Household food insecurity and middle-aged women's health and psychosocial wellbeing in rural Mozambique

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ABSTRACT

Food security, including access to adequate quantities and variety of food, is an essential dimension of health and wellbeing, with important implications for physical health, mental health, and broader psychosocial wellbeing. The implications of food insecurity may be exacerbated by recurrent or chronic experiences on insufficiency. Yet, few studies have examined the relationship between food insecurity and health and psychosocial wellbeing, including the mechanisms through which that relationship may occur. This study used data from two waves of the Men's Migrations and Women's Lives longitudinal study conducted in rural southern Mozambique in 2017 and 2023 (n=1226) to examine the association of household long-term food insecurity with middle-aged women's physical health and selected measures of psychosocial wellbeing. We found that continuous food insecurity is significantly and substantially associated with worse self-rated health, higher frequency of depression, and lower general satisfaction with life. Additionally, we tested for possible mediating or moderating effects of women's empowerment on the relationship between food insecurity and self-rated health and satisfaction with life, but the results did not produce sufficient evidence for either effect.

1. Introduction

Food security, including access to adequate quantities and variety of food, is an essential dimension of health and wellbeing. Yet, many countries, especially in sub-Saharan Africa (SSA) suffer from food insecurity (FAO et al., 2023; World Bank, 2024). Food insecurity may be episodic, resulting from short-term shocks, or may be recurrently or even permanently experienced (WFP and FAO, 2023). In rural SSA, food insufficiency is the most common form of food insecurity, with about 278 million people undernourished in 2023 (FAO et al., 2024). Food insufficiency may lead to immune system suppression (França et al., 2009; Calder and Jackson, 2000) and to a decline in hygiene practice (Talukder, 2008; Richterman et al., 2018), both opening the door for infections (ibid.). Persistent food insufficiency may increase the severity of other causes of poor physical health (França et al., 2009; Calder and Jackson, 2000). Food insufficiency may also be related to poor mental health (Ae-Ngibise et al., 2021; Sorsdahl et al., 2010), decrease productivity and undermine general wellbeing (WFP, 2007; Martins et al., 2011).

Yet, few studies have examined the relationship between food insecurity and health and psychosocial wellbeing in SSA (Sorsdahl et al., 2010; Jebena et al., 2015; Jebena et al., 2017; Ae-Ngibise, 2021; Militao et al., 2022). The few existing studies examining this relationship in the region have found that there are adverse consequences of food insecurity on individuals' health and quality of life. A study of South African adults found that food insufficiency was associated with an elevated risk of anxiety and substance use disorders (Sorsdahl et al., 2010). Household food insecurity was linked to mental distress among pregnant women in Ethiopia (Jebena et al., 2015). Also in Ethiopia, a study of adolescents reported that household food insecurity was associated with poor self-rated health (Jebena et al., 2017).

Most of the existing studies of the relationship between food insecurity and health and psychosocial wellbeing in SSA have been cross-sectional (Ae-Ngibise, 2021; Militao et al., 2022). Yet, episodic and enduring experience of food insecurity could have differing influences on health and psychosocial wellbeing. A review of empirical studies on food insecurity and health outcomes among adults in southern Africa called for more research on the topic in countries without such studies (Militao et al., 2022).

Studies across the world have shown that gender is a key factor in food insecurity, with women heavily affected by it (WFP, 2007; Jung et al., 2016; Botreau and Cohen, 2020). Women may be especially vulnerable to the negative health consequences of food insecurity, if limited empowerment within the household restricts their ability to seek health care or leaves them with a smaller share of household food supplies. In contrast, women with higher levels of empowerment may be better able to manage the impact of food insecurity, potentially reducing deleterious effects of food insecurity on health and psychosocial wellbeing. For instance, women's self-regulation in health behavior, an empowering resource (Cleary and Zimmerman, 2004; Clark and Zimmerman, 2014), could help women to cultivate the ability of making health choices and to develop a sense of control over their lives which could be critical for resisting to succumb to unhealthy behaviors and practices when faced with food insecurity. Women's decision-making autonomy is another dimension of women's empowerment for which, in a situation of food insecurity, women having this ability, could use it to make health-enhancing decisions (Pavey and Sparks, 2010).

Although there are a few studies of the relationship between women's empowerment and food security in SSA (e.g., Tsiboe et al., 2018; Olumakaiye, Popoola and Abioye (2019); Asitik and Abu, 2020; Essilfie et al., 2021), little is known on the potential mediating or moderating role of women's empowerment on the relationship between food insecurity and women's health and psychosocial wellbeing in the region. Thus, in this study we contribute for addressing these issues using unique longitudinal data on middle-aged women

in rural Mozambique – a Sub-Saharan country which is among those highly affected by food insufficiency (FSIN and Global Network Against Food Crises, 2024). Specifically, we assess the relationship between long-term household food insecurity and women's physical health and psychosocial wellbeing and explore whether and how women's empowerment may mediate or moderate this relationship.

2. Background and Hypotheses

There are several ways through which household long-term food insecurity could be linked to women's poor health and poor psychosocial wellbeing. Following Cohen and Wills (1985), food insecurity may be conceptualized as a form of stressful event with potential negative effects on women's health and psychosocial wellbeing. Chronic food insecurity could be considered an enduring stressful condition. As McEwn (1998) showed, for some individuals, food insecurity and worries about food insecurity could be stressful events likely to induce secretion of stress hormones. According to that study, some individuals may not habituate when experiencing a prolonged stressor (such as chronic food insecurity), leading to continued secretion of stress hormones and eventually development of illness.

Researchers have also argued that food insecurity may increase an individual's susceptibility to disease through immune system suppression (França et al., 2009; Calder and Jackson, 2000). Moreover, studies argue that in life-pressing or threatening situations such as high food insecurity, engaging in behaviors oriented to minimizing risks of disease may be of less importance (Talukder, 2008; Lerch, 2024). As Talukder (2008:30) put it in a study from Bangladesh, in a situation of a "struggle for basic needs, such as food, hygiene practice is not expected to bear a high priority". Indeed, a study in rural Haiti found that food insecurity increased risks of unhealthy behaviors including consuming unsafe water and food (Richterman et al., 2018).

