The Multiple Contexts of Food Insecurity: Evaluating the Impact on Child Energy Balance

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Abstract

This study uses data from the Early Childhood Longitudinal Survey, Kindergarten Class of 1998 to explore the impact of food insecurity, school environment and food infrastructure on elementary school-aged children's body weight, food purchasing decisions and physical activity choices. Results show that Federal support for nutrition in the form of expenditures, a lower county unemployment rate, higher average wages, and access to unemployment compensation are associated with a lower risk of being food insecure. Using longitudinal methods, the study finds a positive association between household food insecurity and child BMI, but the connection is not consistent across gender and racial groups.

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Executive Summary

Food security is defined as "access to enough food for an active, healthy life" (USDA, 1997). Food insecurity for the entire population was measured directly for the first time with an 18-item measure included in the April 1995 Current Population Survey (CPS), creating categories of security: high food security, marginal food security, low food security, and very low food security based on the number of food-insecure conditions reported. Households are classified as food insecure with hunger if their reported food-insecure conditions suggest that one or more household members were hungry at some time during the year because the household could not afford enough food. Households with children are further classified by whether any children were hungry at any time during the year because of the household's lack of money and other resources for food (USDA, 1997). In 2010, 14.5% of the United States population was food insecure (Coleman-Jensen et al, 2011).

What is the Issue?

Past research has yielded mixed evidence on the outcomes of food insecurity for children. Some have found shortfalls in academic outcomes (Hernandez et al, 2009; Alaimo et al, 2001) and others have linked food insecurity to behavioral issues (Dunifon and Kowaleski-Jones, 2003). The relationship between food insecurity and child weight outcomes remains unresolved. Some find evidence for a positive link (Bhattacharya et al, 2004; Widome et al, 2009) and others find no evidence (Gunderson et al, 2009; Whitaker & Orzol, 2006) or a negative link (Jones et al, 2003; Rose et al, 2006; Buscemi et al, 2010).

Research is emerging that evaluates community-level determinants of food insecurity. Prior research has identified state-level contextual predictors of household food insecurity (Edwards & Weber, 2003; Bartfeld & Dunifon, 2005). It is an open question if community context measured at a smaller level may yield new insights. The contribution of school context to child food decision making patterns is an additional important piece to understand.

Using data from the Early Childhood Longitudinal Survey-Kindergarten Class of 1998-1999 (ECLS-K), this study examined three related research questions: 1) What is the role of county food infrastructure on food insecurity? 2) What is the impact of the local school food infrastructure on children's food related behaviors? 3) How do changes in food insecurity affect changes in child physical activity and Body Mass Index (BMI)?

What did the Study Find?

County level food infrastructure may have relevance for a household's risk of being food insecure. Federal support for nutrition in the form of expenditures is associated with a lower risk of being food insecure. The strength of the local labor market, both in terms of access to employment and compensation, are important for buffering household risk of food insecurity. County unemployment rate and lower average wages are relevant risk factors. These findings point to the importance of strengthening economic conditions as both an anti-poverty strategy and also as a safeguard against household food insecurity.

Characteristics of county food infrastructure may impact households differently depending on household economic resources. Federal support for nutritional programs has a significant association with lower risk of food insecurity but subgroup analyses indicate that this is present in the non poor sample. Higher county level wages have a protective association with food insecurity among non poor only households while availability of jobs in a county has a significant association among poor households. Community efforts to reduce household food insecurity should be informed of the complex interplay of factors at the community and individual level.

Linkages between school food environments and student food purchasing patterns are also identified in this report. At least one third of the fifth graders surveyed purchased at least one energy dense item at school during the week. Also of interest is the large proportion of schools that offer competitive food outlets (86%). Logistic regression results indicate that the availability of competitive foods increased the odds of purchasing of energy dense drinks. The availability of healthy snacks does not decrease the purchase of energy dense snacks, but instead increases the odds of purchasing both energy dense salty snacks and sweets. Results suggest that rather than being a substitute, healthy snacks are complimentary to energy dense snacks. More time given for recess translated into lower odds of purchasing energy dense sweets. It is possible that as children are exposed to healthier school environments in the form of better food options and more support for exercise and recreation, they may develop healthier eating habits.

Results from the current analysis speak to the mixed literature on the connections between food insecurity and child body weight. Results suggest a positive association between household food insecurity and child BMI. Sub group analysis indicates however that this connection is not consistent across gender and racial groups. Specifically, there is evidence of a significant association between living in food insecure households and elevated BMI for boys but not girls. The effect of food insecurity also varies across racial groups, as a significant association is only present for the African American children in the sample.

Finally, these analyses related changes in food insecurity to changes in children's physical activity across elementary school. Prior research has identified associations between food insecurity and decreased physical activity (Adams et al, 2003). The present analyses do yield evidence of significant linkages between food insecurity and children's physical activity which provides motivation for additional research in this area. It remains an open question if food insecurity leads to diminished physical activity.

How was the Study Conducted?

Data from the kindergarten through the fifth grade waves of the Early Childhood Longitudinal Survey Kindergarten Class of 1998-1999 (ECLS-K) were used to estimate hierarchical linear models linking community context and food insecurity. Logistic regressions related school environment factors to child food purchasing behaviors. Using data from kindergarten, third grade and fifth grade waves, fixed effect techniques related changes in food insecurity to changes in child body mass index (BMI) and physical activity, controlling for the role of food infrastructure.

The Multiple Contexts of Food Insecurity: Evaluating the Impact on Child Energy Balance

The impact of food insecurity on children is an important research issue. Research is emerging that evaluates community-level determinants of food insecurity. Prior research has identified state-level contextual predictors of household food insecurity (Edwards & Weber, 2003; Bartfeld & Dunifon, 2006). This research narrows the focus to the county level to consider the impact of a food infrastructure on household food insecurity. Results break new ground by linking the impact of food insecurity, measured at the household level, to elementary school aged children's energy balance, which is defined as food purchasing decisions, physical activity choices and child body weight. Finally, this research uses fixed effect techniques to relate changes in food insecurity to changes in child body weight, thus extending the analysis to incorporate multiple measurements of food insecurity across the elementary school years.

The structure of the report unfolds as follows: First, I provide a general overview of the general issues surrounding food insecurity that motivate the three questions addressed in this report. Second, I provide information about the data used as well as descriptions of the measures constructed and used in the analyses. Third, I present the modeling strategy and results relating to each of the three research questions. Finally, I provide a discussion and conclusion of how these results inform policy in the area of food insecurity and child energy balance.

BACKGROUND

Food security is defined as "access to enough food for an active, healthy life" (USDA, 1997). Food insecurity for the entire population was measured directly for the first time with an 18-item measure included in the April 1995 Current Population Survey (CPS), creating four categories of security: high food security, marginal food security, low food security, and very low food security based on the number of food-insecure conditions reported.

In 2010, 48 million people lived in food insecure households. Approximately 11 million adults lived in households with very low food insecurity. Food insecurity is an issue for approximately 16 million children in the U.S. In addition, approximately 976,000 (or 1.3 of the Nation's children) children lived in households with very low food security. This remains the highest recorded prevalence rate of food insecurity since 1995 when the first national food security survey was conducted (Nord et al, 2010). Food insecurity varies by household type. Specifically, households with incomes below the poverty line, headed by a single parent, and minority households are more likely to experience food insecurity.

An Ecological Framework for Studying Food Insecurity

The analyses described in this project are motivated by an ecological framework. Ecological theory asserts that a dynamic interrelation exists between the individual and subsystems of the environment (Bronfenbrenner, 1979; Bronfenbrenner, 1992; Bronfenbrenner, 1995). Ecological theory and approaches are not new, and they are widely used to examine the determinants of population health (Green et al, 1996; McLeroy et al, 1993). Using an ecological framework provides an opportunity to examine micro-, meso- and macro-level influences both on household food insecurity and child energy balance outcomes.

At the most basic level, the micro level, the analysis pertains to individual activities, roles and interpersonal relationships in a given setting (Bronfenbrenner, 1992); the meso-level analysis examines relations among groups across settings; and the macro level pertains to socio-cultural and policy-level influences. What affects household food insecurity can be influenced by a combination of micro-, meso- and macro-level factors. Individual and household incomes are important determinants of food choice. At a micro level, the concern is with the ability of individuals and households to afford a healthy diet, and factors such as family income are important. At a meso level, the analysis is focused

more on whether affordable food is available to the individual in his or her community. For example, meso-level forces may include how communities respond to hunger (e.g., the presence or absence of adequate food stores), the variety and mix of retail food outlets and the existence of supports for agricultural production. Macro-level determinants of food security include socio-cultural and policy-level influences, such as the availability of federally funded food assistance programs. Adopting an ecological framework to understand the influences of food security and population-level nutrition motivates an examination of these structural and contextual influences. Additionally, child energy balance outcomes are impacted by environmental influences at various levels.

Community Variation in Food Insecurity.

Much of the available research on community determinants of food insecurity has centered on what promotes differences in food insecurity across states. State level variation represents meso level determinants of food insecurity. Currently, Southern and Western states show the highest rates. For example, Oregon has consistently high hunger rates that persist across a mix of family structure and employment configurations. One conclusion is that broader economic factors affecting the relative cost of living in this state may have an important role (Edwards and Weber, 2003).

Other researchers have used data from the U.S. Department of Agriculture and the U.S. Census to probe the higher than expected rates of hunger in the pacific northwest (Tapogna et al, 2004), arguing that a definitive explanation has not emerged that links state prevalence of hunger to contextual characteristics. State level residential mobility, unemployment rates, poverty, share of renters spending more than 50 percent of income on rent, ethnic diversity, and youthful population were identified as potentially important predictors of food insecurity. Results indicated that residential mobility, poverty, higher housing costs, and youthful population were associated with higher likelihood that a state would experience elevated incidence of food insecurity with or without hunger.

