FOOD INSECURITY AND HUNGER IN THE KINDERGARTEN CLASSROOM: ITS EFFECT ON LEARNING AND GROWTH

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This study investigates the correlation between food insecurity, educational achievement, and health among kindergarten children in the United States. Data from the Early Childhood Longitudinal Study—Kindergarten Cohort are used to analyze educational achievement and physical growth of kindergartners faced with food insecurity. The results demonstrate that children begin to experience the effects of food insecurity even at the most marginal level of household food deprivation. Children in households with any signs of food insecurity score lower and learn less during the school year. (*JEL* I21, I3)

I. INTRODUCTION

Despite the existence of federal food aid programs, food insecurity and hunger remain a problem for some people in the United States.[1] In 1999, nearly 15% of all children lived in households that were either uncertain or unable to provide a sufficient diet at all times due to limited resources (Andrews et al., 2000). Furthermore, nearly 42% of children in households at or below the poverty line reported food insecurity.

Poverty has been shown to adversely affect the cognitive development, academic achievement, and health of children (Alaimo et al., 1998, 2001; Sherman, 1991; Rogers, 1994). Furthermore, studies have found that even moderate undernutrition can have a lasting effect on children's cognitive development and school performance (Center on Hunger, Poverty and Nutrition Policy, 1999; Brown and Pollitt, 1996; Pollitt, 1995).

In developing countries it has been shown that instituting a school breakfast program increases student achievement (Chandler et al., 1995, find positive results in Jamaica; Jacoby et al., 1996, find positive results in Peru). The positive effect on achievement from instituting a school breakfast program stems from two potential sources. Hungry children have a higher tendency to have physical ailments and lower attentiveness (Garrett and Lennox, 1993), which hinders the learning process. Alternatively, to eat the breakfast at school a child must not be absent and will likely not be tardy, which increases the probability of learning (Glewee et al., 1999; Rogers, 1994). A child is less likely to be educated if they are not present. Scrimshaw (1996) indicates that "for most persons, health and functional capacity are determined not primarily by their genetic potential but by their health-related behaviors and the quality of their environment."

This article examines whether the converse of the research holds. That is, does the

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1. Hamilton et al. (1997a) state that food security includes at a minimum the ready availability of nutritionally adequate, safe foods, and ensured ability to acquire foods in socially acceptable ways (e.g., without resorting to emergency food supplies).

ABBREVIATIONS

BMI: Body Mass Index
CDC: Centers for Disease Control and Preventions
ECLS: Early Childhood Longitudinal Study

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lack of food security (the secure availability of safe food supplies) hinder achievement for young children? Furthermore the authors examine the relationship between food insecurity and physical size and growth of kindergartners in the United States. The rich data of the Early Childhood Longitudinal Study, Kindergarten Class of 1998–99 (ECLS), provide nearly ideal data for this research. Not only is the ECLS longitudinal, it also includes the 18-item food security module measuring household food security. Others have examined this relationship, including Alaimo et al. (2001) and Glewwe et al. (1999); however, previous research has not combined longitudinal data and the 18-item food security module.

Accounting for the complex design of the ECLS data, the authors find that the food insecurity "threshold," as defined as three or more affirmative responses on the food security module, has little predictive value on the outcome of interest, be it math score or physical size. Nonetheless, this article finds that answering *any* affirmative responses on the food security module has negative effects on math scores and little to no effect on physical size, be it height, weight, or body mass index (BMI). This holds true for the fall math score, or physical size, as well as the learning, or growth, that occurs during the school year.

The article progresses with further description of the ECLS, estimation techniques, results, and concludes with a discussion.

II. DESCRIPTION OF DATA

The ECLS kindergarten cohort is a sample of 21,260 children who attended kindergarten in fall 1998. The complex design of the ECLS samples kindergartners from approximately 1000 schools. A target of 24 children was sampled in each school. The data are nationally representative with an oversampling of Asian, Pacific-Island children, which population weights account for.

Information on the child is primarily obtained from the parent or guardian. Assessment of cognitive abilities of the child as well as physical size is administered at the school. Further parental information is gathered, including education, income, marriage status and history, welfare program participation (current and past), and other information. The parent or guardian is also asked to use the 18-item food security supplement to assess the household's food security status.

The ECLS administered two child assessments and two parent questionnaires in the kindergarten year. The first assessments and interviews were administered in the fall, the majority completed by October. The second assessment was in the spring, six months (on average) after the fall assessment. Although the child assessment measures are available at two points in time in kindergarten, some of the information from the parent interview is only available once. Although some of the basic information was collected twice, such as household size, income, and makeup, the food security module was administered only in the spring interview.

Information about the school is gathered from both the school administrator (principal) and the teachers who direct the classes in which the sampled students attend. The ECLS gathers information on racial composition of the school and classroom, free and reduced-price breakfast/lunch eligibility and participation, and total enrollment of the school and kindergarten level. Teachers provide information on their background, such as tenure, educational background, salary history, and racial background.

The rich data available on the ECLS allows for appropriate explanatory variables to be included in the estimation, diminishing the possibility of spurious results of food insecurity on math scores, body mass indices, and height and weight measurements.

A. Food Security Measurement

The ECLS includes the 18-item food security survey module. The food security survey module was developed through a collaborative process between private nongovernment researchers, academic researchers, and a federal interagency working group, with leadership from the Department of Agriculture and the Department of Health and Human Services. The interagency group developed the food security measure in the early 1990s to estimate the safe and reliable availability of nutrition (Carlson et al., 1999; Hamilton et al., 1997a, 1997b; USDA, 1995).

