Disentangling food insecurity and maternal depression: which comes first?

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Abstract

Objective: To determine the temporal directionality of the association between food insecurity and maternal depression.

Design: Food insecurity was measured at two time points using the eighteen-item USDA Food Security Scale. Maternal depression was measured at two time points using the fifteen-item Composite International Diagnostic Interview-Short Form. Two structural equation models were utilised to evaluate the impact of food insecurity on maternal depression (model 1) and the impact of maternal depression on food insecurity (model 2). Both models controlled for socio-demographic and parenting characteristics and child behaviour problems, along with prior measures of the dependent variable and concurrent measures of the independent variable.

Setting: Fragile Families and Child Wellbeing (FFCW) study, twenty cities across the USA.

Participants: 4897 mothers who participated in two waves of the FFCW study.

Results: On average, 17 % (time 1) and 15 % (time 2) of mothers experienced food insecurity and 21 % (time 1) and 17 % (time 2) of mothers experienced depression over time. Maternal depression at time 1 was associated with 53 % increased odds (OR = 1·53; B = 0·43; $P < 0·001$) of food insecurity at time 2, controlling for time 1 food insecurity, concurrent depression and covariates. Food insecurity at time 1 was associated with 36 % increased odds (OR = 1·36; B = 0·31; $P < 0·001$) of maternal depression at time 2, controlling for time 1 depression, concurrent food insecurity and covariates.

Conclusions: We found a bidirectional relationship between food insecurity and maternal depression. A holistic approach that combines food assistance and mental health services may be an efficacious approach to reducing both depressive symptoms and food insecurity among low-income mothers.

Food insecurity is inadequate access to nutritious food due to lack of resources[1]. In 2018, 11 % of US households experienced food insecurity at some point during the year. The prevalence of food insecurity is even greater among households with children (14 %), single mother/father households (28 %/16 %), households with incomes below 185 % of the poverty threshold (29 %) and Black (21 %) and Hispanic (16 %) households[1]. Food insecurity is associated with negative health outcomes for children, non-senior adults and senior adults[2]. The most prevalent mental health state associated with food insecurity is depression and depressive symptoms[3]. The relationship between food insecurity and depression is particularly strong among women[4–8] and mothers[9–11]. Depression in women peaks during pregnancy and early motherhood[12], and approximately 10–20 % of mothers experience depression at some point in their lives[13]. Further, maternal depression is known to have lasting consequences on children. These include poorer health[14], delayed language development[15] and behaviour problems such as aggression, hyperactivity and emotional difficulties[16–18].

Several cross-sectional studies have demonstrated a positive association between food insecurity and maternal

depression[17,19–22]. In addition, longitudinal studies have begun to provide a better understanding of the relationship between food insecurity and depression[10,11]. For instance, Munger et al.[11] found that maintaining a status of food insecurity or becoming food insecure over a 2-year period increased the probability of mothers experiencing depression over time. However, for families that became food insecure and participated in the Supplemental Nutrition Assistance Program, Supplemental Nutrition Assistance Program was found to buffer the positive association between food insecurity and maternal depression.

On the other hand, some studies have shown that maternal depression contributes to food insecurity[9,14,23–27]. While most studies have focused on the cross-sectional relationship, two studies using data from the Early Childhood Longitudinal Study-Birth Cohort examined the longitudinal relationship using various methodology. Both studies concluded that maternal depression was associated with elevated household food insecurity 15 months later[23,25]. In summary, the temporal directionality of the association between food insecurity and maternal depression remains unclear. It is unknown whether food insecurity precedes maternal depression or vice versa as there is theory and literature to support each potential pathway.

The social vulnerability perspective can be applied to identify mothers most at risk for experiencing food insecurity and depression[28,29]. While the social vulnerability perspective has consistently been used to study the impact of disasters or environmental hazards on health[30], the impact of experiencing chronic economic deprivation or poor mental health does not differ from experiencing a disaster. In both situations, vulnerability arises from limited or lack of social and economic resources[31]. Thus, the social vulnerability perspective suggests that a mother's social situation can be influenced by socio-economic factors, such as food insecurity, which can perpetuate health problems, such as depression. This is similar to the food inadequacy hypothesis, which is used to describe limited household resources, such as food insecurity, as a contributor of maternal depression[10]. On the other hand, a lack of resources needed to address depression could then exacerbate food insecurity experiences. For instance, grocery shopping and engaging in meal preparation may be difficult for mothers with depression[14,26]. Depressed mothers may be incapable of properly managing their children's meals due to fatigue associated with depression[18]. Finally, depression may impact a mother's ability to obtain and maintain a stable income, which precludes worrying about where the next meal will come from[24,32]. Thus, the mental health hypothesis states that the lack of household resources (i.e., food insecurity) is a consequence of maternal depression[10].