Bartfeld and Dunifon (2006) have developed the concept of state food infrastructure to describe

the potential impact of available federal nutrition assistance programs, state level policies affecting the economic well being of low income families, and state economic and social characteristics. They find that household food insecurity is particularly sensitive to the availability of federal funds for food assistance but also to general levels of economic well being. They also find that median rent is consistently related to household food insecurity. One implication of this research is that high food insecurity can exist in states whose resident characteristics would suggest otherwise. Alternatively, food insecurity can be low in states with a relatively high-risk population in terms of economic characteristics and family structure environment. This suggests that it is important to narrow the focus of the potential context of food insecurity to local area characteristics. The ecological framework used in this project suggests the usefulness of measuring both macro- and meso-level factors at the county level as there is likely to be considerable intrastate variation in the determinants of food insecurity.

The concept of community food security has been developed and focuses on the underlying social, economic and institutional factors within a community that affect the quantitative, quality, and affordability of food. Community food security is seen as a process in which community based programs work with strong federal programs to move people from need to food self sufficiency (Kantor, 2001). Research in this area has identified community characteristics such as access to food stores as being important. Supermarkets, typically more available in suburban areas, can charge lower prices than other food stores because of lower operating costs. Low-income households can benefit from access to these stores in the form of lower total food costs (Kantor, 2001). Examples of community programs that could ease household food insecurity are food buying cooperatives, farmers markets, community gardens, and food stamp outreach programs. From this research, food resource availability, food affordability, and local agricultural resources have been identified as important resources for community food security.

Previous research has identified some important contextual determinants of food insecurity that

warrant an investigation with a smaller lense. The county level is an important level of community analysis as many local decisions affecting food infrastructure are potentially made at this level. For example, counties represent an important unit for decision making about school policy, investments in infrastructure and the delivery of services. Available research suggests a fair amount of county variation in food insecurity rates (Stracuzzi and Ward, 2010; Mathematica Policy Research, 2010). Counties also represent an environment where there are likely to be important interplay of macro-, meso-, and mirco-level influences on food insecurity and child energy balance.

School Food Environment and Child Outcomes

The overall focus of this project is to explore the multiple contexts of food insecurity. An important part of this task is to determine the influence of county level food infrastructure on household food insecurity. Additionally, the school food environment is another key social context for children. The impact of food insecurity may be importantly conditioned by the school context in which the student is located. If a student who resides in a home where there are elevated levels of food insecurity but attends a school where there is a positive food environment, then the effects of food insecurity on child outcomes may be lessened. Alternatively, if a student experiences food insecurity at home and attends a school where the support for positive energy intake and output is not fully supported, then that student may have worse outcomes. Thus, school food infrastructure may moderate the influence of household food insecurity on child outcomes.

Local school wellness policies are an important new tool to promote healthy eating and physical activity through changes in school programs and environments (Food Research and Action Center, 2006). Research is beginning to emerge on the implementation and effectiveness on wellness policies in various states (Probart et al, 2008; Schwartz et al, 2009). The issue of the school food environment has also come to the forefront of the policy debates. In response to the growing number of

obese children in America, Congress reauthorized the Child Nutrition and WIC Act of 2004, mandating that all public schools implement a formal "wellness policy" by July 1, 2006 (Public Law 108-265, section 204). This legislation is in recognition of the rising rates of childhood obesity, and the growing concern for schools' role in intensifying this alarming trend. The aim of these wellness policies is to alter the school environment so that children learn healthful eating habits at a young age; however, research is still emerging on whether these school-based initiatives will be effective in reducing the risk of childhood obesity.

However, before sweeping changes are made to school environments, it is important to consider what we can learn about existing features of school environments that may have important implications for child food related behavior. Currently, the physical environment in which children make purchase decisions is under researched. Food advocates argue that improving the nutrition environment in the cafeteria involves more than changing the kinds of foods available, it also includes creating an atmosphere that fosters community, and strengthens social skills (Food Research and Action Center, 2006). Additionally more time should be allowed for meals. When more time is allowed, such as thirty minutes compared to the typical twenty minutes, children are more likely to eat school lunch and less likely to choose pre-packaged snack food items (Glanz et al., 2005).
Trends in menu items available for students in school have changed in recent years. In addition to the federal lunch and breakfast programs that are highly regulated by the U.S. Department of Agriculture (USDA), more a la carte and competitive foods are being offered. Recent research has found that competitive foods are available in most schools and that as many as one in four children report buying energy dense competitive foods during the week (Hair et al., 2008). In addition, this research found that most of the food purchases are made in school cafeterias during mealtimes, rather than through vending machines. While healthy food choices for children exist, most schools offer almost as many energy dense choices (Hair et al., 2008). Energy dense foods tend to be processed foods that contain

added sugar and fat to improve the taste. The result is more calories per ounce. Food environments that include energy dense food choices may likely contribute to increased childhood obesity. This potential connection highlights the importance of evaluating children's food purchasing behaviors when both healthy and energy dense food options are available.

Competitive foods undermine the nutritional integrity of the federally funded programs and discourage participation (Watkins, 2001). They have diet-related risks due to the low nutrient density, are high in fat, sugars, and calories, and are held to poorly regulated and inadequate nutritional requirements. Competitive foods may stigmatize participation in school meal programs because only children with money can purchase competitive foods (Watkins, 2001). Children may perceive that school meals are primarily for poor children and therefore may be unwilling to accept free or reduced-price meals. It is possible that competitive foods convey a mixed message, in that children are taught in the classroom about good nutrition, but are surrounded by unhealthy choices for their meals (Watkins, 2001). However, competitive foods are often an important source of revenue for schools and therefore difficult to remove from school cafeterias (Story et al, 2006).

Food Insecurity and Child Development

The effects of food insecurity on the development of U.S. children remain an open research issue. Rates of food insecurity are twice as high in households with children as in childless households (Bickel, Carlson, and Nord, 1999). Research in developing countries finds that poor nutrition is related to cognitive delays and temperamental difficulties, among other long-term problems (see Gardner et al., 1999; Aboud and Alemu, 1995; Grantham-McGregor et al., 1994). In a study of low-income U.S. children, parental reports of food insufficiency were related to teacher reports of behavior problems and parent reports of impaired functioning (Murphy, Wehler, and Pagano, 1998). Additionally, Reid (2000) found links between food insecurity and increased behavior problems, as

well as lower cognitive test scores. Food insecurity was not related to children's health. However, child health was defined as low height for age and low weight for age, which is indicators of relatively severe health outcomes, and did not test the effects on child BMI. Dunifon and Kowaleski-Jones (2003) have found that food insecurity is consistently associated with increases in children's behavior problems, but not decreased test scores, and that factors representing families' economic status are significantly associated with food insecurity. In a hospital based sample, children with household food insecurity had greater odds of being in poor health and being hospitalized since birth (Cook et al, 2006).

Jyoti and colleagues (2005) found that food insecurity was predictive of poor developmental trajectories in children. Their results also suggest an association between food insecurity and greater weight gain among boys. Boys in households that transitioned from food insecurity to food security gained less weight than boys remaining food insecure, boys remaining food secure, or boys becoming food insecure. Therefore, the association in boys seems to be with change in food security status, giving evidence for a relatively short lag between cause and effect. They conclude that food insecurity in the early elementary years has developmental consequences.

One mechanism that has been proposed to explain the associations between food insecurity and developmental outcomes is that food insecurity results in compromised dietary quality or quantity (Jyoti et al, 2005). Adults in food-insecure households have lower consumption of fruits and vegetables, and potentially consume more energy from carbohydrates (Drewnowski & Spector, 2004) and had lower intakes of dietary fiber and other vital nutrients. Measures of food insecurity are associated with deficits in nutritional consumption. Using a 24-hour diet recall, as well as a survey of household food supplies, Wolfe and colleagues (1998) found that food insecure households have lower rates of consumption of fruits and vegetables and less food on-hand, providing validation that the USDA measure of food insecurity is associated with actual food intake. Food insecurity may be

associated with either decreases in diet quality or increases in energy density which could lead to accelerated weight gain in children.

Child Energy Balance

Child energy balance is conceptualized as the combination of behaviors related to food consumption and energy expenditure that culminate in body wieght. The prevalence of overweight U.S. youth almost tripled over the past 30 years moving from approximately 5% to 14% among youth age 12-19 (U.S. Department of Health and Human Services, 2008). National surveys from the USDA show that 12 to 18 year olds are consuming about 200 calories more per day in 1996 than they consumed in 1977, particularly from snacks and away from home food (Nielsen, Siega-Riz et al. 2002). The increased preference for food away from home may have may lead to the consumption of larger portion size by children. Additionally, the prevalence of snacking in American children has increased (Jahns, Siega-Riz, & Popkin, 2001) and snacks are now more likely to be store-bought than home-made (Nielson, Siega-Riz, & Popkin, 2002). These factors have contributed to deterioration in the quality of the American diet (St-Onge et al, 2003). Guthrie and others (2002) found that meals and snacks based on food prepared away from home contained more calories per eating occasion, and "away" food was higher in total fat and saturated fat on a per-calorie basis than at-home food. "Away" food contained less dietary fiber, calcium, and iron on a per-calorie basis. Using diet recall data from the National Health and Examination Survey (NHANES), Mancino and colleagues (2010) find that away from home foods add significant calories per meal to children's diets. Given that Lin and others (1999) document the increase in the trend in away from home foods, the added calories to children's diets are likely to increase.

The relationship between household food insecurity and childhood overweight has mixed support in the research literature. Studies relying on cross sectional data (Casey et al, 2006) have

found significant associations between household food insecurity and childhood overweight status but find the association varies across gender and racial categories. Using data from the Panel Study of Income Dynamics, Garasky and colleagues (2008) do not find significant evidence of a significant relationship between food insecurity and childhood overweight, but instead find evidence of the role of financial and community stress.

To aid in resolving the conflicting evidence surrounding the linkages between food insecurity and child overweight (Larson and Story, 2011), the need for research using longitudinal models that also simultaneously consider different elements of food infrastructure has been identified as a priority. Results from the current analysis speak to this mixed literature. Using longitudinal methods that account for self selection bias, analyses in this report aims to contribute to this mixed literature.

