 to 0.19)	−0.11 (−0.26 to 0.05)	−0.16* (−0.29 to −0.02)	−0.19** (−0.33 to −0.04)	−0.14** (−0.24 to −0.04)
Woodcock–Johnson letter–word	−0.16* (−0.30 to −0.01)	−0.01 (−0.16 to 0.14)	−0.07 (−0.18 to 0.05)	−0.03 (−0.16 to 0.10)	−0.03 (−0.08 to 0.14)

* $P < .01$. ** $P < .05$.

Note: The coefficient reported for each quantile and outcome is the coefficient of food insecurity. They are β values and are interpreted the same way as in ordinary least squares regression. Each model for each percentile includes all control variables in Table 1. Confidence intervals are shown in parentheses and t tests were performed for statistical significance.

Table 3. Quantile Regressions of Associations Between Household Food Insecurity and Child Cognitive and Behavioral Outcomes by Gender

Variable	Percentile score				
	10th	25th	50th	75th	90th
Externalizing behaviors					
Boys	0.07 (−0.03 to 0.17)	0.19 (−0.02 to 0.39)	0.25** (0.09 to 0.42)	0.31* (0.03 to 0.59)	0.22 (−0.00 to 0.45)
Girls	0.03 (−0.18 to 0.25)	0.25** (0.07 to 0.43)	0.28** (0.10 to 0.46)	0.29* (0.03 to 0.55)	0.34** (0.08 to 0.60)
Internalizing behaviors					
Boys	0.23** (0.15 to 0.32)	0.21** (0.11 to 0.31)	0.29** (0.11 to 0.48)	0.31** (0.10 to 0.51)	0.51** (0.26 to 0.76)
Girls	0.25** (0.17 to 0.32)	0.30** (0.13 to 0.46)	0.44** (0.21 to 0.67)	0.49** (0.28 to 0.70)	0.39* (0.02 to 0.75)
Peabody Vocabulary					
Boys	0.07 (−0.27 to 0.42)	−0.16 (−0.38 to 0.07)	−0.14 (−0.31 to 0.03)	−0.21* (−0.40 to −0.042)	−0.12 (−0.32 to 0.08)
Girls	0.11 (−0.09 to 0.31)	−0.01 (−0.19 to 0.16)	−0.11 (−0.26 to 0.04)	−0.15* (−0.30 to −0.01)	−0.19* (−0.36 to −0.02)
Woodcock–Johnson letter–word					
Boys	−0.11 (−0.40 to 0.19)	−0.01 (−0.22 to 0.21)	−0.12 (−0.28 to 0.04)	−0.05 (−0.22 to 0.12)	−0.05 (−0.31 to 0.22)
Girls	−0.11 (−0.34 to 0.12)	−0.05 (−0.22 to 0.13)	0.03 (−0.13 to 0.20)	0.09 (−0.07 to 0.25)	0.11 (−0.10 to 0.31)

* $P < .01$. ** $P < .05$.

Note: The coefficient reported for each quantile and outcome is the coefficient of food insecurity. They are β values and are interpreted the same way as in ordinary least squares regression. Each model for each percentile includes all control variables in Table 1. Confidence intervals are shown in parentheses. t tests were performed for statistical significance.

with externalizing and internalizing behavior problems in all quantiles. These findings were consistent with previous studies revealing that food insecurity has (on average) negative associations with child behavior problems²² and with research showing that undernutrition and malnutrition have adverse impacts on brain development and functioning in children.⁹⁻¹¹ These associations remained statistically significant even after accounting for several potential confounding factors (eg, maternal depression, parenting stress, material hardship). For example, food insecurity increases the risk of maternal depression, and there is evidence that maternal depression mediates associations between household food insecurity and child behavior problems.^{33,34}

In addition, these associations were larger for children in the higher quantiles. This means that negative associations between food insecurity and behavior problems are larger for children who have greater behavior problems to begin with. These findings suggest that undernutrition and malnutrition may have greater adverse impacts on some children, which may lead to greater behavioral problems. Because child behavior problems have negative consequences such as lower educational attainment and a greater risk for delinquency,³⁵⁻³⁷ food insecurity may exacerbate these negative consequences and social disparities among children.