Women in rural SSA could be disproportionately affected by food insecurity. In this region, women are typically responsible for daily food provision for their households as part of their domestic duties (Boserup, 1985; Hyder et al., 2005). When food is insufficient in households, women in rural SSA may reduce the portion they eat in favor of other members of households (Maxwell, 1995; Lentz, 2018) and in some households, other members of the household eat first sometimes with little left for women (Akerele, 2011; Hyder et al., 2005). In line with this evidence, studies have indicated that adult women in SSA are particularly affected by food insecurity (UN Statistics Division, 2021). This, together with the evidence pointing to a deteriorating health situation among middle-aged individuals in SSA (Kohler et al., 2017), suggests that food insecurity could be implicated in the level of middle-aged women's health and wellbeing. Furthermore, the adverse consequences of food insecurity on middle-aged women's health and psychosocial wellbeing could be higher among those severely affected by food insecurity (Na et al., 2018). Thus, in this study, we posit that there will be a gradient on the long-term effects of household food insecurity on middle-aged women's health and psychosocial wellbeing – with women in households continuously food insecure severely affected (Hypothesis 1A), followed by those in households continuously quasi-food insecure and women in households periodically food secure (Hypothesis 1B).

In addition to our core hypotheses on the association of long-term food insecurity with women's physical health and psychosocial wellbeing, we propose several exploratory hypotheses around potential mediating or moderating effects of women's empowerment on this association. We argue that women's empowerment may shape the consequences of food insecurity through its influence on women's authority and decision-making in the household. Empowerment may mediate the association between food insecurity and wellbeing, if lack of access to food reduces women's empowerment and thereby leads to worse wellbeing.

Empowerment may also moderate the association between food insecurity and wellbeing if women with higher levels of empowerment are better able to navigate the consequences of food insecurity.

Following Kabeer (2005), we conceptualize that empowerment occurs through agency, resources and achievements. Agency "represents the processes by which choices are made and put into effect"; while resources "are the medium through which agency is exercised" (p. 14). Achievements express the way in which people are able or not able to attain their intended outcomes (e.g., keeping healthy) through resources and agency (Kabeer, 2005). In the context of women's empowerment, Kabeer (1999) argues that agency may take a form of decision-making autonomy. Higher levels of empowerment are likely to be associated with behaviors and practices that improve physical and psychosocial wellbeing. For example, women with limited household decision-making could be more likely to engage in poor hygiene practices (Talukder, 2008; Richterman et al., 2018) such as limited hand and food hygiene which, in turn, increase exposure to pathogens (UNICEF and WHO, 2009).

As noted above, Kabeer (2005) argues that in the context of empowerment, resources are means for an exercise of agency. Empowering women's self-regulation behavior in health and consequent expansion in women's latitude to make choices and to have control over own lives (Cleary and Zimmerman, 2004; Clark and Zimmerman, 2014; Chang, 2019), may define the manner in which women exercise health-related agency. Thus, in general, women with higher levels of empowerment across multiple domains would be expected to have better physical health and higher psychosocial wellbeing. We hypothesize that long-term experiences of food insecurity may lead to reduced empowerment for women, by limiting their sense of control and agency in household processes. Empowerment could thus be a possible mediating pathway contributing to an association between food insecurity and wellbeing (Hypothesis 3A).

We further propose an exploratory hypothesis that empowerment may moderate the association between food insecurity and wellbeing. Self-control which is an outcome of self-regulation empowerment (Cleary and Zimmerman, 2004) involves "a person's belief that he or she has control over his or her health and can maintain it by adapting behaviors" (Chang, 2019:2).

Following Clark and Zimmerman (2014), individuals with high levels of self-control may use accumulated knowledge (e.g., about health risks) and previously developed self-regulating strategies to make choices that minimize behavioral health risks (e.g., consuming unsafe food and water), even under a food insecurity situation. Thus, in a context of food insecurity, those with a lot of choice and control over their lives could be expected to engage more in health preventive behaviors, in that way, reducing the risks of diseases. Consequently, in this study we posit that women's degree of making choices and exercising control over own lives will mediate/moderate the relationship between long-term household food insecurity and women's health and psychosocial wellbeing, with women's enjoyment of a lot of choice and control over own lives working to reduce the negative influences of long-term household food insecurity on women's health and psychosocial wellbeing (Hypothesis 3B).

Data and Methods

Data for this study are from wave 5 and wave 6 of a household survey of the Men's Migrations and Women's Lives (MMWL) longitudinal project collected in four predominantly rural districts in the South of Mozambique with approximately 700,000 inhabitants. Residents of this area experience high levels of food insecurity (Cau and Agadjanian, 2023). The initial data collection in the area took place in 2006 (wave 1) following a multistage sampling process in which 56 villages (14 per district) were first randomly selected, and then 30 women aged 18-40 married to migrants or non-migrants were chosen in each of those villages

for interview (Agadjanian, Arnaldo and Cau, 2011). Wave 5 took place in 2017/2018 and data for wave 6 was largely collected in 2023 (although interviews via phone continued in 2024 for women who could not be found at their original villages). Both wave 5 and wave 6 collected diverse socioeconomic and demographic information including about household food security status. Wave 6 in particular collected diverse information on women's autonomy and their psychosocial wellbeing. The total sample size for the wave 5 was constituted by 1891 women. The dataset for wave 6 has 1885 women. Of these women, 1724 were interviewed in both wave 5 and wave 6. Of the 1724 women, 85 were excluded from the analyses because they were living outside of the study area in wave 5, wave 6 or both. Because the study focuses on middle-aged women, we further excluded 327 women who were below 40 years of age in wave 6 (below 34 years in wave 5). We also excluded 96 women who got into new marriages between wave 5 and wave 6 as they may have changed households. The remaining sample size before considered variables of interest in the study is 1216 women aged 40 years or more in wave 6.

