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FOOD INSECURITY AND EDUCATIONAL ACHIEVEMENT: A MULTI-LEVEL GENERALIZATION OF POISSON REGRESSION

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Abstract

This research examined the relationship between food insecurity, the National School Lunch Program (NSLP), and academic achievement in Georgia's public school system. Georgia is located in the southern U.S. states, where food insecurity has been particularly prevalent. A multilevel Poisson generalized linear model was used to examine the relationship between food insecurity and academic achievement. Findings confirm a strong inverse relationship between food insecurity, as exhibited by participation in the National School Lunch Program, and academic achievement for elementary-age children. The strength of the relationship between food insecurity and academic achievement was different for the younger, elementary-age students (fifth grade) than for the older, middle school-age (eighth grade) students, a key distinction between this study and other research.
Keywords: *Educational achievement, food insecurity, generalized linear model, National School Lunch Program*

1. Introduction

Food insecurity refers to limited, uncertain availability, or inability to acquire nutritionally adequate, safe, and acceptable foods due to financial constraints (Bickel, Nord, Price, Hamilton, & Cook, 2000). Between 2011 and 2013, 14.6% of the 121 million households in the United States (U.S.) experienced food insecurity, on average (U.S. Department of Agriculture, Economic Research Service, 2014). Food insecurity rates are significantly higher than the national U.S. average in eight states (Arkansas, Georgia, Missouri, Mississippi, North Carolina, Ohio, Tennessee, and Texas) and all but one of these eight states (i.e., Ohio) are considered a southern state. The southern U.S. states tended to have the highest percent of households living with food insecurity: Arkansas with 21.2%, Mississippi with 21.1%, and Texas with 18%.

Georgia is currently ranked seventh highest in the U.S. for food hardship rates, with 22% of state's residents indicating that, at times in the past twelve months, they have been without adequate resources to secure sufficient food for the family (Food Research and Action Center, 2013). Furthermore, in Georgia, 16.6% of the households were identified as food-insecure and 6% of the households identified as having very low food security (U.S. Department of Agriculture, Economic Research Service, 2014).

U.S. children are not immune to food insecurity, or the associated detrimental effects (Gunderson, Kreider, & Pepper, 2011). One such problem is that children in food-insecure homes are at increased risk for academic and socio-emotional difficulties (Cook & Frank, 2008). Because of this, the prevalence of food insecurity in the southern U.S. and beyond is of great concern to the policy-makers and program administrators. The federal government's response to food insecure numbers and households has been programs that attempt to alleviate hunger and address the negative effects that hunger and malnutrition have on an individual's health, educational achievement, and development. These programs are in addition to private and charitable foundations' food distribution activities.

One example of a federally-funded program for the alleviation of food insecurity is the Supplemental Nutrition Assistance Program (SNAP), formerly known as the Food Stamp Program, the largest food assistance program in the U.S. (U. S. Department of Agriculture, 1999). The National School Lunch Program (NSLP) is another federally-assisted program that targets food insecurity for children at the school level. The School Breakfast Program (SBP), which is related to the NSLP, addresses food insecurity at the start of the school day.

Despite federal food assistance, such as the NSLP and SBP, and private charitable programs, food insecurity is a persistent local and national problem, still affecting 27.9% of households with children in the U.S. (Gunderson, Kreider, & Pepper, 2011). Because the problem of food insecurity still exists, along with the injurious consequences for children particularly in the southern U.S., this research examines the relationship between food insecurity and academic achievement in Georgia's public school system.

1.1. Food Insecurity in the Southern U.S. State of Georgia

As the United States of America's economy declined during the Great Recession (2007 to 2009) and following the slow economic recovery, an increasing number of Georgians lived on the financial edge, where even a small change in a family's employment situation could immediately plunge them into poverty. Major cities in Georgia had poverty rates at critical levels, including Athens-Clarke County at 33.8% and Atlanta, the state capital, at 22.6%. (U.S. Census, 2010). These areas demonstrated high levels of food insecurity among children, especially among the working poor. As the unemployment rate in Georgia climbed during the Great Recession - along with gas prices, food prices, and housing costs - food insecurity rose significantly especially for households with children.

