Food Insecurity Effects on Children's Academic Growth

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Abstract

Throughout the world, food security has been a persistent issue that is present in many people's lives. Previous literature has found that food insecurity negatively impacts children's physical, social, and cognitive development (Gunderson et al., 2011; Cook et al., 2008; Jyoti et al., 2005; Alaimo et al., 2011; Glewwe et al., 2001; Winicki & Jemison, 2003). This paper investigates how food insecurity hinders academic growth in first grade students throughout the United States. By using survey data from the Early Childhood Longitudinal Study Program (ECLS K:2011), this study explores the relationship between a child's growth in math and reading scores in the first grade and their food security status. My study confirms that food insecurity does result in slower academic growth in math but did not significantly impact growth in reading scores.

Introduction

Food insecurity is a serious issue that millions of people from developed countries and underdeveloped countries encounter every day. According to the United States Department of Agriculture, food insecurity can be defined "as a household level economic and social condition of limited access to food" (USDA). In 2008, 17 million households were food insecure in the United States (Nord et al., 2009). As of 2012, about 16 million children, or one in five children, in the United States lived in a household that was classified as food insecure (Gunderson & Ziliak, 2014; Howard, 2011; Nord et al., 2009). Food insecurity is a persistent problem that can negatively impact children's academic, social, and physical development.

There are many factors other than food insecurity that impact childhood development, including family structure, race, location, and poverty. This study aims to understand the relationship between food insecurity and academic growth without ignoring other influential factors. My hypothesis is that food insecure children will have slower academic growth throughout the school year in math and reading scores. To measure academic achievements, I will be using the percent change in the student's test scores from fall to spring of first grade. By using the percentage change of the test scores instead of the raw scores, I am able to compare the differences across the students and the subjects.

To test my hypothesis, I ran two regressions using two different dependent variables and the same independent variables. The dependent variables are the percent change in math scores and the percent change in reading scores. All the data was collected from the ECLS K:2011 data from the first grade, which was 2012 to 2013. The main variable of interest in this paper is the childhood food security categorical measure. After running both of the regressions, the results showed that low food security was significant at the 1% level for only the math regression. In the

reading regression, the food security variables were not found to be significant. These results confirmed that food insecurity hinders academic achievement in math, but they cannot confirm that food insecurity negatively impacts reading scores.

Literature Review

The literature discussed examines how childhood food insecurity will negatively impact child development. Although the problem of food insecurity is well established in previous literature and research, it is difficult to address issues dealing with food insecurity due to the lack of awareness of the prevalence of the issue within one's own community or family (Ward et al., 2018). Since the United States is a developed country, the issue of food insecurity is not heavily addressed, even though it can have serious effects on young adults and children. Studies have shown that the problem of food insufficiency in the United States is most prevalent among children and young adults (Carlson et al., 1999). Children represent a population whose growth, both physically and mentally, is extremely vulnerable to nutritional stress, whether that be lack of nutrients or chronic food deprivation (Howard, 2011). Many studies have shown that children who are food insecure face many health problems, including anemia, higher probabilities of being hospitalized, poorer general health, and greater levels of aggression and anxiety (Gunderson et al., 2011; Cook et al., 2008). Children who face food insecurity at a young age may have long-lasting effects, which shows the importance of this issue.

There are many factors that can cause childhood food insecurity, including but not limited to, the mother's health, the head of household status, parental income, and maternal mental health (Gunderson & Ziliak, 2014). Although income cannot fully explain food insecurity, it is very relevant when discussing this issue. When focusing on income, poverty can

then be both directly and indirectly linked to the problem of food insecurity. Engle and Black (2008) explains that "poverty limits the chances of educational attainment, and at the same time, educational attainment is one of the prime mechanisms for escaping poverty" (243). Therefore, the studies that research the educational effects of food insecurity within children are extremely valuable in order to understand how to release someone from the vicious cycle of poverty.

It has been established that different socioeconomic and demographic factors can be associated with poverty and food insecurity. Therefore, certain populations of people are more vulnerable than others. Jyoti, Frongillo, and Jones (2005) show differences in the likelihood of being food insecure based on gender. In their study, they found food-insecure girls tended to perform poorly in mathematics and showed improvement in social skills compared to food-insecure boys (Jyoti et al., 2005). This shows that food insecurity is directly linked to developmental consequences for boys and girls, but the consequences are slightly different.