For the cognitive outcomes, food insecurity was associated with a lower Peabody vocabulary score for children in the 50th, 75th, and 90th percentiles. Therefore, food insecurity negatively affected only children in the upper half of the test score distribution. This contrasted with findings on the behavioral outcomes. Also, food insecurity was associated with lower Woodcock-Johnson letter-word identification scores only for children in the 10th percentile, which was consistent with the behavioral outcomes, because children with behavior problems are likely to have lower test scores.^{38,39}

The patterns in these associations were similar when they were examined by gender. Household food insecurity was associated with greater

externalizing and internalizing behavior problems for both boys and girls, and the association was larger for children in the higher percentiles or those with greater behavior problems. For cognitive outcomes, food insecurity was associated with a lower Peabody vocabulary score only for boys and girls in the higher percentiles (75th and 90th). On the other hand, the association between food insecurity and Woodcock-Johnson letter-word identification score was not statistically significant for either boys or girls.

The study had some limitations. First, the findings are generalizable only to children of unmarried mothers, who are aged 5 years and living in large urban cities. Nevertheless, this demographic population is substantially at larger risk for experiencing food insecurity, living in poverty, and having an unstable family structure. Second, the study used a binary measure of food insecurity that includes low-food secure and very low-food secure households. Very low food security is a much more severe form of food insecurity and households were considered very low food secure if they responded affirmatively to ≥ 8 of the 18-question module.²³ The sample in this study had only 89 children (about 4%) living in very low-food secure households, which may not have provided enough statistical power to examine very low food security. Another limitation relates to the years in which the data were collected (between 2003 and 2006), which may not reflect current trends and situations. Finally, although the study controlled for several potential confounding factors, there might have been additional unmeasured characteristics that may explain these associations.

Findings suggest that the negative associations between food insecurity and behavioral outcomes are larger for children with greater behavior problems to begin with. On the other hand, for cognitive outcomes, the negative associations with food insecurity are statistically significant only for the ≥ 50 th percentiles for the Peabody vocabulary score. There is mixed evidence of an association with the Woodcock-Johnson letter-word identification test. The analyses by gender showed a similar pattern. The current findings

contribute to a greater understanding of the relationship between household food insecurity and child cognitive and behavioral outcomes and suggest that food insecurity may potentially exacerbate some of the negative consequences of child behavior problems for educational attainment.

IMPLICATIONS FOR RESEARCH AND PRACTICE

This research used quantile regression to show that the size of the negative associations between food insecurity and child academic and behavioral outcomes differed at different points in the distribution. For the behavioral outcomes, the negative associations with food insecurity were larger for children with greater behavioral problems to begin with. Study findings highlighted the importance of screening children with behavioral problems and poor cognitive outcomes because they may be a greater risk for experiencing food insecurity. These results support the importance of increasing mindfulness about possible food insecurity among students and suggest that behavioral problems and poor cognitive outcomes should be approached holistically with possible food insecurity in mind. This study also provides a snapshot of the possible interactions that food insecurity might have with behavioral and cognitive outcomes, and it may be useful to those who work with children when trying to identify household food insecurity.

The *School Breakfast Program* (SBP) and *National School Lunch Program* (NSLP) are 2 school-based nutrition assistance programs that have been found to be effective in reducing food insecurity.^{40,41} However, take-up rates for the SBP have been found to be lower than for the NSLP because of the difficulty some children face in coming to school before the start of classes to have breakfast. To remove this impracticality, some schools have provided breakfast in the classroom, which has been found to increase the participation rate in the SBP substantially.⁴² Another potential way to increase the participation rate in the SBP and NSLP is through the Community Eligibility Provision, which

allows schools with high poverty rates to serve free meals at no cost to all enrolled students.⁴³ These potential policy options could improve behavioral and cognitive outcomes, reduce absenteeism, and improve educational attainment in children, especially those who are most vulnerable. In addition, the *Supplemental Nutrition Assistance Program* has been found to be effective in reducing food insecurity and poverty.⁴⁴ More research is needed to understand the long-term negative impacts of food insecurity on child academic and behavioral outcomes at different points of the distribution. In addition, future research is needed to examine whether the mechanisms through which food insecurity affects children negatively differ at various points of the distribution.

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