Although a single-method instrument would be desirable, ordering food security on a scale is impossible for the development of valid severity points. The use of several

valid items assists in differentiating household and individual degrees of food insecurity and hunger. Positive responses to the scale items are considered to represent the progression from a "food-secure" household to "food insecure without hunger" and at the more extreme level "food insecure with hunger." For example, the first question asks if in the past 12 months the respondent ever worried that food would run out because money was not available. The last question asks whether a child in the home ever skipped a meal in the past 12 months because money was not available. Because of the increasing severity of the questionnaire, if a household answers four items affirmatively, they are likely to be the first four items.

A household is deemed food insecure if three or more items are affirmed and food insecure with hunger if eight or more items are affirmed. Table 1 details the 18 items on the food security questionnaire. It also defines the threshold of food insecurity without hunger and with hunger.

To better assess the impact food deprivation, given even the slightest indication of deprivation, the authors take advantage of whether any items are affirmed by using a continuous measure of household food security. Of the 21,260 kindergartners, 18,847 have valid responses for the food security supplement. Of these students, 3335 have at least one affirmative response. Table 2 reports frequencies of the food security module, categorizing responses further into Food Secure, Marginally Food Secure, Food Insecure, and Food Insecure with Hunger. As can be seen in the table, about half of the households responding affirmatively to at least one food security supplement item are categorized as food insecure (fourth and fifth columns). Also, the frequency of the number of items affirmed diminishes with the number affirmed, as expected.

B. Descriptive Statistics

Table 3 reports the descriptive statistics for the variables of interest. The authors partition the table by the four dependent variables, math scores, height, weight, and BMI, as well as reporting several key indicators used in the regression analysis. The columns of the table report the mean of the overall sample, the food secure, the marginally food secure, the food insecure, and the food insecure with hunger, respectively. What Table 3 demonstrates is how the households affirming at least one question on the food security module are much more similar to one another than households with no affirmative responses. Although the food security module is ordered from least to most severe experiences of food insecurity, the first affirmative response represents a large decline in food security.

As expected, math scores decline with increasing levels of food insecurity. The average math score in the fall for children with zero affirmative responses on the food security supplement was 20.05. Children with positive responses to the supplement did increasingly worse. Those with one or two positive responses, marginally food secure, scored 3.21 points below those with zero; those food insecure without hunger scored 3.66 below; and those with eight or more scored 4.17 below.

Also, the average gain in math score from fall to spring was more for children in food-secure households. The same pattern continues for the amount of math the children learned during the year. Those with zero responses gained in the math score by an average of 8.09 points, whereas the marginally food secure only gained 7.46 (0.76 worse than the food secure).

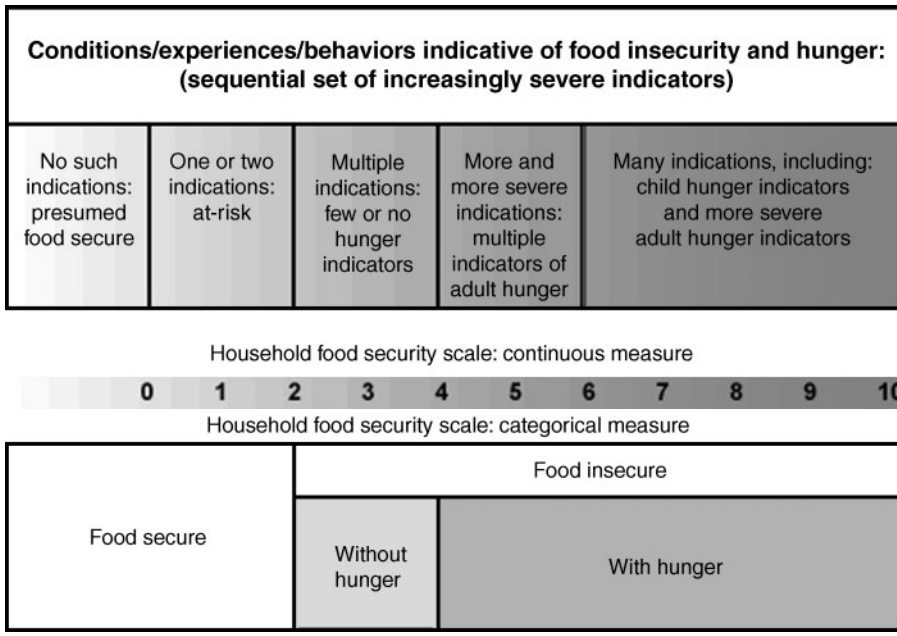
The average height and weight of the children and the amount of growth over the year do not present as clear a pattern as the math scores do. On average, the children from food secure homes are shorter and weigh less than other children, though the differences are not statistically significant. Furthermore, the BMI of children increases with increasing levels of food insecurity;[2] however, the differences are, again, statistically insignificant. Others have found that anthropometric measures are inadequate indicators of food insecurity (Glewwe, Jacoby, and King, 1999).

The remainder of the means reported by food security group is as expected. For instance, the average food secure household (second column of Table 3) has fewer

2. BMI has been found by the Centers for Disease Control and Prevention (2001) to be the only indicator that allows for the accurate measure of weight and height based on age and gender: $\text{BMI} = \text{weight (lb)} \div (\text{height [in]})^2 \times 703$.

