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EDITED BY
Ginny Lane,
University of Idaho, United States

REVIEWED BY
Edward Frongillo,
University of South Carolina,
United States
Mojtaba Shafiee,
University of Saskatchewan, Canada

*CORRESPONDENCE
Sarah A. Misyak
✉ smisyak@vt.edu

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Developing a conceptual framework for the relationship between food security status and mental health among low-income mothers

Rachel A. Liebe[1], Leah M. Adams[2], Valisa E. Hedrick[1], Elena L. Serrano[1,3], Kathleen J. Porter[4], Natalie E. Cook[5] and Sarah A. Misyak[1,3]*

[1]Department of Human Nutrition, Foods, and Exercise, Virginia Tech, Blacksburg, VA, United States, [2]Department of Psychology and Women and Gender Studies Program, George Mason University, Fairfax, VA, United States, [3]Virginia Cooperative Extension's Family Nutrition Program, Virginia Tech, Blacksburg, VA, United States, [4]Department of Public Health Sciences, School of Medicine, University of Virginia, Christiansburg, VA, United States, [5]Department of Population Health Sciences, Virginia Tech, Blacksburg, VA, United States

Introduction: Building household resiliency is one strategy that may help insulate households from the effects of food system volatility that contributes to in food insecurity. A stronger understanding of the relationship between food security and mental health is needed to identify potential factors for intervention to improve household resiliency to food system stressors. Because mothers often make household food decisions, they are an important population for building household resiliency. The purpose of this study was to develop and test a conceptual framework for the relationship between food security and mental health for low-income mothers and to identify potential targets for intervention.

Methods: A conceptual framework was developed based on the existing literature on mental health and food security, as well as factors that impact both constructs. This framework was tested by a path analysis using data from a 2021 cross-sectional survey of low-income Virginia mothers that used validated scales to assess food security status, indicators of mental and physical health, food coping strategies, and social support.

Results and discussion: The initial model was systematically adapted to develop the final retained model. The retained model did not include a direct effect of food security on mental health, but highlighted two significant mediators of the relationship, food coping strategies and social support. While the effect of social support was not practically significant, the effects of food coping strategies as a mediator from food security to perceived stress and life satisfaction were small (β = 0.21, 0.14, respectively; $p < 0.001$). The retained model provides a framework for understanding the relationship between food security and mental health and highlights potential targets for

intervention. Notably, reducing the need for mothers to utilize food coping strategies should be targeted on multiple levels to reduce the impact on mental health and ultimately improve resiliency to future food system shocks.

KEYWORDS

food security, mental health, maternal health, conceptual framework, social support

1. Introduction

The COVID-19 pandemic exposed concerning vulnerabilities in the United States (U.S.) food system (Béné, 2020). Disruption in food supply chains, distribution challenges, and increased food prices all caused challenges for consumers, particularly those with fewer resources (Weersink et al., 2021). While efforts to build a more resilient/robust food system with fewer vulnerabilities are needed, improving household resiliency to volatility in the short term can help mitigate the negative effects of shocks to the food system for families and potentially improve their food security status.

Overall household resiliency defines a household's capacity to protect itself from and withstand stressors, such as an unexpected food supply issue. Households have a variety of both physical and intangible resources that impact resiliency, including financial resources, food coping strategies, and social support (Hobfoll et al., 2018). Shocks that result in a household experiencing food insecurity may result in long-term consequences caused by changes in dietary choices and stress, such as decreased diet quality, poor physical health, and mental distress (Ansah et al., 2019). Identifying strategies that build household resiliency can help insulate households from future shocks resulting from food system volatility and mutually address other concerns, such as the impact of food insecurity and other stressors on mental health status.