Studies evaluating the temporal directionality of the relationship between food insecurity and maternal depression are limited[33]. Using the Early Childhood Longitudinal Study Birth Cohort, Wu et al.[10] found that food insecurity mediated the relationship between socio-economic status and maternal depression, but maternal depression did not mediate the relationship of socio-economic status and food insecurity. Their findings supported the food inadequacy hypothesis (not the mental health hypothesis) among mothers residing in suburban and rural areas. On the other hand, Huddleston-Casas et al.[33] found a recursive relationship between food insecurity and depression over a 2-year period among low-income mothers residing in a rural area. While food insecurity and poverty are more prevalent in rural areas[34], research is lacking on investigating the directionality between food insecurity and maternal depression among urban, socio-economically disadvantaged mothers.

Using an urban sample of socio-economically disadvantaged mothers, who are at increased risk for experiencing food insecurity and depression[31], we evaluated the temporal directionality of the association between food insecurity and maternal depression over a 2-year period. Based on the research that supports the food inadequacy hypothesis where food insecurity predicts maternal depression[10], research that supports the mental health hypothesis where depression predicts food insecurity[23,25] and prior research that used an rural sample indicates a bidirectional relationship exists[33], we hypothesised that there is a bidirectional relationship between food insecurity and depression among an urban sample of socio-economically disadvantaged mothers. In other words, we expected that food insecurity would predict subsequent maternal depression and that maternal depression would predict subsequent food insecurity. Understanding the directionality of this relationship will inform programmes aimed at reducing rates of food insecurity or maternal depression.

Methods

Data

The current study data originated from the longitudinal Fragile Families and Child Wellbeing study, which comprised 4898 children born between 1998 and 2000 in twenty cities across the USA. By design, 75 % of the children were born to unmarried parents. In the original study, mothers and fathers were interviewed after the birth of the focal child in the study and then again when the child was 1, 3, 5, 9 and 15 years old (i.e., waves 1–6). In addition to the main interview survey, a subsample of mothers were assigned to an in-home assessment when the child was 3 and 5 years old. The in-home assessment included questions regarding household food insecurity that were not assessed in the main interview survey. Sampling and study design have been previously reported[35]. The current study used data from wave 3, which corresponds when the child was 3 years old (considered time 1), and wave 4, which corresponds when the child 5 years old (considered time 2), and demographic variables collected

only at baseline (e.g., race), which corresponds with the timing of the birth of the child. The sample consisted of 4897 mothers; one participant was excluded from the analyses due to missing data on all variables of interest.

Mothers with missing data differed from those with complete data on all variables of interest in several ways. Overall, mothers with missing data had higher levels of food insecurity at time 1 and time 2 ($P < 0.05$). A lower proportion of mothers with missing data were White or a race/ethnicity other than Black or Hispanic ($P < 0.05$), and a greater proportion were Black ($P < 0.001$). A lower proportion of the mothers with missing data were married/cohabitating with a new partner ($P < 0.001$); a greater proportion had less than a high school education ($P < 0.001$). A greater proportion of mothers with missing data were in the lowest federal poverty level (FPL) category ($P < 0.001$), and a lower proportion were in the highest FPL categories: FPL 2·00–2·99 ($P < 0.05$) and FPL ≥ 3.00 ($P < 0.001$). A greater proportion of mothers with missing data had public health insurance ($P < 0.001$); a lower proportion had private health insurance ($P < 0.001$). Incarceration of the focal child's father was more common among those with missing data ($P < 0.001$) than those with complete data on all variables of interest.

Measures

Maternal depression

Maternal depression at time 1 and time 2 was determined from mothers' responses to the fifteen-item Composite International Diagnostic Interview-Short Form[36]. The Composite International Diagnostic Interview-Short Form helps to determine major depression status based on the Diagnostic and Statistical Manual of Mental Disorders, fourth edition[37]. Example items in the Composite International Diagnostic Interview-Short Form include feeling sad/blue, having low energy or fluctuations in weight without trying during a 2-week period within the past 12 months. The Fragile Families and Child Wellbeing research team scored the Composite International Diagnostic Interview-Short Form and categorised whether women experienced depression or not[38].

