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Original Contribution

Context and Sequelae of Food Insecurity in Children's Development

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The authors examined the role of food insecurity in the etiology of children's cognitive and mental health problems. Data from a prospective longitudinal study of 1,116 United Kingdom families with twins (sample constructed in 1999–2000) were used to test associations among household food insecurity; income; maternal personality; household sensitivity to children's needs; and children's cognitive, behavioral, and emotional development. Food-insecure children had lower IQs and higher levels of behavioral and emotional problems relative to their peers. After differences in household income, the personalities of children's mothers, and the sensitivity of household organization to children's needs were accounted for, food-insecure children had moderately higher levels of emotional problems relative to food-secure children ($\beta = 0.22$, $P = 0.02$). Differences in children's cognitive development were accounted for by household income, and differences in their behavioral development were accounted for by their mothers' personalities and their households' sensitivity to children's needs. Results suggest that food insecurity was associated with school-aged children's emotional problems but not with their cognitive or behavioral problems after accounting for differences in the home environments in which children were reared. Mothers' personality and household sensitivity to children's needs may present challenges to improving outcomes of children with food insecurity.

child; child development; cognition; food; food supply; mental health; personality; twins

Abbreviation: E-Risk, Environmental Risk Longitudinal Twin Study.

Children reared in poverty experience poor health outcomes and higher-than-usual mortality as adults (1–5). This health disparity is mediated partly by cognitive, behavioral, and emotional problems that emerge in childhood and is linked to a range of adverse outcomes later in life (6–10). Developing programs to safeguard and improve children's cognitive and mental health and thereby disrupt the cycle of life-course disease and disadvantage is a public health priority. However, opportunities for intervention remain elusive, in part because of a lack of clarity over the pathways linking socioeconomic disadvantage to cognitive and mental health problems in childhood.

Elevated levels of cognitive, behavioral, and emotional problems among children living in poverty have been demonstrated (11, 12). However, weak findings regarding the causal effect of household income on these dimensions of children's mental health (13–15) have led investigators to pursue more direct measures of the privations poverty imposes on children and families. Specific ''material hardships,'' shortages of physical resources needed for healthy development, have received attention for being more proximal to children's health than household income and more amenable to intervention than the general state of living in poverty (16–18).

Among these measures, material hardship related to food—food insecurity, food insufficiency, and hunger (hereafter collectively referred to as ''food insecurity'')—stands out as a reliable correlate of cognitive, behavioral, and emotional problems among low-income children (19, 20). Food insecurity is a growing problem in the developed world following the recent economic crisis. In the United States, the Department of Agriculture recently reported an increase in the percentage of families experiencing food insecurity, from 11% in 2007 to nearly 15% in 2008 (21), with nearly

17 million children affected. With the causal nature of associations between food insecurity and children's cognitive and mental health problems still unclear, and as ethics preclude randomly assigning children to food insecurity, observational studies incorporating relevant controls are useful for informing public policy.

Researchers have begun to elucidate neurodevelopmental mechanisms linking early childhood malnutrition to low IQ in middle childhood and subsequently to behavioral problems in adolescence (22, 23). The relation between food insecurity and malnutrition among school-aged children remains a topic of intense interest, but little consensus has been reached. Two recent reviews suggest that food insecurity does influence children's nutritional status (19, 24). However, a recent analysis of the Third National Health and Nutrition Examination Survey found no relation between food insecurity and direct measures of nutrition (dietary recall, blood-based micronutrient assays, body mass index) in school-aged children (25).

Leaving open the question of food insecurity's relation to malnutrition, it remains possible that associations between food insecurity and cognitive, behavioral, and emotional problems among school-aged children (26–31) reflect the discomforts and humiliations of hunger (32) or acute attentional and self-regulatory deficits associated with missing a meal (33–35). It is also possible that these associations are spurious, conditioned by features of children's households that contribute to both food insecurity and cognitive and mental health problems. If cognitive, behavioral, and emotional problems among food-insecure children share a common cause with food insecurity, interventions addressing children's food situations will fail to fully ameliorate poor developmental outcomes.