We focus on the understanding of this relationship in a United States (US) context because the lived experience of food insecurity differs between countries based on a number of factors including food-related norms, livelihood expectations, and food system stability (FAO, 2018). Smith et al. (2017) noted that because of some differences in predictors of food insecurity across World Bank development rankings, policies to address food insecurity should be country-specific. There is general evidence that shows a relationship between food insecurity and mental health in the US, with factors including physical health, behavioral food coping strategies, and social support associated with both components (Melchior et al., 2009; Gundersen and Ziliak, 2014; Pinard et al., 2016; Frongillo et al., 2017; Maynard et al., 2018; Arenas et al., 2019; Myers, 2020; Liebe et al., 2022). Poor physical health and behavioral food coping strategies, especially those that involve acquiring food in stigmatized ways, have both been correlated with food insecurity, negative mental health effects, and reduced quality of life (Weiser et al., 2011; Franklin et al., 2012; Gundersen and Ziliak, 2014, 2018; Jessiman-Perreault and McIntyre, 2017; Jones, 2017; Na et al., 2019; Elgar et al., 2021; Liebe et al., 2022). The literature suggests social support may mitigate some of the negative mental health outcomes for people experiencing food insecurity (Wehler et al., 2004; Siefert et al., 2007; Ajrouch et al., 2010; Hanson and Olson, 2012; Heberlein et al., 2016; Palar et al., 2018). Despite evidence suggesting these factors' involvement in the relationship between food security and mental health, more information is needed to elucidate potential causal pathways among mothers with children in their households in a US context.

Female heads of household (mothers) are a priority population for interventions designed to strengthen household resiliency to food systems shocks. Single-headed female households are more likely than any other household type to experience food insecurity (USDA Economic Research Service, 2021). Among households with children, mothers typically make food decisions to spare others within their household, such as reducing the quality or quantity of their diet (Myers, 2020). The existing research on the mental health of mothers experiencing food insecurity suggests that they are more likely to have a diagnosed mental illness or symptoms of mental illness than mothers who experience food security (Whitaker et al., 2006; Maynard et al., 2018; Tuthill et al., 2019; Zekeri, 2019; Cameron et al., 2020). Additionally, mothers experiencing food insecurity report higher levels of stress, anxiety, and depression than the U.S. average (Liebe et al., 2022). Stress associated with food insecurity may contribute to changes in parenting behavior that ultimately impact children in the household, such as reported increases in the children's risk of depression and anxiety (McIntyre et al., 2003; Ashiabi and O'Neal, 2008; Melchior et al., 2009; Nagata et al., 2019).

Given that mothers are more likely to experience food insecurity and negative mental health outcomes than average, the complex relationship between food insecurity and mental health needs to be better understood to identify opportunities to build household resiliency. This study aimed to develop a conceptual framework for understanding the pathways between food insecurity and mental health outcomes for low-income mothers. We sought to identify pathways including factors that may mediate this relationship as potential areas for future intervention.

2. Methods

A hypothesized conceptual framework of the relationship between food insecurity and mental health outcomes was

