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The Association Between Food Insecurity in Childhood and Mental Illness in Adolescence Within a US Urban Population

By

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Master of Public Health

Epidemiology

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The Association Between Food Insecurity in Childhood and Mental Illness in Adolescence Within a US Urban Population

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B.S.

Tufts University

2012

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An abstract of

A thesis submitted to the Faculty of the
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Abstract

The Association Between Food Insecurity in Childhood and Mental Illness in Adolescence Within a US Urban Population

By Lindsay Eckhaus

Food insecurity, defined as limited access to food due to economic restraint, affects millions of American families. Food insecurity is a social stressor that can lead to negative health outcomes, including mental illness, among children and adolescents. In this paper, we investigate the association between food insecurity in childhood and depression and anxiety in adolescence. We use longitudinal data from the Fragile Families and Child Wellbeing Study, a nationally representative sample of non-marital births in the US. The relationship between food insecurity at age 3 and mental illness symptomatology at age 15 was assessed through linear regression models. We found that food insecurity among children is associated with an increase in depression and anxiety scores among adolescents. In the analysis, we also tested for interaction with sex and for mediation by psychosocial stress variables, including maternal mental illness, parenting stress, and maternal psychological aggression toward children. The interaction and mediation assessments were not statistically significant. Future research should test for alternate pathways and for interaction with other social stressors that may influence the relationship between food insecurity and mental illness.

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Chapter I: Background

Introduction

Mental illness: Definition and prevalence

Mental illness is a major public health concern affecting millions of American adults and adolescents. Two of the most common forms of mental illness are major depression and anxiety disorders. Major depression in characterized by clinical criteria including a two week or more period of depressed mood or loss of interest or pleasure, and symptoms such as difficulty sleeping, difficulty concentrating, and suicidal thoughts (1). Anxiety disorders encompass several disorders including generalized anxiety disorder, phobia, panic disorder, social anxiety, post-traumatic stress disorder (PTSD), and obsessive-compulsive disorder (OCD). Symptoms of these disorders include fatigue, irritability, sleep problems, panic attacks, and avoidant behavior (1), (2). Major depression and anxiety disorders can impair daily functioning at home, work, or school (1), (2).

Mental illnesses, including depression and anxiety disorders, are prevalent among adults. According to the National Institute of Mental Health (NIMH), 44.7 million (18.3%) adults 18 years and older experienced any mental illness in 2016 (3). Among adults, depression is common. In 2016, 6.7% (16.2 million) adults experienced at least one major depressive episode (4). A higher percentage of females (8.5%) compared to males (4.8%) experience depression (4). Whites (7.4%) have a higher rate of depression compared to Hispanics (5.6%), Blacks (5%), and Asians (3.9%), and a similar rate compared to Native Hawaiian/Other Pacific Islanders (7.3%) (4). The highest rates are among persons reporting two or more races (10.5%) and American Indian/Alaskan

Natives (8.7%) (4). Anxiety is more prevalent than depression, with about 19% of the population experiencing any anxiety disorder in a given year (5). These statistics include all anxiety disorders, such as panic disorder, specific phobia, social phobia, generalized anxiety disorder, PTSD, and OCD. Rates of specific and social phobia are highest (7-9%), while rates of disorders more likely to impair daily functioning are lower. For example, 2.7% of the population experiences generalized anxiety disorder, 2.7% experiences panic disorder, 3.6% have PTSD, and 1.2% have OCD (5). Like depression, anxiety is more prevalent among women (23.4%) compared to men (14.3%) (5).

Millions of adolescents, the focus of this research paper, are also affected by depression and anxiety disorders. Among adolescents 12-17 years old, 3.1 million (12.8%) experienced at least one major depressive episode in 2016 (4). According to the nationally representative National Comorbidity Survey-Adolescent Supplement (NCS-A), lifetime prevalence of major depressive disorder or dysthymia among 13-18 year olds is 11.7% (6). As with adults, depression is more prevalent among female adolescents compared to male adolescents, and a much greater disparity has been found: 19.4% versus 6.4%, respectively (4). According to NIMH, rates of depression are highest (13.8%) among Whites and persons reporting 2 or more races (4). Rates among other races are as follows: Hispanic (12.7%), Asian (11.9%), American Indian/Alaska Native (11.5%), and Black (9.1%) (4). However, several other studies have reported greater depressive symptomatology among Hispanic adolescents compared to other racial and ethnic groups (7), (8).

Anxiety disorders are also prevalent among adolescents. According to the NCS-A, lifetime prevalence of any anxiety disorder among adolescents ages 13-18 is 31.9% (6).

Another meta-review of studies in multiple countries including the United States reported a 15-20% lifetime prevalence of anxiety disorders among children or adolescents (9). As with adults, the most common anxiety disorders are specific phobia (19.3%) and social phobia (9.1%). The prevalence of other anxiety disorders includes: generalized anxiety disorder (2.2%), separation anxiety disorder (7.6%), PTSD (5%), and panic disorder (2.3%) (6). Females have higher rates of anxiety disorders than males (9). Stratification of anxiety disorders by race is less frequently studied among adolescents and children, and the research shows conflicting results. Several studies report no between-group differences for race. Others report that, similar to results of depression studies, Hispanic adolescents have more anxiety symptomatology compared to other racial and ethnic groups (7), (10).

Risk factors for depression and anxiety disorders include stressful life events in childhood and adulthood, lack of economic resources, and family history of mental illness (2), (1). One stressful life event, which is also an indicator of economic restraint, is food insecurity. Several research studies have found an association between food insecurity and mental illness among adults, adolescents, and children. This research is described below.

Food insecurity: Definition and prevalence

Food insecurity, defined as limited access to food due to economic restraint, affects millions of American households. Food insecurity may be experienced to varying degrees, including reduced quality and variability of food intake, with or without a decrease in the amount of food consumed. By contrast, food security involves sufficient availability of quality food. The United States Department of Agriculture (USDA)

defines food insecurity as an "economic and social condition" (11). It is separate from hunger, which is a "physiological condition" (11). Food insecurity may or may not lead to hunger. According to the USDA, 15.6 million Americans (12.3% of all households) were food insecure in 2016 (11).

The prevalence of food insecurity is exaggerated in certain populations. By definition, income level is associated with some of the greatest disparities. Of households with incomes below 185% of the federal poverty line (FPL), 31.6% are food insecure (11). However, only 5.6% of households with incomes at and above 185% FPL are food insecure (11). Racial disparities in food insecurity also exist. While the prevalence of food insecurity is 9.3% in households with a non-Hispanic, White head, 18.5% of Hispanic-headed households and 22.5% of Black-headed households are food insecure (11).

Households with children, the focus of this research paper, are also disproportionately affected by food insecurity. These households have a 16.5% prevalence of food insecurity, compared to a 10.5% prevalence among households without children, according to 2016 data (11). Food insecurity is higher among households with children headed by a single adult—ranging from 21.7% (male head) to 31.6% (female head)—compared to married-couple families (9.9%) (11).