For physical health, our outcome is self-rated health. It is based on a standard question asking respondents to rate their physical health. It was coded as a continuous variable with three ratings: 1. excellent; 2. good; and 3. more or less/bad. We use two outcomes of psychosocial wellbeing operationalized as continuous variables: feeling depression symptoms (past seven days: 1. never or rarely; 2. few times or sometimes; and 3. often) and general satisfaction with life (1. very satisfied; 2. quite satisfied; 3. a little satisfied; 4. not satisfied).

Our predictor is long-term household food security status. In both wave 5 and wave 6 respondents were asked a battery of questions on how many times, more or less, certain situations characterizing the availability of food in their households occurred in past six months: i) "there was a shortage of food in your household?"; ii) "there was little variety of food for children in your household?"; iii) "you were worried that you would not have enough to eat?" iv) "you ate less than what you thought you should eat?"; and v) "you skipped a meal because of lack of food?". Based on replies to each of the questions (1. many times; 2. sometimes; and 3. never), an average score from the replies to all questions was estimated for each household. Subsequently, households with a score of 2 or lower were considered as being "very food insecure", those possessing scores between 2 and 3 received the "somewhat food insecure" classification, and households with a score equal or greater than 3 were considered as "food secure". Based on this food security classification of each household in wave 5 and wave 6, we created four measures of long-term household food security status: 1) households continuously food secure – those who were classified as food secure in both wave 5 and wave 6; 2) households periodically food secure – those that were food secure in one of the waves – i.e., wave 5 or wave 6; 3) households continuously quasi-food insecure – those who were classified as somewhat food insecure in both wave 5 and wave 6 or were quasi-food insecure in one of the waves and food insecure in the other; and, 4) households continuously food insecure – those that were food insecure in both wave 5 and wave 6.

Our potential mediator/moderator of interest is women's empowerment (measured in wave 6). Women's empowerment is captured through two indicators: autonomy in decision-making on household and individual things and, women's perception of their choice and control over own lives (a proxy indicator of empowering self-regulation behavior in health). To build the autonomy in decision-making measure, women were asked to tell if they would "ask for permission to do [activity] from [their] husband, or a relative of his if he is not around, or would just have to inform them, or even informing them would not be necessary". The activities were: i) to visit your parents or relatives who live outside this community; ii) to visit a friend or neighbor who lives in this community; iii) to leave the community in order to buy or sell

something or to take care of some business; iv) to go to church; v) to take a child to a health post, hospital, or a witch-doctor; vi) to spend money on family needs (e.g., food, school supplies, clothes for children or other family members); vii) to spend money on your personal needs (e.g., clothes or shoes for yourself); and, viii) to find a job or to engage in commerce. The responses could be "would have to ask for permission", "would have just to inform", "not even informing would be necessary" and "don't know". Those who said that they "would have to ask for permission" to all the eight items were coded as having low autonomy in decision-making, those saying that "not even informing would be necessary" to five items or more were considered as having high autonomy in decision-making and, those in-between (i.e., not even informing would be necessary to at least 1 up to 4 items), were coded as having medium autonomy in decision-making. Those who answered "don't know" to all the items were excluded from the analyses.

The measure of women's choice and control over own lives is based on the following question: "Some people feel they have a lot of choice and control over their lives, while other people feel that have little choice and control over what happens to them. Do you feel that you have a lot of choice and control in your life, some choice and control, little choice and control, or almost no choice and control over what happens in your life?". The possible responses were: i) a lot of choice and control; ii) some choice and control; iii) little choice and control; iv) almost no choice and control; v) don't know/unsure. A variable with three categories was created: coded 1 for "a lot of choice and control", 2 for "some choice and control" and 3 for the remaining options - "little choice and control", "almost no choice and control" and "don't know/unsure".

All models controlled for household size (excluding women and their husbands if they were married – wave 5), women's age, women's education, and a measure of the residence building quality (wave 5). Women's age was coded as a categorical measure with three categories – age 34 to 39, 40-45, and 45 years or more. Women's education was operationalized as a categorical measure with three categories: no schooling, 1-4 years of schooling, and 5 or more years of schooling. Each model also controlled for the baseline outcome condition (wave 5).

To test Hypothesis 1A and 1B (our primary focus), for each outcome we have two models. Model 1 is the baseline and it controls only for household size and baseline outcome condition (wave 5). The full model adds controls.

To test Hypothesis 2 and 3 (our exploratory analyses), for each outcome we have four models. Model 1 is the baseline as in primary analyses. Model 2 adds the potential mediator. Model 3 includes the moderator of interest and an interaction with the food security measure, and Model 4 is a full model adding other controls. This is the recommended modeling approach for this type of longitudinal analyses (Cohen and Wills, 1985). The analyses considered only women aged (34 years or more in wave 5 – or 40 years or more in wave 6) with complete information on variables of interest for each outcome. For all outcomes we employ Ordinary Least-Square Linear Regression (OLS-Regression) for analyses, including robust-cluster standard errors to account for violation of independence among women living in the same community, and, because our sample is longitudinal (with the same women surveyed in both wave 5 and wave 6). All analyses were done using Stata software. Table 1 shows the distribution of the variables used in the study.

