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Associations Between Household Food Insecurity in Early Childhood and Children's Kindergarten Skills

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Using nationally representative data on a recent birth cohort of U.S.-born children in low-income households (n = 2,800–3,700), this study investigates associations between the timing and intensity of early childhood food insecurity and children's kindergarten reading, math, and social-emotional outcomes. Descriptive patterns reveal that approximately 20% of low-income 0- to 5-year-old children reside in food-insecure households. Food insecurity experienced during early childhood is unfavorably associated with social-emotional outcomes in kindergarten, controlling for household income and prior assessments of child social-emotional skills. Results are less consistent for cognitive outcomes but similar in magnitude. If replicated, findings may inform policy efforts to reduce disparities in early skills for approximately 15 million U.S. children in food-insecure households.

In 2014, nearly 20% of U.S. households with children experienced food insecurity, meaning household residents, including approximately 15 million children, did not have adequate access to the quantity of food needed to fuel an active and healthy lifestyle (Coleman-Jensen, Rabbitt, Gregory, & Singh, 2015). Food insecurity experienced during the first 5 years of life, widely recognized as a key period of development during which the foundations for later cognitive and social functioning are laid (Knudsen, Heckman, Cameron, & Shonkoff, 2006), may be especially damaging because of possible indirect effects—through its influence on parental well-being (e.g., Bronte-Tinkew, Zaslow, Capps, Horowitz, & McNamara, 2007)—and direct effects—through disruption of children's brain growth (Nelson, 2000; Tanner & Finn-Stevenson, 2002) and physical development.

Theories about how household food insecurity might indirectly (negatively) influence child development are drawn from the family stress model (Conger & Elder, 1994), which extended to the case of food insecurity, implies that lack of access to resources such as food increases parental stress and depression, which decreases the quality of the parent–child relationship (Crnic, Gaze, & Hoffman, 2005; Crnic & Low, 2002; Goodman et al., 2011; McLeod & Shanahan, 1993; Wachs, Black, & Engle, 2009; Wu & Schimmele, 2005). Parents who are preoccupied with providing food for their children, or who are hungry themselves, may be less sensitive and responsive to their child's needs and engage in fewer activities known to stimulate early cognitive and social development. Moreover, food-insecure families may be more likely to spend that money on food than on educationally stimulating books, toys, and games to promote development. Additionally, hungry children are more irritable, which could evoke negative parental responses, perpetuating a cycle of harsh parent–child interactions (Kiff, Lengua, & Zalewski, 2011). Indeed, research suggests that food insecurity increases maternal depression and reduces positive parenting practices (Bronte-Tinkew et al., 2007), which then interfere with adherence to infant feeding recommendations (e.g., duration of breastfeeding, timing of introduction of solid foods).

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Household food insecurity might also directly (negatively) influence child development if it results in limited nutritional intake among affected children. Even moderate nutritional deficiencies during the critical first few years of life can disrupt the development of key brain processes and structures (Knickmeyer et al., 2008; Tanner & Finn-Stevenson, 2002). These disruptions can in turn impede cognitive and self-regulatory functioning, as well as memory, attention, and behavior (e.g., Grantham-McGregor & Ani, 2001; Halterman, Kaczorowski, Aligne, Auinger, & Szilagyi, 2001; Lozoff, Jimenez, Hagen, Mollen, & Wolff, 2000; Lozoff et al., 1987; Tanner & Finn-Stevenson, 2002; Yehuda & Youdim, 1989). Poor nutrition and hunger sap energy and can increase fatigue, distraction, and irritability (Tanner & Finn-Stevenson, 2002), potentially obstructing children's opportunities to directly engage their caregivers by interfering with gross motor development and reducing the quality of adult–child interactions that do occur. Lethargic infants, toddlers, and preschoolers with less advanced motor skills may not seek out interaction with caregivers and peers, which could result in social isolation and hinder developing social-emotional skills.

For these reasons, it is likely that food insecurity during the first 5 years—and in particular, in infancy and toddlerhood—will influence the constellation of cognitive and social-emotional abilities typically mastered at kindergarten entry that predicts later academic and life success (Duncan, Ziol-Guest, & Kalil, 2010; Duncan et al., 2007; Lee & Burkam, 2002). Specifically, though many studies have found links between food insecurity in the kindergarten or elementary school years and subsequent behavioral and self-regulatory competence (Alaimo, Olson, & Frongillo, 2001; Ashiabi, 2005; Belsky, Moffitt, Arseneault, Melchior, & Caspi, 2010; Dunifon & Kowaleski-Jones, 2003; Jyoti, Frongillo, & Jones, 2005; Melchior et al., 2009; Slopen, Fitzmaurice, Williams, & Gilman, 2010), surprisingly few have examined the entire early childhood period. In a Pennsylvania sample of families with at least one child under age 12, researchers identified links between childhood hunger and clinical levels of psychosocial dysfunction between ages 6 and 12 (Kleinman et al., 1998), though their analysis did not account for family income or economic hardship. Another single-site study of preschool (age 4) and school-age (age 10) children in homeless families in Massachusetts found severe hunger to be predictive of contemporaneous internalizing behavior problems even after controlling for family income (Weinreb et al., 2002). Similarly, a study in Illinois found that food insecurity among 3- to 5-year-old children predicted increased internalizing (and externalizing) behavior problems during the same time period, net of controls for income (Slack & Yoo, 2005). Using Canadian data, food insecurity at ages 1.5 and 4.5 years predicted increased child hyperactivity across ages 4–8 after accounting for family income (Melchior et al., 2014). A cross-sectional examination of 3-year-old children drawn from the Fragile Families and Child-Wellbeing study, a multicity U.S. study, revealed that food insecurity at age 3 was related to greater same-age behavioral problems such as hyperactivity, aggression, and anxiety even after accounting for income-to-needs ratio and material hardship (Whitaker, Phillips, & Orzol, 2006). Notably, none of these studies used nationally representative data and thus the generalizability of findings is unknown.

There is even less evidence linking food insecurity to cognitive development in early childhood; however, such links have been found in older children (Alaimo et al., 2001; Belsky et al., 2010; Jyoti et al., 2005). In a nationally representative sample, food insecurity when children were 9 months old was indirectly associated with reductions in children's cognitive scores at age 2, via maternal depression, controlling for income-to-needs ratio and family economic resources (Bronte-Tinkew et al., 2007; Zaslow et al., 2009). Hernandez and Jacknowitz (2009) assessed patterns of adult (not household) food insecurity between child ages 9 months and 2 years, on 2-year cognitive scores, net of household income; children who lived with food-insecure mothers when they were 2 years old had lower cognitive scores at age 2 than did children whose mothers never reported food insecurity. Finally, using data drawn from emergency health centers in large cities across the United States, Rose-Jacobs et al. (2008) found that children aged 4–36 months in food-insecure households were more likely to be simultaneously rated by their parents as being at developmental risk than were children in food-secure households, though this analysis did not account for family economic resources or hardships.