The extent of food insecurity remained relatively stable over the two decades from 1995 to 2016, with rates ranging from 10% to 15% among American households (12). The prevalence was lowest in 1999 (10.1%) and highest in 2011 (14.9%) (12). Since 2011, there has been a slight decline until the most recent year of data in 2016 (12.3%), though over 15 million Americans remain affected (12). In light of the enduring high

rates of food insecurity in America, food insecurity may have meaningful impacts on society over time.

Food insecurity and health

Food insecurity is associated with numerous health impacts among children. Many research studies define food insecurity and security using the USDA US Food Security Survey Model, or a subset of the questions, and thus there is consistency among the exposure across reports (13), (14), (15), (16). As the focus of our research is on food security among families with children, we use the full 18-item USDA household survey module. The 18-item questionnaire assesses food insecurity at the family-level, rather than at the individual-level (Appendix Table 1). Therefore, children may reside in families that are defined as food insecure, whereas the children themselves may not be. The USDA reports that in almost half of food insecure families, children within the household are not defined as food insecure themselves (12). This situation could arise if caregivers try to shield children from food insecurity, e.g. by reducing their own food intake so that children have sufficient food (12). Additionally, children may receive supplemental food, such as through school lunches, that reduces their level of food insecurity (12). However, researchers often use the household-level definition of food insecurity as a proxy for food-insecure children. Household food insecurity may negatively impact children, such as through a psychosocial stress pathway, described below. When the term “food insecure children” is used in the literature review, it usually means children from food-insecure households, unless otherwise specified.

Food insecurity and physical illness

The association between food insecurity and health consequences has been documented among children. Young children, ages 0-3, who are food insecure have worse caregiver-reported health compared to food secure children of the same age in cross-sectional studies (17), (18). According to a longitudinal study, children who were food insecure at three or all four survey waves between kindergarten and eighth grade reported lower health status compared to those who were food secure during all survey waves (OR=1.66 and OR=2.79, respectively) (19). However, no association was found among children who were food insecure at only one or two survey waves (19). The relationship between food insecurity and weight varies by demographic group. One study using data from the National Health and Nutrition Examination Survey (NHANES) found a positive association between food insecurity and overweight (BMI >= 95%) among certain groups, such as children ages 12-17, girls, and white children, but not among other groups (20). Other studies have found an association between food insecurity and overweight or increased BMI among girls but not boys (21), (15).

Food insecurity and mental illness

Research has also documented an association between food insecurity and mental illness. The focal question of this paper investigates the relationship between food insecurity among toddlers and mental health among adolescents. According to a study of 13-17 year olds, adolescents with higher food insecurity scores experienced an increased odds of past-year anxiety, mood, behavior, and substance disorders (22). Another cross-sectional study found that food insufficient adolescents were more likely to have dysthymia and suicidal thoughts and to have attempted suicide compared to food sufficient adolescents (23). Among this population, depression was more prevalent

among girls (23). A study using NHANES data found an increased odds of "mental disorder with impairment" among both children ages 4-11 and adolescents ages 12-17, stratified by age (24). Using Fragile Families data, the data that we use in this report, researchers found a higher odds of behavioral problems among 3 year olds in households where the mother was defined as food insecure, compared to those from households where the mother was food secure (OR= 2.6; 95% CI= 2.0-3.3) (16). Studies have also documented an association between food insecurity and poor academic performance (25), (15), (26). Two of these studies tested for effect measure modification and found an interaction between academic performance and child sex (15), (26).

Though most US studies have been cross-sectional, one longitudinal American study using Fragile Families data found an association between *household* food insecurity and internalizing and externalizing behaviors, as well as an association between *child* food insecurity and internalizing and externalizing behaviors at years 3 and 5 (27). A longitudinal study of a British population reported higher rates of behavioral problems among food insecure children compared to food secure children (14). In a longitudinal Canadian study, researchers found an association between food insecurity and hyperactivity but not depression or anxiety among children (28). Another Canadian study reported associations between hunger and depression and between hunger and suicidal ideation among children and adolescents (OR=2.3; 95% CI= 1.2-4.3) (29). This study did not find interaction between child sex and hunger on mental health outcomes (29).

The association between food insecurity and mental health also exists among mothers and caregivers. In Whitaker et al.'s 2006 study using Fragile Families data, food insecurity was related to an increased odds of maternal depression and generalized

anxiety disorder (16). Longitudinal studies have found that mothers who became food insufficient overtime were more likely to become depressed compared to those who remained food sufficient (30), (31). Multiple studies have documented an association between food insufficiency and depressive symptoms among low-resource adults, including mothers on welfare and low-wage workers (30), (32).

Pathways from food insecurity to mental illness among children and adolescents

Researchers have hypothesized two main pathways from food insecurity to mental illness among households with children: (1) nutrient deficiency and (2) psychosocial stress. Under pathway 1, food insecurity may lead to nutritional deficiencies which can impact brain development and functioning, and therefore mental health (27), (28). Under pathway 2, household food insecurity may be a stressor on parents and/or children, which can lead to emotional distress, parental depression, poor parenting, and subsequent depression and anxiety disorders among children (25), (27), (33).

Though limited research exists on these pathways, studies that have investigated this topic have focused primarily on pathway 2. Regarding pathway 1, research suggests that mothers may shield their children from the direct effects (i.e. inadequate food intake) of food insecurity in the household (12). Alternatively, children may receive meals at school through food assistance programs and therefore have a lower level of food insecurity (12). In these cases, the negative consequences of household food insecurity are more likely to result from a pathway other than nutrient intake, such as pathway 2 (i.e. psychosocial stress). Studies addressing this pathway have found mixed results. In research using Fragile Families data, maternal depression, maternal generalized anxiety disorder, and parenting stress were not significant mediators of the relationship between

food insecurity and children's internalizing and externalizing behavior (16), (27). However, another study testing pathway 2 found that food insecurity influenced behavior and mental proficiency in toddlers through maternal depression and parenting practices (33). We did not find studies that address pathway 2 by conducting mediation analysis on the outcome of mental illness among adolescents.

Other research has documented that mental illness may lead to food insecurity, rather than vice versa (34), (35). However, in this report, we investigate the effect of food insecurity on mental illness. We are able to address this temporal association using longitudinal rather than cross-sectional data.