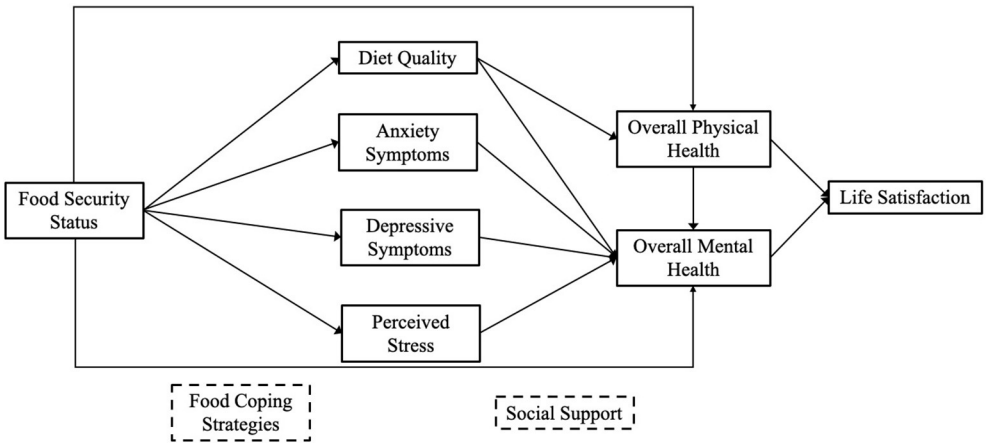

FIGURE 1
Hypothesized conceptual framework of the relationship between food insecurity and mental health for mothers. Solid lines indicate a path between two constructs. Dashed boxes indicate a strategy that may act as a mediator in the pathways directly above. For example, food coping strategies may mediate the relationship between food security status and diet quality, anxiety symptoms, depressive symptoms, and perceived stress. However, food security status was hypothesized to directly impact those outcomes.

developed based on a review of the existing literature (Figure 1). This conceptual framework was used to develop measures for a cross-sectional survey to understand the factors impacting the relationship between food security and mental health for low-income mothers in Virginia. Methods were approved by the Virginia Tech Institutional Review Board.

2.1. Cross-sectional survey

A cross-sectional survey was self-administered *via* Qualtrics (Provo, Utah) from August through October 2021. The methods used to conduct the survey have been described in detail elsewhere (Liebe et al., 2022). The following sections provide a brief overview of the survey.

2.1.1. Participants

Qualtrics identified potential respondents using existing survey panels and listservs. Eligible respondents were low-income adults living in Virginia that identified their gender as a woman or non-binary with children under 18 years old living in their household, and English-speaking. The survey was pre-tested with fifty participants and minor alterations were made to improve the survey flow.

2.1.2. Measures

Food security status was assessed using the 18-item U.S. Department of Agriculture (USDA) Household Food Security Module (Bickel et al., 2000). Scores ranged from 0 to 18, with higher scores indicating worse food security status. Participants were categorized as high, marginal, low, or very low food security based on the thresholds outlined by Bickel and colleagues (Bickel et al., 2000). General physical health and diet quality were assessed with two single-item, validated questions (DeSalvo et al., 2005; Loftfield et al., 2015). Both were rated on a Likert-type scale from 1 (poor) to 5 (excellent).

Mental health and symptoms of mental illness were assessed using scales from the Patient Reported Outcome Measurement Information System (PROMIS). Overall mental health was assessed using the two-item Global Mental Health 2a Scale v1.2, anxiety symptoms were assessed using the four-item Emotional Distress v1.0—Anxiety—Short Form 4a, and depressive symptoms were assessed with Emotional Distress v1.0—Depression—Short Form 4a (Pilkonis et al., 2011, 2014; Hays et al., 2017). Perceived stress over the past month was measured with the National Institutes of Health (NIH) Toolbox Perceived Stress—Adults tool (Kupst et al., 2015). There was no specific timeframe for overall mental health. Anxiety and depression were measured over the past 7 days and perceived stress over the past 30 days. Raw scores from the PROMIS and NIH Toolbox measure were converted to T-scores in which 50 represents the mean for the U.S. general population, with a standard deviation of 10. Higher scores indicated more of the concept being measured (e.g., higher scores indicated greater overall mental health, higher scores indicated greater depressive symptomatology). The final mental health measure, life satisfaction (no specific timeframe), was assessed using the 5-item Satisfaction with Life Scale (Pavot and Diener, 2008). Each item was measured using a Likert-type scale from strongly disagree (1) to strongly agree (7) and scores were summed across all items for scores ranging from 5 to 35.

Social support was measured using a modified version of the 10-item Duke Social Support Inventory (Pachana et al., 2008). Higher scores indicated a greater level of total social

support on a scale from 10 to 30. Food coping strategies were assessed using the Hunger Coping Scales (Pinard et al., 2016). This 15-item scale measures three types of strategies: tradeoffs, financial, and rationing. Scores on each subscale were summed to develop a total coping strategies score on a scale from 0 to 15. Demographic data were also collected with individual questions.

