MODIFYING EFFECTS OF PARTICIPATION IN FEDERAL CHILD NUTRITION PROGRAMS ON THE DEVELOPMENTAL CONSEQUENCES OF HOUSEHOLD FOOD INSECURITY FOR CHILDREN

A Thesis

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by

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ABSTRACT

Food insecurity remains a persistent public health problem for children in the U.S. and is thought to have consequences for child physical, social and academic development. The School Breakfast Program, the National School Lunch Program, and Supplemental Food and Nutrition Program for Women, Infants and Children (WIC) are federally funded programs intended to avert food insecurity and its consequences for children. These nutrition programs have also been associated with child physical, social and academic developmental outcomes. Further research is needed to investigate the complex relations between variables and to establish greater plausibility that associations are causal in nature. This study investigated the causal effects of household food insecurity and child nutrition program participation by using longitudinal data and statistical methods to account for potential bias. Fixed-effects modeling was utilized to minimize bias resulting from selection to participate and to take advantage of dynamic changes in household food insecurity status and program participation between kindergarten and 3rd grade. Household food insecurity, independent of household income and other child- and household-level factors, was associated with poorer social skills and reading performance development among girls, and with greater weight gain among boys. National School Lunch Program participation was associated with better mathematics and reading performance for children. The effects of National School Lunch Program participation were stronger for children with greater socioeconomic need compared to those with less socioeconomic need, suggesting that food assistance participation may impact child development by modifying the effects of stress-related hardships. Neither school breakfast participation nor school lunch participation was associated with greater weight gain. In conclusion, food insecurity may exert its detrimental effects through nutritional and non-nutritional (i.e., stress-related) mechanisms. Similarly, school

nutrition programs may protect children against the effects of food insecurity through nutritional and non-nutritional mechanisms. Further research into potential mechanisms underlying these associations is warranted. Policy implications of the findings are discussed.

BIOGRAPHICAL SKETCH

Diana Jyoti graduated from the University of Wisconsin-Madison in 2003 with dual Bachelor of Science degrees in Nutritional Sciences (concentration in International Agriculture and Natural Resources) and Dietetics. As part of her undergraduate studies, she spent a year in Northern India researching maternal and child health and nutrition. She joined Cornell in 2003 to pursue a Masters of Science degree in community nutrition, with a minor in epidemiology. Before college, she attended Catholic Memorial High School in Waukesha, Wisconsin.

This paper is dedicated to my best friend and husband, Manish Jyoti.

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CHAPTER I.
INTRODUCTION

Food insecurity, the limited or uncertain availability of nutritionally adequate and safe foods (Nord, et al., 2003), remains a persistent public health problem for children in the U.S. Over 13 million children lived in food insecure homes in 2003 (Nord, et al., 2004). Although food insecurity itself is worrisome because of its potential to disrupt the lives of families and children, one reason the issue remains important at the policy level is because of its links with important developmental consequences for children. Food insecurity has been associated with impaired cognitive and academic development, impaired social skills development, and increased odds of becoming overweight or obese in children. These consequences have important implications for the development of a healthy, proficient, economically viable, and skillful society as a whole. They also add to the debate over the government's role in protecting individuals against circumstances that undermine that development.

The association between food insecurity and overweight is of particular concern in a nation where child overweight is swiftly on the rise and childhood obesity has been labeled an epidemic (Institute of Medicine, 2005). It has been estimated that the U.S. spent almost $100 billion in 2003 addressing direct and indirect consequences of obesity alone (Wolf, 2005). In 2001, the U.S. Surgeon General issued a Call to Action to Prevent and Decrease Overweight and Obesity (U.S. Department of Health and Human Services, 2001). There stands considerable interest in what policy and program actions can and should be taken to reverse the obesity epidemic.

The federal government currently operates several child nutrition programs intended to avert food insecurity, malnutrition, and related consequences. The School Breakfast Program (SBP), the National School Lunch Program (NSLP), and the

Supplemental Program for Women, Infants and Children (WIC) operate under jurisdiction of the U.S. Department of Agriculture. All three programs target low-income children for free or reduced-price supplemental food. The oldest of these programs, the NSLP, has operated for almost 60 years.

On June 30, 2004, President Bush signed the Child Nutrition and WIC Reauthorization Act of 2004 into law. The intent of the bill, which received wide bipartisan support from organizations and legislators, was "to renew and strengthen federal child nutrition and school lunch programs and help local communities work with parents to fight America's growing child obesity problem" (Boehner, 2004).

A major assumption underlying the Reauthorization Act is that child nutrition programs promote child well being. Indeed, some evaluations show that child nutrition programs improve dietary intake and nutritional status among children. Less frequently, studies have linked participation in these programs to improved child developmental outcomes such as better psychosocial functioning, improved school performance, decreased odds of overweight, and decreased child mortality (Devaney, Ellwood, & Love, 1997; Kleinman, et al., 2002; Jones, et al., 2003).

On the other hand, there is growing concern that federal food assistance programs are contributing to negative developmental consequences for children (Besharov, 2002; Besharov, 2003). Research studies have linked child overweight to participation in the National School Lunch Program (Whitmore, 2005) and another federal food assistance program, the Food Stamp Program (Gibson, 2004). National School Lunch Program participation has also been linked to worse mathematics performance (Dunifon and Koweleski-Jones, 2003). In the United Kingdom, participation in school breakfast programs has been associated with borderline or abnormal conduct and hyperactivity scores (Shemilt, 2004). Since outcomes and

program participation are both associated with food insecurity, however, we cannot be sure whether outcomes are caused by program participation, by program operations, or by food insecurity.

Given the severe implications of food insecurity for child development and the potential for child nutrition programs to either curb or contribute to these consequences, further evaluation of these relationships is warranted. The ability to make statements of causality requires accumulation of evidence from multiple research studies using strong methodology. Most studies to date have been limited either by cross-sectional designs that do not allow for investigation of more complex relations between variables or by limitations in methodology that has not deal adequately with sources of bias.

The purpose of this study is multifold: first, to establish a conceptual framework for relations among food insecurity, food assistance program participation, and select physical, social, and academic developmental outcomes in children (Part II); second, to investigate the effects of food insecurity on child developmental outcomes using longitudinal methods that allow for strong causal inference (Part III); third, to evaluate effects of participation in the School Breakfast Program and National School Lunch Program on child developmental outcomes using similar longitudinal methods (Part IV), fourth, to investigate associations between WIC participation and child development outcomes (Part V); and fifth, to discuss overall policy implications of the research findings (Part VI).

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CHAPTER II.
CONCEPTUAL FRAMEWORK

Much of quantitative research related to food insecurity has focused on its nutritional effects (Rose, Habicht & Devaney, 1999; Olson, 1999; Rose, 1999; Casey, et al., 2001; Bhattacharya, 2002; Matheson, et al., 2002; Adams, et al., 2003). The common conceptualization is that food insecurity results in impaired quantity or quality of dietary intake, thus impacting nutritional status and ultimately child development outcomes. Many researchers investigating the long-term developmental consequences of food insecurity in children have also assumed that food insecurity exerts its influences by causing malnutrition (Adams, et al., 2003; Brown & Pollitt, 1996; Center on Hunger and Poverty, 1998). A model of this conceptualization is provided in Figure 2.1.

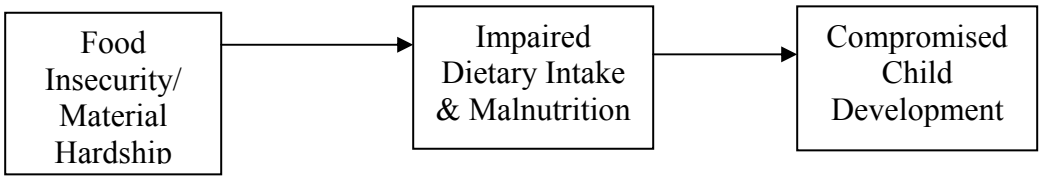

Figure 2.1. Model of the Direct Effects of Food Insecurity on Food Intake and Nutritional Status.

This conceptualization of food insecurity has lead to the assumption that food assistance participation acts as a mediating factor between food insecurity and its effects—that is, program participation, in response to food insecurity, reduces food insecurity, and that, in turn, improves nutrition and child development (Pollitt, 1994; Miller et al, 1998; Rose, et al, 1998; Borjas, 2001; Heflin & Ziliak, 2004; Oberholser & Tuttle, 2004). A model of this pathway is presented in Figure 2.2

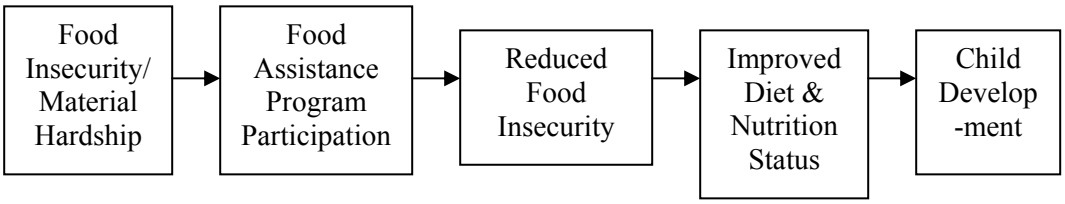

Figure 2.2. Potential Pathway by which Food Assistance Affects Child Development.

This conceptualization likely stems from the fact that federal nutrition programs were initially instated in response to concerns about underconsumption and undernutrition among low-income families (Devaney, et al., 1997).

Life Stress Model and General Stress Mechanisms

This study posits an alternative conceptualization of food insecurity and program participation based on the Life Stress Model. Applied to children, the Life Stress Model hypothesizes that social and economic stressors, experienced at the household- or child-level, cause problems in child development and well-being (Ensel & Lin, 2000). Furthermore it hypothesizes that social and material resources can act as important buffering mechanisms against the effects of stressors (Taylor & Seeman, 1999; Wheaton, 1982; Lin and Ensel, 1989), to the extent that such resources are available (Wong, 1993).

Theoretical bases for such hypotheses grew from the work of previous scholars. As early as 1939, Faris and Dunham were investigating the relationship between social class and mental illness. They reported disproportionate rates of mental illness in the poorest parts of Chicago (Hudson, 2005). Decades later, research

consistently shows that socioeconomic status is a predictor of physical and mental health in individuals (Adler, et al, 1994; Pearlin et al., 2005; Hudson, 2005). Specifically in children, poverty has been linked to psychiatric, behavioral and social adaptation problems (McLeod & Shanahan, 1993; Kleinman, 1998; Petterson & Albers, 2001); detrimental effects on cognitive functioning, IQ, verbal skills, mathematics skills, reading skills, and overall school achievement (Stipek & Ryan, 1997; McLoyd, 1998; Petterson & Albers, 2001); grade retention and placement in special education (McLoyd, 1998); impaired motor development (Petterson & Albers, 2001) overweight and obesity (Kinra, et al., 2005; Drewnowski & Specter, 2004), and shorter stature (Sherry, et al., 1992).

Research clearly identifies stress as a mediating link between socioeconomic status and health (Turner, et al., 1995; Ensel, et al., 1996; Barrett & Turner, 2005). Research studies show that "individuals with lower socioeconomic status report greater exposure to stressful life events and a greater impact of these events on their lives than do individuals with higher socioeconomic status, and that this relationship between socioeconomic status and health begins at the earliest stages of life" (Lupien, et al., 2000).

The experience of stress can be viewed as the result of persistent exposure to circumstances or as the result of individual events or changes in circumstance. Researchers commonly use the terms "life stress" or "stress in the life course" when referring to stress associated with the latter. Life stressors can be desirable or undesirable (Pearlin, et al., 1996). Examples of life stressors include: loss of a family member, loss of a job, divorce, economic shocks, natural disasters, birth of a child, loss of support mechanisms, or crime victimization (Wong; 1993; Patterson, 1995).

Undesirable life stress has been linked to negative effects on psychological, mental, and physical health of adults and children (Ensel and Lin, 2000; Taylor, et al., 1997; Pearlin, 1989; Dohrenwend and Dohrenwend, 1974). Individuals in early and middle childhood are especially vulnerable to such effects since the environment plays "a major role in protecting children from stress or being a cause of stress" during these periods of development (Goodyer, 1988).

Life stress can affect child development through several general mechanisms. First, household financial constraints can lead to restrictions in family spending. These cuts can affect children directly, by limiting opportunities and access to material goods, or indirectly by conditioning children's future achievement aspirations (Flanagan, 1990), impacting children's sense of mastery or control (Conger, et al., 1999), elevating feelings of responsibility and burden (Lehman & Koerner, 2002), and increasing sensitivity to peer evaluation (Silbereisen, et al., 1990).

Second, household stressors can result in parents becoming preoccupied with issues of family welfare. "Responsive parenting is minimized under such conditions, and parents are less patient and [nurturing] with their children and adolescents" (Flanagan, 1990). Punitiveness and inconsistency in parenting often accompany unresponsiveness (McLoyd and Wilson, 1990). Children may receive less cognitive stimulation (McLoyd, 1998) and social interaction (Assel, et al, 2002) in the home. Furthermore, research shows that children are highly sensitive and reactive to their parents' emotional state (McLoyd & Wilson, 1990; Marchand & Hock, 1998; Lupien, et al., 2000). The results can be strained family relationships and impaired parent-child interaction, leading to emotional, cognitive, and behavioral problems in children (Silbereisen, et al., 1990).

Third, economic downturns in the community can lead to pockets of poverty and a narrowed tax base. A narrowed tax base can lead to constrained school and local services and fewer community resources. Children's education and health may get neglected as schools and families are forced to adapt to the implications of such changes (Flanagan, 1990; McLoyd, 1998). Children living in poverty-prone areas may additionally find themselves exposed to harmful environmental stressors such as crime, homelessness, and affiliation with deviant peers (Taylor, et al., 1998; McLoyd, 1998; Barrera, et al., 2002).

Fourth, stress may have more direct biological consequences for children's development. Lupien and colleagues (2000) reported that children from low socioeconomic status showed significantly higher salivary cortisol (i.e., a stress hormone) levels compared to children with high socioeconomic status, and that the differences gradually increased in magnitude from 6 years of age to 10 years of age. More recently the same researchers (2005) showed that glucocorticoid (i.e., a stress hormone) levels in young and older adults correlated with memory performance and cognitive processing, implying that physiological stress can have direct consequences for academic learning and performance. This finding would support research showing that the hippocampus—an area of the brain involved in learning and memory—is particularly sensitive to the effects of stress (Bremner & Vermetten, 2001). Research also suggests that childhood stress can have long-term effects on other aspects neurobiological development (Bremner & Vermetten, 2001).

Life Stress Model Applied to Food Insecurity and Food Assistance

Consistent with the Life Stress Model, the relationships between food insecurity (or material hardship), food assistance participation, and child development outcomes can be exemplified in two hypothesized models. In the first model (Figure 2.3), food insecurity and food assistance program participation act independently to affect child development.

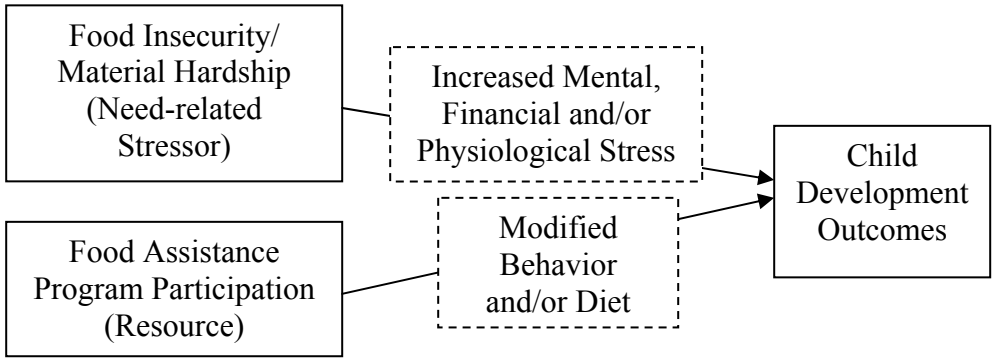

Figure 2.3. Life Stress-Based Model Showing Independent Effects of Food Insecurity and Food Assistance Program Participation on Child Development.

In this model, food insecurity (or material hardship) exerts independent effects on a child by causing financial, mental or physiological stress in a household or child. In contrast to Figure 2.1, the pathway between food insecurity and child development in this model *may or may not* involve impaired nutritional status. A child living in a food insecure household may be protected from experiencing hunger, yet still experience the stress related effects of the circumstances. Also in this model, food assistance exerts independent effects on a child by impacting economic, social or dietary behaviors of the child or household. Alternatively, the *loss* of food assistance may cause its own independent stress-related effects.

In the second model (Figure 2.4), food assistance acts as a financial or social resource to *modify* the stress-related effects of food insecurity on child development. Program participation could modify either 1) the degree to which food insecurity results in stress experienced by a child or household or 2) the degree to which generated stress compromises a child's development.

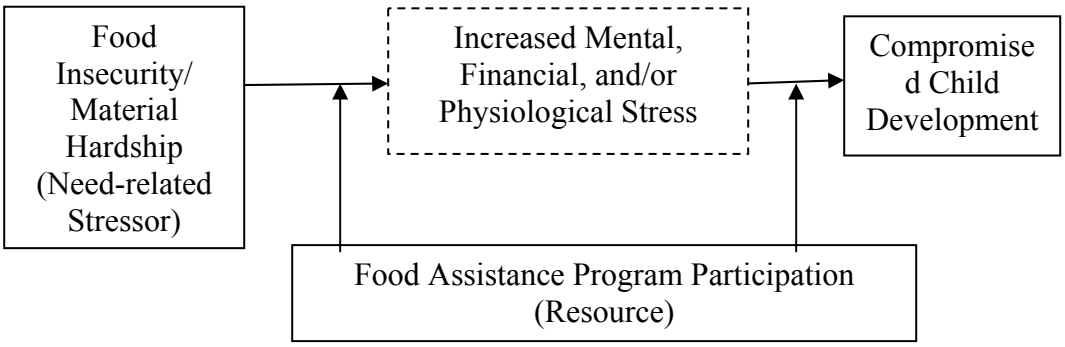

Figure 2.4. Life Stress-Based Model Showing the Modifying Effects of Food Assistance Program Participation on the Stress-Related Effects of Food Insecurity.

There is evidence to support use of the Life Stress Model applied to food insecurity, food assistance, and child development. First of all, child developmental outcomes of interest in this study—weight status, academic or cognitive performance, and social skills—have all been associated with stress, food insecurity, *and* food assistance program participation *independently*. Child overweight has been linked to food insecurity (Frongillo, et al., 1997; Alaimo, Olson, Frongillo, 2001a; Townsend, et al., 2001; Casey, et al., 2001), socioeconomic stress (; Sarlio-Lahteenkorva & Lahelma, 2001; Laitinen, Power, Ek, Sovio, & Jarvelin, 2001), participation in the Food Stamp Program (Johnson, et al., 1999; Jones, 2003; Gibson, 2004), and participation in school meal programs (Jones, 2003). Children's social skills have been linked to food insecurity (Kleinman, et al., 1998; Murphy, et al., 1998a; Stormer

& Harrison, 2003), life stress (Compas, et al., 1991; Mistry, et al., 2002), and participation in school breakfast programs (Murphy, et al., 1998b; Wahlstrom & Begalle, 1999; Shemilt, 2004). Children's academic or cognitive performance has been linked to food insecurity (Winicki & Jemison, 2003; Alaimo, et al., 2001b), biological stress (Lupien, et al., 2005), socioeconomic stress (McLoyd, 1998), and participation in the School Breakfast Program (Meyers, et al., 1989; Kleinman, et al., 2002).

Qualitative studies have documented stress-related effects of food insecurity in the home. Hamelin and colleagues (1999) reported the following stress-related behaviors and reactions among food-insecure adults: feelings of being constrained to go against held norms and values, feelings of powerlessness and exclusion, decreased interest in food and nourishment, fear of losing custody of children, modification of home rituals and eating patterns, feelings that meals were no longer happy gathering opportunities for the family, feelings of regret about not being able to invite guests for dinner, disrupted dynamics between parent and child (e.g., irritability; anger; parents less available because of increased time required to procure food; conversation gap with children because parents are not able to face their incapacity to feed them adequately), deviant behaviors (e.g., saving up food because one is afraid it will not be there anymore), creation of unexpected dependency (e.g., relying on others or relying on credit to eat; accessing soup kitchens or other "stigmatized" food resources), and reliance on "obliged means" (e.g., borrowing money; selling personal belongings; parents depriving themselves to feed their children; going without medical care; going to usurers; stealing).

Connell and colleagues (2005) recently conducted qualitative interviews with *adolescents* regarding their experiences of food insecurity. In addition to reporting

impacts on quality and quantity of foods consumed, they reported: feelings of worry, anxiety, sadness, shame, fear, frustration and limited choice. Parent responses to food insecurity (as reported by children), included: attempting to hide the situation from children, encouraging children to seek or borrow food from other sources, limiting children's social activities, eating less food themselves to save money for the children, and showing anxiety about running out of food.

In other studies, food insecurity was associated with higher likelihood of stressful financial events, such as borrowing money from friends and relatives, falling behind on paying bills, and postponing major purchases or medical care (Hofferth & Ye, 2004). Financial stress resulting from food insecurity or material hardship may cause changes in consumer behavior. Researchers have reported an inverse relation between energy density and energy cost (Drewnowski & Spector, 2004). Foods high in energy, added sugars, fats, and refined grains tend to be those of lowest cost to consumers (Darmon, et al., 2003). Consequently, food insecurity and poverty have been associated with lower consumption of fruits and vegetables, fish, and lean meats (Drewnowski & Spector, 2004) and higher consumption of energy-dense and fatty foods (Darmon, et al., 2003). This could have consequences for nutritional status of children.

Studies also support conceptualization of federal food assistance as a social or financial *resource* that can directly protect or indirectly buffer families and children from stressful hardships (Patterson, 1995). The Food Stamp Program has been shown to increase household food expenditures (Devaney, et al., 1997; Johnson, et al., 1999). It has also been shown to alter consumption patterns: food stamp program participants consumed greater amounts of meats, added sugars, and added fats compared to non-participants (Wilde, et al., 2000). WIC has been found to increase total household

food acquisitions (Daponte, et al., 2001), to increase the likelihood a child will receive preventive health care (Joo Lee, 2000), and decrease consumption of added sugars (Wilde, et al., 2000). The School Breakfast Program has been shown to increase social integration at school, decrease levels of student distraction due to hunger, and reduce parent stress associated with worry about morning feedings and time constraints (Wahlstrom & Begalle, 1999). These are all potential pathways by which food assistance program participation may impact children and families.

An Epidemiological Model for Analysis

As in any epidemiological study, the relationships between variables of interest are complicated by observed and unobserved heterogeneity. A more inclusive model of postulated associations is presented in Figure 2.5.

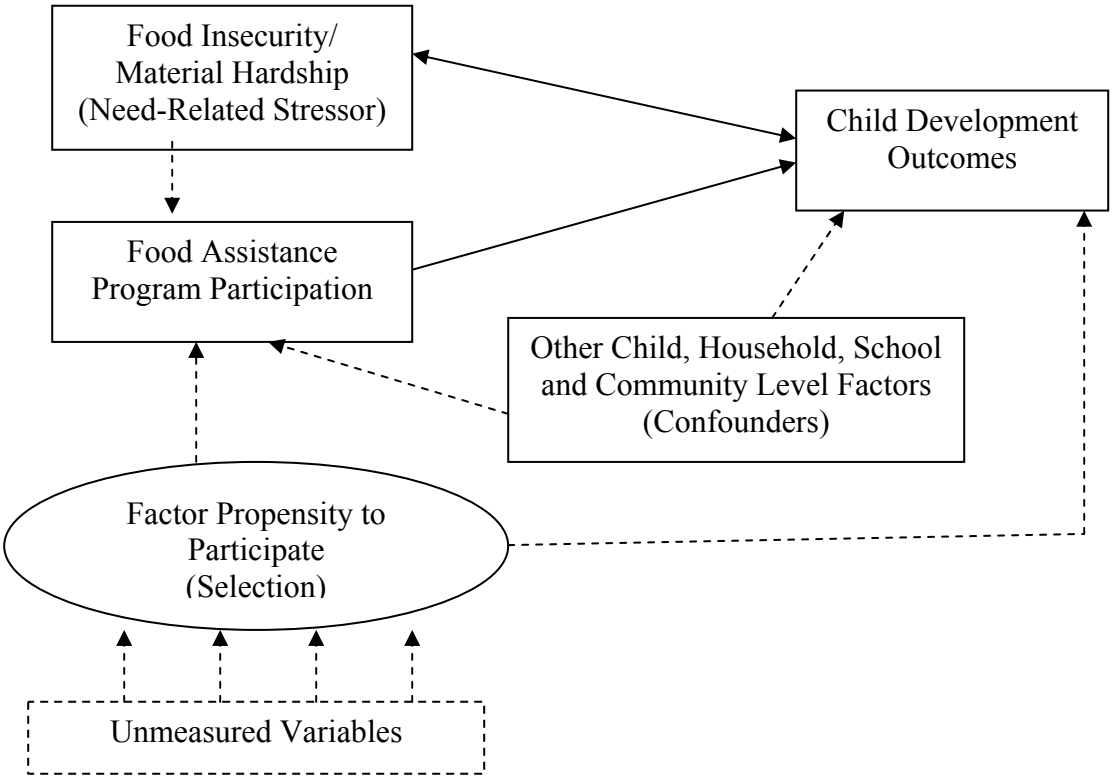

Figure 2.5. Epidemiological Model for Analysis

Individual- and household-level contextual factors are likely to bias relationships between food insecurity, food assistance, and child development outcomes if they are not controlled properly. Examples of potential confounders are: race (Ogden, et al., 2002), birth weight (McLoyd, 1998), parental education (Strauss & Knight, 1999), living in a single parent household (McLoyd & Wilson, 1990, Lipman, et al., 2002), and physical activity (Tremblay & Willms, 2003). Though poverty has been consistently linked to negative health and development outcomes for children (Kleinman, 1998), this study is concerned with establishing whether experiences of food insecurity or program participation have independent causal effects above and beyond (or in lieu of) poverty. It is therefore important to control for household income as well.

Previous studies have reported moderating effects of gender on relationships between stress and development, and also on the benefits of social support for development (Elder, et al., 1985; Wadsworth & Compas, 2002). Investigation of interactions between food insecurity or program participation and gender are warranted.

Recent literature has also emphasized the importance of simultaneously considering community-level factors when analyzing stressor-to-stress-to-outcome relationships (*Barrera, et al., 2002*). Community-level factors include neighborhood socioeconomic context (Duncan, 1994; Robert, 1999; Hamelin, et al, 1999; Elliot, 2000; Ellen, Mijanovich, & Dillman, 2001), geographic distribution of food resources (Block, et al., 2004), school climate (McLoyd, 1998), social culture (Sidebotham, et al., 2001), and the policy environment (Booth, et al., 2001). In one study, lower neighborhood socioeconomic context was associated with higher adult BMI, above and beyond individual-level socioeconomic position, age, sex and race (Robert, 1998).

This effect was not dramatically eliminated after investigating individual-level health behaviors, psychosocial factors, and social integration (support) as potential mediators (Robert, 1999). Another study using longitudinal data reported lower mean IQ and increased mean externalizing behavior problems among 5-year-olds living in poor neighborhoods compared to affluent neighborhoods (Duncan, et al. 1994). However, both studies reported that individual-level socioeconomic indicators were much stronger predictors of health than community-level indicators—a finding that has been supported by other studies as well (Robert, 1998).

The model in Figure 2.5 is further complicated by differences in the propensity of a family or child to participate in food assistance programs. Program participation is both an elective behavior and a responsive behavior. Eligible people can select whether or not to participate, but they are likely to do so in response to certain social, policy, economic, and personal circumstances (Frongillo, 2003). For example, individuals who have lower self-esteem, who are "inflexible", who equate welfare assistance with failure, and who are unable to appraise stress properly will be less likely to select to participate (Wheaton, 1982; Wong, 1993; Patterson, 1995). Alternatively, circumstances such as unemployment and loss of housing are likely to increase the propensity to participate, while circumstances such as social isolation (Patterson, 1995), social stigmatization, and policies that discourage eligible people from applying are likely to inhibit initiation of program participation.

These are examples of factors that researchers can try to control if such data is collected and made available. Unfortunately, most of the time information on such factors is limited. Researchers are unable to control for unobserved factors that influence a person's propensity to participate. The result is that participation is often linked to worse outcomes, since those who select to participate tend to be those with

greater material hardship and need for the services, and that need is usually associated with poorer outcomes. Therefore, the magnitude of the regression coefficients for associations between program participation and outcomes will reflect both 1) the extent to which participation is a reflection of material hardship or need for the program (selection bias), and 2) the extent to which program benefits have caused outcomes. Untangling these two explanations requires making use of longitudinal data and statistical methods that minimize or eliminate selection bias.

The model in Figure 2.5 is made yet more complicated by the possibility of reverse causality—that is, poor development could theoretically cause household food insecurity or material hardship. Social causation and social selection are two possible explanations for association. Social selection theory hypothesizes that individuals who are biologically predisposed to poorer health and development (i.e., overweight, cognitively impaired, learning disabled, mentally ill, or socially inept) will drift into poorer socioeconomic circumstances (including food insecurity). Alternatively, social causation theory hypothesizes that poorer socioeconomic conditions such as food insecurity predispose individuals to poorer health and development (Hudson, 2005).