When looking at the differences between food insecure groups, studies look for differences in certain age groups. Evidence has shown that the older sibling in a family with multiple children tends to experience food insecurity most severely (Heflin et al., 2019; Bhargava et al., 2008). Therefore, age groups and family structure are important when considering the most vulnerable groups of food insecure people. Alaimo, Olson, and Frongillo (2001) find that 6- to 11-year-old food insufficient children have significantly lower arithmetic scores and were more likely to have repeated a grade. Other studies have solidified these results, as well as found higher levels of absenteeism and tardiness for that age group (Jyoti et al., 2005). Not only does food insecurity hinder academic achievement because of absenteeism and tardiness, but it can also delay when children begin school. One study found evidence that the primary school enrollment of malnourished children tended to be delayed because the children

were deemed to be unready for enrollment (Glewwe et al., 2001). If children do not begin school at the appropriate age, it can affect their academic achievements throughout their lifetime.

To dive deeper into the educational effects of food insecurity, Winicki and Jemison (2003) use data from the Early Childhood Longitudinal Study (ECLS) to analyze kindergartener's educational achievement and cognitive development. In order to measure the academic achievement of children, Winicki and Jemison (2003) utilize math test scores. The results found that when food insecurity was prevalent, there would be negative effects on math scores. As expected, the children who were less food secure scored lower and also learned less throughout the year (Winicki & Jemison, 2003). In another study, children's reading scores were used as well as their math scores, and confirmed that food insecurity impaired academic performance in both reading and mathematics (Jyoti et al., 2005). Overall, many studies have shown that children who do face food insecurity scored lower on tests and learn less throughout the school year.

When observing how education from kindergarten affects later academic achievement, Claessens (2009) found that school entry level math skills were consistently predicative of fifth-grade achievement. The early math skills of kindergarteners were not only highly predictive of later math achievement, but it was predictive of later reading achievement as well (Claessens et al., 2009). Therefore, food insecurity can help identify children with delayed trajectories towards educational development. It is important to note that food insecurity is not the only explanation of delayed academic achievement. Many similar factors can cause issues such as food insecurity, poverty, poor academic performance, and poor mental health. Although there is strong evidence and research found about how food insecurity can hinder academic achievement, it is always important to consider all contributing factors and their relationships to one another.

Data and Methodology

The question this study aims to answer is how food insecurity impacts academic growth in first-grade children living in the United States. I hypothesize that children identified as food insecure will experience slower academic growth than their peers. The growth of education levels in the first grade is the focus of this study as opposed to kindergarten. The thought is that the variability between children in terms of kindergarten may be due more than to their experience prior to entering school. The hope is that comparing children who have all had a year in school with equal educational opportunities in the classroom will lessen the impact of the level of preparedness going into kindergarten.

In order to measure the growth in academic achievement, there are many relationships and factors that intertwine. The student's cognitive ability is not the only factor to consider when examining their educational achievement. Family factors are very important to consider when discussing children's educational achievement. When looking at family factors and discussing parental variables, I will be using the term "parents" to refer to anyone in that role for the child. Noble (2006) found that the academic achievements of students were indirectly related to academic activities of students, perceptions of their adapting strategies, and background qualities. These background qualities included family pay, teacher-student ratio, gender of the student, parents' level of education, and the number of negative circumstances in the house. Another study found that parental educational level and socioeconomic status have significant effects on the quality of their child's academic performance (Mejorada, 2011). Therefore, it is important to look at family influenced factors to fully understand what governs children's academic achievement. The sample chosen must include data about the child itself, their family, their household, and their school environment.

The sample being used is from The National Center of Education Statistics (NCES), which sponsors the Early Childhood Longitudinal Study Program (ECLS). The survey data from ECLS is aimed to show childhood development and school progress. The ECLS program for the kindergarten class of 2010 to 2011(ECLS K-2011) follows the same group of students from kindergarten through fifth grade. In kindergarten, there was approximately 18,000 students from about 970 schools throughout the United States that participated. ECLS K-2011 is the third and latest study for the ECLS program. The study emphasizes relationships between the child, family, school, and community. These relationships are critical for early childhood development, specifically cognitive development.