Research question

As documented above, mental illness affects millions of Americans each year. Food insecurity is also common, and evidence suggests that food insecurity may be a risk factor for mental illness among children, adolescents, and adults. In this study, we examine the longitudinal association between food insecurity among 3 year old children and their mental health as 15 year old adolescents. While the association between food insecurity and mental illness has been documented among children and adolescents, few studies have conducted a longitudinal analysis. Two studies we found that use longitudinal data analyze survey waves that are only a few years apart. One Canadian study found a long-term association between hunger in childhood and adolescent depression and suicidal ideation, but a similar timeframe has not been studied in an American population (29). We are analyzing a 12 year span between exposure and outcome among US toddlers and adolescents. This timeframe allows us to investigate a potential long-term effect of food insecurity on adolescent depression and anxiety, rather

than child behavioral outcomes. Additionally, in this study, we focus on a low-resource, vulnerable population that oversamples single mothers and their children using Fragile Families data. Other studies have investigated food insecurity and mental illness using Fragile Families data, but they have only used survey waves 3 and 5, whereas we include survey wave 15. As food insecurity is more prevalent among households headed by a single adult, the Fragile Families population is important to study. Additionally, research has documented that the impact of food insecurity on mental illness may be greatest among low-income groups (22). We also conduct an analysis of interaction between food insecurity and sex, as mental illness is more prevalent among females compared to males, and studies suggest that effect measure modification may exist. Two studies testing for interaction between sex and academic performance found that girls' academic performance was more negatively impacted by food insecurity compared to boys' academic performance (15), (26). However, another study testing for interaction between sex and mental illness did not report effect measure modification (29). Finally, we include mediation analyses to test for mediation by four variables: maternal depression, maternal anxiety, parenting stress, and maternal psychological aggression. These potential mediators are along the psychosocial stress pathway from food insecurity to mental illness, as described above. Previous mediation analyses have found mixed results, and no prior mediation analyses have been conducted on the outcomes of adolescent depression and anxiety (16), (27), (33).

Chapter II: Manuscript

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Abstract

Food insecurity, defined as limited access to food due to economic restraint, affects millions of American families. Food insecurity is a social stressor that can lead to negative health outcomes, including mental illness, among children and adolescents. In this paper, we investigate the association between food insecurity in childhood and depression and anxiety in adolescence. We use longitudinal data from the Fragile Families and Child Wellbeing Study, a nationally representative sample of non-marital births in the US. The relationship between food insecurity at age 3 and mental illness symptomatology at age 15 was assessed through linear regression models. We found that food insecurity among children is associated with an increase in depression and anxiety scores among adolescents. In the analysis, we also tested for interaction with sex and for mediation by psychosocial stress variables, including maternal mental illness, parenting stress, and maternal psychological aggression toward children. The interaction and mediation assessments were not statistically significant. Future research should test for alternate pathways and for interaction with other social stressors that may influence the relationship between food insecurity and mental illness.

Introduction

Mental illness is a major public health concern affecting millions of Americans. Two of the most common forms of mental illness are major depression and anxiety disorders. Symptoms of these disorders include fatigue, irritability, sleep problems, and avoidant behavior (2), (1), and depression and anxiety can impair daily functioning. Adolescents, the focus of this research paper, are affected by depression and anxiety disorders at alarming rates. Among adolescents 12-17 years old, 12.8% experienced at least one major depressive episode in 2016 (4). Depression is more prevalent among females (19.4%) compared to males (6.4%), and among Whites and Hispanics compared to Blacks (4). Anxiety disorders are also common among adolescents. According to the NCS-A, lifetime prevalence of any anxiety disorder among adolescents ages 13-18 is 32.9% (6). Another meta-review reported a 15-20% lifetime prevalence of anxiety disorders among children or adolescents (9). As with depression, females have higher rates of anxiety disorders than males (9). Studies on adolescent anxiety stratified by race show mixed results, but some suggest that Hispanics may have higher rates compared to Blacks and Whites (7), (8).

Risk factors for depression and anxiety include stressful life events in childhood (2), (1). Research has shown that one stressor, food insecurity, is associated with mental illness among children and adolescents. Food insecurity is an "economic and social condition" defined as limited access to food due to economic restraint (12). According to the United States Department of Agriculture (USDA), 15.6 million Americans (12.3% of all households) were food insecure in 2016 (12). The prevalence of food insecurity is exaggerated in certain populations. By definition, food insecurity is most common among

low-income populations. Households with children are disproportionately affected by food insecurity, and households with children headed by a single female have some of the highest rates (31.6%) (12). Racial disparities also exist. While the prevalence of food insecurity is 9.3% in households with a non-Hispanic, White head, 18.5-22.5% of Hispanic- and Black-headed households are food insecure (12).

Multiple studies have documented an association between food insecurity and mental illness among children and adolescents. According to a study of 13-17 year olds, adolescents with higher food insecurity scores experienced an increased odds of past-year anxiety, mood, behavior, and substance disorders (22). Another cross-sectional study found that food insufficient adolescents were more likely to have dysthymia and suicidal thoughts and to have attempted suicide compared to food sufficient adolescents (23). Research using NHANES data found an increased odds of "mental disorder with impairment" among both children ages 4-11 and adolescents ages 12-17, stratified by age (24). Though most studies have been cross-sectional, one longitudinal study using Fragile Families data found an association between food insecurity and internalizing and externalizing behaviors among 3-5 year old children (27). Another longitudinal study of a British population reported higher rates of behavioral problems among food insecure 10 year old children compared to food secure children (14). In a Canadian study, researchers reported associations between hunger and depression and between hunger and suicidal ideation among children and adolescents (OR=2.3; 95% CI= 1.2-4.3) (29). No studies using an American population have examined the longitudinal association between food insecurity among toddlers and mental illness among adolescents.

Researchers have hypothesized two main pathways from food insecurity to mental illness among children: (1) nutrient deficiency, which may impair brain functioning, and (2) psychosocial stress, which can lead to emotional distress, parental depression, and/or poor parenting (27), (16), (15), (33). In this study, we investigate pathway 2. Two prior studies tested pathway 2 on child behavior using Fragile Families data. In these studies, maternal depression, maternal generalized anxiety disorder, and parenting stress were not significant mediators of food insecurity and children's internalizing and externalizing behavior between ages 3 and 5 (16), (27). Another study testing pathway 2 found that food insecurity influenced behavior and mental proficiency in toddlers through maternal depression and parenting practices (33). We did not find studies that investigate mediation on the outcome of mental illness among adolescents.

Research question

In this study, we examine the longitudinal association between food insecurity among 3 year old children and their mental health as 15 year old adolescents. Compared to other longitudinal studies, our study includes a longer timeframe between exposure and outcome. This 12 year timespan allows us to investigate if food insecurity among toddlers impacts adolescent depression and anxiety symptomatology. Additionally, in this study, we focus on a low-resource, oversample of single mothers and their children using Fragile Families data. Other studies have investigated food insecurity and child behavior using waves 3 and 5 of Fragile Families data, whereas we include wave 15. We also conduct an analysis of interaction between food insecurity and sex. Mental illness is more prevalent among females compared to males, and studies suggest that effect measure modification by sex may exist (15), (26). Finally, we include mediation analyses to test

for mediation by four variables along the psychosocial stress pathway: (1) maternal depression, (2) maternal anxiety, (3) parenting stress, and (4) maternal psychological aggression.

Methods

Dataset

The Fragile Families and Child Wellbeing Study is a longitudinal study that follows a cohort of US children from birth until age 15. It is a nationally representative sample of non-marital births from 20 US cities with populations of over 200,000 (36). For the initial survey wave, data was collected on 4,898 births—3,673 (75%) of which were non-marital. These births were collected from 75 hospitals between 1998-2000. Births were ineligible if mothers planned to put babies up for adoption or if the birth father was deceased. Additionally, mothers were ineligible if they were unable to interview in English or Spanish (36).

