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Growing Up with A Food Insecure Adult: The Cognitive Consequences of Recurrent Versus Transitory Food Insecurity Across the Early Elementary Years

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Abstract

To investigate how kindergarteners cognitively developed in a family with an adult who experienced recurrent versus transitory food insecurity, a sample of 1040 kindergarteners (mean age=5.6) from the Early Childhood Longitudinal Study, Kindergarten Class of 2010-11 (ECLS-K: 2011) was analyzed using multilevel growth modeling. Results indicated that kindergarteners from homes with an adult who experienced recurrent food insecurity (twice within a 24-month period; *n*=490) initially had slower growth in reading relative to their counterparts who were in homes with an adult who was food insecure only once over the same time period (*n*=550). However, this initial disadvantage diminished over time. As a result, the recurrent group's reading trajectory converged with that of their transitory peers by second grade. These findings highlight the value of adopting a more temporal view of food insecurity and its developmental consequences.

Keywords: adult food insecurity; cognitive development; multilevel growth modeling

Introduction

Despite the wide availability and abundance of food across the US, millions of households struggle daily to provide food for their children. In 2012, roughly 17.6 million households could not provide enough food for their families because they lacked resources to acquire it, a phenomenon known as *food insecurity* (Coleman-Jensen, Nord, & Singh, 2013). Young children from homes experiencing food insecurity are particularly vulnerable. Not only can food insecurity jeopardize their physical health (Fiese, Gundersen, Koester, & Washington, 2011; Jyoti, Frongillo, & Jones, 2005), but it can also impair their cognitive and behavioral outcomes (Alaimo, Olson, & Frongillo, 2001; Ashiabi & O'Neal, 2008; Howard, 2011; Jyoti et al., 2005; Winicki & Jemison, 2003). These consequences have been shown to persist over time. For instance, children—and especially girls—from families who became food insecure experienced slower gains in reading as they progressed from kindergarten to third grade (Jyoti et al., 2005).

This present study also examines food insecurity's association with children's cognitive development. In contrast to prior studies, however, it leverages a method—known as multilevel growth modeling—to describe how kindergarteners' reading ability develops through second grade in the presence of an adult in the household who experienced *recurrent* rather than *transitory* food insecurity. In this study, adults were classified as experiencing *recurrent* food insecurity if they were food insecure twice: both in the year prior to their child's spring of kindergarten as well as first grade. The *transitory* group also experienced food insecurity a year prior to their child's spring of kindergarten; however, transitory adults became food secure in the year prior to their child's spring of first grade.

Though frequent or persistent food insecurity tends to be less prevalent than occasional or episodic food insecurity (Nord, 2013), more frequent bouts of food insecurity over time have been posited to be more detrimental for children's developmental outcomes due to the potential for its

disadvantages to accumulate (Burke, Jones, Fram, & Frongillo, 2012). However, evidence of this cumulative effect remains limited, leaving several questions unresolved. For example, does recurrent food insecurity accumulate in ways such that children develop more slowly over time relative to their transitory counterparts? Or might children living in homes with recurrently food insecure adults have cognitive trajectories that converge with that of their peers from temporarily food insecure homes? By describing how kindergarteners fare developmentally in homes with a recurrent versus transitory food insecure adult, this study contributes to a more nuanced picture of the food insecurity-development relationship, one that has yet to be fully described in the extant literature.

The rest of this paper is structured as follows. First, the main theoretical underpinnings of food insecurity's link to children's cognitive development are explained, followed by a review of relevant empirical evidence of how recurrent and transitory food insecurity differentially influences children's developmental outcomes, with a specific focus on their reading abilities. Then, the study's research design is described, including the dataset, measures and analytical method used. This is followed by the study's results. Finally, the implications of this study's findings are discussed for both theory and practice.

Food Insecurity and Children's Development

What is Food Insecurity?

In the United States, operational definitions of *food security* and *food insecurity* were formally developed in 1989, when the Life Sciences Research Office (LSRO) gathered a panel of experts to conceptually define both food security and insecurity (Gundersen & Ziliak, 2014; National Research Council, 2006). According to LSRO, *food security* is defined as, "…access to enough food for an active, healthy life. It includes at a minimum (a) the ready availability of nutritionally adequate and safe foods and (b) an assured ability to acquire acceptable foods in socially

acceptable ways (e.g., without resorting to emergency food supplies, scavenging, stealing, or other coping strategies)." (National Research Council, 2006, p. 43). On the other hand, *food insecurity* occurs, "… whenever the availability of nutritionally adequate and safe foods or the ability to acquire acceptable foods in socially acceptable ways is limited or uncertain." (National Research Council, 2006, p. 43). Though food insecurity is a phenomenon typically used to describe a household as a whole, specific members within a household may experience food insecurity (e.g., an adult) while others, such as children, may not (National Research Council, 2006).

Theoretical Framework

Two primary theoretical frameworks help explain how children's cognitive development can be influenced by food insecurity: one focuses on the health and nutritional consequences of food insecurity, while the other, conceptualizes food insecurity and its subsequent influences on children's development within a broader class of material hardships (Belsky, Moffitt, Arseneault, Melchior, & Caspi, 2010; Gershoff, Aber, Raver, & Lennon, 2007).

Prior research has posited that food insecurity can negatively affect the nutritional status of the child leading to poorer health and nutritional outcomes thereby resulting in poorer developmental outcomes. For example, children from food insecure households may lack micronutrients, vitamins and minerals (e.g., iron) that are critical to healthy development (Rose-Jacobs et al., 2008). As a result, children may be at risk for diseases such as anemia, which can impair their cognitive functioning (Brown & Pollitt, 1996). On the other hand, children in food insecure households may, in some instances, shift their consumption to energy-dense, and cheaply available fast foods (Ashiabi & O'Neal, 2008) leading to obesity, which has been linked to poorer child developmental outcomes. It is important to note, however, that the empirical evidence linking food insecurity to overweight or obesity is far from definitive (Eisenmann, Gundersen, Lohman, Garasky, & Stewart, 2011); for instance, children from low-income households that are food

secure rather than insecure have been shown to have a higher odds of being overweight in the presence of maternal stressors (Gundersen, Lohman, Garasky, Stewart, & Eisenmann, 2008).