Within the ECLS sample, there are children participating from various types of backgrounds. This nationally represented sample includes children from different socioeconomic groups, geographical regions, and ethnic groups. Information about the children, parents, teachers, school administration, and day-care providers were collected during this survey. The questions asked during the survey provided information about the child's cognitive, social, emotional, and physical development. The goal of collecting this data is to see how various student, home, classroom, school, and community factors at differing points in the child's life relate to cognitive, social, and emotional development (NCES, 2011).

There are two dependent variables being tested, but the variables are measured the same. The dependent variables are found using the item response theory (IRT) scale score in math and reading. IRT procedure is a method for modeling assessment data that makes it possible to calculate an overall score for each domain measured for each child. The children were administered assessments in math and reading, but the children were not given the same number of questions. Therefore, the IRT scale score estimates the number of questions a child would

have answered correctly in each data collection round if the child was administered all questions on the assessment. Since there are a different number of questions administered and the content is not equivalent for each assessment, the raw results cannot be compared across subjects. In order to measure the educational achievement across subjects, I am going to find the percent change from fall test scale scores to the spring test scale scores.

I will be running two separate regressions using the percent changes in math and reading as the dependent variables. Since the scale scores can be used for comparison among children, and the percent changes can be compared across all subjects, I will be able to measure the growth in academic achievement and compare the differences in growth across math and reading. My regression equations are as follows:

$$
\begin{aligned}
&Percent\ Change\ Math\ IRT\ Scale\ Score \\
&\quad = \beta_0 + \beta_1 \cdot lowfoodsecurity + \beta_2 \cdot verylowfoodsecurity + \beta_3 \cdot Black \\
&\quad + \beta_4 \cdot Asian + \beta_5 \cdot NativeHawaiian + \beta_6 \cdot AmericanIndian + \beta_7 \\
&\quad \cdot twoormoreraces + \beta_8 \cdot Hispanic + \beta_9 \cdot suburb + \beta_{10} \cdot town + \beta_{11} \cdot rural \\
&\quad + \beta_{12} \cdot onesibling + \beta_{13} \cdot twosibling + \beta_{14} \cdot threesibling + \beta_{15} \\
&\quad \cdot fourormoresibling + \beta_{16} \cdot belowpovertythreshold + \beta_{17} \\
&\quad \cdot 200\%belowpovertythreshold + \beta_{18} \cdot publicschool + \beta_{19} \\
&\quad \cdot oneparenthousehold + \beta_{20} \cdot oneparentandpartnerhousehold + \beta_{21} \\
&\quad \cdot guardianhousehold + \beta_{22} \cdot parenteducationhighschool + \beta_{23} \\
&\quad \cdot parenteducationvocationaltech + \beta_{24} \cdot parenteducationbachelor + \beta_{25} \\
&\quad \cdot parenteducationmasters + \beta_{26} \cdot disability + \beta_{27} \cdot non \\
&\quad - englishspeaking + \beta_{28} \cdot male + \beta_{29} \cdot fallmathIRTscalescore + \mu
\end{aligned}
$$

$$
\begin{aligned}
&Percent\ Change\ Reading\ IRT\ Scale\ Score \\
&\quad = \beta_0 + \beta_1 \cdot lowfoodsecurity + \beta_2 \cdot verylowfoodsecurity + \beta_3 \cdot Black \\
&\quad + \beta_4 \cdot Asian + \beta_5 \cdot NativeHawaiian + \beta_6 \cdot AmericanIndian + \beta_7 \\
&\quad \cdot twoormoreraces + \beta_8 \cdot Hispanic + \beta_9 \cdot suburb + \beta_{10} \cdot town + \beta_{11} \cdot rural \\
&\quad + \beta_{12} \cdot onesibling + \beta_{13} \cdot twosibling + \beta_{14} \cdot threesibling + \beta_{15} \\
&\quad \cdot fourormoresibling + \beta_{16} \cdot belowpovertythreshold + \beta_{17} \\
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&\quad \cdot guardianhousehold + \beta_{22} \cdot parenteducationhighschool + \beta_{23} \\
&\quad \cdot parenteducationvocationaltech + \beta_{24} \cdot parenteducationbachelor + \beta_{25} \\
&\quad \cdot parenteducationmasters + \beta_{26} \cdot disability + \beta_{27} \cdot non \\
&\quad - englishspeaking + \beta_{28} \cdot male + \beta_{29} \cdot fallreadingIRTscalescore + \mu
\end{aligned}
$$