Against this backdrop, the importance of subsidized or free school meals becomes unambiguous (Bradford & Medora, 2008), especially because of the strong relationship between food insecurity and poverty. Beyond poverty, other factors associated with an increased likelihood of experiencing food insecurity in the U.S. included low levels of education, living in a single parent household, and living in a Hispanic-headed household (Hamilton, Cook, Thompson, Buron, Frongillo, Olson, & Wehler, 1997). In addition, Dunifon and Kowaleski-Jones (2004) concluded that low family income is significantly and negatively associated with continuous food insecurity. They also indicated that African American children are more likely to be marginally food insecure and that higher paternal education is associated with a reduced likelihood of marginal food insecurity.

1.2. National School Lunch Program and School Breakfast Program and Effects of Food Insecurity on Children

The NSLP is a U.S. government-assisted food security program that operates in over 100,000 public schools, nonprofit private schools, and residential child care institutions in the U.S. The goal of NSLP is to provide nutritionally balanced, low-cost or free lunches to children each school day. Children from families with incomes at, or below, 130% of the poverty level are eligible for free meals. Those children from families with incomes between 130% and 185% of the poverty level are eligible for reduced-price meals, for which students can be charged no more than $0.40 USD. Children from families with incomes over 185% of the poverty level pay a full price (National School Lunch Program Fact Sheet, 2013). For example, in the 2013-2014 academic year, the poverty level in the U.S. was $23,550 USD, so that 130% of the poverty level is $30,615 USD for a family of four which is at upper range of the eligibility criteria, 185% of the poverty level is $43,568 USD for a family of four (U.S. Department of Health and Human Services, 2013).

In the 2011 academic year, the NSLP subsidized the cost of free or reduced-price lunches for over one million students in Georgia's schools (Food Research and Action Center, 2013). Schools where 40% or more of the students get free or reduced price lunches also qualify for Title I federal funds to pay for special programs to close their achievement gap. Thus, the importance of the relationship between food insecurity and academic achievement has been long recognized by policy makers and analysts.

Participation in NSLP and the SBP have significant ramifications for this relationship between food insecurity and educational achievement. Several studies, (Alaimo, Briefel, Frongillo, & Olson, 2001; Meyers, Sampson, Weitzman, Rogers, & Kayne, 1989) have indicated that children who are hungry are less likely to be ready to learn and more apt to exhibit behavioral problems than children who arrive at school with adequate nutrition. As poor health and nutrition may hinder a child's ability to learn **(**Pollitt, 1990), meals provided by the NSLP have become a critical part of the safety net against food insecurity. Without the safety net, the consequences of food insecurity in early childhood include limiting a child's cognitive and socio-emotional development, which ultimately can impair school achievement and, thus, long-term productivity and economic potential. Jyoti, Frongillo, & Jones (2005) have shown that, by the third grade, children who had been food insecure in kindergarten incurred a 13% lower achievement scored in their reading and math tests compared to their food-secure peers. Children experiencing hunger have lower math scores and they are more likely to repeat a grade than those who are not hungry (Alaimo, Olsen, & Frongillo, 2001). Hinrichs (2010) also found that the NSLP led to a significant increase in educational opportunity and attainment. Specifically, increasing NSLP coverage by 10%, led to increased educational attainment by 0.365 years in women and approximately 1 year in men (Hinrichs, 2010).

Hungry children are also more likely to suffer from hyperactivity, absenteeism, generally poor behavior, and poor academic functions (Murphy, Wehler, Pagano, Little, Kleinman, & Jellinek, 1998). Echoing these findings, Nord (2009) found that food insecure children exhibit more behavioral problems and lower math and reading achievement scores. Those who participate in the NSLP demonstrate more positive behavior in the classroom, increasing their chances of academic success *ceteris paribus.* In addition, subsidized lunches offered to children in the program may encourage children to attend school more consistently than they otherwise may have, which may lead to better educational outcomes.

The state of Georgia has a particularly troubling number of students at risk for decreased academic performance due to food insecurity. While 46% of the households with children in Georgia qualify for free lunches, an additional 21% of households qualify for reduced price lunches (Food Research and Action Center, 2012). It is in light of these statistics that this

research analyzes the importance of food insecurity's effects on children's educational achievement.

Few studies have examined the impact of the NSLP on food insecurity despite the link between hunger and its effects on children. One study (Nord & Kantor, 2006) provides indirect evidence of the importance of NSLP in alleviating food insecurity. After controlling for selection and measurement error problems, Gundersen, Kreider, & Pepper (2012) report evidence that the NSLP leads to substantial reductions in food insecurity and improves health outcomes. It is not just the alleviation of food insecurity that links NSLP and food security. Food insecurity rates are substantially higher among participants (39.9%) than among nonparticipants 26.3% (Gunderson, Kreider, & Pepper, 2011) and households with children are more likely to be insecure (Nord et al., 2010). Because of the difference in the food insecurity rates, it is common to approximate food insecurity in children with participation in the NSLP.