The evidence of declining levels of physical activity among children is well established. Approximately half of American youth are not physically active on a regular basis (U.S. Surgeon General, 1999). In addition, as children grow older, the likelihood of engaging in physical activity declines with the rate of decline being larger for girls than boys. Sallis (1993) estimates that between the ages of 10 and 17, boys' physical activity level declines by 1.8% and 2.7% per year while the corresponding estimates for girls range from 2.6% to 7.4%. Physical activity levels also decrease by young adulthood (Gordon-Larsen, Nelson et al. 2005). Taken together, food consumption behaviors and physical activity patterns are important correlates of child health and well being and are important ingredients of child energy balance. Relatively few studies have charted the impact of household food insecurity on these behaviors, and available evidence is mixed. Further research in this area would be important for determining the complex interplay among these dimensions of child well being.

To summarize, using data from the Early Childhood Longitudinal Survey-Kindergarten Cohort, this study examines three related research questions: 1) What is the role of county food infrastructure on food insecurity? 2) What is the impact of the local school food infrastructure on children's food

related behaviors? 3) How do changes in food insecurity affect changes in child physical activity and BMI?

DATA AND MEASUREMENT

Early Childhood Longitudinal Survey Kindergarten Class of 1998-1999

The Early Childhood Longitudinal Survey Kindergarten Class of 1998-1999 (ECLS-K) is based on a nationally representative sample of approximately 22,000 children who were enrolled in roughly 1,000 kindergarten programs during the 1998-1999 school year. These children were selected from both public and private kindergartens, offering full-day and part-day programs. The sample is designed to support separate estimates of public and private school kindergartners; Black, Hispanic, White, and Asian children; and children by socioeconomic status (U.S. Department of Education, 2002). Analysis on the first two research questions used data from the sample of children surveyed in the spring of fifth grade. The fifth grade wave was chosen for cross sectional analyses because it contained measures of food purchasing behaviors. This aspect of the data supports the second research question. Additionally, the fifth grade wave was the most current wave of the data available at the start of this project. Analysis on the first two research questions used data from the sample of children surveyed in the spring of fifth grade. Analyses supporting the third research question used data from the kindergarten (1999), third grade (2002) and fifth grade (2004) waves of the data.

Overall, this data provides a good fit to the research questions as it provided data on child overweight, food insecurity and had repeated measures of both of these constructs. Additionally, the restricted data availability afforded the afforded the ability to append census data for the multilevel modeling of county level predictors of household food insecurity. In descriptive analyses, weighted data is presented. For multivariate analyses, un-weighted data is used.

Dependent Measures

Household Food Insecurity. Food security status of the children's families was assessed based on responses to 18 food security questions in the spring-fifth grade parent interview. The questions measured a wide range of food insecurity and reduced food intake issues. They were combined into a scale using statistical methods based on the Rasch measurement model. The items and the food security scale based on them have been validated using both ethnographic and statistical methods. Calculations of the Household Food Security scale variables were carried out in accordance with the standard methods described in *Guide to Measuring Household Food Security, Revised 2000* (U.S. Department of Agriculture 2000). Analysis of the ECLS-K data using Rasch methods indicated that use of the standard benchmark household scores was appropriate.

In these analyses, a categorical measure of Household Food Security status is formed by dividing food insecurity into three USDA-defined categories: food secure, food insecure without hunger, food insecure with hunger. Food insecure without hunger and food insecure with hunger were grouped together such that the variable equals 1 if the household falls into either category. Additionally, these analyses use categorical measure of Adults' Food Security status because of concerns of number of children influencing the responses to the individual items.

Child Food Purchasing. The Child Food Consumption Questionnaire consists of 19 items related to the child's food choices. In this report, I focus on questions pertaining to the purchasing behaviors of children while at school. There are also general questions about food consumption but it becomes difficult disentangle food consumed at school from food consumed away from school. The three questions used here ask if students purchased energy dense drinks, energy dense salty snacks or energy dense sweets anytime during the last week. These variables were transformed into dichotomous variables to determine if an item was purchased or not. Analyzing both the energy dense food

purchases and the availability of healthy foods within the school will assist in assessing the potential impact a positive school food environment can have on child energy balance.

Children's Physical Activity. Parents are also asked about, in a typical week, how many days does their child get exercise that causes rapid breathing and perspiration, and a rapid heartbeat for 20 continuous minutes. The Centers for Disease Control and Prevention (CDC) recommends that adults engage in moderate intensity physical activity for at least 30 minutes on at least five days a week and that children and adolescents engage in at least 60 minutes of moderately intense physical activity on most days of the week.(Centers for Disease Control, 2006) so this measure represents an underestimate of the CDC recommendation but it is the only measure available across the three time periods in the ECLS-K and serves as a reasonable proxy for physical activity. The ECLS-K data does not contain data on direct measurement of physical activity and relies on parent report which may not capture the full range of child activity.

Child Body Mass Index (BMI). BMI is calculated by dividing the weight of the child by the height squared of the child. Based on the Centers for Disease Control-recommended definition a child is considered obese if they are in the 95th percentile of the expected BMI for their height and weight. All children were measured twice to reduce measurement error. If the two measurements were less than 2 inches apart the average of the two was computed as the composite measurement of height. Otherwise the value that was closest to 43 inches was used as the composite. Similar procedures were used to calculate the weight composite score. The average of weight values that were less than 5 pounds apart were used to compute the composite score.

<u>Independent Measures</u>

County Level Food Infrastructure. To measure county level food infrastructure, data is gathered from a variety of sources described below and appended to the ECLS-K data via county identifiers available from the restricted use data that is available from the National Center for Educational Statistics. Following the lead of previous research in this area (Tapagna et al 2004; Bartfeld and Dunifon, 2006; Bartfeld and Wang, 2006), I conceptualize county level food infrastructure as involving three major dimensions: Federal assistance, economic attributes, and social attributes. Across data sources external to the ECLS-K data, measurements were taken from 2000. This allows a common point across the diverse sets of data available at the county level. Outcomes for children in the ECLS-K is the 2003-2004 academic year data (fifth grade), which is later than the measurements of county level characteristics. Availability of federal assistance. Following from prior research (Bartfeld and Dunifon, 2006), I track the value of Supplemental Nutritional Assistance Program (SNAP) benefits per poor person. This is a measure of average monthly number of SNAP recipients divided by the number of poor persons. Information on number of poor persons comes from the Census Bureau's Small Area Poverty Estimates. Recent research (Nord and Golla, 2009; Coleman-Jensen and Nord, 2010) suggest that food stamp or SNAP resources are especially important to food insecure households. Federal spending on agriculture resources and nutritional programs is seen as an important macro level determinant of food insecurity. This data is measured at the county level from the Economic Research Service of the USDA program function classifications that use census data at the county level to assess federal spending in these areas. This data is drawn from the 2000 Consolidated Federal Funds Reports data from the U.S. Department of Commerce, Census Bureau, and I hypothesize that spending in these areas will be associated with greater food security. Specifically, federal spending on agriculture and nutritional resources includes agricultural assistance, agricultural research and services, forest and land management, water and recreation resources. This data also includes spending on nutrition and food

programs as well as public assistance and unemployment. I construct two variables from these data. The first variable is spending on agricultural resources and it is an index of spending in two areas: agricultural assistance and agricultural research and services. The second variable is spending on supports for nutrition and is an index of expenditures on food and nutrition as well as public assistance and unemployment compensation. Recent research (Reeder, Calhoun, and Bagi, 2001) has demonstrated regional differences in federal spending and its effects on local areas. This research has also identified this category as representing federal spending that is likely to result in developing local infrastructure related to food supports. These characteristics are seen as representing macro-level determinants of food insecurity. Economic Attributes of Communities County unemployment rate is coded to the county to measure local area ability to find work, which should be positively related to household food insecurity. To remain consistent with other indicators, I measure this in 2000. This data was obtained from the Bureau of Labor Statistics. Percent at or below the poverty line is included from the 2000 census to measure overall economic well-being in the county. Median rent is coded from the 2000 census to counties and is used as a marker of household costs. Average wages per job is coded from the Bureau of Economic Analysis to capture job quality in 2000. This variable captures the average wage for each industry and occupation. Social Context. Percentage of households that moved in the last five years is taken from the 2000 census. Prior work has linked residential stability with food security (Topogna et al, 2004; Bartfeld and Dunifon, 2005). Tapoagna et al (2004) has identified this characteristic as potentially leading to household food insecurity because larger households with children will be more prone to problems with food availability. Residential stability is included as a proxy for the strength of bonds among community members. The expectation is that the greater the mobility of the population, the weaker the social bonds and the greater the likelihood of food insecurity. Prior research has linked residential stability to increased social bonds among community members (Coleman, 1988; Sampson, Raudenbush, and Earls, 1997). In general, I view

federal support, economic attributes, and social context as measures of both macro and meso-level determinants of food insecurity.

School Food Environment. The school administrator is asked to respond to how adequate the school cafeteria is for meeting student needs. One of the main recommendations to improve the nutrition environment in the cafeteria is to create a relaxed atmosphere that fosters community and strengthens social skills (Food Research and Action Center, 2006). Schools with better cafeterias will promote an overall positive food environment. School administrators are asked if students can purchase food or beverage items from vending machines, school store, canteen or snack bar. Competitive foods often do not meet nutritional guidelines and have been associated with decreased consumption of healthier foods such as fruit and low-fat milk (Cullen et al., 2007). Research has also suggested that the sale of competitive foods is especially harmful for low-income students and sends a mixed message about nutrition (Food Research and Action Center, 2006). The availability of competitive food outlets is one of the most important aspects of the food environment to consider when analyzing child food purchasing behaviors. Administrators were asked if students can purchase various healthy snacks from vending machines, school stores, canteen, snack bar or a la carte items from the cafeteria during school hours. Healthy snacks consist of fruits or vegetables, low-fat baked goods, low-fat or fat-free ice cream, 100-percent fruit juice, and 100-percent vegetable juice. Unhealthy snacks measured in the dependent variables include energy dense items; candy, baked goods, salty snacks, ice cream or frozen yogurt, soda, and sports drinks. The survey measures the time given to students for their lunch period as well as time given for recess during the day. These measures are important because children who are given more time to eat are more likely to eat school lunch and less likely to grab prepackaged food they can eat on the go (Food Research and Action Center, 2006). In addition, research found noted improvements in afternoon academics when children were given ample opportunity to be physically

active during the lunch break. Teachers are asked to report the days per week children attend physical education class. This variable is an indicator of the importance a school places on the overall health education of its students.