In the present study, we examined the association of food insecurity with children's cognitive, behavioral, and emotional outcomes, considering household income and what we term ''nonmaterial household features'' as possible common causes of food insecurity and children's cognitive and mental health problems. Low income is a material feature of households that constrains resources, affecting children's food situation, their physical environment, and their parents' stress levels (36–39). Most studies of food insecurity and children's mental health account for the effects of income. However, household features that influence how resources are allocated may also contribute to food insecurity. We considered 2 such features that are plausible contributors to children's cognitive and mental health problems: maternal personality and low household sensitivity to children's needs.

Maternal personality is a nonmaterial feature of children's households that contributes to food insecurity by affecting how money is spent and saved, the availability of social support during times of stress, and coping responses. Simultaneously, maternal personality affects children's mental health through genetic and parenting pathways. Personality includes a strong inherited component, demonstrates reasonable stability from early adulthood on (40–42), and predicts socioeconomic and health outcomes (43–46). Research has coalesced around a 5-factor model of personality comprising openness to experience (imagination, creativity, cleverness), conscientiousness (planfulness, responsibility, organization), extraversion (outgoingness, energy, dominance), agreeableness (empathy, generosity, cooperativeness), and neuroticism (negativity, anxiety, insecurity) (42, 47). Persons with low levels of the traits conscientiousness, extraversion, and agreeableness and high levels of the trait neuroticism are more likely to make impulsive purchases, fail to save money, struggle to build and maintain relationships, and cope ineffectively with stress (48–52), all of which, in turn, influence families' success in meeting household needs when risk of food insecurity is greatest (53–57). Interestingly, this personality profile also predicts parenting behaviors that contribute to children's cognitive, behavioral, and emotional problems (58–61).

Household sensitivity to children's needs is a nonmaterial feature of children's households likely correlated with food insecurity. Neglectful and chaotic households are associated with parental factors linked to food insecurity, including poor parental mental health, substance abuse, cognitive impairment, and limited social support (62–64). Household sensitivity to children's needs also influences children's development; children living in neglectful and chaotic household environments have higher levels of cognitive, behavioral, and emotional problems (65–68).

Studies linking food insecurity to children's outcomes in nationally representative samples of school-aged children have sought to control for nonmaterial features of children's households by using proxy measures such as income, presence of a father figure in the home, mother's age, and race/ethnicity (26, 28). While such measures help to contextualize food insecurity in children's lives, they do not address variation in resource allocation or parenting behaviors or in the sensitivity of household organization to children's needs.

Our study tested the hypothesis that food insecurity contributes to cognitive, behavioral, and emotional problems among school-aged children independently of household features that place them at risk for food insecurity and poor developmental outcomes. We began by comparing, at age 12 years, children who were and were not exposed to food insecurity during ages 7–10 years. We next evaluated household features' associations with food insecurity and children's developmental outcomes. After establishing these associations, we tested associations between food insecurity and children's developmental outcomes before and after statistically controlling for variation in household features. Lastly, we replicated these analyses with an additional statistical control for each of the outcomes measured when children were aged 5 years to account for the possibility that differences in cognitive, emotional, and behavioral problems observed at age 12 years predated the experience of food insecurity at ages 7–10 years.

MATERIALS AND METHODS

Sample

Participants were members of the Environmental Risk Longitudinal Twin Study (E-Risk), which tracks the

development of a nationally representative birth cohort of 2,232 British children. The sample was selected from a larger birth register of twins born in England and Wales in 1994–1995 (69). Details about the sample have been reported previously (70). Briefly, the E-Risk sample was constructed in 1999–2000, when 1,116 families with same-sex twins aged 5 years (93% of those eligible) participated in home-visit assessments. Families were recruited to represent the United Kingdom population of families with newborns in the 1990s, based on residential location throughout England and Wales and mother's age (i.e., older mothers having twins via assisted reproduction were underselected, and teenage mothers with twins were overselected). We used this sampling to replace high-risk families lost to the register via nonresponse and to ensure sufficient numbers of children reared in high-risk environments. Follow-ups were conducted when the children were aged 7 years (98% participation), 10 years (96% participation), and, most recently, 12 years (96% participation). Parents gave informed consent and children gave assent. The National Health Service Central Office for Research Ethics Committees approved each phase of the study.