There is some evidence to support social selection related to outcomes in this study. Waaktar and colleagues (2004), using longitudinal data, found that adolescent depressive symptoms predicted stressful life events, rather than the other way around. There is also clear and consistent evidence that stigmatization of obesity leads to lower wages, less educational opportunities, and inequalities in preventive health care for obese adults (Puhl & Brownell, 2001; Cawley, 2004). On the other hand, social causation hypotheses have been supported in many studies (Turner et al., 1995; Costello, et al., 2003; Hudson, 2005). Yet another hypothesis, reciprocal causation, was reported in one study. In that study, stressful life events at one point significantly

predicted social problem behaviors among adolescents the following year, which in turn predicted stressful life events one year later (Kim, et al., 2003).

The models in this study (Figures 2.3 and 2.4) are consistent with social causation theory. Panel data are necessary to confirm that causal mechanisms operate in the hypothesized direction. Researchers can rule out reverse causality by following individuals over time and observing that a causal variable in fact precedes its expected effect.

The following papers will build upon the conceptual models presented in this section. The first paper investigates independent causal effects of food insecurity on selected indicators of child development. The second paper investigates the independent and modifying causal effects of school meal program participation on child development. Advanced statistical models are used to account for biasing factors that may interfere with the ability to make causal inferences.

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CHAPTER III.
HOUSEHOLD FOOD INSECURITY AND CHILD DEVELOPMENT

Food insecurity affects school children's academic performance, weight gain, and social skills

ABSTRACT

Food insecurity has been associated with diverse developmental consequences for US children primarily from cross-sectional studies. We used longitudinal data to investigate how food insecurity over time related to changes in reading and mathematics test performance, weight and BMI, and social skills in children. Data were from the Early Childhood Longitudinal Study—Kindergarten Cohort, a prospective sample of about 21,000 nationally representative children entering kindergarten in 1998 and followed through 3rd grade. Food insecurity was measured by parent interview using a modification of the USDA module where households were classified as food insecure if they reported ≥1 affirmative responses in past year. Households were grouped into four categories based on temporal occurrence of food insecurity in kindergarten and 3rd grade. Children's academic performance, height, and weight were directly assessed. Children's social skills were teacher-reported. Analyses examined effects of modified food insecurity on changes in child outcomes using lagged, dynamic, and difference (i.e., fixed-effects) models and controlling for child and household contextual variables. In lagged models, food insecurity was predictive of poor developmental trajectories in children before control for other variables. Food insecurity thus serves as an important marker for identifying children who fare worse in terms of subsequent development. In all models with controls, food

insecurity was associated with diverse outcomes, and associations were found to differ by gender. This study provides the strongest empirical evidence to date that food insecurity is linked to specific developmental consequences for children, and that these consequences may be both nutritional and non-nutritional.

INTRODUCTION

Despite federal food assistance and private charitable programs, food insecurity is a persistent national problem (1) affecting 11% of all households (2) and 16% of households with children (3). Food insecurity refers to limited or uncertain availability of or inability to acquire nutritionally adequate, safe and acceptable foods due to financial resource constraint (1). More specifically, food insufficiency refers to an inadequate amount of food intake due to resource constraint (4).

Food insecurity and insufficiency are associated with adverse health and developmental outcomes in U.S. children (5-12). Among 6 to 12 y old children, food insufficiency was associated with poorer mathematics scores, grade repetition, absenteeism, tardiness, visits to a psychologist, anxiety, aggression, psychosocial dysfunction, and difficulty getting along with other children (13-15). Among 15 to 16 y old adolescents, food insufficiency was associated with depressive disorders and suicide symptoms after controlling for income and other factors (16). Recently, food insecurity was associated with poor social functioning, but not with academic performance or attained body mass index (BMI), in kindergarten children (17).

Cross-sectional studies also suggest possible associations between food insecurity and overweight in children. White girls 8- to 16-y-old from food-insufficient households were 3.5 times more likely to be overweight than food-sufficient girls after controlling for potential confounding factors (18). Casey and

colleagues reported significantly higher prevalence of overweight among children from low-income, food insufficient households in contrast to high-income, food sufficient households, but no differences between food insufficient and food sufficient low-income households (19).

These cross-sectional studies suggest that food insecurity has consequences for academic performance, social skills, and weight in children. Longitudinal data, however, have clear analytical advantages over cross-sectional data. First, the temporal nature allows for measurement of change over time (20). For example, how does the transition from food security to food insecurity relate to weight gain? Second, temporality helps ensure that observed outcomes are associated with initial exposure status and not due to reverse causality. Third, investigation of intra-individual changes reduces effects of unmeasured confounders (20). Absent a randomized design, longitudinal data provide the best means to establish that observed effects are causal and not due to confounding, selection bias, or reverse causality (21).

Only one prior study has examined the effects of food insecurity on aspects of child development using longitudinal methods (22). Data from the Early Child Longitudinal Study-Kindergarten Cohort (ECLS-K)[1] showed that reporting 3 or more indicators of food insecurity in the spring of kindergarten was not associated with physical growth across the kindergarten year, but that reporting at least one indicator of food insecurity was significantly associated with impaired learning in mathematics from fall to spring of the kindergarten year. This study was limited by the short

[1]β, regression coefficient
ECLS-K, Early Child Longitudinal Study-Kindergarten Cohort
FIS, food insecurity
HH, household
IRT, Item Response Theory
K, kindergarten
NHANES III, Third National Health and Nutrition Examination Survey
PSID, Panel Survey on Income Dynamics

duration of time between assessments, lack of data on changes in food insecurity, and inability to establish whether exposure to food insecurity preceded the learning effect.

This study aimed to determine relations between household food insecurity and selected dimensions of children's academic, social, and physical development over several years using a prospective longitudinal study design and modeling techniques that attempt to account for bias. The selected developmental outcomes were mathematics performance, reading performance, weight, BMI, and composite social skills. First, we examined whether household food insecurity at kindergarten resulted in poorer subsequent development. Second, we examined how changes in food insecurity were associated with concurrent development.

SUBJECTS AND METHODS

Non-restricted, public use data were obtained from the ECLS-K (23), which utilized a multistage probability, cluster sample design to select a nationally representative sample of 21,260 kindergarten children attending 1,592 elementary schools in 1998-1999. Data were collected non-experimentally by means of survey and direct assessment over four consecutive years. We utilized parent, teacher and child data from spring of kindergarten (1999) and spring of 3rd grade (2002). Data from children with full response—i.e., eligible children who completed some assessment data *or* had a parent who completed the family section of the parent interview—were available for 20,578 children in the spring of 1999 and for 15,305 children in the spring of 2002. Attrition was mainly due to children moving outside of the primary sampling units or moving to areas where they could not be located. Locatable movers from a random 50% of schools were followed. A small number of children became ineligible because they moved outside of the U.S.A. or died. Our two

analytic samples consisted of 1) about 13,500 children for whom full data—a scored reading or mathematics assessment *and* parent completion of the USDA food security module—were available at kindergarten and 2) about 11,400 children for whom this full data were available at both kindergarten *and* 3rd grade.

The ECLS-K longitudinal design offered four advantages. First, it gave opportunity to analyze the effects of changes in food security status over time. Second, the large sample size allowed for substantial statistical power. Third, national representation of the sample allowed for generalizations to the entire population. Fourth, ample supplementary information regarding characteristics of the children, parents, and home environments were collected as part of the ECLS-K.

Food Insecurity

Household food insecurity was measured using the USDA's Household Food Security Survey Module, an18-item scale designed to capture experiences associated with inadequate quality and quantity of the household food supply within the past 12 mo (1,24). The USDA module was administered to parents by means of telephone interview in the spring of 1999 and the spring of 2002. Parents responded in the affirmative or negative to each of the experiences itemized in the scale. In standard guidelines for use (1), households that affirm two or less responses are classified as food secure, and households that affirm three or more responses are classified as food insecure.

A previous study using ECLS-K data suggests experiencing food insecurity at even marginal levels is associated with child development (22). Using the standard threshold of three or more affirmative responses to the USDA food security module had less value in predicting mathematical test performance compared to a threshold of one or more affirmative responses on the module. Also, households affirming one or

two responses (labeled marginally food secure) were more similar in mean baseline characteristics to households affirming greater than two responses compared to households affirming no responses. The authors concluded that reporting *any* affirmative response on the module signifies increased food insecurity.

We created two separate binary variables to represent the experience of food insecurity in both 1999 and 2002. For the first variable, only households reporting greater than two affirmative responses on the USDA module were coded as food insecure; all other households were coded as food secure. For the second variable, households reporting *any* (1 or more) affirmative response on the USDA module were coded as food insecure; households reporting zero affirmative responses were coded as food secure. Of the households having valid responses, 8.7% reported three or more affirmative responses and 17.1% reported at least one affirmative response. Our preliminary results confirmed that the second measure better predicted differences in development, and this variable was used for all successive analysis.

To capture changes in food insecurity over time, a categorical variable was created to represent transitions into and out of food insecurity. Respondents were categorized into four groups: remained food secure at both times (persistent food secure), remained food insecure at both times (persistent food insecure), transitioned from food security to food insecurity (became food insecure), and transitioned from food insecurity to food security (became food secure).

Academic Performance

Direct assessments of mathematics and reading ability were individually administered in kindergarten and 3rd grade. The mathematical proficiency test measured understanding of the properties of numbers, mathematical operations, problem solving, understanding of patterns and relationships among numbers,

formulating conjectures, and identifying solutions. The reading proficiency test measured basic literacy, vocabulary, and reading comprehension (24).

Scaled scores for the mathematics and reading performances were calculated using item response theory (IRT). Although assessments are grade-appropriate and non-identical over time, IRT places each score on a continuous ability scale, making possible longitudinal measurements of gain in achievement. The scores represent estimates of the number of items students would have answered correctly had they completed all of the questions in all of the first- and second-stage forms. Values for IRT mathematics and reading scores ranged from 0 to 123 and from 0 to 154 respectively. Reliability of the test scores was high, between 0.92 and 0.95 (24).

Weight, height, and BMI

Children's heights and weights were directly assessed in both kindergarten and 3rd grade. A Shorr Board was used to obtain height measurements. A digital bathroom scale was used to obtain weight measurements. Heights and weights were each measured twice to minimize measurement error and the mean of each set of values was used. If two height values were ≥5 cm apart, the composite height was set as the value closest to 109.2 cm (the average height for a 5-y-old child) at kindergarten. In the case that the two weight values were ≥2.3 kg apart, the composite weight was set as the value closest to 18.2 kg (the average weight for a 5-y-old child) at kindergarten. BMIs (kg/m^2) were calculated from heights and weights (24). Weights and BMIs were within normal ranges for appropriate ages (25).

Social Skills

Children's social skills were assessed by teacher questionnaires. Teachers rated how often their students exhibited certain social skills and behaviors on a scale of one (never) to four (very often), for a variety of behaviors within each of five

overall scales. Three of the five scales captured positive aspects of children's development: approaches to learning (behaviors that affect ease of benefiting from the learning environment); self control (ability to control behavior); and interpersonal skills (forming and maintaining friendships, getting along despite differences, comforting or helping others, and showing sensitivity). The other two scales captured externalizing (acting-out) and internalizing (anxiety, loneliness, low self-esteem, sadness) problem behaviors. Scores were computed only if the student was rated on at least two-thirds of the items within each of the five scales. All of these measures were adapted from Gresham and Elliott's (26) Social Skills Rating System. The reliability for the teacher social rating scales is high (24).

Following preliminary analysis with individual scales, we averaged the individual scales to create a composite social skills behavior score, where a higher score indicated better social skills. The scale for internalizing problem behaviors was not averaged into the score for two reasons: first, its low correlation with the other scale measures; and second, previous literature questioning the validity of teacher-ratings of internalized behaviors (24-26). Change in social skills score was calculated by subtracting the kindergarten composite score from the 3rd grade composite score. Separate analysis was done using a composite average of all five scales (including internalizing behaviors) and yielded similar results.

Control Measures

Controlling for many individual, parent and household variables in the analysis reduced the possibility of spurious associations between the variables of interest. The following child-specific data were collected by means of direct assessment and parent report at both times: gender, age, birth weight, home language, race-ethnicity, disability (diagnosed activity, mobility, speech, hearing or vision problem), health

insurance coverage, and frequency of exercise per week. Children were classified into four race-ethnicity categories: non-Hispanic white, non-Hispanic black or African-American, Hispanic of any race, and other (which includes children of Native American and Asian descent). Children were categorized as normal birth weight, low birth weight (≥1500 and <2500 g), or very low birth weight (<1500 g). We created dichotomous variables for: non-English as the home language, the presence of a child disability, and child health insurance coverage. Child psychomotor skills were assessed at kindergarten only and rated on a composite scale of 0 (poor) to 17 (excellent).

Parents reported the following information about home environments at both times: family income (multiples of $5000 up to $40,000; $40,001-50,000; $50,001-75,000; $75,001-100,000; $100,001-200,000; >$200,001), number of parents in household (1; 2; no biological/step parents), household size (total number people), mother's age, father's age, parent marital status (married; divorced; widowed; separated; never married; no biological/adoptive parent in home), mother's age at first birth, parent employment (≥35 h/w; <35 h/w; looking for work; not in labor force; no mother/father in household), highest education level attained by either parent (<8^{th} grade; 9^{th}-12^{th}; high school diploma; vocational/technical program; some college; bachelor's degree; some graduate/professional school; master's degree; doctorate/professional degree), child care arrangements (no non-parental care; relative care; non-relative care; center-based program; other/variation), number of siblings, parent ratings of his or her own depression and ability to "get going" (never; sometimes/moderate amount; most of time;), region of residence (Northeast; Midwest; South; West), area of residence (large/mid-size city; suburb/large town; small town/rural), and neighborhood safety rating (not at all safe; somewhat safe; very safe).

Data regarding the death of a close relative in the past two years and the number of places the child had lived in the past three years were collected in the spring of 2002 only.

Composite variables were created to capture transitions between kindergarten and 3rd grade for relevant background variables. Categorical variables were: child disability (no change; became disabled, became non-disabled), child health insurance (no change; became covered, became uninsured), parent marital status (no change; became married, became divorced, became separated, became widowed), parent employment (no change; became part time; became full time; change to looking; change to not in labor force); child care arrangements (no change; change to no non-parental care; started center-based care; started relative care; started non-relative care), region of residence (no change; moved to Northeast; moved to South; moved to Midwest; moved to Pacific), and area of residence (no change: moved to large city; moved to large town/suburb; moved to rural/small town). Differences between kindergarten and 3rd grade values were computed for: child's frequency of exercise, household income, number of parents, household size, highest education level attained by either parent, number of siblings, parent ratings of his or her own depression and ability to "get going", and neighborhood safety rating.

Statistical Methods

Preliminary analyses showed non-normal distributions for change in BMI, change in weight, initial mathematics score, and initial reading score. Logarithmic transformations of these variables were used to create measures with normal distributions. Results are reported after back transformations of means and regression coefficients.

Initial analysis determined whether children with missing data due to loss to follow-up differed in any way from those with complete data. A binary variable distinguished children with missing data from those with complete data across both time points, which was then regressed (logistic) upon all available background variables. Any variable identified as predicting the probability of missing data was included in the analysis as a covariate.

Multiple linear regression methods were used to test the differential effects of food insecurity transitions on the five child developmental outcomes of interest: change in mathematics score, change in reading score, change in weight and BMI (controlling for height), and change in social skills score. The SAS *surveyreg* (version 9.1, SAS Institute, Cary, NC) procedure accounted for effects of survey clustering, primary sampling units, and sample weights. ECLS-K sampling weights adjusted for an over-sampling of Asian and Pacific Islanders and non-response. Analyses were run using the full sample and gender-stratified samples. Differences were deemed significant at the 5% level.

Models

Each of the five developmental outcomes was analyzed using four models: (1) lagged model without controls, (2) lagged model with controls, (3) dynamic model, and (4) difference model. The lagged model assessed the effects of initial food insecurity on subsequent development. This model makes use of the temporal sequence to establish that food insecurity precedes its effect and that the association is not likely due to reverse causality. For the first analysis, change in development score was modeled as a function of initial development score and initial food insecurity (food insecure vs. food secure):

$$\Delta\ score_{3-k} = \beta_0 + \beta_1\ score_k + \beta_2\ FIS_k + E$$

where the subscripts 3 and k refer to the time of assessment (3rd grade or kindergarten) and FIS refers to food insecurity status.

The previous model estimated effects of kindergarten food insecurity on subsequent developmental trajectories without regard to background characteristics. A second lagged model was conducted in which time-invariant variables were controlled: $\Delta\ score_{3\text{-}k} = \beta_0 + \beta_1\ score_k + \beta_2\ FIS_k + \beta_3\ covariates_k + E.$

To reduce bias further, a third lagged model was conducted in which both time-invariant and time-varying variables were controlled:

$$\Delta\ score_{3\text{-}k} = \beta_0 + \beta_1\ score_k + \beta_2\ FIS_k + \beta_3\ covariates_k + \beta_4\ covariates_{3\text{-}k} + E,$$

Though the lagged model is useful in establishing direction, it does not take into account food insecurity at 3rd grade. A dynamic model has the advantage of capturing the differential effects of food insecurity between kindergarten and 3rd grade. For the dynamic model analysis, change in development score was modeled as a function of initial development score, time-invariant covariates, time-varying covariates, and food insecurity modeled as a four-category variable to capture both persistent and transitional effects:

$$\Delta\ score_{3\text{-}k} = \beta_0 + \beta_1\ score_k + \beta_2\ \Delta FIS_{3\text{-}k} + \beta_3\ time\text{-}invariant\ covariates_k + \beta_4\ time\text{-}varying\ covariates_k + \beta_4\ \Delta\ time\text{-}varying\ covariates_{3\text{-}k} + E$$

The difference model is a reduced version of the dynamic model concerned only with transitions. Change in development score was modeled as a function of time-varying covariates and change in household food insecurity:

$$\Delta\ score_{3\text{-}k} = \beta_0 + \beta_1\ \Delta FIS_{3\text{-}k} + \beta_2\ \Delta\ covariates_{3\text{-}k} + E,$$

Continuous variables, including food insecurity, were entered into the model as differences. Categorical variables were entered into the class statement, with 0 representing no change from kindergarten to 3rd grade and each level other than 0

representing a change in status (e.g., 1=became divorced, 2=became married, 3=became widowed).

The difference model removes individual fixed effects and eliminates the influence of time-invariant unobserved (and observed) heterogeneity by differencing out effects of factors that that remain unchanged over time and focusing entirely on transitions. This model theoretically gives the least biased estimates of association (30), assuming there is a short lag between the experience of becoming food insecure and its effect on child development relative to the duration of time between measurements. We controlled for as many relevant child- and household-level time-varying covariates as available.

RESULTS

Observed changes in outcomes were in expected ranges for child age and developmental stage **(Table 3.1).** Reading IRT score increased by 70.43 points, mathematics IRT score by 53.37 points, weight by 10.96 kg, and BMI by 1.99 kg/m^2. Teacher-rated social skills score changed little (-0.06 points). Mean weights at kindergarten and 3rd grade were slightly above the expected norm for a healthy-weight population. The observed mean weight of 22.5 kg and mean age of 6.23 years at kindergarten corresponds roughly to the 65th percentile weight-for-age for a healthy population. Three years later, the observed mean weight of 34.26 kg corresponds roughly to the 75th percentile weight-for-age for a healthy population (25).

Without controlling for background variables, children from households experiencing food insecurity at kindergarten demonstrated a 2.34 point smaller increase in mathematics score, a 4.39 point smaller increase in reading score, a 0.27 unit greater gain in BMI, a 0.44 kg greater gain in weight, and a 0.08 point greater decline in social skills score compared with children from food-secure households at

Table 3.1.
Selected Developmental Outcomes at Kindergarten and 3rd Grade, and Changes in Outcomes [2]

Outcome	Spring, 1999 Kindergarten		Spring, 2002 3rd Grade		Difference, Kindergarten to 3rd Grade	
	n	Mean ±SD	n	Mean ±SD	n	Mean ±SD
Mathematics Score	13556	32.17 ±11.57	12362	85.49 ±17.75	11460	53.37 ±12.35
Reading Score	13055	39.35 ±13.55	12287	108.70 ±20.03	10990	70.43 ±16.12
BMI, kg/m^2	13504	16.42 ±2.32	11936	18.63 ±3.86	11011	1.99 ±2.12
Weight, kg	13511	22.58 ±4.45	11972	34.26 ±9.19	11056	10.98 ±5.08
Social Skills Score	13119	3.22 ±0.55	10169	3.18 ±0.56	9261	-0.06 ±0.54

[2] Includes children with complete data: scored academic assessment *and* food security portion of parent interview completed

kindergarten **(Table 3.2).** Stratification by gender showed the associations between academic outcomes and kindergarten food insecurity were significant for both males and females. Associations between kindergarten food insecurity and changes in BMI and weight were significant for females only (β=0.503 kg/m^2 and β=0.827 kg). The association between kindergarten food insecurity and change in social skills was significant for males only (β= -0.135).

After controlling for both time-varying and time-invariant covariates in the lagged model, the association between kindergarten food insecurity and change in mathematics score remained negative, although significantly only for females (β= -1.766, P<0.017). Kindergarten food insecurity also showed significant effects for BMI, weight, and social skills outcomes among females only (β=0.428 kg/m^2, β=0.764 kg, and β=0.09 points). Sign changes were observed for reading performance, BMI, and weight outcomes among males, but associations remained non-significant.

Over time, persistent food insecurity as well as transitions into and out of food insecurity were found to have effects on several outcomes **(Table 3.3)**. Children from persistently food *insecure* households showed a 0.35 kg/m^2 greater gain in BMI (P<0.028) and a 0.65 kg greater gain in weight (P<0.026) compared with children from persistently *food secure* households after controlling for all time-invariant and time-varying covariates, including initial height and change in height. These associations were significant among girls (β=0.55 kg/m^2 and β=1.041 kg, respectively) but not among boys in the stratified analysis.

Persistent food insecurity was not significantly associated with differential changes in mathematics score, reading score, or social skills score when contrasted with persistent food security in the full sample. Among girls only, however, persistent

Table 3.2. Lagged Model Effects of Kindergarten Food Insecurity (FI) on Outcomes, Where FI Defined as ≥1 Affirmative Responses on USDA Module

Change in Outcome, Kindergarten to 3rd Grade	Effect of Kindergarten Food Insecurity					
	Controlling only for Kindergarten Outcome Score		Additionally Controlling for Kindergarten Background Covariates[3]		Additionally Controlling for Changes (Kindergarten to 3rd grade) in Background Covariates[4]	
	n	β-coefficient (p-value)	n	β-coefficient (p-value)	n	β-coefficient (p-value)
Mathematics Scaled Score						
All	11180	-2.335 (<0.0001)	9090	-1.303 (0.0116)	8191	-1.474 (0.0051)
Males	5682	-2.099 (0.0009)	4497	-1.038 (0.1695)	4157	-1.091 (0.1652)
Females	5498	-2.578 (<0.0001)	4365	-1.589 (0.0176)	4034	-1.766 (0.0165)
Reading Scaled Score						
All	10758	-4.387 (<0.0001)	8545	-0.631 (0.3249)	7907	-0.242 (0.7222)
Males	5452	-3.878 (<0.0001)	4332	-0.545 (0.5120)	4010	0.097 (0.9114)
Females	5306	-5.116 (<0.0001)	4213	-1.025 (0.2358)	3897	-0.738 (0.4220)
BMI (kg/m^2)[5]						
All	10869	0.274 (0.0003)	8571	0.088 (0.4184)	7898	0.162 (0.1151)
Males	5534	0.082 (0.4156)	4360	-0.181 (0.1285)	4013	-0.098 (0.3922)
Females	5335	0.503 (<0.0001)	4211	0.384 (0.0137)	3885	0.428 (0.0022)
Weight (kg)[iii]						
All	10869	0.440 (0.0036)	8571	0.260 (0.2365)	7898	0.276 (0.1341)
Males	5534	0.128 (0.4934)	4360	-0.205 (0.3817)	4013	-0.210 (0.3127)
Females	5335	0.825 (0.0002)	4211	0.740 (0.0155)	3885	0.761 (0.0024)
Social Skills Scaled Score						
All	9160	-0.083 (<0.0001)	7295	0.007 (0.7858)	6812	0.013 (0.5919)
Males	4595	-0.135 (<0.0001)	3648	-0.052 (0.1464)	3411	-0.048 (0.1743)
Females	4566	-0.037 (0.1538)	3648	0.083 (0.0054)	3401	0.091 (0.0016)

[3] Controlling for kindergarten outcome score, child's age, child's gender, child's race-ethnicity, whether child low birthweight, initial child disability status, initial child health insurance status, whether first language spoken at home not English, initial household income, initial household size, initial frequency of child's exercise, parents' age, mother's age at first birth, initial parent marital status, initial parent highest education, initial parent depression rating, initial parent rating of ability to get going, initial child care status, initial parent employment status, initial number of parents, initial number of siblings, initial neighborhood safety rating, initial area of residence, and initial region of residence

[4] Additionally controlling for *changes* in: disability status, child health insurance status, household income, household size, frequency of exercise, parent marital status, parent highest education, parent depression rating, parent rating of ability to get going, child care status, parent employment status, number of parents, number of siblings, region of residence, area of residence, neighborhood safety rating; number of close relatives died in past 2 y, number of residences for more than 4 mo in past 2 y

[5] Additionally controlling for child's initial height and change in height

Table 3.3.
Dynamic Model Effects of Food Insecurity Over Time, Where Food Insecurity Defined as 1 or More Affirmative Responses on USDA Module[6]

Change in Outcome, Kindergarten to 3rd Grade	n	Effect Over Time In Comparison to Persistently Food Secure				In comparison to Became Food Secure
		Persistently Food Insecure	Became Food Secure	Became Food Insecure	Food Insecure At Any Time	Became Food Insecure
		β-coefficent (p-value)	β-coefficent (p-value)	β-coeffienct (p-value)	β-coefficent (p-value)	β-coefficient (p-value)
Math Score						
All	8189	-0.615 (0.462)	-1.503 (0.005)	-0.957 (0.220)	-1.025 (0.032)	0.546 (0.541)
Males	4155	-0.085 (0.942)	-1.156 (0.147)	0.008 (0.942)	-0.411 (0.543)	1.164 (0.406)
Females	4034	-1.098 (0.326)	-1.680 (0.045)	-1.451(0.156)	-1.41 (0.039)	0.114 (0.853)
Reading Score						
All	7906	-0.902 (0.421)	0.081 (0.908)	-3.209 (0.0007)	-1.343 (0.039)	-3.290 (0.003)
Males	4009	1.219 (0.330)	-0.419 (0.688)	-2.834 (0.069)	-0.820 (0.414)	-2.415 (0.168)
Females	3897	-2.911 (0.078)	0.739 (0.465)	-3.568 (0.0035)	-1.913 (0.030)	-4.307 (0.003)
BMI (kg/m^2)[7]						
All	7896	0.354 (0.028)	0.027 (0.809)	0.018 (0.889)	0.133 (0.151)	-0.009 (0.956)
Males	4011	0.196 (0.300)	-0.232 (0.076)	0.107 (0.584)	0.024 (0.848)	0.339 (0.119)
Females	3885	0.552 (0.021)	0.313 (0.060)	-0.075 (0.704)	0.263 (0.052)	-0.388 (0.119)
Weight (kg)[v]						
All	7896	0.649 (0.026)	0.034 (0.869)	0.092 (0.701)	0.258 (0.122)	0.059 (0.840)
Males	4011	0.319 (0.353)	-0.438 (0.068)	0.243 (0.496)	0.124 (0.854)	0.680 (0.092)
Females	3885	1.040 (0.016)	0.535 (0.068)	-0.069 (0.841)	0.502 (0.038)	-0.605 (0.165)
Social Skills Score						
All	6812	0.020 (0.625)	0.008 (0.739)	-0.030 (0.287)	-0.001 (0.982)	-0.039 (0.255)
Males	3411	0.021 (0.711)	-0.080 (0.038)	-0.009 (0.826)	-0.023 (0.467)	0.071(0.169)
Females	3401	0.033 (0.542)	0.123 (<.0001)	-0.060 (0.101)	0.032 (0.269)	-0.182 (<.0001)

[6] Controlling for kindergarten outcome score, child's age, child's gender, child's race/ethnicity, whether child born low birth weight, whether child's first language spoken at home not English, initial and change in child disability status, initial and change in child health insurance status, initial and change in household income, initial and change in household size, initial and change in frequency of child's exercise, initial and change in parent highest education level, mom's age, dad's age, mom's age at first birth, whether mom was married at child's birth, initial and change in parent depression rating, initial and change in parent rating of ability to get going, initial and change in type of family in household, initial and change in parent marital status, initial and change in child care status, initial and change in parent employment status, whether close relative died in past 2 y, total number places child lived for more than 4 mo in past 3 y, initial and change in neighborhood safety rating, initial and change in area of residence, initial and change in region of residence

[7] Additionally controlling for child's initial height and change in height

food insecurity was associated with a smaller increase in reading score (β= -2.91; P<0.078)) compared to persistent food security. Children from households transitioning from food *security* to food *insecurity* exhibited a 3.21 point smaller increase in reading score (P<0.0007) in contrast to children from households remaining food secure. The significance of this contrast was observed regardless of gender. Children from households transitioning from food *insecurity* to food *security* exhibited a 1.50 point smaller increase in mathematics score (P<0.005) in contrast to children from households remaining food secure. Transitioning from food *insecurity* to food *security* was also associated with a greater increase in social skills score for females (P<0.0001) but with a smaller increase in social skills for boys (P<0.038).