Family Food Infrastructure. Several variables were selected that represent food infrastructure measured at the micro, meso and macro levels. At the micro level, parental food behaviors were included in the model. Specifically, the number of days that the child ate the morning and evening meal together with their family was included. Whether a child regularly received a complete meal at school was considered as a measure of support at the school level. Finally, whether the child's family received support from the Food Stamp program or TANF benefits was also considered as measures of the federal food safety net.

COUNTY FOOD INFRASTRUCTURE AND FOOD INSECURITY

In this section, I focus on the connections between county food infrastructure and food insecurity. I introduce the analytic strategy, and present both descriptive and multivariate results. Hierarchical linear modeling (Raudenbush & Bryk, 2002) is used to model the clustering of cases (i.e., children) within larger units (in this case, counties). Each participant is associated with both individual-level (level 1) and county-level (level 2) characteristics. This variance pattern presents the opportunity to discern which differences in household food insecurity are attributable to individuals and which are due to counties. A basic random intercept HLM model is comprised of level 1 and level 2 models. Because the dependent variable is a dichotomous variable, a logit model is specified. The level 1 model (presented in Equation 1) is a child specific model, shown in equation 1. In this model, food insecurity for child i in county j is a function of child-specific characteristics (X_{ij}).

$$\text{Log}[p_{ij}/(1-p_{ij})] = \beta_{0j} + \boldsymbol{\beta}\, \mathbf{X_{ij}} + \varepsilon_{ij} \quad (1)$$

In the level two model, the average level of food insecurity (β_{0j}) within a county is modeled as a function of community variables (N_j) measured at the county level),), as in Equation 2.

$$\beta_{0j} = \gamma_{00} + \boldsymbol{\gamma_{01}}\mathbf{N_j} + \mu_{0j} \quad (2)$$

These data has a fair amount of clustering within counties. In the total sample, 9,540 children clustered in 850 counties. In the poor sample, 1,665 children are clustered in 307 counties. In the non poor sample, 7,870 children are clustered in 787 counties.

In all analyses, I control for an extensive set of background characteristics of the child's family, including: average household income; household size; number of siblings; parents' education; child gender, age, and race; maternal employment; welfare receipt over the study period; receipt of food stamps; maternal age at the birth of the child; and household structure. These variables are measured in the spring of fifth grade.

Table 1 presents mean values of the household and contextual variables for the total sample as well as separately for the poor and non poor sample. Households were identified as being poor if their household income was equal or below the federally set poverty thresholds for a family of their size. Overall, six percent of the sample has experienced food insecurity based on the response to the adult food insecurity items. Not surprisingly, a higher proportion of poor households indicate being food insecure, 21 percent, as compared to non poor households where only 3 percent of households are food insecure.

Table 2 presents coefficients from the random intercept model. Consistent with other research on household predictors of food insecurity, several attributes have significant associations with food insecurity. Households with higher income have lower levels of food insecurity. Parental education is associated with lower food insecurity; specifically, having a college degree is associated with more food security. Family structure is associated with food security status. As found in other research on this issue, women who are separated or never married are more likely to head food insecure

households. Interestingly, divorced mothers are not more likely than married mothers to head food insecure households. Households with more children are more likely to experience food insecurity, a scenario that is plausible given the additional constraints that larger household sizes may confer on household food budgets. Household residential mobility is also associated with lower food security. This perhaps signals a situation in which households are also depleting their economic resources because of the financial stress of moving. Regarding federal program usage, households who are receiving benefits through Temporary Assistance to Needy Families (TANF) are also more likely to be food insecure. Individual characteristics also are associated with the risk of being food insecure. African American and Asian American households are less likely to be food insecure, while Hispanic households are more likely to be food insecure.

Results from analyses presented in Table 2 suggest that there are several indicators of county level characteristics that are associated with household level food insecurity. Recall that the local food infrastructure has been conceptualized in this report to involve three components: Federal support for food and nutrition, economic attributes and social attributes. These analyses suggest that the components of each sphere may have relevance for household food insecurity. Residing in a county with higher spending on nutrition related programs is associated with lower household food insecurity. Regular Federal financial commitment to programs for both nutrition and income support, is likely to create a stronger food infrastructure that would in turn support households as they strive to maintain regular access to food.

Regarding economic attributes, two county level indicators are noteworthy. First, higher unemployment rates are associated with higher risk of household food insecurity. This suggests that instability in employment opportunities contribute to an environment where food insecurity may be more likely to occur. Additionally, living in a community where higher wages are present is associated with a greater likelihood of being food secure. In sum, both the availability of jobs and the

amount that workers are compensated have special relevance to promoting the food security of households in these communities. This suggests that promoting the economic health of communities can have far reaching implications for a range of important outcomes for households.

Social characteristics also have implications for food insecurity. County residential stability is associated with greater food security at the household level. Scholars have interpreted residential stability as proxying for community social capital, as discussed by Coleman (1988). It is perhaps the interconnections between residents fostered by lower residential turnover that might promote communities where there is both information and assistance for those who may be in need of help with providing food for their households.

Factors Associated with Food Insecurity among Poor and Non poor Households. Table 3 presents additional estimates from models relating level one and level two characteristics to household food insecurity status among poor and non poor households. Significant factors differ between the two groups. For both low income and regular income households, having a parent who is a college graduate is associated with significantly lower risk of experience food insecurity. Among low income households, maternal work efforts are significantly associated with decreased risk of food insecurity.

Federal program usage may reflect different food security scenarios among low income and regular income households. Among non poor households, receiving food stamps is associated with higher risk of food insecurity. It may be likely that households who do not fall in the official definition of poverty but still qualify for food assistance are households whose economic supports are still tenuous and partly because of that might be more likely to experience food insecurity. Among poor households, receiving TANF benefits is associated with greater risk of food insecurity. In this case, receipt of income assistance may indicate those who are especially economically disadvantaged, and as such, are more vulnerable to experience food insecurity.

Turning to the pattern of associations among the county-level food environment indicators and

food insecurity, federal spending on nutritional programs, measured at the county level, is associated with a lower risk of household food insecurity among non poor households. Additionally residing in a county with more residential stability is a protective factor for food security, but only among non poor households. Living in communities with a more youthful population is a risk factor for household food insecurity for households who are not poor.

Economic attributes of communities have connections to household food security, suggesting their relevance to food environments. However, different significance patterns are observed among poor and non poor households. County unemployment rate is associated with greater food insecurity but this is observed only among low income households. In contrast, average wages, measured on the county level, has a protective association with food insecurity but is significant among non poor households. It could be that among non poor households, available jobs in the community are likely to be more financially rewarding and that there may be greater sensitivity to wage differentials among these likely better employment opportunities. One implication of this finding is poor households are more likely to have adults that are unemployed as employment reduces the probability of being poor. In essence, poor households need to first have a job, while the non-poor need higher wages to reduce food insecurity[1].

[1] Data from the 2000 Economic Research Service (ERS) county typology was also appended to these data. The ERS county typology is a classification system that was developed by Cook and Mizer (1994) to group counties by economic and policy-relevant characteristics. These typologies are mutually exclusive and include farming-dependent communities. Farming dependent communities are defined as those in which at least 20 percent of a weighted annual average total labor and proprietor income comes from farming. The expectation is that farming dependent communities have more support for food related needs and therefore would be associated with lower levels of household food insecurity. The county typologies: Mining-dependent (mining contributes 15 percent or more of a weighted annual average of total labor and proprietor income), manufacturing-dependent (manufacturing contributes a weighted annual average of 30 percent or more of total labor and proprietor income), government-dependent (Federal, State, and local government activities contributed a weighted annual average of 25 percent or more of total labor and proprietor income), and service-dependent service activities (private and personal services, agricultural services, wholesale and retail trade, finance and insurance, real estate, transportation, and public utilities) contributed a weighted annual average of 50 percent or more of total labor and proprietor income).

Results from these analyses indicate that living in a manufacturing-dependent county is associated with a lower risk of household food insecurity. This is contrary to expectations but may reflect that manufacturing dependent counties are perhaps more urban and because of that more likely to have better supports for food

How Much Can County Characteristics Explain Inter-county Differences in Food Insecurity?

An important consideration in the community influences on food insecurity is the extent to which household and county level characteristics are able to explain the variation in county food insecurity status. Key parameters estimated from three models are used to address this issue. These three models include an empty model which includes a random intercept but does not have level 1 or level 2 variables; a household-level model which includes a random intercept and also household –level variables but no level 2 variables; and the model that contains independent variables at Level 1 and Level 2. The random components of the three models, estimated separately for the total sample, the poor sample and the non poor sample are presented in Table 4. Across all of the target groups, the variance of the μ_{0i}, the Level 2 error, decreases from the empty model to a low in the full model. For example, among the total sample, the variance decreases from .636 in the empty model to .224 in the full model. This drop in variance is even more pronounced for the non poor sample where the variance falls from .267 in the empty model to .064 in the full model. This suggests that much of the between context variance in food insecurity can be explained by the household and contextual variables included in the model.

Discussion

Significant associations were found that suggest that all three dimensions of county food infrastructure have relevance for a household's risk of being food insecure. Federal support for nutrition in the form of expenditures is associated with a lower risk of being food insecure. The implications of this finding is that while local efforts are important for promoting healthy environments for food stability, there is still an important role for the federal government in supporting these efforts.

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security. These variables were added after the main analysis and provide more detail on how characteristics of the community environment may influence the likelihood of a household being food insecure. However, these variables were ultimately omitted from the final models in the interest of overall model parsimony.

The strength of the local labor market, both in terms of access to employment and compensation, are important for buffering household risk of food insecurity. County unemployment rate and lower average wages are relevant risk factors. These findings points to the importance of strengthening economic conditions as both an anti-poverty strategy but also as a safeguard against food insecurity for households. In contrast to prior research focusing on county level data within a single state (Bartfeld and Wang, 2006), there is no evidence of household food insecurity being sensitive to variations in housing conditions, measured here as county level average rent.