TABLE 1
Status Categories for Standard Food Security Measurement Scale Using 18-Item Food Security Supplement (Cutoff Points in Order of Severity and Food Security)

Items	Status
Worried food would run out Food bought didn't last	**Food secure**
Couldn't afford to eat balanced meals Relied on few kinds of low-cost food for children Adult cut size or skipped meals Couldn't feed children balanced meal Adult ate less than felt should	**Food insecure without hunger**
Adult cut size or skipped meals, 3+ months Children were not eating enough Adult hungry but did not eat Respondent lost weight Cut size of child's meals Adult did not eat whole day Child hungry Adult not eat whole day, 3+ months Child skipped meal Child skipped meal, 3+ months Child not eat for whole day	**Food insecure with hunger**



family members, is more likely to be married, is less likely to participate in either free or reduced-price meals, and has more income than marginally food-secure households, food-insecure households, or food insecure with hunger households.

III. ESTIMATION

In estimating the effect of food insecurity on variables of interest, the complex design of the data potentially biases and confounds estimation. This can be said for most empirical estimations using complex data. Most

TABLE 2
Frequency of Affirmative Responses on the Food Security Module

Number of Items Affirmed	Food Secure	Marginally Food Secure	Food Insecure	Food Insecure with Hunger	Total
0	15,512	0	0	0	15,512
1	0	1,054	0	0	1,054
2	0	576	0	0	576
3	0	0	429	0	429
4	0	0	285	0	285
5	0	0	250	0	250
6	0	0	276	0	276
7	0	0	104	0	104
8	0	0	0	102	102
9	0	0	0	73	73
10	0	0	0	66	66
11	0	0	0	43	43
12	0	0	0	34	34
13	0	0	0	22	22
14	0	0	0	8	8
15	0	0	0	4	4
16	0	0	0	2	2
17	0	0	0	4	4
18	0	0	0	3	3
Total	15,512	1,630	1,344	361	18,847

Source: Calculated from the ECLS Kindergarten Cohort.

TABLE 3
Descriptive Statistics of Variables of Interest

			Difference from Food Secure		
	Overall Mean	Food Secure	Marginally Food Secure	Food Insecure	Food Insecure with Hunger
Fall math score	19.425	20.05	−3.21	−3.66	−4.17
Spring math score	27.487	28.23	−3.95	−4.23	−5.11
Gain in math score	8.093	8.22	−0.76	−0.59	−0.95
Fall height	44.687	44.71	*−0.12*	−0.19	*0.05*
Spring height	45.971	46.00	−0.15	−0.17	*−0.07*
Gain in height	1.288	1.29	*−0.03*	*0.01*	*−0.15*
Fall weight	46.490	46.48	*−0.10*	*0.03*	*0.95*
Spring weight	49.609	49.57	*0.06*	*0.09*	*1.41*
Gain in weight	3.139	3.12	*0.15*	*0.02*	*0.37*
Fall BMI	16.286	16.27	*0.05*	*0.13*	*0.26*
Spring BMI	16.411	16.38	*0.12*	*0.13*	*0.46*
Fall household size	4.511	4.456	0.213	0.411	0.401
Spring household size	4.549	4.496	0.178	0.401	0.441
Poverty level[a]	2.921	3.268	−1.762	−2.057	−2.345
Food security raw score	0.628	0.000	1.344	4.503	10.001
Married	0.686	0.730	−0.229	−0.248	−0.302
Free/reduced price meals	0.326	0.267	0.303	0.356	0.361
Income	51.272	57.214	−30.387	−35.005	−39.941
Fall overweight	0.115	0.112	*0.016*	*0.024*	*0.028*
Spring overweight	0.115	0.112	*0.017*	*0.016*	*0.026*
Age (in months)	68.481	68.486	*68.487*	*68.401*	*68.709*
Male	0.513	0.510			

Source: Calculated from the ECLS Kindergarten Cohort.

Note: Numbers in *italics* are not statistically different from the food secure mean (with a *p*-value of 0.05). The numbers reported account for the complex design of the ECLS.

[a]Poverty measure calculated as the percent of Health and Human Services poverty level, where 1.50 equals 150% of the poverty level. The poverty level takes into consideration household income and household size.

large nationally representative surveys stratify the population into several dimensions to increase reliability of the data while minimizing costs of obtaining the data. Unfortunately, the sample surveyed is no longer a simple random sample. This has the potential of biasing point estimates in a regression analysis framework and likely deflating standard errors.

Fortunately, the ECLS provides both strata and primary sampling unit information, allowing for the complex design of the sample to be accounted for in estimating the effect of food insecurity on math scores and physical measures. Accounting for the complex design of the data, the authors institute ordinary least squares when estimating the effect of food insecurity on math scores, height in inches, and weight in pounds.[3] The authors use the logit model when estimating the effect on obesity and underweight, which are dichotomous variables.

The key explanatory variables are the three indicators of increasingly severe levels of food insecurity. The equation estimated is as follows:

$$Y_i = \alpha + \beta * X + \delta_1(\text{at least 1}) + \delta_2 * (\text{more than 2}) + \delta_3 * (\text{more than 7}),$$

where Y is either math score, height, weight, or BMI; X is a vector of control variables; and δ_1, δ_2, and δ_3 indicate the number of affirmative responses on the food security scale.

The three food security coefficients, δ_1, δ_2, and δ_3, estimate differences between households within each of the four food security categories. With fall math scores as the dependent variable, the δ_1 coefficient estimates the difference between the math scores of children in households affirming at least one response with children in households affirming none. One would expect the δ_1 coefficient to be negative. Because the indicator variables in this analysis overlap, the "at least one" category includes the "more than two" category, each successive coefficient reports the difference from the previous variable. For instance, the estimated point estimate of δ_2 is the effect of having more than two positive responses above and beyond having at least one affirmative response. Thus, to get the effect of being food insecure with hunger, one would sum the three coefficients to get the cumulative effect of being in a food insecure with hunger household compared to being in a food-secure household.