2.2. Analysis

A path analysis was performed using R version 4.1.2 (R Core Team, Vienna, Austria). The hypothesized model (Figure 1) was tested and adapted based on modification indices. The model was intended to provide an initial framework for the relationship between food security and mental health, as it is based on cross-sectional data. As outlined in the introduction, there is significant evidence to support that people experiencing food insecurity are more likely to experience poor mental health, which provides a theoretical justification for the proposed direction of the relationship between food security and mental health status. Although there is some evidence suggesting the relationship between depressive symptoms and food insecurity may be bidirectional (Maynard et al., 2018), it is unlikely that there would be an impact of reverse causality in this case because the time window measuring depression is so short (previous 7 days) compared to the time window for measuring food security status (previous 12-months). Therefore, based on the conceptual and statistical relationship, the direction of model flow is appropriate. Regression was used to determine if there was an interaction between food security and potential mediators.

Model fit was assessed using the Comparative Fit Index (CFI), Root Mean Square Error of Approximation (RMSEA), and Chi-Square. A CFI $>$ 0.90 is considered an acceptable fit (Bentler and Bonett, 1980). RMSEA of 0.05 or less is considered a close fit, 0.08 or less as a reasonable fit, and $>$0.10 represents a model with poor fit (Browne and Cudeck, 1993). A non-significant chi-square test is indicative of good model fit, however, chi-square is sensitive to sample size, and thus this threshold is often not met with large samples (Smith and McMillan, 2001). Standardized regression coefficients (β) were reported for each relationship. Absolute values of β were used to estimate effects, and thresholds were set for small ($>$0.10), medium ($>$0.30), and large ($>$0.50) effects (Cohen, 1988). The threshold for statistical significance was set *a priori* at $p \leq 0.05$.

3. Results

3.1. Survey respondent demographics

Survey participants (n = 1,029) were an average of 34.0 ± 9.8 years old but age ranged from 18 and 80 years old.

TABLE 1 Demographics of low-income Virginia mothers that completed the mental health and food security survey (n = 1,029).

Demographic characteristics	Mean ± SD or *n* (%)
Age, years	34.0 ± 9.8
Highest education completed	
Less than high school	70 (6.8)
High school or GED	410 (39.8)
Some college	319 (31.0)
Associate's	119 (11.6)
Bachelor's	85 (8.3)
Postgraduate	26 (2.5)
Race	
White	670 (65.1)
Black or African American	239 (23.2)
Asian	26 (2.5)
Two or more races	52 (5.1)
Other	42 (4.1)
Ethnicity	
Hispanic	100 (9.7)
People in household	4.2 ± 1.7
Children living in household	2.0 ± 1.1
Child age, years	7.6 ± 5.2
Annual household income, $	25,000 ± 16,032
Food security status[a]	
High	174 (16.9)
Marginal	128 (12.4)
Low	269 (26.1)
Very low	458 (44.5)

[a]Food security was measured using United States Department of Agriculture Household Food Security Module.

Most respondents (77.6%, n = 799) reported their education as some college or less. More than two-thirds of respondents had experienced low or very low food security in the past 12 months. Almost two-thirds (65.0%, n = 673) identified as white and 23.4% (n = 242) identified as Black or African American. Additionally, 9.7% (n = 100) of respondents identified as Hispanic or Latino (see Table 1).