County level social conditions also matter for food insecurity. Specifically, there is an argument to be made for the strength of community connections among residents. Here, results are based on a proxy of this process, namely whether the county experiences stability of residents over a five year period but the results are consistent with other research that indicate that communities that are residentially stable are also areas where resident interconnections are more likely to flourish and with them, information and assistance. This finding is also consistent with prior research that finds associations between state level residential stability and food security (Bartfeld and Dunifon, 2005).

Characteristics of county food infrastructure may impact households differently depending on household economic resources. Federal support for nutritional programs has a significant association with lower risk of food insecurity but subgroup analyses indicate that this is present in the non poor sample. Elements of the meso level economic sphere also have differing effects. Higher county level wages have a protective association with food insecurity among non poor households while availability of jobs in a county has a significant association among poor households. There is evidence that efforts to improve local area employment access and compensation might have varying impacts on different segments of the local community.

LOCAL SCHOOL FOOD INFRASTRUCTURE AND CHILDREN'S FOOD BEHAVIORS

This section focuses on the relationship between local school food infrastructure and children's food purchasing behavior. As discussed earlier, the local food environment and connections to food children purchase during school has important implications for the overall context of food insecurity. Using logistic regression analyses, I test for the association among measures of school environment variables and child purchasing behavior, controlling for factors such as gender, race, maternal education and age, number of siblings, income category, and maternal employment. These results are presented as odds ratios.

Table 5 represents the regression analysis of purchasing energy dense drinks, salty snacks and sweet snacks. The only school food environment factor that had a statistically significant association with the purchasing of energy dense drinks was the availability of competitive food outlets. When competitive food outlets are available, the odds of purchasing energy dense drinks increase by 65%. The school food environment factor that had a significant effect on the purchasing of energy dense salty snacks was the availability of healthy snacks for purchase which was associated with increased odds of purchasing salty snacks. There were multiple factors that influenced the purchasing of energy dense sweets. Adequacy of the cafeteria was associated with increased odds of purchasing energy dense sweets. Availability of healthy snack for purchase increased the odds of purchasing energy dense sweets by 7%. For every 15 minute increase given for recess, the odds reduced 10% for purchasing energy dense sweets.

These results suggest that there are several factors in the elementary environment that influence the purchasing of energy dense food and drink. Of the control variables tested, three variables had the largest influences on the purchasing of energy dense food and drink. African American children had increased odds of purchasing energy dense food and drink. In addition, a mother's full-time employment also increases the odds of purchasing energy dense food and drink. When mothers work

35 hours or more per week, the odds of purchasing energy dense salty snacks or drinks increased 20%. These results suggest that certain populations may be targeted for intervention due to their higher tendency of purchasing energy dense food and drinks.

Discussion

The aim of these analyses was to identify linkages between school food environments and student food purchasing patterns. At least one third of the fifth graders surveyed purchased at least one energy dense item at school during the week. Also of interest is the large proportion of schools that offer competitive food. This number is discouraging to those concerned about the lack of regulation and nutritional guidelines in place for competitive foods in the schools.

The only school food environment factor that had a significant association with the purchasing of energy dense drinks was the availability of competitive food outlets. The odds of purchasing the drinks increased 65% with the presence of competitive food outlets. This result suggests that perhaps the majority of energy dense drinks offered in elementary schools are through competitive food outlets.

The availability of healthy snacks does not decrease the purchase of energy dense snacks, but in fact increases the odds of purchasing both energy dense salty snacks and sweets. This result contradicts the theory that when offered a variety of food options including healthier foods, student purchasing of energy dense foods will decrease. Many schools have tried to justify the availability of energy dense foods by offering healthy foods as options. These analyses indicate that rather than being a substitute, healthy snacks are complimentary to energy dense snacks.

One school food environment factor was associated with decreased odds of purchasing energy dense sweets. For every 15 minute increase given for recess, the odds reduced 10% for purchasing energy dense sweets. It is possible that as children are exposed to healthier environments, here captured by increased time for recess at school, they develop a desire for healthier eating habits.

Some limitations are important to note. The consumption survey given to students used to examine food purchasing behaviors is a self-report survey and may be subject to social desirability bias. These results provide an interesting starting point for future research on the relationship between early competitive food purchases in grade five and later competitive food purchases in subsequent grades. Early behaviors often set the stage for later years. If school policy makers and researchers are able to more clearly understand how an elementary school food environment may influence the food purchasing behaviors of young children, we may better inform youth consumption patterns. In particular, these findings suggest the positive role of recess in promoting healthy eating habits. Time for recess and other breaks during the school day have been under scrutiny as increasingly more academic work is being emphasized within elementary schools as a way of meeting the objectives associated with No Child Left Behind. Recess has been defended by supporters who argue that breaks are helpful for children throughout the school day (Ramstetter, 2010). This research lends support to the value of recess not only for cognitive and physical benefits but also to choices children make in purchasing food at school.

FOOD INSECURITY AND CHILD ENERGY BALANCE

This focus of this section is to relate changes in food insecurity to changes in child energy balance, measured with Child body mass index (BMI) and child physical activity. This analysis relies on fixed effect techniques that address non random selection. These analyses rely on individual fixed effect modeling that take advantage of the repeated measures of food insecurity, selected food infrastructure variables, and child physical activity and BMI. In these data, food insecurity questions were administered in spring of kindergarten, third grade, and fifth grade. This method addresses issues of selection that may bias estimates of the effects of food insecurity on individual outcomes. Bias might occur if there are family specific unmeasured characteristics that influence both the

likelihood of experiencing household level food insecurity as well as influencing child BMI and physical activity.

The fixed-effects model is shown below (for a more complete description see Greene, 1997 or Deaton, 1997). Each variable in the equation is averaged over all assessed time points for a specific child (for example, food insecurity$_{i.}$ is the average level of food insecurity across all periods in which that child is observed). Here, the observed time periods are spring of kindergarten, spring of third grade, and spring of fifth grade. This average value is then subtracted from the value at a specific time point for that child (food insecurity$_{it}$, the average food insecurity at a specific time point). As a result, all time-invariant measured and unmeasured characteristics for a specific child, (including Mother and Child variables as well as other time-invariant measures such as child gender), drop out of the model. This includes any persistent components of the error term that are correlated across time.

$$Y_{it} - Y_{i.} = \alpha_{it} - \alpha_{i.} + \beta_1(\text{food insecurity}_{it} - \text{food insecurity}_{i.}) + \beta_2(\text{food infrastructure characteristics}_{it} - \text{food infrastructure characteristics}_{i.}) + \gamma_1(\text{controls}_{it} - \text{controls}_{i.}) + \varepsilon_{it} - \varepsilon_{i.}$$

It should be noted that these analyses do not remove the biasing effects of unmeasured variables that change with time. For example, components of maternal mental health or child temperament that change with time and are unmeasured may still bias the estimates. In other analyses, available on request, I also estimated models for a panel that included a measurement of children in eighth grade in spring of 2007. These fixed effect estimates reveal similar patterns of association to those presented in this report. However, physical activity data was not available for this wave. Additionally, the kindergarten through fifth grade panel focused just on elementary school children and this developmental focus was of intellectual interest. Because this analysis is based on fixed effect techniques, static child specific controls such as gender, race, and regional residence drop out

from the models. Models do account for changes in poverty status, marital status and number of siblings. In this analysis, there were 9,467 children who were non-missing on measures of food insecurity and included in the analysis.

Table 6 presents weighted characteristics for the children over the three time periods. Mean characteristics are also presented separately by gender and race. In the overall sample, a small proportion, 8 percent, of the children experienced food insecurity. A larger percentage of African American and Hispanic Children have experienced food insecurity, with percentages of 14 and 15 percent respectively. The average BMI for children in this sample was 18.14, with higher BMIs observed among African American and Hispanic children (18.42 and 18.81 respectively). Lower BMI was observed for Caucasian and Asian children (17.88 and 17.68). In the overall sample, children participate in exercise that causes rapid breathing, perspiration and a rapid heartbeat for at least 20 continuous minutes on an average of almost 4 days per week. Mean days of rapid exercise is higher for boys (4.11 versus 3.63 days) than for girls and highest among Caucasian children (4 days) and lowest among Asian children (3.2 days).

In the overall sample, children eat dinner with their families about 6 days a week (5.6) and slightly lower days for eating breakfast together (4.15). African American and Hispanic children eat breakfast with their families less frequently than do Caucasian and Asian children. Descriptive statistics reveal similar patterns for eating dinner together as a family. Approximately 48 percent of the children receive a complete lunch at school that is offered through the school lunch program. This percentage is slightly higher among Hispanic children (53%). A small percent of the sample lived in families that received TANF benefits (5%), although this percent is twice as much for African American children (12 percent). Approximately, 13 percent of the children lived in families that received SNAP benefits. This proportion is higher for African American and Hispanic children (35 and 18 respectively).

Over half of the sample is Caucasian and approximately 18 percent identify as African American and 15 percent as Hispanic. The majority of children live in married parent families (72 percent) but this percent is much lower (37 percent) among African American children. Equal portions of the study sample are boys and girls.

Changes in food insecurity may impact child energy balance, independent of controls for family characteristics. Food infrastructure may mediate the impact of food insecurity on child energy balance but also may have independent effects. Table 7 presents the results of models that test the hypothesis that food insecurity may have a positive impact on child BMI. First, child BMI is regressed on food insecurity. These results are shown in the top panels of the table. Second, family level controls are included in the models. These results are shown in the middle panels of the table. Finally, food infrastructure variables are included in the models to assess whether food insecurity may still have an association on child BMI. These results are shown in the bottom panels of the table. Separate models are estimated by gender and race. Table 8 presents the results from similar analyses that focus on child physical activity.

Results suggest that food insecurity has a positive effect on child BMI in the overall sample and that this effect persists with the inclusion of family controls and food infrastructure. However, sub analysis reveals that this pattern of association between food insecurity and child BMI are present for boys but not girls. Further analysis by race reveals that food insecurity is only a significant positive predictor of child BMI among African American children.