The main independent variable of interest is the child's food security level. This variable is directly related to the question of interest, which is whether food insecurity hinders academic achievement. The categorical measure of the child's food security status is based on the child's food security raw score. The child's food security raw score is a simple count of the number of child-referenced food security questions affirmed by the parents. The questions asked to the parents measured the households' experiences related to food insecurity and reduced food intake in the last 12 months. Depending on how the parent answered the questions, the child was put into three categories: food secure, low food security, and very low food security. It is important to note that that child's food security status is directly impacted by parents' lifestyle, income, and decisions. The hypothesized relationship is that the children who score low and very low food security will show slower academic growth from fall to spring in comparison to food secure children.

Other independent variables include family and household composite variables that give more insight into family dynamics. Composite variables were created to understand the family makeup and the background of the family members. Variables included are the number of siblings, the level of parental education, the parents' poverty level, and the parental role in the household. The number of siblings and the parental role in the household are both variables that

focus on resource issues. The more siblings a child has means the less amount of time a parent has to focus on the child, therefore resulting in slower academic growth relative to children with less siblings. The parental role in the household, whether that be two parents, one parent and partner, one parent, or other guardians, is critical when looking at the household support. Support in terms of financial support, emotional support, and educational support can affect the ability for the child to grow academically. Therefore, children with one parent and partner, one parent, or guardians present will show slower academic growth throughout the year relative to children belonging to two parent households.

Along with that, the parental educational level is collected in order to examine the relationship between the parental educational attainment and their child's academic achievements. The parent's education can be broken down into five different categories, including less than a high school education, graduating high school, vocational or technical school, bachelor's degree, and masters or doctorate degree. The relationship would be that children whose parents have higher levels of education will show greater academic growth relative to children whose parents did not complete high school, which is the omitted group.

Another variable includes the parents' poverty level. The parents' poverty level is measured to see the relationship between poverty and education. The poverty levels are broken into three categories: below poverty threshold, at or above poverty threshold below 200% of poverty threshold, and at or above 200% of poverty threshold. The predicted relationship is that parents who are below the poverty threshold will result in their children showing slower academic growth relative to children who belong to households that are above the poverty threshold. Overall, households with less siblings, have two parents present, have higher parental

educational attainment, and are above 200% poverty threshold will have children who show greater academic growth throughout the school year.

When assessing a child's academic achievements, it is important to look at variables that describe the child. Critical variables to include are the child's sex, language, and race or ethnicity. The child's sex is an important variable to include because it points to developmental differences between males and females. Some articles emphasized these differences between sexes, which anticipates the results to show females having slower academic growth throughout the year relative to males (Jyoti et al., 2005).

The child's language is measured on whether or not the child speaks English. If the child did not pass an English language screener, they were given assessments in Spanish. This does not mean that every Spanish speaking individual was given a Spanish assessment. Along with that, they do not offer tests in any other languages except English and Spanish, which puts other language speaking students at a disadvantage. Therefore, the predicated relationship is that non-English speakers will show slower academic growth throughout the school year relative to English speaking children.

Lastly, the child's race and ethnicity are important to collect in order to show systemic problems in the country that oppress certain groups of people. The races are broken up into seven categories: white, black/African American, Hispanic, Asian, American Indian, Native Hawaiian/Pacific, and two or more races. The predicted relationship is that children classified as anything other than white or Asian will show slower academic growth throughout the school year and Asians will show greater academic growth relative to children who are white. This is because Asian students tend to be anointed as high achieving which increases their efforts and

performs better (Lee & Zhou, 2017). Overall, children who are male, speak English, and are classified as white will show greater academic growth in comparison to others.

The remaining independent variables are control variables that include child's disability status, private or public-school attendance, and the locality of schools. In this study, I will be controlling for children who have a disability. Based on the parents' interview, questions were asked about the child's ability to take care of themselves, their ability to learn, their coordination, and their behavior. Depending on the answers to these questions, the children were categorized as having a disability or not having a disability. The predicted relationship is that children who do have an intellectual or physical disability will have slower academic growth in math and reading relative to children without a disability.