The control variables include child characteristics, family and household characteristics, classroom characteristics, location, and parental education. The child specific variables are race, gender, age in months at the time of the assessment, and, in the case of measuring gain scores or growth, the number of months since the fall assessment. Family characteristic variables include total household size, income (and income squared), and parental structure (single- or dual-parent household). Classroom variables include percent of students African American, percent Hispanic, and whether it is an all-day class. Six indicator variables for location ranging from rural to medium-size city (with large city being the omitted variable) make up the location variables. Last, parental education for both the mother and father is measured with indicator variables for highest level of education completed: high school not completed, high school, a college degree, and more than a college degree.

The formidable breadth and depth of the ECLS data allow for substantial controls to be instituted in the regression analysis. Not only are many variables measured that are rarely accessible in a large nationally representative data set, but the large number of students sampled allows for the inclusion of many control variables without the fear of bumping up against limited degrees of freedom. The effect that most of the control variables have on the dependent variable can be easily predicated; however, for others it may not be clearly a positive or negative effect, just that it will be an effect. For example, one can expect child math scores to be positively associated with parental college completion. On the other hand, it is less clear whether a rural setting would have a positive or negative effect on a kindergartner's math score. Nonetheless, we can expect there to be differences in achievement between the locations. By including both the obvious

3. We use the survey commands in Stata 7 (Statacorp, 2001), which corrects for complex sampling design.

and not-so-obvious control variables, the estimated effect of food insecurity on kindergarten physical and academic status in the beginning of the school year and the growth and learning experienced over the school year is more accurately estimated.

IV. RESULTS

It seems reasonable to expect the food security status of a child's home to affect his or her physical size and growth. Similarly, one might expect food security to affect the child's academic capacity at the beginning of the year and learning over the course of the year. For instance, a child from a food-insecure home might begin the school year being relatively undersized and academically underprepared but begin a growth and learning spurt due to the regular availability of nutritious school meals. The authors find that the food security of a child's home, be it secure, marginally secure, insecure, or insecure with hunger, affects both the initial test score taken in the fall and the learning that occurs over the year in a detrimental way.[4] The children from less food secure homes not only score lower at the beginning of the year but also learn less over the course of the school year.[5] However, this study do not find that the food security status of a child's home predicts their physical size or growth.

A. Math Scores

Overall, answering at least one affirmative response on the 18-item questionnaire has a larger estimated effect than being classified as food insecure. That is, children in homes with one or two affirmative responses on the food security module (marginally food secure) are more similar to those children categorized as food insecure (with or without hunger) than they are similar to food secure children.

In estimating the effect of food insecurity on student math scores, the authors use the set of explanatory variables discussed earlier. Though the set of explanatory variables accounts for observable differences, there remains the possibility that unobservable characteristics may affect both math scores and food insecurity. With this caveat we present our results.

Table 4 reports the estimated effect of food insecurity on math scores in the fall when the children enter school. The effect of affirming any items on the food security module has negative effects on the fall math score, similar to affirming at least three items, and doubles quantitatively when affirming at least eight items. In each of these models, the estimated effects are statistically significant. However, when all three indicator variables of food insecurity are included, only the "at least one" indicator variable is statistically significant. The remaining two more severe indicators of food insecurity have negative effects on math score in that they are negative in sign, but they are not statistically different from the "at least one" variable. Though the authors do not go into detail explaining the remaining explanatory variables, they affect math scores in the direction that theory predicts. The authors report the explanatory variables in Tables 4 and 5 for comparison to the variables of interest, namely, the food security indicators.

Like the effect of food insecurity on the fall math score, the effect on learning—that is, the gain in math score from the fall to the spring—is also negative, as reported in Table 5. However, in the case of learning throughout the year, the more severe food insecure categories do not appear to affect learning. In fact, the estimated coefficients for the more severe measures of food insecurity are never statistically significant. Another difference between the estimated effect on math scores in the fall and spring is that the number of explanatory variables statistically significant (at a p-value of 0.05) in the learning equation decreases dramatically, from 25 to 8. This should not be surprising because of the fact that in the learning equation (Table 5) the fall math score is included as an

4. There is the possibility that there are unobserved characteristics that might affect both math score and number of affirmative responses on the food security questionnaire. These could be from genetic or cultural characteristics. Thus far, no research has uncovered any such correlation, but the possibility exists and is therefore important to take under consideration.

5. Because the ECLS currently only covers the kindergarten year, the authors are unable to address the question of whether these early setbacks of coming from a non–food secure home are recoverable, or if the setbacks are permanent. A report by Barlow and Dietz (1998) indicate lasting physical ailments to people overweight as children, including (but not limited to) knee or hip joint pain, diabetes, and gallbladder disease.

TABLE 4
Estimated Effect of Food Insecurity on the Fall Math Score for the Entire Sample