Food insecurity can also be conceptualized as a *material hardship* (Belsky et al., 2010; Gershoff et al., 2007). As a material hardship, food insecurity is posited to function together with other material hardships, such as residential instability, to cumulatively influence children's cognitive skills (Gershoff et al., 2007). This influence, distinct from that of family income, is posited to operate via several interrelated channels (Gershoff et al., 2007). First, the pathway linking material hardship to cognitive outcomes is mediated first and foremost through parental stress; this stress, in turn, simultaneously affects both (1) parental investments in their children, such as their time, energy and support; and (2) positive parenting behaviors, including warmth and cognitive stimulation (Gershoff et al., 2007). Importantly, the pathway through which increased material hardship, in tandem with lowered incomes, influences children's cognitive skills is primarily via the parental investment mechanism—in the case of food insecurity, for example, parents may need to tradeoff time and resources spent on children's learning because of the additional time they may spend worrying about or accessing food.

Apart from other material hardships, food insecurity as assessed at the household level has not only been shown to increase parental stress (Dunifon & Kowaleski‐Jones, 2003; Huang, Matta Oshima, & Kim, 2010) but depression (Bronte-Tinkew, Zaslow, Capps, Horowitz, & McNamara, 2007; Melchior et al., 2009) and anxiety (Whitaker, Phillips, & Orzol, 2006). Importantly, these behavioral responses to food insecurity are hypothesized to compromise parent's caretaking and parenting abilities (Alaimo et al., 2001; Whitaker et al., 2006), thereby interfering with their ability to fully engage and interact with their children (Ashiabi & O'Neal, 2008; Rose-Jacobs et al., 2008). In fact, prior research has shown that household food insecurity can negatively influence positive parenting practices (Bronte-Tinkew et al., 2007), disrupt parent-child

relationships (Hamelin, Habicht, & Beaudry, 1999) and lead mothers to possess a "dim outlook on their parenting role" (Powers, 2013, p. 2). Collectively, these behavioral consequences of food insecurity on parents and their parenting abilities can accumulate to influence children's cognitive development (Alaimo, et al., 2001).

Recurrent Versus Transitory Food Insecurity

While theoretical rationales linking food insecurity to children's cognition are well-established, how recurrent and transitory food insecurity might differentially influence children's development has received less attention. Burke et al.'s (2012) analysis of persistent and non-persistent household food insecurity hypothesizes that persistent food insecurity can be more detrimental for children's developmental outcomes, as it can "[reflect] an accumulation of risks over and above what is experienced by a child who encounters rare and episodic food hardships." (p. 361). While it is intuitive that children living in homes experiencing recurrent food insecurity could exhibit lowered outcomes due to an accumulation of food insecurity's risks, the empirical evidence supporting this hypothesis is modest.

For instance, in their analyses of data from the Early Childhood Longitudinal Study, Kindergarten Class of 1998-9 (ECLS-K:1998-9), Jyoti et al., (2005) found that girls from homes experiencing three repeated bouts of food insecurity (as assessed at the household level) from kindergarten through third grade had smaller gains in reading relative to those from homes who experienced a single bout of food insecurity in the child's kindergarten year (Jyoti et al., 2005). Overall, however, children in recurrently food insecure homes had reading gains commensurate with their peers in homes that were consistently food secure over the same time. Thus, children from recurrently food insecure homes were not developmentally disadvantaged in ways that theory might have predicted.

Transitions into and out of household food insecurity, however, mattered. Kindergarteners experienced a smaller change, on average, in reading between kindergarten and third grade if they were from a household that transitioned into food insecurity rather than when a household transitioned out of food insecurity. Such transitions also mattered for children's behavioral outcomes. For instance, Howard (2011) also examined a cohort of kindergarteners from the ECLS-K 1998-9 and found that kindergarteners from homes that transitioned out of food insecurity (i.e., subsequently becoming food secure) when they were in first and third grades, scored *lower* on behavioral outcomes (interpersonal relationships, self-control, and approaches to learning), an effect which persisted into fifth grade. Finally, in their analysis of household food insecurity and children's development, Kimbro and Denney (2015) found that children from households that became food insecure had lowered interpersonal skills, self-control and externalizing behaviors relative to children who were from food secure homes.

In related evidence, Hernandez and Jacknowitz (2009) analyzed data from the first two waves of the Early Childhood Longitudinal Study – Birth Cohort (ECLS-B) to examine whether persistent versus transitional food insecurity among adults compromised the cognitive outcomes of infants and toddlers as they developed from 9 months to 24 months old. They did not detect an effect of recurrent adult food insecurity (insecure when the child was both 9 and 24 months) on infants' and toddlers' cognitive scores (e.g., communication skills as well as listening and problem-solving abilities)—a finding that echoes that of Jyoti and colleagues (2005). Hernandez and Jacknowitz (2009) suggested that this effect could have arisen because persistently food insecure adults may have developed stronger coping mechanisms. Though persistent food insecurity had no effect, children of adults who became food insecure at 24 months had lowered cognitive scores. Thus, as adults transitioned from being food secure to insecure, this transition had a contemporaneous negative influence on children's development.

Collectively, these findings suggest that although recurrent food insecurity may matter for the cognitive outcomes of a particular subgroup (i.e., girls), transitions in and out of food insecurity—especially becoming food insecure—may be more salient. However, prior work examining recurrent and transitory food insecurity leaves two key issues open to further investigation. First, with the exception of Hernandez and Jacknowitz (2009), research on food insecurity's influence on children's development has typically relied on a measure of food insecurity at the *household* level, creating uncertainty over who exactly within the household is experiencing food insecurity (e.g., an adult, a child or the child's siblings) (Hernandez & Jacknowitz, 2009); thus, how kindergarteners develop explicitly in the presence of an *adult* who experiences either recurrent or transitory food insecurity has yet to be fully explored. Second, prior studies have typically examined developmental change between two points in time (e.g., kindergarten and third grade), which may mask effects over children's developmental span; leveraging longitudinal modeling strategies, such as multilevel growth modeling, can reveal additional insights. For example, longitudinal modeling can shed light on the extent to the reading trajectories of children growing up with a recurrently food insecure adult diverges or converges with the trajectories of children in transitory settings, leading to a more nuanced picture of development in the wake and aftermath of recurrent or transitory food insecurity.