The current study addresses this gap in the literature by using nationally representative data on a recent birth cohort of children in the United States to test whether household food insecurity across a child's critical first 5 years is related to a comprehensive set of kindergarten outcomes that are predictive of later academic and life success. We do so by asking first whether the timing of food insecurity across early childhood predicts kindergarten cognitive and social-emotional outcomes, and second, whether the

intensity of food insecurity across three distinct developmental time points relates to kindergarten cognitive and social-emotional outcomes.

To address the first question, we explore associations between food insecurity when children are 9 months old, 2 years old, and preschool age and children's kindergarten reading and math skills, as well as their levels of hyperactivity, conduct problems, and approaches to learning. We focus on these developmental periods because the first 5 years of life are now widely recognized as the most sensitive period of development (Shonkoff & Phillips, 2000), with vulnerability to adverse early experiences declining slightly as children move from infancy into toddlerhood and then the preschool years (see McCoy, 2016). We conduct this analysis in two stages, first testing each time point at which we expect food insecurity to exert particularly negative effects on development individually and then including all periods of food insecurity in a single model to assess independent contributions of each wave of food insecurity net of others. All analyses are limited to the subsample of children in low-income households (households with incomes at or below 185% of the Federal Poverty Line [FPL] at any point from 9 months to preschool).

We anticipate, in light of research discussed previously on parental well-being and related disruptions to the parent–child relationship as well as direct effects on early brain and physical development, that food insecurity in infancy, followed closely by food insecurity in toddlerhood, should be more damaging than food insecurity as children approach school entry, for both cognitive and social outcomes. We base this hypothesis on the fact that the home and parents are the primary contexts for development when children are infants and only slightly less so when they are 2 years old. During infancy, children form attachment relationships with primary caregivers, usually parents, that template children's approaches to subsequent social interactions, which themselves constitute platforms for engagement in activities that support cognitive growth (Bowlby, 1982). If food insecurity in infancy limits opportunities for these relationships to be established or to unfold fully, then food insecurity at this time would be expected to disrupt later social and cognitive development. These developmental processes continue as children transition into toddlerhood (around age 2), gaining mobility and language skills that expand exposure to a wider range of socially and cognitively stimulating experiences. Fatigue and lethargy from hunger that disrupts gross motor skill development could stunt exploration of the environment and the absence of sensitive, responsive, and stimulating parenting—perhaps because hungry children cannot elicit these responses, hungry parents cannot give them, or both—may limit opportunities for enriching social interaction. This in turn interferes with learning and the attainment of key milestones of toddlerhood such as emerging self-regulation (e.g., Cole, Michel, & Teti, 1994; Zhou et al., 2002), now recognized to undergird critical cognitive and social skills extending into primary school (Raver, Garner, & Smith-Donald, 2007). Additionally, brain development occurs most rapidly during the first 2 years of life (Dekaban, 1978; Knickmeyer et al., 2008) and thus may be most vulnerable to even moderate nutritional deprivation. Nevertheless, food insecurity in the year immediately preceding kindergarten could also undermine children's behavior, as it has been found to do for 3- to 5-year-olds (Slack & Yoo, 2005), and cognitive functioning, if it interferes with children's abilities to learn in their preschool environments. For the reasons discussed earlier, we do not anticipate, though, that food insecurity in the preschool year will exert as negative an influence as that experienced in the first 2 years.

To address the second question, we compare the kindergarten outcomes of children who experienced food insecurity at any one wave, any two, or at all three waves leading up to kindergarten entry to those of children who experienced no food insecurity in the years before kindergarten. Here, we hypothesize that more episodes of food insecurity will be linked with worse outcomes than a single episode of food insecurity because it would be expected to disrupt parent–child interactions and the resources parents provide, and have more severe and global effects on the developing brain, all of which would undermine a child's emerging cognitive and self-regulatory skills over a greater period. However, it is possible that children adjust to chronic food insecurity over time, whereas episodic food insecurity is more damaging to early development because it gives rise to instability and unpredictability in parenting practices, investment in developmentally stimulating materials, and in the availability of sufficient nutrition to support energy levels, mood, and attention (Hernandez & Jacknowitz, 2009; Hill, Morris, Gennetian, Wolf, & Tubbs, 2013).

Method

Data and Sample

Data are drawn from the Early Childhood Longitudinal Study–Birth Cohort (ECLS–B), a nationally

representative study of children born in 2001. More than 14,000 birth certificates were sampled from 96 counties or county clusters; of the 14,000, approximately 10,700 children participated in the baseline wave of data collection. Parents were interviewed and children were assessed in 2001, when children were 9 months old; in 2003, when they were 2 years old; in 2005–2006, when were in preschool; and in 2006–2007, when they were in kindergarten (kindergarten data were collected over 2 years, as not all children entered kindergarten in the fall of 2006). The current study uses data from all four waves, for which response rates were 74%, 93%, 91%, and 92%, respectively. National Center for Education Statistics-constructed weights were applied to account for the study's complex sampling design, oversampling of certain populations (e.g., twins; Asian-Pacific islanders) and for survey nonresponse; the weighted sample is representative of all children born in the United States in 2001.

Given that the low-income and food-insecure populations are highly overlapping, all analyses focus on the subsample of children with valid food insecurity and outcome data, who were in households with incomes at or below 185% of the FPL (the income cutoff for the Special Supplemental Nutrition Program for Women, Infants, and Children [WIC]) at any wave between 9 months and preschool, hereafter referred to as "low-income." Missing data on covariates, though negligible, were multiply imputed using the imputation for chained equations procedure in Stata 13, and estimates were combined across 10 imputed data sets using the *mim* command. The application of survey weights, discussed earlier, adjusts for survey nonresponse; additionally, in regression models, we used Stata's *subpop* command so that standard errors would account for cases excluded from the analytic sample because they were not low income. Thus, the final analytic sample for models predicting cognitive outcomes included approximately 3,700 children with full food insecurity data across the first three waves (9 months, 2 years, and preschool) as well as kindergarten cognitive assessment data; the analytic sample for models predicting social-emotional outcomes included approximately 2,800 children with valid food insecurity data and kindergarten teacher-reported social-emotional outcome data (all *N*s are rounded to the nearest 50 in compliance with NCES security standards).