	Coefficient	*P*-Value	Coefficient	*P*-Value	Coefficient	*P*-Value	Coefficient	*P*-Value
At least one	−0.472	(0.01)					−0.380	(0.08)
More than two			−0.523	(0.03)			−0.058	(0.85)
More than seven					−1.019	(0.04)	−0.687	(0.22)
Assesment age (months)	0.430	(0.00)	0.430	(0.00)	0.430	(0.00)	0.430	(0.00)
Single parent (fall)	−1.984	(0.00)	−1.987	(0.00)	−1.997	(0.00)	−1.987	(0.00)
Single mom (fall)	0.286	(0.58)	0.288	(0.58)	0.299	(0.57)	0.294	(0.57)
Household size (fall)	−0.445	(0.00)	−0.448	(0.00)	−0.452	(0.00)	−0.443	(0.00)
Household income	0.023	(0.00)	0.023	(0.00)	0.023	(0.00)	0.023	(0.00)
Income squared	0.000	(0.00)	0.000	(0.00)	0.000	(0.00)	0.000	(0.00)
Medium city	−0.307	(0.18)	−0.310	(0.17)	−0.310	(0.17)	−0.305	(0.18)
Large suburb	−0.048	(0.84)	−0.046	(0.85)	−0.046	(0.85)	−0.049	(0.84)
Medium suburb	−0.882	(0.00)	−0.886	(0.00)	−0.881	(0.00)	−0.878	(0.00)
Large town	−1.649	(0.00)	−1.652	(0.00)	−1.654	(0.00)	−1.652	(0.00)
Small town	−1.201	(0.00)	−1.209	(0.00)	−1.207	(0.00)	−1.207	(0.00)
Rural	−1.706	(0.00)	−1.707	(0.00)	−1.700	(0.00)	−1.709	(0.00)
All-day kindergarten	0.656	(0.00)	0.664	(0.00)	0.669	(0.00)	0.658	(0.00)
% class African American	−1.437	(0.00)	−1.467	(0.00)	−1.475	(0.00)	−1.451	(0.00)
% class Hispanic	−1.549	(0.00)	−1.551	(0.00)	−1.562	(0.00)	−1.544	(0.00)
Hispanic	−1.765	(0.00)	−1.776	(0.00)	−1.779	(0.00)	−1.766	(0.00)
African American	−1.732	(0.00)	−1.734	(0.00)	−1.729	(0.00)	−1.726	(0.00)
Asian	1.227	(0.00)	1.227	(0.00)	1.228	(0.00)	1.223	(0.00)
Other race	−1.421	(0.01)	−1.432	(0.01)	−1.439	(0.01)	−1.419	(0.01)
Mom high school dropout	−2.119	(0.00)	−2.130	(0.00)	−2.138	(0.00)	−2.112	(0.00)
Dad high school dropout	−1.946	(0.00)	−1.948	(0.00)	−1.956	(0.00)	−1.940	(0.00)
Mom high school degree	−0.893	(0.00)	−0.897	(0.00)	−0.896	(0.00)	−0.889	(0.00)
Dad high school degree	−1.032	(0.00)	−1.032	(0.00)	−1.038	(0.00)	−1.033	(0.00)
Mom college	0.963	(0.00)	0.970	(0.00)	0.981	(0.00)	0.968	(0.00)
Dad college	1.035	(0.00)	1.037	(0.00)	1.037	(0.00)	1.033	(0.00)
Mom more than college	1.826	(0.00)	1.834	(0.00)	1.841	(0.00)	1.830	(0.00)
Dad more than college	2.283	(0.00)	2.284	(0.00)	2.284	(0.00)	2.285	(0.00)
Boy	−0.240	(0.07)	−0.246	(0.06)	−0.251	(0.06)	−0.244	(0.07)
Constant	−6.842	(0.00)	−6.855	(0.00)	−6.894	(0.00)	−6.857	(0.00)
Observations	11,240		11,240		11,240		11,240	

Source: Calculated from the ECLS Kindergarten Cohort.

explanatory variable.[6] Nonetheless, affirming at least one item on the food security module remains statistically significant and negative, as expected, in the learning equation. It is worth mentioning that the effect of affirming at least one item would more than counterbalance the effect of the child's mothers being educated beyond a college degree (with a two-year degree the omitted variable in the education indicators).

When examining the effect of food security on math scores and learning for the population at or below 150% of the federal poverty guidelines, much less can be said. Table 6 reports the estimated effect of food security on the fall math scores and the effect on learning over the year.[7] In the case of the population at or below 150% of the federal poverty level, the food security measures do not explain math scores or learning. One exception to this is the second column in

6. Without the fall score as an explanatory variable the estimated coefficient for "*At least one question affirmed*" more than doubles and increases in statistical significance. There is a possibility that the fall score is correlated with a child's innate ability. However, these authors feel that not including the fall score suffers from severe omitted variable bias, dominating the potential for inconsistency arising from child-specific ability correlated with the error term. Erring on conservative estimates, the authors proceed with the smaller estimated coefficient by including fall score in the model.

7. Additional explanatory variables are included in the estimation but not reported here. Similar patterns continue from the previous analysis, such as the number of statistically significant explanatory variables dropping in the learning equation. These results are available to interested readers.

TABLE 5
Estimated Effect of Food Insecurity on Learning over the Kindergarten Year