Significant effects of food insecurity were found using the difference model as well **(Table 3.4).** When children from households that became food *insecure* were contrasted with children from households that became food *secure*, food insecurity was associated with a smaller increase in reading score (β = -3.41; P<0.005). Though the observed associations were negative for both boys and girls, the association for boys was somewhat weaker and not statistically significant.

Gender-stratified analysis using the difference model shows differential effects of food insecurity on BMI, weight, and social skills. Becoming food insecure was associated significantly with *greater* weight and BMI gains among boys (β=1.165 kg and β=0.430 kg/m^2, respectively) but non-significantly with *smaller* weight and BMI gains among girls (β= -0.809 kg and β= -0.446 kg/m^2, respectively). Becoming food insecure was associated significantly with greater *decline* in social skills score among girls (β= -0.135; P<0.005) but with greater *improvement* in social skills score among boys (β=0.124; P<0.050).

Table 3.4.
Difference Model Effects of Transitions in Food Insecurity Status, Where Food Insecurity Defined as 1 or More Affirmative Responses on USDA Module

Change in Outcome, Kindergarten to 3rd Grade	n	Became Food Insecure vs. Became Food Secure[8] β-coefficent (p-value)
Mathematics Scaled Score		
All	8775	-0.012 (0.991)
Males	4450	0.168 (0.911)
Females	4325	-0.047 (0.974)
Reading Scaled Score		
All	8471	-3.413 (0.005)
Males	4292	-3.182 (0.102)
Females	4179	-3.833 (0.014)
BMI (kg/m^2)[9]		
All	8471	-0.005 (0.978)
Males	4305	0.430 (0.059)
Females	4167	-0.446 (0.091)
Weight (kg) [vii]		
All	8472	0.135 (0.681)
Males	4305	1.165 (0.019)
Females	4167	-0.809 (0.105)
Social Skills Scaled Score		
All	7275	-0.001 (0.986)
Males	3644	0.124 (0.050)
Females	3631	-0.135 (0.005)

[8] Controlling for change in household income, change in child disability status, change in number of parents in household, change in parent marital status, change in mother's employment status, change in father's employment, change in child insurance status, change in parent depression rating, change in parent rating of ability to get going, difference in household size, change in frequency of child's exercise, whether close relative died in past 2 y, change in parent education status, total number places child lived in past 3 y for more than 4 mo, change in child care status, change in area of residence, change in region of residence, change in number of siblings in houshold, change in neighborhood safety rating

[9] Additionally controlling for child's change in height

Background characteristics for the subset of children with full data are summarized in **Tables 3.5-3.6**. Included are the characteristics for the 15.6% of kindergarteners from households affirming one or more responses on the USDA food security module. **Table 3.7** summarizes background characteristics over time. Characteristics of the entire sample at kindergarten have been reported elsewhere (17). Between kindergarten and 3rd grade, 77.9% of children's households remained food secure, 6.0% remained food insecure, 9.7% became food secure and 6.5% became food insecure (n=11,460). 22.2% experienced food insecurity at one *or* both times.

DISCUSSION

The first aim of the study was to examine the effects of household food insecurity at kindergarten on subsequent selected dimensions of child development. Food insecurity at kindergarten predicted impaired academic performance in reading and mathematics for girls and boys, greater decline in social skills for boys, and greater weight and BMI gains for girls. Food insecurity thus serves as an important marker for identifying children with delayed trajectories of development.

After controlling for known confounders in the lagged model, food insecurity at kindergarten predicted poorer mathematics performance for girls, greater BMI and weight gains for girls, and greater improvement in social skills for girls. The relationship between social skills and food insecurity in girls was unexpected. A limitation of using the lagged model, however, is that it does not control for changes in food insecurity between kindergarten and 3rd grade; that is, we do not know whether the improvement in social skills observed among girls is due to initial food insecurity or simultaneous improvements in food security. In fact, the dynamic model showed

Table 3.5.
Child and Family Background Characteristics for the ECLS-K Cohort at Kindergarten, 1998-99[10]

Background Variable	All Children		Food Insecure Children[11]	
	n	Mean ±SD	n	Mean ±SD
Child's age, mo	11460	74.70 ±4.40	1792	74.64 ±4.47
Household income, $	11460	56,889 ± 56,532	1792	25,726 ±21,576
Household members, n	10359	4.50 ±1.33	1592	4.82 ±1.74
Siblings, n	10359	1.44 ±1.12	1592	1.38 ±1.29
Mother's age, y	10186	34.02 ±6.41	1566	32.33 ±6.88
Father's age, y	8850	36.80 ±6.70	1053	35.18 ±7.17
Mother's age at first birth, y	9751	24.63 ±5.44	1489	21.78 ±4.73
Frequency child exercises, d/wk	11123	3.92 ±2.29	1736	3.84 ±2.40

[10] Includes only children with full data available at both kindergarten, 1998-99, *and* third grade, 2003: scored reading or math assessment *and* food security portion of parent interview completed
[11] Where FI defined as ≥1 affirmative response on USDA module

Table 3.6.
Child and Family Background Characteristics for the ECLS-K Cohort at Kindergarten, 1998-99[12]

Characteristic	n	All Children %	n	Food Insecure Children[13] %
Household Food Insecurity	11460		1792	
Fully food secure		84.36		0
Marginally food secure		7.74		49.50
Food insecure		7.90		50.50
Without hunger		6.34		40.51
With moderate hunger		1.37		8.75
With severe hunger		0.19		1.23
Child Level				
Female	11460	49.07	1792	47.6
Race/ethnicity	11449		1791	
White, non-Hispanic		62.05		40.2
Black, non-Hispanic		11.35		18.87
Hispanic		16.60		28.25
Other, or more than one race		9.99		12.67
Child health insured	11452	92.16	1790	85.70
Child disabled	10353	13.73	1591	16.34
Low birth weight	11460	10.37	1792	15.41
Household Level				
Household income at or below poverty line	11460	16.88	1792	56.70
Mother's employment status	10316		1581	
≥35 h/wk		44.71		43.33
<35 h/wk		23.15		18.41
Looking for work		2.83		5.76
Not in labor force		27.80		30.87
No mother in household		1.51		1.64
Father's employment status	10273		1573	
≥35 h/wk		75.72		55.00
<35 h/wk		2.85		2.67
Looking		1.30		3.62
Not in labor force		2.66		4.45
No father in household		17.46		34.27

[12] Includes only children with full data available at both kindergarten, 1998-99, *and* third grade, 2003: scored reading or math assessment *and* food security portion of parent interview completed

[13] Food insecurity defined as ≥1 affirmative responses on USDA module

Table 3.6 (Continued)

Parents in household, n	11460		1792	
One		18.10		33.60
Two		80.15		63.78
No biological or step parents		1.75		2.62
Marital status of biological parents	11454		1792	
Married		74.76		54.19
Divorced/Separated		11.48		20.54
Widowed		0.80		1.28
Never married		10.83		21.09
No biological/adoptive parents		2.13		2.90
First language spoken at home not English	11395	12.15	1780	22.70
Caregiver self-reported depression	11299		1760	
Never		72.81		52.16
Sometimes/Moderate Amount		22.03		36.08
Most of Time		5.16		11.76
Caregiver self-reported “can’t get going”	11303		1759	
Never		58.28		43.15
Sometimes/Moderate amount		33.76		42.47
Most of time		7.96		14.39
Child care status	10287		1577	
No non-parental care		51.84		56.94
Relative care		18.09		21.05
Non-relative care		10.75		7.93
Center based program		17.18		11.60
Other		2.13		2.48
Parent education, highest level attained	11460		1792	
Less than high school diploma		7.73		19.03
High school diploma		23.72		35.94
Vocational/tech program degree		5.42		7.20
Some college		26.83		25.61
Bachelor’s degree with/without some grad school		22.81		9.99
Graduate/professional degree		13.5		2.23
Area of residence	11460		1792	
Central city		37.43		43.69
Urban fringe/suburbs and large town		39.15		31.70
Small town and rural		23.42		24.61
Parental rating of safety for playing outdoors	11445		1789	
Not at all safe		3.05		7.94
Somewhat safe		23.96		38.74
Very safe		72.99		53.33
Region of residence	11460		1792	
Northeast		19.34		14.79
Midwest		26.29		21.71
South		32.50		33.76
West		21.87		29.74

Table 3.7.
Changes in Child and Family Background Characteristics for the ECLS-K Cohort, Kindergarten to 3rd Grade, 1998-99 to 2002[14]

	n	All Children %
Child Level		
Child health insured	11452	
No change		80.16
Became insured		14.33
Became uninsured		5.51
Child disabled	10353	
No change		74.21
Became disabled		19.43
Became non-disabled		6.36
Household Level		
Household income	11460	
Remained at or below poverty threshold		11.37
Remained above poverty threshold		76.81
Entered poverty		6.31
Exited poverty		5.51
Mother's employment status	10316	
No change		62.81
Started ≥35 h/wk		13.81
Started <35 h/wk		12.66
Change to looking for work		2.24
Changed to not in labor force		7.31
Change to no mother in household		1.17
Father's employment status	10273	
No change		80.70
Started ≥35 h/wk		2.26
Started <35 h/wk		2.76
Started looking		1.32
Change to not in labor force		2.38
Change to no father in household		5.59
Parents in household	11460	
No change		88.74
Change to 1 parent household		6.09
Change to 2 parent household		4.51
Change to household with no biological or step parent		0.65

[14] Includes only children with full data available at both kindergarten, 1998-99, *and* third grade, 2003: scored reading or math assessment *and* food security portion of parent interview completed

Table 3.7 (Continued)

Marital status of biological parents	11454	
No change		83.59
Change to married		6.54
Change to divorced/separated		2.94
Change to widowed		4.59
Change to no biological/adoptive parents in household		1.49
Has had close relative die in past 2 y	11456	28.02
Caregiver self-reported depression	11299	
No Change		69.67
Increase in Depression		13.07
Decrease in Depression		17.16
Caregiver self-reported “can’t get going”	11303	
No change		60.29
Increase in problem		15.84
Decrease in problem		23.88
Child care status	10287	
No change		58.14
Change to no non-parental care		20.96
Change to relative care		9.39
Change to non-relative care		3.25
Change to center based program		6.81
Change to other arrangement		1.45
Parent education, highest level attained	11460	
Decrease in education		4.45
No change		78.89
Increase in education		16.65
Area of residence	11460	
No change		96.45
Moved to central city		0.97
Moved to urban fringe/suburbs and large town		1.96
Moved to small town/rural area		0.63
Parental rating of safety for playing outdoors	11445	
No change		75.30
Increase in safety		10.02
Decrease in safety		14.68
Region of residence	11460	
No change		99.38
Moved to northeast		0.11
Moved to midwest		0.12
Moved to south		0.19
Moved to west		0.20
Number of places child lived for more than 4 mo in past 2 y, n	11449	
0		0.81
1		87.94
2		9.98
3+		1.27

the greatest improvement in social skills among girls from households becoming food insecure between kindergarten and 3rd grade.

For the second aim, we examined the relationship of changes in food insecurity over time on concurrent development using dynamic and difference models, each having its own advantages. Whether contrasted with children from persistently food secure households (in the dynamic model) or households that became food secure (in either the dynamic or difference model), children from households that became food insecure exhibited poorer reading performance, and this was especially significant among girls. The magnitude of the difference was about one-fourth of the SD of the change from K to 3rd grade. For girls, there is evidence for a relatively short lag between food insecurity and its effects on reading from comparing results in Tables 2 and 3. Persistent food insecurity through 3rd grade increased the delay in reading (β= -2.911) relative to the effect of food insecurity at kindergarten alone (β= -0.738). The association of kindergarten food insecurity with reading performance reversed if the household left food insecurity by 3rd grade (β=0.739). Given evidence of a short lag, and given that the difference model provides the least biased estimates of association under this assumption, we conclude that the difference model represents a true association between food insecurity and delayed reading performance among girls. Although the direction of the association was the same for boys, the association was not significant, and there was no evidence for a relatively short lag.

In regards to predicting mathematics performance, the effect of food insecurity at kindergarten, rather than change in status over time, matters most for boys and girls. Coefficients for remaining food insecure or becoming food secure (dynamic model) were similar to effects of kindergarten food insecurity (lagged model) on mathematics performance, suggesting no effect of 3rd grade status. This may be in part due to the

possibility of long lag between food insecurity and its effect on mathematics performance.

Though the links between malnutrition and cognition (31) and between fasting and cognition in children (32) have been well established, literature reporting on the effects of less severe forms of food insecurity on academic performance is less consistent. Two studies have reported significant associations between food insecurity and lower test scores for arithmetic, letter-word, and passage comprehension (7,15), although associations with reading performance and two other measures of cognitive functioning were not found to be significant in one of the studies (15). Alternatively, three studies reported no significant cross-sectional associations between food insecurity and cognitive or academic performance (8,11,17). No studies to date have attempted longitudinal, gender-stratified analyses, therefore this study advances the field by providing the strongest longitudinal evidence that food insecurity is associated with impaired reading performance for girls. Our study is also consistent with previous findings using ECLS-K of a negative association between kindergarten food insecurity and mathematics learning (22).

This is the first study to investigate the longitudinal relationship between household food insecurity and social skills in children. Comparisons between Tables 2 and 3 suggest a short lag between food insecurity and socials skills for girls: food security status at 3rd grade changes the observed effect on social skills relative to kindergarten food insecurity. Under the assumption of short lag, we find an association between food insecurity and impaired social skills among girls. Girls from households becoming food insecure exhibited smaller gains in social skills whether compared to girls from households becoming food secure (B= -0.135 in difference model, $P<0.005$) or persistently food secure households (β= -0.06 in dynamic model;

P<0.101). For boys, unexpectedly, it appears that the transition from food *insecurity* to food *security* is associated with modest deficits in social skills over time (B= -0.124 in difference model; P<0.050). Evidence for a short lag is less clear for boys, however, making this association questionable.

This study used teacher reports of social skill competence rather than parent or child report, direct observation, or a combination of methods. Studies suggest that both teacher and parent reports are important for assessing overall social competence of children (33). These teacher reports did not account for factors such as teacher distress or cultural background (27). Nonetheless, reliabilities for the rating scales were found to be high and teacher-reported social skills provide the best means of measuring social competence in the absence of additional data.

The association found between household food insecurity and impaired social skills development among girls is consistent with cross-sectional studies reporting significantly greater risks of psychosocial dysfunction and behavioral and attention problems among hungry and at-risk-for-hungry children compared to not-hungry children (13,14), though neither study reported gender-stratified results and both were restricted to analysis of low-income children. The finding among girls is also consistent with cross-sectional studies linking food insecurity with decreased levels of positive behavior (8), decreased levels of teacher-rated "social ability" (17), difficulty getting along with other children (15) and greater levels of social behavior problems (7,10) in children. No previous study exists, however, to corroborate the potential association between food insecurity and *better* social skills among boys, perhaps due to the lack of gender-stratified, longitudinal analyses.

Less clear are the conclusions that can be drawn from analysis of the effect of food insecurity on weight or BMI. Though results from the difference model support

an association between food insecurity and reduced gain in weight among girls, caution is warranted in interpreting the results due to the possibility of a long lag between cause and effect. Rather, the strong association between kindergarten food insecurity and subsequent greater weight gain among girls remains significant regardless of food insecurity at 3rd grade, suggesting that the change in food security status matters little. The difference model also suggests an association between food insecurity and *greater* weight gain among boys. From the dynamic model, 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. Unless we are sure about this assumption, however, we do not know whether the difference model provides the least biased estimates of association. This study was not able to control for parental height and weight in assessing effects on child weight and BMI.

Overweight and obesity have emerged in recent years as major public health problems. To date, only one study has looked at the effects of household food insufficiency on child weight status by gender (15). Food-insufficiency was associated with reduced risk of overweight among 2- to 7-y-old girls but with increased risk of overweight among 8- to 16-y-old non-Hispanic white girls. The strong association between kindergarten food insecurity and greater subsequent weight gain among girls in this study could explain the greater risk of overweight among older girls if the effect is cumulative. Two previous cross-sectional studies using ECLS-K to examine effects of food insecurity found no associations with BMI or weight status (17,22)

Several mechanisms may explain associations between food insecurity and developmental outcomes. One possible mechanism is that food insecurity results in compromised dietary quality or quantity (34). Studies show that adults in food insecure households had lower consumption of fruits and vegetables (35), had less food on hand (35), obtained a higher percentage of energy from carbohydrate (36), and had lower intakes of dietary fiber and other vital nutrients (36) compared with food secure households. Alternatively, economic deprivation may be associated with consumption of cheap, energy-dense foods that contribute to weight gain (37,38). Either decreases in diet quality or increases in energy density could lead to accelerated weight gain and may relate to academic and social development in children.

Another possible mechanism is that food insecurity acts as a psychological or emotional stressor affecting parent and child behavior. Lupien and colleagues (39) found that children of low socioeconomic status have significantly higher cortisol levels than children of high socioeconomic status, and that this effect emerges as early as age 6. Cumulative exposure to high levels of cortisol in humans has been related to depression, cognitive deficits, and atrophy of brain structures involved in learning and memory (40,41). Several studies have shown that economic hardship is linked with increases in children's social behavior problems, and that this association can be mediated by parent-child interactions (40-44) as well as children's feeling of control or mastery over time in relation to perceived financial difficulties (45,46). One study in Canada has linked food insecurity directly with stress, anxiety, sociofamilial perturbations and disrupted household dynamics (47).

The latter mechanism, in which food insecurity acts as a stressor, would better support observed gender differences in the effects of food insecurity. That is, it better explains how food insecurity at the household level could affect girls and boys

differentially at the individual level. Previous studies have reported gender differences in children's and adolescents' reactions to life stress and acute stress (16,45,47-53). A recent study suggests that higher levels of anxiety may protect preadolescent boys from engaging in antisocial behaviors, which might partially explain the increase in social skills score observed among boys transitioning into food insecurity in this study (53).

Overall, this study provides the strongest empirical evidence to date that food insecurity is linked to developmental consequences for girls and boys, particularly impaired social skills development and reading performance for girls. There are three possible explanations for the associations between food insecurity and development outcomes: first, child development problems result in concurrent household food insecurity; second, food insecurity results in concurrent developmental consequences, and third, other variables confound the relationship. Since there is no theoretical reason to assume that impaired child development causes household food insecurity and we have controlled for confounders at the individual and household levels, the most plausible interpretation of the results is that food insecurity in the early elementary years results in developmental consequences. Furthermore, the consequences of food insecurity for children may be both nutritional and non-nutritional.

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CHAPTER IV.
PARTICIPATION IN THE NATIONAL SCHOOL LUNCH AND SCHOOL BREAKFAST PROGRAMS AND CHILD DEVELOPMENT

INTRODUCTION

Household (HH)[15] food insecurity and food insufficiency have been linked to nutritional and non-nutritional consequences for children. A growing body of literature shows that for children and adolescents, HH food insecurity is associated with higher prevalence of inadequate intake of key nutrients in children (1,2), risk of overweight or greater weight gain (2-4), poor school performance and academic delays (4-10), and poor social functioning and behavior problems (4-7,11-14).

Federal food assistance programs exist in the U.S. to prevent HH food insecurity and its consequences. The School Breakfast Program (SBP) and National School Lunch Program (NSLP) comprise the second largest of these programs in terms of federal expenditures, exceeding $7 billion combined in 1998 (15). School nutrition programs have been associated with positive developmental outcomes for children. SBP participation has been associated cross-sectionally with improvements in nutritional status, verbal skills, academic performance, comprehension, attendance and psychosocial functioning and with reduced hyperactivity and tardiness among school-aged children in the U.S. and developing countries (16-24). Qualitative studies have also cited child benefits from implementation of universally free breakfast programs, including better concentration, increased alertness, improved social

[15] AFDC=Aid to Families with Dependent Children (also known as Temporary Assistance for Needy Families (TANF))
ECLS-K=Early Child Longitudinal Study—Kindergarten Cohort
FSP=Food Stamp Program
HH=household
K=kindergarten
NSLP=National School Lunch Program
SBP=School Breakfast Program
USDA=U.S. Department of Agriculture

behavior, decreased discipline problems, better attendance, and general improvements in math and reading scores (25,26). NSLP participation has recently been associated with increased overall intakes of essential vitamins and nutrients (27) and a reduced risk of overweight in U.S. children (10).

On the other hand, there is growing concern that school meal programs may be contributing to negative health and social consequences associated with food insecurity. NSLP and SBP participation have been associated with higher intakes of fat (28,29) and overall energy (28). In England, school breakfast attendance was associated with borderline or abnormal conduct and hyperactivity scores among primary school children (30). NSLP participation has been associated with lower mathematics scores (9) and with weight gain, triceps fatfold thickness and overweight (31,32) among school-aged children. The potential link between school meals and overweight is of particular concern in a nation where rates of overweight and obesity are escalating. The role of schools in curbing overweight has received recent attention. One study reported that a school policy or practice of offering healthy menu alternatives was not found to be associated with reduced risk of overweight and obesity, but that a more intensive program meeting U.S. Centers for Disease Control recommendations for school-based healthy eating programs was associated with reduced risk of overweight and obesity (33).

Program participation, both at the child and school levels, is an elective behavior that responds to social, economic and personal circumstances (34), making it difficult to distinguish between causal effects of the program and selection effects of the choice to participate. Selection bias can occur if participants are more highly motivated to achieve program-related outcomes compared to non-participants (35). Investigations done primarily with cross-sectional data cannot be used to untangle the

complex relations among food insecurity, program participation and developmental outcomes; this analysis must be done using longitudinal data.

Longitudinal data have clear analytical advantages over the use of cross-sectional data. First, the temporal nature of the data allows for the measurement of change across time. Thus, the data can be used to examine how change is associated dynamically with other factors using multiple time points (36). For example, how does the transition from non-participation to participation relate to consequent weight gain? Second, since individuals are measured temporally, one can be more certain that observed outcomes are associated with initial exposure status and not due to reverse causality. Third, longitudinal data allow for investigation of intra-individual changes, thus reducing effects of unmeasured confounders (36). In short, absent a randomized design, longitudinal data provide the best means to establish that observed effects are causal and not due to confounding, selection bias, or reverse causality (37).

Whitmore (32) used Early Childhood Longitudinal Data-Kindergarten Cohort (ECLS-K) panel data to investigate the association between school lunch participation and overweight among white students ineligible for free or reduced-price lunch and attending schools participating in the school lunch program. Kindergarteners consuming school lunches were about two percentile points more likely to be obese after two years, controlling for baseline obesity and multiple background characteristics. This analysis did not involve food insecurity.

Four studies to date have used longitudinal data to examine effects before and after start of school breakfast programs in U.S schools. Controlling for baseline comprehension test scores, Meyers and colleagues (18) reported better comprehension test scores among SBP-participating 3rd to 6th graders compared to non-participants after initiation of the program in the school. This study did not take into account food

insecurity status. Controlling for ethnicity, grade level, child gender, marital status, and food insufficiency, Murphy and colleagues (38) reported improved math grades and decreased symptoms of child- and teacher-reported psychosocial problems among children who increased their rate of receiving school breakfasts after implementation of universally free breakfast programs in three public schools. Worobey and colleagues (39) reported better performance on several pre-academic performance tasks among preschoolers who participated six weeks in a class-initiated breakfast program compared to preschoolers who consented not to participate. Bro and colleagues (40) reported better on-task vocational and academic behavior among Caucasian high school boys after they all participated in an in-class breakfast program. All four analyses were however limited by small sample sizes and likely bias due to selection, differences in performance at baseline (41), and other uncontrolled confounders. Furthermore, no analysis investigated the potential interaction between food insecurity and school breakfast participation.

The investigation of program participation as a potential modifier between food insecurity and developmental outcomes is important if we consider an alternative conceptual framework to the one usually assumed. Most researchers have assumed that program participation reduces food insecurity or malnutrition, thereby improving outcomes. The Life Stress Model is an alternative conceptualization in which program participation acts as a resource to modify the effects of food insecurity (a stressor) on outcomes. Preliminary evidence for a modifying role of food assistance comes from a study reporting reduced risk of overweight among food insecure girls participating in the Food Stamp Program (FSP) and NSLP compared to non-participating food insecure girls (10). To our knowledge, no studies have investigated whether NSLP or SBP participation acts as a modifier between food insecurity and child outcomes.

The purpose of this study was to determine relations between child participation in the School Breakfast Program or National School Lunch Program, household food insecurity and selected dimensions of children's academic, social, and physical development over several years using a prospective longitudinal study design and modeling techniques that attempt to account for bias. First, we investigated whether participation in the SBP or NSLP had independent effects on changes in child reading and mathematics test performance, social skills development, and weight gain, while controlling for food insecurity and other covariates. Second, we investigated whether SBP or NSLP participation modified the relationships between need for food assistance and child development outcomes.

OVERVIEW OF SCHOOL NUTRITON PROGRAMS

School Breakfast Program

The School Breakfast Program, administered by the U.S. Department of Agriculture (USDA), was started in 1967 and aimed to provide breakfasts to "nutritionally needy" children, particularly children of low-income families and working mothers, as well as those living in rural areas where children might have to travel long distances to school (42). It became a permanent entitlement program in 1975 (43). The SBP provides mid-day meals to students at full price, reduced price, or for free, according to uniform national eligibility criteria based on family income and size. Children from families with incomes at or below 130 percent of the poverty line are eligible for free breakfasts and children from families with incomes between 130 and 185 percent of the poverty line are eligible for reduced price breakfasts (42). In 2003-2004, 43 children received free or reduced-price school breakfast for every 100 who received free or reduced-price school lunch (44). Schools are reimbursed based

on the number of meals served and the percentage of free or reduced-price meals. Any child attending a SBP-participating school may purchase a school breakfast, although the vast majority of children participating in the program are those receiving free or reduced-price breakfasts (15,42). Universal school breakfast programs are rare and refer to any school program that offers breakfast at no charge to all students, regardless of income (44).

On a typical day in 2002-2003, over 8 million children were served school breakfasts through more than 78,000 public and private schools and residential child care institutions (45). About 22 percent of children attending participating schools participated in the program each day, and 83 percent of breakfasts served were free or reduced-price (46). School breakfasts are expected to provide one-fourth of the recommended dietary allowances for energy and select nutrients (43), no more than 30 percent of calories from fat, and less than 10 percent of calories from saturated fat (44).

National School Lunch Program

The USDA enacted the National School Lunch Program in 1945 as a "measure of national security, to safeguard the health and well-being of the Nation's children" (47). Any child in a participating school may purchase a school lunch, and about half of all children in participating schools regularly participate in the program on a given day (42). Like the SBP, children from families with incomes at or below 130 percent of the poverty line are eligible for free lunches and children from families with incomes between 130 and 185 percent of the poverty line are eligible for reduced price lunches (42). Children from households receiving food stamps, receiving Temporary Assistance for Needy Families, or participating the Food Distribution Program on

Indian Reservations are also eligible for free school meals (47). About half of all school lunches served go to children from low-income families (48).

School lunches are required to provide at least one-third of the recommended dietary allowances for energy and select nutrients (protein, vitamin A, vitamin C, iron, calcium), no more than 30 percent of calories from fat, and less than 10 percent of calories from saturated fat (47).

About 99 percent of all public schools and 20 percent of all private schools participated in the NSLP in 1994, and over half of all children in participating schools regularly participated in the program (42,46). In 2003-2004, over 28 million children participated in the NSLP, and about 58% of these children were receiving free or reduced-priced lunches on a typical day (46).

SUBJECTS AND METHODS

Restricted-use data were obtained from the ECLS-K (49), which utilized a multistage probability, cluster sample design to select a nationally representative sample of 21,260 kindergarten children attending 1,592 elementary schools in 1998-1999. Data were collected non-experimentally by means of survey and direct child assessment over four consecutive years. We utilized parent, teacher, child and administrator data from kindergarten (1998-99) and spring of 3rd grade (2002). Data from children with full response—i.e., eligible children who completed some assessment data *or* had a parent who completed the family section of the parent interview—were available for 20,578 children in the spring of 1999 and for 15,305 children in the spring of 2002. Attrition was mainly due to children moving outside of the primary sampling units or moving to areas where they could not be located. Locatable movers from a random 50% of schools were followed. A small number of

children became ineligible because they moved outside of the U.S.A. or died. Our two analytic samples consisted of 1) about 12,800 children for whom full data—a valid scored reading or mathematics assessment, parent report of child's participation in the NSLP or SBP, *and* parent completion of the USDA food security module—were available at kindergarten and 2) about 10,600 children for whom full data were available at both kindergarten *and* 3rd grade.

The ECLS-K longitudinal design offered four advantages. First, the large sample size allowed for substantial statistical power. Second, it gave opportunity to analyze the effects of dynamic changes in program participation over time. Third, national representation of the sample allowed for generalizations to the entire population. Fourth, ample supplementary information regarding characteristics of the children, parents, schools, and home environments were collected as part of the ECLS-K.