2. Data and Methodology

The educational achievement data were taken from the Georgia Department of Education and Governor's Office of Student Achievement, as reported in the "2008 Georgia Report Card for Parents" (Georgia Public Policy Foundation, 2009). The Georgia Report Card for Parents provides information to help parents make informed decisions about the quality of public education in Georgia according to the Policy Foundation. The Report Card includes data not only about academic achievement, but also on the percentage of the students taking the end of year achievement tests who qualify for free or reduced-priced lunches under the National School Lunch Program.

2.1. Sample Description

This analysis was performed at the school level for both fifth and eighth grade students for the 2007-2008 academic school year. Georgia has 159 counties, with 1,283 elementary schools and 506 middle schools. This includes a total of 123,215 fifth graders and 124,544 eighth graders. Data on the *NSLP* and *College* variables came from the United States Department of Agriculture, Economic Research Services, *Food Environment Atlas* (2011) and the U.S. Census Bureau (2009), respectively. Table 1 provides school-level and county-level descriptive information for the variables in both the fifth and eighth grade data sets.

2.2. Dependent Variables

The hypothesis to be tested is that there is a strong inverse relationship between food insecurity, as exhibited by participation in the NSLP, and achievement test scores in reading and mathematics. To measure student achievement, an *achievement* score and an *exceeding standards* score were used as variables at each grade level for fifth and eighth grade students. These students are in their last years of elementary and middle schools respectively. The dependent variable, *achievement*, is the percentage of students in elementary and middle schools that *met or exceeded standards* on the reading and mathematics section of the Criterion Referenced Competency Test (CRCT). The CRCT is widely used as a measure of academic success in Georgia, designed to measure how well students acquire the skills and knowledge described in the Georgia state-mandated content standards in reading, English/language arts, mathematics, science and social studies. The CRCT assessments intend to provide information on academic achievement at the student, class, school, system, and state levels. Georgia law, as amended by the A+ Education Reform Act of 2000, requires that all students in elementary and middle schools take the CRCT (Grant, 2014).

Table 1. Descriptive Statistics of School and County Level Data

Variable	*Min*	*Max*	*Mean*	*SD*
School Level: fifth Grade ($N_{schools}$ = 1183)				
Dependent Variable: Percent Achieving Standard	0	77.5	24.46	14.01
Dependent Variable: Achievement	54	100	85.76	9.07
Poverty Rate - NSLP[1] %	0.00	100.00	57.60	27.0
Share of Children in Poverty %	6.4	50.4	21.293	8.07
Full Time Enrollment Per School (FTE)	61	2076	622.26	257.11
School Site Spending Per FTE ($ USD)	155	14642	7299.53	1221.33
School Level: eighth Grade ($N_{schoools}$=506)				
Dependent Variable: Percent Achieving Standard	0	88.0	24.18	13.04
Dependent Variable: Achievement	23.7	100	85.89	10.43
Poverty Rate - NSLP[1] %	3.00	100.00	57.00	25.00
Share of Children in Poverty %	6.4	50.4	22.08	8.65
Full Time Enrollment Per School (FTE)	37	6604	760.80	490.90
School Site Spending Per FTE ($ USD)	351	70683	8120.25	4682.70
County Level Data ($N_{counties}$=159)				
Single Parent Households %	13.2	77.2	36.31	10.59
High School Graduates %	58.4	93.6	83.12	6.57
College Graduates %	4.7	47.6	26.32	12.28
Caucasian %	14.11	96.48	55.31	18.58
African American %	0.32	73.80	31.14	17.67
Hispanic %	0.82	31.65	8.59	6.02
Asian %	0.03	10.53	2.93	2.58
American Indian %	0.00	1.36	0.22	0.07
Hawaiian %	0.00	.57	0.06	0.06

[1]The Poverty Rate is the percentage of students participating in the National School Lunch Program (NSLP). Children from families with incomes at or below 130% of the poverty level are eligible for free meals; those with incomes between 130% and 185% of the poverty level are eligible for reduced-price meals. U.S. Department of Agriculture (2015).
Note: *SD* is the standard deviation.