[Table 1 about here]

Results

Table 1 shows that of the 1126 households in the study, approximately 7% were continuously food secure (i.e., food secure in both wave 5 and wave 6), about 31% periodically food secure (i.e., food secure at least in one of wave 5 or wave 6), 44% continuously quasi-food insecure and nearly 18% continuously food insecure. It also shows that on average, participant women in the study tended to self-rate their health status at 2.11 or "good", tended to have felt depression symptoms "few times or sometimes", and were on average, "quite satisfied" with their life in general. How levels of women's self-rated health, depression symptoms and feeling of general satisfaction with life vary with the long-term household food security status is assessed in figures 1 to 3. Figure 1 shows that, on average, women's self-rating of their health varies with the status of their long-term household food security – with those living in households that were continuously food secure displaying, on average, better rating (1.97), those in households continuously food insecure worse rating (2.30), and those in households continuously quasi-food insecure (2.13) and in households periodically food secure (2.00), in-between by a gradient way. When looking at women's feeling of depression symptoms by the long-term household food security status, a similar picture emerges, with women in households continuously food secure revealing, on average, fewer symptoms of depression (1.35), those in households continuously food insecure most symptoms (1.78) and women in other long-term food security statuses in-between (Figure 2). Finally, Figure 3 shows women's rating of their general satisfaction with life by the long-term food security statuses of their households. On average, women in households continuously food secure appraised their satisfaction with life more favorably (1.39) than women in the other statuses of the long-term household food security, with those in households continuously food insecure indicating worse average ratings of general satisfaction with life (2.03). These descriptive findings are in line with the expectation of a gradient on long-term influences of household food insecurity on middle-aged women's health and psychosocial wellbeing, with women in households continuously food secure and those in households continuously food insecure in the opposite extremes of health and quality of life (better versus poor health and poor quality of life, respectively). Next, we assess whether these descriptive patterns persist in the multivariable analyses.

[Figure 1 to 3 about here]

Long-Term Household Food Insecurity, Self-Rated Health, Depression Symptoms and General Satisfaction with Life

Table 2 shows OLS-Regression results of the association between long-term household food insecurity and our three outcomes of interest. Panel A displays results for women's self-rated health; Panel B for women's depression symptoms and Panel C for women's general satisfaction with life. Model A1 in Panel A reveals that being a woman from a household continuously food insecure is significantly associated with a poorer self-rating of the health status in comparison to a woman in a household continuously food secure, net of the baseline self-rated health and the household size. For a woman in a household continuously food insecure, self-rating of health decreases, on average, by 0.30, net of the baseline self-rated health and household size (Coefficient [Coeff.]=0.30, $p<0.01$). When we add key woman and household characteristics in Model A2, the disadvantages of women living in households that were continuously food insecure remain higher. This finding is in line with Hypothesis 1A that posited that women in households experiencing long-term food insecurity will display worse health status. Although living in households continuously quasi-food insecure ($p=0.11$, Model A2) and in households periodically food secure is also associated with lower self-rating of health, the difference in comparison to those living in households

continuously food secure is not statistically significant. Thus, sufficient evidence to support Hypothesis 1B with respect to self-rated health is not found.

Panel B of Table 2 shows analyses of the association between long-term household food insecurity and the frequency of women's feeling of symptoms of depression. Model B1 indicates that long-term household food insecurity is significantly associated with frequently feeling depression symptoms, net of the baseline depression symptoms and household size. In comparison to a woman residing in a household continuously food secure, on average, the feeling of depression symptoms increases by 0.43 for a woman living in a household continuously food insecure, by 0.33 for a woman in a household continuously quasi-food insecure and by 0.25 for a woman from a household periodically food secure ($p<0.01$). These findings are unchanged when we control for woman and household characteristics, lending support to Hypotheses 1A and 1B (Model B2 Table 2).

Finally, Panel C displays results of the analyses of the association between long-term household food insecurity and the general satisfaction with life. Model C1 shows that the long-term household food insecurity is significantly associated with lower satisfaction with life, net of the baseline satisfaction with life and the household size. Specifically, it indicates that on average, for a woman residing in a household continuously food insecure satisfaction with life is lower by 0.61 in comparison to her counterpart in a household continuously food secure; that of a woman living in a household continuously quasi-food insecure lower by 0.51 and that of a woman in a household periodically food insecure lower by 0.27, relative to the reference household ($p<0.05$). When we add individual and household characteristics in Model C2, the difference of the level of satisfaction with own quality of life between women living in households with these food insecurity statuses in comparison to women in households that were continuously food secure reduces in magnitude but remains high – coefficients are 0.54, 0.45 and 0.22 for women in households that were in households continuously food insecure, continuously quasi-food insecure and periodically food insecure, respectively (Model C2, Table 2). These findings support hypothesis 1A and 1B.

[Table 2 about here]

We also explored an alternative approach to modeling the longitudinal data in which we assess the long-term impacts of household food insecurity at wave 5 on the outcomes at wave 6, net of household food insecurity at wave 6 (results not shown but available). In these additional analyses the household food security status has three categories: 1. household food secure; 2. household somewhat food insecure; and, 3. household food insecure; with household food secure as the reference category. For self-rated health, living in a household food insecure in wave 5 was significantly associated with lower self-rated health in wave 6 net of self-rated health in wave 5 and household size in wave 6. When adding food insecurity measures in wave 6, the coefficient for food insecurity in wave 5 lost statistical significance. For the depression symptoms outcome, it was found that on average, living in a household that was food insecure or somewhat food insecure in wave 5 was significantly associated with frequently feeling depression symptoms in wave 6, net of food insecurity in wave 6 and other controlling variables. For the satisfaction with life outcome, results from additional analyses were generally similar to those for self-rated health.

The Potential Mediating/Moderating Role of Women's Empowerment

Our analyses also explored the potential mediating/moderating role of women's empowerment on long-term household food insecurity. For self-rated health, the coefficient of living in a household that was continuously food insecure slightly declined in magnitude (from 0.30 to 0.28) with the addition of the

measure of a woman's autonomy in decision-making. Interaction terms between food insecurity measures and autonomy in decision-making indicators were not statistically significant (see Panel A of Table A1 in Annexes). When adding the measure of a woman's perception of her degree of choice and control over own life, although the coefficient for residing in a household that was continuously food insecure was only slightly abated, the interaction of residence in a household that was periodically food secure and having some choice and control over own life was statistically significant ($p<0.05$); that of living in the same type of household and the enjoyment of a lot of choice and control over own life was marginally statistically significant ($p<0.10$). The interaction term between residence in a household that was continuously food insecure and the enjoyment of some choice and control over own life was also marginally statistically significant (see Panel B of Table A1 in Annexes). These findings appear not to support the Hypothesis 2 and to lend a limited support to Hypothesis 3 on the prediction that self-regulation behavior as indicated by the degree of a woman's choice and control over own life would moderate the relationship between food insecurity and her physical health.