Accordingly, the purpose of this study is to answer the following research question: How do kindergarteners' cognitive trajectories (as captured by achievement in reading) differ if they are from a home with an adult who experiences recurrent versus transitory food insecurity?

Method

Dataset

This study used secondary data from the restricted use version of the Early Childhood Longitudinal Survey, Kindergarten Class of 2010-11 (ECLS-K: 2011) (National Center for

Education Statistics, 2015) which is a nationally representative cohort of children who entered kindergarten in fall 2010 (Mulligan, Hastedt, & McCarroll, 2012). This study used data from four waves: the fall of kindergarten, the spring of kindergarten, and the spring of both first and second grades. All unweighted sample sizes presented below are rounded to the nearest 10 per National Center for Educational Statistics (NCES) regulations.

Sample

This study's analytic subsample (unweighted) consisted of 1040 children who lived in homes with adults who experienced either recurrent or persistent food insecurity. Both groups lived with a food insecure adult at some point in the 12 months prior to the spring of kindergarten; however, the transitory food insecure group (n=550) became food secure at some point in the 12 months prior to the spring of first grade while the persistent food insecure group (n=490) remained food insecure. To draw inferences to the underlying population of children living in homes with either a recurrent or transitory food insecure adult, this study used sampling weights which accounted for non-response and unequal probability of section. In addition, Taylor series linearization was used to adjust standard errors which used primary sampling unit (PSU) and strata information.

Measures

Outcome

Reading. Children's abilities in reading were based on Item Response Theory (IRT)-based scale scores for reading (language use and literacy), which were on an equivalent scale thereby ensuring comparability across children and time. The scores, known as theta-scores, ranged from -6 to 6 and had reliabilities (Cronbach's alphas) of .95 in the fall and spring of kindergarten and .93 and .91 in the spring of first and second grades, respectively (Tourangeau et al., 2015).

Main Predictors

Adult food security status. Adult food security was based on the US Department of Agriculture's (USDA) Household Food Security Survey Module (HFSSM) administered as part of the ECLS-K parent interview (Tourangeau et al., 2015). The HFSSM is a valid and reliable instrument consisting of 18 items that are mapped onto the "different experiential and behavioral stages as food insecurity becomes more severe" (Bickel, Nord, Price, Hamilton, & Cook, 2000, p. 9). Accordingly, the questions of the HFSSM are ordered such that the greater number of items that are positively affirmed indicates a higher level of severity of household food insecurity (Bickel et al., 2000). Conceptually, this measure captures, in part, food deprivation as well as the underlying constraint each household faces in their ability to obtain food (Bickel et al., 2000). The first 10 items of the HFSSM consists of the Adult Food Security Survey Module (National Research Council and Institute of Medicine, 2013) and, accordingly, responses to these first 10 items were used in this study to capture adult food insecurity. The HFSSM is retrospective, asking the main respondent to the ECLS-K parent interview (often a parent or guardian who had most knowledge of the child's care, education and health (Tourangeau et al., 2012)) to recall their experiences in the prior 12-months. Individuals responded to the module twice: once when their child was in the spring of kindergarten and again when their child was in the spring of first grade. Internal consistency reliabilities of the adult food security module were high: α=.89 for the spring of kindergarten and α=.87 for the spring of first grade.

Consistent with prior research using adult food insecurity as a predictor (Hernandez & Jacknowitz, 2009), adults were first categorized into two groups at each wave: Food Secure (FS); and Food Insecure (FI). Adults were classified as FS if they had raw scores on the first 10 items of the HFSSM of 0 to 2, while FI adults had raw scores of 3 to 10. Adults who were FI in the year prior to spring of kindergarten and first grade were categorized as recurrent. On the other hand,

adults who were FI in the year before the spring of kindergarten, but became FS at some point a year before the spring of first grade were classified as transitory.

Age and Age^2. Since the spacing between reading assessments varied, the child's age (in months) at assessment was used as the main metric representing time. Age was centered on a child's age at first assessment. A quadratic term for age (age^2) was also used since it provided a better fit to the data relative to a linear (age only) trajectory (i.e., reading grew over time, but that growth slowed).

Control Predictors

An extensive set of control variables were used, capturing material hardships, attributes of both the parent (e.g., depression and stress) and their child as well as the child's school. Certain controls were fixed across time versus time-varying based on their availability in the dataset. Based the on work of Gershoff et al. (2007), Jyoti et al. (2005) and Howard (2011), several controls—especially material hardships and parental attributes—were allowed to predict children's reading trajectories, thereby controlling for their concurrent influences with food insecurity over time.

Parent and household controls.

Material hardship. Given food insecurity's role as part of material hardship, time-invariant controls capturing three other material hardships were included (Gershoff et al., 2007): (1) financial hardship; (2) residential mobility; and (3) medical care. These hardship measures were constructed as they appear in Gershoff et al., (2007). Financial hardship was an indicator variable based on whether the respondent encountered financial problems or was unable to pay monthly bills since the child was born. Residential mobility was a count variable, ranging from 0 to 6, documenting the number places that a child had lived 4 months or more since birth. Finally, access to medical care was a count variable, ranging from 0 to 3, and was created by summing three

underlying indicator variables: whether a child visited the doctor and/or dentist in the past year or not; and whether the child had health insurance. Financial hardship was collected in the fall of kindergarten, while residential mobility and medical care access was collected in the spring. Both measures were centered on their means in the sample.

Parental depression. A twelve-item version of the Center for Epidemiologic Studies Depression Scale (CES-D) (Radloff, 1977) was administered in the spring kindergarten wave. The items captured different feelings and experiences parents had (e.g., fear, anger, depression) during the past week on a four-point Likert scale: never; some of the time; a moderate amount of time; and most of the time. Internal consistency reliability was high (α =.87). Consistent with prior research using the 12-item CES-D from the ECLS-K (Claessens, Engel, & Curran, 2015) an indicator variable was created that classified adults as being at an elevated risk for depression if they scored 10 or higher on the CES-D (coded as 10 or higher=1; 0 otherwise).