3.2. Model selection

The proposed model (Figure 1) was a poor fit for the data [CFI = 0.59; RMSEA = 0.28; $X^2_{(df=23,\ n=1,029)} = 1{,}885.86$, $p < 0.001$]. The poor fit may have been a result of the time

frames of the mental health indicators. Overall mental health was measured without a specific time frame, whereas anxiety and depressive symptoms and stress were measured on specific timeframes (7 days and 1 month, respectively). Therefore, in the next model, mental health symptoms were switched so the model's specification was consistent with the measures' timeframes, with the most proximal mental health measures as outcomes. This reorganized mode was supported by the modification indices, which suggested this had the highest expected parameter change. This model had a CFI of 0.93 and RMSEA of 0.13, and $X^2_{(18,1,029)} = 349.40$, $p < 0.001$ indicating a better, but still poor fit. In the next series of models, changes were made systematically based on the modification indices. The potential pathways from food security to mental health symptoms (anxiety, depression, and stress) and diet quality, independent of food coping strategies, were systematically removed. This model had a CFI of 0.93, an RMSEA of 0.14, and $X^2_{(21,1,029)} = 355.20$, $p < 0.001$. Additionally, pathways from social support to diet quality and life satisfaction were added. The retained model (Figure 2 and Table 2) had a CFI of 0.97, an RMSEA of 0.086, and $X^2_{(20,1,029)} = 171.90$, $p < 0.00$.

3.3. Retained model

In the retained model, food security had a large negative effect on food coping strategies ($\beta = -0.76$, $p < 0.001$) indicating that improved food security status was associated with fewer food coping strategies. Additionally, there was a small positive effect of food security status on social support ($\beta = 0.27$, $p < 0.001$). While food security was also associated with overall physical health, this relationship was practically insignificant (0.10, $p < 0.001$). Therefore, this pathway was not included in the retained model (Figure 2).

Two mediators in the relationship between food security and mental health outcomes emerged. No significant interactions were found between food security and either mediator for any of the pathways. Social support mediated the relationship between food security and overall mental health, but this effect was not practically significant ($\beta = 0.06$, $p < 0.001$). Similar results were seen for the effect on life satisfaction ($\beta = 0.05$, $p < 0.001$). The second mediator was food coping strategies, which impacted anxiety and depressive symptoms, perceived stress, and life satisfaction. The findings indicated food coping strategies mediated the relationship between food security and both anxiety and depressive symptoms, although these effects were small ($\beta = 0.26$ for both, $p < 0.001$). Food coping strategies also acted as a mediator on perceived stress and life satisfaction; these indirect effects were small ($\beta = 0.21$, 0.14, respectively; $p < 0.001$).

4. Discussion

The purpose of this study was to develop and test an initial conceptual framework of the relationship between food security and mental health for low-income mothers. Factors associated with the relationship had been identified in the literature, but potential pathways had not been explored. Importantly, the findings of this study suggest no direct effect of food security status on mental health outcomes, which was part of the initial framework based on the literature. We identified two mediators, with food insecurity impacting mental health through food coping strategies and social support. Understanding these pathways is critical because they can be targeted through future interventions to improve household resiliency for future food system instability.

4.1. Food coping strategies role in mental health

The findings of this study suggest reliance on food coping strategies is more common among people experiencing food insecurity and may potentially contribute to feelings of anxiety, depression, and perceived stress symptoms. These findings reflect previous literature suggesting mothers who utilize food coping strategies, compounded by poor mental health and stress, may also suffer from lower household resilience and other adverse consequences (Hobfoll et al., 2018; Ansah et al., 2019). Furthermore, as mothers experiencing food insecurity rely on more food coping strategies, they may also experience greater symptoms of mental illness and stress (Puddephatt et al., 2020).

People experiencing poor mental health may not be able to build the necessary resilience capacity to respond as effectively to future crises, which is problematic for overall food system stability as more households could remain food insecure (Ansah et al., 2019). The link between current resiliency and future food security status is supported by literature from countries other than the U.S. suggesting current household resiliency levels positively correlate with food security status during future shocks (Lokosang et al., 2014; d'Errico et al., 2018; Ansah et al., 2019). Furthermore, the current capacity to handle an unanticipated crisis is related to the ability of the household to adapt practices (e.g., seeking alternative income sources), to prevent future shocks from impacting the household (Ansah et al., 2019). Because mothers may be forced to rely on these strategies to prevent reductions in food quantity, mitigating the negative effects may depend on multi-level interventions. On a systemic level, increased monetary assistance may reduce the financial burden preventing mothers from building household resiliency. On an individual level, strategies to help build self-efficacy