The study includes surveys of mothers, fathers, primary caregivers, and children, as well as in-home assessments and teacher surveys in certain survey waves. Survey waves occurred at the children's birth (baseline), age 1, age 3, age 5, age 9, and age 15. The study collects information on demographics, children's mental and physical health, parents' mental and physical health, family routines, housing characteristics, food insecurity, parenting, child development, and behavior, among other topics. Complete information on the Fragile Families survey design and sample sizes can be found in the research methodology paper by Reichman et al. (2001).

Sample

In the current study, we investigate the long-term association between food insecurity in childhood, at survey wave 3, and depression and anxiety symptomatology in adolescence, at survey wave 15. Therefore, the dataset is subset to participants in both waves 3 and 15 who have data for the food insecurity and mental health variables. Of the 4,898 births, 4,054 are in either waves 3 or 15, and 2,678 participate in both the in-home survey at year 3 and the teen survey at year 15 (37). Participants are included if they have values for the covariates and mediators included in our models, described below. The final analytic sample has 2,539 observations.

Outcome variables

We are investigating depression and anxiety among adolescents. These outcomes are measured through the teen survey at wave 15.

In Fragile Families, depression is measured using questions from the Center for Epidemiologic Studies Depression Scale (CES-D) (38). This survey is a screening test for depressive symptomatology. This scale has been used in multiple nationally representative epidemiologic studies, including the National Health and Nutrition Examination Surveys (NHANES) and the National Longitudinal Study of Adolescent Health (Add Health). While the full CES-D includes 20 questions, Fragile Families uses a subset of five questions to estimate depressive symptoms (Appendix Table 2). These five questions are included because previous research found these indicators to be more reliable across different races and ethnicities within a population (39). Respondents answered each question on a 4-point scale, which we recoded to 0-3, from “strongly disagree” to “strongly agree”. We summed the responses on each question to calculate a composite depressive symptoms score. The scores range from 0-15, with 15 being the

most depressed. As there is not a validated cutoff to define depression with these five questions, we use a continuous rather than a dichotomous scale.

Anxiety is measured by six questions from the Brief Symptom Inventory 18 (BSI 18). The BSI 18 is an assessment that measures psychological distress and psychiatric symptomatology (40). The assessment includes three 6-question subscales for somatization, anxiety, and depression. Fragile Families uses a slightly modified version of the 6-question anxiety subscale to measure adolescent anxiety symptomatology (Appendix Table 3). Respondents answered each question on a 4-point scale, which we recoded to 0-3, from "strongly disagree" to "strongly agree". We summed the responses on each question to calculate a composite anxiety score. The scores range from 0-18, with 18 being the most anxious. As there is not a validated cutoff to define anxiety with these six questions, we use a continuous rather than a dichotomous scale.

Exposure variable

Household food insecurity is measured with a slightly modified version of the United States Department of Agriculture (USDA) 18-item US Household Food Security Survey Module. The survey module is used by the USDA to report national estimates of food insecurity. The survey asks questions that address adult (10 questions) and child (8 questions) food insecurity. When combined, the full 18-question survey measures household food insecurity. Questions in the survey address lack of access to food due to financial barriers (Appendix Table 1).

We use the full household food insecurity module, rather than the child subset, to investigate childhood food insecurity at year 3. In about 50% of food insecure households, children are not defined as food insecure according to the child questionnaire

(11). This situation could arise if caregivers try to shield children from food insecurity, e.g. by reducing their own food intake so that children have sufficient food (12). Additionally, children may receive supplemental food, such as through school lunches, that reduces their level of food insecurity (12). However, researchers often use the family-level definition of food insecurity as a proxy for food-insecure children, because household food insecurity may negatively impact children, such as through a psychosocial stress pathway.

We dichotomized food security status using guidelines from both USDA and Fragile Families. Food security is defined as 0-2 positive responses to the 18-item questionnaire, and food insecurity is defined as 3+ positive responses.

Mediator variables

In this study, we explore the psychosocial stress pathway from food insecurity to mental illness. To do so, we investigate four possible mediators. Two of these mediators are measures of maternal mental health: maternal depression and maternal anxiety. The other mediators measure parenting attitudes and practices: parenting stress and parental aggression towards children. All of the mediator variables are taken from the year 3 survey.

Maternal mental health is measured with questions from the Composite International Diagnostic Interview – Short Form (CIDI-SF). The CIDI is a World Health Organization (WHO)-developed diagnostic assessment for psychological disorders, and the CIDI-SF is a subset of questions from the CIDI (41). The questions are based on the Diagnostic and Statistical Manual of Mental Disorders (DSM-IV). Maternal depression is defined by meeting criteria for a major depressive episode (MDE) within the past 12

months. These criteria include having a dysphoric (i.e. depressive) mood or anhedonia (i.e. inability to enjoy pleasurable activities) lasting over half the day, nearly every day, for a period of two weeks. Respondents must also have at least three depressive symptoms, including loss of interest, fatigue, and change in weight, among others, to be counted as a case (37). Maternal anxiety is defined by meeting criteria for generalized anxiety disorder (GAD). GAD is defined as a six month or longer period of excessive worry and anxiety about more than one thing and difficulty controlling worries, which occur on most days. Respondents must also answer yes to at least three physiological symptoms of anxiety, including restlessness and irritability, among others, to be defined as a case. Both maternal depression and anxiety were included as dichotomous variables in the models.

Stress due to parenting is measured by four questions from the Job Opportunities and Basic Skills Training Program (JOBS) Child Outcomes Study (Appendix Table 4). These questions were designed to measure parenting stress brought on by life stressors including change in employment, income, and other factors (42). Each question is scored from 0-3, and the composite continuous parenting stress scores range from 0-12.

Maternal aggression is measured by five questions that assess psychological aggression (Appendix Table 5). These questions come from the Parent-Child Conflict Tactics Scales (CTSPC) (43). Each question is scored from 0-6, and the composite continuous psychological aggression scores range from 0-30.

Interaction term

We assessed for interaction between child sex and food insecurity in both the depression and the anxiety models by including the sex*food insecurity interaction term.

Control variables

We controlled for seven demographic factors: mother's race/ethnicity, mother's marital status at baseline, mother's education level at baseline, poverty level at year 3, child's sex, mother's age at childbirth, and child's age in months at year 3. Maternal race/ethnicity is used as a proxy for child's race/ethnicity. It includes four categories: White, Non-Hispanic; Black, Non-Hispanic; Hispanic, and Other. Mother's marital status is a dichotomous variable that reports if the mother was married to the baby's father at baseline, as this definition was part of the study design. Education is an 8-level ordinal variable that includes values from less than high school to graduate school. Poverty level is a 4-level ordinal variable that measures the total household income compared to the federal poverty threshold. Time-dependent covariates were included from data at survey wave 3, the year in which we are testing the exposure, unless they were only available at baseline. Mother's marital status was included from baseline data, rather than year 3, as this variable was part of the design of the Fragile Families sample. We did not include maternal employment status as 15% of the sample was missing, but maternal education and poverty level are included and capture socioeconomic status.