	Coefficient	*P*-Value	Coefficient	*P*-Value	Coefficient	*P*-Value	Coefficient	*P*-Value
At least one	−0.380	(0.03)					−0.432	(0.04)
More than two			−0.259	(0.25)			0.136	(0.65)
More than seven					−0.330	(0.47)	−0.131	(0.80)
Fall math score	0.919	(0.00)	0.919	(0.00)	0.919	(0.00)	0.919	(0.00)
Assessment age (months)	0.054	(0.00)	0.053	(0.00)	0.053	(0.00)	0.054	(0.00)
Timegain	1.042	(0.00)	1.044	(0.00)	1.044	(0.00)	1.042	(0.00)
Single parent (spring)	−0.365	(0.37)	−0.362	(0.37)	−0.365	(0.37)	−0.366	(0.37)
Single mom (spring)	0.387	(0.47)	0.352	(0.52)	0.342	(0.53)	0.388	(0.47)
Household size (spring)	0.049	(0.27)	0.044	(0.32)	0.041	(0.36)	0.048	(0.28)
Household income	0.003	(0.16)	0.003	(0.09)	0.003	(0.07)	0.003	(0.15)
Income squared	0.000	(0.30)	0.000	(0.22)	0.000	(0.18)	0.000	(0.29)
Medium city	−0.305	(0.20)	−0.309	(0.20)	−0.310	(0.19)	−0.305	(0.20)
Large suburb	−0.235	(0.38)	−0.233	(0.39)	−0.233	(0.39)	−0.235	(0.38)
Medium suburb	−0.110	(0.71)	−0.115	(0.70)	−0.113	(0.70)	−0.108	(0.72)
Large town	−0.519	(0.16)	−0.520	(0.15)	−0.521	(0.14)	−0.519	(0.15)
Small town	−0.271	(0.31)	−0.275	(0.30)	−0.273	(0.30)	−0.270	(0.31)
Rural	−0.221	(0.42)	−0.218	(0.43)	−0.213	(0.44)	−0.220	(0.43)
All-day kindergarten	1.126	(0.00)	1.133	(0.00)	1.136	(0.00)	1.126	(0.00)
% class African American	−0.700	(0.04)	−0.723	(0.04)	−0.724	(0.04)	−0.698	(0.04)
% class Hispanic	−0.465	(0.23)	−0.474	(0.22)	−0.481	(0.21)	−0.466	(0.23)
Hispanic	−0.306	(0.10)	−0.316	(0.10)	−0.317	(0.09)	−0.305	(0.10)
African American	−1.555	(0.00)	−1.557	(0.00)	−1.556	(0.00)	−1.554	(0.00)
Asian	0.530	(0.11)	0.533	(0.11)	0.534	(0.11)	0.530	(0.11)
Other race	−0.356	(0.18)	−0.369	(0.16)	−0.373	(0.16)	−0.356	(0.18)
Mom high school dropout	−1.093	(0.00)	−1.108	(0.00)	−1.114	(0.00)	−1.093	(0.00)
Dad high school dropout	−0.120	(0.65)	−0.127	(0.64)	−0.133	(0.62)	−0.121	(0.65)
Mom high school degree	−0.331	(0.02)	−0.335	(0.02)	−0.336	(0.02)	−0.330	(0.02)
Dad high school degree	−0.125	(0.41)	−0.126	(0.41)	−0.128	(0.40)	−0.125	(0.41)
Mom college	0.186	(0.25)	0.193	(0.23)	0.198	(0.22)	0.186	(0.24)
Dad college	0.018	(0.92)	0.020	(0.90)	0.020	(0.90)	0.017	(0.92)
Mom more than college	0.359	(0.06)	0.366	(0.06)	0.369	(0.05)	0.359	(0.06)
Dad more than college	−0.038	(0.86)	−0.039	(0.86)	−0.039	(0.85)	−0.038	(0.86)
Boy	0.139	(0.18)	0.133	(0.20)	0.132	(0.21)	0.139	(0.18)
Constant	−0.409	(0.72)	−0.437	(0.70)	−0.455	(0.69)	−0.412	(0.72)
Observations	11,497		11,497		11,497		11,497	

Source: Calculated from the ECLS Kindergarten Cohort.

TABLE 6
The Estimated Effect of Food Insecurity on Math Scores and Learning for Those in Homes at or Below 150% of Poverty

	Coefficient	*P*-Value	Coefficient	*P*-Value	Coefficient	*P*-Value	Coefficient	*P*-Value
Fall math score								
At least one	−0.173	(0.45)					0.203	(0.53)
More than two			−0.512	(0.09)			−0.627	(0.15)
More than seven					−0.585	(0.33)	−0.200	(0.76)
Observations	2,568		2,568		2,568		2,568	
Learning								
At least one	−0.352	(0.11)					−0.345	(0.20)
More than two			−0.288	(0.26)			−0.077	(0.82)
More than seven					−0.019	(0.97)	0.270	(0.67)
Observations	2,547		2,547		2,547		2,547	

Source: Calculated from the ECLS Kindergarten Cohort.
Note: Identical explanatory variables are included in this estimation as in previous models but not reported here.

TABLE 7
CDC BMI for Age Guidelines for Underweight, Overweight, and Obese (Updated 2001)

	Boys			Girls		
Age	**Underweight**	**Overweight**	**Obese**	**Underweight**	**Overweight**	**Obese**
4	14.03	16.93	17.84	13.71	16.80	18.03
5	13.84	16.84	17.94	13.52	16.80	18.26
6	13.74	17.01	18.41	13.43	17.10	18.84
7	13.72	17.40	19.15	13.43	17.63	19.68
8	13.80	17.96	20.07	13.54	18.32	20.70

Source: CDC (2001).

the top part, which reports those affirming at least three items on the food security module to have a large negative effect on fall math score. The result does not hold up when the other food security measures are included, however. The nonresults continue when the authors estimate the effect on learning in the first year.

B. Physical Measures

It may be reasonable to expect extra growth and weight gain to occur in children that come from more severe levels of food insecurity as they enter kindergarten. For instance, constant access to nutritious food might trigger a growth spurt in a child with less nutritious eating habits. Although a greater reliance on high-calorie, high-fat convenience foods, soda consumption, and diminished physical activity has occurred in all pediatric groups, poor children have been found to be disproportionately more reliant on these foods than the nonpoor (Rector, 1998).[8] Strategies to cope with food insecurity, such as the reliance on high-fat foods, may contribute to body fat gain, especially when this occurs on a cyclical basis in response to periodic food shortages (i.e., when food stamps run out before the end of the month) (Dietz, 1995; Wilde and Ranney, 2000). Alternatively, we could reasonably expect overweight and obese children that are entering kindergarten to become, in fact, less "overweight" from the healthy meals served in school.

8. Cutts et al. (1998) report that preschool children classified as "hungry" or "at risk for hunger" consumed more soda or other sugared drinks than nonhungry children, thus contributing to "empty" calories.