A second dependent variable, *exceeding standards*, represents the percentage of students in elementary and middle schools that *exceeded standards* on the reading and math sections of the CRCT (Georgia Public Policy Foundation, 2009). These scores were used to measure year-to-year student achievement on statewide assessments of "Adequate Yearly Progress" (AYP), one of the cornerstones of the United States' federal No Child Left Behind Act of 2001.

2.3. Explanatory Variables

The NSLP explanatory variable represents the percent of students taking the CRCT tests who are eligible to participate in the NSLP in each elementary and middle school in Georgia. This variable is used as a proxy for food insecurity. This is not a perfect proxy, however, due to two fundamental identification problems. First, children receiving free or reduced-price meals under NSLP are likely to differ from eligible, but non-participating children, in ways that are not observed in the data. Second, the association between participation in the NSLP and food insecurity may be, at least partly, an artifact of household misreporting of program participation (Gunderson, Kreider, & Pepper, 2011). Numerous indicators for food security

have been proposed, but the different indicators do not always provide the same information on food security and are, thus, not considered equivalent (Santeramo, 2015). Despite these shortcomings, participation in NSLP has been widely recognized and used as a proxy for socio-economic status (e.g., poverty) and food insecurity (Caldas & Bankston, 1997; Gunderson, Kreider, & Pepper, 2011).

Another explanatory variable included in the analysis is the amount of school spending per full-time equivalency (FTE). School spending was determined by dividing the funds expended at the school site level (as reported to the Georgia Department of Education) by the number of students in the school. School expenditures are hypothesized to have a positive relationship with the dependent variables – *achievement* and *exceeding standards*.

This study also includes explanatory variables that are representative of the human capital base at the county level where the schools are located, as well as the socioeconomic status of students. To represent the human capital factor, the percentages of the county population with college degrees were included as an explanatory variable. Lastly, measurements of single parent households and racial groups are included to capture their hypothesized associations with educational achievement.

2.4. Model Description

A generalization of Poisson regression in the generalized linear model (glm) framework, was used to model the percentage of those achieving standards employing the SAS GLIMMIX procedure (SAS/STAT *User's Guide*, 2008). The glm framework was selected for two primary reasons. First, both dependent variables were non-normally distributed. The *exceeding standards* outcome is a count variable, distributed as a Poisson random variable, and *achievement* is also a Poisson variable, as negative values are not possible and the results are bounded by a maximum score. Typical log transformations for non-normal count data have been shown to be ineffective (O'Hara & Kotze, 2010). Specifically, with count data, transformations have been shown to have biased results and can lead to impossible predictions, such as a negative number of individuals achieving the academic standards of interest. Use of the Poisson distribution was supported by histograms of the outcome variables (see Figures 1 and 2), which reflected non-normality.

Let $Y_i, \ldots, Y_n$ be independent random variables with Y_i denoting the number of events (i.e., *exceeding standards* and *achievement*). These events are out of n_i chances of success (i.e., FTE and possible achievement score). The expected value of the Y_i is:

$$E(Y_i) = \mu_i = n_i\theta_i, \tag{1}$$

where θ_i is some covariate pattern. The generalized linear model is, therefore:

$$E(Y_i) = \mu_i = n_i \exp(x_i^T\beta). \tag{2}$$

A natural link function for such an expression is the log-link:

$$\log(\mu_i) = \log(n_i) + x_i^T\beta. \tag{3}$$

Typically, $\log(n_i)$ is termed the *offset* and is a known constant, incorporated into the estimation procedure. Therefore, the natural log of the outcome was modeled as a linear function of the predictors.