Measures

Food Insecurity

Our primary measure of food insecurity status was constructed using parent responses to the full 18 items of the U.S. Department of Agriculture's (USDA) Core Food Security Module (CFSM), which was asked at each survey wave. Ten of the 18 items measure adult food insecurity and the remaining 8 items assess child food insecurity; together, the 18 items measure household food insecurity. Researchers are often cautioned against using the eight child items alone because they typically register food security of the oldest child in the household; instead, the standard approach is to use all 18 items (Bickel, Nord, Price, Hamilton, & Cook, 2000) and to control for number and age of all household children. Personal communication with officials at the USDA suggested sensitivity tests using just the 10 adult items and, separately, just the 8 child items but in a subsample in which the focal child was the oldest or only child. Results from these alternate specifications are discussed in the Supplementary Analyses section below. For our main specification, we followed prior studies that had the full CFSM available and that sampled families with children (e.g., Bronte-Tinkew et al., 2007; Zaslow et al., 2009), as well as USDA recommendations (Bickel et al., 2000; Nord & Coleman-Jensen, 2014; M. Nord, personal communication, February 2014), and created a series of dummy variables from the 18 household items: these dummy variables represented food security (0–2 items endorsed), low food security (3–7 items endorsed), and very low food security (8–18 items endorsed). This approach to coding all 18 CFSM items is considered a standard coding scheme, which we replicated at each wave prior to kindergarten (i.e., 9 months, 2 years, preschool).

To assess associations between intensity of food insecurity and kindergarten outcomes, we constructed a series of dummy variables capturing the number of episodes of food insecurity experienced across early childhood. At each wave, households were classified as food insecure if they endorsed three or more of the 18 CFSM items (i.e., if they were coded as experiencing low or very low food security at that wave); three dummy variables were entered in models indicating any household food insecurity at any one wave, any household food insecurity at any two waves, and any household food insecurity at all three waves, with no household food insecurity at any wave as the reference category.

Table 1 presents descriptive statistics including the proportion of our low-income sample that was food secure at 9 months, 2 years, and preschool. Notably, even among low-income families,

Table 1
Descriptive Statistics by Household Food Insecurity Status at 9 Months, 2 Years, and Preschool

	Full sample		FI at 9 months		FI at 2 years		FI at preschool	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Kindergarten outcomes								
Hyperactivity	11.12	4.52	11.16	4.51	11.32	4.62	11.21	4.50
Conduct problems	7.30	3.31	7.30	3.33	7.36	3.38	7.37	3.34
Approaches to learning	14.97	3.13	14.90	3.14	14.82	3.15	14.88	3.14
Reading	39.95	13.65	39.14	13.61	39.17	13.63	39.18	13.50
Math	40.92	9.76	40.37	9.83	40.37	9.82	40.34	9.81
Household food insecurity								
Food secure, 9 months	0.80		0.88		0.88		0.88	
Low food security, 9 months	0.15		0.10		0.10		0.10	
Very low food security, 9 months	0.04		0.03		0.03		0.03	
Food secure, 2 years	0.86		0.91		0.91		0.91	
Low food security, 2 years	0.11		0.07		0.07		0.07	
Very low food security, 2 years	0.03		0.02		0.02		0.02	
Food secure, preschool	0.80		0.88		0.88		0.88	
Low food security, preschool	0.16		0.09		0.09		0.09	
Very low food security, preschool	0.05		0.03		0.03		0.03	
Family characteristics								
No. children under 6	0.74	0.84	0.80	0.86	0.79	0.87	0.76	0.86
No. children over 7	0.63	0.98	0.68	1.02	0.70	1.04	0.65	1.01
Family size, 9 months	4.05	1.38	4.13	1.42	4.14	1.42	4.09	1.41
Family size, 2 years	4.08	1.38	4.15	1.42	4.21	1.42	4.12	1.41
Family size, preschool	4.27	1.39	4.32	1.42	4.37	1.43	4.33	1.44
Average income	27,467	15,566	24,850	14,137	23,597	12,884	23,490	12,426
Household receives benefits	0.86		0.90		0.89		0.88	
Low-income family at 9 months	0.82		—		0.85		0.82	
Low-income family at 2 years	0.78		0.81		—		0.83	
Low-income family at preschool	0.80		0.80		0.84		—	
Maternal characteristics								
Depression at 9 months	0.16		0.17		0.17		0.18	
Depression at 2 years	0.11		0.11		0.11		0.11	
Depression at preschool	0.17		0.18		0.18		0.19	
Mother less than HS	0.31		0.34		0.35		0.35	
Mother HS	0.38		0.38		0.38		0.39	
Mother some college	0.26		0.24		0.23		0.23	
Mother college or more	0.05		0.04		0.04		0.04	
White	0.42		0.39		0.38		0.39	
Black	0.20		0.21		0.22		0.22	
Hispanic	0.32		0.34		0.34		0.33	
Asian	0.06		0.06		0.06		0.06	
Single mother	0.29		0.31		0.31		0.30	
Immigrant	0.27		0.28		0.28		0.28	
Mother over 20 at birth	0.83		0.82		0.82		0.82	
Fluent in English	0.83		0.81		0.81		0.80	
Mother is employed	0.45		0.42		0.42		0.43	
Child-care use								
Parental care only, 9 months	0.54		0.56		0.57		0.57	
Home-based care, 9 months	0.39		0.38		0.37		0.38	
Center-based care, 9 months	0.06		0.06		0.06		0.06	
Parental care only, 2 years	0.56		0.57		0.58		0.60	
Home-based care, 2 years	0.31		0.31		0.29		0.29	
Center-based care, 2 years	0.13		0.13		0.12		0.11	

Table 1
Continued

	Full sample		FI at 9 months		FI at 2 years		FI at preschool	
	M	*SD*	*M*	*SD*	*M*	*SD*	*M*	*SD*
Parental care only, preschool	0.27		0.28		0.28		0.28	
Home-based care, preschool	0.21		0.21		0.20		0.20	
Center-based care, preschool	0.52		0.51		0.51		0.52	
Child characteristics								
Child is male	0.52		0.51		0.52		0.52	
Child age (months)	68.07	4.42	68.08	4.43	68.01	4.45	68.06	4.43
Child disability status	0.07		0.08		0.07		0.07	
Bayley cognitive score (9 months)	76.57	10.00	76.39	10.10	76.42	9.90	76.38	9.75
Bayley behavior score (9 months)	5.16	0.99	5.13	0.99	5.14	0.98	5.13	1.00
Bayley cognitive score (2 years)	124.78	10.12	124.58	9.98	124.52	10.32	124.32	10.20
Bayley behavior score (2 years)	3.41	0.83	3.41	0.84	3.39	0.84	3.38	0.83
On-time kindergarten entry	0.74		0.74		0.74		0.74	

Note. Data are drawn from the Early Childhood Longitudinal Study–Birth Cohort (ECLS–B) 9-month kindergarten restricted use data file. N = 3,700. Sample is limited to low-income families defined as families with incomes ever at or below 185% of the Federal Poverty Line (FPL). Because a family could be food insecure at more than one wave (i.e., could be represented more than once in the 9 months, 2 years, and preschool food-insecure columns), the full sample column is not a weighted average of the 9 months, 2 years, and preschool columns. The low-income status row indicates, among families who were ever low-income as defined by having incomes at or below 185% of the FPL, what proportion was low-income at each wave. *N*s are rounded to the nearest 50 per NCES data security requirements.

the majority of families are food secure; 80% of families were food secure when children were 9 months old and in preschool, and 86% of families were food secure when children were 2 years old.