Evidence for a mediating or a moderating influence of our measures of women's empowerment and the frequency of feeling depression symptoms was not detected in our exploratory analyses (Table A2 in Annexes).

With respect to women's general satisfaction with their quality of life, the exploratory analyses appear to suggest a mediating influence of a woman's autonomy in decision-making as with the addition of the autonomy indicators the coefficients of food insecurity reduced in magnitude considerably –0.61 in Model A1 to 0.54 in Model A2 for a woman in a household continuously food insecure; from 0.51 to 0.47 for a woman in a household continuously quasi-food insecure, and from 0.27 to 0.24 for a woman in a household periodically food secure. These findings appear to support Hypothesis 2 with respect to women's general satisfaction with life (Panel A of Table A3 in Annexes). These analyses also detected a statistically significant interaction between residing in a household that was continuously quasi-food insecure and the enjoyment of a medium autonomy in decision-making ($p<0.05$) – which provides some support to Hypothesis 3. Evidence of a possible mediating/moderating role of the measure of self-regulation behavior in health on general satisfaction with life was not detected (Panel B of Table A3 in Annexes).

Conclusion

Overall, the analyses we presented in this study appear to show strong association of long-term food insecurity with their quality of life in SSA, net of other factors. These findings lend further support to previous studies that found an association of food insecurity with health outcomes in the region (e.g., Sorsdahl et al., 2010; Na et al. 2019). We also expand this literature by showing that the association of food insecurity with physical health and mental health symptoms is even higher when food insecurity is recurrently or continuously experienced. We also conducted exploratory analyses on potential mediating/moderating role of women's empowerment as proxied by autonomy in decision-making and perceptions on choices and control over own life. We found limited support for a mediating role for women's empowerment in the association between food insecurity and health outcomes. Although empowerment does not substantially mediate the association between food insecurity and self-rated health or depression, it does partially mediate the association with overall life satisfaction. Food insecurity may be associated with lower levels of life satisfaction in part because it is linked to lower levels of decision-making power for women. We hypothesized that women's autonomy/decision-making might help middle-aged women to manage the effects of food insecurity, either by making better health choices or by managing stress/anxiety. However, this hypothesis did not find strong support – it appears that food

insecurity, especially if long term/chronic, is a fundamental structural challenge that cannot be mitigated by individual abilities and aspirations.

Table 1. Distribution of variables for the long-term household food insecurity and middle-aged women's health and psychosocial wellbeing analyses (percentage, unless otherwise indicated), MMWL panel

Variable	**%**	**n**
Outcomes (measured in Wave 6)		
Woman's self-rated health (1. excellent; 2. good; and 3. more or less/bad)*	2.11(0.67)	1126
Woman felt depression symptoms past 7 days (1. never or rarely; 2. few times or sometimes; 3. often)*	1.65(0.70)	1124
Woman's general satisfaction with life (1. very satisfied; 2. quite satisfied; 3. a little satisfied; 4. not satisfied)*	1.82(0.88)	1125
Predictor		
HH's Food security status (wave 5 & wave 6)		
HH continuously food secure (i.e., food secure in both wave 5 and wave 6)	6.66	75
HH periodically food secure (i.e., is food secure at least in one of wave 5 or wave 6)	30.91	348
HH continuously quasi-food insecure	44.49	501
HH continuously food insecure	17.94	202
Mediators/Moderators		
Woman's empowerment		
Autonomy in decision-making on household and individual things		
High autonomy	18.83	212
Medium autonomy	43.16	486
Low autonomy	38.01	428
Women's Self-Control		
A lot of choice and control	39.88	449
Some choice and control	31.53	355
Little or almost none	28.60	322
Controls		
Baseline self-rated health (1. excellent; 2. good; and 3. more or less/bad), wave 5	2.23(0.45)	1126
Baseline depression level (1. never; 2. sometimes; and 3. often), wave 5	1.73(0.55)	1124
Baseline general life satisfaction (1. very satisfied; 2. quite satisfied; 3. a little satisfied; 4. not satisfied), wave 5	2.34(0.79)	1125
Woman's age (wave 5)		
34-39	42.01	473
40-45	36.23	408
45 years or more	21.76	245
Woman's education		
No education	28.95	326
1 to 4 years	48.40	545
5 years or more	22.65	255
HH housing conditions and assets index (range, 0-6)*	3.76(1.54)	1126
HH's family size (range, 1-34)*	7.71(3.39)	1126
N		1126

Notes: * Mean and standard deviations in parentheses; the analytic sample size varies among outcomes.