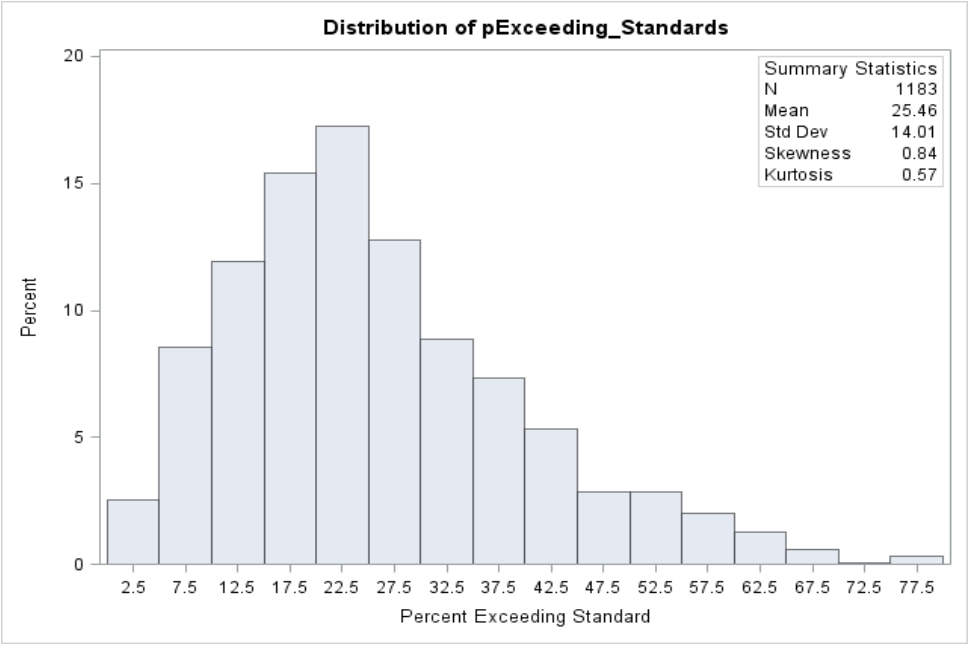

Figure 1. Histogram of Outcome, Percent Exceeding Standards, Fifth Grade

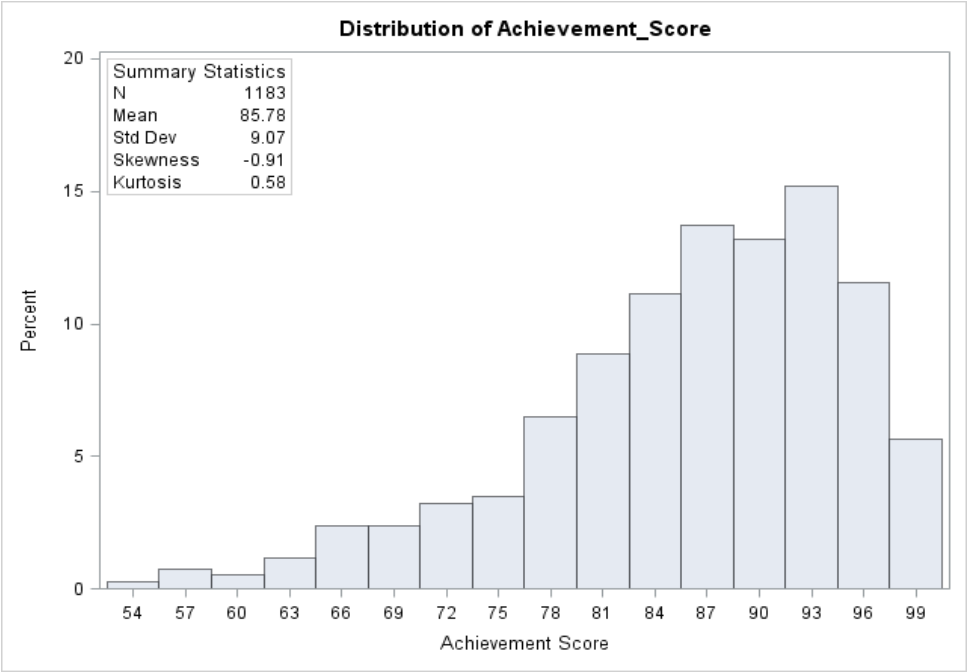

Figure 2. Histogram of Outcome, Achievement, Fifth Grade

The second qualification for selecting the glm framework was the clustered nature of the data (individual schools are clustered within counties), which further complicates the nature of the data set. The assumption is that schools within counties share similar characteristics and would violate conventional independence assumptions. Traditional linear regression methods fail to account for such clustering, which creates a dependence of observations within a county (Raudenbush & Bryk, 2002). To account for this dependence of schools within counties, a multilevel model in the glm framework was used to capture this clustered data.