Along with that, the survey breaks down the schools that the child is attending into two categories: public or private. Private schools include any type of religious or other private schools. Public schools tend to have a larger population, which affects the teacher to student ratio and ultimately, the children's learning outcome. This study will restrict the sample to public schools to examine student to teacher ratio. Also, children who go to private schools may be offered more opportunities and come from higher income families. The predication is that children who go to public schools will show slower academic growth throughout the year relative to private schools.

The final variable that will be included is the locality measurement, which categorizes the location of the schools in the survey. These locations are put into four categories: town, suburb, city, and rural. The predicted relationship is that children who go to school in cities will have slower academic growth children who go to school in the other locations. Besides the percent changes in the scores of math and reading, all of the variables will be dummy variables with one

of the groups in each variable being dropped in order to compare the results. To get a closer look at the number of responses for each variable, the description of the variables, and sample questions for each one, Appendix B provides thorough information. Along with that, Appendix A provides the summary statistics for each variable.

Results

Table 1: Results

	Dependent Variables	
Independent Variables	Percentage Change Math Scores	Percentage Change Reading Scores
Constant	66.39*** (2.43)	58.10*** (1.79)
Low Food Security	-2.62** (1.17)	-1.37 (1.04)
Very Low Food Security	2.98 (4.17)	-0.99 (2.98)
Black/African American	-4.67*** (1.18)	-2.12** (0.94)
Asian	0.31 (1.04)	-1.56* (0.84)
Native Hawaiian/Pacific Islander	-3.79 (2.42)	-0.041 (3.19)
American Indian/Alaska Native	0.47 (2.60)	-0.059 (2.37)
Two or More Races	-1.00 (1.27)	0.66 (1.13)
Hispanic	-3.90*** (0.80)	-2.68*** (0.66)
Suburb	-1.44** (0.62)	-0.13 (0.51)
Town	-1.18 (1.44)	1.80 (1.15)
Rural	1.53* (0.87)	2.77*** (0.73)
One Sibling	0.064 (0.87)	0.54 (0.71)
Two Siblings	0.54 (0.92)	1.81** (0.77)
Three Siblings	0.41 (1.12)	0.79 (0.96)
Four or More Siblings	0.32 (1.54)	0.13 (1.30)
Below Poverty Threshold	-1.17 (0.95)	-2.85*** (0.79)
Below 200% Poverty Threshold	-1.83** (0.82)	-1.36* (0.70)
Public School	0.76	-0.93

	(0.82)	(0.78)
One Parent and Partner Household	-2.80** (1.12)	0.67 (1.04)
One Parent Household	-1.50* (0.84)	0.15 (0.68)
Guardian/Other Household	-5.93*** (1.92)	-3.70* (2.02)
Parent Education High School Only	1.46 (1.16)	3.53*** (0.91)
Parent Education Vocational/Technical/Some School	1.70 (1.21)	4.38*** (0.94)
Parent Education Bachelors/Graduate	2.75** (1.29)	4.38*** (1.03)
Parent Education Masters/PhD	3.07** (1.36)	5.68*** (1.14)
Disability	-2.85*** (0.84)	-3.06 (0.73)
Non-English Speaking	-1.00 (0.95)	-0.34 (0.76)
Male	2.39*** (0.54)	-1.34*** (0.45)
Fall Math IRT Scale Score	-0.69*** (0.025)	-
Fall Reading IRT Scale Score	-	-0.44*** (0.13)
R^2	*0.2895*	*0.2749*
N	*3025*	*3025*
F-stat	*28.84****	*47.09****

*Note: Due to heteroskedasticity being present in all regressions; robust standard errors are reported in parentheses. *** indicates significance at the 1% level, ** indicates significance at the 5% level, and * indicates significance at the 10% level.*

The hypothesis being tested is that low food security in children will result in slower academic growth throughout the year in math and reading scores. For my model, I will be looking at the percentage changes in the IRT scale scores from fall to spring in the first grade. I ran two separate regressions for both school subjects, and the same independent variables were used for the two regressions. After running each regression, I used the White Test to check for

heteroskedasticity, which was present in both regressions. In order to fix this problem, robust standard errors were used.