Food insecurity

The household food security level was measured at time 1 and time 2 from mothers' responses to the eighteen-item USDA Household Food Security Survey Module questionnaire[1]. The scale determines food insecurity status by asking questions about food hardships related to a lack of financial resources or running out of food in the past 12 months[39]. Mothers with fewer than three affirmative responses were classified as food secure, and mothers who gave three or more affirmative response were categorised as food insecure[1].

Covariates

Covariates known to be related to both food insecurity and maternal depression were included in the analyses. Covariates included: teen mom status (teen mom (reference) *v.* not a teen mom (age ≥ 20 at focal child's birth), race/ethnicity (White/other (reference), Black or Hispanic), nativity status (foreign born *v.* native born (reference)), marital status (single/divorced/widowed (reference) *v.* married/cohabiting), education (less than high school, high school or greater (reference)), employment status (employed *v.* unemployed (reference)), household income based on the family income in relation to the federal poverty line (FPL) (FPL ≤ 0.99 (reference), 1·00–1·99, 2·00–2·99; FPL ≥ 3.00) health insurance (public health insurance (reference), private health insurance or uninsured), paternal incarceration (father has been incarcerated since child's birth *v.* father has not been incarcerated (reference)), child behaviour problems score (continuous)[40], parenting stress (continuous)[41] and co-parenting support (continuous)[42]. The mother's status as a teenager at the focal child's birth, along with her race/ethnicity, and nativity status were measured at baseline. All other covariates were assessed at time 1. The Department of Health and Human Services issues the FPL based on annual average estimates of the cost to cover basic needs. Income level for each participant was calculated by the Fragile Families and Child Wellbeing team where self-reported annual household income by the FPL corresponded to the number of individuals residing in the household.

Analyses

Descriptive statistics were calculated for the full sample and by food insecurity and depression status at time 1. Independent samples *t* tests and χ^2 analysis were used to determine differences by food insecurity and depression status using Stata SE statistical software version 15.0 (StataCorp). Two structural equation models were used to evaluate the impact of food insecurity on maternal depression (model 1) and the impact of maternal depression on food insecurity (model 2). Socio-demographic characteristics, child behaviour problems and parenting characteristics were included as covariates in all models to control for factors that may be related to food insecurity and maternal depression. In addition, models predicting depression (time 2) controlled for prior depression status (time 1) and concurrent food insecurity status (time 2); models predicting food insecurity (time 2) controlled for prior food insecurity status (time 1) and concurrent depression status (time 2). OR and unstandardised estimates are presented. Structural equation models were conducted in Mplus version 8.3 (Muthen & Muthen). The current study utilised fully saturated models to test our hypotheses informed by the literature; as such, model fit statistics are not available. Full information maximum likelihood was utilised to account for missing data.

Results

Sample characteristics

Table 1 presents descriptive statistics for the full analytic sample, by food security status and by depression status.

At time 1, 17 % of the mothers were food insecure and 21 % were depressed. At time 2, 15 % of the mothers were food insecure and 17 % were depressed. The majority of the mothers did not have the focal child as a teenager (83 %), were native born (83 %), were

Table 1 Descriptive statistics of sample and by food insecurity and depression status, M (SD) or %

	Full sample		Food insecurity (time 1)				Depression (time 1)			
			Food insecure		Food secure		Depressed		Not depressed	
	n 4897		n 559		n 2699		n 868		n 3353	
Dependent variables (time 2) (%)										
Food insecurity										
Food insecure	15		46		9‡		27		12¶	
Food secure	85		54		91		73		88	
Depression										
Depressed	17		30		15‡		43		10¶	
Not depressed	83		70		85		57		90	
Independent variables (time 1) (%)										
Food insecurity										
Food insecure	17		100		0		29		14¶	
Food secure	83		0		100		71		86	
Depression										
Depressed	21		36		19‡		100		0	
Not depressed	79		64		81		0		100	
Control variables (baseline) (%)										
Teen mom status										
Teen mom	17		19		18		18		18	
Not a teen mom	83		81		82		82		82	
Race/ethnicity										
White/other	25		18		27‡		25		26	
Black	48		51		48		53		47¶	
Hispanic	27		31		25†		22		27¶	
Nativity										
Native	83		83		86		89		84¶	
Foreign	17		17		14		11		16	
Control variables (time 1) (%)										
Marital status										
Single	39		50		37‡		48		36¶	
Married/cohabitating	61		50		63		52		64	
Education										
< High school	35		47		31‡		38		32‖	
≥ High school	65		53		69		62		68	
Employment										
Employed	56		46		57‡		47		58¶	
Unemployed	44		54		43		53		42	
Income based on FPL										
≤ 0·99	42		68		38‡		50		40¶	
1·00–1·99	25		21		26†		25		25	
2·00–2·99	14		7		15‡		11		14§	
≥ 3·00	19		4		21‡		13		21¶	
Health insurance										
Public	39		55		38‡		47		37¶	
Private	36		17		39‡		27		38¶	
Uninsured	25		28		23*		27		24	
Paternal incarceration										
Been incarcerated	44		60		42‡		52		41¶	
Not been incarcerated	56		40		58		48		59	
	Mean	SD	Mean	SD	Mean	SD	Mean	SD	Mean	SD
Child behaviour problems score	25·98	14·31	32·50	15·40	24·64	13·70‡	30·85	15·18	24·62	13·76¶
Parenting stress	2·25	0·67	2·52	0·72	2·20	0·65‡	2·52	0·68	2·18	0·65¶
Co-parenting support	21·19	4·09	19·97	4·57	21·35	3·94‡	19·78	4·75	21·54	3·83¶