Measures

All child outcomes were measured when children were aged 5 and 12 years. We chose these measures because they are commonly used in research on children's cognitive and mental health problems. Children's IQ was assessed with the Wechsler Intelligence Scale for Children (71) prorated using procedures described by Sattler (72). Children's behavioral problems were measured using the externalizing scale in the Teacher Report Form (73), completed by children's teachers, and a conduct problems scale (74, 75), completed by the child. (The composite behavioral problems measure was constructed by averaging standardized scores on these scales.) Children's emotional problems were measured using the internalizing scale in the Teacher Report Form, completed by children's teachers and, for the age 12 years measure only, the Multidimensional Anxiety Scale for Children (76) and the Children's Depression Inventory (77), both completed by the child. (The composite emotional problems measure was constructed by averaging standardized scores on these scales.)

Food insecurity. Family food situation was reported by the mother to a clinical interviewer when children were aged 7–10 years using a 7-item scale developed by the US Department of Agriculture (Web Table 1; this information is described in the first of 2 supplementary tables, each referred to as "Web Table" in the text and posted on the *Journal*'s Web site (http://aje.oupjournals.org/)) (78). This scale distinguishes families that are 1) food secure (i.e., no evidence of food insecurity; 0–1 positive responses), 2) food insecure without hunger (i.e., food insecurity is evident, but there is no reduction in the family's food intake; 2–4 positive responses), or 3) food insecure with hunger (i.e., food intake is reduced; 5–7 positive responses). In the E-Risk sample, fewer than 2% of families experienced food insecurity with hunger, so we combined their data with those of the other food-insecure families. Using both assessments available to us, we identified families that were "ever food insecure" (food insecure at the age 7 and/or age 10 years assessments) and compared them with those that were always food secure.

Features of children's households. We measured 3 household features. One was material (household income) and 2 were nonmaterial (maternal personality and household sensitivity to children's needs).

Household income was reported by the mother to a clinical interviewer when children were aged 5–7 years. We adjusted household income for household size and composition by using Cutler and Katz's (79) weighting to account for differential consumption of resources by adults and children. We then standardized household income to a family of 2 adults and 2 children and grouped families into quartiles bounded by £10,000, £18,000, and £26,000 per year (1 British pound sterling = approximately US $1.55).

Maternal personality was assessed when children were aged 5–7 years. At the end of the interview session, interviewers rated the mother using the 44-item version of the Big Five Inventory, which measures 5 dimensions of personality: openness to experience, conscientiousness, extraversion, agreeableness, and neuroticism (80). Scores were standardized and averaged across measurements.

Household sensitivity to children's needs was assessed using a scale derived from interviewer ratings when children were aged 7–10 years. After visiting with families, interviewers coded their perceptions of the home using a selection of items based on the Home Observation for Measurement of the Environment (81, 82) and the University of Washington Parenting Clinic Parent-Child Observations Questionnaire (83). Scale items evaluate parents' attention to children's needs as well as maintenance and organization of the home environment to support child development. Items were selected that were not directly dependent on households' material resources. Items were summed and the resulting score standardized to create a continuous measure. This scale demonstrated strong internal consistency reliability (Cronbach's $\alpha = 0.803$). Because it is a new scale developed for this study, scale items are listed in Table 1 by food insecurity status.

Data analysis

Our study tested the hypothesis that food insecurity contributes to cognitive, behavioral, and emotional problems among school-aged children independently of features of their households that place them at risk for both food insecurity and poor developmental outcomes. We first compared the means of our mental health measures across children who experienced food insecurity and those who did not. We next tested whether income, maternal personality, and household sensitivity to children's needs predicted food insecurity and children's mental health outcomes independently of household income. Finally, we tested the relation between food insecurity and each of the outcomes in a series of regression models beginning with a bivariate model and subsequently adding material and nonmaterial household features as covariates. Logistic regression models were used to predict food insecurity. Ordinary least squares