SBP Participation

A child was classified as having participated in the SBP if his or her parent reported the child "usually receives a breakfast provided by the school." Children of parents who reported that the school did not offer breakfast to its students were classified as non-participants. Although data were available on the reported number of breakfasts children had received in the previous five school days, we did not include these data in our measure of participation since only parents reporting "usual participation" by their children were asked to supply this information. Children of parents who reported they do not "usually" eat school breakfast would have been wrongly coded as eating no school breakfasts during the 5-day period, thereby greatly reducing accuracy of the measure. Information about whether the child received free,

reduced-price or full price school breakfasts was collected at 3rd grade only and therefore not utilized.

To capture changes in SBP participation over time, a categorical and a continuous variable were created. Respondents were categorized into the following four groups: never participated, participated at both K and 3rd grade, started participating between K and 3rd grade, and stopped participating between K and 3rd grade. The continuous variable was computed as the difference between the dichotomous values representing SBP participation at K and 3rd grade, where starting participation was coded as 1, stopping participation was coded as –1, and no change in participation was coded as 0.

NSLP Participation

A child was classified as having participated in the NSLP if his or her parent reported the child "usually receives a complete lunch offered at school," regardless of whether the lunch was free, reduced-price or full price. Children of parents who reported that the school did not offer lunch to its students were classified as non-participants.

To capture changes in participation over time, a categorical and a continuous variable were created. Respondents were categorized into the following four groups on the basis of participation: never participated, participated at both K and 3rd grade, started participating between K and 3rd grade, and stopped participating. The continuous variable was computed as the differences between the dichotomous values representing participation at K and 3rd grade, where starting participation was coded as 1, stopping participation was coded as –1, and no change in participation was coded as 0.

Food Insecurity

Household food insecurity was measured using the USDA's Household Food Security Survey Module, an18-item scale designed to capture experiences associated with inadequate quality and quantity of the household food supply within the past 12 mo (50,51). The USDA module was administered to parents by means of written survey in the spring of 1999 and the spring of 2002. Parents responded either in the affirmative or negative to each of the experiences itemized in the scale. In standard guidelines for use (50), households that affirm two or less responses are classified as food secure, and households that affirm three or more responses are classified as food insecure.

Based on similar previous work by other researchers (8) and by the authors of this study (4), we defined food insecurity as 1 or more affirmative responses on the USDA module. Households affirming zero experiences on the module were coded as food secure. Of the households having valid responses, 17.1% were food insecure according to this modified definition. To capture changes in modified food insecurity over time, a categorical and a continuous variable were created to represent transitions into and out of food insecurity. Percentages of children falling into each category have been published previously (4).

Composite Need/Material Hardship

Food insecurity is one measure of the extent to which families are able to meet their basic needs, or in other words, the extent to which families experience "material hardship" (52). A recent study reported that over half of poor families face multiple hardships (53). The use of food insecurity alone may be insufficient for capturing experiences and consequences that federal assistance programs intend to address. If this is true, we expect to see small, if any, modifying effects of SBP or NSLP

participation in our results. We created a composite "need" measure in an attempt to better represent overall material hardship and to take advantage of data on multiple measures seemingly related to this construct (52). Rotated factor analysis determined that the following four variables loaded onto one factor: 1) (the inverse of) highest education level of either parent in HH, 2) (the inverse of) HH poverty index ratio category (≤130%; >130% & ≤185%; >185% & ≤240%; >240% & ≤295%; >295% & ≤350%; >350% & ≤405%; >405%), 3) (the inverse of) home computer ownership, and 4) food insecurity defined as ≥1 affirmative response on USDA module. Z-scores for each variable (K and 3rd grade) were computed for each child, weighted according to K factor loadings, and averaged into composite "need" scores, with separate scores generated for K and 3rd grade. A higher value indicates greater "need" or "material hardship". Change in "need" was computed by subtracting kindergarten scores from 3rd grade scores. A higher difference indicated a greater increase in need.

Academic Performance

Direct assessments of mathematics and reading were individually administered in K and 3rd grade. The mathematical proficiency test measured understanding of the properties of numbers, mathematical operations, problem solving, understanding of patterns and relationships among numbers, formulating conjectures, and identifying solutions. The reading proficiency test measured basic literacy, vocabulary, and reading comprehension (51).

Scaled scores for the mathematics and reading performances were calculated using item response theory (IRT). IRT procedures place each score on a continuous ability scale, making longitudinal measurements of gain in achievement possible although assessments are grade-appropriate and non-identical over time. The scores represent estimates of the number of items students would have answered correctly

had they completed all of the questions in all of the first- and second-stage forms. Values for IRT mathematics scores ranged from 0 to 123 and for IRT reading scores from 0 to 154. Reliability of the test scores was high, between 0.92 and 0.95 (Bose, 2002).

Weight, height, and BMI

Children's heights and weights were directly assessed in both kindergarten and 3rd grade. A Shorr Board was used to obtain height measurements. A digital bathroom scale was used to obtain weight measurements. Heights and weights were each measured twice to minimize measurement error and the mean of each set of values was used. If two height values were ≥5 cm apart, the composite height was set as the value closest to 109.2 cm (the average height for a 5-y-old child) at kindergarten. In the case that the two weight values were ≥2.3 kg apart, the composite weight was set as the value closest to 18.2 kg (the average weight for a 5-y-old child) at kindergarten. BMIs (kg/m^2) were calculated from heights and weights (51). Weights and BMIs were within the normal range for appropriate ages (54).

Social Skills

Children's social skills were assessed by teacher questionnaires. Teachers rated how often their students exhibited certain social behaviors on a scale of one (never) to four (very often), for a variety of behaviors within each of five overall scales. Three of the five scales captured positive aspects of children's development: approaches to learning (behaviors that affect ease of benefiting from learning environment); self control (ability to control behavior); and interpersonal skills (forming and maintaining friendships, getting along despite differences, comforting or helping others, and showing sensitivity). The other two scales captured externalizing (acting-out) and internalizing (anxiety, sadness, low self-esteem, loneliness) problem

behaviors. Scores were computed only if the student was rated on at least two-thirds of the items within each of the five scales. All of these measures were adapted from Gresham and Elliott's Social Skills Rating System (55). The reliability for the teacher social rating scales is high (51).

Following preliminary correlation analysis and investigation of the effects of individual scales, we averaged the individual scales to create a composite social skills behavior score. The scale for internalizing problem behaviors was not averaged into the score for two reasons: first, its low correlation with the other scale measures; and second, previous literature questioning the validity of teacher-ratings of internalized behaviors (56-58). Change in social skills score was calculated by subtracting the kindergarten composite score from the 3rd grade composite score. Separate analyses using a composite average of all five scales yielded similar results.

Control Measures

Controlling for many child, parent and environmental variables in the analysis reduced the possibility of spurious associations between the variables of interest. The following child-specific data were collected at both times: gender, age, birth weight, home language, race-ethnicity, disability (diagnosed activity, mobility, speech, hearing or vision problem), health insurance coverage, and frequency of exercise per week. Children were classified into four race-ethnicity categories: non-Hispanic white, non-Hispanic black or African-American, Hispanic of any race, and other (which includes children of Native American and Asian descent). Children were categorized as normal birth weight, low birth weight ($\geq$1500 and <2500 g), or very low birth weight (<1500 g). We created dichotomous variables for: non-English as the home language, child disability, and child health insurance. Child psychomotor skills were assessed at kindergarten only and rated on a composite scale of 0 (poor) to 17 (excellent).

Additionally, parents reported the following household-level contextual information in the spring of 1999 and 2002: family income (multiples of $5000 up to $10,000; $40,001-50,000; $50,001-75,000; $75,001-100,000; $100,001-200,000; >$200,001), number of parents in household (1; 2; other arrangement), household size (total number people), mother's age, father's age, parent marital status (married; divorced; widowed; separated; never married; no biological/adoptive parent in home), mother's age at first birth, parents' employment (≥35 h/wk; <35 h/wk; looking for work; not in labor force; no mother/father in household), highest education level attained by either parent (<8th grade; 9th-12th; high school diploma; vocational/technical program; some college; bachelor's degree; some graduate/professional school; master's degree; doctorate/professional degree), child care arrangements (no non-parental care; relative care; non-relative care; center-based program; other/variation), number of siblings, parent ratings of his or her own depression and ability to "get going" (never; sometimes/moderate amount; most of time;), region of residence (Northeast; Midwest; South; West), area of residence (large/mid-size city; suburb/large town; small town/rural), and neighborhood safety rating (not at all safe; somewhat safe; very safe). Death of a close relative in the past two years and the number of places the child had lived in the past three years were assessed in 3rd grade only.

Composite variables were created to capture differences or transitions across time for all relevant background variables. Categorical variables were: child disability (no change; became disabled, became non-disabled), child health insurance (no change; became covered, became uninsured), child's exercise (difference in frequency per week), household income (difference in category), number of parents in home (difference), household size (difference), parent marital status (no change; became

married, became divorced, became separated, became widowed), parents' employment (no change; became part time; became full time; change to looking; change to not in labor force); parent education (difference in highest level achieved), child care arrangements (no change; started no non-parental care; started center-based care; started relative care; started non-relative care), number of siblings (difference), parent depression and ability to act (difference in rating), region of residence (no change; moved to Northeast; moved to South; moved to Midwest; moved to Pacific), area of residence (no change: moved to large city; moved to large town/suburb; moved to small town/rural area), and neighborhood safety rating (difference in rating).

Statistical Methods

Preliminary analyses showed non-normal distributions for change in BMI, change in weight, initial mathematics score, and initial reading score. Logarithmic transformations of these variables were used to create measures with normal distributions for analysis. Results are reported after back transformations of means and regression coefficients.

Initial analysis determined whether children with missing data due to loss to follow-up differed in any way from those with complete data. A binary variable distinguished children with missing data from those with complete data across both time points, and was regressed (logistic) upon all available background variables. Any variable identified as predicting the probability of missing data was included in the analysis as a covariate.

Contingency tables compared the numbers of children participating in two programs simultaneously at kindergarten, as well as the numbers of children transitioning into and out of multiple programs simultaneously. Chi-square tests assessed whether children were more likely to start or stop two programs concurrently

than to start one program while leaving another. The programs compared were the SBP, the NSLP, the Food Stamp Program (FSP), and Aid to Families with Dependent Children (AFDC).

Multiple linear regression methods were used to test for differential effects on four child developmental outcomes of interest: change in mathematics score, change in reading score, change in weight (controlling for height), and change in social skills score. The SAS *surveyreg* procedure (version 9.1, SAS Institute, Cary, NC) was used to account for effects of survey clustering, primary sampling units, and sample weights. ECLS-K sampling weights adjusted for an over-sampling of Asian and Pacific Islanders and non-response. Differences were deemed significant at the 5% level.

For school breakfast, separate sets of analyses were run using 1) the full sample (N=12,268), and 2) a restricted subset of children attending SBP-participating schools *and* not changing schools between K and 3rd grade (N=6020). Schools were classified as SBP-participating if the school principal, administrator, or headmaster reported that the school participated in the USDA's school breakfast program at 3rd grade. Schools' participation in the USDA breakfast program was not directly assessed at K, precluding its use in classifying children more accurately. Though it is possible that schools started or stopped offering the USDA school breakfast program in the time a child moved from K to 3rd grade, this number was likely to be small and non-influential overall. We did not use parents' report of school breakfast participation because the information did not always correspond with administrators' report, and administrators' report was considered a more reliable measure. Among the full sample, 67.56% of children attended SBP-participating schools at 3rd grade. This number is similar to parent-reported rates of school participation at K (66.32%) and 3rd

grade (69.74%), and corresponds with reported rates of national school participation (44,59).

For school lunch, separate sets of analyses were run using 1) the full sample (N=12,268) and 2) a restricted subset of children attending NSLP-participating schools *and* not changing schools between K and 3rd grade (N=6223). Despite data collected from parents on schools' offering of lunches, administrator reports of school participation were deemed more reliable. Schools were classified as NSLP-participating if a school principal, administrator, or headmaster reported that one or more children in the school participated in the free lunch program at kindergarten. Administrators were not directly asked about school NSLP participation. Though it is possible that schools offered the NSLP without any children in the school participating in the *free* meal program, the likelihood of such misclassification was deemed to be small and non-influential overall. A proportion of administrators did not report the number of children participating in the free school lunch program, therefore reducing the size of the restricted sample. Among the full sample, 88.49% of children (n=13176) attended NSLP-participating schools at K. This number was slightly lower than parent-reported (90.13%) and nation-wide (92%) (48) estimates of school-level participation.

We narrowed our analysis to NSLP- or SBP-participating schools to eliminate potential bias resulting from a school's decision to participate in the USDA programs. We narrowed our analysis to children that did not change schools between K and 3rd grade to eliminate potential bias resulting from changes in school-level factors. We have assumed that the bias due to selection and school-level confounding is larger than potential bias resulting from restriction. Results using the restricted samples may not be representative of all children since children from participating and non-

participating schools may differ in ways we have not controlled, and similarly, children that did not change schools may differ from children that did change schools in ways that we have not controlled. Rather, we report results analyzed using the full sample for comparison in making generalizations.

Models

Each of the four developmental outcomes of interest was analyzed using four models: (1) a lagged model without controls, (2) a lagged model with controls, (3) a dynamic model, and (4) a difference model. The lagged model was used to assess the effects of kindergarten participation in the SBP or NSLP, or the interaction between participation and food insecurity at kindergarten, on subsequent development. This model has advantages over cross-sectional models because it makes use of the temporal sequence of data to establish that participation precedes its effect and that the association is not likely due to reverse causality. For the first analysis, change in development score was modeled as a function of kindergarten development score and kindergarten SBP or NSLP participation, controlling for kindergarten food insecurity only:

$$\Delta\, score_{3-k} = \beta_0 + \beta_1\, score_k + \beta_2\, FIS_k + \beta_3\, SNPP_k + E,$$

where the subscripts 3 and k refer to the time of assessment (3rd grade or kindergarten), SNPP refers to participation in the school nutrition program, and FIS refers to food insecurity status.

The previous model allowed for prediction of future trajectories of development on the basis of kindergarten participation and food insecurity without regard to background characteristics. To further investigate these associations, a second lagged model was conducted in which child-level and household-level time-invariant and time-varying variables were controlled:

$$\Delta\ score_{3\text{-}k} = \beta_0 + \beta_1 score_k + \beta_2\ covariates_k + \beta_3\ covariates_{3\text{-}k} + \beta_4 FIS_k + \beta_5\ SNPP_k + E$$

The same model was run including an interaction term and substituting composite need for food insecurity:

$$\Delta\ score_{3\text{-}k} = \beta_0 + \beta_1\ score_k + \beta_2\ covariates_k + \beta_3\ covariates_{3\text{-}k} + \beta_4\ FIS\ or\ NEED_k + \beta_5\ SNPP_k + \beta_6\ FIS\ or\ NEED_k * SNPP_k + E,$$

where NEED refers to the continuous composite measure of material hardship or need.

Though the lagged model is useful in establishing direction, it does not take into account food insecurity at 3rd grade. A dynamic model has the advantage of capturing the differential effects of food insecurity between kindergarten and 3rd grade. For the dynamic model analysis, change in development score was modeled as a function of initial development score, time-invariant and time-varying covariates, food insecurity over time, and SBP participation over time. SBP participation was modeled as a four-category variable to capture the effects of both persistent and transitional participation. The dynamic model was:

$$\Delta\ score_{3\text{-}k} = \beta_0 + \beta_1\ score_k + \beta_2\ time\text{-}invariant\ covariates_k + \beta_3\ time\text{-}varying\ covariates_k + \beta_4 \Delta\ time\text{-}varying\ covariates_{3\text{-}k} + \beta_5\ \Delta FIS_{3\text{-}k} + \beta_6\ \Delta SNPP_{3\text{-}k} + E,$$

The difference model is a reduced version of the dynamic model concerned only with changes over time. For the difference model analysis, change in development score was modeled as a function of changes in *time-varying* covariates, difference in food insecurity or composite need over time, and difference in SBP participation over time:

$$\Delta\ score_{3\text{-}k} = \beta_0 + \beta_1 \Delta\ covariates_{3\text{-}k} + \beta_2\ \Delta FIS\ or\ NEED_{3\text{-}k} + \beta_3\ \Delta SNPP_{3\text{-}k} + E$$

The same model was run including an interaction term and substituting composite need for food insecurity:

$$\Delta \text{ score}_{3\text{-}k} = \beta_0 + \beta_1 \Delta \text{ covariates}_{3-k} + \beta_2 \Delta \text{FIS or NEED}_{3-k} + \beta_3 \Delta \text{SNPP}_{3-k} + \beta_4 \Delta \text{FIS or NEED}_{3-k} * \Delta \text{SNPP}_{3-k} + E,$$

Continuous variables were entered into the model as differences over time. Categorical variables were entered into the class statement, with 0 representing no change from kindergarten to 3rd grade and each level other than 0 representing a change in status (e.g., 1=became divorced, 2=became married, 3=became widowed).

The difference model removes individual fixed effects and eliminates the influence of time-invariant unobserved (and observed) heterogeneity by differencing out effects of factors that that remain unchanged over time and focusing entirely on transitions. We accounted for time-varying heterogeneity by controlling for as many relevant child- and household-level time-varying covariates as possible. This model theoretically gives the least biased estimates of association (60), assuming there is a short lag between starting or stopping the SBP and its effect on child development relative to the duration of time between measurements. This model only lends claim to causality if effects are able to play out temporally.

RESULTS

Means for outcome scores at K and 3rd grade have been previously presented (4). Between K and 3rd grade, reading scaled scores increased by 70.43 (±16.12) points, mathematics scaled scores increased by 53.37 (±12.35) points, weights increased by 10.98 (±5.08) kg, and social skills scaled scores decreased by -0.06 (±0.54) points.

Chi-square analyses showed transitions in SBP participation were associated with parallel transitions in school lunch participation ($P<0.0001$). Children were less likely to start one school nutrition program while stopping the other, in comparison to

starting both simultaneously or stopping both simultaneously. Transitions in SBP participation were not associated with parallel transitions in AFDC participation (P<0.2330) and were slightly associated with parallel transitions in Food Stamp Program (FSP) participation (P<0.011). Transitions in *free or reduced-price* school lunch participation were associated with parallel transitions in FSP participation (P<0.0001) and AFDC participation (P<0.0009), but transitions in *any* school lunch participation were not (P<0.2135 and P<0.4558, respectively).

School Breakfast Program

Of all parents, 23.52% (n=15133) and 26.13% (n=12979) reported their children participated in the SBP at K and 3rd grade, respectively. From administrator reports of school participation, we calculated 38.68% of 3rd graders attending SBP-participating schools were receiving breakfasts. Child participation rates based on parent report of school participation were similar (35.49% at K and 37.48% at 3rd grade). Among the full (non-restricted) sample of children (N=11,539), 67.20% had never participated in the SBP, 14.85% participated at both K and 3rd grade, 11.08% started participating between K and 3rd grade, and 6.87% stopped participating between K and 3rd grade.

Among the restricted sample of children—those attending a SBP-participating school *and* not changing schools between K and 3rd grade—54.00% of children never participated in the SBP at either time, 22.39% participated both times, 15.14% started participating between K and 3rd, and 8.47% stopped participating between K and 3rd.

Kindergarten background characteristics according to SBP participation are presented in **Tables 4.1 and 4.2**. The prevalence of SBP participation among food insecure children was 43.55% in K and 50.54% at 3rd grade, compared to 19.28% and 22.21% among food secure children at these times. Alternatively, 32.27% and 26.36%

Table 4.1.
Background Characteristics According to SBP Participation, *Full and Restricted Samples*

Characteristic	Full Sample		Restricted Sample (Attended SBP-Participating School at 3rd and No School Change Between K and 3rd)	
	% of SBP Participants at K having characteristic	% of characteristic group participating in SBP at K	% of SBP Participants at K having characteristic	% of characteristic group Participating in SBP at K
Child-level factors				
Gender				
Female	47.63	22.86	48.01	31.53
Male	52.37	24.15	51.99	32.48
Race				
White	32.94	13.40	35.47	20.95
Black	31.28	52.01	27.80	58.78
Hispanic	23.60	32.08	23.24	38.13
Other	12.18	26.71	13.49	38.81
Disabled	15.49	25.45	14.19	32.28
Child not health insured	15.03	40.30	15.77	46.83
Non-English language spoken at home	19.84	34.71	20.77	41.32
Birth weight				
≥2500 g	83.59	22.14	84.67	30.84
Low birthwt (≥1500g;<2500 g)	7.92	31.04	7.20	37.76
Very low birthwt (<1500 g)	8.49	38.52	8.13	43.52
HH-Level				
Food insecure*	32.27	43.55	31.95	52.07
Below Poverty Threshold	46.70	54.14	44.44	57.88
Poverty Index Ratio				
<130%	59.60	50.63	57.81	54.54
≥130% and <185%	15.37	27.67	16.08	33.10
≥185% and <240%	8.37	19.66	9.39	26.25
≥240% and <295%	5.23	12.75	5.53	18.50
≥295% and <350%	3.32	9.06	3.23	12.90
≥350% and <405%	2.92	9.25	3.00	14.33
≥405%	5.20	5.19	4.96	10.75

* Where food insecurity defined as ≥1 affirmative response on USDA module

Table 4.1 (Continued)

Highest education level of parent in HH				
8th grade or below	6.86	53.04	7.20	55.80
9th-12th grade	14.86	54.15	14.01	56.38
High school diploma	38.83	35.47	38.96	40.70
Vocational/technical program	6.94	28.79	7.15	36.80
Some college	23.69	20.84	23.63	26.81
Bachelor's degree	5.82	7.49	6.22	14.08
Grad/profess. School-no degree	0.76	7.38	0.75	16.25
Master's degree (MA,MS)	1.83	6.05	1.79	11.31
Doctorate or profess. Degree	0.42	2.17	0.29	4.31
Number of parents in HH				
1 Parent HH	36.22	40.22	32.10	46.42
2 Parent HH	59.79	18.29	64.03	27.15
Other Arrangement	3.99	48.30	3.86	52.76
Parent marital status				
Married	49.35	16.42	53.81	25.24
Separated	7.68	40.21	6.93	47.43
Divorced	10.41	28.73	8.89	32.02
Widowed	1.15	33.33	0.92	34.78
Never married	26.51	47.50	25.23	54.76
No biological/adoptive parents	4.90	47.80	4.21	51.05
Mother not married at child's birth	51.69	41.49	48.03	46.52
Parent rating of depression				
Never depressed	62.97	20.51	64.81	29.28
Sometimes depressed	31.81	28.98	31.16	36.85
Most of the time depressed	5.22	43.83	4.02	48.57
Parent rating of inability to "get going"				
Never unable to "get going"	54.14	21.67	54.36	30.54
Sometimes	40.00	24.41	39.95	32.14
Most of the time	5.86	38.45	5.69	45.93
Mother's employment				
≥35 h/w	47.40	24.05	48.16	31.54
<35 h/w	13.77	14.43	13.43	22.21
Looking for work	7.55	47.93	6.41	51.61
Not in labor force	29.23	23.83	29.66	32.31
No mother in HH	2.05	28.90	2.34	38.46
Father's employment				
≥35 h/w	51.56	16.30	54.16	24.13
<35 h/w	3.24	26.26	3.35	31.45
Looking for work	2.52	42.08	2.55	46.34
Not in labor force	5.01	37.05	5.70	46.70
No father in HH	37.66	41.45	34.25	48.53

Table 4.1 (Continued)

Child care status				
No non-parental care	53.30	23.31	54.75	31.97
Relative care	24.07	29.74	25.87	38.89
Non-relative care	7.05	15.94	6.82	21.94
Center-based care	13.06	17.35	9.83	20.91
Other/variation	2.51	27.80	2.74	37.96
Ever serious financial problems since child's birth	34.67	34.40	31.72	39.61
Past WIC participation	79.52	40.84	79.69	46.63
Past Head Start participation	37.33	55.09	38.66	60.65
Participated Food Stamps in last 12 mo	37.34	57.01	33.22	60.02
Participated AFDC in last 12 mo	15.35	53.49	13.43	58.00
Participated School lunch program				
Full price meals	15.41	13.99	16.16	20.32
Free/reduced price meals	73.71	55.86	73.00	58.46
Neighborhood safety rating				
Not at all safe	6.31	42.42	4.97	45.74
Somewhat safe	35.93	32.22	34.58	40.69
Very safe	57.76	19.31	60.45	27.89
Location of residence				
Central city	42.06	24.90	34.52	30.83
Urban fringe	26.38	16.46	24.09	23.71
Small town/rural	31.55	32.88	41.38	41.91
Region of residence				
Northeast	11.58	15.06	8.47	20.30
Midwest	19.28	18.14	19.19	28.51
South	51.03	34.23	53.31	39.41
West	18.12	19.49	19.02	27.97

Table 4.2.
Background Characteristics According to SBP Participation, *Full and Restricted Samples*

Characteristic	Full Sample			Restricted Sample (Attended SBP-Participating School at 3rd and No School Change Between K and 3rd)	
	Participated in SBP at K	Did not participate in SBP; parent reported SBP offered at school	Parent reported SBP not offered at school, did not participate	Participated in SBP at K	Did not participate in SBP at K
	Mean	Mean	Mean	Mean	Mean
Child-level factors					
Age, mo	74.91	74.68	74.69	74.82	74.64
Composite motor score	11.65	12.27	12.72	11.75	12.43
Frequency exercise, d/wk	3.97	4.00	3.79	3.93	3.97
HH-Level					
Composite need score	-0.015	-0.443	-0.710	-0.017	-0.448
Income, $	25,725	50,080	75,991	26,013	49,256
HH size	4.80	4.51	4.45	4.82	4.50
# siblings	1.75	1.44	1.40	1.74	1.42
Mother's age, y	31.53	33.31	35.02	31.86	33.63
Father's age, y	34.55	36.04	37.78	34.87	36.38
Mother's age at first birth, y	20.79	23.81	26.29	21.00	24.08

of children participating in the SBP at K and 3rd grade respectively were food insecure. Participation rates in the SBP exceeded 40% among children with the following characteristics: black race, no health insurance, HH in poverty, neither parent with a high school diploma, separated or never married parents, father and/or mother looking for work, no father in HH, one parent HH, neighborhood rated as not at all safe, parent rated as depressed most of the time, and previous or current participation in WIC, the FSP, or AFDC. Alternatively SBP participants were proportionately more likely to be white, from households below poverty, from households with two married parents, from the central city, from the Southern region, and to have younger and less educated parents who work full time.

Of all children, 27.68% were eligible for free-priced meals at kindergarten and an additional 13.06% of children were eligible for reduced-price meals. Of children eligible for free-price meals, 50.63% and 58.81% at K and 3rd grade respectively were receiving school breakfasts at these times. Of children eligible for reduced-price meals, 27.67% and 33.09% at K and 3rd grade respectively were receiving school breakfasts at these times.