Technically, a person is classified as overweight or obese according to their BMI. The Centers for Disease Control and Prevention (CDC) occasionally releases BMI guidelines for underweight, at-risk of overweight, and overweight according to age and gender, which they updated in 2001 (CDC, 2001). Furthermore, because boys and girls differ in height, weight, and body fatness as they mature, BMI allows for greater investigation of the impact food insecurity has on physical development. Table 7 reports the updated CDC guidelines for underweight, at-risk overweight, and overweight for boys and girls at several different ages.

The prevalence of child at-risk overweight and child overweight in the ECLS is quite high at 26% and 11.5%, respectively (Table 8). Further, the percentage of children categorized as at-risk overweight and

TABLE 8
The Proportion of the Sample Classified as Overweight and Obese, Respectively, Accounting for Complex Sample Design

Overweight	
Food secure	25.8%
Marginally food secure	26.4%
Food insecure	27.1%
Food insecure with hunger	29.3%
Total	26.0%
Obese	
Food secure	11.2%
Marginally food secure	12.9%
Food insecure	12.8%
Food insecure with hunger	13.7%
Total	11.5%

Source: Calculated from the ECLS Kindergarten Cohort.

TABLE 9
The Estimated Effect of Food Insecurity on Physical Size and Growth

	Coefficient	*P*-Value	Coefficient	*P*-Value	Coefficient	*P*-Value	Coefficient	*P*-Value
Fall BMI								
At least one	0.031	(0.71)					−0.032	(0.71)
More than two			0.106	(0.36)			0.125	(0.35)
More than seven					0.127	(0.59)	0.040	(0.88)
Observations	11,398		11,398		11,398		11,398	
Spring BMI								
At least one	−0.007	(0.86)					−0.013	(0.78)
More than two			0.003	(0.95)			−0.013	(0.85)
More than seven					0.116	(0.23)	0.137	(0.19)
Observations	11,650		11,650		11,650		11,650	
Fall height								
At least one	−0.073	(0.21)					−0.076	(0.31)
More than two			−0.058	(0.48)			−0.017	(0.88)
More than seven					0.050	(0.81)	0.121	(0.58)
Observations	11,401		11,401		11,401		11,401	
Spring height								
At least one	0.020	(0.59)					−0.001	(0.99)
More than two			0.044	(0.26)			0.069	(0.23)
More than seven					−0.058	(0.41)	−0.118	(0.18)
Observations	11,659		11,659		11,659		11,659	
Fall weight								
At least one	−0.036	(0.91)					−0.233	(0.48)
More than two			0.225	(0.59)			0.342	(0.51)
More than seven					0.534	(0.58)	0.406	(0.71)
Observations	11,402		11,402		11,402		11,402	
Spring weight								
At least one	0.048	(0.63)					0.007	(0.96)
More than two			0.094	(0.51)			0.059	(0.77)
More than seven					0.200	(0.43)	0.143	(0.61)
Observations	11,659		11,659		11,659		11,659	

Source: Calculated from the ECLS Kindergarten Cohort.
Note: Identical explanatory variables are included in this estimation as in previous models but not reported here.

overweight increases with more severe food insecurity, from 25.8% at-risk overweight in food secure homes to 29.3% at-risk overweight in food insecure with hunger homes, and from 11.2% overweight to 13.7% overweight.

In estimating the effect of food insecurity on BMI and the change in BMI over the school year, the authors include the same set of explanatory variables used in the previous analysis on math scores. One set of explanatory variables unavailable in this data set is parent's height and weight, and subsequently their BMI.[9] The ECLS is an educational data set. Thus it is not surprising that parental height and weight are not included. Additionally, the data to this point only cover one year of the child's life, and changes in BMI may not be detectable in this time period. With these caveats, the authors briefly present and discuss the results of food insecurity on BMI.

Table 9 reports the results of increasing levels of food insecurity on BMI. These results are not statistically significant. This inability to reject the null hypothesis is robust to alternative measures of physical size and growth. As alternative measures of size the authors used height, weight and also used indicator variables for overweight, obese, and underweight.[10] The food security measures remained statistically insignificant.

9. Anand et al. (1999) find that regardless of income, a child with an obese parent is at increased risk of becoming overweight.

10. In the case of the indicator variables for overweight, underweight, and obese, the authors estimated these models both with a linear probability framework and a logit model. Neither estimation rejected the null hypothesis. These results are available to interested readers.

The authors believe the lack of any significant results is partly due to an insignificant amount of time being observed and partly due to a lack of important control variables.

V. DISCUSSION

This research examines the effect of food insecurity on a child's mental and physical development. Specifically, we examine the differential effect of a child being in a home responding affirmatively to 0, 1 or 2, 3 to 7, and 8 to 18 items in the food security supplement.

This article finds that affirming one or two items in the food security supplement is as important as being classified as food insecure by affirming three or more items. Of the 18,962 respondents that completed the food security supplement in the spring of the kindergarten year, 18%, or 3335, affirmed at least one item and 1705 affirmed at least three items. The designation of three or more affirmative responses being food insecure bears less weight in this analysis than affirming any items.

Further research is needed in this area and will no doubt increase as future waves of the ECLS data become available. This research demonstrates the importance of nutritional stability, young children, and learning. Children from homes with any level of nutritional instability fare worse than those that are truly food secure. Similar results come from research in developing countries. One potential policy implication of this work involves increasing efforts to target the food insecure in the school meals program. This could involve introducing universal free meals or increasing the after-school snack program.

Food security categorization appears to affect academic achievement, both in terms of ability entering school and learning over the school year but does little in predicting physical size or development.