Figure 1. Women's self-rated health by long-term household food security status

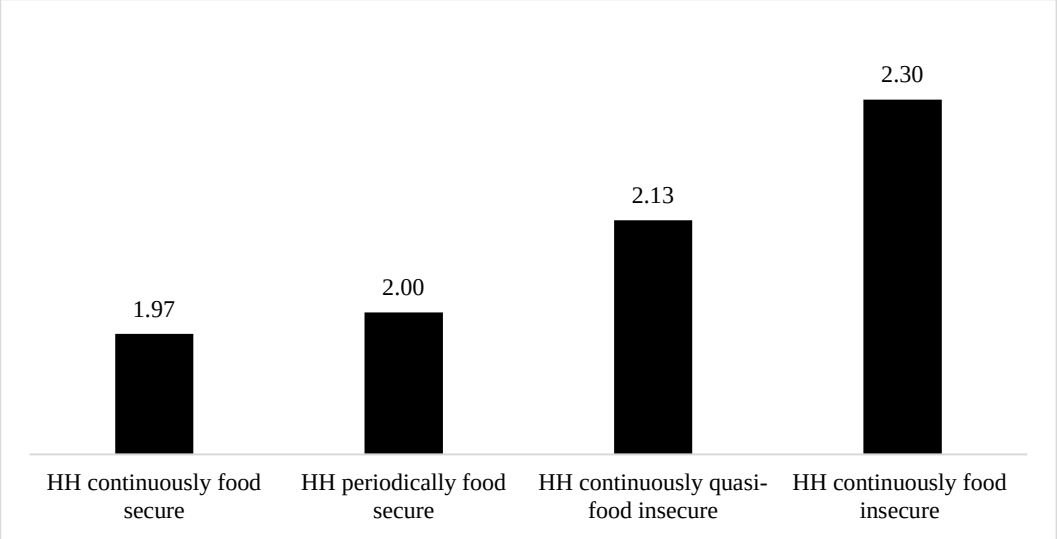

Figure 2. Women's feeling of depression symptoms by long-term household food security status

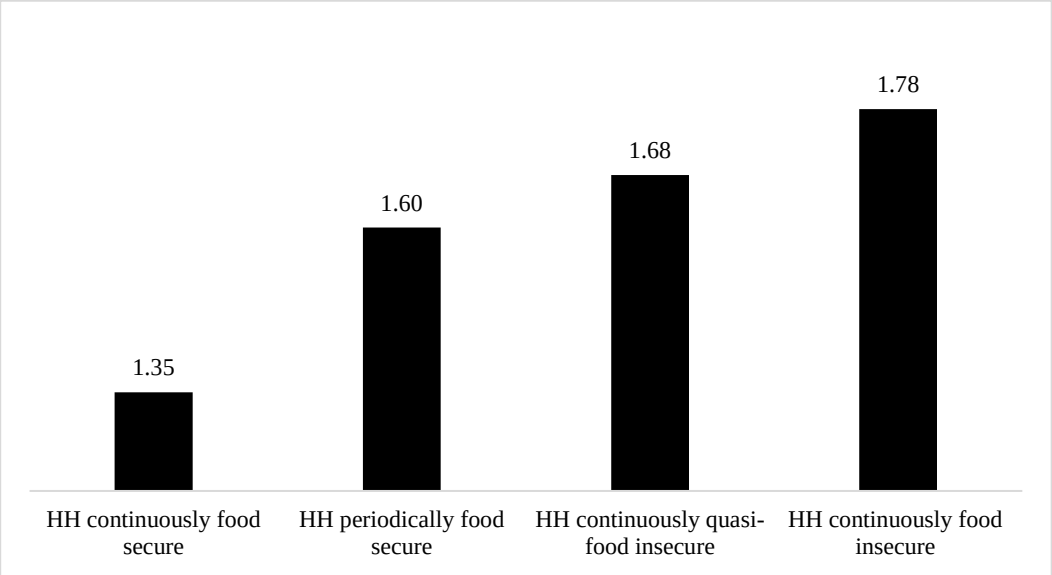

Figure 3. Women's feeling of general satisfaction with life by long-term household food security status

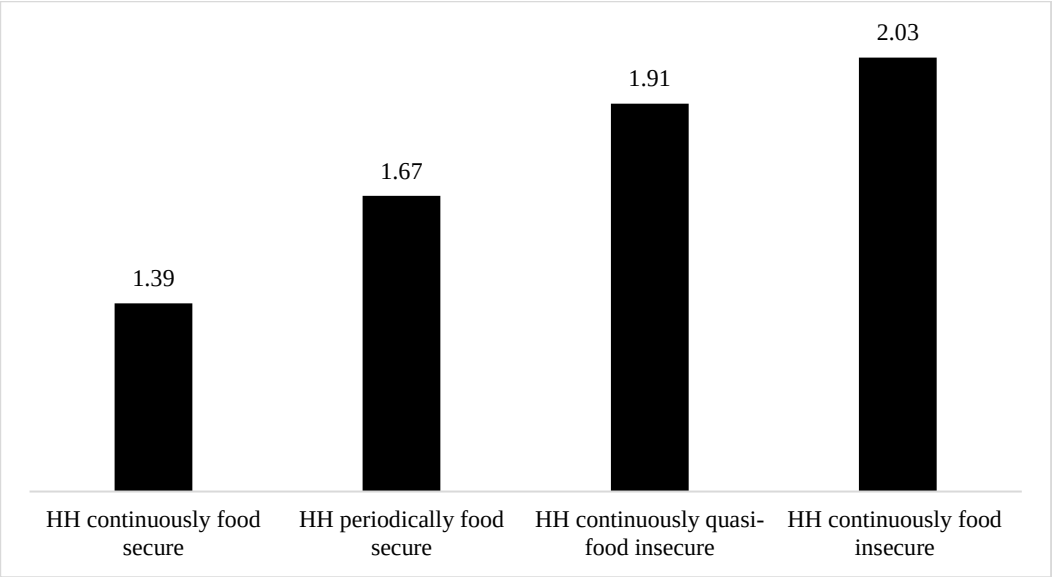

Table 2. OLS-Regression results of the association between long-term household food insecurity and self-rated health, depression symptoms, and general life satisfaction, MMWL panel.