*$P \leq 0.05$;
†$P \leq 0.01$;
‡$P \leq 0.001$ different from food insecure.
§$P \leq 0.05$;
‖$P \leq 0.01$;
¶$P \leq 0.001$ different from depressed.
Independent samples t tests (continuous) and χ^2 analysis (dichotomous) were used to determine differences among mothers by food insecurity and depression status.

married/cohabitating (61 %), had a high school diploma or greater (65 %) and were employed (56 %). Forty-two percentage of mothers reported incomes of FPL ≤ 0·99. Most mothers reported that they had public health insurance (39 %), while 36 % had private health insurance and 25 % were uninsured. Almost half (44 %) of the mothers reported that the focal child's father had been incarcerated. The average child behaviour problems score was 25·98 (SD 14·31), the average parenting stress score was 2·25 (SD 0·67) and the average co-parenting support score was 21·19 (SD 4·09).

Families who were food insecure at time 1 were more likely to experience food insecurity at time 2 (46 % v. 9 %; P ≤ 0·001). Similarly, mothers who experienced depression at time 1 were more likely to experience depression at time 2 (43 % v. 10 %; P ≤ 0·001). Mothers who resided in food insecure households at time 1 were more likely to experience depression at time 2 (30 % v. 15 %; P ≤ 0·001). Mothers who were depressed at time 1 were more likely to experience food insecurity at time 2 (27 % v. 12 %; P ≤ 0·001).

In general, mothers residing in food insecure households were more disadvantaged than mothers residing in food secure households. Racial differences existed by food insecurity status; a lower proportion of mothers living food insecure households were White/other (18 % v. 27 %; P ≤ 0·001. Compared with mothers residing in food secure households, a greater proportion of mothers living in food insecure households were single (50 % v. 37 %; P ≤ 0·001), less educated (less than high school: 47 % v. 31 %; P ≤ 0·001), had lower employment rates (46 % v. 57 %; P ≤ 0·001), had lower incomes (FPL ≤ 0·99: 68 % v. 38 %; P ≤ 0·001), reported greater rates of public health insurance (55 % v. 38 %; P ≤ 0·001), were more likely to be uninsured (28 % v. 23 %; P ≤ 0·05) and had lower rates of private health insurance (17 % v. 39 %; P ≤ 0·001). Paternal incarceration was more common among mothers residing in food insecure households (60 % v. 42 %; P ≤ 0·001). Mothers living in food insecure households also reported more child behaviour problems (32·50 (SD 15·40) v. 24·64 (SD 13·70); P ≤ 0·001), greater parenting stress (2·52 (SD 0·72) v. 2·20 (SD 0·65); P ≤ 0·001) and less co-parenting support (19·97 (SD 4·57) v. 21·35 (SD 3·94); P ≤ 0·001) compared with mothers living in food secure households.

In general, mothers experiencing depression were more disadvantaged than mothers who were not depressed. Racial differences existed by depression status; a greater proportion of depressed mothers were Black (53 % v. 47 %; P ≤ 0·001), and a lower proportion of depressed mothers were Hispanic (22 % v. 27 %; P ≤ 0·001). A greater proportion of depressed mothers were native born (89 % v. 84 %; P ≤ 0·001). The proportion of single mothers was higher among those who were depressed (48 % v. 36 %; P ≤ 0·001). Depressed mothers had lower employment rates (47 % v. 58 %; P ≤ 0·001) and lower incomes (FPL ≤ 0·99: 50 % v. 40 %; P ≤ 0·001, FPL ≥ 3·00: 13 % v. 21 %; P ≤ 0·001).