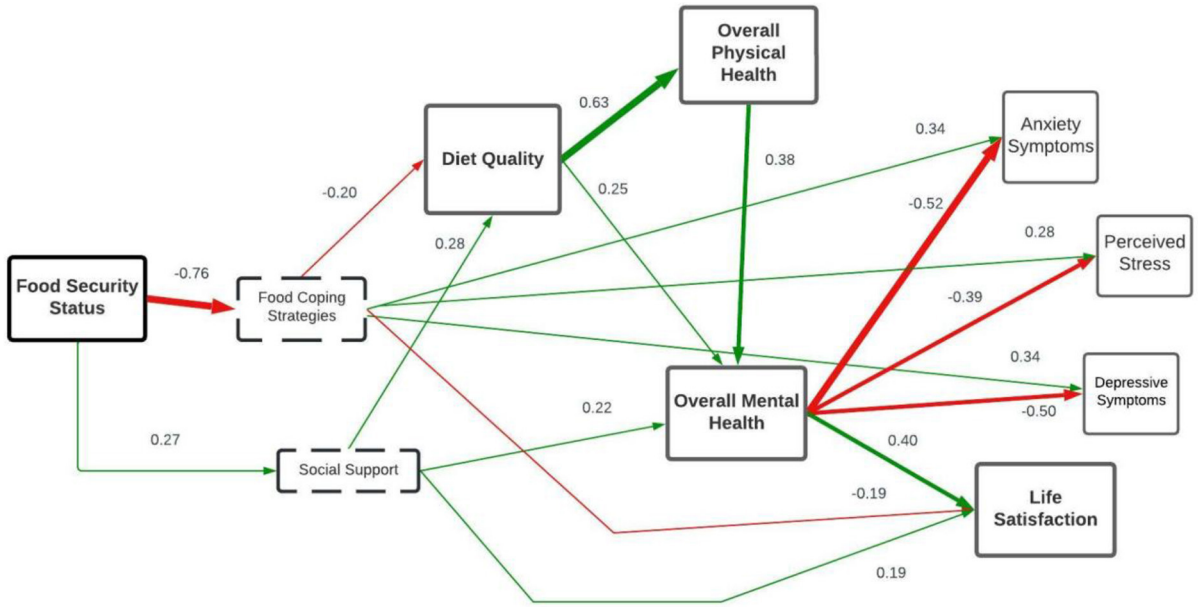

FIGURE 2
Path model with standardized regression coefficients for relationship between food insecurity and mental health among low-income mothers ($n = 1{,}029$). Figure is excluding pathways that had a negligible effect size ($f^2 < 0.02$). Line thickness designates effect size, with a large effect indicated by the thickest lines. Line color indicates whether the relationship is positive (green) or negative (red). Dashed boxes represent strategies for addressing food insecurity. Tools used to assess measures: Food Security—United States Department of Agriculture Household Food Security Module; Social Support—Modified Duke Social Support Inventory; Food Coping Strategies—Hunger Coping Scales; overall mental health—Patient Reported Outcomes Measurement Information System (PROMIS) Global Mental 2a Scale v1.2; Anxiety—PROMIS Emotional Distress v1.0—Anxiety—Short Form 4a; Depression—PROMIS Emotional Distress v1.0—Depression—Short Form 4a. Stress—National Institutes of Health Toolbox Perceived Stress for Adults; Life Satisfaction—Satisfaction with Life Scale; Overall Physical Health—one-item Likert-type scale (DeSalvo et al., 2005); Diet Quality—one-item Likert-type scale (Loftfield et al., 2015).

related to food resource management, through federally-funded nutrition education programs like Supplemental Nutrition Assistance Program-Education or the Expanded Food and Nutrition Education Program, may improve resiliency in response to future stressors (Kaiser et al., 2015; Ansah et al., 2019). These strategies may simultaneously improve resiliency and reduce the need for food-coping strategies in the future.