Covariates	**Women's Self-rated Health**		**Women's Depression Symptoms**		**Women's General Satisfaction with Life**	
	Model A1	**Model A2**	**Model B1**	**Model B2**	**Model C1**	**Model C2**
Predictor						
Long-Term HH's Food security status (wave 5 & wave 6)						
HH continuously food secure (Ref.)	1	1	1	1	1	1
HH periodically food secure	0.04	0.03	0.25**	0.25**	0.27*	0.22*
HH continuously quasi-food insecure	0.15	0.15	0.33**	0.33**	0.51**	0.45**
HH continuously food insecure	0.30**	0.29**	0.43**	0.43**	0.61**	0.54**
Controls						
Baseline self-rated health (wave 5)	0.14**	0.13*	0.03	0.03	0.05	0.01
Age (wave 5)						
46 years or more (Ref.)		1		1		1
40-45 years		-0.12*		-0.03		0.12+
34-39 years		-0.20**		0.02		0.09
Woman's education						
No education (Ref.)		1		1		1
1-4 years		0.06		0.01		0.12*
5 years or more		0.13*		-0.05		0.17*
Women's marital status						
Married women (Ref)		1		1		1
Not married women		-0.00		0.15*		0.41*
HH housing conditions and assets index		-0.01		0.03+		-0.02
HH Size (wave 5)	-0.01	-0.01	0.00	0.00	-0.00	0.00
Intercept	1.73**	1.86**	1.28**	1.14**	1.33**	1.21**
N	1126	1126	1124	1124	1125	1125

Notes: Ref.=Reference; HH= Household; Analyses include robust-cluster standard errors; Significance * - p<0.05; ** - p<0.01; + - p<0.10.

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ANNEXES

Table A1. OLS-Regression results of the association between long-term household food insecurity and self-rated health, with women's empowerment as a mediator/moderator, MMWL panel.

Covariates	Women's Empowerment Indicator A: Autonomy in Decision-Making				Women's Empowerment Indicator B: Self-Regulation Behavior in Health			
	Model A1	**Model A2**	**Model A3**	**Model A4**	**Model B1**	**Model B2**	**Model B3**	**Model B4**
Predictor								
Long-Term HH's Food security status (wave 5 & wave 6)								
HH continuously food secure (Ref.)	1	1	1	1	1	1	1	1
HH periodically food secure	0.04	0.03	-0.01	-0.02	0.04	0.03	0.37*	0.38*
HH continuously quasi-food insecure	0.15	0.14	0.17	0.17	0.15	0.15	0.28	0.32+
HH continuously food insecure	0.30**	0.28**	0.28+	0.26+	0.30**	0.29**	0.56**	0.60**
Mediators								
Autonomy in decision-making on household and individual things								
High autonomy		0.09	0.25	0.16	na	na	na	na
Medium autonomy		0.06	0.03	0.03	na	na	na	na
Low autonomy (Ref.)		1	1	1	na	na	na	na
Women's Self-Control								
A lot of choice and control	na	na	na	na		-0.04	0.21	0.23
Some choice and control	na	na	na	na		-0.01	0.31	0.36
Little or almost none (Ref.)	na	na	na	na		1	1	1
Interaction Terms								
HH periodically food secure * High autonomy			-0.17	-0.09	na	na	na	na
HH periodically food secure * Medium autonomy			0.13	0.15	na	na	na	na
HH continuously quasi-food insecure * High autonomy			-0.19	-0.13	na	na	na	na
HH continuously quasi-food insecure * Medium autonomy			-0.03	-0.01	na	na	na	na
HH continuously food insecure * High autonomy			-0.14	-0.06	na	na	na	na
HH continuously food insecure * Medium autonomy			0.00	0.05	na	na	na	na
HH periodically food secure * A lot of choice and control							-0.38+	-0.40+
HH periodically food secure * Some choice and control							-0.54*	-0.57*
HH continuously quasi-food insecure * A lot of choice and control							-0.19	-0.23
HH continuously quasi-food insecure * Some choice and control							-0.13	-0.20
HH continuously food insecure * A lot of choice and control							-0.25	-0.32
HH continuously food insecure * Some choice and control							-0.48+	-0.53+

Notes: Ref.=Reference; HH= Household; Na=Not applicable; Analyses include robust-cluster standard errors; Significance * - p<0.05; ** - p<0.01; + - p<0.10.

Table A1. Continued.

Controls								
Baseline self-rated health (wave 5)	0.14**	0.14**	0.14**	0.13*	0.14**	0.14**	0.15**	0.14**
Age (wave 5)								
46 years or more (Ref.)				1				1
40-45 years				-0.12*				-0.11*
34-39 years				-0.20**				-0.19**
Woman's education								
No education (Ref.)				1				1
1-4 years				0.06				0.06
5 years or more				0.13*				0.13*
Women's marital status								
Married women (Ref)				1				1
Not married women				-0.02				0.00
HH housing conditions and assets index				-0.01				-0.01
HH Size (wave 5)	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01
Intercept	1.73**	1.70**	1.69**	1.83**	1.73**	1.75**	1.52**	1.63**
N	1126	1126	1126	1126	1126	1126	1126	1126

Notes: Ref.=Reference; HH= Household; Na=Not applicable; Analyses include robust-cluster standard errors; Significance * - p<0.05; ** - p<0.01; + - p<0.10.

Table A2. OLS-Regression results of the association between long-term household food insecurity and depression symptoms, with women's empowerment as a mediator/moderator, MMWL panel.

Covariates	Women's Empowerment Indicator A: Autonomy in Decision-Making				Women's Empowerment Indicator B: Self-Regulation Behavior in Health			
	Model A1	**Model A2**	**Model A3**	**Model A4**	**Model B1**	**Model B2**	**Model B3**	**Model B4**
Predictor								
Long-Term HH's Food security status (wave 5 & wave 6)								
HH continuously food secure (Ref.)	1	1	1	1	1	1	1	1
HH periodically food secure	0.25**	0.25*	0.22+	0.22+	0.25**	0.24*	0.14	0.12
HH continuously quasi-food insecure	0.33**	0.33**	0.38**	0.38**	0.33**	0.32**	0.24	0.22
HH continuously food insecure	0.43**	0.43**	0.57**	0.56**	0.43**	0.42**	0.35+	0.36*
Mediators								
Autonomy in decision-making on household and individual things								
High autonomy		-0.02	0.12	0.06	na	na	na	na
Medium autonomy		-0.12*	-0.08	-0.10	na	na	na	na
Low autonomy (Ref.)		1	1	1	na	na	na	na
Women's Self-Control								
A lot of choice and control	na	na	na	na		-0.15*	-0.29+	-0.31+
Some choice and control	na	na	na	na		-0.05	-0.08	-0.07
Little or almost none (Ref.)	na	na	na	na		1	1	1
Interaction Terms								
HH periodically food secure * High autonomy			0.11	0.12	na	na	na	na
HH periodically food secure * Medium autonomy			-0.00	0.01	na	na	na	na
HH continuously quasi-food insecure * High autonomy			-0.30	-0.28	na	na	na	na
HH continuously quasi-food insecure * Medium autonomy			-0.02	-0.01	na	na	na	na
HH continuously food insecure * High autonomy			-0.23	-0.21	na	na	na	na
HH continuously food insecure * Medium autonomy			-0.24	-0.20	na	na	na	na
HH periodically food secure * A lot of choice and control							0.18	0.20
HH periodically food secure * Some choice and control							0.05	0.06
HH continuously quasi-food insecure * A lot of choice and control							0.12	0.12
HH continuously quasi-food insecure * Some choice and control							0.05	0.06
HH continuously food insecure * A lot of choice and control							0.18	0.14
HH continuously food insecure * Some choice and control							-0.05	-0.05