Depressed mothers reported greater rates of public health insurance (47 % v. 37 %; P ≤ 0·001) and lower rates of private health insurance (27 % v. 38 %; P ≤ 0·001). Paternal incarceration was more common among depressed mothers (52 % v. 41 %; P ≤ 0·001). Depressed mothers reported more child behaviour problems (30·85 (SD 15·18) v. 24·62 (SD 13·76); P ≤ 0·001), greater parenting stress (2·52 (SD 0·68) v. 2·18 (SD 0·65); P ≤ 0·001) and less co-parenting support (19·78 (SD 4·75) v. 21·54 (SD 3·83); P ≤ 0·001) compared with their non-depressed counterparts.

Bidirectional analyses of the food insecurity–maternal depression relationship

The model evaluating the food inadequacy hypothesis is depicted in Fig. 1. Food insecurity at time 1 was associated with 36 % increased odds (OR = 1·36; B = 0·31; P < 0·05) of maternal depression at time 2, controlling for prior depression status (OR = 5·12; B = 1·63; P < 0·001), concurrent food insecurity (OR = 1·81; B = 0·59; P < 0·001) and covariates (not pictured). Other paths in the model indicated that food insecurity at time 1 was a significant predictor of concurrent maternal depression (B = 0·11; P < 0·001). In addition, food insecurity (OR = 5·84; B = 1·76; P < 0·001) and maternal depression (OR = 1·82; B = 0·60; P < 0·001) at time 1 significantly predicted food insecurity at time 2.

The model examining the mental health hypothesis is depicted in Fig. 2. Maternal depression at time 1 was associated with 53 % increased odds (OR = 1·53; B = 0·43; P < 0·001) of food insecurity at time 2, controlling for
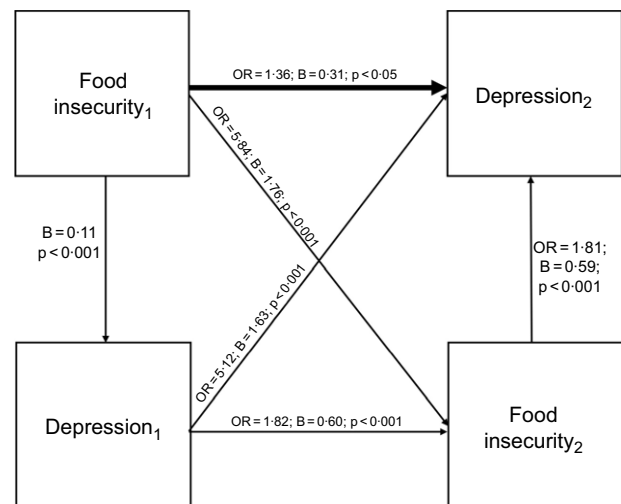
Fig. 1 Model depicting food inadequacy hypothesis: food insecurity predicting maternal depression over a 2-year period (n 4897). Main path of interest is bolded in the figure. The following covariates were included in the analysis but not included in the figure: teen mom status, race/ethnicity native status, marital status, education, employment status, household income based on the family income in relation to the federal poverty line (FPL), health insurance, paternal incarceration, child behaviour problems score, parenting stress and co-parenting support. This is a fully saturated model; as such, model fit statistics are not available
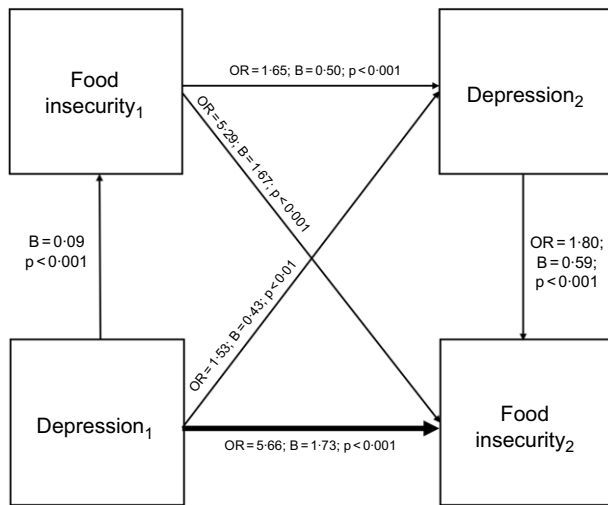
Fig. 2 Model depicting mental health hypothesis: maternal depression predicting food insecurity over a 2-year period (*n* 4897). Main path of interest is bolded in the figure. The following covariates were included in the analysis but not included in the figure: teen mom status, race/ethnicity native status, marital status, education, employment status, household income based on the family income in relation to the federal poverty line (FPL), health insurance, paternal incarceration, child behaviour problems score, parenting stress and co-parenting support. This is a fully saturated model; as such, model fit statistics are not available