Analyses

We conducted linear regression to assess the relationship between (1) food insecurity and depression symptomatology and (2) food insecurity and anxiety symptomatology. PROC GLM in SAS 9.4 Statistical Software was used to conduct the linear regression analyses. We used a theoretical model to determine which covariates should be included as confounders to calculate the most valid and precise beta estimates of the relationship between food insecurity and mental health outcomes. After

determining the control variables, we conducted an interaction assessment between child sex and food insecurity. Then we conducted the mediation analyses. Each of the four mediators were tested individually in the multivariate depression and anxiety models to test for the four different pathways.

Prior to this analysis, we conducted chi-square and t-tests to determine if our final sample of 2,539 observations differed in demographics from the baseline sample of 4,898 births. We also conducted descriptive analyses of the covariates, mediator variables, and outcome variables overall and stratified by food security status in our final sample. Chi-square and t-tests were performed to determine if covariates and mediator variables differed by food security status.

Results

Descriptive statistics

Overall, 41.1% of our final sample lives at or below the federal poverty level (FPL), and 80% live below 300% of the FPL (Table 1). The sample is 77.4% non-White, including 50.4% Black, Non-Hispanic, and 23.3% Hispanic. In this study, 61.9% of the population has a high school degree or less. By design of the study, there is an oversample of non-marital births—74.5% of mothers are not married to the baby's father. Our analytic sample is similar in demographics to the sample at baseline, though some differences exist. Our sample has different poverty and education distributions, including a higher level of participants below the FPL (41.4% versus 36%) and a higher education level (38.1% versus 35.1% have some college or above). Our sample is also less Hispanic (23.3% versus 27.1%) and more Black, non-Hispanic (50.4% versus 47.8%).

In our study sample, 412 children (16.2%) meet criteria for the exposure, household food insecurity at survey wave 3. Table 1 shows the breakdown of the descriptive statistics by food security level. Food insecure children have higher levels of poverty and are a higher percentage racial minority compared to food secure children. Their mothers have lower levels of education and are less likely to be married to their fathers compared to food secure children.

Overall, 15.4% of children have mothers who meet criteria for depression at year 3, and 5.1% have mothers who meet criteria for generalized anxiety disorder at year 3. There is a large difference in maternal mental health status by food security level (Table 1). Compared to mothers who do not experience household food insecurity, mothers who experience household food insecurity are more likely to be depressed (27.2% versus 13.2%) and anxious (12.1% versus 3.7%). Additionally, levels of parenting stress and maternal psychological aggression are higher among the food insecure group compared to the food secure group.

Table 1 also presents descriptive data on the outcomes, adolescent depression symptomatology and adolescent anxiety symptomatology. In the full sample, the average score for adolescent depressive symptoms at wave 15 is 3.0 on a 15-point scale. The overall average score for adolescent anxious symptoms at wave 15 is 4.9 on an 18-point scale. These mental illness scores are higher on average for the food insecure group.

Linear models, including cofounders

There is a significant association between household food insecurity at year 3 and adolescent depression symptomatology at year 15 in both bivariate and multivariate linear models (Table 2). In the bivariate model, the average depressive symptoms score

on the 15-point scale is 0.6 points higher for food insecure adolescents compared to food secure adolescents ($p<0.05$). In the multivariate model including all seven confounders, the average depression symptomatology score is 0.4 points higher for food insecure adolescents ($p<0.05$).

There is also a significant association between household food insecurity at year 3 and adolescent anxiety symptomatology at year 15 in both bivariate and multivariate models (Table 3). In the bivariate model, the average anxious symptoms score on the 18-point scale is 0.8 points higher for food insecure adolescents compared to food secure adolescents ($p<0.05$). In the multivariate model, the average anxiety symptomatology score is 0.7 points higher for food insecure adolescents ($p<0.05$).

Linear models, including interaction

We tested for interaction between sex and food insecurity for both the depression and the anxiety models. The interaction term was not significant in the multivariate depression model ($p=0.34$) or the multivariate anxiety model ($p=0.97$). Therefore, we conclude there is no interaction between sex and food security status for either adolescent depression symptomatology or adolescent anxiety symptomatology. We do not include the interaction term in the models when testing for mediation.

Linear models, including mediators

We tested both the depression and anxiety multivariate linear models for mediation by four factors: (1) maternal depression, (2) maternal anxiety, (3) parenting stress, and (4) maternal psychological aggression. We did not find mediation by any of these individual variables for either the depression or the anxiety models. The beta estimate for food insecurity changed minimally for adolescent depressive symptoms and

adolescent anxious symptoms in the mediation models (Tables 2 and 3). The association between food insecurity and depressive symptoms and between food insecurity and anxious symptoms remained significant after testing for each of the mediators.

Discussion

In this study, we investigate the relationship between food insecurity in childhood and mental illness in adolescence. We found that food insecurity at age 3 is associated with a statistically significant increase in depression symptomatology and anxiety symptomatology at age 15 in both crude and adjusted analyses. After controlling for covariates, food insecurity is associated with an increase of 0.4 points on a 15-point scale for depression and an increase of 0.7 points on an 18-point scale for anxiety. These findings are consistent with other cross-sectional and longitudinal studies demonstrating an association between food insecurity and mental illness or behavioral issues among children and adolescents (22), (23), (27), (14), (16). To our knowledge, we are the first to demonstrate that this relationship is retained in an American population over a 12 year period between exposure and outcome, i.e. from childhood to adolescence.

We found no interaction between food insecurity and sex for either the depression or the anxiety models. We conducted the interaction assessment because mental illness is more prevalent among females compared to males, and studies have found interaction between child sex and food insecurity for different outcomes, including physical health and academic performance (15), (26). Our finding of no interaction is consistent with a Canadian study that did not find effect measure modification of child sex on the association of hunger with depression and suicidal ideation (29). As interaction between

food insecurity and sex was not significant, we conclude that the pathway from food insecurity to mental illness affects girls and boys similarly.

This study is the first to test for mediation along the pathway from childhood food insecurity to adolescent mental illness over an extended time period. Multiple studies hypothesize that food insecurity may lead to mental illness among children and adolescents through a psychosocial stress pathway. According to this pathway, food insecurity may influence parental emotional distress, parental mental illness, or poor parenting practices, which can in turn lead to mental illness among children (16), (27), (33). While many studies suggest this hypothesis, few studies test it.

We test the psychosocial stress pathway with four variables: (1) maternal depression, (2) maternal anxiety, (3) parenting stress, and (4) maternal psychological aggression toward children. The few studies testing this pathway have used varied mediators and have come to different conclusions. One study testing this pathway found that food insecurity influenced behavior and mental proficiency in toddlers through parenting practices and maternal depression (33). Another study found that food insecurity was associated with fewer positive parenting practices and influenced toddler overweight status and infant feeding practices through this pathway (13). Prior research using Fragile Families data did not find mediation from food insecurity to child behavior by maternal depression, maternal anxiety, or parenting stress (16), (27). Similar to these studies, we did not find mediation by maternal depression, maternal anxiety, or parenting stress. We additionally tested for mediation by parenting behaviors. To do so, we included variables that indicate maternal psychological aggression towards children

(Appendix Table 5). The results show that these variables also did not mediate the relationship between exposure and outcome.