Kindergarten Reading, Math, and Social-Emotional Outcomes

All kindergarten outcomes were measured in the fall of the year the child first attended kindergarten and, to ease interpretability, were standardized to have a mean of 0 and a standard deviation of 1; thus, coefficients in regression models may be interpreted as effect sizes. Unstandardized outcome means by food security status are presented in Table 2.

Kindergarten reading and math skills. Kindergarten reading and math skills were measured directly by trained data collectors. Reading ability was assessed using a measure developed specifically for the ECLS–B, which evaluated letter and letter-sound knowledge, print conventions, and expressive and receptive vocabulary skills. Math skills were evaluated with a measure developed for the ECLS–B that assessed children's number sense, properties, operations, measurement, and geometry and spatial abilities. For both reading and math, item response theory-derived (IRT) scale scores provided by the ECLS–B were used.

Kindergarten social-emotional skills. Using items drawn from the Preschool and Kindergarten Behavior Scales, 2nd ed. (Merrell, 2003) and the Social Skills Rating Scale (Gresham & Elliot, 1990), kindergarten teachers rated children's behavior on a 5-point scale (1 = *behavior never observed* to 5 = *behavior observed very often*). We created three measures of social-emotional development: hyperactivity (e.g., how well child pays attention, resists distraction, sits still; α = .89 for average of five items), conduct problems (e.g., how often child pushes, tantrums; α = .91 for average of four items), and approaches to learning (e.g., how focused, independent, eager to learn child was; α = .89 for average of four items).

Covariates

All covariates (except where noted) were drawn from the 9-month wave to reduce the likelihood that covariates and food insecurity were simultaneously determined. Standard demographic and household economic variables theoretically or empirically linked to food insecurity, kindergarten skills, or both included household size; number of children age 6 and younger in the home; number of children age 7 and older in the home; maternal race, education, marital status, employment status, immigrant status, and English proficiency; household urbanicity; whether the family received any

Table 2
Reading, Math, and Social-Emotional Outcomes in Kindergarten by Household Food Insecurity Status at 9 Months, 2 Years, and Preschool

	9 Months					
	Food secure		Low food security		Very low food security	
Kindergarten outcomes	*M*	*SD*	*M*	*SD*	*M*	*SD*
Hyperactivity	10.90	4.44	11.70	4.67	12.68	4.86
Conduct problems	7.13	3.19	7.72	3.60	8.61	3.80
Approaches to learning	15.12	3.10	14.51	3.19	14.10	3.09
Reading	40.57	13.75	37.52	12.67	36.95	13.38
Math	41.41	9.80	38.79	9.25	39.46	9.30
	2 Years					
	Food secure		Low food security		Very low food security	
Kindergarten outcomes	*M*	*SD*	*M*	*SD*	*M*	*SD*
Hyperactivity	10.97	4.46	11.73	4.80	13.29	4.48
Conduct problems	7.23	3.28	7.47	3.35	8.79	3.69
Approaches to learning	15.09	3.12	14.35	3.18	13.74	2.62
Reading	40.44	13.60	36.81	13.83	37.26	12.63
Math	41.38	9.64	38.36	10.08	37.14	9.60
	Preschool					
	Food secure		Low food security		Very low food security	
Kindergarten outcomes	*M*	*SD*	*M*	*SD*	*M*	*SD*
Hyperactivity	10.91	4.49	11.78	4.61	12.39	4.35
Conduct problems	7.14	3.22	7.86	3.44	8.20	3.98
Approaches to learning	15.12	3.11	14.52	3.17	13.84	2.96
Reading	40.55	13.64	37.15	13.30	38.51	14.07
Math	41.36	9.76	39.15	9.44	38.86	9.84

Note. Data are drawn from the Early Childhood Longitudinal Study–Birth Cohort (ECLS–B) 9-month kindergarten restricted use data file. Sample is limited to low-income families defined as families with incomes ever at or below 185% of the Federal Poverty Line (FPL). Means are weighted using jackknife replicate weights WK1C1-90 and WK45T1-90 for reading, math, and social-emotional outcomes, respectively.

public benefits, including food stamps (SNAP) and WIC; and household income (see below). Additionally, several prior studies have consistently identified maternal depression as both a symptom and a cause of increased risk for food insecurity (Bronte-Tinkew et al., 2007; Casey et al., 2004; Whitaker et al., 2006); maternal depression is also known to decrease children's cognitive and social skills (e.g., Goodman et al., 2011). Therefore, all models also controlled for maternal depression, drawn from the wave corresponding with food insecurity. On the child level, all models controlled for measures of child gender, age, year child entered kindergarten (2006 vs. 2007), whether the child had a diagnosed special need (at the 2-year wave), and three dummy variables indicating whether the child experienced home-based, center-based, or parental child care (omitted) at the wave when food insecurity was assessed.

Income. To reduce possible confounding of food insecurity status with low-income status, in addition to limiting the analytic sample to low-income households we also included an average measure of household income from 9 months through preschool as a covariate in all analyses. At each wave, parents were asked to report their household's total pretax earnings in the last year, including salaries, interest, retirement, and so on. We averaged reported pretax household income across 9 months, 2 years, and preschool, as permanent measures of income are more predictive of food insecurity than are measures of current income (e.g., Gundersen & Gruber, 2001).

Lagged cognitive and social-emotional measures. Finally, we included prior measures of child cognitive or social-emotional development to adjust for time-invariant child-level omitted variables (discussed further below). These lagged child outcomes were drawn from the wave immediately preceding the measurement of food insecurity; that is, in models predicting kindergarten cognitive outcomes from 2-year food insecurity, 9-month cognitive outcomes were controlled; in models predicting kindergarten cognitive outcomes from preschool-year food insecurity, 2-year cognitive outcomes were controlled. Lagged measures of social-emotional functioning were used in models predicting kindergarten social-emotional outcomes.