Without controlling for any background covariates, participation in the SBP at K was associated with poorer gains in reading performance and mathematics performance, greater weight gain, and poorer social skills scores among children attending the same SBP-participating school in K and 3rd grade **(Table 4.3).** Results using the non-restricted sample were similar **(Table 4.4).**

After controlling for kindergarten covariates *and* changes in covariates over time, participation in the SBP remained associated with smaller gains in reading and mathematics performance among the restricted sample (Table 4.3) although the link

Table 4.3.
Lagged Model Analysis of Effects of Kindergarten SBP Participation, *Restricted Sample* ♣

Change in Outcome, K to 3rd	Controlling only for K food insecurity♦ and K outcome score		Additionally controlling for initial values and changes in child and HH covariates, including change in HH food insecurity [16] ♦	
	n	Beta-coefficient (p-value)	n	Beta-coefficient (p-value)
Reading Scaled Score				
ALL	4295	-6.766 (<0.0001)	3191	-3.190 (0.0021)
Males	2207	-7.272 (<0.0001)	1635	-3.581 (0.0133)
Females	2088	-6.353 (0.0001)	1556	-2.3231 (0.0483)
Mathematics Scaled Score				
ALL	4545	-3.321 (0.0012)	3358	-1.185 (0.0902)
Males	2338	-3.645 (0.0002)	1714	-1.097 (0.288)
Females	2207	-2.959 (0.0257)	1644	-0.7533 (0.3659)
Weight (kg) ∞				
ALL	4474	0.839 (0.0001)	3284	0.577 (0.0041)
Males	2297	0.668 (0.0202)	1675	0.258 (0.3831)
Females	2177	1.018 (0.0001)	1609	0.938 (0.0008)
Social Skills Scaled Score				
ALL	4013	-0.126 (<0.0001)	2983	-0.109 (<0.0001)
Males	2033	-0.107 (0.0012)	1509	-0.150 (0.0001)
Females	1980	-0.156 (<0.0001)	1474	-0.052 (0.1138)

♣ Subset of children attending SBP-participating school at 3rd grade AND not changing schools between K and 3rd

♦ Where food insecurity defined as ≥ 1 affirmative response on USDA module

[16] Additionally controlled for K composite motor skills score, child age, child gender, child composite race, child birthweight, initial and change in child health insurance, initial and change in child disability, initial and change in HH income, initial and change in highest education level of either parent in HH, initial and change in parent ratings of depression and inability to "get going", initial and change in child frequency of exercise, parents' ages, initial and change in parents' employment status, whether mother married at child's birth, initial and change in number of siblings, initial and change in HH size, initial and change in neighborhood safety rating, initial and change in child care status, initial and change in number of parents in HH, initial and change in marital status of parents, initial and change in location of residence, initial and change in region of residence, past participation in WIC, Head Start participation, number of residences for more than 4 mo in past 3 y, whether close relative died in past 2 years

∞ Additionally controlled for initial and change in height

Table 4.4.
Lagged Model Analysis of Effects of Kindergarten Participation in SBP, *Full Sample*

Change in Outcome, K to 3rd	Controlling only for K food insecurity♦ and K outcome score		Additionally controlling for changes in child- and HH-level covariates, including change in HH food insecurity [17] ♦	
	N	β-coefficient (p-value)	N	β-coefficient (p-value)
Reading Score				
ALL	10110	-7.346 (<0.0001)	7427	-3.057 (0.0001)
Males	5124	-7.650 (<0.0001)	3765	-0.655 (0.5932)
Females	4986	-7.156 (<0.0001)	3662	-2.829 (0.0039)
Mathematics Score				
ALL	10523	-3.560 (<0.0001)	7443	-1.567 (0.0043)
Males	5348	-4.344 (<0.0001)	3909	-2.078 (0.0082)
Females	5175	-2.737 (0.0009)	3798	-0.763 (0.2550)
Weight (kg)∞				
ALL	10170	1.904 (<0.0001)	7430	1.495 (0.0001)
Males	5174	1.578 (0.0005)	3771	0.989 (0.0875)
Females	4996	2.303 (<0.0001)	3659	2.163 (<0.0001)
Social Skills Score				
ALL	8606	-0.117 (<0.0001)	6397	-0.0775 (0.0012)
Males	4318	-0.100 (<0.0001)	3209	-0.0902 (0.0031)
Females	4288	-0.143 (<0.0001)	3188	-0.0476 (0.0782)

♦ Where food insecurity defined as ≥ 1 affirmative response on USDA module

[17] Additionally controlled for K composite motor skills score, child age, child gender, child composite race, child birthweight, initial and change in child health insurance, initial and change in child disability, initial and change in HH income, initial and change in highest education level of either parent in HH, initial and change in parent ratings of depression and inability to "get going", initial and change in child frequency of exercise, parents' ages, initial and change in parents' employment status, whether mother married at child's birth, initial and change in number of siblings, initial and change in HH size, initial and change in neighborhood safety rating, initial and change in child care status, initial and change in number of parents in HH, initial and change in marital status of parents, initial and change in location of residence, initial and change in region of residence, past participation in WIC, Head Start participation, number of residences for more than 4 mo in past 3 y, whether close relative died in past 2 years

∞ Additionally controlled for initial and change in height

remained significant at the 5% level for reading only. SBP participation remained associated with increased weight gain, the association being strong and significant among females but not for males. SBP participation also remained associated with impaired social skills, the association being stronger (and significant) among males compared to females (Table 4.3). Coefficients and p-values generated using the full sample were similar to those generated using the restricted sample (Table 4.4).

Comparisons of results from the dynamic model with results from the lagged model suggest that SBP participation at 3rd grade is not irrelevant **(Table 4.5).** In most cases, participation in the SBP at both K and 3rd grade resulted in an effect approximately two times larger than the effect of kindergarten participation alone, after controlling for the same covariates. For example, children who participated in the SBP at both kindergarten and 3rd grade showed a 0.995 kg greater increase in weight compared to children who never participated ($P<0.0001$). This effect was about two times larger than the effect of K participation alone on weight gain ($\beta=0.577$ kg). Also, in most cases, the effect of starting SBP between K and 3rd (in comparison to never participating) mimicked the effect of K participation. For example, starting SBP participation between K and 3rd grade was associated with greater weight gain ($\beta=0.606$ kg; $P<0.005$), the magnitude of the effect about equivalent to the effect of K participation on weight gain ($\beta=0.577$ kg). Results for the other outcomes are comparable in this regard. Analyses of the full sample and restricted sample yielded similar results **(Table 4.6).**

Analysis of main effects of SBP participation using the difference model showed no significant effects of starting SBP participation (compared with stopping) on developmental outcomes among the restricted sample **(Table 4.7).** Gender-

Table 4.5.
Dynamic Model Analysis of Effects of SBP Participation Over Time[18], *Restricted Sample* ♣

Change in Outcome, K to 3rd		Effect in comparison to never participated in SBP				Effect in comparison to stopped SBP
	n	**Started SBP** β-coefficient (p-value)	**Stopped SBP** β-coefficient (p-value)	**Always SBP** β-coefficient (p-value)	**Ever SBP** β-coefficient (p-value)	**Started SBP** β-coefficient (p-value)
Reading Score						
ALL	3177	-0.723 (0.5050)	-0.678 (0.5564)	-4.837 (0.0002)	-2.079 (0.0058)	-0.045 (0.9754)
Male	1629	-0.450 (0.7914)	-1.021 (0.4993)	-5.018 (0.0024)	-2.163 (0.0347)	0.571 (0.7990)
Female	1548	-1.357 (0.3130)	-0.004 (0.9980)	-4.333 (0.3126)	-1.898 (0.0870)	-1.354 (0.4650)
Mathematics Score						
ALL	3344	-0.712 (0.3506)	-0.500 (0.5406)	-1.904 (0.0500)	-1.038 (0.0917)	-0.213 (0.8361)
Male	1708	-0.762 (0.4982)	-0.270 (0.8403)	-1.908 (0.1430)	-0.980 (0.2707)	-0.491 (0.7703)
Females	1636	-0.964 (0.3514)	-0.689 (0.5553)	-1.264 (0.2149)	-0.972 (0.2031)	-0.275 (0.8487)
Weight (kg) ∞						
All	3270	0.606 (0.0048)	0.377 (0.1659)	0.995 (<0.0001)	0.659 (0.0001)	0.225 (0.4623)
Male	1669	0.191 (0.5216)	-0.160 (0.7270)	0.567 (0.0966)	0.197 (0.4658)	0.355 (0.4602)
Female	1601	0.956 (0.0028)	1.089 (0.0009)	1.393 (0.0002)	1.145 (<0.0001)	-0.126 (0.7537)
Social Skills Score						
All	2970	-0.099 (0.0179)	-0.074 (0.0617)	-0.176 (<0.0001)	-0.116 (<0.0001)	-0.025 (0.6158)
Male	1503	-0.081 (0.2301)	-0.075 (0.2301)	-0.226 (<0.0001)	-0.127 (0.0008)	-0.006 (0.9332)
Female	1467	-0.121 (0.0170)	-0.064 (0.1896)	-0.109 (0.0039)	-0.098 (0.0027)	-0.057 (0.3710)

[18] Controlled for: K outcome score, K and change in food insecurity (defined as ≥1 affirmative response on USDA module), K composite motor skills score, child age, child gender, child composite race, child birthweight, past WIC participation, Head Start participation, K and change in HH income, K and change in highest education level of either parent in HH, K and change in parent ratings of depression and inability to "get going", K and change in frequency of exercise, parents' ages, mother's age at first birth, whether mother married at first birth, K and change in number of siblings, K and change in HH size, K and change in neighborhood safety rating, K and change in child health insurance, K and change in child disability, K and change in number of parents in HH, K and change in parent marital status, K and change in child care status, K and change in parents' employment status, K and change in location of residence, K and change in region of residence, number of places family has lived for more than 4 mo in past 3 y, whether close relative died in past 2 y

♣ Subset of children attending SBP-participating school at 3rd grade AND not changing schools between K and 3rd

∞ Additionally controlled for initial and change in height

Table 4.6.
Dynamic Model Analysis of Effects of SBP Participation Over Time[19], *Full Sample*

Change in Outcome, K to 3rd		Effect in comparison to never participated in SBP				Effect in comparison to stopped SBP
	n	**Started SBP** β-coefficient (p-value)	**Stopped SBP** β-coefficient (p-value)	**Always SBP** β-coefficient (p-value)	**Ever SBP** β-coefficient (p-value)	**Started SBP** β-coefficient (p-value)
Reading Score						
ALL	7300	-1.135 (0.2088)	-0.490 (0.6686)	-4.832 (<0.0001)	-2.152 (0.0004)	-0.644 (0.6515)
Male	3700	-1.816 (0.1523)	-1.395 (0.3584)	-4.917 (<0.0001)	-2.709 (0.0013)	-0.421 (0.8260)
Female	3600	-0.706 (0.5515)	-0.189 (0.8960)	-4.635 (<0.0001)	-1.843 (0.0306)	-0.517 (0.7628)
Mathematics Score						
ALL	7578	-0.584 (0.4132)	-0.378 (0.6532)	-2.021 (0.4132)	-0.978 (0.0544)	-0.257 (0.7797)
Male	3842	-0.911 (0.3401)	-1.132 (0.2262)	-2.726 (0.0062)	-1.652 (0.0171)	0.408 (0.7602)
Females	3736	-0.369 (0.6721)	0.262 (0.7678)	-1.009 (0.3081)	-0.372 (0.5828)	-0.631 (0.5326)
Weight (kg) ♦						
All	7307	0.456 (0.0075)	0.248 (0.3096)	1.061 (<0.0001)	0.585 (<0.0001)	0.207 (0.4828)
Male	3706	0.463 (0.0661)	0.105 (0.7605)	0.897 (0.0057)	0.485 (0.0233)	0.357 (0.3891)
Female	3601	0.361 (0.1295)	0.512 (0.1077)	1.238 (<0.0001)	0.700 (0.0006)	-0.148 (0.6714)
Social Skills Score						
All	6293	-0.062 (0.0342)	-0.040 (0.2770)	-0.116 (<0.0001)	-0.073 (0.0009)	-0.022 (0.6177)
Male	3157	-0.062 (0.1464)	0.029 (0.4912)	-0.172 (0.1464)	-0.068 (0.0301)	-0.091 (0.0673)
Female	3136	-0.065 (0.0997)	-0.084 (0.0938)	-0.046 (0.1631)	-0.065 ().0159)	0.019 (0.7525)

[19] Controlled for: K outcome score, K and change in food insecurity (defined as ≥1 affirmative response on USDA module), K composite motor skills score, child age, child gender, child composite race, child birthweight, past WIC participation, Head Start participation, K and change in HH income, K and change in highest education level of either parent in HH, K and change in parent ratings of depression and inability to "get going", K and change in frequency of exercise, parents' ages, mother's age at first birth, whether mother married at first birth, K and change in number of siblings, K and change in HH size, K and change in neighborhood safety rating, K and change in child health insurance, K and change in child disability, K and change in number of parents in HH, K and change in parent marital status, K and change in child care status, K and change in parents' employment status, K and change in location of residence, K and change in region of residence, number of places family has lived for more than 4 mo in past 3 y, whether close relative died in past 2 y

♦ Additionally controlled for initial and change in height

stratified analyses showed a likely interaction between SBP participation and gender, with the effect of SBP participation being associated with a greater (but non-significant) increase in reading score among males but with a smaller (but non-significant) increase in reading score among females. This interaction did not manifest, however, using the full sample of children in the analysis **(Table 4.8**).

Lagged model analysis showed no significant interaction effects between composite need and SBP participation for any outcomes using the restricted sample **(Table 4.9).** There was a significant interaction effect between *food insecurity* and SBP participation using the restricted sample however (Table not shown). Kindergarten SBP participation among food secure children was associated with smaller gains in mathematics score (β= -3.384 points) but SBP participation among food insecure children was associated with positive gains in mathematics score (β=0.474 points), with the difference being significant (P<0.0123). This interaction effect was not found to be significant using the full sample **(Table 4.10).**

Difference model analysis revealed a significant interaction effect between change in composite need and starting SBP-participation (compared to stopping participation) for mathematics performance **(Table 4.11).** The effect of starting the SBP on change in mathematics score for girls from HHs reporting *increased* "need" was positive (β=1.164 points) and 2.70 points *greater* (P<0.006) than for girls from HHs reporting decreased "need" (β= -1.537 points). The sign and significance of this interaction effect for girls did not disappear when we analyzed the full sample **(Table 4.12).** No other interaction effects were found to be significant among the restricted sample; however, worth noting is the positive effect of SBP-participation on reading

Table 4.7 and 4.8.
Difference Model Analysis of Effects of Starting SBP Participation in Contrast to Stopping SBP Participation between K and 3rd Grade[20], *Full and Restricted Samples*

Change in Outcome, K to 3rd	Full Sample		Restricted Sample ♣	
	n	β-coefficient (p-value)	n	β-coefficient (p-value)
Reading Scaled Score				
ALL	7837	-0.930 (0.562)	3445	0.249 (0.871)
Male	3965	-0.242 (0.920)	1758	2.199 (0.349)
Female	3872	-1.288 (0.452)	1687	-1.915 (0.306)
Mathematics Scaled Score				
ALL	8137	-1.106 (0.331)	3627	-0.698 (0.540)
Male	4120	-0.624 (0.713)	1846	-0.206 (0.899)
Female	4017	-1.236 (0.308)	1781	-0.645 (0.677)
Weight (kg) ∞				
ALL	7857	0.335 (0.262)	3564	0.287 (0.520)
Male	3983	0.505 (0.238)	1814	0.297 (0.636)
Female	3874	-0.025 (0.953)	1750	0.069 (0.892)
Social Skills Scaled Score				
ALL	6735	-0.032 (0.536)	3216	-0.037 (0.572)
Male	3375	-0.068 (0.333)	1619	-0.026 (0.742)
Female	3360	-0.024 (0.738)	1597	-0.056 (0.489)

[20] Controlled for number of places family has lives for more than 4 mo in past 3 y, whether close relative died in past 2 y, and changes in: HH food insecurity (defined as ≥1 affirmative response on USDA module), HH income, highest education level of either parent in HH, parent ratings of depression and inability to "get going", frequency of child exercise, number of siblings, number of parents in HH, HH size, neighborhood safety rating, child health insurance, parents' employment status, child care status, parent marital status, child disability, location of residence, region of residence

♣ Subset of children attending SBP-participating school at 3rd grade AND not changing schools between K and 3rd

∞ Additionally controlled for initial and change in height

Table 4.9.
Lagged Model Analysis of Interaction Between Kindergarten Composite Need Score and Kindergarten SBP Participation, *Restricted Sample* [21♣]

Change in Outcome, K to 3rd	n	Effect of kindergarten SBP at 1st Quartile of kindergarten need score (less than median need) β-coefficient	Effect of kindergarten SBP at 3rd Quartile of kindergarten need (greater than median need) β-coefficient	Difference β-coefficient (p-value for interaction)
Reading Scaled Score				
ALL	3358	-3.157	-1.898	-1.259 (0.407)
Male	1717	-3.698	-2.0616	-1.636 (0.420)
Female	1641	-2.2125	-1.6978	-0.515 (0.777)
Mathematics Scaled Score				
ALL	3539	-0.7708	-1.390	0.619 (0.487)
Male	1802	-0.936	-0.457	-0.479 (0.737)
Female	1737	-0.258	-1.951	1.693 (0.197)
Weight (kg)[∞]				
ALL	3459	0.9041	1.166	-0.2619 (0.688)
Male	1760	0.1931	0.972	-0.7789 (0.425)
Female	1699	1.4492	1.2566	0.1926 (0.829)
Social skills scaled score				
ALL	3133	-0.0984	-0.0983	-0.0001 (0.999)
Male	1580	-0.1227	-0.1882	0.0655 (0.3798)
Female	1553	-0.0727	0.0163	-0.089 (0.1813)

[21] Controlled for K composite motor skills score, child age, child gender, child composite race, child birth weight, initial child health insurance, initial child disability, initial parent ratings of depression and inability to "get going", initial child frequency of exercise, parents' ages, initial parents' employment status, whether mother married at child's birth, initial number of siblings, initial HH size, initial neighborhood safety rating, initial child care status, initial number of parents in HH, initial marital status of parents, initial location of residence, initial region of residence, past participation in WIC, Head Start participation, number of residences for more than 4 mo in past 3 y, whether close relative died in past 2 years

♣ Subset of children attending SBP-participating school at 3rd grade AND not changing schools between K and 3rd

[∞] Additionally controlled for initial and change in height

Table 4.10.
Lagged Model Effects of Interaction Between Kindergarten Composite Need Score and Kindergarten SBP Participation, *Full Sample* [22]

Change in Outcome, K to 3rd	n	Effect of kindergarten SBP at 1st Quartile of kindergarten need score (less than median need) β-coefficient	Effect of kindergarten SBP at 3rd Quartile of kindergarten need (greater than median need) β-coefficient	Difference β-coefficient (p-value for interaction)
Reading Scaled Score				
ALL	8015	-1.324	-2.993	-1.669 (0.1514)
Male	4065	-2.172	-3.042	-0.870 (0.5603)
Female	3950	-1.175	-2.918	-1.743 (0.2782)
Mathematics Scaled Score				
ALL	8325	-0.597	-1.319	-0.722 (0.4206)
Male	4225	-1.736	-2.146	-0.410 (0.7280)
Female	4100	0.240	-0.332	-0.572 (0.6410)
Weight (kg)♦				
ALL	8009	0.738	0.626	-0.112 (0.7001)
Male	4070	0.968	0.216	-0.752 (0.0477)
Female	3939	0.463	1.058	0.595 (0.1675)
Social skills scaled score				
ALL	6840	-0.102	-0.069	0.033 (0.4008)
Male	3426	-0.089	-0.078	0.011 (0.8381)
Female	3414	-0.110	-0.052	0.058 (0.2570)

[22] Controlled for K outcome score, K composite motor skills score, child age, child gender, child composite race, child birth weight, initial HH food security status (defined as ≥1 affirmative response on USDA module), initial child health insurance, initial child disability, initial HH income, initial highest education level of either parent in HH, initial parent ratings of depression and inability to "get going", initial child frequency of exercise, parents' ages, initial parents' employment status, whether mother married at child's birth, initial number of siblings, initial HH size, initial neighborhood safety rating, initial child care status, initial number of parents in HH, initial marital status of parents, initial location of residence, initial region of residence, past participation in WIC, Head Start participation, number of residences for more than 4 mo in past 3 y, whether close relative died in past 2 years

♦ Additionally controlled for initial and change in height

Table 4.11.
Difference Model Analysis of Effects of Interaction Between Change in Composite Need Score and Change in SBP Participation Over Time, *Restricted Sample*[23]

Change in Outcome, K to 3rd	n	Effect of Starting SBP (in contrast to Stopping SBP) at 1st Quartile of Need (1 Quartile Decrease in Need Below Median Change) β-coefficient	Effect of Starting SBP (in contrast to Stopping SBP) at 3rd Quartile of Need (1 Quartile Increase in Need Above Median Change) β-coefficient	Difference β-coefficient (P-value for interaction)
Reading Scaled Score				
All	3442	-0.1557	0.616	0.772 (0.568)
Males	1758	2.560	1.211	-1.381 (0.487)
Females	1684	-2.895	-0.895	2.085 (0.253)
Mathematics Scaled Score				
All	3624	-1.343	-0.140	1.203 (0.333)
Males	1846	0.7813	-1.153	-1.934 (0.279)
Females	1778	-1.537	1.164	2.701 (0.006)
Weight (kg) ∞				
All	3561	0.149	0.388	0.239 (0.552)
Males	1814	0.314	0.356	0.032 (0.959)
Females	1747	-0.125	0.188	0.313 (0.542)
Social Skills Scaled Score				
All	3213	-0.011	-0.051	-0.040 (0.530)
Males	1619	-0.028	-0.003	0.025 (0.791)
Females	1594	-0.008	-0.085	-0.077 (0.331)

♣ Subset of children attending SBP-participating school at 3rd grade AND not changing schools between K and 3rd

[23] Controlling for number of places family has lives for more than 4 mo in past 3 y, whether close relative died in past 2 y, and changes in: parent ratings of depression and inability to "get going", frequency of child exercise, number of siblings, number of parents in HH, HH size, neighborhood safety rating, child health insurance, parents' employment status, child care status, parent marital status, child disability, location of residence, region of residence

∞ Additionally controlled for initial and change in height

Table 4.12.
Difference Model Effect of Interaction Between Change in Composite Need Score and Participation in SBP Over Time, *Full Sample* [24]

Change in Outcome, K to 3rd	N	Effect of Starting SBP (in Contrast to Stopping SBP) at 1st Quartile of Need (Change in Need 1 Quartile Below Median Change) β-coefficient	Effect of Starting SBP (in Contrast to Stopping SBP) at 3rd Quartile of Need (Change in Need 1 Quartile Above Median Change) β-coefficient	Difference β-coefficient (P-value for interaction)
Reading Scaled Score				
All	7832	-1.531	-0.047	1.484 (0.251)
Males	3964	-0.061	-0.328	-0.267 (0.892)
Females	3868	-3.190	0.518	3.709 (0.011)
Mathematics Scaled Score				
All	8132	-1.454	-0.639	0.815 (0.365)
Males	4119	-0.063	-1.306	-1.243 (0.365)
Females	4013	-2.559	0.114	2.673 (0.020)
Weight (kg) ♦				
All	7852	0.193	0.498	0.305 (0.406)
Males	3982	0.423	0.656	0.233 (0.657)
Females	3870	-0.189	0.132	0.321 (0.508)
Social Skills Scaled Score				
All	6731	0.024	-0.079	-0.103 (0.828)
Males	3375	-0.067	-0.051	0.016 (0.822)
Females	3356	-0.015	-0.028	-0.013 (0.835)

[24] Controlling for number of places family has lives for more than 4 mo in past 3 y, whether close relative died in past 2 y, and changes in: parent ratings of depression and inability to "get going", frequency of child exercise, number of siblings, number of parents in HH, HH size, neighborhood safety rating, child health insurance, parents' employment status, child care status, parent marital status, child disability, location of residence, region of residence

♦ Additionally controlling for change in height

performance for boys, regardless of whether they were increasingly or decreasingly needy (β=2.56 points and 1.21 points, respectively) **(Table 4.11).**

Analysis of interaction effects between changes in *food insecurity* and SBP-participation using the difference model revealed no significant effects at the 5% level. Very small numbers of children transitioned in *both* food security status *and* SBP-participation, however, making coefficients in the difference model susceptible to variations due to chance. Thus, we do not report results for the interaction between changes in food insecurity and SBP-participation, but rather rely upon the interaction between changes in composite need and SBP-participation for more accurate estimates of effects.

School Lunch Program

Of all parents, 55.76% (n=15,838) and 77.78% (n=13,197) reported their children participated in the NSLP at K and 3rd grade, respectively. Using administrator reports of school participation in the NSLP, we calculated 63.01% and 87.89 % of children attending NSLP-participating schools were usually receiving school lunches at K and 3rd grade, respectively. Among the full sample of children (N=12,268), 16.27% never participated in the NSLP, 47.51% participated at both K and 3rd grade, 29.85%% started participating between K and 3rd grade, and 6.37% stopped participating (N=12,268). Among the restricted sample of children—those attending NSLP-participating schools *and* not changing schools between K and 3rd grade—13.29% never participated in the NSLP at either time, 48.70% participated both times, 32.87% started participating between K and 3rd, and 5.14% stopped participating between K and 3rd

Of all parents, 30.16% of 34.16% reported their children participated in the free or reduced-price NSLP at K and 3rd grade, respectively. Of children participating

in the NSLP, 54.09% and 43.92% at K and 3rd grade respectively were receiving free or reduced price meals. Using administrator reports of school participation in NSLP, we calculated 34.08% and 38.60% of children attending NSLP-participating schools were receiving free or reduced-price school lunches at K and 3rd grade, respectively. Among the full sample of children (N=12,268), 62.10% never participated in the free or reduced-price NSLP, 22.20% participated in the free or reduced-price NSLP both K and 3rd grade, 10.65% started participating, and 5.05% stopped participating (N=12,268). Among the restricted sample of children, 63.19% never participated in the free or reduced-price NSLP at either K or 3rd grade, 21.57% participated in the free or reduced-price NSLP at both times, 10.88% started participating between K and 3rd grade, and 4.36% stopped participating.

Kindergarten background characteristics according to NSLP participation are presented in **Tables 4.13 to 4.15**. Participation rates in the NSLP exceeded 65% among children with the following characteristics: black or Hispanic race, not health insured, non-English language spoken at home, very low birth weight, household poverty index ratio below 185%, parents' highest education equal to high school degree or less, one parent or widowed household, separated or never married parents, no father in household, mother and/or father looking for work, parent rated as most of the time depressed, neighborhood rated as not at all safe, residence in a rural area or small town, residence in the Southern region of the U.S., and past or current participation in WIC, the FSP, or AFDC.

The prevalence of *any* school lunch participation among food insecure children was 68.83% in K and 89.66% in 3rd grade, compared to 53.04% and 75.93% among

Table 4.13.
Background Characteristics According to Any NSLP Participation or Free/Reduced-Price NSLP Participation, *Full Sample*

Characteristic	% of NSLP Participants at K having characteristic	% of free/reduced price NSLP Participants at K having characteristic	% of characteristic group participating in NSLP at K	% of characteristic group participating in free/reduced price NSLP at K
Child-level factors				
Gender				
Female	49.22	48.88	56.10	30.13
Male	50.78	51.12	55.43	30.19
Race				
White	48.06	26.98	45.79	13.91
Black	20.16	29.87	81.71	65.49
Hispanic	20.54	29.52	67.32	52.34
Other	11.24	13.63	58.47	38.35
Disabled	14.27	15.15	56.66	32.05
Child not health insured	10.86	15.36	69.83	53.35
Non-English language spoken at home	16.51	25.04	69.65	57.13
Birth weight				
≥2500 g	87.15	83.32	54.67	28.27
Low birthwt (≥1500 &<2500 g)	6.44	8.04	60.40	40.76
Very low birthwt (<1500 g)	6.41	8.65	69.11	50.43
HH-Level				
Food insecure*	21.16	33.54	68.83	59.02
Below Poverty Threshold	71.91	48.19	50.01	73.31
Poverty Index Ratio				
<130%	37.76	64.10	77.79	71.43
≥130% and <185%	14.39	19.28	62.61	45.37
≥185% and <240%	9.65	7.81	54.30	23.77
≥240% and <295%	8.59	3.41	49.22	10.57
≥295% and <350%	6.83	2.03	43.66	7.02
≥350% and <405%	5.62	1.36	41.20	5.40
≥405%	17.16	2.01	39.61	2.51

* Where food insecurity defined as ≥1 affirmative response on USDA module

Table 4.13 (Continued)

Highest education level of parent				
8th grade or below	4.36	7.58	82.09	77.19
9th-12th grade	9.27	15.45	81.90	73.80
High school diploma	30.17	39.42	66.40	46.93
Vocational/technical program	5.76	6.09	56.49	32.30
Some college	25.95	23.28	54.11	26.25
Bachelor's degree	14.90	5.57	44.82	9.06
Grad./profess. school—no degree	1.69	0.88	38.80	10.94
Master's degree (MA,MS)	4.93	1.24	37.12	5.03
Doctorate or professional degree	2.97	0.50	35.99	3.30
Number of parents in HH				
1 Parent HH	26.17	37.32	69.92	53.95
2 Parent HH	71.14	58.82	51.37	22.98
Other Arrangement	2.70	3.85	78.03	60.33
Parent marital status				
Married	63.80	48.28	50.12	20.50
Separated	5.28	7.78	66.10	52.62
Divorced	9.15	10.38	60.22	36.94
Widowed	0.94	1.15	66.40	44.00
Never married	17.56	27.63	75.63	64.36
No biological/adoptive parents	3.28	4.78	77.07	60.80
Mother not married at child's birth	35.78	51.68	69.50	52.88
Parent rating of depression				
Never depressed	69.79	63.26	53.99	26.23
Sometimes depressed	26.78	31.73	58.23	36.98
Most of the time depressed	3.43	5.02	69.48	54.46
Parent rating of inability to "get going"				
Never unable to "get going"				
Sometimes	57.32	55.44	54.60	28.29
Most of the time	38.64	39.21	56.03	30.46
	4.05	5.35	64.04	45.32
Mother's employment				
≥35 h/w	48.28	42.65	59.53	27.93
<35 h/w	18.41	15.18	46.58	20.40
Looking for work	4.46	7.36	70.59	61.87
Not in labor force	27.14	33.04	53.45	34.56
No mother in HH	1.71	1.76	57.83	31.74
Father's employment				
≥35 h/w	65.45	49.21	49.89	19.91
<35 h/w	3.04	3.49	60.06	36.64
Looking for work	1.80	2.84	75.27	62.90
Not in labor force	3.49	5.00	64.52	49.05
No father in HH	26.21	39.46	71.50	57.13

Table 4.13 (Continued)

Child care status				
No non-parental care	52.37	57.32	55.45	39.34
Relative care	20.49	24.50	61.98	16.97
Non-relative care	7.65	5.94	41.20	16.87
Center-based care	17.47	9.86	56.30	34.15
Other/variation	2.01	2.38	54.36	32.21
Ever serious financial problems since child's birth	25.66	35.17	62.57	45.45
Past WIC participation	57.12	82.47	70.87	55.15
Past Head Start participation	21.11	34.46	76.73	66.65
Participated Food Stamps in last 12 mo	21.44	38.51	79.69	77.37
Participated AFDC in last 12 mo	9.18	16.45	77.42	74.93
Participated School Breakfast Program	36.80	55.86	89.12	73.71
Neighborhood safety rating				
Not at all safe	4.31	6.72	69.98	58.93
Somewhat safe	29.71	39.02	64.05	45.46
Very safe	65.97	54.26	52.00	23.12
Location of residence				
Central city	42.70	48.38	60.45	37.05
Urban fringe	31.68	27.19	45.90	21.31
Small town/rural	25.61	24.43	64.55	33.30
Region of residence				
Northeast	11.77	11.95	35.75	19.65
Midwest	22.00	17.46	48.21	20.69
South	45.70	46.20	74.63	40.81
West	20.53	24.39	51.89	33.34