Parenting stress. Four items from the Parenting Stress Index (PSI) (Abidin, 1990) were administered in the spring kindergarten parent interview. Parents were asked how true (completely, mostly, somewhat, not at all) several statements were: being a parent was harder than expected; their child did things that bothered them; they felt angry with their child; they had to make sacrifices to meet their child's needs. Internal consistency reliability was moderate (α=.56). Using factor analysis, the four items were composited into a single continuous score, standardized to have a mean of 0 and standard deviation (SD) of 1.

Parental warmth and investment. Parental warmth was a continuous composite based on a parent's response, in four categories (completely true, mostly true, somewhat true, not at all true) to 4 items from the Home Observation for Measurement of the Environment (HOME) Scale (Caldwell & Bradley, 1984): they have warm, close ties with their child; their child likes them and wants to be near them; even in a bad mood, they always show their child love; they express

affection by hugging, kissing or holding (α =.65). Factor analysis was used to create a continuous factor score, with a mean of 0 and SD of 1.

Parental investment in children were based on two sets of measures from the spring kindergarten parent interview. The first captured the frequency that parents read books to their child (every day or less than every day). The second included the extent to which parents or family members engaged in cognitively enriching activities with the child. This was a count variable ranging from 0 to 4, based on summed responses on a set of indicator variables capturing whether the child visited a library, bookstore, museum or zoo in the past month. This measure was centered on its mean in the sample.

Additional parent and household control variables included a household's socioeconomic status (SES) that was based on an NCES-constructed continuous index compositing parents' education, occupational prestige and income. Controls for marital status (time-varying: married or not) and the employment status of the primary parent (35 or more hours per week, <35 hours per week, not employed) were included.

Child and school controls.

Child level controls included their gender, disability status, age at kindergarten entry, number of siblings (time-varying), racial and ethnic background (White non-Hispanic, Black non-Hispanic, Hispanic, Asian and Other), health status (time-varying in three categories: excellent, very good/good, fair/poor) and home language (English or non-English). Also, included was an indicator for whether the child received free and reduced price lunch. Controls related to a child's school included the percentage of children who qualified for free lunch and percent minority (centered at their sample means).

Analytic Strategy

To estimate whether kindergartener's reading development differed between recurrent versus transitory food insecure groups, a 2-level growth model was estimated for reading outcomes (Y_{ti}) at time *t* for child *i*:

Level-1 (Individual Quadratic Growth Model)

$$Y_{ti} = \pi_{0i} + \pi_{1i}(T) + \pi_{2i}(T)^2 + \sum_{k=1}^{K} \pi_{ki}(G_{kti}) + e_{ti}$$

where:

T = Age (in months) at occasion *t*, centered on a child's age at first assessment: $(AGE_{ti} - AGE_{0i})$

Y_{ti} = Reading scores on occasion *t*.

π_{0i} = True initial reading score at the age when child *i* was first assessed.

π_{1i} = True instantaneous growth rate in reading scores at child *i*'s first assessment age conditional on time-varying controls G_{kti}.

π_{2i} = True rate of acceleration in reading scores conditional on time-varying controls G_{kti}.

π_{ki} = The effects of time-varying covariates G_{kti} where k=1,…,K, on reading scores.

e_{ti} = Residual specific to *i*th child, assuming $e_{ti} \sim N(0, \sigma_e^2)$.

Level-2 (Between Child Model)

$$\pi_{0i} = \gamma_{00} + \gamma_{01}(RECURRENT\_FI_i) + \sum_{q=2}^{Q} \gamma_{0q}(Z_{qi}) + r_{0i}$$

$$\pi_{1i} = \gamma_{10} + \gamma_{11}(RECURRENT\_FI_{ii}) + r_{1i}$$

$$\pi_{2i} = \gamma_{20} + \gamma_{21}(RECURRENT\_FI_{ii})$$

$$\pi_{ki} = \gamma_{k0} \text{ for each } k=3,\ldots,K$$

where:

γ_{00} = Mean true initial status in the outcome when $RECURRENT\_FI_i$ and Z_{qi} are constrained to zero.

γ_{01} = Effect of residing with a recurrently food insecure adult on mean true status in reading.

γ_{0q} = Effect of select controls Z_{qi} on mean true status in reading.

γ_{10} = The mean true conditional instantaneous growth rate in reading.

γ_{11} = The mean true effect residing with a recurrently food insecure adult on the instantaneous growth rate.

γ_{20} = The mean true conditional rate of acceleration in reading.

γ_{21} = The mean true effect of residing with a recurrently food insecure adult on the rate of acceleration.

γ_{k0} = The mean true effect of time-varying covariates G_{kti} on reading.

r_{0i} , r_{1i} = The level-2 random effects capturing deviations in child *i*'s initial status, and instantaneous growth rates, respectively.

An unstructured variance-covariance matrix was specified for the level-2 random effects:

$$\Phi = \text{var}\begin{bmatrix} r_{0i} \\ r_{1i} \end{bmatrix} \sim \begin{bmatrix} \tau_{00} & \tau_{01} \\ \tau_{10} & \tau_{11} \end{bmatrix}$$

where τ_{00} represents the variance of the random intercept, τ_{11} is the variance of the instantaneous growth rate and τ_{10} and τ_{01} represent the covariance between the random intercept and the instantaneous growth rate. A random effect for the rate of acceleration was not included due to model non-convergence in a set of preliminary models. Also, though not explicitly shown in the level-2 model specification, predictors that were likely to have been confounded with food insecurity's influence—particularly, material hardship measures—were incorporated level-2 to predict initial status, growth rate and acceleration.