prior food insecurity status (OR = 5·66; B = 1·73; $P < 0.001$), concurrent depression (OR = 1·80; B = 0·59; $P < 0.001$) and covariates (not pictured). Additional paths in the model suggested that maternal depression at time 1 was a significant predictor of concurrent food insecurity (B = 0·09; $P < 0.001$). Maternal depression (OR = 5·29; B = 1·67; $P < 0.001$) and food insecurity (OR = 1·65; B = 0·51; $P < 0.001$) at time 1 significantly predicted maternal depression at time 2.

Discussion

The purpose of the current study was to evaluate the temporal relationship between food insecurity and maternal depression over a 2-year period. Our findings support our hypothesis that there is a bidirectional relationship between food insecurity and maternal depression[33]. The results support both the mental health hypothesis and the food inadequacy hypothesis[10].

According to the mental health hypothesis, a lack of household resources (i.e., food insecurity) is a consequence of maternal depression. This can be explained through the ways in which depressive symptoms impact a mother's ability to manage her family's resources. Depressive symptoms such as fatigue may make necessary chores such as grocery shopping and meal preparation difficult for mothers[14,18,26,43]. Maternal depression likely has a large impact on the financial stability of the family,

as it may inhibit mothers from obtaining and maintaining a stable income[24,32]. Further the costs associated with managing depression (e.g., medical assistance, medication) may tax the family's limited income, putting the household at increased risk of food insecurity.

Our findings also supported the food inadequacy hypothesis[10]. Maternal depression was predicted by prior food insecurity experiences. This finding aligns with previous studies, which found that food insecurity was predictive of depression[10,11]. Overall, 46 % of those who were food insecure at time 1 remained so at time 2. Further, 74 % of mothers classified as depressed at time 1 remained so at time 2. The cumulative experiences of food insecurity and depression sustained over a period of time may impact mothers differently than acute exposure. This aligns with the accumulation of adversity model, which suggests that persistent exposure to adversity (e.g., food insecurity) over the life course places individuals at increased risk for negative health outcomes (e.g., depression)[44].

To our knowledge, only one previous study specifically aimed to assess the directionality of the relationship between food insecurity and maternal depression[33]. Our research findings aligned with Huddleston-Casas et al.[33], who also found a bidirectional relationship between food insecurity and maternal depression. The results remained consistent despite differences in the study populations. Our sample consisted of urban, socio-economically disadvantaged mothers of young children (age 3 at time 1 and age 5 at time 2); Huddleston-Casas et al.[33] included a small sample of rural women with children under age 13. Food insecurity differs in urban compared with rural areas, with rural areas experiencing greater poverty and high rates of food insecurity[34]. Additionally, differences in methodology existed. We used structural equation models to analyse two waves of data, whereas Huddleston-Casas et al.[33] used structural equation models to analyse three waves of data, and Wu et al.[10] used autoregressive cross-lagged models to analyse three to four waves of data. The consistency of these findings despite differing study populations and methodology strengthens our confidence in the results. However, future studies evaluating these relationships among a variety of demographically diverse study samples are needed to fully elucidate the temporal process of food insecurity and maternal depression.

The findings from the current study indicate that to adequately address food insecurity, maternal depression should also be addressed and to adequately address maternal depression, food insecurity should also be addressed. Simply providing mothers with access to additional food resources (such as Supplemental Nutrition Assistance Program or the Special Supplemental Nutrition Program for Women, Infants and Children) may not be enough to adequately address and overcome food insecurity. If depressive symptoms prevent mothers from managing and preparing meals for their families, simply providing

them with food is an inadequate strategy. A more holistic approach that combines mental health services with food resources may be necessary for mothers to improve depressive symptoms and manage/overcome food insecurity. Similarly, previous researchers found that access to food assistance programmes (e.g., Supplemental Nutrition Assistance Program) buffered the association between food insecurity and maternal depression[11]. While our findings indicate that a holistic approach that combines food assistance and mental health services may better address food insecurity, additional studies are needed. Specifically, randomised controlled trials evaluating the efficacy of mental health services, food assistance programmes or a combination of both to address food insecurity and maternal depression are needed.