4.2. Psychosocial resources may provide iterative opportunities for intervention

Psychosocial resources, which include social support, life satisfaction, and optimism, have considerable overlap with personal resources known to impact household resiliency (Boehm et al., 2015; Ansah et al., 2019). Though the current model was not designed to assess this, these resources may provide an opportunity to improve future resilience capacity. Practices to promote mindfulness, such as meditation and yoga, may improve wellbeing and satisfaction with life and could be considered as potential strategies for future interventions targeting mothers experiencing food insecurity and negative mental health outcomes (Boehm et al., 2012).

4.2.1. Life satisfaction

The findings of this study suggested food coping strategies mediate the relationship between food security and life satisfaction for low-income mothers experiencing food insecurity. Individuals with low resources may tend to experience significantly more stressful experiences contributing to worse life satisfaction (Gallo, 2009). Chronic stress exposure can also impede a person's ability to restore the resources necessary for building household resilience capacity (Gallo et al., 2005; Boehm et al., 2015). Therefore, experiencing worse life satisfaction may contribute to less resilience to future shocks leading to future food insecurity, reliance on food coping strategies, and further worsening life satisfaction. Additionally, child life satisfaction is correlated with mother life satisfaction, suggesting the effects of food insecurity may also impact children in the household (Hoy et al., 2013). Interventions aiming to disrupt the pathway between chronic stress, negative mental health outcomes and less resilience to future shocks may not only improve resiliency but address disparities in life

TABLE 2 Path model statistics for relationship between food insecurity and mental health among low-income mothers in Virginia ($n = 1,029$)[a].

	Estimate	Beta[b]	SE	*P*-value	Effect size[c]
Predictors of social support					
Food security status	1.17	0.27	0.13	<0.001	Small
Predictors of food coping strategies					
Food security status	−2.54	−0.76	0.07	<0.001	Large
Predictors of overall physical health					
Diet quality	0.64	0.63	0.03	<0.001	Large
Food security status	0.09	0.10	0.02	<0.001	Negligible
Predictors of diet quality					
Food coping strategies	−0.06	−0.20	0.01	<0.001	Small
Social support	0.06	0.28	0.01	<0.001	Small
Predictors of overall mental health					
Social support	0.44	0.22	0.05	<0.001	Small
Diet quality	2.38	0.25	0.30	<0.001	Small
Overall physical health	3.60	0.38	0.29	<0.001	Medium
Predictors of anxiety symptoms					
Food coping strategies	0.83	0.34	0.06	<0.001	Medium
Overall mental health	−0.48	−0.52	0.02	<0.001	Large
Predictors of depressive symptoms					
Food coping strategies	0.92	0.34	0.07	<0.001	Medium
Overall mental health	−0.51	−0.50	0.02	<0.001	Large
Predictors of perceived stress					
Food coping strategies	0.04	0.28	0.00	<0.001	Small
Overall mental health	−0.02	−0.39	0.00	<0.001	Medium
Predictors of life satisfaction					
Overall mental health	0.29	0.40	0.02	<0.001	Medium
Overall physical health	0.54	0.08	0.21	<0.001	Negligible
Social support	0.30	0.19	0.04	<0.001	Small
Food coping strategies	−0.37	−0.19	0.05	<0.001	Small

[a]Tools used to assess measures: Food Security—United States Department of Agriculture Household Food Security Module; Social Support—Modified Duke Social Support Inventory; Food Coping Strategies—Hunger Coping Scales; Overall mental health—Patient Reported Outcomes Measurement Information System (PROMIS) Global Mental 2a Scale v1.2; Anxiety—PROMIS Emotional Distress v1.0—Anxiety—Short Form 4a; Depression—PROMIS Emotional Distress v1.0—Depression—Short Form 4a. Stress—National Institutes of Health Toolbox Perceived Stress for Adults; Life Satisfaction—Satisfaction with Life Scale; Overall Physical Health—one-item Likert-type scale (DeSalvo et al., 2005); Diet Quality—one-item Likert-type scale (Loftfield et al., 2015).