By substituting the Level-2 model into Level-1, this model can be expressed in composite form as:

$$\begin{aligned} Y_{tij} = {} & \gamma_{00} + \gamma_{10}(T) + \gamma_{20}(T)^2 \\ & + \gamma_{01}(RECURRENT\_FI_i) + \gamma_{11}(RECURRENT\_FI_i \times T) + \gamma_{21}(RECURRENT\_FI_i \times T^2) \\ & + \sum_{k=3}^{K} \gamma_{k0}(G_{kti}) + \sum_{q=2}^{Q} \gamma_{0q}(Z_{qi}) + r_{0i} + r_{1i}(T) + e_{ti} \end{aligned}$$

The relevant parameters of interest in this model are γ_{11} and γ_{21} which, when considered together, captured how quadratic growth rates in children's cognitive outcomes, on average, differed by recurrent versus transitory food insecure groups. This study adopted a significance level (α) of .05 to test whether the estimates of γ_{11} and γ_{21} were significantly different from zero.

All models were fit to sample data using Stata 14.2 (StataCorp, 2015). Stata's multilevel mixed effect generalized linear model survey command (svy: melgm) was used with the subpopulation option. All models incorporated appropriate sample weights to account for non-response while standard errors were based on the Taylor linearization method. Models included only data with non-missing sample weights, strata and primary sampling unit (PSU) information. Only individuals with complete covariate information were used in model estimations.

Results

Sample Descriptive Statistics

Table 1 provides weighted descriptive statistics on the analytic sample, overall, in the kindergarten year and disaggregated by recurrent and transitory food insecurity. Statistically significant differences between the groups are noted in the last column of the table. Children from each group were similar across a wide range of characteristics: for example, by race/ethnicity, children were predominately White and Hispanic, while the majority were in very good or excellent health. Though the reading ability scores in the recurrent group were slightly lower than in the transitory group by about 0.04 theta score points (effect size (ES) of 0.05), this difference was not statistically significant at conventional levels of significance (α=.05).

<<insert Table 1 here>>

Although all adults were food insecure 12 months prior to the spring of their child's kindergarten year, recurrently food insecure adults experienced several disadvantages relative to their transitory counterparts. Of material hardships, a significantly higher proportion of recurrently food insecure adults experienced financial hardship—roughly 16 percentage points (p<.001) higher relative to transitory food insecure adults. In addition, a higher proportion of recurrently food insecure adults had an elevated risk of depression (21 percentage points higher; p<.001).

They were also less likely to be married (p<.05), to work 35 or more hours per week (p<.05) and had lower socioeconomic status (p<.001). In sum, these descriptives indicate that children living with a recurrent versus transitory food insecure adult were similar across a range of observed characteristics in the fall of kindergarten. However, recurrent food insecure adults, themselves, faced disadvantages relative to their transitory counterparts; the most noteworthy of these disadvantages—financial hardship, depression, unemployment and lower socioeconomic status.

Reading Trajectories: Recurrent Versus Transitory Adult Food Insecurity

Table 2 presents the main growth modeling results. Relevant parameter estimates for the effect of recurrent versus transitory adult food insecurity are presented as they appear in the composite model specification. Also shown are the concurrent effects of material hardships on children's reading trajectories. Complete results showing the effects of all model predictors are in the supplemental Appendix.

<<insert Table 2 here>>

In this model, the non-significant estimate on the indicator for recurrent food insecurity ($\hat{\gamma}_{01}$ =0.08; p=.22) indicates that the difference in reading scores in the fall of kindergarten between from a home with a recurrent or transitory food insecure adult was indistinguishable from zero. However, significant coefficient estimates were detected on linear (i.e., age) and quadratic (i.e., age^2) slopes for time interacted with the recurrent food insecurity predictor ($\hat{\gamma}_{11}$ =-0.0165; p<.05; and $\hat{\gamma}_{21}$ =0.0004; p<.05 respectively). This indicated that children from the recurrent group initially experienced a slower rate of growth in reading versus the transitory group; yet, that growth decelerated *less* rapidly over time. The consequence of this slower deceleration is important—it led the recurrent group's trajectory to converge with that of the transitory group. In effect, the initial disadvantage that children from the persistent group experienced in their reading

growth diminished over time. Also noteworthy is that this effect existed even after accounting for other significant relationships between residential mobility as well as medical care on children's reading trajectories.

To illustrate this phenomenon, Figure 1 displays the fitted average reading trajectories for the transitory and persistent groups as children progressed from the fall of kindergarten (mean age=5.6 years) to the spring of second grade (mean age=8.1 years). As shown, the predicted growth curves display a distinctive divergence-convergence pattern. As kindergarteners progressed beyond the fall of first grade, their reading abilities diverged, with children in the transitory group exceeding children in the recurrent group. For example, in the spring of kindergarten (mean age=6.1 years), the instantaneous rate of growth (i.e., the slope of the line tangent to the growth curve) was 0.13 points per month for children in the recurrent group; while in the transitory group it was higher at 0.14 points per month. By the spring of first grade (mean age=7.1 years), this model predicts a difference in reading abilities between transitory and recurrent groups of approximately .083 theta score points—an effect size (ES) of roughly 0.13.

Yet, the recurrent group's reading abilities decelerated less rapidly: the instantaneous rate of growth slowed by .07 points between spring of kindergarten and first grade for the transitory group; in contrast, it slowed by .06 points over the same time period in the recurrent group. The result: as shown in Figure 1 at the end of second grade (mean age=8.1 years), the recurrent group's trajectory converged with that of their transitory counterparts. The predicted gap by the spring of second grade narrowed to .04 theta score points (ES=.07).

<<insert Figure 1 here>>

Sensitivity Analysis Results: A 3-Level Model

Though a 2-level model was originally specified and fitted to data, children were also clustered within school which introduced a third level of clustering. Unfortunately, growth models did not

converge in a 3-level model with linearized standard errors (the prescribed variance estimation method when analyzing the ECLS-K survey data). However, an alternative 3-level model was refitted to data along with sampling weights and robust standard errors that were clustered by school. Table 3 displays relevant parameter estimates from this 3-level model showing that the differential effect of recurrent versus transitory food insecurity remained consistent with the 2-level specification.

<<insert Table 3 here>>

Discussion

Food insecurity has been shown to influence children's developmental outcomes, particularly during critical formative stages of their cognitive development as they enter and progress through the formal schooling system. The objective of this study was to describe differences in reading abilities over time for kindergarteners living with an adult experiencing recurrent versus transitory food insecurity, thereby contributing to a more nuanced picture of the food insecurity-child development relationship.