Strengths and limitations

The current study used a longitudinal approach to answer an important research question regarding the association between food insecurity and maternal depression. Understanding this relationship is necessary to protect this vulnerable population from depression and reduce its negative and long-lasting impact on children. However, the study did have some limitations. Due to the nature of secondary data, we were only able to include two time points, as food insecurity was only assessed at two time points. Future studies evaluating the relationship of food insecurity and maternal depression across multiple time points will give researchers more confidence in the pattern of this relationship. In addition, mothers self-reported on all the variables of interest. The findings may have been different if additional reporters had been included. Also, both main topics are of a sensitive nature and may be particularly prone to response bias. Nonetheless, the measures used to assess food insecurity[1] and maternal depression[36] are well established and accepted in the literature. Further, the study sample is not representative of all mothers as it only includes low-income urban mothers in the USA and purposive sampling was used by the parent study to oversample unmarried mothers. Findings may differ among mothers who are socio-economically or culturally different from the participants in this study. However, the findings are particularly relevant to this population who is at risk of experiencing food insecurity.

Conclusion

The results of this study indicate that there is a bidirectional relationship between food insecurity and maternal depression. This is an informative public health discovery because it indicates that incorporating food assistance programmes and mental health services may be beneficial for low-income mothers. Providing mothers seeking food assistance with information regarding accessing mental health services, in addition to screening for food insecurity and providing food assistance resources to low-income mothers seeking mental health services, may be a more efficacious approach to reducing chronic food insecurity as well as maternal depression.

References

1. Coleman-Jensen A, Rabbitt M, Gregory C *et al.* (2019) *Household food insecurity in the United States in 2018 [ERR-270].* Washington, DC: United States Department of Agriculture Economic Research Service.
2. Gundersen C & Ziliak JP (2015) Food insecurity and health outcomes. *Health Affairs* **34**, 1830–1839.
3. Maynard M, Andrade L, Packull-McCormick S *et al.* (2018) Food insecurity and mental health among females in high-income countries. *Int J Environ Res Public Health* **15**, 1424.
4. Heflin CM (2005) Food insufficiency and women's mental health: findings from a 3-year panel of welfare recipients. *Social Sci Med* **61**, 1971–1982.
5. Siefert K, Heflin CM, Corcoran ME *et al.* (2001) Food insufficiency and the physical and mental health of low-income women. *Women Health* **32**, 159–177.

6. Siefert K, Heflin CM, Corcoran ME et al. (2004) Food insufficiency and physical and mental health in a longitudinal survey of welfare recipients. J Health Social Behav 45, 171–186.

7. Kaiser L (2007) Who is food-insecure in California? Findings from the California Women's Health Survey, 2004. Public Health Nutr 10, 574–581.

8. Sharpe PA, Whitaker K, Alia KA et al. (2016) Dietary intake, behaviors and psychosocial factors among women from food-secure and food-insecure households in the United States. Ethnicity Dis 26, 139.

9. Hernandez DC (2014) Maternal depression mediates the association between intimate partner violence and food insecurity. J Women's Health 23, 29–37.

10. Wu Q (2018) Family socioeconomic status and maternal depressive symptoms: mediation through household food insecurity across five years. Social Sci Med 215, 1–6.

11. Munger AL (2016) The role of the supplemental nutrition assistance program in the relationship between food insecurity and probability of maternal depression. J Hunger Environ Nutr 11, 147–161.

12. Dietz PM, Williams SB, Callaghan WM et al. (2007) Clinically identified maternal depression before, during, and after pregnancies ending in live births. Am J Psychiatr 164, 1515–1520.

13. Center on the Developing Child at Harvard University (2009) Maternal Depression can Undermine the Development of Young Children: Working Paper No. 8. Cambridge, MA: Harvard University.

14. Casey P, Goolsby S, Berkowitz C et al. (2004) Maternal depression, changing public assistance, food security, and child health status. Pediatrics 113, 298–304.

15. Stein A, Malmberg LE, Sylva K et al. (2008) The influence of maternal depression, caregiving, and socioeconomic status in the post-natal year on children's language development. Child: Care Health Dev 34, 603–612.

16. Narayanan MK & Naerde A (2016) Associations between maternal and paternal depressive symptoms and early child behavior problems: testing a mutually adjusted prospective longitudinal model. J Affective Disord 196, 181–189.

17. Whitaker RC (2006) Food insecurity and the risks of depression and anxiety in mothers and behavior problems in their preschool-aged children. Pediatrics 118, e859–868.

18. Leschied AW, Chiodo D, Whitehead PC et al. (2005) The relationship between maternal depression and child outcomes in a child welfare sample: Implications for treatment and policy. Child Fam Soc Work 10, 281–291.