The first regression used the dependent variable percentage change in math scores. This regression has an R^2 of 0.2895, which means that this regression explains about 28.95% of the variation in the percent change in math scores from the ECLS K:2011 survey data. There were 3,025 observations in this regression. Out of my two main variables of interests, which are low food security and very low food security, only one was significant. Low food security was significant at the 5% level and found that if the student is categorized as having low food security, then on average their gain in their math score over the year is 2.62 percentage points lower than a student who is food secure. Since this study is directly measuring a child's academic growth through test scores throughout the school year, these result supports the argument that food insecurity can hinder a child's academic growth.

The second regression used the dependent variable percentage change in reading scores. This regression has an R^2 of 0.2749, which means that this regression explains about 27.49% of the variation in the percent change in reading scores from the ECLS K:2011 survey data. Again, there were 3,025 observations in this regression. Out of my two variables of interest, neither variable was statistically significant. This may be because food security might not impact reading scores as much as other subjects. Although the food security variables were not significant in this regression, there were many other significant variables.

The variable that measured the initial IRT scores of the math and reading tests for the fall were included in both regressions. Both of the variables were found to be significant. In the math regression, the results found that for each additional unit increase in the fall math score, the student is expected to see a 0.69 percentage point lower growth in the math score over the year.

Similar results were found in the reading regression, where the student is expected to see a 0.44 percentage point lower growth in the reading score over the year. This showed that controlling for the student's initial fall score was important because if the students score higher in the fall, they have less room for growth in the spring.

There are many similarities in the results when comparing the significant variables across the two regressions. When looking at the race variables, the Black or African American variable was significant across both regressions. If the child was Black or African American, their average gain in their math score over the year is 4.67 percentage points lower than a student who was white and their average gain for their reading score is 2.12 percentage points lower than a student who was white. Along with that, the Hispanic variable was significant and found that on average, Hispanic student's gain in their math and reading scores were lower than a student who was white. The Asian variable was only significant at the 10% level in the reading regression and it explained that if the student was Asian, then on average their gain in their reading score over the year was 1.56 percentage points lower than a student who was white. This result was surprising since it did not follow the previous research about Asian student's educational attainment (Lee & Zhou, 2017). This may be because Asian students may have gone into first grade very prepared and therefore, may not have as much room to grow relative to other students, even after controlling for their initial score. This result may be due to the small sample of Asians in this survey. The other race variables, including Native Hawaiian or Pacific Islander, American Indian or Alaska Native, and the variable for two or more races were not significant. These variables may not have been significant because the sample sizes for those races were not represented as much as the Black, Hispanic, and Asian population.

When looking at the locations of schools, the variable that accounted for schools located in rural locations were found to be statistically significant in the math and reading regressions relative to schools in cities. If the child went to school in a rural area, their average gain in their math score over the year is 1.53 percentage points greater than a student in the city. This similar result was found in the reading regression, where their gain in reading scores over the year is 2.77 percentage points greater than students who go to school in cities. On the other hand, the variable that accounted for schools located in suburban locations was statistically significant and negatively correlated in the math regression. In both regressions, the variable that attributed for schools located in towns was not significant. This could be because towns have the smallest number of schools and the smallest percentage of students attending them in comparison to the other locations (NCES). When measuring for the differences in the school type in terms of whether the school was public or private, the public-school variable was found to not be statistically significant in either regression.

Some other variables that described the children's characteristics included disability, non-English speaking, and male. If the child had a disability, their gain in math scores over the year is 2.85 percentage points lower than students who did not have a disability. This relationship was predicted. Another important result was that for the math and reading regression, the male variable was significant at the 1% level and found opposite results. If the student was a male, their gain on average in math scores over the year was 2.39 percentage points greater than females, but their gain on average in reading scores over the year was 1.34 percentage points less than females. This is exactly what previous literature had found, so therefore, my regressions help verify their results (Jyoti et al., 2005).

The variables that measured for parent's poverty level were below poverty threshold and below 200% of the poverty threshold. The variable that accounted for parents being below the poverty threshold was statistically significant at the 1% level for the reading regression. If the parent was below the poverty threshold, then on average their child's gain in reading scores over the year is 2.85 percentage points less than students whose parents are above the poverty threshold. If the parents were below 200% of the poverty threshold, they were found to be statistically significant for the math and reading regressions. The correlation was also negative, which shows that poverty negatively impacts educational achievement.