Table 1. Interviewer Perceptions (%) of Household Sensitivity to Needs of Food-secure and Food-insecure[a] Children at Ages 7 and 10 Years, Environmental Risk Longitudinal Twin Study, 1999–2000[b,c]

	Food Secure (n = 1,845)	Food Insecure (n = 278)
Somewhat or yes		
Parent monitors the child appropriately	88.7	73.7
Parent is aware of the child's needs	94.8	87.4
Parent is emotionally supportive of the child	94.8	71.9
Visible rooms of the house are clean	89.8	71.9
Child has a predictable daily schedule	94.4	76.3
Use of the TV is appropriate	73.8	46.0
Family encourages the child to have hobbies	67.9	37.4
No		
Parenting of the child is overly permissive, negligent	78.2	56.1
Child lacked attention to personal hygiene	90.7	73.4
Home interior is dark/monotonous	75.1	47.5
Home is chaotic or overly noisy	67.5	36.7
Child is neglected	96.9	84.9

[a] Food insecurity refers to material hardship related to food, including hunger.

[b] $P < 0.001$ for all comparisons (Fisher's exact test).

[c] For 2 children included in the analytic sample, data on all scale items were missing, and scale scores were imputed for regression analysis.

regression models were used to predict children's developmental outcomes. All models account for the study's twin design and resulting dependency among observations within a household using the procedure described by Williams (84). All analyses were conducted using Stata 10.1 software (85).

Data on food insecurity status and at least one outcome measure were available for over 95% of the original E-Risk sample of children and families (2,125 children in 1,063 families). For regression modeling, missing data on household income and household sensitivity to children's needs were imputed for 56 children and 2 children, respectively, using the multiple imputation routine *ICE* (86). No maternal personality data were missing.

RESULTS

Children reared in households experiencing food insecurity ($n = 278$) had significantly lower IQs and higher levels of behavioral and emotional problems at age 12 years than their food-secure counterparts (Figure 1, $P < 0.001$ for all). Food-insecure households had lower incomes than

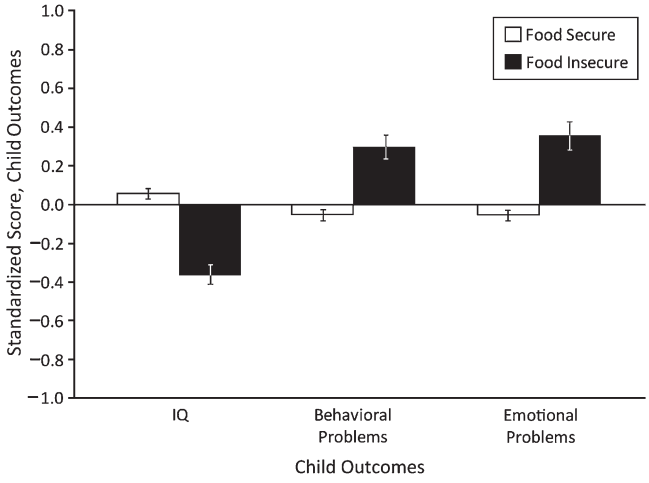

Figure 1. Mental health, at age 12 years, of United Kingdom children always food secure and ever food insecure during ages 7–10 years, Environmental Risk Longitudinal Twin Study, 1999–2000. Food insecurity refers to material hardship related to food, including hunger. Error bars indicate ±1 standard error; $P < 0.001$ for all comparisons.

food-secure households ($\chi^2 = 204.47$, $P < 0.001$). In addition, mothers in food-insecure households were more likely to have high-risk personality profiles (low conscientiousness, extraversion, and agreeableness, and high neuroticism), and their households were less sensitive to children's needs (Figure 2) ($P < 0.001$ for all).

Table 2 shows that children living in poor households, whose mothers had high-risk personality profiles, and whose households were insensitive to children's needs were significantly more likely to experience food insecurity ($P < 0.001$ for all). Such children also had low IQs and high levels of behavioral and emotional problems ($P < 0.001$ for all).