Elements of food infrastructure are relevant for children's BMI, as revealed by these results. Sharing family meals in morning and the evening are associated with significant reductions in child BMI. This result is robust across gender and race specific analyses. Interestingly, receiving a complete lunch on a regular basis at school is associated with increased BMI among elementary school aged children. Receipt of Food Stamps is not associated with child BMI in the overall sample.

However, food stamp receipt is associated with decreases in BMI among girls but not boys. Food stamp receipt is associated with a protective effect on BMI among white and Asian children. Receipt of TANF benefits is associated with decreased child BMI by approximately a half a point on the BMI scale (b = -.46). This pattern of a protective association between TANF receipt and Child BMI appears most strongly among African American and Hispanic children.

Several family characteristics are also associated with protective effects to child weight. Living in married parent families is associated with lower child BMI, but this effect holds for girls but not boys in these data. This protective effect is not observed among Hispanic children. Across the models, having more siblings is associated with increases in child BMI.

Table 8 presents fixed effect estimates regressing child physical activity on food insecurity, family controls and food infrastructure. Contrary to expectations that household food insecurity may have an impact on children's physical activity, these estimates do not provide evidence of a significant effect. Some elements of the food infrastructure available to children do have connections to physical activity. In the overall sample, more days eating the morning and evening meal together has positive associations with more time spent in physical activity. However, sub group analyses indicate that this might be not robust across ethnic groups. Eating dinner together as a family is associated with more physical activity but only among African American and Hispanic children. Eating breakfast together seems to be associated with protective effects for Asian children's physical activity but not in other ethnic groups. Receiving a complete lunch at school is associated with more physical activity among the total sample but sub group analysis reveals significant associations only among Asian children. Food stamp receipt has negative effects on physical activity while TANF receipt has significant positive effects but only among Caucasian children.

Discussion

The relationship between household food insecurity and childhood overweight has mixed

support in the research literature. Studies relying on cross sectional data (Casey et al, 2006) have found significant associations between household food insecurity and childhood overweight status but find the association varies across gender and racial categories. Using data from the Panel Study of Income Dynamics, Garasky and colleagues (2008) do not find significant evidence of a significant relationship between food insecurity and childhood overweight, but instead find evidence of the role of financial and community stress.

To aid in resolving the conflicting evidence surrounding the linkages between food insecurity and child overweight (Larson and Story, 2011), the need for research using longitudinal models that simultaneously consider different elements of food infrastructure has been identified as a priority. Using longitudinal methods that account for self section bias, I find evidence of a positive association between household food insecurity and child BMI. Sub group analysis suggests however that this connection is not consistent across gender and racial groups.

Specifically, results suggest a significant association between living in food insecure households and elevated BMI for boys but not girls. This finding is counter to international evidence of girls' health being differentially impacted by food insecurity (Belachew et al, 2011). Much of the prior research on gender differences in the association between food insecurity and child health has focused on boys nutritional needs being elevated to the detriment of girls within the home. These results suggest perhaps a different but equally complex model is at play in American food insecure homes that has implications for child weight. One conjecture from the prior literature and these results could be that boys are given better access to food and this could trigger potentially maladaptive eating patterns that translate into issues with body weight. These findings should inform future efforts to interdict in childhood weight imbalance that certain household conditions such as food insecurity may have differential impacts depending on the gender of the child. An important intervening process that is beyond the scope of the data available in this investigation is the food intake patterns of children in

food insecure home and how this may differ across gender and over time.

The effect of food insecurity also varies across racial groups. While food insecurity is associated with increased child body weight in the overall sample, subgroup analysis reveals that this association only holds for the African American children in the sample, and that the effect is rather large. Increases in food insecurity are associated with almost a half a point increase in African American children's body mass index. Nationally, African American children are likely to live in households that food insecure (Nord, 2009). Prior research on urban black families suggest that mothers in food insecure households were more likely to participate in compensatory feeding practices perceived to be buffers against periodic food shortages such as the use of high energy supplements and appetite stimulants that resulted in elevated child body weight (Feinberg et al, 2008). The current results suggest that food insecurity may instigate a complex response in African American homes that place children differentially at risk of higher body weight. These results suggest that food insecure African American children may be particularly at risk for weight gain.

Food infrastructure matters for children's weight. Models tested in these analyses sought to evaluate the connections between food insecurity and child weight and whether these relationships were altered when elements of the child's food infrastructure were considered. Food infrastructure was measured such that family, school, and federal contributions were considered, based on theoretical models that children's weight outcomes are likely influenced by features of the micro, meso and macro environment.

Parental food behaviors evaluated in these analyses were the number of days per usual week that a family ate the morning and evening meal together. These behaviors were of interest as these were healthy practices linked to better diet quality (Burgess-Chappouz et al, 2009) that could be adopted by families in a wide range of economic and food security situations. Hammons (2011) finds that the frequency of shared meals is significantly related to nutritional health among children.

Children are more likely to be in a normal weight range and have healthier eating patterns. Results from this research confirm this with models that account for non random selection over time. Food insecure youth have reported eating more fast food but fewer family meals (Widome et al, 2009). These findings suggest that making shared meals a priority is a relatively modifiable behavior that could be considered a resource for healthy weight, and should be an educational priority for youth living in food insecure households. Further research should explore the implications of parenting style in family meal promotion, as authoritative parenting is associated with the production of more family meal time (Berge et al, 2010). Unfortunately, these data lacked sufficient repeated measures of parenting style to further investigate this potential mechanism.

These analyses also tested for one aspect of school contributions to food infrastructure, the provision of a full school meal during the school day. Fixed effect estimates suggest that eating a school meal is associated with higher child body weight index. There is relatively scant research on the relationship between participation in National School Lunch Program (NLSP) and child weight status (Larson and Story, 2011). Some cross sectional evidence has not found evidence of a relationship (Boumtje et al, 2005; Hoefferth and Curtin, 2005). Still other cross sectional research has found evidence of a protective effect of NLSP on child weight status (Jones et al, 2005).

The present research relies on longitudinal data and uses methods that address potential self selection into receiving a lunch and finds positive associations between receipt of a complete lunch and child BMI. This is consistent with Millimet (2010) who also analyzed data from the ECLS-K, using kindergarten, first and third grade waves, and finds that participation in the school lunch program is associated with increased weight gain. They suggest that lunches provided by the program may not always be in compliance with federal standards about nutritional content. Data on whether the lunch was free or reduced price was only available in two of the three waves used for this research. Because of the repeated measures design, I was unable to include this information in the analysis and

rely instead on a question that assess whether the child receives a lunch at all. This does not permit a full consideration of the potential federal subsidization of the program for those in need. This caveat should be kept in mind when drawing policy conclusions from this result.

Investigations using cross sectional data have failed to find evidence of a link between food assistance and weight status in children (Jones et al, 2003; Ver Ploeg et al, 2008; Hofferth and Curtin, 2005). Available longitudinal evidence has suggested the presence of a positive relationship between federal food assistance programs such as the SNAP program as it was known before the switch to the Supplemental Nutrition Assistance Program (SNAP) (Kimbro & Rigby, 2010; Gibson, 2006; Gibson, 2004). In contrast, elements of the food infrastructure tested here, receipt of TANF and SNAP, and suggest that there might be protective effects on child body weight, but the pattern of results vary across groups. Estimates indicate that that the effects are significant for girls and white children. This is in contrast to other research (Baum, 2010; Meyerhoefer and Pylypchuk, 2008; Ver Ploeg and Ralston, 2008) that indicates that, among adults, SNAP benefits have significant positive effects on obesity among females. but these effects are relatively small. Food stamp receipt also has a protective effect among Asian children as well.

Receiving TANF funds have protective effects among the overall sample and subgroup analyses reveal that this effect is stronger for boys and among African American and Hispanic children. Overall these results signal the potential for a protective role for federal safety net programs in reducing children body weight.

Finally, these analyses related changes in food insecurity to changes in children's physical activity across elementary school. Food insecurity may be a factor that initiates a stress response that leads to disordered eating, reduced physical activity, and depression, all of which may be related to weight gain (Jones, 2005). Additionally prior research has identified associations between food insecurity and decreased physical activity (Adams et al, 2003). The present analyses do not find

significant linkages between food insecurity and children's physical activity and motivates additional research in this area. Emerging research has begun to explore how children experience household strategies (Fram, Frongillo and Jones, 2011). Preliminary results suggest that children are more aware of parental coping strategies and implement strategies of their own in food insecure households. Food insecure children are more likely to experience depressive symptoms and this may impact a child's motivation to be physically active. Future research should explore the mechanisms by which household food insecurity might matter for a wide range of health outcomes. The physical activity measure available in the ECLS-k is a crude measure. Subsequent research using data that contains data on objectively measured physical activity as well as having measurements on socio cognitive measures might be well placed to further inform this important area of child energy balance research.

CONCLUSIONS

At present, record numbers of Americans are experiencing food insecurity, as measured as the lack of consistent access to adequate food (Wright et al, 2010). Food insecurity poses real consequences for children's health and well-being. Further, research suggests that food insecurity, even at very small levels, has consequences for children. The findings of the current research are relevant to current policy concerning the determinants and consequences of food insecurity for children as they speak to a variety of important questions about the multiple contexts of food insecurity in the United States and the impact for child energy balance outcomes.

Analyses produced in connection to the first research question provide more finely measured estimates of a local food infrastructure. Prior research in the general area of context and food insecurity has focused on state level variation. These results identify proximal indicators of food insecurity that use another level of aggregation and as such provide a comparison point for developing community food security profiles. Other analyses of contextual predictors of food insecurity have

largely used data sets centered on state level variation or local variation in a limited geographic unit of a single state. Prior research in this area has used data that was not linked to child outcome data, leaving researchers to extrapolate across data sources.