[b]Beta value represents the standardized regression coefficient.

[c]Effect sizes determined by absolute value of the Beta. Greater than 0.10 was small, 0.30 was medium, and 0.50 was large.

satisfaction contributing to health inequities (Boehm et al., 2015).

4.2.2. Social support

Although the effect of social support as a mediator in the relationship between food security and mental health was negligible, social support was associated with both greater food security and mental health in the current model. Mothers who can rely on the support of friends or family may be more prepared for future food systems shocks for several reasons. First, supportive environments foster personal resiliency through psychosocial resource development, such as greater self-efficacy and optimism (Boehm et al., 2015; Hobfoll et al., 2018). Mothers may then be able to rely on that social support and personal resiliency during a crisis to

avoid significant resource loss. Secondly, as vulnerable mothers expend already limited resources to address a shock, they may experience greater stress (Hobfoll et al., 2018). Mothers experiencing food insecurity may be vulnerable to worsening mental health through other pathways as well. Since social support is correlated with positive mental health outcomes, efforts to increase social support may be warranted to improve mental health outcomes among those made vulnerable by food insecurity (Liebe et al., 2022).

4.3. Limitations

Several limitations of this study should be noted. First, participants in the cross-sectional survey were randomly selected from all members of the panels who met the eligibility criteria for the study. The representativeness of the sample to the state and national population of low-income mothers was not explored. However, the conceptual framework presented still highlighted pathways worthy of exploration at the national level. Secondly, all data collection occurred during the COVID-19 pandemic, and we were unable to isolate the effect of the pandemic on the survey findings given the sparsity of literature on the mental health of mothers experiencing food insecurity. Thirdly, a measure of depressive symptoms utilizing a 2-week timeframe would have been more in line with the current Diagnostic and Statistical Manual of Mental Disorders (DSM-V; American Psychiatric Association, 2013). However, the PROMIS scale utilized is a validated tool for assessing depressive symptoms. Finally, there are inherent challenges of a mediation model that is cross-sectional given that mediation implies an order of events. Despite the unknown effect of the pandemic and challenges with a cross-section mediation model, the study findings still suggest a mediating effect of food coping strategies and social support that warrants further exploration with longitudinal studies.

4.4. Framework implications and conclusions

The conceptual framework of the relationship between food security and mental health identified in this study suggests there are opportunities for intervention to improve household resiliency to unanticipated shocks. Interventions targeting household resiliency improvement may impact food system stability at the household level and contribute to greater food security and mental health for vulnerable mothers. This model can provide justification for research and practice targeting food coping strategies to improve the mental health of mothers experiencing food insecurity. Future research should explore potential variations in pathways by demographic characteristics to determine relevant intervention opportunities for different populations. Additionally, the role of other psychosocial resources and social determinants of health could be explored to strengthen the model. In the long term, the effect of interventions to improve resiliency by reducing the need to rely on food coping strategies should be explored to strengthen food system stability at the household level.

Data availability statement

The raw data supporting the conclusions of this article will be made available by the authors, without undue reservation.

Ethics statement

The studies involving human participants were reviewed and approved by Virginia Tech Institutional Review Board. Written informed consent for participation was not required for this study in accordance with the national legislation and the institutional requirements.

Author contributions

RL: conceptualization, data analysis, and writing—original draft preparation. LA and VH: conceptualization, methodology, and writing-review and editing. ES, KP, and NC: conceptualization and writing—review and editing. SM: conceptualization, methodology, supervision, project administration, and writing—review and editing. All authors have read and agreed to the published version of the manuscript.

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Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

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