Several takeaways from the study are important to highlight. First, in contrast to transitory food insecure adults, recurrently food insecure adults were initially: less financially stable, at a higher risk of depression and of lower socioeconomic status. Yet, their children in the fall of kindergarten did not differ across key characteristics, including their gender, race/ethnicity, disability status, health status or achievement Second, results from a multilevel growth model show that kindergarteners from homes with a recurrently food insecure adult initially had slower growth in reading relative to their counterparts who became food secure over the same time period (between a year prior to the spring of kindergarten and a year prior to first grade). Though their rate of growth slowed over time, the recurrent group's reading abilities decelerated less rapidly; as a result, the recurrent group's reading trajectory converged with that of their transitory peers by

second grade. Notably, this pattern remained robust to the presence of other material hardships as well as socioeconomic status which were also found to have distinct, contemporaneous effects on the reading trajectories of these kindergarteners.

What might underlie these differential trends? The broader material hardship literature offers two potential insights that may provide plausible reasons for these trends. As Gershoff and colleagues (2007) discovered, material hardship is *positively* related to positive parenting practices. Though this runs counter to prior evidence, they posit that parents experiencing material hardship may be altering their positive behaviors towards their children to compensate for such hardships. If so, then it is plausible to suggest that adults facing recurrent food insecurity may be making investments and engaging in positive parenting behaviors in compensatory ways that, over time, benefited their children's development. Further work is needed to understand whether and how compensatory parenting practices might occur in the wake of recurrent versus transitory food insecurity and if those practices buffer the developmental effects of food insecurity.

In a similar vein, Gershoff and colleagues (2007) also found that in the presence of material hardship, parental stress *positively* influenced parental investments (e.g. time and money). If so, enhanced stress induced by recurrent versus transitory food insecurity may have led recurrently food insecure parents to make investments that promoted their children's reading development. While evidence demonstrates that food insecurity can heighten parental stress, thereby lowering children's behavioral outcomes (Huang et al., 2010; Slack & Yoo, 2005), whether parental stress responses differ under recurrent versus transitory food insecurity remains open for further empirical investigation.

Finally, these results can also be interpreted from the point of view of children living with a transitory rather than a recurrently food insecure adult. As such, a more rapid deceleration of reading trajectories occurred for children from homes with an adult who experienced transitory

versus recurrent food insecurity. Borrowing from the family instability literature (Fomby & Cherlin, 2007), this might reflect a phenomenon known as the *instability hypothesis* which suggests that transitions, themselves, and the disruptions they cause, can have a cumulative effect dampening children's outcomes. Thus, in the context of food insecurity, the experience of being in a home with an adult who cycles in and out of food insecurity could be potentially more disruptive than being in a recurrently food insecure home. As reviewed earlier in this study, there is some empirical support for the instability hypothesis: for instance, Howard (2011) found that children in homes that transitioned into food security had lowered non-cognitive outcomes. However, to more accurately assess this hypothesis, it will be important for future studies to capture the frequency and the duration of episodes of food insecurity throughout the year.

There are several limitations and assumptions of this study. First, these analyses support correlational inferences, not causal, and only suggest that recurrent and transitory adult food insecurity are associated with differential patterns in children's cognitive outcomes over time. Second, though a rich set of covariates were included to control for any potential confounding influences—most importantly, material hardships—there are additional factors, both observable and unobservable, as well as time-varying and time-invariant that were not fully accounted for which could potentially influence these findings. Finally, given that an adult's food security status is documented only at an undetermined point within a 12-month window (i.e., the precise timing of food insecurity is uncertain), this study has assumed relative stability in an adult's food status with each of those 12-month windows. It also assumed that an adult's food insecurity status did not fundamentally shift after the spring of 1st grade. Despite these limitations, however, these results do provide strong and compelling evidence establishing a differential association between recurrent versus transitory adult food insecurity and kindergartener's reading development across time.

In closing, there are several broader lessons of this work, both for practice and theory. First, these findings highlight the value of adopting a more temporal view of food insecurity and its developmental consequences. As the study has shown, exposure to food insecurity itself is not static, nor are its effects on young children's cognitive outcomes. From a practical standpoint, the time-varying dimension to food insecurity underscores the importance of not only screening for food insecurity during routine physician visits—which is currently recommended by the American Academy of Pediatrics (AAP) (Council on Community Pediatrics and Committee on Nutrition, 2015)—but also tracking episodes of food insecurity for families with young children across time. Importantly, with this understanding of food insecurity across time coupled with data on key developmental milestones, we can develop a better understanding at what points along children's developmental pathways that they may be particularly vulnerable to food insecurity's effects. For example, children from food insecure homes who attend public schools on a traditional calendar might be more vulnerable to an episode of food insecurity during the summer months, a time when both their access to food as well as educational opportunities can be limited. Finally, in demonstrating how differential exposure to the duration of food insecurity influenced children's development, this work can help to further elaborate existing theories about food insecurity's relationship to children's outcomes—though existing theoretical frameworks have established a link between food insecurity and children's outcomes, incorporating not just exposure, but the frequency and duration of those exposures over time can lead to more robust theory of food insecurity and its developmental consequences.

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Tables and Figures

Table 1. Means (weighted) (M) and standard deviations (SD) for the analytic sub-sample in the fall of kindergarten (K) disaggregated by adult food security status.

