Title: Association between food insecurity and depression among older adults from low- and middle-income countries

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ABSTRACT

Background: To examine the association between self-reported food insecurity and depression in 34129 individuals aged ≥50 years from six LMICs (China, Ghana, India, Mexico, Russia, and South Africa).

Methods: Cross-sectional, community-based, nationally representative data from the WHO Study on global AGEing and adult health (SAGE) were analyzed. Self-reported past 12-month food insecurity was assessed with two questions on frequency of eating less and hunger due to lack of food. Questions based on the World Mental Health Survey version of the Composite International Diagnostic Interview were used for the endorsement of past 12-month DSM-IV depression. Multivariable logistic regression analysis and meta-analysis were conducted to assess associations.

Results: 34,129 individuals aged ≥50 years [mean (SD) age 62.4 (16.0) years; 52.1% females] were included in the analysis. Overall, the prevalence of moderate and severe food insecurity were 6.7% and 5.1%, respectively, while the prevalence of depression was 6.0%. Meta-analyses based on country-wise estimates showed that overall, moderate food insecurity (vs. no food insecurity) is associated with a non-significant 1.69 (95%CI=0.82-3.48) times higher odds for depression, while severe food insecurity is significantly associated with 2.43 (95%CI=1.65-3.57) times higher odds for depression.

Conclusions: In this large representative sample of older adults from six LMICs, those with severe food insecurity were over two times more likely to suffer from depression (compared to no food insecurity). Utilizing lay health counsellors and psychological interventions may be effective mechanisms to reduce depression among food insecure populations. Interventions to address food insecurity (e.g., supplemental nutrition programs) may reduce depression at the population level but future longitudinal studies are warranted.

INTRODUCTION

Depression is characterized by persistent sadness and a lack of interest or pleasure in previously rewarding or enjoyable activities (World Health Organization, 2020a). Globally, depression is a common mental disorder affecting more than 264 million people (World Health Organization, 2020b). Importantly, the Global Burden of Disease Study 2010 demonstrated that depression is responsible for 40.5% of total disability-adjusted life years (DALYs) caused by mental and substance-use disorders (Whiteford, Ferrari, Degenhardt, Feigin, & Vos, 2015). Depression may be disproportionally affecting low- and middle-income countries (LMICs), as these countries bear more than 80% of the global years lost to disability due to depression, while the majority of people with depression in LMICs do not receive appropriate treatment (Jacob, Pizzol, Veronese, Stubbs, & Koyanagi, 2019). Furthermore, depression in late life is of particular importance from a public health and clinical point of view as its prevalence is high (approximately 7%) (World Health Organization, 2017), while it is associated with greater risk of morbidity and suicide, poorer cognitive, physical, and social functioning, and increased levels of self-neglect, all of which may result in premature mortality (Fiske, Wetherell, & Gatz, 2009; Yohannes & Baldwin, 2008). It is therefore important to identify correlates of depression among the older population in LMICs to inform targeted prevention efforts.

To date, several correlates of depression have been identified in such settings, including, for example, female gender (Tomlinson, Grimsrud, Stein, Williams, & Myer, 2009), lack of social support (Cheng et al., 2014), low self-esteem (Azizi, Khamseh, Rahimi, & Barati, 2013), stressful life events (Tao et al., 2011), family history of psychiatric disorders (Chin, Wan, Choi, Chan, & Lam, 2016), chronic conditions (Das et al., 2013), and low socioeconomic status

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(SES) (Fernández-Niño, Manrique-Espinoza, Bojorquez-Chapela, & Salinas-Rodríguez, 2014). With respect to low SES, several studies have found that indicators of SES are associated with depression, and that income alone is not necessarily an adequate measure of SES, given the multi-dimensional nature of poverty (Alkire & Foster, 2011; Alkire et al., 2015). In this regard, one example was the study of Zimmerman and Katon which suggests that employment status and ratio of debt-to-assets (but not income) were causally related to depression (Zimmerman & Katon, 2005). As such, food insecurity (i.e., state of being without reliable access to a sufficient quantity of affordable, nutritious food) can be considered to be another dimension of SES linked to depression. Importantly, food insecurity may be related to depression via poor nutrition or increased feelings of shame, which are factors that can increase risk for depression (Gilbert, 2000; Li et al., 2017).