Let the random intercepts multilevel regression equations be specified at school-level (for the i^{th} school in the j^{th} county), individually for the fifth grade and for the eighth grade analysis:

$$Log(Achieve_{ij}) = Log(FTE_{ij}) + \beta_{1ij} + \beta_{2ij}povrate_{ij} + \beta_{3ij}sitespend_{ij} + \varepsilon_{ij} \quad (4)$$

The multilevel model identifies the random intercept at county-level (for the j^{th} county):

$$\beta_{1j} = \gamma_{1j} + \gamma_{2j}PCTSingparHH_j + \gamma_{3j}PCTcollege_j + \gamma_{4j}PCTHisp_j + \gamma_{5j}PCTBlack_j + \gamma_{6j}PCTAsian_j + r_j \quad . \quad (5)$$

Subtracting *Log(FTE)* (the offset) from both sides, and combining the school and county-level models, yields the final model:

$$Log(Achieve_{ij}) = \gamma_{1j} + \gamma_{2j}PCTSingparHH_j + \gamma_{3j}MedHHINC_j + \gamma_{4j}PCTcollege_j + \gamma_{5j}PCTHisp_j + \gamma_{6j}PCTBlack_j + \gamma_{7j}PCTAsian_j + \beta_{2ij}povrate_{ij} + \beta_{3ij}sitespend_{ij} + \varepsilon_{ij} + r_j \quad (6)$$

The multilevel model identifies the random component of the intercept as r_j at the county level and the random component at the school level is ε_{ij}. This is the empirical model estimated in this analysis. Through exponentiation of equation (6) we find:

$$Achieve_{ij} = \exp(\gamma_{1j} + \gamma_{2j}PCTSingparHH_j + \gamma_{3j}PCTcollege_j + \gamma_{4j}PCTHisp_j + \gamma_{5j}PCTBlack_j + \gamma_{6j}PCTAsian_j + \beta_{2ij}povrate_{ij} + \beta_{3ij}sitespend_{ij} + \varepsilon_{ij} + r_j), \quad (7)$$

simplifying to:

$$Achieve_{ij} = \exp(\gamma_{1j}) * \exp(\gamma_{2j}PCTSingparHH_j) * \exp(\gamma_{3j}PCTcollege_j) * \exp(\gamma_{4j}PCTHisp_j) * \exp(\gamma_{5j}PCTBlack_j) * \exp(\gamma_{6j}PCTAsian_j) * \exp(\beta_{2ij}povrate_{ij}) * \exp(\beta_{3ij}sitespend_{ij}) \exp(\varepsilon_{ij})\exp(r_j) \; . \quad (8)$$

For the second outcome of interest, the model becomes:

$$Percent\_Exceed_{ij} = \exp(\gamma_{1j} + \gamma_{2j}PCTSingparHH_j + \gamma_{3j}PCTcollege_j + \gamma_{4j}PCTHisp_j + \gamma_{5j}PCTBlack_j + \gamma_{6j}PCTAsian_j + \beta_{2ij}povrate_{ij} + \beta_{3ij}sitespend_{ij} + \varepsilon_{ij} + r_j), \quad (9)$$

which simplifies to:

$$Percent\_Exceed_{ij} = \exp(\gamma_{1j}) * \exp(\gamma_{2j} PCTSingparHH_j) * \exp(\gamma_{3j} PCTcollege_j) * \exp(\gamma_{4j} PCTHisp_j) * \exp(\gamma_{5j} PCTBlack_j) * \exp(\gamma_{6j} PCTAsian_j) * \exp(\beta_{2ij} povrate_{ij}) * \exp(\beta_{3ij} sitespend_{ij}) \exp(\varepsilon_{ij}) \exp(r_j). \quad (10)$$

In equations (9) and (10), $Achieve_{ij}$ is the primary measure of student achievement for the i^{th} elementary (or middle school) in the j^{th} county, defined as the percentage of students passing the reading and math sections of the CRCT, the educational achievement measure in Georgia. In equations (6) – (8), $percent\_exceed_{ij}$ is the percentage of students who exceeded standards for the i^{th} elementary or middle school in the j^{th} county on the reading and math sections of the CRCT.

The school-level independent variables were $sitespend_{ij}$, the school spending per full-time equivalency (FTE) that was determined by dividing the funds expended at the school site by FTE, and $povrate_{ij}$, the school-level poverty rate as measured by participation in the NSLP's free or reduced-price lunch program. The county-level independent variables were specified as: $PCTSingparHH_j$, the percent of single parent households as defined by the US Census; $PCTcollege_j$, the percent of adults with college degrees; $PCTHisp_j$, the percent of the county population identified as Hispanic; $PCTBlack_j$, the percent of the county population identified as African-American; and $PCTAsian_j$, the percent of the county population identified as Asian.