Next, the variables that represented household structure were found to be important in both regressions. If the student had one parent, their average gain for their math score over the year was 1.50 percentage points lower than a student who had two parents. This negative correlation was also found in students that lived in one parent and partner households for the math regression. The variable measuring households ran by a guardian was significant for both the math and reading regression. Relative to students belonging to two parent households, if the student belonged to a guardian household, their gain in math scores over the year is 5.93 percentage points lower and their gain in reading scores over the year is 3.70 percentage points lower. Overall, children that belong to two-parent households academically achieve more throughout the school year in math and reading.

Another variable that represented family structure was the sibling variable. In the reading regression, the results found that if the child had two siblings, then their average gain in their reading score would be 1.81 percentage points greater than a child with no siblings. A reason for this could be that siblings help each other with schoolwork and learn from one another. If the student has two siblings and was the youngest sibling, there is an academic advantage to being

the younger sibling since they would be exposed to what the older siblings were learning. In the math regression, the sibling variable was not found to be significant.

Another influential variable is the measure of the parent's educational attainment. For the math regression, the variables that describes parents with bachelor's degree, masters, graduate, or doctorate degree were significant at the 5% level. For the reading regression, the variables that describe the parent only having a high school education, the parent going to a technical or vocational school, the parent having a bachelor's or graduate degree, and the parent having a masters or doctorate degree were all significant at the 1% level. A trend that appeared most the time throughout the regressions showed that the more educated the parents were, the larger the coefficient became. An example to show this trend could be found when comparing the reading regression results between bachelor's degree and master's degree. Relative to students whose parents do not have a high school education, if the student's parent had a bachelor's degree, then their average gain in their reading score over the year is 5.52 percentage points greater. Yet, if the student's parent had a master's degree, then their average gain in their reading score over the year is 6.90 percentage points greater than a student whose parents do not have a high school education. So therefore, the educational attainment of the parent made a large impact on child's academic achievements.

Conclusion

After running the two regressions, I could confirm that food insecurity had negative impacts on children's academic achievements in math. On the other hand, this study found that food insecurity did not significantly impact growth in reading scores. Therefore, my hypothesis was partially true. The study was able to confirm that there were many other variables impacting children's academic achievements, including specific races, family structures, and parental education attainment. Overall, there are many other variables that can help explain what hinders academic achievement in children other than food insecurity.

There were issues in my analysis that can be further researched in future studies. One issue was that the time frame that was observed in this study only analyzed first grade statistics. This limited the number of observations, but more importantly, it limited the amount of potential growth for students. Children start kindergarten at different levels depending on what their parents or guardians had taught them. Depending on the amount of information the child knows going into school, it impacts how well they do on tests. If they scored well on their first test, then they have less potential to show more growth for their second test. The ECLS K:2011 survey data follows the same children from kindergarten to fifth grade. In the future, the results would be more applicable and realistic if the study looked at the student's growth from kindergarten to fifth grade. Studying how food insecurity impacted educational achievements in the first grade is a step in the right direction to fully understand how food insecurity impacts children's cognitive development.

Appendix A: Summary Statistics

Variable	Mean	Standard Deviation	Minimum	Maximum
Percentage Change in Math Scores	25.59	17.17	-24	129
Percentage Change in Reading Scores	23.97	14.28	-24	89
Low Food Security	0.06	0.24	0	1
Very Low Food Security	0.005	0.07	0	1
Black/African American	0.07	0.26	0	1
Asian	0.06	0.25	0	1
Native Hawaiian/Pacific Islander	0.005	0.07	0	1
American Indian/Alaska Native	0.01	0.12	0	1
Two or More Races	0.05	0.21	0	1
Hispanic	0.36	0.48	0	1
Suburb	0.40	0.49	0	1
Town	0.04	0.20	0	1
Rural	0.15	0.36	0	1
One Sibling	0.41	0.49	0	1
Two Siblings	0.30	0.46	0	1
Three Siblings	0.11	0.32	0	1
Four or More Siblings	0.05	0.22	0	1
Below Poverty Threshold	0.27	0.44	0	1
Below 200% Poverty Threshold	0.20	0.40	0	1
Public School	0.91	0.29	0	1
One Parent and Partner Household	0.06	0.23	0	1
One Parent Household	0.19	0.39	0	1
Guardian/Other Household	0.02	0.13	0	1
Parent Education - High School Only	0.20	0.40	0	1
Parent Education - Vocational/Technical/Some School	0.27	0.44	0	1
Parent Education - Bachelors/Graduate	0.24	0.43	0	1
Parent Education - Masters/PhD	0.14	0.35	0	1
Disability	0.14	0.35	0	1
Non-English Speaking	0.23	0.42	0	1
Male	0.52	0.50	0	1
Fall Math IRT Scale Score	59.39	14.56	14.83	135.03
Fall Reading IRT Scale Score	78.33	17.36	40.88	135.57