Analytic Strategy

Despite the descriptive nature of our analysis, we aimed to reduce selection bias in our estimates by implementing residualized change models (National Institute of Child Health and Human Development Early Child Care Research Network & Duncan, 2003), which account for time-invariant child and family characteristics by adjusting for unobserved or omitted variables associated with the lagged outcome. This approach is recommended when exact repeated measures of outcomes over time are not available, as is the case in the current analysis (making a fixed effects analysis untenable). The residualized change model takes the generic form below when assessing the relationship between food insecurity at 2 years and kindergarten outcomes (note there is no lagged outcome at 9 months because it is the baseline wave, and thus an equation predicting kindergarten outcomes from 9-month food security status is not shown):

$$\begin{aligned}\text{Kindergarten Outcomes}_i &= \alpha + \beta_1(\text{Low Food Security 2 yr}) \\ &\quad + \beta_2(\text{Very Low Food Security 2 yr}) \\ &\quad + \beta_3(\text{Bayley Score 9 mo}) \\ &\quad + \beta_k(\text{Covariates}) + \epsilon_i\end{aligned} \tag{1}$$

In Equation 1, the given kindergarten outcome is predicted from household food insecurity at 2 years, the appropriate lagged version of the outcome (Bayley mental or adaptive behavior scores at 9 months), and covariates. β_1 and β_2 represent the difference in the level of the outcome at kindergarten for children in households who experienced low and very low food security, respectively, relative to those who were food secure at 2 years, conditional on the child's lagged outcome from the wave prior to when food insecurity was assessed. Although this approach controls for the effect of food insecurity on outcomes up to 9 months, it does not capture food insecurity that began at age 1 and extended until 2 years. Likewise, for the model predicting kindergarten outcomes from preschool-year food insecurity in which 2-year outcomes are lagged (Equation 2, below), food insecurity experienced prior to age 2 that might have influenced age 2 outcomes is controlled for, but food insecurity that might have occurred after the 2-year year interview and before preschool is not.

$$\begin{aligned}\text{Kindergarten Outcomes}_i &= \alpha + \beta_1(\text{Low Food Security Preschool}) \\ &\quad + \beta_2(\text{Very Low Food Security Preschool}) \\ &\quad + \beta_3(\text{Bayley Score 2 yr}) \\ &\quad + \beta_k(\text{Covariates}) + \epsilon_i\end{aligned} \tag{2}$$

To address the possibility that β_1 and β_2 in Equations 1 and 2 are absorbing effects of food insecurity at subsequent time points, we ran additional models in which we control for food insecurity at all available time points, estimating the independent association of food insecurity at any one time point on kindergarten outcomes, net of other episodes of food insecurity (Equation 3).

$$\begin{aligned}\text{Kindergarten Outcomes}_i &= \alpha + \beta_1(\text{Low Food Security 9 mo}) \\ &\quad + \beta_2(\text{Very Low Food Security 9 mo}) \\ &\quad + \beta_3(\text{Low Food Security 2 yr}) \\ &\quad + \beta_4(\text{Very Low Food Security 2 yr}) \\ &\quad + \beta_5(\text{Low Food Security Preschool}) \\ &\quad + \beta_6(\text{Very Low Food Security Preschool}) \\ &\quad + \beta_7(\text{Bayley Score 9 mo}) \\ &\quad + \beta_k(\text{Covariates}) + \epsilon_i\end{aligned} \tag{3}$$

Here, β_1 (for instance) is limited to the proportion of the association between low food security at 9 months and kindergarten outcomes that is independent of the association between food insecurity at other time points and the same outcomes. Finally, Equation 4 presents the model estimating associations between intensity of food insecurity across early childhood and kindergarten outcomes. In this model, β_1 (for example) represents the

average difference in kindergarten outcomes between children who lived in a food-insecure household at any one time point (e.g., 9 months, 2 years, *or* preschool), relative to children who lived in households experiencing no food insecurity across the early childhood years.

$$\begin{aligned}\text{Kindergarten Outcomes}_i &= \alpha + \beta_1(\text{One Episode of Food Insecurity}) \\ &\quad + \beta_2(\text{Two Episodes of Food Insecurity}) \\ &\quad + \beta_3(\text{Three Episodes of Food Insecurity}) \\ &\quad + \beta_4(\text{Bayley Score 9 mo}) \\ &\quad + \beta_k(\text{covariates}) + \epsilon_i\end{aligned} \tag{4}$$

In addition to including lagged outcome measures as additional predictors in the above models, we also included a near-exhaustive set of covariates as described above. This vector of covariates is expressed as β_k in the above equations. Alongside the lagged dependent variable, the inclusion of this rich set of covariates yields the most appropriate analysis given limitations of the available data.

Results

Predicting Kindergarten Reading, Math, and Social-Emotional Outcomes From the Timing of Household Food Insecurity

To address our first research question regarding associations between the *timing* of food insecurity across early childhood and kindergarten cognitive and social-emotional skills, we estimated a series of ordinary least-squares (OLS) regression models. Table 3 presents results from the first series of models, which predicted the respective kindergarten outcome from the three-level food insecurity variable (low food security, very low food security, with food secure as the reference) at each time point, separately; estimates reflect effect sizes relative to children in food-secure households. All models included the full set of covariates described above (i.e., standard demographic and household economic controls as well as maternal depression).

At 9 months, very low food security was associated with increased hyperactivity and conduct problems, and reduced reading scores; associations between very low food security and approaches to learning did not meet conventional levels for

Table 3
Regression Models Predicting Reading, Math, and Social-Emotional Outcomes in Kindergarten From Timing of Household Food Insecurity Across Early Childhood

	Hyperactivity			Conduct problems			Approaches to learning			Reading			Math		
	b	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*
9 months															
Low food security	.12	.07	.08	.13	.07	.07	−.11	.08	.16	−.10	.06	.12	−.15	.06	.01
Very low food security	.28	.11	.02	.40	.13	.00	−.21	.11	.06	−.22	0.08	.01	−.13	.10	.17
N	2,300			2,350			2,350			3,050			3,050		
2 years															
Low food security	−.01	.09	.91	−.01	.09	.91	−.10	.08	.25	−.13	.06	.04	−.18	.07	.02
Very low food security	.41	.15	.01	.41	.18	.02	−.34	.12	.00	−.07	.11	.54	−.27	.12	.02
N	2,200			2,250			2,250			2,900			2,900		
Preschool															
Low food security	.06	.07	.42	.11	.07	.14	−.06	.08	.41	−.12	.05	.01	−.09	.06	.13
Very low food security	.12	.12	.32	.16	.16	.33	−.25	.12	.04	.00	.10	.98	−.12	.11	.28
N	2,200			2,250			2,250			2,900			2,900		