	Recurrent Food Insecurity		Transitory Food Insecurity		
	M	SD	M	SD	
Fall K reading score	-0.75	0.85	-0.79	0.72	
Material hardships					
Number of places child lived since birth	2.29	1.34	1.98	1.10	
Health insurance, doctor & dentist visits	2.69	0.55	2.63	0.61	
Financial problems since child's birth	0.67	0.44	0.51	0.46	***
Elevated risk for depression	0.45	0.46	0.24	0.39	***
Parenting stress	0.23	1.14	0.14	1.11	
Parental warmth	-0.20	1.13	-0.12	1.08	
Parent reads books to child everyday	0.43	0.46	0.43	0.45	
Cognitive stimulating activities	1.63	1.19	1.70	1.10	
Socioeconomic status	-0.71	0.48	-0.51	0.54	***
Marital status	0.47	0.46	0.61	0.44	*
Parental employment status					
Not employed	0.55	0.46	0.43	0.45	*
<35 hours/week	0.30	0.43	0.32	0.43	
35 or more hours/week	0.15	0.33	0.25	0.40	*
Male	0.56	0.46	0.54	0.45	
Disability status	0.22	0.39	0.20	0.36	
Age (in months) at K entry	66.07	3.85	65.42	4.27	
Number of siblings	1.89	1.23	1.69	1.25	
Race/ethnicity					
White non-Hispanic	0.38	0.45	0.34	0.43	
Black non-Hispanic	0.14	0.32	0.15	0.33	
Hispanic	0.37	0.45	0.40	0.45	
Asian, non-Hispanic	0.01	0.11	0.03	0.15	
Other: Native American, Pacific Islander or Multi-racial	0.09	0.26	0.08	0.25	
Health status					
Excellent	0.38	0.45	0.45	0.45	
Very good or good	0.55	0.46	0.48	0.46	
Poor	0.07	0.24	0.06	0.22	

Home language is English	0.27	0.41	0.29	0.41
Receives FRPL	0.20	0.37	0.26	0.40
Percent eligible for free and reduced price lunch (FRPL)	68.45	24.68	65.45	25.74
Percent non-White	56.06	29.63	58.54	30.32
N (unweighted)	230		270	

Note: Significant differences between groups based on bivariate regressions of each variable on a group indicator variable (recurrent=1; transitory=0). All regressions based on Stata's svy command with the subpopulation option.

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 2. Selected parameter estimates from a 2-level growth model describing the association between adult food insecurity (recurrent versus transitory) and children's reading growth trajectories from fall of kindergarten to spring of second grade. Early Child Longitudinal Study, Kindergarten Class of 2010-11.

	Parameter estimate	Linearized SE
Fixed effects		
Age	0.1756***	(0.0056)
Age-squared	-0.0028***	(0.0002)
Recurrently food insecure	0.0767	(0.0634)
Recurrently food insecure x Age	-0.0165*	(0.0066)
Recurrently food insecure x Age-squared	0.0004*	(0.0002)
Material hardships		
Number of places child lived since birth	0.0224	(0.0236)
No. of places lived since birth x Age	-0.0041*	(0.0019)
No. of places lived since birth x Age-squared	0.0001	(0.0001)
Health insurance, doctor & dentist visits	0.0393	(0.0668)
Health insurance, doctor & dentist visits x Age	0.0116*	(0.0053)
Health insurance, doctor & dentist visits x Age-squared	-0.0003*	(0.0001)
Financial hardship	-0.0360	(0.0650)
Financial hardship x Age	-0.0005	(0.0057)
Financial hardship x Age-squared	-0.0000	(0.0002)
Constant	-0.6988***	(0.1238)
Variance components		
Level-1		
Within-child	0.1274***	(0.0120)
Level-2 (Between child)		
In intercept	0.4347***	(0.0371)
In rate of change (Age)	0.0002***	(0.0000)
Covariance	-0.0059***	(.00091)
N (unweighted; child by wave)	2340	

Notes: Estimates presented based on a composite model specification of a multi-level (2-level) growth model. All models fit to the ECLS-K: 2010 data using a multi-level mixed effects generalized linear model (GLM) for complex survey data (svy:meglm) in Stata 14.2. Model includes sampling weights to

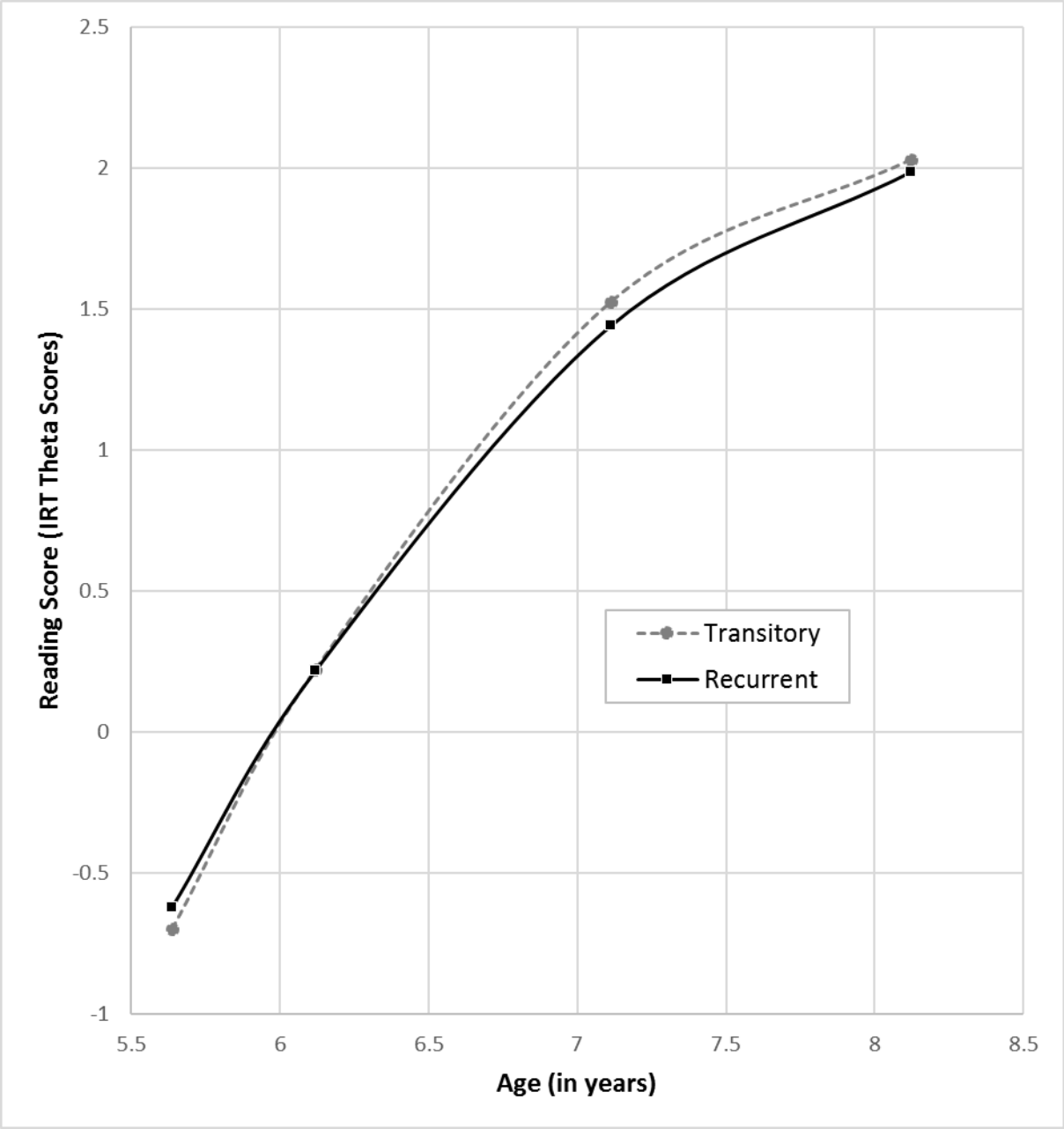
account for non-response and unequal probability of selection. Linearized standard errors in parentheses. Model also controls for covariates as described in the measures section (full results in the supplemental appendix).
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Table 3. A 3-level growth model describing the association between adult food insecurity (transitory versus persistent) and children's reading growth trajectories from fall of kindergarten to spring of second grade. Early Child Longitudinal Study, Kindergarten Class of 2010-11.