It is possible that we did not find mediation by psychosocial stress variables because food insecurity influences mental illness via a different mechanism. Studies have hypothesized that food insecurity may lead to reduced food intake and nutrient deficiency, which may lead to mental illness in developing brains. Research on this topic has led to mixed results. A meta-analysis of American studies suggests that food insecure children eat fewer nutrient-dense and more energy-dense foods compared to food secure children (44). This evidence is corroborated through studies reporting that food insecurity is related to overweight in toddlers and children (15), (13). Other research shows that children do not suffer from the nutritional effects of household food insecurity. A study using NHANES data found few differences in food intake between food secure and food insecure children ages 6-17 (45). A Canadian study found no differences on a long list of nutrient intake variables, except for protein, by food security status among children ages 1-4 (46). This study found that food insecure adolescent females ages 14-18 ate more energy-dense foods compared to food secure adolescents of the same demographic, but nearly all other indicators did not differ for adolescents of either sex (46). Therefore, it is unclear whether nutritional deficiency influences adolescent mental illness.

Another possible pathway from food insecurity in childhood to mental illness in adolescence is through childhood behavioral issues. Several studies, including those using Fragile Families data, report that food insecurity among toddlers and children influences children's behavioral outcomes (16), (27), (14). One study found that adjusting for toddler behavior at age 1½ mediated the association between food insecurity among

toddlers and inactivity/inattention symptomatology among children between ages 4½ and 8 (28). In this study, we did not adjust for childhood behavior, which could be explored in future analyses.

It is also possible that the psychosocial stress pathway from food insecurity to adolescent mental illness is less influential within our population. Two other studies using Fragile Families data did not find mediation by psychosocial stress and maternal mental illness along the pathway from food insecurity to child behavioral problems in year 3 and year 5 data (16), (27). Food insecurity is just one of many stressors that this vulnerable population suffers. Compared to food secure children, food insecure children in this sample are poorer and a higher percentage racial minority, and their mothers are more single, have less education, and suffer from mental illness at higher rates (Table 1). This population is exposed to many other social stressors, including poor housing conditions, violence, and discrimination, among others. The combination of multiple exposures may create a psychosocial stress pathway leading to poor mental health outcomes. Food insecurity is an important social stressor but is not the only one.

In this study, we found that the association between food insecurity and mental illness is statistically significant, though we cannot determine if the between-group differences in depression symptomatology and anxiety symptomatology are clinically meaningful. The average scores on the depression scale are 2.0 for food secure adolescents and 2.4 for food insecure adolescents. The average scores on the anxiety scale are 4.7 for food secure adolescents and 5.4 for food insecure adolescents. A higher value for each measure indicates more depressed and more anxious, but we cannot conclude if the increases merit different clinical interventions.

Strengths

There are several strengths to this study. The data source is a nationally representative sample of non-marital births in the US. It is a longitudinal study with information on children from birth until age 15. Therefore, we were able to conduct a longitudinal analysis, which allows us to account for temporality of the exposure, food insecurity, and the outcome, mental illness. With many years of data, we examined a 12 year period between food insecurity and depressive and anxious symptoms. This long time period between childhood and adolescence has not been investigated in previous studies on food insecurity and mental illness. The full dataset has almost 5,000 observations, and our sample includes 2,539 observations, which gives us statistical power.

Additionally, many of the variables are based on validated scales for the constructs they represent. The outcome, household food insecurity, is measured with a slightly modified version of the USDA 18-item US Household Food Security Survey Module. This survey is used by the USDA to report national estimates of food insecurity. The mediator variables also all use validated scales. The scores for maternal depression and anxiety are taken from the CIDI-SF questionnaire, which was consistent with the DSM-IV at the time of administration. The scores are valid representations of clinical mental illness, rather than mental illness symptomatology. The parenting stress variables use questions from the JOBS Child Outcomes Study, and the maternal aggression variables use questions from CTSPC (Appendix Tables 4 and 5).

Limitations

There are a few limitations concerning the variables in our study. The outcomes for depression and anxiety are self-report questionnaires for depression and anxiety symptomatology, rather than clinical definitions. Depression is defined by answers to five questions from the CES-D questionnaire. Though Perreira et al. (2005) found that these five questions are more valid than the full questionnaire when applied to a multicultural population, there is no validated cutoff for depression with these five questions. For anxiety, Fragile Families uses all six questions from the BSI 18 anxiety subscale, but there is no validated cutoff for anxiety. There may also be underreporting of depressive and anxious symptoms due to social desirability bias.

Additionally, there are some limitations concerning temporality of variables. We tested all four mediator variables at wave 3, the same time as the exposure variable. Therefore, we cannot conclude that food insecurity occurred before the mediators. Instead, there may be a common cause to food insecurity and the mediators, such as socioeconomic status. However, we controlled for socioeconomic variables, including poverty level and maternal education level, in our analysis. Additionally, some of the covariates include values at baseline and others include values at wave 3, depending on the data availability and the survey design. Finally, as there is a 12 year time period between exposure and outcome, it is possible that exposure status changed overtime. For example, children who were food insecure at age 3 may have become food secure at another point during the study time frame. However, the USDA food security questionnaire asks about food insecurity over the past 12 months, so the exposure captures at least one year of food security status.

Conclusion

Our study underscores prior research findings that food insecurity and mental illness are associated among children and adolescents. This paper is the first to show how this relationship is maintained over a 12 year period in a population of vulnerable American children. The long-term association suggests that exposures encountered during a critical time in childhood may influence health status later in life. Therefore, interventions aimed at addressing food insecurity and other social stressors may be most successful if they target families with young children. Though we tested for mediating factors, we did not find that maternal mental health, parenting stress, or parenting behaviors influences the trajectory from food insecurity in childhood to mental illness in adolescence. The psychosocial stress pathway may be more complex in this vulnerable population, as these children are exposed to multiple stressors that are associated with childhood mental illness. Future research should investigate how food insecurity interacts with other social stressors to influence mental illness. Future studies should also test for alternate pathways, such as nutrient deficiency and childhood behavior, that may influence the relationship between food insecurity and mental illness.