Note. Data are drawn from the Early Childhood Longitudinal Study–Birth Cohort (ECLS–B) 9-month kindergarten restricted use data file. Sample is limited to low-income families defined as families with incomes ever at or below 185% of the Federal Poverty Line (FPL). *N*s are rounded to the nearest 50 per NCES data security requirements. Models are weighted using jackknife replicate weights WK1C1-90 and WK45T1-90 for reading, math, and social-emotional outcomes, respectively. Dependent variables are standardized to ease interpretation. Covariates included in all models but not shown are maternal education, employment, average income (from Waves 1 to 3), household receipt of public benefits, race, immigrant status, English proficiency, maternal depression (drawn concurrently), mother age at child's birth, number of people in the household (drawn concurrently), number of children under 6 in the household, number of children in the household over 7, urbanicity, child-care use (drawn concurrently), child gender, child age, kindergarten entry year, and child special needs status as well as measures of child behavior and cognitive ability (Bayley) drawn from 9 months in the 2-year models and 2 years in the preschool models. Covariates are drawn from Wave 1 unless otherwise indicated.

statistical significance at $p = .06$, but were negative. Low food security at 9 months was related to decreased math scores. At 2 years, very low food security was again associated with increased hyperactivity and conduct problems, and with decreased approaches to learning and math skills; low food security was also linked to decreased reading and math performance. At preschool, very low food security was significantly linked with decreased approaches to learning only, whereas low food security was linked with reduced reading scores.

Table 4 presents results from the second series of models, in which food insecurity (low food security, very low food security, with food secure as the reference) at each time point was entered simultaneously. Accounting for later experiences of food insecurity, food insecurity at 9 months continued to be associated with increased levels of conduct problems and with lower levels of reading and math skills. Additionally, low food security was marginally associated with hyperactivity at 9 months ($p < .10$). Accounting for all other experiences of food insecurity, food insecurity at 2 years was associated with increased hyperactivity and reduced approaches to learning and math scores. Finally, controlling for previous experiences of food insecurity, preschool food insecurity was associated with more conduct problems and lower approaches to learning and reading scores.

In sum, across both Tables 3 and 4, we observe broad negative associations between earlier food insecurity—at 9 months and 2 years—whether examined in isolation or in concert with all other time points of food insecurity. We observe consistent evidence of an association between early food insecurity and social-emotional outcomes and approaches to learning. Associations between early food insecurity and math and reading outcomes are less consistent, but compelling. In both Tables 3 and 4, very low food security at 9 months was related to reading outcomes and very low food security at 2 years was related to math; low food security at 9 months was negatively related to math performance. Given the low overall prevalence of food insecurity, the very low food security cells, particularly in Table 4, are likely to be quite small and potentially underpowered.

Predicting Kindergarten Reading, Math, and Social-Emotional Outcomes From the Intensity of Household Food Insecurity

Table 5 presents results that address our second research question regarding associations between the *intensity* of food insecurity across early

Table 4
Regression Models Predicting Reading, Math, and Social-Emotional Outcomes at Kindergarten From Episodes of Household Food Insecurity, Controlling for All Other Episodes of Food Insecurity Across Early Childhood

	Hyperactivity			Conduct problems			Approaches to learning			Reading			Math		
	b	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*
9 months															
Low food security	.12	.07	.08	.15	.07	.04	−.10	.07	.15	−.08	.06	.16	−.12	.05	.03
Very low food security	.17	.11	.13	.26	.12	.03	−.10	.11	.36	−.19	.09	.03	−.06	.10	.58
2 years															
Low food security	.02	.10	.88	−.09	.10	.37	−.09	.09	.36	−.10	.06	.12	−.15	.07	.03
Very low food security	.34	.16	.04	.26	.20	.18	−.25	.12	.04	−.03	.11	.80	−.25	.13	.06
Preschool															
Low food security	.09	.07	.18	.14	.07	.04	−.07	.08	.35	−.10	.05	.05	−.06	.06	.31
Very low food security	.16	.13	.20	.22	.16	.19	−.26	.13	.04	−.02	.10	.81	−.12	.11	.26

Note. Data are drawn from the Early Childhood Longitudinal Study–Birth Cohort (ECLS–B) 9-month kindergarten restricted use data file. Sample is limited to low-income families defined as families with incomes ever at or below 185% of the Federal Poverty Line (FPL). *N*s are rounded to the nearest 50 per NCES data security requirements. Models are weighted using jackknife replicate weights WK1C1-90 and WK45T1-90 for reading, math, and social-emotional outcomes, respectively. Dependent variables are standardized to ease interpretation. Covariates included in all models but not shown are maternal education, employment, average income (from Waves 1 to 3), household receipt of public benefits, race, immigrant status, English proficiency, maternal depression, mother age at child's birth, number of people in the household, number of children under 6 in the household, number of children in the household over 7, urbanicity, child-care use, child gender, child age, kindergarten entry year, and child special needs status as well as measures of child behavior and cognitive ability (Bayley) drawn from the 9-month wave. Covariates are drawn from Wave 1 unless otherwise indicated.

Table 5
Regression Models Predicting Reading, Math, and Social-Emotional Outcomes in Kindergarten From Intensity of Household Food Insecurity Across Early Childhood

	Hyperactivity			Conduct problems			Approaches to learning			Reading			Math		
	b	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*	*b*	*SE*	*p*
FI at any one wave	.15	.06	.01	.16	.06	.01	−.12	.06	.04	−.19	.04	.00	−.20	.05	.00
FI at any two waves	.18	.09	.04	.22	.10	.03	−.24	.08	.01	−.19	.06	.00	−.28	.07	.00
FI at all three waves	.30	.13	.02	.26	.13	.05	−.30	.14	.03	−.19	.11	.09	−.18	.11	.10
N	2,800			2,900			2,900			3,700			3,700		

Note. Data are drawn from the Early Childhood Longitudinal Study–Birth Cohort (ECLS–B) 9-month kindergarten restricted use data file. Sample is limited to low-income families defined as families with incomes ever at or below 185% of the Federal Poverty Line (FPL). *N*s are rounded to the nearest 50 per NCES data security requirements. Models are weighted using jackknife replicate weights WK1C1-90 and WK45T1-90 for reading, math, and social-emotional outcomes, respectively. Dependent variables are standardized to ease interpretation. Covariates included in all models but not shown are maternal education, employment, average income (from Waves 1 to 3), household receipt of public benefits, race, immigrant status, English proficiency, maternal depression, mother age at child's birth, number of people in the household, number of children under 6 in the household, number of children in the household over 7, urbanicity, child-care use, child gender, child age, kindergarten entry year, and child special needs status as well as measures of child behavior and cognitive ability (Bayley) drawn from the 9-month wave. Covariates are drawn from Wave 1 unless otherwise indicated.

childhood and kindergarten outcomes. Again, separate models were estimated for each kindergarten outcome; all three indicators representing 1, 2, or 3 episodes of food insecurity across the three study waves were entered simultaneously. Estimates reflect effect sizes relative to children who resided in food-secure households at all waves.