One study carried out in Mexico on 33,011 participants with a mean age of 44 years found that participants with moderate food insecurity (OR =1.45, 95% CI = 1.28 to 1.64) and severe food insecurity (OR =2.04, 95% CI = 1.76 to 2.37) were more likely to suffer from depression as compared to participants with mild food insecurity (Kolovos, Zavala, Leijen, Melgar-Quiñonez, & van Tulder, 2020). Moreover, another study carried out in South Africa on 8,801 participants, found that those who were depression free at baseline, and resided in a food insecure hotspot community had a significantly higher incidence of depression (aRR = 1.11, 95% CI:1.01–1.22) compared to those who resided in a food secure hotspot (Tomita et al., 2020). However, apart from these studies, there are no other studies from LMICs that used nationally representative datasets of the general population. Other studies from LMICs that have focused on the relationship between food insecurity and depression have utilized specific populations such as mothers who recently gave birth and people living with HIV, and thus, generalizability is severely limited (Ayano, Tsegay, & Solomon, 2020; Dewing, Tomlinson, le Roux, Chopra, &

Tsai, 2013; Khoshgoo, Eslami, Al-Hosseini, & Shidfar, 2020; Natamba et al., 2017; Tuthill et al., 2020).

Moreover, there is very limited information on this topic among older adults from this setting (Isaura et al., 2019; Mesbah, Sulaiman, Mohd Shariff, & Ibrahim, 2020). Thus, it is clear that more research is needed in large representative samples of older adults from diverse LMICs to further elucidate on the association between food insecurity and depression, especially given the high prevalence of both conditions in these countries (United Nations, 2019). Furthermore, multi-country studies are needed as such studies allow exploration of associations between depression and food insecurity irrespective of national policies and available facilities, and at the same time allow comparison between countries to understand whether associations are context-specific.

Therefore, the aim of the present study was to examine the association between food insecurity and depression in 34129 individuals aged ≥50 years from six LMICs (China, Ghana, India, Mexico, Russia, and South Africa). It was hypothesized that those who experience food insecurity will have higher odds for depression compared to those who do not suffer from food insecurity.

METHODS

The survey

Data from the Study on Global Ageing and Adult Health (SAGE) were analyzed. These data are publicly available through http://www.who.int/healthinfo/sage/en/. This survey was undertaken in China, Ghana, India, Mexico, Russia, and South Africa between 2007 and 2010.

Based on the World Bank classification at the time of the survey, Ghana was the only low-income country, and China and India were lower middle-income countries although China became an upper middle-income country in 2010. The remaining countries were upper middle-income countries.

Details of the survey methodology have been published previously (Kowal et al., 2012). Briefly, in order to obtain nationally representative samples, a multistage clustered sampling design method was used. The sample consisted of adults aged ≥18 years with oversampling of those aged ≥50 years. Trained interviewers conducted face-to-face interviews using a standard questionnaire. Standard translation procedures were undertaken to ensure comparability between countries. The survey response rates were: China 93%; Ghana 81%; India 68%; Mexico 53%; Russia 83%; and South Africa 75%. Sampling weights were constructed to adjust for the population structure as reported by the United Nations Statistical Division. Ethical approval was obtained from the WHO Ethical Review Committee and local ethics research review boards. Written informed consent was obtained from all participants.

Depression

Questions based on the World Mental Health Survey version of the Composite International Diagnostic Interview (Kessler & Üstün, 2004) were used for the endorsement of past 12-month DSM-IV depression using the same algorithm in previous SAGE studies (Garin et al., 2016; Koyanagi et al., 2014) (Details provided in **Table 1**).