Table 4.14.
Background Characteristics of Full Sample According to Any NSLP Participation or Free/Reduced-Price NSLP Participation

Characteristic	Participated in free lunch NSLP at K	Participated in reduced price NSLP at K	Participated full price NSLP at K	Did not participate in NSLP at K, parent reported program offered at child's school	Did not participate in NSLP at K, parent reported program NOT offered at child's school
	Mean	Mean	Mean	Mean	Mean
Child-level factors					
Age, mo	74.575	74.667	74.987	74.668	74.772
Composite motor score	11.688	12.050	12.677	12.334	12.626
Frequency exercise, d/wk	3.881	3.981	4.106	3.881	3.727
HH-Level					
Composite need score	0.080	-0.197	-0.671	-0.604	-0.729
Income, $	20,394	33,037	67,366	62,753	81,316
HH size	4.971	4.594	4.271	4.474	4.495
# siblings	1.880	1.518	1.224	1.420	1.399
Mother's age, y	31.586	32.099	34.114	34.200	35.149
Father's age, y	34.795	34.796	36.777	36.858	37.789
Mother's age at first birth, y	20.425	22.274	25.289	25.178	26.499

Table 4.15.
Background Characteristics According to Any Participation in NSLP or Free/reduced Price Participation in NSLP, *Restricted Sample*[♣]

Characteristic	% of NSLP Participants at K having characteristic	% of free/reduced price NSLP Participants at K having characteristic	% of group participating in NSLP at K	% of group participating in free/reduced price NSLP at K
Child-level factors				
Gender				
Female	49.69	50.47	55.21	28.12
Male	50.31	49.53	55.02	27.17
Race				
White	55.55	32.88	46.66	13.84
Black	18.13	29.83	86.74	71.54
Hispanic	15.76	23.68	66.14	49.80
Other	10.56	13.61	59.68	38.56
Disabled	14.84	15.03	57.24	28.55
Child not health insured	10.73	16.50	71.07	54.75
Non-English language spoken at home	12.85	21.58	67.83	57.05
Birth weight				
≥2500 g	87.05	82.62	53.80	25.61
Low birthwt (≥1500 &<2500 g)	6.48	8.38	59.26	38.46
Very low birthwt (<1500 g)	6.48	9.00	74.29	51.79
HH-Level				
Food insecure*	19.49	32.46	69.29	57.87
Below Poverty Threshold	24.88	45.31	80.38	73.44
Poverty Index Ratio				
<130%	34.31	61.76	78.21	70.62
≥130% and <185%	15.57	21.91	62.50	44.13
≥185% and <240%	10.49	8.44	54.62	22.04
≥240% and <295%	9.65	3.23	50.00	8.39
≥295% and <350%	7.47	1.43	41.88	4.01
≥350% and <405%	6.35	1.06	41.38	3.45
≥405%	16.16	2.17	39.44	2.66

[♣] Subset of children attending SBP-participating school at 3rd grade AND not changing schools between K and 3rd

* Where food insecurity defined as ≥1 affirmative response on USDA module

Table 4.15 (Continued)

Highest education level of parent				
8th grade or below	3.39	6.33	81.34	76.12
9th-12th grade	7.50	13.41	82.25	73.72
High school diploma	31.23	41.78	64.79	43.48
Vocational/technical program	6.04	6.52	57.06	30.88
Some college	26.90	24.39	53.23	24.21
Bachelor's degree	15.41	5.59	45.04	8.19
Grad./profess. School-no degree	1.68	0.87	39.42	10.22
Master's degree (MA,MS)	5.20	0.68	39.11	2.58
Doctorate or professional degree	2.65	0.43	37.44	3.08
Number of parents in HH				
1 Parent HH	23.72	36.25	70.75	54.22
2 Parent HH	73.60	59.71	50.87	20.70
Other Arrangement	2.68	4.03	82.69	62.50
Parent marital status				
Married	67.25	50.25	49.82	18.65
Separated	5.08	7.96	69.66	54.70
Divorced	8.60	10.95	57.62	36.74
Widowed	1.03	1.31	66.00	42.00
Never married	15.02	25.06	78.76	65.85
No biological/adoptive parents	3.02	4.48	83.62	62.07
Mother not married at child's birth	32.50	48.81	71.15	52.33
Parent rating of depression				
Never depressed	71.07	64.11	53.64	24.12
Sometimes depressed	25.72	30.72	56.58	33.68
Most of the time depressed	3.21	5.17	74.81	60.00
Parent rating of inability to "get going"				
Never unable to "get going"	55.51	53.10	54.16	25.79
Sometimes	40.35	40.82	54.73	27.56
Most of the time	4.14	6.08	67.71	49.48
Mother's employment				
≥35 h/w	49.18	41.28	59.19	24.40
<35 h/w	18.18	15.16	43.73	17.91
Looking for work	3.84	6.62	69.62	58.86
Not in labor force	26.84	34.31	52.28	32.81
No mother in HH	1.96	2.63	63.64	42.05
Father's employment				
≥35 h/w	68.07	50.71	48.95	17.97
<35 h/w	3.09	3.42	60.69	33.10
Looking for work	1.26	2.21	75.00	64.58
Not in labor force	3.65	5.27	68.87	49.01
No father in HH	23.93	38.39	71.71	56.68

Table 4.15 (Continued)

Child care status				
No non-parental care	52.15	58.05	54.36	29.76
Relative care	20.88	25.36	61.70	36.85
Non-relative care	8.06	5.98	40.64	14.84
Center-based care	16.50	8.12	54.51	13.19
Other/variation	2.42	2.49	52.67	26.72
Ever serious financial problems since child's birth	24.13	33.69	62.07	42.52
Past WIC participation	54.45	82.53	70.61	53.39
Past Head Start participation	19.87	33.73	78.33	65.43
Participated Food Stamps in last 12 mo	18.20	35.14	79.46	76.87
Participated AFDC in last 12 mo	7.74	14.69	80.26	76.38
Participated School Breakfast Program	35.93	56.64	87.24	69.73
Neighborhood safety rating				
Not at all safe	2.68	4.42	65.15	53.79
Somewhat safe	26.71	36.26	64.63	43.97
Very safe	70.61	59.33	51.90	21.85
Location of residence				
Central city	35.77	40.84	61.71	35.34
Urban fringe	29.58	25.76	42.66	18.63
Small town/rural	34.65	33.50	64.00	30.94
Region of residence				
Northeast	7.60	7.20	26.21	12.46
Midwest	25.25	18.19	46.66	16.86
South	50.87	53.26	77.70	40.80
West	16.28	21.35	49.53	32.58

food secure children at these times. Alternatively, 21.16% and 15.57% of children receiving *any* school lunch at K and 3rd grade respectively were food insecure. The prevalence of free or reduced-price school lunch participation among food insecure children was 59.02% in K and 73.75% in 3rd grade, compared to 24.18% and 27.91% among food secure children at these times. Of children receiving free or reduced-price school lunch, 33.54% and 29.21% at K and 3rd grade respectively were food insecure. 71.43% of children eligible for free-price meals and 45.37% of children eligible for reduced-price meals at K were participating in free or reduced price school lunches at K.

Without controlling for any background covariates, participation in the NSLP at K was associated with poorer gains in reading performance and mathematics performance, greater weight gain, and poorer social skills scores among children attending the same -participating school in K and 3rd grade **(Table 4.16).** Results using the full (non-restricted) sample were similar **(Table 4.17).**

After controlling for initial background variables and changes in background variables (Table 4.16), the associations between *any* school lunch participation and changes in reading and mathematics scores remained significant for girls only. These associations were similar in magnitude and significance using the non-restricted sample (Table 4.17).

In the dynamic model, persistent NSLP participation across time was associated significantly with poorer reading gains for girls (β= -2.655 points, P<0.0151) and greater weight gain among males (β=0.711 kg, P<0.0236) using the restricted sample **(Table 4.18).** Using the full sample, the reading effect remained significant but the weight effect did not **(Table 4.19).**

Table 4.16.
Lagged Model Analysis of Effects of *Any* NSLP Participation at Kindergarten,

Change in Outcome, K to 3rd	Controlling only for initial score and initial food insecurity		Additionally controlling for initial and changes in background covariates, including change in food insecurity[25]	
	n	β-coefficient (P-value)	n	β-coefficient (P-value)
Reading Scaled Score				
All	4910	-5.473 (<0.0001)	3762	-2.214 (0.0010)
Male	2472	-5.277 (<0.0001)	1886	-1.586 (0.1297)
Female	2438	-5.657 (<0.0001)	1876	-2.271 (0.0037)
Mathematics Scaled Score				
All	5029	-3.281 (<0.0001)	3842	-1.582 (0.0017)
Male	2535	-3.515 (<0.0001)	1925	-1.140 (0.1495)
Female	2494	-3.035 (<0.0001)	1917	-1.902 (0.0019)
Weight (kg)[∞]				
All	4946	0.476 (0.0010)	3764	0.032 (0.8110)
Male	2493	0.608 (0.0022)	1887	0.280 (0.1699)
Female	2453	0.345 (0.0645)	1877	-0.180 (0.3846)
Social Skills Scaled Score				
All	4555	-0.071 (0.0055)	3486	0.001 (0.9780)
Male	2263	-0.071 (0.0242)	1725	-0.018 (0.6093)
Female	2292	-0.078 (0.0248)	1761	0.028 (0.3967)

Restricted Sample[♣]

♣ Subset of children attending SBP-participating school at 3rd grade AND not changing schools between K and 3rd

[25] Additionally controlled for K composite motor skills score, child age, child gender, child composite race, child birthweight, initial and change in child health insurance, initial and change in child disability, initial and change in HH income, initial and change in highest education level of either parent in HH, initial and change in parent ratings of depression and inability to "get going", initial and change in child frequency of exercise, parents' ages, initial and change in parents' employment status, whether mother married at child's birth, initial and change in number of siblings, initial and change in HH size, initial and change in neighborhood safety rating, initial and change in child care status, initial and change in number of parents in HH, initial and change in marital status of parents, initial and change in location of residence, initial and change in region of residence, past participation in WIC, Head Start participation, number of residences for more than 4 mo in past 3 y, whether close relative died in past 2 years

[∞] Additionally controlled for initial and change in height

Table 4.17. Lagged Model Analysis of Effects of Any Participation in the NSLP at Kindergarten, *Full Sample*[♣]

Change in Outcome, K to 3rd	Controlling only for initial score and initial food insecurity		Additionally controlling for initial and changes in background covariates, including change in food insecurity[26]	
	n	B-coefficient (P-value)	n	β-coefficient (P-value)
Reading Scaled Score				
All	10635	-5.572 (<0.0001)	7806	-2.656 (<0.0001)
Male	5390	-5.163 (<0.0001)	3959	-2.067 (0.0025)
Female	5245	-5.991 (<0.0001)	3847	-3.428 (<0.0001)
Mathematics Scaled Score				
All	11055	-2.902 (<0.0001)	8087	-1.759 (<0.0001)
Male	5618	-2.833 (<0.0001)	4103	-1.569 (0.0030)
Female	5437	-3.039 (<0.0001)	3984	-1.954 (0.0004)
Weight (kg)[∞]				
All	10684	0.481 (<0.0001)	7796	0.187 (0.1168)
Male	5438	0.461 (0.0010)	3960	0.152 (0.3187)
Female	5246	0.520 (0.0010)	3836	0.171 (0.3114)
Social Skills Scaled Score				
All	9057	-0.075 (<0.0001)	6727	-0.020 (0.3194)
Male	4545	-0.078 (0.0011)	3371	-0.025 (0.3049)
Female	4512	-0.077 (0.0003)	3356	-0.008 (0.7609)

[♣] Subset of children attending SBP-participating school at 3rd grade AND not changing schools between K and 3rd

[26] Additionally controlled for K composite motor skills score, child age, child gender, child composite race, child birthweight, initial and change in child health insurance, initial and change in child disability, initial and change in HH income, initial and change in highest education level of either parent in HH, initial and change in parent ratings of depression and inability to "get going", initial and change in child frequency of exercise, parents' ages, initial and change in parents' employment status, whether mother married at child's birth, initial and change in number of siblings, initial and change in HH size, initial and change in neighborhood safety rating, initial and change in child care status, initial and change in number of parents in HH, initial and change in marital status of parents, initial and change in location of residence, initial and change in region of residence, past participation in WIC, Head Start participation, number of residences for more than 4 mo in past 3 y, whether close relative died in past 2 years

[∞] Additionally controlled for initial and change in height

Table 4.18.
Dynamic Model Analysis of Effects of *Any* NSLP Participation Over Time[27], *Restricted Sample*[♣]

Change in Outcome, K to 3rd		Effect in comparison to never participated in NSLP				Effect in comparison to stopped NSLP
	n	**Stopped NSLP** β-coefficient (p-value)	**Started NSLP** β-coefficient (p-value)	**Always NSLP** β-coefficient (p-value)	**Ever NSLP** β-coefficient (p-value)	**Started NSLP** β-coefficient (p-value)
Reading Score						
ALL	3754	-2.990 (0.0319)	0.249 (0.7209)	-1.877 (0.0213)	-1.539 (0.0396)	3.239 (0.0183)
Male	1881	-2.891 (0.1436)	0.671 (0.5124)	-0.776 (0.5213)	-0.998 (0.3412)	3.563 (0.0761)
Female	1873	-2.137 (0.3061)	-0.412 (0.6636)	-2.655 (0.0151)	-1.734 (0.1036)	1.725 (0.4062)
Mathematics Score						
ALL	3834	-0.053 (0.9580)	0.912 (0.1041)	-0.979 (0.1347)	-0.040 (0.9452)	0.965 (0.3134)
Male	1920	1.103 (0.4709)	0.932 (0.2712)	-0.557 (0.5743)	0.462 (0.5942)	-0.081 (0.9537)
Females	1914	-1.004 (0.5521)	1.244 (0.1635)	-0.944 (0.3236)	-0.235 (0.8126)	2.248 (0.1079)
Weight (kg) [∞]						
All	3756	-0.124 (0.6849)	0.362 (0.0973)	0.360 (0.0637)	0.198 (0.3178)	0.489 (0.0889)
Male	1882	0.249 (0.5769)	0.533 (0.1238)	0.711 (0.0236)	0.497 (0.1168)	0.280 (0.4687)
Female	1874	-0.461 (0.3320)	0.068 (0.7976)	-0.070 (0.8088)	-0.156 (0.5751)	0.544 (0.2345)
Social Skills Score						
All	3480	-0.0167 (0.6859)	-0.0164 (0.5194)	-0.009 (0.7578)	-0.014 (0.6005)	0.003 (0.9940)
Male	1722	-0.040 (0.5011)	-0.0113 (0.7563)	-0.020 (0.6100)	-0.0239 (0.5190)	0.0289 (0.6004)
Female	1758	0.036 (0.5289)	-0.0076 (0.8086)	0.0215 (0.6009)	0.0167 (0.6452)	-0.044 (0.4190)

[27] Controlled for: K outcome score, K and change in food insecurity (defined as ≥1 affirmative response on USDA module), K composite motor skills score, child age, child gender, child composite race, child birthweight, past WIC participation, Head Start participation, K and change in HH income, K and change in highest education level of either parent in HH, K and change in parent ratings of depression and inability to "get going", K and change in frequency of exercise, parents' ages, mother's age at first birth, whether mother married at first birth, K and change in number of siblings, K and change in HH size, K and change in neighborhood safety rating, K and change in child health insurance, K and change in child disability, K and change in number of parents in HH, K and change in parent marital status, K and change in child care status, K and change in parents' employment status, K and change in location of residence, K and change in region of residence, number of places family has lived for more than 4 mo in past 3 y, whether close relative died in past 2 y

[♣] Subset of children attending SBP-participating school at 3rd grade AND not changing schools between K and 3rd

[∞] Additionally controlled for initial and change in height

Table 4.19.
Dynamic Model Analysis of Effects of *Any* NSLP Participation Over Time[28], *Full Sample*

Change in Outcome, K to 3rd	n	Effect in comparison to never participated in NSLP: Stopped NSLP β-coefficient (p-value)	Started NSLP β-coefficient (p-value)	Always NSLP β-coefficient (p-value)	Ever NSLP β-coefficient (p-value)	Effect in comparison to stopped NSLP: Started NSLP β-coefficient (p-value)
Reading Scaled Score						
ALL	7783	-0.738 (0.4310)	0.816 (0.2389)	-2.336 (0.0015)	-0.753 (0.2642)	1.554 (0.0540)
Male	3944	-1.471 (0.2925)	0.979 (0.2723)	-1.384 (0.1623)	-0.625 (0.4928)	2.451 (0.0526)
Female	3839	-0.391 (0.7625)	0.317 (0.7372)	-3.729 (0.0001)	-1.268 (0.1580)	0.708 (0.5588)
Mathematics Scaled Score						
ALL	8063	-0.148 (0.8348)	0.901 (0.1138)	-1.278 (0.0300)	-0.175 (0.7407)	1.049 (0.1080)
Male	4087	-0.298 (0.7492)	1.299 (0.0727)	-0.671 (0.3508)	0.110 (0.8618)	1.597 (0.0970)
Females	3976	-0.157 (0.8872)	0.498 (0.4979)	-1.869 (0.0180)	-0.510 (0.5022)	0.655 (0.4763)
Weight (kg) [∞]	7774	0.002 (0.9911)	0.085 (0.6113)	0.288 (0.0663)	0.125 (0.3989)	0.083 (0.7190)
All	3944	-0.304 (0.3380)	0.037 (0.8710)	0.253 (0.1885)	-0.005 (0.9768)	0.346 (0.2352)
Male	3830	0.124 (0.7323)	0.104 (0.6525)	0.268 (0.2718)	0.165 (0.4856)	0.019 (0.9522)
Female						
Social Skills Scaled Score						
All	6713	-0.025 (0.4100)	-0.003 (0.8805)	-0.021 (0.3386)	-0.016 (0.3920)	0.022 (0.4971)
Male	3361	-0.003 (0.9368)	0.011 (0.7170)	-0.019 (0.4701)	-0.004 (0.8745)	0.014 (0.7458)
Female	3352	-0.050 (0.2863)	-0.023 (0.3820)	-0.019 (0.5697)	-0.031 (0.2924)	0.026 (0.5502)

Controlling for changes in food insecurity and other covariates in the difference model, starting *any* school lunch participation was associated with

[28] Controlled for: K outcome score, K and change in food insecurity (defined as ≥1 affirmative response on USDA module), K composite motor skills score, child age, child gender, child composite race, child birthweight, past WIC participation, Head Start participation, K and change in HH income, K and change in highest education level of either parent in HH, K and change in parent ratings of depression and inability to "get going", K and change in frequency of exercise, parents' ages, mother's age at first birth, whether mother married at first birth, K and change in number of siblings, K and change in HH size, K and change in neighborhood safety rating, K and change in child health insurance, K and change in child disability, K and change in number of parents in HH, K and change in parent marital status, K and change in child care status, K and change in parents' employment status, K and change in location of residence, K and change in region of residence, number of places family has lived for more than 4 mo in past 3 y, whether close relative died in past 2 y

[∞] Additionally controlled for initial and change in height

significant and positive gains in both reading (β=6.23 points) and mathematics (β=3.90 points) performance **(Table 4.20).** The significance of these associations with NSLP participation remained when using the full sample (**Table 4.21**) and regardless of gender. Starting *any* NSLP participation was not significantly associated with subsequent weight gain or social skills development (Table 4.20).

Lagged model analysis showed no significant interaction effects between composite need and NSLP participation using the restricted or full samples **(Tables 4.22 and 4.23),** nor did it show significant interaction effects between food insecurity and NSLP participation (Table not shown).

The magnitude of effects of starting *any* NSLP participation (compared to stopping) on gains in reading and mathematics performance remained high regardless of transitions in need status (**Table 4.24).** The effect of starting any NSLP participation on reading was about two points greater (P<0.1688), however, among children from households with an increase in composite need compared to children from households with a decrease in composite need, with the difference being greater and marginally significant among boys (β=3.54 points; P<0.0748) compared to girls **(Table 4.24).** This interaction was not significant using the full sample **(Table 4.25).** And while starting any NSLP participation was associated with poorer social skills gains for children from households becoming less needy (β= -0.068 points), it had a positive effect on social skills among girls becoming more needy (β= 0.049 points), with the difference being marginally significant (P<0.0679). This interaction was not significant using the full sample (Table 4.25).

Table 4.20.
Difference Model Analysis of Effects of Starting Any NSLP Participation versus Stopping Participation, *Restricted Sample*[♣] [29]

Change in Outcome, K to 3rd	n	Effect of Starting *Any* School Lunch Participation (vs. Stopping Participation) β-coefficient (p-value)
Reading Scaled Score		
ALL	4019	6.228 (<0.0001)
Male	2008	5.221 (0.0033)
Female	2011	6.805 (<0.0001)
Mathematics Scaled Score		
ALL	4112	3.897 (0.0001)
Male	2055	3.725 (0.0111)
Female	2057	4.323 (0.0003)
Weight (kg) [∞]		
ALL	4035	0.367 (0.2618)
Male	2019	0.403 (0.3709)
Female	2016	0.229 (0.5728)
Social Skills Scaled Score		
ALL	3724	-0.031 (0.5558)
Male	1841	-0.064 (0.3545)
Female	1883	-0.002 (0.9747)

[♣] Subset of children attending SBP-participating school at 3rd grade AND not changing schools between K and 3rd

[29] Controlled for number of places family has lives for more than 4 mo in past 3 y, whether close relative died in past 2 y, and changes in: HH food insecurity (defined as ≥1 affirmative response on USDA module), HH income, highest education level of either parent in HH, parent ratings of depression and inability to "get going", frequency of child exercise, number of siblings, number of parents in HH, HH size, neighborhood safety rating, child health insurance, parents' employment status, child care status, parent marital status, child disability, location of residence, region of residence

[∞] Additionally controlled for change in height

Table 4.21.
Difference Model Analysis of Effects of Starting Any NSLP Participation[30], *Full Sample*

Change in Outcome, K to 3rd	n	Effect of Starting Any School Lunch Participation (vs. Stopping Participation) β-coefficient (p-value)
Reading Scaled Score		
ALL	8352	5.112 (<0.0001)
Male	4226	5.236 (<0.0001)
Female	4126	5.104 (0.0003)
Mathematics Scaled Score		
ALL		
Male	8655	2.878 (<0.0001)
Female	4383	3.561 (0.0003)
	4272	2.259 (0.0182)
Weight (kg) ∞		
ALL	8356	0.050 (0.9855)
Male	4239	-0.026 (0.9440)
Female	4117	-0.057 (0.8574)
Social Skills Scaled Score		
ALL	7182	-0.030 (0.4132)
Male	3596	-0.041 (0.4469)
Female	3586	-0.029 (0.5291)

[30] Controlling for number of places family has lives for more than 4 mo in past 3 y, whether close relative died in past 2 y, and *changes* in: HH food insecurity (defined as ≥1 affirmative response on USDA module), HH income, highest education level of parent in HH, parent ratings of depression and inability to "get going", frequency of child exercise, number of siblings, number of parents in HH, HH size, neighborhood safety rating, child health insurance, parents' employment status, child care status, parent marital status, child disability, location of residence, region of residence

∞ Additionally controlling for change in height

Table 4.22.
Lagged Model Analysis of Interaction Between Kindergarten Composite Need and *Any* NSLP Participation at Kindergarten[31], *Restricted Sample*[♣]

Change in Outcome, K to 3rd	n	Effect of Any NSLP Participation at 1st Quartile of Need Score (Less Than Median Need) β-coefficient	Effect of Any NSLP Participation at 3rd Quartile of Need Score (Greater Than Median Need) β-coefficient	Difference β-coefficient (p-value for interaction)
Reading Scaled Score	3964	-2.247	-1.549	(0.4888)
ALL	1988	-2.291	-0.557	(0.2525)
Male	1976	-2.063	-2.578	(0.7054)
Female				
Mathematics Scaled Score				
ALL	4051	0.431	0.311	(0.6593)
Male	2029	-1.301	-1.352	(0.9611)
Female	2022	-1.529	-2.332	(0.4506)
Weight (kg)[∞]				
ALL	3968	-0.059	0.258	(0.5209)
Male	1989	0.050	0.468	(0.2488)
Female	1979	-0.179	-0.162	(0.9568)
Social skills scaled score	3670	-0.011	0.005	(0.6750)
ALL	1812	-0.022	-0.011	(0.8513)
Male	1858	0.004	0.022	(0.7167)
Female				

[31] Controlled for K outcome score, K composite motor skills score, child age, child gender, child composite race, child birth weight, initial child health insurance, initial child disability, initial parent ratings of depression and inability to "get going", initial child frequency of exercise, parents' ages, initial parents' employment status, whether mother married at child's birth, initial number of siblings, initial HH size, initial neighborhood safety rating, initial child care status, initial number of parents in HH, initial marital status of parents, initial location of residence, initial region of residence, past participation in WIC, Head Start participation, number of residences for more than 4 mo in past 3 y, whether close relative died in past 2 years

[♣] Subset of children attending SBP-participating school at 3rd grade AND not changing schools between K and 3rd

[∞] Additionally controlled for initial and change in height

Table 4.23.
Lagged Model Analysis of Interaction Between Kindergarten Composite Need and *Any* NSLP Participation at Kindergarten[32], *Full Sample*

Change in Outcome, K to 3rd	N	Effect of Any NSLP Participation at 1st Quartile of Need Score (Less Than Median Need) β-coefficient	Effect of Any NSLP Participation at 3rd Quartile of Need Score (Greater Than Median Need) β-coefficient	Difference β-coefficient (p-value for interaction)
Reading Scaled Score				
ALL	8436	-1.008	-2.476	(0.1142)
Male	4280	-1.637	-2.818	(0.3931)
Female	4156	-1.479	-4.347	(0.0909)
Mathematics Scaled Score				
ALL	8751	-0.995	-2.418	(0.0139)
Male	4443	-0.465	-2.486	(0.0230)
Female	4308	-1.435	-2.254	(0.3138)
Weight (kg)[∞]				
ALL	8417	0.257	0.088	(0.4395)
Male	4282	0.118	-0.097	(0.3900)
Female	4135	0.327	0.253	(0.7602)
Social skills scaled score				
ALL	7205	-0.027	-0.035	(0.7327)
Male	3607	-0.024	-0.039	(0.7767)
Female	3598	-0.028	-0.023	().8687)

[32] Controlled for K outcome score, K composite motor skills score, child age, child gender, child composite race, child birth weight, initial child health insurance, initial child disability, initial parent ratings of depression and inability to "get going", initial child frequency of exercise, parents' ages, initial parents' employment status, whether mother married at child's birth, initial number of siblings, initial HH size, initial neighborhood safety rating, initial child care status, initial number of parents in HH, initial marital status of parents, initial location of residence, initial region of residence, past participation in WIC, Head Start participation, number of residences for more than 4 mo in past 3 y, whether close relative died in past 2 years

[∞] Additionally controlled for initial and change in height

Table 4.24.
Difference Model Analysis of Effects of Interaction Between Change in Composite Need and Change in *Any* NSLP Participation Over Time[33], *Restricted Sample*[♣]

Change in Outcome, K to 3rd	N	Effect of Starting Any NSLP Participation (in Contrast to Stopping) at 1st Quartile of Need (1 Quartile Decrease in Need Below Median Change) β-coefficient	Effect of Starting Any NSLP Participation (in Contrast to Stopping) at 3rd Quartile of Need (1 Quartile Increase in Need Above Median Change) β-coefficient	Difference β-coefficient (P-value for interaction)
Reading Scaled Score				
ALL	4016	5.026	7.104	2.078 (0.1688)
Male	2008	3.366	6.906	3.540 (0.0748)
Female	2008	6.096	7.186	1.090 (0.6121)
Mathematics Scaled Score				
ALL	4109	3.593	4.159	0.566 (0.5678)
Male	2055	3.885	3.580	-0.305 (0.8452)
Female	2054	3.353	5.047	1.694 (0.2379)
Weight (kg)[∞]				
ALL	4032	0.420	0.319	-0.101 (0.7803)
Male	2019	0.548	0.264	-0.284 (0.6356)
Female	2013	0.169	0.254	0.085 (0.8616)
Social Skills Scaled Score				
ALL	3721	-0.067	-0.001	0.066 (0.2604)
Male	1841	-0.070	-0.061	0.004 (0.9057)
Female	1880	-0.068	0.049	0.117 (0.0679)

[33] Controlled for number of places family has lives for more than 4 mo in past 3 y, whether close relative died in past 2 y, and changes in: parent ratings of depression and inability to "get going", frequency of child exercise, number of siblings, number of parents in HH, HH size, neighborhood safety rating, child health insurance, parents' employment status, child care status, parent marital status, child disability, location of residence, region of residence

[♣] Subset of children attending SBP-participating school at 3rd grade AND not changing schools between K and 3rd

[∞] Additionally controlled for change in height

Table 4.25.
Difference Model Analysis of Effects of Interaction Between Change in Composite Need and *Any* NSLP Participation Over Time[34], *Full Sample*

Change in Outcome, K to 3rd	N	Effect of Starting Any NSLP Participation (in Contrast to Stopping) at 1st Quartile of Need (1 Quartile Decrease in Need Below Median Change) β-coefficient	Effect of Starting Any NSLP Participation (in Contrast to Stopping) at 3rd Quartile of Need (1 Quartile Increase in Need Above Median Change) β-coefficient	Difference β-coefficient (P-value for interaction)
Reading Scaled Score				
ALL	8347	4.494	5.649	1.155 (0.3197)
Male	4225	4.772	5.713	0.941 (0.5566)
Female	4122	4.065	5.994	1.929 (0.2169)
Mathematics Scaled Score				
ALL	8650	2.820	2.987	0.167 (0.8417)
Male	4382	4.438	2.884	-1.554 (0.2237)
Female	4268	1.230	3.229	1.999 (0.0621)
Weight (kg)[∞]				
ALL	8351	-0.192	0.204	0.396 (0.1880)
Male	4238	-0.220	0.220	0.440 (0.3390)
Female	4113	-0.170	0.037	0.207 (0.6739)
Social skills Scaled Score				
ALL	7178	-0.059	-0.005	0.054 (0.2024)
Male	3596	-0.086	0.006	0.092 (0.1508)
Female	3582	-0.038	-0.021	0.017 (0.7422)

[34] Controlled for number of places family has lives for more than 4 mo in past 3 y, whether close relative died in past 2 y, and changes in: parent ratings of depression and inability to "get going", frequency of child exercise, number of siblings, number of parents in HH, HH size, neighborhood safety rating, child health insurance, parents' employment status, child care status, parent marital status, child disability, location of residence, region of residence

[∞] Additionally controlled for change in height

DISCUSSION

The parallel transitions in starting or stopping program participation were expected given that eligibility rests on similar criteria and given the current system of direct certification. Direct certification is a provision allowing children from HHs participating in the FSP or AFDC to be certified for free school meals without the HH having to conduct additional applications. Furthermore, children may receive both school breakfasts and school lunches simultaneously. The associated nature of program participation, however, makes it impossible to interpret whether the effects witnessed are due solely to changes in SBP participation or to the combined effect of changes in multiple programs. This phenomenon should be regarded foremost in drawing conclusions from this study.