Multiple dimensions of county food infrastructure may have relevance for a household's risk of being food insecure. Federal support for nutrition in the form of expenditures is associated with a lower risk of being food insecure. The strength of the local labor market, both in terms of access to employment and compensation, are important for buffering household risk of food insecurity. County unemployment rate and lower average wages are relevant risk factors. These findings point to the importance of strengthening economic conditions as both an anti-poverty strategy but also as a safeguard against household food insecurity.

Characteristics of county food infrastructure may impact households differently depending on household economic resources. Federal support for nutritional programs has a significant association with lower risk of food insecurity but subgroup analyses indicate that this is present in the non poor sample. Higher county level wages have a protective association with food insecurity among non poor households while availability of jobs in a county has a significant association among poor households. Community efforts to reduce household food insecurity should be informed of the complex interplay of factors at the community and individual level.

This research identifies characteristics of the county food infrastructure that might impact household food insecurity. To this end, county food infrastructure was conceptualized using an ecological framework that describes county food infrastructure as having three key dimensions that captured both macro (federal support for food and nutrition) and meso level (economic and social attributes) influences on food insecurity. Additionally, this research examined whether the same factors were associated with food insecurity in poor and non poor households. Several interesting findings emerge from these multilevel analyses.

The second research question guiding this project was whether school environment might influence child purchasing decisions while at school. Having better information about what features of the local school food environment can impact child energy balance behaviors will aid in illuminating what may constitute a healthy food environment. This is information that is needed in the ongoing discussion about how best to promote school wellness policies.

Results indicated that at least one third of the fifth graders surveyed purchased at least one energy dense item at school during the week. Also of interest is the large proportion of schools that offer competitive food outlets. This number is discouraging to those concerned about the lack of regulation and nutritional guidelines in place for competitive foods in the schools. The availability of competitive foods increased the odds of purchasing of energy dense drinks. The availability of healthy snacks does not decrease the purchase of energy dense snacks, but in fact increases the odds of purchasing both energy dense salty snacks and sweets. Results suggest that rather than being a substitute, healthy snacks are complimentary to energy dense snacks. More time given for recess translated into lower odds of purchasing energy dense sweets. It is possible that as children are exposed to healthier school environments, they may develop healthier eating habits.

The third question guiding these analyses was to assess whether food insecurity affected child weight status and physical activity patterns. Analyses conducted take advantage of the repeated measurements of food insecurity across the entire panel of the ECLS K data. Fewer investigations have been able to utilize multiple measurements of food insecurity and child BMI. Currently the research evidence base is mixed on the connections between food insecurity and child weight. The analyses here help to resolve the mixed literature on this issue.

Results suggest that there is a positive association between household food insecurity and child BMI. Sub group analysis suggests however that this connection is not consistent across gender and racial groups. Specifically, results suggest a significant association between living in food insecure

households and elevated BMI for boys but not girls. The effect of food insecurity also varies across racial groups. Subgroup analysis reveals that this association only holds for the African American children in the sample.

These analyses also related changes in food insecurity to changes in children's physical activity across elementary school. Prior research has identified associations between food insecurity and decreased physical activity (Adams et al, 2003). The present analyses do not find significant linkages between food insecurity and children's physical activity and provides motivation for additional research in this area. It remains an open research question if food insecurity leads to diminished physical activity.

Overall, the research on food insecurity has evolved and grown since the 1997 when the USDA instrument was first measured. However, important gaps in our understanding of the determinants and consequences of food insecurity remain. Consideration of the various contexts in which household food insecurity is located is an important step in better understanding the correlates and consequences of food insecurity for child health related behaviors. Future research should build on this work by also considering the mechanism by which food insecurity exerts effects on children's on coping strategies and how this might impact energy balance behaviors.

Table 1 Variable Means and Standard Deviations (N= 9,540 children, 1,665 poor children, 7,870 non poor children).

	Total		*Poor*		*Nonpoor*	
	Mean	Sd	Mean	Sd	Mean	Sd
Food Insecure	0.06		0.21		0.03	
Income, Education & Employment						
In poverty	0.17					
Less than High School	0.07		.28		.03	
High School Graduate	0.20		.36		.16	
Some College	0.34		.30		.35	
College Graduate or more	0.39		.07		.46	
Mother is employed	0.73		0.54		0.77	
Federal Program Usage						
Receives TANF	0.03		0.15		0.01	
Receives SNAP	0.11		0.50		0.03	
Race						
Black	0.11		0.25		0.08	
Hispanic	0.17		0.33		0.14	
Asian	0.06		0.08		0.06	
Other race	0.04		0.06		0.04	
Child Characteristics						
Child is male	0.51		0.50		0.51	
Child age	11.23	0.38	11.23	0.40	11.23	0.37
Household Type						
Married	0.74		0.43		0.81	
Separated	0.04		0.11		0.03	
Divorced	0.11		0.18		0.10	
Never married	0.09		0.24		0.06	
Widowed	0.02		0.03		0.01	
Number of siblings	1.56	1.15	2.15	1.52	1.43	1.01
Residential Characteristics						
Lives in a city	0.35		0.42		0.33	
Lives in a rural area	0.23		0.27		0.22	
Lives in a suburb	0.39		0.28		0.41	
Number of places lived	1.11	0.37	1.16	0.47	1.10	0.34
Federal Support for Food and Nutrition	***Measured at County Level)***					
% of poor receiving SNAP	0.42		0.45		0.42	
Federal spending on agriculture ($1,000,000s)	6.23	16.50	5.52	11.91	6.375	17.32
Federal spending on Nutrition ($1,000,000s)	74.10	152.45	79.3	154.4	73.00	152.0
Social Attributes						
% living in same place as 5 years ago	0.55		0.55		0.55	
% under 18	0.26		0.26		0.26	
Economic Attributes						
Unemployment rate	3.84	1.33	4.08	1.59	3.83	1.34
% in poverty	0.11		0.13		0.11	
Average Wages per job ($10,000)	33.04	9.2	31.9	10.02		
Median Rent ($100s)	576.49	208.91	519.8	201.1	575.9	209.11

Table 2. Coefficients from Random Intercept Logistic Regression analyses of Food Insecurity (N = 9,450 Children).

Fixed Effect	*Coefficient*	*SE*
Intercept	-1.722	1.48
Level 1 Variables		
Income, Education & Employment		
Income level	-.302***	.019
High School Graduate	.017	.144
Some College	-.021	.143
College Graduate or more	-.728***	.192
Mother is employed	-.089	.098
Federal Program Usage		
Receives TANF	.374**	.178
Receives SNAP	.009	.142
Race		
Black	-.371**	.167
Hispanic	.298**	.141
Asian	-.518*	.282
Other race	.063	.258
Child Characteristics		
Child is male	-.134	.090
Child age	.056	.128
Household Type		
Separated	.361**	.161
Divorced	.213	.132
Never married	.348**	.140
Widowed	.218	.283
Number of siblings	.152***	.033
Residential Characteristics		
Lives in a city	.013	.138
Lives in a suburb	-.051	.140
Number of places lived	.294***	.104
Level 2 Variables (Measured at the County Level)		
Federal Support for Food and Nutrition		
% of poor receiving SNAP	.134	.363
Federal spending on agriculture ($1,000,000s)	.002	.003
Federal spending on Nutrition ($1,000,000s)	-.001***	.0003
Economic Attributes		
Unemployment rate	.154***	.041
% in poverty	-1.96*	1.135
Average Wages per job	.014***	.010
Median Rent ($100s)		
Social Attributes		
% living in same place as 5 years ago	-1.925***	.836
% under 18	1.352	1.657
Random Effect	Component	DF
Intercept	.233	840

*=p<.1 **=p<.05***p=<.01. Note: Level two variables have been centered around the grand mean. Reference categories are white, high school drop out, rural area, married.

Table 3. Coefficients from Random Intercept Logistic Regression of Food Insecurity for Poor and Non Poor Children).

	Non Poor		*Poor*	
Fixed Effect	Coefficient	SE	Coefficient	SE
Intercept	-4.65**	2.056	-2.690	2.09
Level 1 Variables				
Education & Employment				
High School Graduate	-.187	.294	-.058	.192
Some College	-.443	.304	-.131	.176
College Graduate or more	-1.565***	.343	-.728**	.330
Mother is employed	.034	.157	-.329**	.123
Federal Program Usage				
Receives TANF	.412	.396	.476**	.188
Receives SNAP	.915**	.262	.077	.152
Race				
Black	.190	.226	-.535**	.220
Hispanic	.587***	.187	.123	.229
Asian	.020	.364	-.839**	.350
Other race	.283	.311	.111	.393
Child Characteristics				
Child is male	-.101	.136	-.165	.121
Child age	.055	.181	.095	.177
Household Type				
Separated	.987***	.262	.382**	.196
Divorced	.731***	.181	.297	.200
Never married	.858***	.204	.429**	.179
Widowed	.575	.432	.344	.379
Number of siblings	.224***	.053	.039	.042
Residential Characteristics				
Lives in a city	-.107	.191	.129	.191
Lives in a suburb	.014	.178	-.148	.206
Number of places lived	.503***	.140	.222*	.126
Level 2 Variables (Measured at the County Level)				
Federal Support for Food and Nutrition				
% of poor receiving SNAP	.556	.448	-.367	.512
Federal spending on agriculture ($1,000,000s)	.0011	.003	.002	.004
Federal spending on Nutrition ($1,000,000s)	-.002***	.001	-.0003	.0001
Economic Attributes				
Unemployment rate	.019	.064	.86***	.044
% in poverty	1.67	1.262	-2.280	1.416
Average Wages per job	-.022**	.013	.001	.014
Median Rent ($100s)	.000	.001	.001	.001
Social Attributes				
% living in same place as 5 years ago	-2.255**	1.066	-1.574	1.257
% under 18	3.431*	2.114	-.367	2.259
Random Effect	Variance Component	DF	Variance Component	DF
Intercept	.110	777	.258	297

*=p<.1, **=p<.05,***=p<.01. Note: Level two variables have been centered around their grand mean. Reference categories are high school dropout, white, rural area, and married. (n=9,540)

Table 4. Variance components from random intercept models (n = 9,540)