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Tables

Table 1. Characteristics of a cohort of US children and adolescents by food security status based on Fragile Families data

	Overall (n=2,539)			Food secure (n=2,127)			Food insecure (n=412)		
Variable	**N**	**%**	**M(SD)**	**N**	**%**	**M(SD)**	**N**	**%**	**M(SD)**
Child sex									
Female	1,226	48.3		1,041	48.9		185	44.9	
Male	1,313	51.7		1,086	51.1		227	55.1	
Child age at year 3 (months)*			35.4 (2.3)			35.4 (2.3)			35.7 (2.4)
Mother's age at childbirth (years)*			25.1 (6.0)			25.3 (6.1)			24 (5.5)
Mother's marital status at childbirth*									
Married to baby's father	648	25.5		601	28.3		47	11.4	
Not married to baby's father	1,891	74.5		1,526	71.7		365	88.6	
Maternal race/ethnicity*									
White, non-Hispanic	576	22.7		513	24.1		63	15.3	
Black, non-Hispanic	1,279	50.4		1,048	49.3		231	56.1	
Hispanic	591	23.3		491	23.1		100	24.3	
Other	93	3.7		75	3.5		18	4.4	
Poverty category at year 3[a]*									
0-49%	567	22.3		420	19.8		147)	35.7	
50-99%	486	19.1		361	17.0		125	30.3	
100-199%	634	25.0		545	25.6		89	21.6	
200-299%	345	13.6		315	14.8		30	7.3	
300%+	507	20.0		486	22.9		21	5.1	
Mother's education status at childbirth*									
Less than high school	779	30.7		606	28.5		173	42.0	

High school or equivalent	791	31.2		646	30.4		145	35.2
Some college or technical school	674	26.5		590	27.7		84	20.4
College or graduate school	295	11.6		285	13.4		10	2.4
Maternal mental health at year 3								
Maternal depression*	392	15.4		280	13.2		112	27.2
Maternal anxiety*	129	5.1		79	3.7		50	12.1
Parenting indicators at year 3								
Parenting stress[b]*			5 (2.6)			4.8 (2.6)		6.0 (2.7)
Maternal psychological aggression[c]*			8.2 (4.8)			7.9 (4.7)		9.4 (4.9)
Adolescent mental health								
Adolescent depression symptomatology[d]*			3.0 (3.0)			2.9 (3.0)		3.5 (3.1)
Adolescent anxiety symptomatology[e]*			4.9 (3.9)			4.7 (3.9)		5.6 (4.0)

[a]Poverty category is measured by total household income compared to the federal poverty level.

[b]Parenting stress is measured by four questions from the Job Opportunities and Basic Skills Training Program (JOBS) Child Outcomes Study (Appendix Table 4).

[c]Maternal aggression is measured by five questions from the Parent-Child Conflict Tactics Scales (CTSPC) (Appendix Table 5).

[d]Adolescent depression symptomatology is measured by five questions from the Center for Epidemiologic Studies Depression Scale (CES-D) (Appendix Table 2).

[e]Adolescent anxiety symptomatology is measured by six questions from the Brief Symptom Inventory 18 (BSI 18) (Appendix Table 3).

*Significant difference between food secure and food insecure groups at alpha=0.05.

Table 2. Associations of food insecurity and psychosocial stress mediator variables in childhood (year 3) with depressive symptoms in adolescence (year 15) based on Fragile Families data

	Model 1[a]		Model 2[b]		Model 3[c]		Model 4[d]		Model 5[e]		Model 6[f]	
	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI
Exposure												
Household food insecurity	0.58*	0.26, 0.89	0.41*	0.09, 0.73	0.35*	0.03, 0.68	0.39*	0.06, 0.71	0.36*	0.03, 0.68	0.35*	0.03, 0.68
Mediator												
Maternal depression					0.43*	0.11, 0.75						
Maternal anxiety							0.25	-0.28, 0.78				
Parenting stress									0.04	-0.00, 0.09		
Maternal psychological aggression											0.04*	0.01, 0.06

[a]Model 1: Unadjusted results

[b]Model 2: Results were adjusted for maternal ethnicity/race, maternal marital status, poverty level, maternal education, maternal age at childbirth, child sex, and child's age in months at year 3.

[c]Model 3: Results were adjusted as in Model 2, plus maternal depression.

[d]Model 4: Results were adjusted as in Model 2, plus maternal anxiety.

[e]Model 5: Results were adjusted as in Model 2, plus parenting stress.

[f]Model 6: Results were adjusted as in Model 2, plus maternal psychological aggression.

*p<0.05

Table 3. Associations of food insecurity and psychosocial stress mediator variables in childhood (year 3) with anxious symptoms in adolescence (year 15) based on Fragile Families data

	Model 1[a]		Model 2[b]		Model 3[c]		Model 4[d]		Model 5[e]		Model 6[f]	
	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI	β	95% CI
Exposure												
Household food insecurity	0.83*	0.42, 1.24	0.66*	0.24, 1.08	0.60*	0.18, 1.02	0.66*	0.24, 1.09	0.59*	0.17, 1.02	0.62*	0.20, 1.04
Mediator												
Maternal depression					0.46*	0.04, 0.88						
Maternal anxiety							-0.04	-0.73, 0.64				
Parenting stress									0.06	-0.00, 0.11		
Maternal psychological aggression											0.03	-0.00, 0.06

[a]Model 1: Unadjusted results

[b]Model 2: Results were adjusted for maternal ethnicity/race, maternal marital status, poverty level, maternal education, maternal age at childbirth, child sex, and child's age in months at year 3.

[c]Model 3: Results were adjusted as in Model 2, plus maternal depression.

[d]Model 4: Results were adjusted as in Model 2, plus maternal anxiety.

[e]Model 5: Results were adjusted as in Model 2, plus parenting stress.

[f]Model 6: Results were adjusted as in Model 2, plus maternal psychological aggression.

*p<0.05

Chapter III: Public Health Implications

In this paper, we investigate the association between food insecurity and mental illness in a vulnerable population of children from 20 major American cities. Both food insecurity and mental illness, including depression and anxiety, are prevalent in America. Prior research has found an association between food insecurity and mental illness among adults, adolescents, and children. Researchers hypothesize that the association may be due to a pathway involving (1) nutrient deficiency or (2) psychological stress. However, few studies have researched the association and mechanism involved using longitudinal data. Additionally, no American study has investigated the association between food insecurity in childhood and mental illness in adolescence, when depression and anxiety often emerge. In this study, we research the long-term relationship between food insecurity and depression and anxiety symptomatology to test if the influence of this stressor is maintained over time.

We found that food insecurity at year 3 is associated with a statistically significant increase in depression and anxiety scores at year 15. This association is significant in both crude and multivariate analyses that control for confounders. In mediation analyses, we did not find mediation by any of four variables that we tested: (1) maternal depression, (2) maternal anxiety, (3) parenting stress, and (4) maternal psychological aggression toward children. These four variables were chosen as they are indicators along the psychosocial stress pathway. We also did not find interaction between food insecurity and sex.

Our study underscores prior research findings that food insecurity and mental illness are associated among children and adolescents. This paper is the first to show how

this relationship is maintained over a 12 year period in a population of vulnerable American children. The long-term association suggests that exposures encountered during a critical time in childhood may influence health status later in life. Therefore, interventions aimed at addressing food insecurity and other social stressors may be most successful if they target families with young children.

However, it is also important to note that we cannot determine if the between-group differences in depression and anxiety are clinically meaningful. The average scores on the depression scale are 2.0 for food secure adolescents and 2.4 for food insecure adolescents. The average scores on the anxiety scale are 4.7 for food secure adolescents and 5.4 for food insecure adolescents. A higher value for each measure indicates more depressed and more anxious, but we cannot conclude if the increases merit different clinical interventions. Future research should use clinically validated measures of depression and anxiety to more accurately define subjects into different groups.