In general, as the intensity of food insecurity increased across early childhood, so too did negative associations with outcomes. Specifically, any one episode of food insecurity in early childhood was associated with increased hyperactivity and conduct problems, and decreased approaches to learning, reading, and math skills. The same pattern emerged for any two episodes of food insecurity in early childhood: two episodes of food insecurity connoted increased hyperactivity and conduct problems and decreased approaches to learning, reading, and math skills. Moreover, these coefficients were typically larger than those for a single episode of food insecurity. Although the size of the coefficients predicting social-emotional outcomes from three episodes of food insecurity were larger still, only associations between hyperactivity and approaches to learning reached statistical significance at conventional ($p < .05$) levels; the association with conduct problems was significant at $p = .05$. Associations between three episodes of food insecurity and cognitive outcomes were not statistically significant, though they were in the expected (negative) direction; moreover, the association between reading outcomes and three episodes of food insecurity was marginally significant ($p = .09$). Again, because of the relatively low overall prevalence of food insecurity, cells for food insecurity across all three time points were more sparsely populated, and thus analyses could have been underpowered. This may explain the lack of consistent associations between food insecurity and cognitive outcomes (although associations between early food insecurity and social-emotional outcomes were more stable).

Supplementary Analyses

To test the sensitivity of our main results to various analytic decisions, we conducted a series of supplementary analyses. First, we experimented with different approaches for measuring food insecurity. In the published literature, there exists wide variation in how researchers have used the 18-item USDA CFSM. For instance, some use just the 10 adult-focused items (e.g., Hernandez & Jacknowitz, 2009), some separate the eight child-focused items (Korenman, Abner, Kaestner, & Gordon, 2013), and others use all 18 items (e.g. Gundersen & Kreider, 2009; Jyoti et al., 2005). Of those studies that use all 18 items, there is variation in how those items are coded: as a binary indicator measuring any versus no food insecurity continuously (0–18) or as a series of variables identical to those used in the current study.

To ensure that our findings are not artifacts of how food insecurity was measured, we reanalyzed our data using indicators of food insecurity that were constructed from the 10 adult-focused CFSM

items only. Results were largely unchanged from those presented above in Tables 3 and 4 (Tables S1 and S2, respectively). We then recoded our food insecurity indicators using just the eight child-focused CFSM models. As discussed earlier, we followed recommendations from individuals at the USDA and reduced our sample to families where the focal child was the only or oldest child because items are believed to capture only the oldest household child's experience of food insecurity (M. Nord, personal communication, February 2014; A. Coleman-Jensen, personal communication, September 2014). This drastically reduced our sample size and thus limited the stability and precision of estimates and our power to detect significant effects. Not surprisingly then, in these models (Tables S3 and S4), the pattern of results departed somewhat from that in our main models (Tables 3 and 4); food insecurity at 9 months and preschool, separately, was not associated with kindergarten outcomes. At 2 years, food insecurity was linked with greater hyperactivity and lower approaches to learning scores; associations with math were marginally significant ($p = .10$). This pattern was largely replicated in analyses that entered food insecurity at all time points simultaneously; food insecurity at 2 years was associated with hyperactivity and approaches to learning, as well as reading and math outcomes. Finally, we also estimated models with a continuous food insecurity variable (count of items endorsed ranging from 0 to 18) as well as with a two-item screener found in prior research to effectively capture similar variation in food insecurity as the full scale (Hager et al., 2010); across these alternate approaches, our pattern of significant results was substantively unchanged (these last two alternate specifications are available from the authors upon request).

Next, we reasoned that perhaps associations between 9-month food insecurity and kindergarten outcomes were often stronger than later food insecurity because models predicting outcomes from 9-month food insecurity do not include a lagged outcome. Although models predicting outcomes from food insecurity at the 2-year and preschool waves included controls for the outcome variable, measured at the preceding wave, no such measure was available at the 9-month wave because it was the study's baseline data collection wave. To assess this possibility, we reestimated all models without the inclusion of the lagged child outcomes, assuming that if associations between food insecurity at the 2-year and preschool waves became stronger without its inclusion then perhaps the absence of the lagged outcome at 9 months explained the significant results; however, results from models that excluded lagged outcomes for all waves were unchanged from those presented in our main models. We also experimented with drawing all covariates from the wave contemporaneous with food security, as opposed to drawing most covariates from the baseline wave, in case the latter approach discarded important information that changes over time. Results were not changed under this alternate specification (results available upon request).

Discussion

This study examines whether the timing and intensity of food insecurity across the sensitive first 5 years of life are associated with a constellation of kindergarten reading, math, and social-emotional skills predictive of later academic success. Using nationally representative data on a recent birth cohort of U.S.-born children, our results suggest that food insecurity in infancy and toddlerhood is linked with reductions in both cognitive and social-emotional skills in kindergarten; associations between food insecurity in the preschool-year and kindergarten social and cognitive outcomes were less consistent. This is generally the case when food insecurity is considered at these key early developmental time points separately, as well as net of each other when measured simultaneously. Not surprisingly, increasing episodes of food insecurity—from 1 to 2 to 3 (vs. none)—across early childhood is linked with poorer kindergarten outcomes across all domains of development.

When considering the effects of timing of food insecurity on kindergarten outcomes, why might household food insecurity at 9 months and 2 years be predictive of both cognitive and social-emotional outcomes nearly 4 years later? If mothers in food-insecure households bear the brunt of inadequate access to food, this could reduce the quality and quantity of parenting children experience: As mentioned previously, mothers in food-insecure homes may be more withdrawn, distracted, stressed, and depressed, which has been shown to detract from healthy parent–child interactions (e.g., Crnic & Greenberg, 1990; Crnic & Low, 2002; Crnic et al., 2005; McLeod & Shanahan, 1993; Wu & Schimmele, 2005; Zhou et al., 2002). These interactions, particularly in infancy and early childhood, form the basis for healthy subsequent cognitive and social development by offering a secure basis for exploration, scaffolding and arranging of socialization and

learning opportunities, and provision of a "practice space" for the development of regulatory strategies (e.g., Bowlby, 1982; Cole et al., 1994; Dodge, 1991; Eisenberg, Cumberland, & Spinrad, 1998; Sroufe, Egeland, Carlson, & Collins, 2005). Limited opportunities for stimulation by adult caregivers can also impede a successful cycle of synaptogenesis and synaptic pruning—processes by which developing brains produce an overabundance of neural connections and then prune away those that are underused—which may ultimately limit cognitive abilities (Tau & Peterson, 2010). Children in food-insecure households may be deprived of these rich experiences at a key point in development when they stand to benefit from them the most.