These features of children's households fully explained statistical associations between food insecurity and children's IQ and behavioral problems, and they reduced the association between food insecurity and children's emotional problems by half, although the latter association remained statistically significant (Table 3). Household income accounted for the association between food insecurity and IQ. In the bivariate model (model I), food insecurity predicted lower IQ, but once income was added to the model (model II), this association was attenuated below the $\alpha = 0.05$ level of statistical significance. The relation between food insecurity and children's behavioral problems was largely independent of household income but was fully accounted for by differences in nonmaterial features between food-insecure and food-secure households (model III). In contrast, neither income nor nonmaterial features of households, nor their combination, fully accounted for the association between food insecurity and children's emotional problems (model IV), although nonmaterial features of children's households accounted for about half of this relation. Complete results for all models are included in Web Table 2.

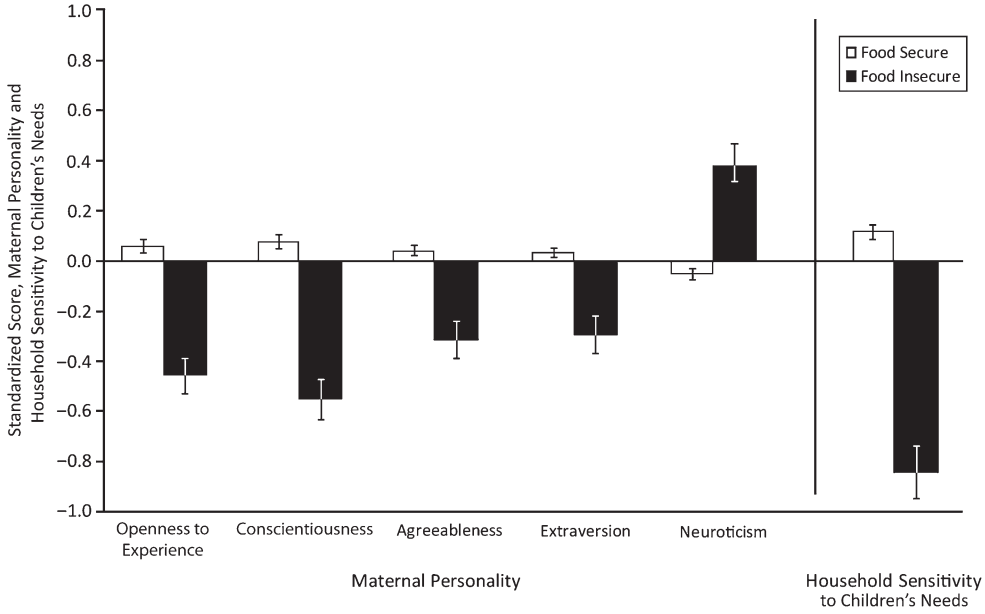

Figure 2. Maternal personality and household sensitivity to children's needs in food-secure and food-insecure households, Environmental Risk Longitudinal Twin Study, 1999–2000. Food insecurity refers to material hardship related to food, including hunger. Error bars indicate ±1 standard error; $P < 0.001$ for all comparisons.

We conducted 2 sensitivity analyses to test the robustness of these findings. First, to evaluate potential confounding due to differences in children's cognitive and mental health predating experience of food insecurity at ages 7–10 years, we reestimated the models presented in Table 3 after adding statistical controls for the same measures of children's cognitive and mental health collected at age 5 years. Second, to evaluate how the effects of food insecurity might be influenced by unequal distributions of covariates among food-insecure and food-secure children, we conducted analyses parallel to those shown in the final row of Table 3 using propensity-score matching techniques (87) implemented with the routine *psmatch2* (88). Results were consistent with those presented in Table 3 and are available from the authors.

DISCUSSION

Findings from this study enhance understanding of the role that food insecurity plays in the etiology of childhood cognitive and mental health problems in 2 ways. First, we found that food insecurity was associated with lasting emotional distress for children independent of their families' incomes, their mothers' personalities, and their households' sensitivity to children's needs. The emotional problems measure we used tapped childhood anxiety and depression, which are known to predict maladjustment in adulthood (10, 89), including major depressive disorder, a leading cause of disability and health burden worldwide (90). Children living in food-insecure households at ages 7–10 years experienced greater emotional problems at age 12 years relative to peers living in households that were similar but food secure, although the difference was small. This finding, derived from an epidemiologically sound sample and identified within a longitudinal design accounting for household features unmeasured in previous studies, constitutes the strongest evidence to date that food insecurity, and not just impoverished, chaotic, and neglectful households prone to disrupted food situations, can influence children's mental health.