Though we tested for mediating factors, we did not find that maternal mental health, parenting stress, or parenting behaviors influences the trajectory from food insecurity in childhood to mental illness in adolescence. The psychosocial stress pathway may be more complex in this vulnerable population, as these children are exposed to multiple stressors that are associated with childhood mental illness. Future research should investigate how food insecurity interacts with other social stressors to influence mental illness. Future studies should also test for alternate pathways, such as nutrient deficiency and childhood behavior, that may influence the relationship between food insecurity and mental illness.

Appendices

Appendix Table 1. Food insecurity questionnaire[a]

Number	Item	Response options
D1a	In the last 12 months, (I/we) worried whether (my/our) food would run out before (I/we) got money to buy more.	Often, sometimes, never true
D1b	In the last 12 months, the food that (I/we) bought just didn't last, and (I/we) didn't have money to get more.	Often, sometimes, never true
D1c	In the last 12 months, (I/we) couldn't afford to eat balanced meals.	Often, sometimes, never true
D1d	In the last 12 months, (we/I) relied on only a few kinds of low-cost food to feed (CHILD)/the children) because (we were/I was) running out of money to buy food.	Often, sometimes, never true
D1e	In the last 12 months, (I/we) couldn't feed ([CHILD]/the children) a balanced meal, because (I/we) couldn't afford that.	Often, sometimes, never true
D3	In the last 12 months, ([CHILD] was/the children were) not eating enough because (I/we) just couldn't afford enough food.	Often, sometimes, never true
D4	In the last 12 months, did (you/you or other adults in your household) ever cut the size of your meals or skip meals because there wasn't enough money for food?	Often, sometimes, never true
D4a	How often did this happen? Was it almost every month, some months but not every month, or in only 1 or 2 months?	Often, sometimes, never true
D5	In the last 12 months, did you ever eat less than you felt you should because there wasn't enough money to buy food?	Yes, no
D6	In the last 12 months, were you ever hungry, but didn't eat because you couldn't afford enough food?	Yes, no
D7	Sometimes people lose weight because they don't have enough to eat. In the last 12 months, did you lose weight because there wasn't enough food?	Yes, no
D9	In the last 12 months, did (you/you or other adults in your household) ever not eat for a whole day because there wasn't enough money for food?	Yes, no
D9a	How often did this happen? Was it almost every month, some months but not every month, or in only 1 or 2 months?	Almost every month, some months but not every month, only 1 or 2 months

D10	In the last 12 months, since (INTERVIEW MONTH), 2001, did you ever cut the size of ([CHILD's]/any of the children's) meals because there wasn't enough money for food?	Yes, no
D11	In the last 12 months, did ([CHILD]/any of these children) ever skip a meal because there wasn't enough money for food?	Yes, no
D11a	How often did this happen? Was it almost every month, some months but not every month, or in only 1 or 2 months?	Almost every month, some months but not every month, only 1 or 2 months
D12	In the last 12 months, (was [CHILD]/were the children) ever hungry, but you just couldn't afford more food?	Yes, no
D13	In the last 12 months, did ([CHILD]/any of the children) ever not eat for a whole day because there wasn't enough money for food?	Yes, no

[a]Questions are drawn and modified from the US Department of Agriculture Household Food Security Survey Module.

Appendix Table 2. Adolescent depressive symptoms questionnaire[a]

Number	Item	Response options
	Thinking about the past four weeks, do you strongly agree, somewhat agree, somewhat disagree, or strongly disagree with this statement?	
k6d2c	I feel I cannot shake off the blues, even with help from my family and my friends.	Strongly agree, somewhat agree, somewhat disagree, strongly disagree
k6d2n	I feel sad.	Strongly agree, somewhat agree, somewhat disagree, strongly disagree
k6d2s	I feel happy.	Strongly agree, somewhat agree, somewhat disagree, strongly disagree
k6d2x	I feel life is not worth living.	Strongly agree, somewhat agree, somewhat disagree, strongly disagree
k6d2ac	I feel depressed.	Strongly agree, somewhat agree, somewhat disagree, strongly disagree

[a]Questions are drawn and modified from the Center for Epidemiologic Studies Depression Scale (CES-D).

Appendix Table 3. Adolescent anxious symptoms questionnaire[a]

Number	Item	Response options
	Thinking about the past four weeks, do you strongly agree, somewhat agree, somewhat disagree, or strongly disagree with this statement?	
k6d2c	I feel I cannot shake off the blues, even with help from my family and my friends.	Strongly agree, somewhat agree, somewhat disagree, strongly disagree
k6d2n	I feel sad.	Strongly agree, somewhat agree, somewhat disagree, strongly disagree
k6d2s	I feel happy.	Strongly agree, somewhat agree, somewhat disagree, strongly disagree
k6d2x	I feel life is not worth living.	Strongly agree, somewhat agree, somewhat disagree, strongly disagree
k6d2ac	I feel depressed.	Strongly agree, somewhat agree, somewhat disagree, strongly disagree

[a]Questions are drawn and modified from the Brief Symptom Inventory 18 (BSI 18).

Appendix Table 4. Parenting stress variables[a]

Number	Item	Response options
	Please tell me how much you agree or disagree with each statement.	
B6a	Being a parent is harder than I thought it would be.	Strongly agree, somewhat agree, somewhat disagree, strongly disagree
B6b	I feel trapped by my responsibilities as a parent.	Strongly agree, somewhat agree, somewhat disagree, strongly disagree
B6c	I find that taking care of my child(ren) is much more work than pleasure.	Strongly agree, somewhat agree, somewhat disagree, strongly disagree
B6d	I often feel tired, worn out, or exhausted from raising a family.	Strongly agree, somewhat agree, somewhat disagree, strongly disagree

[a]Questions are drawn and modified from the Job Opportunities and Basic Skills Training Program (JOBS) Child Outcomes Study.

Appendix Table 5. Maternal psychological aggression variables[a]

Number	Item	Response options
	(First), how many times in the past year did you (READ ITEM)? Was it once in the past year, twice, 3-5 times, 6-10 times, 11-20 times, more than 20 times in the past year, it happened but not in the past year, or this never happened?	
J6	Shouted, yelled, or screamed at	Never, once, twice, 3-5 times, 6-10 times, 11-20 times, more than 20 times, yes but not in the past year
J10	Threatened to spank or hit but didn't actually do it	Never, once, twice, 3-5 times, 6-10 times, 11-20 times, more than 20 times, yes but not in the past year
J8	Swore or cursed at	Never, once, twice, 3-5 times, 6-10 times, 11-20 times, more than 20 times, yes but not in the past year
J14	Called him/her dumb or lazy or some other name like that	Never, once, twice, 3-5 times, 6-10 times, 11-20 times, more than 20 times, yes but not in the past year
J9	Said you would send him/her away or would kick him/her out of the house	Never, once, twice, 3-5 times, 6-10 times, 11-20 times, more than 20 times, yes but not in the past year

[a]Questions are drawn and modified from the Parent-Child Conflict Tactics Scales (CTSPC).