Model	*Fixed effect*		*Random Effect*	
	Intercept coeff.	S.E.	Variance Component	p-value
Empty Model				
Total sample	-2.73	.054	.636	.000
Poor sample	-1.35	.074	.309	.000
Non poor sample	-3.37	.062	.267	>.500
Level I variables				
Total sample	-1.86	1.45	.297	>.500
Poor sample	-2.23	2.04	.296	.028
Non poor sample	-4.04	.086	.156	>.500
Level 1 and Level 2 variables				
Total sample	-1.59	1.48	.224	>.500
Poor sample	-2.25	2.09	.266	.029
Non poor sample	-4.05	.090	.064	>.500

TABLE 5. Logistic Regression estimates of associations between School Environment Factors and child food purchasing behaviors. (n=9,540)

DRINKS	B	S.E.	Odds Ratio
Competitive Foods	.504**	0.17	1.66
Cafeteria Meets Needs	0.028	0.04	1.03
Healthy Snacks Avail	0.015	0.02	1.02
PE Times/Week	0.059	0.05	1.06
Time for Lunch	0.054	0.08	1.06
Time for Recess	0.073	0.05	1.08
Boy	-0.022	0.08	0.98
Black	.714**	0.14	2.04
Asian	-0.118	0.20	0.89
Hispanic	.267*	0.12	1.31
Other Race	.454*	0.20	1.57
Mother Education	-.070*	0.03	0.93
Mother age	-0.003	0.01	0.99
Number of Siblings	-0.064	0.04	0.94
Income Category	-0.025	0.02	0.98
maternal employment	.178*	0.08	1.19
SALTY SNACKS			
Competitive Foods	-0.077	0.11	0.93
Cafeteria Meets Needs	0.017	0.03	1.02
Healthy Snacks Avail	.063**	0.01	1.07
PE Times/Week	-0.061	0.04	0.94
Time for Lunch	-0.043	0.07	0.96
Time for Recess	-0.003	0.04	1.00
Boy	-0.062	0.07	0.94
Black	.320**	0.12	1.38
Asian	-0.193	0.16	0.82
Hispanic	0.209	0.11	1.23
Other Race	.373*	0.18	1.45
Maternal Education	-.067**	0.02	0.94
Maternal Age	-0.001	0.01	1.00
Number of Siblings	-0.005	0.04	1.00
Income Category	0.01	0.02	1.01
maternal employment	.187*	0.07	1.21

Note: *= p< .05, **= p< .01

TABLE 5. Continued Logistic Regression estimates of associations between School Environment Factors and child food purchasing behaviors. (n=9,540)

SWEETS	B	S.E.	Odds Ratio
Competitive Foods	0.053	0.11	1.05
Cafeteria Meets Needs	.099**	0.03	1.10
Healthy Snacks Avail	.065**	0.01	1.07
PE Times/Week	-0.021	0.04	0.98
Time for Lunch	-0.056	0.07	0.95
Time for Recess	-.103*	0.04	0.90
Boy	-0.058	0.07	0.94
Black	.438**	0.12	1.55
Asian	-0.26	0.15	0.77
Hispanic	0.059	0.10	1.06
Other Race	0.218	0.17	1.24
maternal education	-0.032	0.02	0.97
maternal age	-0.009	0.01	0.99
Number of Siblings	0.024	0.03	1.02
Income Category	0.014	0.01	1.01
maternal employment	0.119	0.07	1.12

Note: *= p< .05, **= p< .01

Table 6. Descriptive Characteristics for Longitudinal Change Analyses (n = 9,467)

	Total		Boys		Girls		White		Black		Hispanic		Asian	
Variable	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**	**Mean**	**S.D.**
Food insecure	0.08	0.28	0.08	0.27	0.09	0.28	0.05	0.22	0.14	0.34	0.15	0.35	0.08	0.27
Child BMI	18.14	3.94	18.20	3.94	18.07	3.94	17.88	3.65	18.42	4.47	18.81	4.26	17.68	3.75
Physical Activity	3.88	2.12	4.11	2.13	3.63	2.09	4.00	2.05	3.82	2.26	3.65	2.18	3.20	2.18
In Poverty	0.20	0.40	0.20	0.40	0.20	0.40	0.09	0.29	0.42	0.49	0.36	0.48	0.22	0.42
Male	0.51	0.50					0.52	0.50	0.50	0.50	0.51	0.50	0.50	0.50
White	0.55	0.50	0.56	0.50	0.55	0.50								
Black	0.15	0.36	0.15	0.36	0.15	0.36								
Hispanic	0.18	0.38	0.18	0.38	0.18	0.39								
Asian	0.06	0.24	0.06	0.24	0.07	0.25								
Other Race	0.05	0.23	0.05	0.23	0.05	0.22								
Mother is Married	0.72	0.45	0.72	0.45	0.72	0.45	0.81	0.39	0.37	0.48	0.69	0.46	0.86	0.34
Number of sibs	1.53	1.17	1.53	1.16	1.53	1.18	1.44	1.04	1.59	1.32	1.65	1.18	1.74	1.62
Lives in rural area	0.22	0.41	0.22	0.41	0.21	0.41	0.27	0.45	0.13	0.34	0.08	0.26	0.08	0.28
Lives in Mid West	0.25	0.44	0.25	0.43	0.26	0.44	0.32	0.47	0.16	0.37	0.11	0.32	0.20	0.40
Lives in South	0.33	0.47	0.34	0.47	0.32	0.47	0.32	0.47	0.60	0.49	0.28	0.45	0.16	0.37
Lives in West	0.23	0.42	0.23	0.42	0.23	0.42	0.14	0.35	0.08	0.27	0.47	0.50	0.49	0.50
Lives in North East	0.18	0.39	0.19	0.39	0.18	0.39	0.22	0.41	0.16	0.36	0.14	0.35	0.15	0.35
# days eat breakfast together	4.15	2.48	4.15	2.48	4.15	2.48	4.47	2.50	3.35	2.25	3.69	2.39	4.07	2.50
# days eat Dinner together	5.63	1.76	5.61	1.77	5.65	1.75	5.64	1.69	5.45	1.92	5.64	1.87	5.71	1.88
Receives TANF	0.05	0.23	0.05	0.22	0.06	0.23	0.03	0.16	0.12	0.33	0.07	0.26	0.06	0.24
Receives SNAP	0.13	0.34	0.13	0.34	0.14	0.34	0.07	0.25	0.35	0.48	0.18	0.39	0.12	0.32
Gets a lunch at school	0.48	0.50	0.48	0.50	0.48	0.50	0.46	0.50	0.48	0.50	0.53	0.50	0.42	0.49

Table 7. Fixed Effect Estimates of associations between Food Insecurity and Child BMI (n = 9,467)

	TOTAL		Boys		Girls		White		Black		Hispanic		Asian	
Main Effect														
Food Insecure	0.21	**	0.41	***	-0.01		0.18		0.63	**	0.20		-0.22	
Family Controls														
Food Insecure	0.19	**	0.40	***	-0.03		0.13		0.62	**	0.22		-0.25	
In Poverty	0.00		-0.09		0.10		0.06		-0.03		-0.13		-0.09	
Married	-0.26	***	-0.18		-0.34	***	-0.69	***	0.59	**	0.20		-1.14	***
Number of sibs	0.38	***	0.27	***	0.50	***	0.27	***	0.09		0.82	***	0.41	***
Food Infrastructure														
Food Insecure	0.23	**	0.41	***	0.03		0.18		0.54	**	0.22		-0.10	
In Poverty	0.06		-0.04		0.16		0.13		0.11		-0.16		0.10	
Married	-0.20	**	-0.07		-0.33	***	-0.59	***	0.52	**	0.28		-1.12	***
Numsib	0.32	***	0.22	***	0.43	***	0.20	***	0.07		0.71	***	0.27	
# days breakfast together	-0.18	***	-0.17	***	-0.19	***	-0.19	***	-0.19	***	-0.16	***	-0.07	**
# days Dinner Together	-0.08	***	-0.06	***	-0.10	***	-0.07	***	-0.17	***	-0.08	***	-0.01	
Get a lunch at school	1.53	***	1.65	***	1.41	***	1.58	***	0.85	***	1.55	***	0.99	
Receive SNAP	-0.15		-0.03		-0.27	**	-0.38	**	-0.26		0.35	*	-1.15	***
Receive TANF	-0.46	***	-0.65	***	-0.28	*	-0.15		-0.61	**	-0.66	***	-0.65	

Note: * = p <.10, ** = p < .05, *** = p <.01

Table 8. Fixed Effect Estimates of associations between Food Insecurity and Child Physical Activity (n = 9,467)

	Total		Boys		Girls		White		Black		Hispanic		Asian	
Main Effect														
Food Insecure	0.04		-0.04		0.12		0.00		0.19		0.07		-0.04	
Family Controls														
Food Insecure	0.04		-0.04		0.13	*	0.00		0.22		0.08		-0.02	
In Poverty	0.02		0.06		-0.03		0.00		-0.06		0.03		-0.13	
married	0.04		0.05		0.02		-0.01		0.04		0.12		0.16	
Number of sibs	-0.06	**	-0.02		-0.11	***	-0.02		-0.18	**	-0.11	**	0.04	
Food Infrastructure														
Food Insecure	0.04		-0.03		0.12		0.02		0.25	*	0.09		-0.28	
In Poverty	0.02		0.07		-0.03		0.06		-0.09		0.01		-0.04	
married	0.04		0.05		0.02		-0.01		0.05		0.11		0.08	
numsib	-0.06	**	-0.02		-0.10	**	-0.01		-0.18	**	-0.08		0.01	
# days breakfast together	0.03	***	0.03	***	0.03	***	0.01		0.03		0.07		0.08	**
# days Dinner Together	0.03	***	0.02	*	0.03	**	0.01		0.07	***	0.06	***	-0.06	
Get a lunch at school	0.08	**	0.08	*	0.08	*	0.03		-0.04		0.15		0.41	**
Receive SNAP	-0.04		-0.12		0.05		-0.33	***	0.19		0.06		0.23	
Receive TANF	0.10		0.16		0.05		0.22	*	-0.05		0.08		0.30	

Note: * = p <.10, ** = p < .05, *** = p <.01

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