Second, although exposure to food insecurity appears to make some contribution to children's emotional distress, primarily other features of children's households explained differences in cognitive, behavioral, and emotional problems between food-insecure children and their peers in this study. Specifically, children who experience food insecurity are cared for by mothers with poor self-control and depressive and antisocial tendencies (low conscientiousness, high neuroticism, and low agreeableness), and they live in households providing less structure and nurturance. These characteristics of mothers and the household environments they provide appear to function as risk factors for both food insecurity and cognitive and mental health problems among children, above and beyond the general risk imposed by poverty. However, our data did not enable us to exclude the possibility that household features were caused by food insecurity predating our baseline assessments.

Our study has several strengths. First, the longitudinal design allowed temporal ordering of measurement for household features, food insecurity, and children's cognitive and mental health outcomes that parallels the hypothesized causal model, with the exception that sensitivity to children's needs was measured concurrently with food insecurity. Most previous studies relied on cross-sectional data, raising concerns over possible reverse causality. Second, food insecurity was reported by mothers, whereas child outcomes were reported by teachers and the children

Table 2. Associations of Household Features With Food Insecurity[a] and Child Outcomes, Environmental Risk Longitudinal Twin Study, 1999–2000[b]

Household Feature	Household Food Insecurity (n = 2,125)		Child Outcome, Coefficient (SE)		
	OR	95% CI	IQ (n = 2,112)	Behavior Problems (n = 2,121)	Emotional Problems (n = 2,123)
Income[c]					
<£10,000 (reference)	1.00				
£10,000–£17,999	0.57**	0.38, 0.84	0.33*** (0.07)	−0.18* (0.08)	−0.02 (0.07)
£18,000–£26,000	0.10***	0.04, 0.23	0.51*** (0.08)	−0.31*** (0.08)	−0.18* (0.07)
>£26,000	0.02***	0.00, 0.10	1.06*** (0.07)	−0.52*** (0.07)	−0.30*** (0.07)
Maternal personality[d]					
Openness to experience	0.76*	0.58, 0.98	0.35*** (0.03)	−0.18*** (0.03)	−0.13*** (0.03)
Conscientiousness	0.62***	0.50, 0.77	0.22*** (0.03)	−0.26*** (0.04)	−0.18*** (0.04)
Extraversion	0.70**	0.56, 0.89	0.08** (0.03)	−0.03 (0.03)	−0.07* (0.03)
Agreeableness	0.77*	0.62, 0.95	0.09** (0.03)	−0.18*** (0.04)	−0.12*** (0.03)
Neuroticism	1.63***	1.31, 2.03	−0.14*** (0.03)	0.13*** (0.04)	0.07* (0.03)
Household sensitivity to children's needs	0.61***	0.51, 0.72	0.23*** (0.03)	−0.25*** (0.04)	−0.21*** (0.03)

Abbreviations: CI, confidence interval; OR, odds ratio; SE, standard error.

*$P < 0.05$; **$P < 0.01$; ***$P < 0.001$.

[a] Food insecurity refers to material hardship related to food, including hunger.

[b] Odds ratios and 95% CIs are reported for logistic regression models and coefficients (SEs) for ordinary least squares regression models. All models were adjusted for nonindependence of outcomes among twins according to the procedure outlined by Williams (84).

[c] 1 British pound sterling = approximately US $1.55.