The less than full participation rates among children eligible for free or reduced-price meals are consistent with previous reports (61-64) and have been found to be related to factors such as administrative constraints surrounding the application and approval process, parents' and children's perceived quality and variety of foods served, parents' and children's perceived stigma, structural barriers such as the school meal schedule (42), and parents' attitudes about the appropriate roles of family versus school and whether the program will save them time or energy (65).

School Breakfast

There is substantial evidence that breakfast consumption at all is associated with child well-being, including improved nutritional adequacy, reduced likelihood of overweight or weight gain, improved cognitive and academic performance, better memory and alertness, enhanced creativity, improved mood, and reduced problem behaviors (66-71). Less clear are the associations between *school* breakfast program participation and outcomes, in most part due to inherent differences in the selection to

participate. The statistical models used in this study aimed to deal with such selection bias.

The associations found between participation in the SBP and poorer development outcomes using the lagged and dynamic models exemplify such selection issues. We had expected that children from families with greater need would be more likely to select to participate, thereby associating participation with poor development outcomes. In fact, it appears from the dynamic model that selection effects are cumulative: those who participated at both times showed the worst development outcomes and were therefore likely to be the most needy.

When we used the difference model—the model giving the least biased estimates of association under the assumption of relatively short lag between cause and effect—the negative associations with SBP participation were largely negated (and non-significant) compared to the lagged and dynamic models. In one case, the sign of the coefficient changed directions: SBP participation was associated with a 2.2 point greater gain in reading for boys compared to non-participation, though the effect was not significant. The positive association remained regardless of the interaction with change in composite need: the effect of SBP participation among boys with increased need was 2.5 points, and the effect of SBP participation among boys with decreased need was 1.2 points (Table 4.4). This finding is consistent with a quantitative study reporting a clear association for boys between school breakfast and better performance on the language segment of the Comprehension Test of Basic Skills (18) and with studies reporting improved verbal fluency and reading scores among Jamaican (19) and U.S. children (26) receiving free school breakfasts.

Mathematics performance and social skills were not associated with SBP participation (from the difference model). These results are generally not consistent

with previous works reporting positive and significant associations between school breakfast participation and similar cognitive or social outcomes (18,20,23,26,38-41). The mathematics finding *was* consistent, however, with a couple of studies reporting no measurable academic effects from taking part in school breakfast (45,72).

Similarly, SBP participation was not associated with greater weight gain between K and 3rd grade using the difference model. Two previous cross-sectional studies also found no significant associations between school breakfast program participation and weight, overweight, or triceps fatfold thickness (31,73). We conclude there is no evidence that the SBP contributes to excessive weight gain among school children.

This was the first study ever to examine the modifying effects of SBP participation. Given the small numbers of individuals changing in both food insecurity status and school meal program participation during the same time period, difference- model analysis of the interaction between program participation and food insecurity was likely to generate unreliable results. We decided that analysis of the interaction between program participation and composite need generated more reliable coefficients. In this analysis, we found starting SBP participation had a positive effect on mathematics score for increasingly "needy" girls, and this effect was significantly greater than the effect of starting SBP participation for less "needy" girls. This interaction was significant using both the restricted sample—children attending the same SBP-participating school at K and 3rd grade—and the full sample in analysis, supporting external validity of the finding. We conclude that SBP participation is more beneficial for improving the mathematics scores of more needy girls compared to less needy girls, where need has been defined by a weighted and standardized composite of low HH income, HH food insecurity, low parental education, and

absence of a computer in the household. Furthermore, this finding can be generalized to all children.

School Lunch

Very little prior research has been done investigating the effects of school lunch on child well being. The one study that has looked at developmental outcomes was limited by cross-sectional data. That study found that NSLP participation was associated with poorer mathematics test scores and increased externalizing behavior after attempting to address selection issues and confounding (Dunifon and Kowaleski-Jones, 2003).

In this study, the lagged and dynamic models showed school lunch participation to be associated with poorer reading and mathematics outcomes for the children after controlling for covariates. These associations likely reflect selection bias similar to that described above.

Using the difference model, however, negative effects largely disappeared. We found positive and significant associations between starting any school lunch participation (compared with stopping) and gains in both mathematics and reading test scores, after controlling for covariates. The magnitudes of these differences were large. For reading, the difference (6.2 points) was about four-tenths of the SD of the change from K to 3rd grade. For mathematics, the difference (3.9 points) was about one-third of the SD of the change from K to 3rd grade. These associations remained significant regardless of changes in composite need status during the same time period. In fact, the effect was largest for girls and boys with increased need between K and 3rd grade. Keeping in mind limitations of the difference model, we conclude with greatest confidence that NSLP participation is beneficial for improving reading and mathematics scores of primary school-aged children. Moreover, these

associations were significant using the full sample in analyses, permitting generalization to all children.

Moreover, results showed evidence that school lunch participation modifies the effect of material hardship (need) on reading. Gains in reading scores were 3.5 points higher among boys with increasing "need" between K and 3rd grade compared to boys with decreasing "need", where need has been defined by a weighted and standardized composite of low HH income, HH food insecurity, low parental education, and absence of a computer in the household.

Using the difference model, we found no significant effects of school lunch participation on weight gain. This finding is consistent with two studies that reported no evidence school lunch participation contributed to overweight or greater weight-for-height among poor children (73,74). Our finding is inconsistent with three other studies nevertheless. The first study reported greater risk of obesity among NSLP participants (32). That study, however, used a select population of white children ineligible for free or reduced-price lunches and did not control for food insecurity and several other factors that we controlled, perhaps explaining the difference in results. The second study reported relationships between school lunch participation and greater weight and triceps fatfold thickness of school-aged children, but that study did not control for food insecurity or attempt to deal with selection issues (31). The third study reported *reduced* risk of overweight among low-income, food insecure, school-aged girls who participated in the NSLP compared to those who did not participate (10). That study did not utilize longitudinal data, nor control for as many household-level covariates. Thus, we conclude with greatest confidence that school lunch participation is not a factor contributing to excessive weight gain among primary school children.

The relationship between *any* school lunch participation and social skills was modified by composite need for girls, suggesting a positive influence of school lunch among girls with increasing material hardship.

Conclusions

The first aim of this study was to investigate whether participation in the SBP or NSLP had independent main effects on changes in developmental outcomes. Not controlling for covariates, school meal participation was strongly associated with negative consequences for all outcomes. Thus, program participation is one means of identifying or targeting children who stand to gain from public health interventions, though practitioners should be cautious not to amplify existing perceptions of stigmatization (42).

Comparisons of the three models used in this study suggest that the difference model provides the least biased estimates of association. Our analysis is not however invulnerable to the limitations discussed above. The difference model gives the greatest confidence of association only if the lag between cause and effect is relatively short and if we have controlled sufficiently for other changing factors during the same time. Nonetheless, we believe it provides the best evidence for or against causality absent a randomized design. We are not aware of any other studies that have examined the effects of school meal programs using this type of model.

NSLP participation was found to be associated significantly with increased gains in reading and mathematics performance. Possible mechanisms include improved nutritional status (75), improved school attendance (23), and reduced financial or mental stress experienced by the child or family (26,76). SBP

participation predicted increased gains in mathematics scores for boys, though the relationship was not significant.

There are several possible reasons why we did not find significant impacts of school breakfast on measured child outcomes in this study. First, it is possible that participation resulted in better developmental outcomes, but that the positive effects were negated by persistent selection bias. The inability to control for unobserved changes and experiences between K and 3rd grade could have led to biased results, particularly if changes in motivational reasons for participation were not controlled. For example, if the reason children stopped SBP participation was because they started receiving more breakfasts at home, and such breakfasts were healthier or associated with decreased stress in the home, then we would not expect stopping the program to be associated with worse outcomes. In this study, we controlled for school, child and HH-level changes using a difference model that attempted to also remove time-invariant heterogeneity. Still, we cannot rule out exogenous influences without the use of a randomized controlled trial, which would undoubtedly be unethical.

Second, our measure of participation may be imprecise and biased. Participation was defined on the basis of parent report rather than direct observation, increasing the likelihood of error due to reporting by proxy. Misclassification may have resulted if parents reported their children ate lunch foods other than those provided through the National School Lunch Program. Bias may have resulted from different interpretations of the term "usually" for affirming participation. Furthermore, the measure does not take into account the rate of participation, categorizing all children who "usually" received meals together regardless of how frequently they actually received them or ate them. In reporting significant findings, Murphy (38) used direct observation of participation rates to compare children who

"rarely" (<20%), "sometimes" (≥20% and <80%), and "often" (≥80%) participated in the SBP. Before and after the universally free breakfast program was offered, he found that children who "sometimes" participated had math grades and depression scores that more closely resembled children who "rarely" participated compared to those who "often" participated. In fact, anxiety scores at time two were highest for children who "sometimes" participated. All combined, the availability of more precise measures of SBP and NSLP participation would have increased the likelihood of observing significant differences in outcomes.

Third, this study was unable to distinguish between the effects of receiving school breakfast and the effects of receiving free- or reduced- price breakfast. We might expect to see greater effects where economic benefits existed. Previous studies reporting positive effects of school breakfast involved provision of universal free breakfast programs (18,23,38-40,45). Studies of the effects of universal free breakfast programs may have greater inherent control over selection issues since these programs do not require certification processes for free or reduced-price meals and have been associated with less perceived stigma (26).

Fourth, a long lag period between starting SBP participation and its effects on child development outcomes relative to the duration between measures would likely alter difference model results. This would especially be true if participating children did not start receiving breakfasts until shortly before their 3rd grade measurements were taken. While much of research shows that life events have their greatest impact 3 to 6 months after they occur (77), other researchers have expressed concern that the length of time between measurement of the stressor and measurement of an outcome variable can have considerable impact on the magnitude of the stressor-outcome relationship (78).

Fifth, it is possible that the benefits of school breakfast are not realized at the household level. Consistent with the Life Stress Model, food assistance programs may work by alleviating stress or altering behavior patterns within the household. Unlike food stamps or welfare checks, parents may not be able to redistribute the benefits of school breakfast to suit their needs, thereby having no effect on stress or behavior patterns within the household.

Despite recent concerns that school meals are contributing to obesity among the poor by substituting or contributing additional calories, fat and sodium (32,79,80), we found no evidence that school meal participation was related to excessive weight gain among primary school children. This finding is consistent with a recent, well-conducted study reporting no effect of the SBP on total number of calories consumed among school children. In fact, the same study concluded SBP improved quality of overall calories consumed (24).

The second aim of this study was to investigate whether SBP or NSLP participation modified the relationships between need for food assistance and child development outcomes. We found instances in which school meal participation had more positive effects on reading performance, social skills and mathematics performance among children with increased or high need compared to children with decreased or low need. Given these findings, the school breakfast and lunch programs should be expanded to all schools with a high demographic of "needy" children, and coverage should be encouraged particularly among children from characteristic "needy" households. Some research suggests that increasing the availability of the program in schools would lead to more low-income children regularly consuming breakfast (81,82). Furthermore, the presence of an interaction, for some outcomes at

least, supports use of the Life Stress Model as an alternative conceptualization of relations between food insecurity, food assistance, and outcomes.

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CHAPTER V.
WIC PARTICIPATION AND CHILD DEVELOPMENT

Introduction

Participation in the Special Supplemental Nutrition Program for Women, Infants and Children (WIC) has been associated cross-sectionally with: increased iron and Vitamin C intakes for infants and children (Rush, et al., 1988), increased intakes of 10 key nutrients among preschool children (Rose, et al., 1998), decreased consumption of added sugars (Wilde, et al., 2000), lowered odds a child will have a nutritional deficiency (Joo Lee, 2000), lowered odds a child will be diagnosed with failure to thrive (Joo Lee, 2000), greater likelihood of child immunization (Rush, et al., 1988), greater likelihood of having a regular source of health care (Rush, et al., 1998), better infant feeding practices (Gordon & Nelson, 1988), reduced iron-deficiency anemia among infants and children (U.S.. Department of Health and Human Services, 1978; Vasquez-Seoane, et al., 1985; Yip, et al., 1987), increased newborn birth weight, prevention of low birth weight (Kennedy, et al., 1982; Metcoff, et al., 1985), lowered risk of preterm delivery (Kotelchuck, et al., 1984), and reduced infant mortality (Devaney, et al, 1992). Alternatively, WIC participation has been associated cross-sectionally with lower intakes of calcium and protein for infants (Rush, et al., 1988). Little is known, however, about the long-term effects of WIC participation on the social, physical and cognitive development of children.

Most large-scale evaluations of WIC have relied on observational comparisons between participants and non-participants; however these studies have not adequately dealt with selection bias (Devaney, et al., 1997). Selection remains a problem since

predictors of WIC participation also tend to be predictors of child developmental outcomes.

WIC benefits may exert their effects either through mediating or moderating mechanisms. Potential mediating mechanisms include: better or worse child nutritional status due to altered quality or quantity of dietary intake, better child health due to improved child immunization status, more nutritious breast milk due to altered dietary intakes of mothers, altered nutritional status of infants due to substitution of formula for breast milk, better child health due to improved pregnancy outcomes, better child health due to WIC referrals to health or social services, or improved feeding and health-related behaviors due to nutrition education. For example, a recent review of literature has linked breastfeeding (compared to formula feeding) with reduced risk of obesity later in life (Owen, et al., 2005). As a financial or social resource, WIC may also act by moderating the stress-related effects of food insecurity and poverty, consistent with the Life Stress Model.

The purpose of this study was to determine whether WIC participation has long-term effects on children's weight status, social skills, and academic performance. First, we investigated whether past WIC participation predicted kindergarten developmental outcomes. Second, we investigated whether past WIC participation predicted mean change in developmental outcomes between kindergarten and third grade.

Special Supplemental Nutrition Program for Women, Infants, and Children (WIC)

The U.S. Department of Agriculture enacted the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) in 1972 as a two-year pilot program in response to "growing concern about evidence of malnutrition and

related health problems among low-income pregnant women and children" (Devaney, et al., 1997). The three main benefits to participants include: 1) vouchers for supplemental foods, including infant formula, that promote increased intakes of protein, vitamins A and C, calcium, and iron; 2) nutrition education focusing on behavioral change and health promotion, and 3) referrals to health care and social service providers (Devaney, et al., 1997).

Women, infants and children are eligible for participation if their household income is less than or equal to 185 percent of the poverty line. AFDC and Medicaid participants are automatically eligible (Devaney, et al., 1997)

In 2003, spending for WIC totaled $4.5 billion and monthly participation in the program averaged 7.6 million people. Participation was comprised of 24 percent women, 26 percent infants under the age of 1 year, and 50 percent children between one and four years of age (U.S. Department of Agriculture, 2004). Almost all eligible infants participate in the program (Devaney, et al., 1997).

Methods

All subjects, methods and measures are the same as reported in PART III, with the exception of the following changes:

Measure of WIC Participation

Parents were asked to report whether the child received WIC benefits as an infant or child, and also whether the mother received WIC benefits while pregnant with or breastfeeding the same child. Data were combined to create a composite variable; children were classified as WIC participants if either they or their mother had received benefits. 39.46% of mothers had received WIC benefits while pregnant or breastfeeding, and 44.08% of children had received direct WIC benefits. Overall,

45.45% of 16,541 child-parent dyads were classified as WIC participants. WIC participation was reported as a past experience; therefore changes in participation could not be assessed.

Models

Each of the four developmental outcomes of interest was analyzed using two models: 1) a cross-sectional model, and 2) a lagged model. For the first model, kindergarten outcome score was modeled as a function of previous WIC participation, controlling for kindergarten food insecurity and other factors:

$$score_k = \beta_0 + \beta_1 FIS_k + \beta_2 WIC + \beta_3 covariates_k + E,$$

where the subscripts k and 3 refer to the time of assessment (kindergarten and 3rd grade), WIC refers to participation in WIC, and FIS refers to greater than one affirmative response on the USDA food insecurity module.

For the lagged model, change in outcome score between kindergarten and 3rd grade was modeled as a function of initial score and previous WIC participation, controlling for food insecurity over time, as well as time invariant *and* time-varying cofactors:

$$\Delta score_{3-k} = \beta_0 + \beta_1 score_k + \beta_2 FIS_k + \beta_3 \Delta FIS_{3-k} + \beta_4 WIC + \beta_5 covariates_k + \beta_6 \Delta covariates_{3-k} + E$$

For this model, analyses were run using the full sample and the subset of children that did not change schools between kindergarten and 3rd grade. We used the latter sample to eliminate the effects of unobserved, time-varying school-level factors that could bias the results. Potential modifying effects of WIC participation on food security status were not investigated since WIC participation preceded kindergarten food security status by quite a long period.

Results

Of the respondents classified as food insecure at kindergarten (≥1 affirmative response on USDA module) 76.02% had participated in WIC. Conversely, 29.18% of past WIC participants were living in food insecure homes at kindergarten. Background characteristics of WIC participants are presented in **Tables 5.1 and 5.2**. The following factors were indicative of WIC participation rates higher than 70%: black race/ethnicity; highest parent education less than a high school diploma; mother and/or father looking for work at kindergarten; parents never married; no father in household at kindergarten; neighborhood rated as unsafe to play in at kindergarten; and participation in Head Start, the Food Stamp Program, or the School Breakfast Program at kindergarten. WIC participating families had, on average, lower incomes, younger parents, more siblings and a greater number of people within each household. WIC participating families were disproportionately more likely to be minorities, to have parents working full time, to be less educated, to reside in the South, and to reside within a large city.

After controlling for background covariates, WIC participation was associated with lower kindergarten math and reading scores for boys and girls, greater kindergarten weight for girls, and lower kindergarten social skills scores for boys and girls **(Table 5.3).** Additional controls for class and school level factors yielded similar results for all outcomes.

Table 5.1.
Background Characteristics of WIC Participants and Non-Participants

	Participated in WIC Mean	**Did not participate in WIC** Mean	**P-value for difference by ANOVA**
Income	28.297.5	74,261.2	<0.0001
Mom's age	31.074	35.359	<0.0001
Dad's age	34.089	37.816	<0.0001
Child's age	74.611	74.817	0.0034
Mom's age at first birth	21.035	26.319	<0.0001
No. siblings	1.599	1.392`	<0.0001
HH size	4.669	4.455	<0.0001
No. times exercise per week	3.956	3.886	0.065

Table 5.2.
Background Characteristics of WIC Participants

Characteristic	% of WIC participants having characteristic	% of group having characteristic that participated in WIC
Male	51.73	46.07
Race		
White	39.68	31.23
Black	23.96	78.83
Hispanic	24.39	64.88
Other race	11.96	47.87
Birth weight category		
Normal birth weight	86.35	43.88
Low birth weight	7.60	56.87
Very low birth weight	6.05	61.24
Mother's work status, at K		
>35 h/w	45.93	45.59
<35 h/w	17.35	35.54
Looking for work	6.42	79.58
Not in labor force	28.24	44.78
No mother in HH	2.06	58.19
Father's work status, at K		
>35 h/w	55.83	34.46
<35 h/w	3.19	50.49
Looking for work	2.24	73.00
Not in labor force	4.48	66.06
No dad	34.25	73.92
Child care status, at K		
No non-parental care	52.84	45.16
Center-based care	12.21	31.93
Relative care	24.51	58.97
Non-relative care	2.90	34.11
Other/varies	2.55	54.25
Child health insured, at K	86.19	42.12
Mom married at child's birth	49.27	30.52
Highest education level of either parent, at K		
<8th grade educ	5.67	84.71
9th-12th	12.54	87.01
High school diploma	37.76	67.17
Vocational/tech. school	7.27	58.50
Some college	27.40	46.49
Bachelor's degree	6.60	16.25
Some graduate school	0.97	18.37
Master's degree	1.28	8.02
Doctorate/profess. degree	0.51	5.06

Table 5.2 (Continued)

Parent Marital Status, at K		
Married	52.65	33.03
Separated	6.63	66.48
Divorced	10.82	57.07
Widowed	1.07	61.79
Never married	25.06	86.13
No biological/adoptive parents	3.77	79.94
Child disabled, at K	15.46	49.73
Number of parents in household, at K		
1 parent HH	33.42	71.52
2 parent HH	63.33	36.60
Other arrangement	3.25	81.91
Location of residence, at K		
Central city	43.63	49.94
Large town/urban fringe	30.78	36.46
Small town/rural	25.59	53.05
Region of residence, at K		
Northeast	15.14	37.27
Midwest	22.53	40.15
South	39.16	53.13
West	23.17	46.73
Parent self rating of depression, at K		
Never depressed	65.24	40.37
Sometimes/moderate amount	30.15	52.33
Most of the time	4.61	75.00
Parent self rating of "can't get going," at K		
Never	53.69	40.84
Sometimes/moderate amount	40.93	47.50
Most of the time	5.38	68.32
Parent rating of neighborhood safety, at K		
Not safe	5.57	72.03
Somewhat safe	34.57	59.80
Very safe	59.87	37.80
Child participated in Head Start	30.31	87.57
Received Food stamps in 12 mo before K	30.28	90.78
Child received school breakfasts, at K	40.84	79.52
Child received school lunches, at K	70.87	57.12

Table 5.3.
Effects of WIC Participation on Kindergarten Child Development Scores, *Full Sample*

Kindergarten Outcome	Effect of WIC Participation[35]	
	n	β-coefficient (P-value)
Mathematics scaled score[36]		
All	9360	-1.258 (0.0006)
Males	4767	-1.530 (0.004)
Females	4593	-0.852 (0.0571)
Reading scaled score[40]		
All	9061	-1.231 (0.0039)
Males	4622	-1.397 (0.0194)
Females	4439	-0.848 (0.1707)
Weight (kg)[37] ∞		
All	9332	0.312 (0.0300)
Males	4754	0.091 (0.6455)
Females	4578	0.482 (0.0268)
Social skills scaled score[41]		
All	9133	-0.090 (<0.0001)
Males	4647	-0.0908 (0.0020)
Females	4486	-0.0772 (0.0047)

[35] Controlling for: K food insecurity (≥1 affirmative response on USDA module), K composite motor skills score, child age, child gender, child race, low birth weight, HH income, highest parent education level attained by K, parent ratings of depression and inability to "get going" at K, ownership of a home computer at K, frequency of exercise at K, parents' ages, whether mother married at child's birth, number of siblings at K, HH size at K, parent rating of neighborhood safety at K, whether child health insured at K, parents' employment status at K; child care status at K; parent marital status at K; cild disability at K; number of parents in HH at K; region of residence at K; location of residence at K; child participation in Head Start

[36] Results were similar after additionally controlling for school-level factors: individual tutoring/extra assistance in reading given by specialists, aides, and teachers at K; frequency of lessons per week in reading and language arts at K; frequency of lessons per week in mathematics at K; child individually tutored in reading or math in school at K; type of school (public, private religious, private non-religious, other private); class size; type of K class (full day or half day); percent minorities in K class; total K enrollment in school; and administrator reports of whether the following were problems with school: school funding levels decreased significantly over past 3 years; school's average family income decreased significantly over past 3 years; school enrollment increased significantly over past 3 years; significant reduction in staffing or teacher shortage over past 3 years; racial, ethnic or religious tension in school neighborhood; crime in school neighborhood

[37] Results were similar after additionally controlling for school-level factors: type of school at K (public, private religious, private non-religious, other private); class size at K; type of K class (full day or half day); percent minorities in K class; total K enrollment in school; and administrator reports at K of whether the following were problems with school: school funding levels decreased significantly over past 3 years; school's average family income decreased significantly over past 3 years; school enrollment increased significantly over past 3 years; significant reduction in staffing or teacher shortage over past 3 years; racial, ethnic or religious tension in school neighborhood; crime in school neighborhood

[∞] Additionally controlled for child height

Lagged model analysis showed that WIC participation was associated with greater weight gain among girls, impaired social skills development among girls and boys, and delays in reading and mathematics performance for girls and boys between kindergarten and 3rd grade, although the delays in academic performance were only significant for males **(Table 5.4).** Results were similar regardless of using the full sample or the restricted sample of children that did not change schools during this period **(Table 5.4).**

Discussion

Cross-sectional and lagged models showed significant developmental delays associated with WIC participation. Caution is warranted in interpreting these findings, however, since the associations are likely to be biased by strong selection effects. Families that participated in WIC were likely to have had greater need for the services and therefore a greater propensity to participate. Any positive effects of the programs were likely negated by such selection, as well as the long lag period between participation and measurement of outcomes. Whereas previous analyses of programs attempted to control for this bias by using dynamic and difference models to assess dynamic effects over time, such analysis is not applicable here because our measure of WIC participation is not dynamic. Plausibility statements about WIC's effects on child development are inappropriate given lack of analytical methods that can adequately deal with selection.

Future longitudinal investigations of WIC's effects are warranted and should focus on dynamic changes in participation in relation to subsequent or concurrent infant development. Additionally, resources and programs should be targeted to children of families that have participated in WIC since these children are likely to

have worse trajectories of development, even after controlling for relevant background factors.

Table 5.4.
Effects of WIC Participation on Changes in Development Scores Between Kindergarten and 3rd Grade, *Full and Restricted♥ Samples*

Change in Developmental Outcome	Effect of Participation in WIC[38]			
	Full Sample		Children that did not change schools between K and 3rd grade	
	n	β-coefficient (p-value)	n	β-coefficient (p-value)
Mathematics score				
ALL	8179	-1.230 (0.0065)	6520	-1.060 (0.0061)
Males	4150	-1.819 (0.0038)	3288	-1.490 (0.0125)
Females	4029	-0.755 (0.1819)	3232	-0.770 (0.2269)
Reading score				
All	7897	-1.497 (0.0163)	6303	-0.966 (0.1220)
Males	4005	-2.424 (0.0078)	3182	-1.638 (0.0613)
Females	3892	-0.682 (0.4253)	3121	-0.198 (0.8353)
Weight (kg)∞				
All	7886	0.261 (0.0722)	6380	0.358 (0.0202)
Males	4006	-0.074 (0.7258)	3225	-0.008 (0.9714)
Females	3880	0.737 (0.0002)	3155	0.751 (0.0002)
Social skills score				
All	6803	-0.067 (0.0003)	5697	-0.051 (0.0051)
Males	3407	-0.051(0.0442)	2851	-0.034 (0.1965)
Females	3396	-0.073 (0.0017)	2846	-0.056 (0.0069)

♥ Children that did not change schools between K and 3rd grade

[38] Controlled for: K outcome score, K and change in food insecurity (defined as ≥1 affirmative response on USDA module), K composite motor skills score, child age, child gender, child composite race, child birth weight, Head Start participation, K and change in HH income, K and change in highest education level of either parent in HH, K and change in parent ratings of depression and inability to "get going", K and change in frequency of exercise, parents' ages, mother's age at first birth, whether mother married at first birth, K and change in number of siblings, K and change in HH size, K and change in neighborhood safety rating, K and change in child health insurance, K and change in child disability, K and change in number of parents in HH, K and change in parent marital status, K and change in child care status, K and change in parents' employment status, K and change in location of residence, K and change in region of residence, number of places family has lived for more than 4 mo in past 3 y, whether close relative died in past 2 y

∞ Additionally controlled for initial and change in child's height

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CHAPTER VI.
POLICY IMPLICATIONS

Public health scientists have argued "the main objective of an evaluation is to influence decisions" and decision-makers may use the findings of evaluations to "continue, change, expand, or end a project or intervention" (Habicht, et al, 1999). In using evaluative research, policymakers must ask: is the intervention worth continuing, and should it be extended? (Habicht, et al., 1984) The purpose of this chapter, therefore, is to use the research findings from the previous papers to address the first of these two questions: are federal child nutrition programs worth continuing? As discussed in Part V, little can be implied from the evaluation of WIC due to the likely persistence of selection effects. Analysis will therefore focus on policies related to the School Breakfast Program (SBP) and National School Lunch Program (NSLP).