Appendix B: Independent Variables Description

Category	Variable	Number of Responses	Description	Dropped Group	Sample Question(s)
Child's Food Security	Low Food Security	189	Parents were asked questions that measured the household's experiences related to food insecurity and reduced food intake in the last 12 months. 8 of the 18 questions were based on child-referenced items, in which children were given raw scores. Raw scores between 2-4 were considered low food security. Raw scores between 5-8 were considered very low food security.	Food Security (2,820)	• In the last 12 months, (was your child/were the children) ever hungry but you just couldn't afford more food? • In the last 12 months, did any of the children ever skip meals because there wasn't enough money for food?
	Very Low Food Security	16			

Child's Race	Black/African American	214	This information was collected during the parent interview about the race and/or ethnicity of the child. Parents were asked to indicate which of the race categories their child belonged to.	White (1,315)	• What is the child's race?
	Asian	196			
	Native Hawaiian/Pacific Islander	15			
	American Indian/Alaska Native	44			
	Two or more races	146			
	Hispanic	1,095			
School Location	Suburb	1,217	This variable defined the school's location and created four categories: city, suburb, town, and rural. Each locality is defined on the NCES website. https://nces.ed.gov/surveys/ruraled/definitions.asp	City (1,205)	• What is your school address?
	Town	127			
	Rural	476			
Number of Siblings	1 sibling	1,231	This variable counted the number of siblings the study child had.	No siblings (405)	• Are you (NAME) the child's full sister? Half-sister? Stepsister? Adoptive sister?
	2 siblings	893			
	3 siblings	340			
	4 or more	156			

Parent Poverty Level	Below Poverty Threshold	812	The household poverty status was determined by comparing total household income reported in the parent interview to the weighted 2015 poverty thresholds from the U.S. Census Bureau. There are three thresholds. If the household had an exact income that fell below the appropriate threshold, they were considered below poverty threshold. If the household had an exact income that was at or above the poverty threshold but below 200% of the threshold, they were classified as below 200% poverty threshold. If the household had a total income that was at or above 200% of the poverty threshold, they were classified as above poverty threshold.	Above Poverty Threshold (1,629)	• What was the total income of all persons in your household in the past year?
	Below 200% Poverty Threshold	584			
School Type	Public School	2,753	This variable describes if the study child attended a public or private school.	Private School (272)	• Which of the following characterizes your school: regular public school, public magnet school, charter school, catholic school, or other private school?

Parental Role in Household	One Parent and Partner Household	174	This variable described the type of parents living in the household with the study child. The options included two biological/adoptive parents, one biological/adoptive parent and one other parent/partner, one biological/adoptive parent only, and other guardian(s). If the study child was living with a parental figure such as a grandparent, this was considered a guardian.	Two Parent Household (2,238)	• Do you have a spouse or a partner who lives in the household? • What is your relationship to the child?
	One Parent Household	561			
	Guardian/Other Household	52			
Parental Education	Parent Education High School Only	611	During the parent interview, parents were asked about their highest level of education. The options ranged from having less than a high school education to a PhD.	Parent Education less than High School (435)	• What is the highest grade/year of school that you (NAME) have completed?
	Parent Education Vocational/Technical/Some School	815			
	Parent Education Bachelors/Graduate	730			
	Parent Education Masters/PhD	434			

Child's Disability	Disability	429	Based on information from the parent's interviews, this variable was created to indicate whether or not the child has a disability diagnosed by a professional.	No disability (2,596)	• Did the child receive physical therapy? Occupational therapy? Speech therapy? Psychological services?
Child's Sex	Male	1,558	This information was collected from the schools and confirmed by the parents about the child's sex.	Female (1,467)	• I have a child recorded as male/female. Is that correct?
Primary Language	Non-English	686	Explains if English is the primary language spoken in the home of the child.	English (2,339)	• Is any language other than English regularly spoken in your home?

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