[d] Maternal personality traits were each entered in separate regression models. Associations of maternal personality traits and household sensitivity to children's needs with child outcomes were adjusted for household income.

themselves, minimizing risk of reporter bias. Previous studies obtained information about food insecurity and children's outcomes from mothers, potentially inflating correlations among these measures. Third, measurements of mother's personalities and household organization enabled us to account for potential common causes of food insecurity and children's outcomes, other than low income. Previous studies lacked such measures or relied on proxies such as household composition. Finally, use of a nationally representative sample with exceptional retention across 7

Table 3. Association Between Food Insecurity[a] and Child Outcomes, Environmental Risk Longitudinal Twin Study, 1999–2000[b]

	Child Outcome		
	IQ (n = 2,112)	Behavior Problems (n = 2,121)	Emotional Problems (n = 2,123)
I. Bivariate model	−0.41** (0.07)	0.34** (0.08)	0.41** (0.09)
II. Model adjusted for household income	−0.10 (0.07)	0.20* (0.09)	0.33** (0.09)
III. Model adjusted for nonmaterial household features[c]	−0.05 (0.07)	0.07 (0.08)	0.22* (0.09)
IV. Model adjusted for all household features[d]	0.02 (0.07)	0.06 (0.08)	0.22* (0.09)

*$P < 0.05$; **$P < 0.001$.

[a] Food insecurity refers to material hardship related to food, including hunger.

[b] All values are expressed as regression coefficient (standard error). Coefficients are from ordinary least squares regression models with standard errors adjusted for nonindependence of outcomes among twins according to the procedure outlined by Williams (84).

[c] Nonmaterial personality and household sensitivity to children's needs.

[d] All household features include income, maternal personality, and household sensitivity to children's needs.

years of follow-up permits inference regarding the general population. Previous studies using longitudinal data or measures of nonmaterial household features relied on high-risk samples drawn from limited geographic areas, constraining the external validity of findings.

This study also has limitations. Most prominently, data were derived from a sample of twins and may therefore not be generalizable to singleton births. However, E-Risk families were selected to represent the distribution of maternal age at first birth in the population (91) (i.e., by matching maternal age to that in the general population, older mothers whose twins resulted from assisted reproduction were underrepresented), and participants are comparable to the general population of mothers and children regarding a variety of mental health and cognitive markers as well as sociodemographic characteristics (70, 92–94). In addition, the prevalence of food insecurity in our United Kingdom sample (9.7%) (95) matches reports from other developed countries (28, 96–99). A second limitation is that all measures were not obtained at all data collections. Consequently, designs that afford greater power for causal inference by ruling out confounding by unobserved time-invariant factors, including exposure to food insecurity prior to the baseline assessment, could not be implemented. However, the temporal ordering of measures in our study goes some ways toward ruling out reverse causation.

Third, we lacked measures of fathers' characteristics. However, these characteristics were represented indirectly to the degree that they influence household sensitivity to children's needs and are influenced by mothers' mate preferences indexed in their personalities. In addition, mothers are the main caregivers of almost all children in the E-Risk sample, and requiring measures from fathers would generate missing data for single-mother families. Finally, our study included a coarse measure of household income, although the measure was adjusted for household size and composition. Unfortunately, because of reliability concerns related to self-reports of actual income rather than income categories, richer data were not available.

Results from the current study have implications for how the public health field theorizes and studies food insecurity's role in the etiology of children's cognitive and mental health problems, as well as for public health practice. At the level of theory, our findings suggest that characteristics of parents and households that affect children's development also contribute to determining whether children's households become food insecure. Currently, much research treats characteristics of mothers and parenting as outcomes of food insecurity or as mediators of food insecurity's effects on children. Theorists should consider whether these factors should also be viewed as common causes of both food insecurity and children's cognitive and mental health problems.

At the level of public health practice, our findings suggest 3 goals. First, programs to ameliorate children's food insecurity must be prepared to engage caregivers who struggle with poor self-control and depressive and antisocial personality tendencies, and to deliver benefits to children in the face of household environments providing little structure or nurturance. Second, evaluations of programs seeking to ameliorate children's food insecurity should focus on emotional rather than cognitive or behavioral outcomes; our study and 2 previous studies (29, 100) suggest this domain is the one in which food insecurity is most likely to have causal effects. Third, to improve the mental health of poor children, investment in interventions shown to improve parenting and reduce child neglect, such as the Nurse Family Partnership (101, 102), is a necessary complement to benefits that supplement household food supplies. Without such complementary intervention, stabilizing household food situations may do little to improve children's mental health.

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