Equations (8) and (10) illustrate the multiplicative nature of the parameter estimates. With the log-linear relationship, a one-unit increase in a predictor leads to a multiplicative increase (or decrease) of β in the outcome. Further details regarding interpretations are provided in the results section.

3. Results

3.1. Fifth Grade Analysis

Findings confirm the hypothesis that there is a strong inverse relationship between food insecurity, as exhibited by participation in NSLP, and achievement test scores for the fifth grade students. The coefficient of *NSLP* was negative, and significant, in both the *percent_exceed* and *achieve* outcomes ($p < .01$), as reported in Tables 2 and 3, respectively. Recall that interpretation of the coefficients is multiplicative. That is, for a 1 unit increase in *NSLP*, *percent_exceed* standards decrease by a multiplicative factor of 0.228 ($p<.0001$). As this exponentiated coefficient is less than one, there is an inverse relationship between food insecurity and percent of students achieving standards. For a 1 unit increase in *NSLP*, *achieve* decreases by a multiplicative factor of 0.77 ($p<.0001$), again indicating an inverse relationship between food insecurity and academic achievement scores.

For the outcome *percent_achieve*, there were other significant predictors. A positive relationship between *pASIAN* and *percent_exceed* was found, indicating that as the percent of Asians in the county increases by one unit, so does the rate of children achieving the academic standard ($\exp(\gamma_{3j})=1.027$, $p<.0001$) by a multiplicative of 1.027. Also, a negative relationship between *pBLACK* and *percent_exceed* was found, indicating that as the rate of blacks in the county increases, the rate of children achieving the academic standard decreases ($\exp(\gamma_{2j})=0.996$, $p=.0064$) by a multiplicative of 0.996, which seems negligible since this multiplicative factor is so close to 1. The same holds true for school site spending ($\exp(\beta_{3ij})=1.00$, $p=.0103$) in that the effect is significant, but not particularly meaningful since the coefficient is equal to 1. The outcome *achieve* also had significant predictors. However, again, the significance was not particularly important as the exponentiated coefficient was approximately 1.

Table 2. Poisson Regression Results, *Percent Achieving Standard,* Fifth and Eighth Grade Students

Effect	*Est*	*SE*	*DF*	*p*	*Exp(Est)*
Fifth Grade					
Intercept	3.7082	0.08539	154	***	
Poverty Rate - NSLP	-1.48	0.04556	1020	***	0.228
School Site Spending	0.000025	9.57E-06	1020	**	1
PCTSingparHH	0.00358	0.002056	1020	NS	1.004
pCollege Graduate	0.000771	0.00131	154	NS	1.001
pASIAN 2010	0.02662	0.006556	154	***	1.027
pBLK 2010	-0.00352	0.001274	154	**	0.996
pHISP 2010	-0.00069	0.00226	154	NS	0.999
Eighth Grade					
Intercept	-0.7631	0.1644	153	***	
Poverty Rate - NSLP	-1.6001	0.1405	343	***	0.202
School Site Spending	-0.00002	9.31E-06	343	NS	1
PCTSingparHH	0.009106	0.005277	153	NS	1.009
pCollege Graduate	0.002076	0.004168	153	NS	1.002
pASIAN 2010	0.01275	0.01905	343	NS	1.013
pBLK 2010	-0.00685	0.003327	343	**	0.993
pHISP 2010	0.01586	0.005564	343	**	1.016

Note: *NS* indicates not statistically significant, * $p \leq .10$, ** $p \leq .05$, *** $p \leq .001$

Table 3. Poisson Regression Results, *Achievement,* Fifth and Eighth Grade Students

Effect	*Est*	*SE*	*DF*	*p*	*Exp(Est)*
Fifth Grade					
Intercept	4.6242	0.01855	154	***	
Poverty Rate - NSLP	-0.2608	0.009999	1020	***	0.77
School Site Spending	2.81E-06	2.03E-06	1020	NS	1
PCTSingparHH	-0.00024	0.000439	1020	NS	1
pCollege Graduate	-0.00104	0.000287	154	***	0.999
pASIAN 2010	0.005732	0.001544	154	***	1.006
pBLK 2010	-0.00046	0.000268	154	NS	1
pHISP 2010	-0.00137	0.00048	154	***	0.999
Eighth Grade					
Intercept	4.6929	0.1045	153	***	
Poverty Rate - NSLP	-0.3944	0.09371	342	***	0.674
School Site Spending	-6.40E-06	4.86E-06	342	NS	1
PCTSingparHH	-0.00024	0.003356	153	NS	1
pCollege Graduate	0.003658	0.002834	153	NS	1.004
pASIAN 2010	-0.01234	0.01429	342	NS	0.988
pBLK 2010	-0.00018	0.00212	342	NS	1
pHISP 2010	0.002635	0.004039	342	NS	1.003