19. Bronte-Tinkew J, Zaslow M, Capps R et al. (2007) Food insecurity works through depression, parenting, and infant feeding to influence overweight and health in toddlers. J Nutr 137, 2160–2165.

20. Hromi-Fiedler A, Bermúdez-Millán A, Segura-Pérez S et al. (2011) Household food insecurity is associated with depressive symptoms among low-income pregnant Latinas. Matern Child Nutr 7, 421–430.

21. Mathews L, Morris MN, Schneider J et al. (2010) The relationship between food security and poor health among female WIC participants. J Hunger Environ Nutr 5, 85–99.

22. Zekeri AA (2010) Household food insecurity and depression among single mothers in rural Alabama. J Rural Soc Sci 25, 90–102.

23. Noonan K (2016) Effects of maternal depression on family food insecurity. Econ Hum Biol 22, 201–215.

24. Corman H, Curtis MA, Noonan K et al. (2016) Maternal depression as a risk factor for children's inadequate housing conditions. Social Sci Med 149, 76–83.

25. Garg A, Toy S, Tripodis Y et al. (2015) Influence of maternal depression on household food insecurity for low-income families. Acad Pediatr 15, 305–310.

26. Melchior M, Caspi A, Howard LM et al. (2009) Mental health context of food insecurity: a representative cohort of families with young children. Pediatrics 124, e564–572.

27. Laraia BA (2009) Grandmothers, fathers, and depressive symptoms are associated with food insecurity among low-income first-time African-American mothers in North Carolina. J Am Dietetic Assoc 109, 1042–1047.

28. Andrew MK & Keefe JM (2014) Social vulnerability from a social ecology perspective: a cohort study of older adults from the National Population Health Survey of Canada. BMC Geriatr 14, 90.

29. Cutter SL, Boruff BJ & Shirley WL (2003) Social vulnerability to environmental hazards. Soc Sci Quarterly 84, 242–261.

30. Peek L & Stough LM (2010) Children with disabilities in the context of disaster: a social vulnerability perspective. Child Dev 81, 1260–1270.

31. Morrow BH (1999) Identifying and mapping community vulnerability. Disasters 23, 1–18.

32. Lerner D & Henke RM (2008) What does research tell us about depression, job performance, and work productivity?. J Occup Environ Med 50, 401–410.

33. Huddleston-Casas C (2009) Food insecurity and maternal depression in rural, low-income families: a longitudinal investigation. Public Health Nutr 12, 1133–1140.

34. Food Research & Action Center (2018) Rural hunger in America: get the factors. https://frac.org/wp-content/uploads/rural-hunger-in-america-get-the-facts.pdf (accessed May 2020).

35. Reichman NE, Teitler JO, Garfinkel I et al. (2001) Fragile families: sample and design. Children Youth Serv Rev 23, 303–326.

36. Kessler RC, Andrews G, Mroczek D et al. (1998) The World Health Organization composite international diagnostic interview short-form (CIDI-SF). Int J Methods Psychiatr Res 7, 171–185.

37. American Psychiatric Association (1994) Diagnostic and Statistical Manual of Mental Disorders. DSM-IV. Washington, DC: American psychiatric association.

38. Bendheim-Thoman Center for Research on Child Wellbeing (2018) User's Guide for Fragile Families and Child Wellbeing Study Public Data, Year 9. https://fragilefamilies.princeton.edu/sites/fragilefamilies/files/year_9_guide.pdf (accessed November 2018).

39. Bickel G, Cristofer P, William H et al. (2000) Guide to Measuring Household Food Security. Alexandria, VA: United States Department of Agriculture, Food and Nutrition Service.

40. Achenbach T (1992) Manual for the Child Behavior Checklist 2/3 years. Burlington, VT: University of Vermont, Department of Psychiatry.

41. Abidin R (1995) Parent Stress Inventory. Odessa, FL: Psychological Assessment Resources.

42. Choi JK & Becher EH (2018) Supportive coparenting, parenting stress, harsh parenting, and child behavior problems in nonmarital families. Family Process Published online: 20 June 2018. doi: 10.1111/famp.12373.

43. Kaplan SJ (1999) Child and adolescent abuse and neglect research: a review of the past 10 years. Part I: physical and emotional abuse and neglect. J Am Acad Child Adolesc Psychiatr 38, 1214–1222.

44. Evans GW, Chen E, Miller G et al. (2012) How Poverty gets under the Skin: a Life Course Perspective. The Oxford Handbook of Poverty, Child Development. Oxford: Oxford University Press.

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