	Parameter	Robust *SE*
Fixed effects		
Age	0.1755***	(0.0054)
Age-squared	-0.0029***	(0.0002)
Recurrently food insecure	-0.0099	(0.0669)
Recurrently food insecure x Age	-0.0147*	(0.0067)
Recurrently food insecure x Age-squared	0.0004*	(0.0002)
Constant	-0.6494***	(0.1180)
Variance components		
Level-1		
Within-child	0.0632***	(0.0120)
Level-2 (Between child)		
In intercept	0.5397***	(0.0468)
In rate of change (Age)	0.0005***	(0.0000)
Covariance	-0.0102***	(0.00094)
Level-3 (Between school)		
In intercept	0.0167***	(0.02019)
N (unweighted; child by wave)	2710	

Notes: Estimates presented based on a composite model specification of a multi-level (3-level) growth model. Model fit to the ECLS-K: 2011 data using a mixed model (mixed) in Stata 14.2. Model includes sampling weights to account for non-response and unequal probability of selection. Robust standard errors in parentheses. Model also controls for covariates as described in the measures section.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$

Figure 1. Fitted reading trajectories for children living with an adult experiencing recurrent or transitory food insecurity.



Supplemental Appendix

A 2-level growth model describing the association between adult food insecurity (recurrent versus transitory) and children's reading growth trajectories from fall of kindergarten to spring of second grade. Early Child Longitudinal Study, Kindergarten Class of 2010-11.

	Parameter	SE
Age	0.1756***	(0.0056)
Age-squared	-0.0028***	(0.0002)
Recurrently food insecure	0.0767	(0.0634)
Recurrently food insecure x Age	-0.0165*	(0.0066)
Recurrently food insecure x Age-squared	0.0004*	(0.0002)
Material Hardships		
Number of places child lived since birth	0.0224	(0.0236)
No. of places lived since birth x Age	-0.0041*	(0.0019)
No. of places lived since birth x Age-squared	0.0001	(0.0001)
Health insurance, doctor & dentist visits	0.0393	(0.0668)
Health insurance, doctor & dentist visits x Age	0.0116*	(0.0053)
Health insurance, doctor & dentist visits x Age-squared	-0.0003*	(0.0001)
Financial hardship	-0.0360	(0.0650)
Financial hardship x Age	-0.0005	(0.0057)
Financial hardship x Age-squared	-0.0000	(0.0002)
Elevated risk of depression	0.0573	(0.0592)
Parenting stress	-0.0711***	(0.0208)
Parental warmth	-0.0137	(0.0184)
Read books everyday	0.0965	(0.0561)
Cognitive stimulating activities	0.0102	(0.0239)
Socio-economic status (SES)	0.3425***	(0.0750)
SES x Age	-0.0129*	(0.0052)
SES x Age-squared	0.0003*	(0.0001)
Married	0.0495	(0.0469)
Parental employment status (ref: Not employed)		
<35 hours/week	0.0086	(0.0651)
35 or more hours/week	0.0321	(0.0824)

Male	-0.0432	(0.0525)
Has disability	-0.1471	(0.0805)
Age at school entry (centered)	0.0071	(0.0064)
Number of siblings (centered)	-0.0408*	(0.0192)
Race/ethnicity (ref: White)		
Black non-Hispanic	0.0457	(0.1052)
Hispanic	0.1091	(0.0935)
Asian, non-Hispanic	0.5481**	(0.2055)
Other	0.0336	(0.1275)
Home language is English	-0.2570*	(0.1029)
Home language is English x Age	-0.0028	(0.0083)
Home language is English x Age-squared	0.0002	(0.0002)
Health status (ref: Excellent)		
Very good or good health	0.0076	(0.0257)
Fair or poor health	-0.0167	(0.0513)
Receives free lunch	-0.0901	(0.0564)
Percent eligible for free and reduced price lunch (FRPL)	0.0015	(0.0010)
Percent non-White	-0.0019	(0.0012)
Constant	-0.6988***	(0.1238)
Variance components		
Level-1		
Within-child	0.1274***	(0.0120)
Level-2 (Between child)		
In intercept	0.4347***	(0.0371)
In rate of change (Age)	0.0002***	(0.0000)
Observations (unweighted; child by wave)	2333	

Notes: Estimates presented based on a composite model specification of a multi-level (2-level) growth model. All models fit to the ECLS-K: 2011 data using a multi-level mixed effects generalized linear model (GLM) for complex survey data (svy:meglm) in Stata 14.2. Model includes sampling weights to account for non-response and unequal probability of selection. Linearized standard errors in parentheses.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$