Notes: Ref.=Reference; HH= Household; Na=Not applicable; Analyses include robust-cluster standard errors; Significance * - p<0.05; ** - p<0.01; + - p<0.10.

Table A2. Continued.

Controls								
Baseline depression symptoms (wave 5)	0.03	0.03	0.03	0.03	0.03	0.03	0.03	0.03
Age (wave 5)								
46 years or more (Ref.)				1				1
40-45 years				-0.02				-0.03
34-39 years				0.04				0.03
Woman's education								
No education (Ref.)				1				1
1-4 years				0.01				0.03
5 years or more				-0.05				-0.03
Women's marital status								
Married women (Ref)				1				1
Not married women				0.14*				0.19*
HH housing conditions and assets index				0.03				0.03
HH Size (wave 5)	0.00	0.00	0.00	0.00	0.00	-0.00	-0.00	0.00
Intercept	1.28**	1.33**	1.30**	1.18**	1.28**	1.39**	1.47**	1.33**
N	1124	1124	1124	1124	1124	1124	1124	1124

Notes: Ref.=Reference; HH= Household; Na=Not applicable; Analyses include robust-cluster standard errors; Significance * - p<0.05; ** - p<0.01; + - p<0.10.

Table A3. OLS-Regression results of the association between long-term household food insecurity and general satisfaction with life, with women's empowerment as a mediator/moderator, MMWL panel.

Covariates	Women's Empowerment Indicator A: Decision-Making Autonomy				Women's Empowerment Indicator B: Self-Regulation Behavior in Health			
	Model A1	**Model A2**	**Model A3**	**Model A4**	**Model B1**	**Model B2**	**Model B3**	**Model B4**
Predictor								
Long-Term HH's Food security status (wave 5 & wave 6)								
HH continuously food secure (Ref.)	1	1	1	1	1	1	1	1
HH periodically food secure	0.27*	0.24*	0.20+	0.20+	0.27*	0.26*	0.38+	0.30
HH continuously quasi-food insecure	0.51**	0.47**	0.31**	0.29**	0.51**	0.50**	0.61*	0.54**
HH continuously food insecure	0.61**	0.54**	0.51**	0.46**	0.61**	0.60**	0.75**	0.72**
Mediators								
Autonomy in decision-making on household and individual things								
High autonomy		0.45**	0.42	0.31	na	na	na	na
Medium autonomy		0.07	-0.10	-0.08	na	na	na	na
Low autonomy (Ref.)		1	1	1	na	na	na	na
Women's Self-Control								
A lot of choice and control	na	na	na	na		-0.06	0.08	0.01
Some choice and control	na	na	na	na		-0.10	0.05	0.05
Little or almost none (Ref.)	na	na	na	na		1	1	1
Interaction Terms								
HH periodically food secure * High autonomy			-0.10	-0.11	na	na	na	na
HH periodically food secure * Medium autonomy			0.12	0.07	na	na	na	na
HH continuously quasi-food insecure * High autonomy			0.07	0.06	na	na	na	na
HH continuously quasi-food insecure * Medium autonomy			0.32*	0.29*	na	na	na	na
HH continuously food insecure * High autonomy			0.09	0.08	na	na	na	na
HH continuously food insecure * Medium autonomy			-0.01	0.04	na	na	na	na
HH periodically food secure * A lot of choice and control							-0.14	-0.10
HH periodically food secure * Some choice and control							-0.16	-0.14
HH continuously quasi-food insecure * A lot of choice and control							-0.18	-0.20
HH continuously quasi-food insecure * Some choice and control							-0.08	-0.07
HH continuously food insecure * A lot of choice and control							-0.07	-0.19
HH continuously food insecure * Some choice and control							-0.34	-0.37

Notes: Ref.=Reference; HH= Household; Na=Not applicable; Analyses include robust-cluster standard errors; Significance * - p<0.05; ** - p<0.01; + - p<0.10.

Table A3. Continued.

Controls								
Baseline general satisfaction with life (wave 5)	0.05	0.03	0.03	0.00	0.05	0.05	0.05	0.01
Age (wave 5)								
46 years or more (Ref.)				1				1
40-45 years				0.12+				0.12+
34-39 years				0.09				0.10
Woman's education								
No education (Ref.)				1				1
1-4 years				0.10+				0.13*
5 years or more				0.15*				0.19**
Women's marital status								
Married women (Ref)				1				1
Not married women				0.31*				0.44**
HH housing conditions and assets index				-0.01				-0.02
HH Size (wave 5)	-0.00	-0.01	0.00	0.00	-0.00	-0.01	-0.01	0.00
Intercept	1.33**	1.26**	1.35**	1.22**	1.33**	1.39**	1.29**	1.21**
N	1125	1125	1125	1125	1124	1124	1124	1124

Notes: Ref.=Reference; HH= Household; Na=Not applicable; Analyses include robust-cluster standard errors; Significance * - p<0.05; ** - p<0.01; + - p<0.10.