Note: *NS* indicates not statistically significant, * $p \leq .10$, ** $p \leq .05$, *** $p \leq .001$

3.2 Eighth Grade Analysis

Findings again confirmed the hypothesis that there is a strong inverse relationship between food insecurity, as exhibited by participation in NSLP, and achievement test scores for the eighth grade schools. The coefficient of *NSLP* was negative and significant for both the *percent_exceed* and *achieve* outcomes, respectively (Tables 2 and 3). The effect was more extreme in the eighth grade case than for the fifth graders. That is, the exponentiated coefficient was smaller for eighth graders, indicating that the inverse relationship was even stronger for eighth grade students. There were other statistically significant relationships between *percent_achieve* and *pBLACK* (p=.0403) and *pHISP* (p=.0046). These were of little practical importance due to the near-unity exponentiated coefficient relationships (Exp(Est) = 1.000 and 1.003, respectively).

4. Conclusions and Implications

Regarding both outcomes of interest, the percentage of students achieving academic standards and exceeding standards in reading and math scores on the CRCT tests, there was a significant inverse relationship between NSLP eligibility rates for fifth and eighth grade students in Georgia and academic achievement. These findings support previous work for the elementary-age children. For the fifth grade students, the inverse relationship was strong. However, for the eighth grade students, the relationship was even stronger. A key contribution of this research is in differentiating the effects of NSLP on academic achievement between elementary and middle-school children.

There are several explanations for the difference in the strength of the relationship. First, the data sets samples were different size (1183 elementary schools in the analysis and 506 middle schools) and not representative of a longitudinal data collection design. However, several factors could have affected the comparability of the samples such as changing standards between elementary and middle schools, greater emphasis on CRCT score accountability between schools, and other factors.

The second explanation for the difference in the strength of the relationship lies in actual participation of eighth grade students in the NSLP rather than eligibility for free/reduced lunches. For instance, in San Francisco, only 37% of eligible high school students take advantage of a subsidized meal program (Pogash, 2008) and in other areas of the country, the percentage is even lower. Several studies have found a social stigma associated with redemption of free/reduced school lunch and breakfast, leading to students failing to utilize the nutritional assistance available to them (Mirtcheva & Powell, 2009; Bailey-Davis, Virus, McCoy, Wojtanowski, Veur, & Foster, 2013). As students become older, the effect of peer pressure may interfere with participation in the NSLP. Thus, while students are eligible for NSLP, they may not actually make use of the program resources.

Without capitalizing on the NSLP, students may remain hungry and, therefore, remain at risk for diminished academic performance. This becomes particularly true for the eighth grade analysis, as "most elementary-school children see no problem with free lunches, school officials say, but by the time they enter middle school, social status intervenes" (Pogash, 2008). Students from food insecure families are then either paying cash or going hungry if lunches are not available at home, particularly at the eighth grade level. Underutilization of NSLP may be a source of the different relationships in the eighth grade analysis when compared to the fifth grade analysis. At the very least, the effects of NSLP are not realized in closing the achievement gap for all students. This may be an important consideration for policy makers.

The differentiating effects of NSLP on academic achievement further confuse the issue of using the proxy as a food insecurity indicator. By keeping the analysis at the school-level,

some of the aggregation problems noted in problems with food security indexes have been mediated (Santeramo, 2015). However, it seems that the fidelity of the NSLP is of crucial concern – both for policy-makers and researchers trying to use NSLP as a proxy for food insecurity.

Finally, the importance and magnitude of the effects of poverty and/or food insecurity on school achievement have been clearly distinguished from other contributing factors, such as school funding and race. The use of multi-level estimation methods to incorporate demographics of the county together with school-level eligibility for NSLP and resulting achievement scores enabled this differentiation of factors to highlight the most pressing problem - poverty and food insecurity - in a large proportion of Georgia's households which will undermine attempts to educate and prepare school children for life and future employment.

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