REFERENCES

Alaimo, K., R. R. Briefel, E. A. Frongillo, Jr., and C. M. Olson. "Food Insufficiency Exists in the United States: Results from the Third National Health and Nutrition Examination Survey." *American Journal of Public Health*, 88(3), 1998, 419–26.

Alaimo, K., C. M. Olson, E. A. Frongillo, and R. R. Briefel. "Food Insufficiency, Family Income, and Health in US Preschool and School-Aged Children." *American Journal of Public Health*, 91(5), 2001, 781–87.

Anand, R. S., P. P. Basiotis, and B. W. Klein. *Profile of Overweight Children: Nutrition Insights 13*. Alexandria, VA: USDA Center for Nutrition Policy and Promotion, 1999.

Andrews, M., M. Nord, G. Bickel, and S. Carlson. "Household Food Security in the United States, 1999." Food and Rural Economics Division, Economic Research Service, U.S. Department of Agriculture. Food Assistance and Nutrition Research Report No. 8, 2000.

Barlow, S. E., and W. H. Dietz. "Obesity Evaluation and Treatment Expert Committee Recommendations. The Maternal and Child Health Bureau, Health Resources and Services Administration and the Department of Health and Human Services." *Pediatrics*, 102(3), 1998, E29.

Brown, J. L., and E. Pollitt. "Malnutrition, Poverty and Intellectual Development." *Scientific American*, 274(2), 1996, 38–43.

Carlson, S. J., M. S. Andrews, and G. W. Bickel. "Measuring Food Insecurity and Hunger in the United States: Development of a National Benchmark Measure and Prevalence Estimates." *Journal of Nutrition*, 129(2), 1999, 510S–516S.

Center on Hunger, Poverty and Nutrition Policy. "Statement on the Link between Nutrition and Cognitive Development in Children." Center on Hunger, Poverty and Nutrition Policy, Tufts University, Medford, MA, 1999.

Centers for Disease Control and Prevention. "CDC Growth Charts: United States, BMI-for-age charts, 2 to 20 years of age." Online document, accessed August 10, 2001, available at www.cdc.gov/nchs/about/major/nhanes/growthcharts/bmiage.txt.

Chandler, A. K., S. P. Walker, K. Connolly, and K. Grantham-McGregor. "School Breakfast Improves Verbal Fluency in Undernourished Jamaican Children." *Journal of Nutrition*, 125(4), 1995, 894–900.

Cutts, D. B., A. M. Pheley, and J. S. Geppert. "Hunger in Midwestern Inner-City Young Children." *Archives of Pediatric and Adolescent Medicine*, 152(5), 1998, 489–93.

Dietz, W. H. "Does Hunger Cause Obesity?" *Pediatrics*, 95(5), 1995, 766–67.

Garrett, P., and N. Lennox. "Rural Families and Children in Poverty," in *Persistent Poverty in Rural America*, edited by E. N. Castle. Rural Sociological Society Task Force on Persistent Rural Poverty. Boulder, CO: Westview Press, 1993.

Glewwe, P., H. Jacoby, and E. King. "Early Childhood Nutrition and Academic Achievement: A Longitudinal Analysis." International Food Policy Institute. Discussion Paper No. 68, Brief, 1999.

Hamilton, W. L., J. T. Cook, W. W. Thompson, L. F. Buron, E. A. Frongillo, C. M. Olson, and C. A. Wehler. "Household Food Security in the United States in 1995: Summary Report of the Food Security Measurement Project." Alexandria, VA: Office of Analysis and Evaluation, Food and Consumer Service, U.S. Department of Agriculture, 1997a.

———. "Household Food Security in the United States in 1995: Technical Report." Alexandria, VA: Office of Analysis and Evaluation, Food and Consumer Service, U.S. Department of Agriculture, 1997b.

Jacoby, E., S. Cueto, and E. Pollitt. "Benefits of a School Breakfast Program among Andean Children in Huaraz, Peru." *Food Nutrition Bulletin*, 17(1), 1996, 54–64.

Meyers, A. F., A. E. Sampson, M. Weitzman, B. L. Rogers, and H. Kayne. "School Breakfast Program and School Performance." *American Journal of Disabled Children*, 143, 1989, 1234–39.

Pollitt, E., ed. "The Relationship between Undernutrition and Behavioral Development in Children: A Report of the International Dietary Energy Consultative Group (IDECG) Workshop on Malnutrition and Behavior." *Journal of Nutrition*, 125(8S), 1995.

Rector R. "The Myth of Widespread American Poverty." *Heritage Foundation Backgrounder*, 1221, September 18, 1998.

Rogers, S. "The Link between Nutrition and Learning." Missouri Department of Elementary and Secondary Education, Missouri Department of Health, Missouri Department of Social Services, and University Missouri Extension. *Step-by-Step*, l5(3), 1994.

Scrimshaw, N. S. "Nutrition and the Health, from Womb to Tomb." *Nutrition Today*, 31(2), 1996, 55–67.

Sherman, A. "Child Poverty in America: The Worsening Toll It Exacts." *Choices*, 6(3), 1991, 22–25.

Statacorp. "Stata Statistical Software: Release 7.0." College Station, TX: Stata Corporation, 2001.

USDA Food and Consumer Service, Office of Analysis and Evaluation. "Food Security Measurement and Research Conference: Papers and Proceedings." Alexandria, VA: USDA, 1995.

Wilde, P., and C. K. Ranney. "The Monthly Food Stamp Cycle: Shopping Frequency and Food Intake Decisions in an Endogenous Switching Regression Framework." *American Journal of Agricultural Economics*, 82(1), 2000, 200–13.