There are many forms of rationality underlying public policy processes. Participants in the policy process can approach a problem from technical, economic, social, political, administrative, and legal rationalities (Pelletier). To analyze conditions from each of these rationalities would be very difficult and time-consuming. Rather, this section will focus mainly on using technical findings to inform policy options. According to Tim Clark (2002), the policy process is "a social dynamic that determines how the good and the bad in life are meted out—that is, who gets what, when, and how." Technical information is important in policymaking because it should be based on a certain standard of scientific rigor and objectivity. Thus, it helps to make reasoned decisions among competing interests (Pollitt, 1999).

Decision-makers should be conscious, however, that intelligence alone can not resolve competing value interests inherent to policy processes (Clark, 2002). "Program and policy decisions are the result of multiple actions by multiple actors" (Weiss,

1988), each with competing interests, perspectives, values and personal goals (Clark, 2002). Policymakers should therefore strive to resolve value tradeoffs by achieving common interest (or common value) solutions to policy problems, whereby the common goals of opposing actors may be achieved. The research conducted in this thesis was intended to serve as an evaluation of program's causal impact. The result is that data are appropriate for informing all-or-none policy solutions—that is, whether the program should be discontinued, continued, or expanded in scope. Data from this paper are not sufficient for drawing out common interest solutions. Further research is recommended to assess the feasibility and appropriateness of alternate policy solutions and to determine the best common interest solution among all possible solutions. For example, a policy of improved targeting may better address conflicting interests and values. Such a policy could be assessed by analyzing data for potential effect modifications other than "composite need", determining the proportion of children correctly identified as needing the program (sensitivity), determining the proportion of children correctly identified as not needing the program (specificity), or analyzing data to determine the income level where program effects disappear. Alternate policies to be researched include: changing access to or utilization of program inputs; improving quality or quantity of nutrition education; reducing barriers to household ability to provide breakfast or lunch; streamlining program administration; changing cutoffs for free- or reduced-price participation; changing the cost of benefits (i.e., eliminating or increasing the cost of lunch for reduced-price participants; mandating healthier foods in programs; regulating the sale or quality of competitive foods in schools; and redirecting resources to other programs known to improve child development outcomes.

Whatever the best policy solution may be, a rudimentary analysis of child nutrition policy is warranted in order to determine appropriate recommendations given the technical research at hand. Clark (2002) provides a useful framework for mapping the policy process. One of the dimensions in that framework is problem orientation. Problem orientation includes five "tasks" that must be carried out in order to address a problem thoroughly. These five tasks are: 1) clarifying goals, 2) describing trends, 3) analyzing conditions, 4) projecting developments, and 5) inventing, evaluating, and selecting policy alternatives. This paper will proceed by discussing child nutrition policy in light of each of these tasks.

CLARIFYING GOALS

The first task in problem definition is to clarify the goals of the participants or stakeholders involved in the policy process. "Goals are the preferred outcomes in a specific context in terms of the distribution of values, practices, and institutions" (Clark, 2002). Though I certainly cannot speak for all stakeholders, I can clarify fundamental values and practices shared by most of American society. Fundamentally, most people value security, democracy, equal opportunity, and human rights, including "the right to a standard of living adequate for the health and well-being of himself and of his family." These are values that have been written in the Declaration of Independence and the Universal Declaration of Human Rights. In addition, one of the goals written in the United States Constitution is to "promote the general welfare."

Many individuals in society would argue that "promoting the general welfare" includes the goal of protecting needy children from circumstances that undermine their development and full potential. Using the liberal-conservative perspective on social

program targeting proposed by Pelletier (2005), this line of thinking stereotypically coincides with the values and interests of political liberals. Liberals often refer to increasing program coverage as "helping the needy", "fulfilling our moral duty", or "protecting human rights." They often refer to decreasing program coverage as "failing the poor", "shirking moral duty", or "widening disparities" (Pelletier, 2005).

Alternatively, many Americans value hard work ethic, personal reward, and individuality. These values have had several impacts on shaping common goals. First, they have led to the prevalent view that poverty and overweight are conditions of individual failure rather than social causation (Curtis, 1997). Second, they have led many people to favor tax-relief policies over policies that promote social welfare programs, public health programs, and universal health care (Winston, 2002). Third, they have led to a greater base of support for welfare interventions that provide support services (i.e., Head Start, job training) instead of cash income and material support. McLoyd (1998) writes, "That such [support service] interventions are the core essence of America's antipoverty policies reflects Americans' preference for indirect rather than direct approaches to poverty reduction, their aversion to social insurance programs similar to those that exist in European countries, and their conviction that governmental policies should promote equality of opportunity rather than equality of condition."

The values of individuality and personal reward more often coincide with the values and interests of the conservative side of the liberal-conservative political spectrum. Conservatives often refer to decreasing program coverage as "eliminating fraud, waste, and inefficiency." They often refer to increasing program coverage as "wasting resources", "creating dependency", and "cheating welfare" (Pelletier, 2005).

In summary, many Americans share the common goal of promoting the social and economic welfare of society as a whole. This usually entails programs to protect children from circumstances that undermine or impair their development. Such protection, however, must be balanced with appropriate targeting in the interest of those who want programs that are cost-efficient, effective, accountable to taxpayers, and that do not contribute to dependency or other behaviors that undermine social and economic progress.

DESCRIBING TRENDS

The second task in problem orientation is to describe past and current trends. By analyzing past events and decisions, we can come to understand how closely current situations approximate community goals (Clark, 2002).

One way in which society has resolved to promote equal opportunity and general welfare is by providing a safety net against poverty and food insecurity. Domestic food assistance programs are a policy mechanism, generally backed by "liberals", designed to protect Americans against the consequences and experiences of food insecurity and malnutrition. Along with other social programs, they are intended to "ensure a socially acceptable minimum welfare safety net for needy segments of the population" (Davis, 1995).

On June 30, 2004, President Bush signed the Child Nutrition and WIC Reauthorization Act of 2004 into law. The intent of the bill, which had received wide bipartisan support from civil society organizations and legislators (Boehner, 2004), was "to renew and strengthen federal child nutrition and school lunch programs and help local communities work with parents to fight America's growing child obesity problem" (Boehner, 2004). The bill called for the following overall reforms: 1) the

establishment of local wellness policies in schools to fight childhood obesity; 2) the strengthening and streamlining of the certification process for participation in WIC and school meal programs; 3) increased access to program participation for vulnerable children, and 4) cost containment measures to address concerns about efficiency in the WIC program. These initiatives correspond with both "liberal" and "conservative" goals as described in the previous section. Trends related to the SBP and NSLP programs are discussed in greater detail below.

National School Lunch Program

There have been several recent policy changes at the federal level relating to the National School Lunch Program. The first major policy issue involves measures to strengthen and streamline certification processes for participation in the program. In the late 1980's, the U.S. Department of Agriculture (USDA) introduced direct certification. Under direct certification, children of families receiving welfare or food stamps could be automatically certified to receive free school meals, precluding the need for a separate application process. Evaluations of program processes reported that direct certification increased the number of children certified for free meals and slightly increased overall NSLP participation, while at the same time improving program integrity (Mathematica Policy Research, Inc., 2005). The Child Nutrition and WIC Reauthorization Act of 2004 has gone a step further by *requiring* that children in food-stamp-receiving households be directly certified for free school meals (USDA, February 15, 2005). Given the effects of the previous legislation, the 2004 policy change will likely increase overall participation in school meal programs among low-income children. At the same time, direct certification is contingent upon Food Stamp

Program and AFDC participation; therefore decreased support for these welfare programs is likely to result in decreased school meal participation rates.

The Child Nutrition and WIC Reauthorization of 2004 also authorized the following policy changes aimed at increasing participation: 1) encouraging more schools to participate in Provisions 2 and 3, options that enable schools composed mainly of low-income students to provide free meals to all of its students regardless of their income; 2) allowing families to fill out only one application for all children in the household; 3) providing migrant, homeless and runaway children with automatic eligibility for free school meals; 4) starting a pilot project in five states which offers free school meals to families currently eligible for reduced-price meals, and 5) making it possible for more children from military families to receive free and reduced-price meals by excluding privatized housing vouchers from being counted as income (Food Research and Action Center, 2005c).

The second major policy issue related to the National School Lunch Program involves concerns about the quality of foods offered in schools. Commentators have criticized schools for contributing to the growth in obesity (Besharov, 2002; Besharov, 2003). The 2004 Child Nutrition and WIC Reauthorization Act specifically mandated that schools address the nutritional content of competitive foods offered in schools. Competitive foods are "foods from a la carte cafeteria sales, vending machines, school stores, snack bars, and similar sources that do not qualify as reimbursable meals under the National School Lunch Program or the School Breakfast Program" (Cohen, et al., 2004). They tend to be processed foods high in sugar, fat, saturated fat, trans fat, and sodium (Porbart, et al., 2005). One study found that students purchasing competitive foods reduced their school-lunch servings, portion weight and/or item selection and

increased their school lunch item plate waste, resulting in lower intakes of vitamins and minerals (Templeton, 2005).

There has also been a recent movement to incorporate more fresh and healthy foods into school meals. The Child Nutrition and WIC Reauthorization Act of 2004 authorized several policy changes aimed at increasing the quality of foods in school meals. The Fresh Fruit and Vegetable Pilot Program, which provides free fruits and vegetables to students in elementary and secondary schools, was expanded to four more states and two more Indian reservations. The 2004 Act has also authorized expansion of the Local Foods and School Gardens Program, a program supporting farm-to-cafeteria projects and school garden programs. Over 400 school districts now support the "farm-to-cafeteria" movement (Burros, 2005).

The third major policy issue relating to the National School Lunch Program is the debate over expansion of the Summer Food Service Program. The Summer Food Service Program provides free or reduced-price school lunches to children during the summer recesses. The meals are served at sponsoring community organizations or schools. The 1981 and 1982 Omnibus Budget Reconciliation Acts made it more difficult for agencies to sponsor the Summer Food Service Program, resulting in a large reduction in the number of participants (Lipsky & Thibodeau, 1990). Currently, the Summer Food Service Program serves a little over two million children nationally (Gordon & Briefel, 2000), or about 19 children for every 100 children who receive free or reduced-price school lunches during the school year (FRAC, 2005a).

In response to growing concern about summer nutrition, policymakers in several states have supported measures to introduce or expand summer food programs. The Lugar Summer Food Pilot Program, a bill introduced by Senator Lugar, was first implemented in 2001 and aimed to increase student participation in and decrease

sponsor paperwork for the Summer Food Service Program in 13 states. The result was increased participation in the program by 25 percent among those states, compared with an eight percent decrease in participation among other states around the country (Sidwell, 2005). In 2005, the pilot program was expanded to six more states under authorization of the Child Nutrition and WIC Reauthorization Act (FRAC, 2005c). Also in 2005, the Oregon State House of Representatives and Senate approved a bill giving $150,000 more to help schools in Oregon expand their summer free and reduced-price lunch programs (Manthey, 2005). Interest groups such as the Food Research Action Center (FRAC) continue to pressure governments to allocate more funds to expand summer meal program participation (FRAC, 2005a).

The fourth major policy issue concerning the National School Lunch Program is that of lunch scheduling. Some lawmakers are pushing for a measure to mandate 30-minute lunch periods in schools. The average lunch period, the time allowed for a child to both get to the lunchroom and to eat their lunch, is now 23.7 minutes according to the School Nutrition Association. Advocates are concerned that this is not enough time for children to get through the lunch line, sit down and consume their food properly. Children have also complained about not being able to finish their lunches (Vaishnav, 2005). Some advocates have expressed concern that the short lunch period also encourages children to purchase junk foods from vending machines and other sources (Christian Science Magazine, 2005). I posit that the short lunch period may even lead to reduced participation in the school lunch program if children do not feel that they have enough time to properly receive the meals and consume them too. Alternatively, school administrators have argued that extending the lunch period would take time away from academics (Vaishnav, 2005). Philosophically, the debate over school lunch period scheduling amounts to a clash in values over whether

children's physical and health needs should receive priority over academic scores. Administrators contend that the length of the school day necessitates a tradeoff between one and the other. The debate also amounts to a power struggle over whether lawmakers should be able to interfere legislatively in school scheduling.

The fifth and last major policy change has been the recent legislation emphasizing local school wellness programs. By the first day of the 2006-2007 school year, every school district that participates in the National School Lunch Program is required (under the 2004 Reauthorization Act) to enact a "local school wellness policy"—a policy to address obesity and promote healthy eating and physical activity through changes in school environments (Boehner, 2004; FRAC, 2005c). The policy must address school meal guidelines. Development of the wellness policies must involve participation of all stakeholders—parents, students, school food service staff, the school board, school administrators, and the public. This is the first legislation of which I am aware to formally recognize the importance of environmental and school factors in shaping the health behaviors of children. It is also the first piece of child nutrition legislation to devolve responsibility to schools and local communities to implement their own local policies that "reflect local needs."

School Breakfast Program

The most important policy developments involving the School Breakfast Program have focused on participation, coverage, and allocation of funds. As mentioned earlier, the SBP was authorized by the Child Nutrition Act of 1966 as a pilot program to provide funding for breakfast in poor areas and areas where children had to travel long distances to school. The program became a permanent entitlement program in 1975, "with the objective of having the program 'available in all schools

where it is needed to provide adequate nutrition for children in attendance.' (Center for Nutrition Policy and Promotion, 1998)."

In 1978, there was a strong attempt to create a national mandate for school participation in the SBP where more than 40 percent of children were eligible for free or reduced-price meals, but the mandate was not passed due to resistance (Parker, 1999). In 1981, funds for the SBP were cut significantly, resulting in decreased participation rates among schools and children (Parker, 1999). Then in 1983, Congress earmarked more funds for the breakfast program in response to an evaluation reporting positive benefits for children (Parker, 1999). The Child Nutrition Act of 1989 further expanded availability of the program by requiring the Secretary of Agriculture to provide funds to states in support of starting breakfast programs in low-income areas (Center for Nutrition Policy and Promotion, 1998).

In 1994, U.S. Congresswoman Lynn Woolsey introduced the Meals for Achievement Act, a bill to expand the SBP to include all children in elementary levels regardless of their economic status. The result was a law giving the Secretary of Agriculture authority to conduct universal school breakfast pilot projects in six districts nationwide in order to study the effects of such programs in schools (Woolsey, 1999).

Around the same time, efforts were underway in Minnesota to expand the school breakfast program. The Minnesota legislature committed funds for three years to establish a pilot program in four elementary schools where free breakfasts were served universally to all children in the schools. More than anything, the project highlighted the importance of getting support at the grassroots level by informing decision-makers, families, and school officials about the benefits of breakfast so that they could become spokespersons for legislative action. As a result of grassroots

advocacy, the Minnesota legislature allocated a million dollars to fund more universal school breakfast programs. The events in Minnesota were important in getting school breakfast on the political agenda among more than just policymakers.

Although the SBP has more than doubled in size since 1990 (U.S. Committee on Ways and Means, 2004), only about two-thirds of schools currently participate in the program. Advocates of the program have pushed for more funding to expand the program to cover all children. Recently, several school districts across the U.S. have made steps in that direction. In Montgomery, Alabama, for example, the School Board voted to make the breakfast available to every child in the district (Jones, 2005). But while some school districts are expanding their programs (Metaxas, 2005), other districts have had to eliminate programs due to budget cuts (Del Greco, 2005).

Other Trends

Despite the existence of federal food assistance programs, food insecurity has remained a persistent problem for children in the United States. Where the public food safety net has failed to meet basic needs of low-income households, the voluntary sector has often responded by providing emergency feeding organizations such as food banks, food pantries, soup kitchens, and shelters. Curtis (1997) argues that in the 15 years prior to 1997, "[economic and tax] policy changes have increased pressures on food assistance programs" and "have shifted responsibility for food and income assistance from the federal government to the states and the private sector."

Federal budgetary pressures have become even more eminent in recent years. "Gale and Kotlikoff (2004) estimate that paying for tax cuts to become permanent and for new prescription drug benefits for the elderly will require a cut of 58 percent in all federal spending other than interest, defense, homeland security, social security,

Medicare and Medicaid" (Battacharya, et al., 2004). The President's goal of reducing the federal budget deficit will also likely take precedence over social services. Evidence for this is the President's 2005 proposal to eliminate food stamps for 300,000 members of low-income families with children (FRAC, 2005b) and the 2006 budget reconciliation plan which gives Congress the authority to cut $3 billion from agricultural programs over the next five years (Chen, 2005).

The No Child Left Behind Act, signed into law in 2001, is an example of a policy designed to protect the education of all citizens. The law requires that schools demonstrate continuous improvement in academic achievement for the school as a whole and for defined subgroups of students (Minnesota Department of Education). Federal funding for the program, however, has been limited despite promises otherwise.

States are also facing declines in financial resources as a result of downturns in the economy. In 2001, the National Conference of State Legislatures reported that 36 states were considering budget cutes or "holdbacks" to address fiscal problems. (FRAC, 2002)

ANALYZING CONDITIONS AND PROJECTING DEVELOPMENTS

The third and fourth tasks in problem orientation are examining conditions through scientific inquiry and making projections about future trends. Analyzing conditions gives us the means by which we can make generalizations about cause and effect and therefore rationally evaluate policy options. Projecting developments involves answering questions about what is likely to happen in the future given past trends and conditions (Clark, 2002).

The research conducted in Part III investigated the causal impacts of food insecurity among a representative group of U.S. grade school children using a fixed-effects model to reduced effects of bias. Results of the study showed that food insecurity was associated with impaired academic development among both boys and girl, impaired social skills development among girls, and greater weight gain among boys. Given these results only, we can project that food insecurity will likely have detrimental effects on children's reading performance, weight gain, and social skills in the future, barring changes in any uncontrolled factors that could influence these relationships. Past trends also suggest that food insecurity is likely to remain prevalent among children in the United States despite the existence of federal food assistance programs.

Nevertheless, there is reason to believe that child nutrition programs will impact children by means other than averting food insecurity. Research conducted in Part IV investigated the causal impacts of school meal programs also using a fixed-effects model to reduce effects of bias. School breakfast program participation was associated with improvements in reading for boys, regardless of their estimated need for the program. The school breakfast program also had a positive and protective effect on mathematics scores for girls with increased material hardship compared to girls with decreased material hardship. School lunch program participation was associated with greater improvements in mathematics and reading performance for both girls and boys, regardless of their estimated need for the program. The effect of school lunch on reading performance was significantly stronger for boys with increased material hardship compared to boys with decreased material hardship. Neither school lunch participation nor school breakfast participation was causally related to greater weight gain among these children. Barring major changes in

uncontrolled policy or social factors, we can project that these programs will have the same effects on children in the present and future.

As noted earlier, recent trends in child nutrition policy have emphasized improvements in the quality of school meals, promotion of greater participation in school meals among low-income children, and expansion of school breakfast and summer food service programs to include greater coverage among low-income areas. These policy changes are likely to reduce unmet need, potentially resulting in overall improvements in reading and mathematics scores and weight status. Alternatively, policy changes that discourage participation in the Food Stamp Program and welfare programs are likely to also decrease school meal participation among those families most in need of the services, resulting in greater unmet need.

In summary, food insecurity is likely to remain a prevalent problem with adverse consequences for children's academic and social development. School meals may or may not help to avert household food insecurity; however, these programs *are* likely to cause improvements in academic performance among children, and the improvements are likely to be greatest among children with more socioeconomic need for the programs. The programs are not likely to contribute to overweight or obesity in school children.

EVALUATING AND SELECTING POLICY ALTERNATIVES

As mentioned earlier, the research in this thesis can be used to evaluate three main policy alternatives. The first alternative is to continue the current level of funding for child nutrition programs. The second alternative is to discontinue funding for child nutrition programs (with the option of redirecting funds to other programs). The third alternative is to increase funding for expansion of child nutrition program

participation and coverage beyond what was authorized in the 2004 Reauthorization Act. Each of these alternatives is discussed below.

The first policy alternative reflects maintenance of the status quo. Under the status quo, many children who stand to benefit from school nutrition programs will not become beneficiaries. Only about half of all children and only one-quarter of all free-price eligible children were participating in the SBP at kindergarten and 3rd grade. The SBP was only offered in about two-thirds of schools. Additionally, only half of all children and three-quarters of all free-price eligible children were participating in the NSLP in kindergarten. Under the assumption that selection is not responsible for all differences in participation, these statistics suggest that there are children who stand to gain academically, and likely in other ways, from expanding participation to more schools and more students.

Children from middle- and upper-income families would also fail to benefit under the status quo. Research from this thesis shows that children with less economic "need" were also likely to benefit academically from the NSLP (though the magnitude of the association was weaker compared to "more needy" children). Time constraints, lack of parental supervision, busy work schedules, and child attitudes and preferences are among the reasons such children may skip lunch or eat unhealthy lunches. Neglecting to promote participation among this group would result in a missed opportunity to address needs that are often overlooked.

The status quo would satisfy the goals of those citizens who resist expansion of the program under the perception that it would lead to increased inefficiency, waste, and government spending. The status quo would conflict with the goals of citizens who support downsizing the program under the perception that it contributes to fraud, laziness, and dependency.

The second policy prescription—discontinuation of child nutrition programs—rests upon three major assumptions. The first assumption is that funds would be redirected to programs that have similar or better effects on child development or other outcomes. The second assumption is that private organizations would assume responsibility for unmet food needs, and that they would be equally or more effective in "filling this gap." The third assumption is that discontinuation would not generate any negative effects.

Given current budgetary pressures and fiscal deficits, there is no reason to believe that expropriated funds would be allocated to other social service programs. On February 2005, the U.S. President proposed to cut billions of dollars from programs such as Medicaid, The Community Services Block Grant, the Food Stamp Program, Head Start, child care assistance, and housing assistance (FRAC, 2005b).

Regarding the second assumption, research suggests that voluntary organizations would not be able to respond adequately the sudden spike in demand for services caused by discontinuation of school meal programs (Cook & Brown, 1997). In the short term, many families would experience greater stress resulting from unmet needs, resulting in more developmental problems for children. Privatized food assistance has also been criticized for its long-term social consequences. One qualitative study found that voluntary food assistance organizations in Pennsylvania have formed a "shadow government" that 1) closely parallels the bureaucracy, rigidity, and depersonalization of government agencies, 2) masks state failings, and 3) contributes to "the view of poverty in America as primarily the result of personal defects and temporary misfortunes" rather than the product of structural factors that produce poverty and food insecurity (Curtis, 1997). Furthermore, there are no formal mechanisms by which voluntary organizations can be held accountable to benefactors.

Ultimately, privatized food assistance may be no better a substitute for public assistance.

Regarding the third assumption, discontinuation of the school meal programs is likely to negatively impact agricultural producers. The USDA supports American agricultural producers by providing USDA-purchased food to the National School Lunch and Summer Food Service Programs. The Food Distribution Division of USDA's Food and Nutrition Service (FNS) coordinates the distribution of commodities to these sites. Nearly 60 percent of the foods purchased for the Child Nutrition Programs are in surplus at the time of purchase. In 2004, the USDA purchased over $7.7 million worth of commodities for school nutrition programs (Food and Nutrition Service, 2003). The link between child feeding programs and agricultural support is likely to result in powerful political resistance to discontinuation of the programs.

In summary, a policy of discontinuation would likely have negative impacts for children who do or would receive benefits through the program. Politically, the policy would coincide with the values and interests of many fiscal and political "conservatives", but the policy would likely be met with strong, active, bipartisan resistance from those who favor social welfare, investments in academic achievement, and agricultural support.

The third policy option calls for greater appropriation of funds to expand school meal programs to cover more schools and to encourage more participation. Additional funds could be used directly to facilitate program implementation in more schools or indirectly to increase outreach to parents, students and school administrators (FRAC, 2002).

One programmatic approach to increasing participation in the SBP is to offer universal-free breakfast programs in all schools. Studies have shown beneficial effects from implementation of universal-free breakfast programs. At the more immediate level, these programs have been found to increase participation in school breakfast (FRAC, 2005a; Wahlstrom & Begalle, 1999; Bernstein, 2004), decrease stigma associated with the program (Wahlstrom & Begalle, 1999), and increase overall likelihood of eating a nutritionally substantive breakfast (Bernstein, 2004). Child academic performance and psychosocial functioning have also reportedly improved after implementation of pilot programs in schools (Bro, et al., 1996; Wahlstrom & Begalle, 1999; Worobey & Worobey, 1999). The provision of universal-free breakfast programs in all schools would be one means of ensuring that the benefits of breakfast reach all children, regardless of reasons for needing the program. This policy is likely to be met with resistance by those who perceive that expanding the program to children who traditionally were not characterized as "needy" is excessive and uneconomical. Results from this thesis, however, support the notion that school breakfast benefits children regardless of their estimated financial need for the program.

A second programmatic approach to increasing participation in the SBP is to expand summer meal programs. During the school year, school lunches can provide more than one-half of nutrients to low-income children (FRAC, 2005a). Low-income families who depend upon these resources more often turn to food banks and other highly stigmatized food resources during the summer months in order to make ends meet (Sidwell, 2005). Barriers to summer food program participation include: lack of transportation to the meal sites, lack of awareness, and absence of programs in the vicinity. At the program-level, barriers to program sponsorship include: difficulty in

securing funding, lower USDA reimbursement rates per meal, and administrative complexity (Sidwell, 2005). Funds could be used to address these barriers.

The policy tradeoffs for program expansion are largely financial. Policymakers must answer: how much extra money are taxpayers willing to pay toward school meal programs so that children might achieve up to 7 points higher on standardized academic tests? An important question also arises within this decision: how important and relevant are academic tests as an indicator of 1) educational attainment and learning ability (proximally) and 2) social welfare (distally)? These are issues that need to be researched and discussed further within academia and among communities.

Given the three policies proposed above, I recommend the last policy of expansion of school nutrition programs beyond current authorizations—particularly, greater school participation in the universal school breakfast programs and greater participation in summer meal programs. I believe this is the policy most in agreement with societal goals of opportunity, equality, education, and social and economic progress while at the same time having little consequence in terms of promoting inefficiency or long-term dependency. I believe the technical findings discussed above also support such a policy. More research is required to determine whether promoting increased participation in the NSLP among current non-participants would result in any impacts.

The problem, of course, is that the policy of expansion would substantially increase costs to the government (and ultimately to taxpayers). Given current budgetary pressures and competing priorities (e.g., homeland security, outsourcing of jobs), there is likely to be resistance to policies that would further expand school meals programs beyond what was authorized in the 2004 Child Nutrition and WIC

Reauthorization Act. More research on projected costs and administrative feasibility is needed before such a policy change is justified. It is also very important for policymakers and activists to 1) provide avenues for citizens to openly and constructively dialogue about the value of these tradeoffs and 2) to research and propose alternative solutions not analyzed in this paper that may better reflect emerging common interests and goals (e.g., improved targeting; healthier program foods; redistribution of resources to other child programs). In less abstract terms, promotion of this dialogue can start with: educating parents and school administrators about the benefits and costs of school meals; bringing media attention to the programs; fostering communication among federal, state, and local levels of government; pressuring politicians to introduce related bills or "take up the issue"; ensuring funding for related research; and ensuring that diverse actors in the policy community become "enlightened" to the results of evaluations like the one conducted in this paper (Weiss, 1988).

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CHAPTER VII.
CONCLUSION

Evaluations can be classified based on 1) type of indicators and 2) the degree of confidence that impacts were in fact the result of the public health intervention (Habicht, et al., 1999). In this study, we assessed indicators of impact. Specifically, we assessed impacts on children's social skills development, academic performance, and weight gain. These were outcomes deemed crucial to child welfare and ultimately to the progress of society. The evaluations can further be classified as plausibility designs because they attempted to establish greater confidence that observed associations were causal in nature by: 1) ruling out confounding influences, 2) using a control group of non-participants, 3) using longitudinal data, and 4) using longitudinal statistical models that dealt with potential selection to participate. Though we cannot completely rule out alternative explanations for the observed differences, the methods used in this paper allow us to make stronger conclusions about the causal effects of school meal programs. We cannot make strong conclusions about the effects of WIC, however, due to methodological limitations of the data available and the likely persistence of selection effects.

One of the main functions that evaluations can serve is guidance for improving policies (Weiss, 1988). Although the technical findings of this study can be used to support policies in favor of expanding school meal programs, the nature of the data and the decision-making process in which it will enter are far too complex to justify any certain policy recommendations. Further research is needed to corroborate these findings and to determine whether alternative policy options are more appropriate. Policymakers should be cautious not to use technical results of this paper to promote

one-sided policy agendas without first conducting full analyses of the political arena and considering alternate policies that may better reflect common values and interests.

The findings of this study may influence policy by offering a new approach to the conceptualization of relations between food insecurity, food assistance, and child outcomes. Previous studies have assumed that food assistance programs impact child development by averting food insecurity and malnutrition. Findings from this study, however, show that food assistance participation can also impact child development by modifying the effects of stressful life events.

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