Even if mothers in food-insecure homes do not exhibit decreased parenting quality, infants and toddlers who directly experience food insecurity may be less active and have compromised gross motor skills and thus less likely to explore their environments and engage others in social interaction, reducing overall opportunities for social and cognitive development (Chavez, Martinez, & Yaschine, 1975; Tanner & Finn-Stevenson, 2002). As mentioned earlier, there are also direct effects of food insecurity on brain development that would be expected to reduce cognitive and social skills in kindergarten. These include reduced myelination (generation of fatty cells that cover neural axons and speed transmission of information in the cortex), which can occur even in the context of mild undernutrition (Nelson, 2000), and reduced cortical gray matter volume growth that could stem from inadequate nutrition in the context of poverty in the United States (Hanson et al., 2013). Additionally, micronutrient deficiencies such as protein–energy malnutrition and iron deficiency anemia could contribute to fatigue and social and emotional withdrawal in hungry children (Tanner & Finn-Stevenson, 2002), as well as to short- and long-term impairments in cognitive performance (Grantham-McGregor, Powell, Walker, Chang, & Fletcher, 2008; Yehuda & Youdim, 1989). Emerging evidence has called attention to the possibility that insufficient quantities of a third nutrient—docosahexaenoic acid (DHA)—may also harm early brain development, as maternal DHA intake during pregnancy predicted cognitive development in the first 2 years of life (Rees, Sirois, & Wearden, 2014). Thus, prenatal food insecurity, which some mothers in the present sample likely endured, and possibly postnatal food insecurity experienced directly by children could limit access to foods replete with DHA and thus could negatively influence subsequent cognitive development.

When considering associations between the *intensity* of food insecurity across early childhood and kindergarten outcomes, we expected that more food insecurity would be more detrimental, such that any two episodes would be more negatively associated with outcomes than any single episode and that the most potent negative association would derive from persistent food insecurity across all three waves. In general, our expectations were supported by the data with coefficients increasing in strength and magnitude with the number of episodes of food insecurity, though smaller cell sizes among those who were always food insecure likely limited our ability to consistently detect significant associations between that group and outcomes. Among those who experienced food insecurity at all three waves, associations were more consistently negative for social outcomes. This aligns with findings from prior studies linking food insecurity in the years surrounding preschool and kindergarten to negative social and emotional development (Melchior et al., 2014; Slack & Yoo, 2005; Weinreb et al., 2002; Whitaker et al., 2006).

In general, we found more consistent associations between preschool-year food insecurity and kindergarten social outcomes than for kindergarten cognitive outcomes. It may be that in the preschool year, when nearly 80% of the sample is in some form of nonparental child care, time spent in the care of other adults offers access to additional food sources that offsets the experience of hunger enough to allow children to benefit from exposure to the added cognitive stimulation provided in these settings, which in turn offsets negative cognitive outcomes. Indeed, the federal Child and Adult Care Food Program subsidizes the provision of food to low-income children in Head Start and community-based child-care settings (mostly centers) and in so doing may reduce food insecurity among participating children (Heflin, Arteaga, & Gable, 2015). Center-based child care in the years leading up to kindergarten entry has been shown to promote cognitive development (e.g., National Institute of Child Health and Human Development Early Child Care Research Network & Duncan, 2003) but to increase behavior problems as well (e.g., Belsky et al., 2007). Thus, if children in center-based care are both exposed to additional food and to additional cognitive stimulation that would not only promote cognitive development but also produce more behavior problems, we might not see as many consistent negative associations between food

insecurity in the preschool-year and kindergarten cognitive outcomes as we would see in the kindergarten social outcomes. However, our models did control for exposure to nonparental care, and the inclusion of these controls did not change estimates, so this remains an open question.

The present study is not without limitations, the most substantial of which is the noncausal nature of our estimates. Although we included a comprehensive set of covariates at the household, maternal, and child levels as well as lagged outcome measures, the possibility remains that observed associations arise from the presence of an omitted variable that both elevates food insecurity risk and reduces children's kindergarten skills. A thorough review of the literature strongly suggests that likely omitted variables that may explain this association—like maternal depression and measures of material hardship beyond food insecurity, such as residential instability and lack of medical care (e.g., Gershoff, Aber, Raver, & Lennon, 2007)—are either directly included or are highly correlated with covariates that were included. We also recognize that with our lagged dependent variable approach, we are unable to capture food insecurity that may have occurred between child assessments and the included measure of food insecurity (e.g., in models predicting kindergarten cognitive outcomes from preschool-year food insecurity, controlling for 2-year cognitive outcomes captures food insecurity up to age 2 but not food insecurity that may have occurred between the 2-year and preschool waves). Additionally, in testing for the association between duration of food insecurity and kindergarten outcomes (Table 4), the number of children in families experiencing food insecurity across all three waves is relatively small (N = 100–150). Although this sample size should be sufficient for the present analysis, it is possible that estimates generated from it are underpowered, potentially understating the importance of persistent food insecurity. Similarly, small sample sizes precluded our ability to test for heterogeneity in these patterns of association by key demographic subgroups who may be at increased risk of experiencing food insecurity and less likely to seek food assistance, such as children in immigrant families (e.g., Chilton et al., 2009; Kaiser et al., 2004). Future research should collect the full set of variables collected in the ECLS–B but at more frequent intervals to permit more methodologically rigorous methods like fixed effects modeling and should do so with oversamples of certain subgroups such as children of immigrants. It would also be instructive if such future studies extended data collection beyond kindergarten and into elementary school to permit investigation of the influence of food insecurity in early childhood on later outcomes. Although we find negative associations between food insecurity and kindergarten outcomes, it is possible that such associations are underestimates if the true negative effects of food insecurity across childhood are not fully realized until later in formal schooling.

Despite these limitations, our results, if confirmed by future research, highlight points of intervention for food assistance policies. Reducing episodes of food insecurity in the earliest years, when children are 2 years of age or younger, is an urgent consideration as Child Nutrition and WIC reauthorization are overdue.

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Supporting Information

Additional supporting information may be found in the online version of this article at the publisher's website:

Table S1. Regression Models Predicting Kindergarten Skills From Adult Food Insecurity, Food Insecurity Time Points Entered Separately

Table S2. Regression Models Predicting Kindergarten Skills From Adult Food Insecurity, Food Insecurity Time Points Entered Simultaneously

Table S3. Regression Models Predicting Kindergarten Skills From Child Food Insecurity, Sample Reduced to Families in Which Focal Child Is the Oldest Child, Food Insecurity Time Points Entered Separately

Table S4. Regression Models Predicting Kindergarten Skills From Child Food Insecurity, Sample Reduced to Families in Which Focal Child Is the Oldest Child, Food Insecurity Time Points Entered Simultaneously