Food insecurity

Food insecurity was defined with the use of the two following questions: "In the last 12 months, how often did you ever eat less than you felt you should because there wasn't enough food?" and "In the last 12 months, were you ever hungry, but didn't eat because you couldn't afford

enough food?" Both of these questions had as answer options: every month (coded=1); almost every month (coded=2); some months, but not every month (coded=3); only in 1 or 2 months (coded=4); never (coded=5). These items were adapted from similar items in food security questionnaires such as the US Household Food Security Survey Module and National Health and Nutrition Examination Survey (NHANES) Food Security module. As in previous SAGE studies, those who answered 1 through 3 to both questions or answered 1 to either item were categorized as severely food insecure. Those who did not meet the criteria for severe food insecurity but answered 2 through 4 for either question were coded as moderately food insecure. Those who answered 5 to both items were categorized as food secure (Koyanagi et al., 2019; Schrock et al., 2017).

Control variables

The control variables were selected based on past literature (Montgomery, Lu, Ratliff, & Mezuk, 2017), and included age, sex, wealth quintiles based on income, highest level of education achieved (primary, secondary, tertiary), physical activity, and smoking (never, current, past). Levels of physical activity were assessed with the Global Physical Activity Questionnaire and were classified as low, moderate, and high based on conventional cut-offs (Bull, Maslin, & Armstrong, 2009).

Statistical analysis

The statistical analysis was performed with Stata 14.1 (Stata Corp LP, College station, Texas). The analysis was restricted to those aged ≥50 years. We conducted country-wise multivariable logistic regression analysis to assess the association between food insecurity (exposure) and depression (outcome). The regression analysis was adjusted for age, sex, wealth, education, physical activity, and smoking. Furthermore, in order to assess the between-country

heterogeneity that may exist in the association between food insecurity and depression, we calculated the Higgins's I^2 based on estimates from each country. The Higgins's I^2 represents the degree of heterogeneity that is not explained by sampling error with a value of <40% often considered as negligible and 40-60% as moderate heterogeneity (Higgins & Thompson, 2002). A pooled estimate was obtained by random-effect meta-analysis. All variables were included in the models as categorical variables with the exception of age (continuous variable). The sample weighting and the complex study design were taken into account in the analyses. Results from the regression analyses are presented as odds ratios (ORs) with 95% confidence intervals (CIs). The level of statistical significance was set at $P<0.05$.

RESULTS

A total of 34129 individuals aged ≥50 years [mean (SD) age 62.4 (16.0) years; 52.1% females] were included in the current analysis. The sample size by country was as follows: 13175 (China); 4305 (Ghana); 6560 (India); 2313 (Mexico); 3938 (Russia); 3838 (South Africa). Overall, the prevalence of moderate and severe food insecurity was 6.7% and 5.1%, respectively, while the prevalence of depression was 6.0%. The sample characteristics by country are shown in **Table 2**. The prevalence of depression ranged from 1.1% (China) to 12.9% (India), while the prevalence of severe food insecurity ranged from 0.3% (China) to 21.5% (South Africa). In all countries, the prevalence of depression was highest among those with severe food insecurity with the exception of Ghana where the prevalence was highest among those with moderate food insecurity (**Figure 1**). The country-wise association between moderate food insecurity (vs. no food insecurity) is shown in **Figure 2**. Overall, moderate food insecurity was not significantly associated with depression (OR=1.69; 95%CI=0.82-3.48) with a high level of between-country heterogeneity (I^2=85.2%). In terms of severe food insecurity

(vs. no food insecurity), overall, the OR (95%CI) was 2.43 (1.65-3.57) with a low level of between-country heterogeneity (I^2=31.0%) (**Figure 3**).

DISCUSSION

In this large representative sample of older adults from multiple LMICs, it was found that those who suffer from severe food insecurity compared to no food insecurity were over two times more likely to have depression. Furthermore, overall, moderate food insecurity was not associated with depression. To the best of our knowledge, this is the first study on food insecurity and depression among older adults using nationally representative data from LMICs, while it is also the first multi-country study on this topic.

The present findings both support and add to previous literature. They support previous literature through providing further evidence for an association between food insecurity and a higher odds of depression in LMICs (Dewing et al., 2013; Kolovos et al., 2020), and add to previous literature through showing that an association exists in a large sample of older adults from multiple LMICs, which broadly represent different geographical locations and levels of socio-economic and demographic transition.

Food insecurity may be associated with higher odds of depression through several mechanisms. First, food insecurity results in poor nutrition as when food becomes scarce, people tend to change their dietary habits to those which are cheaper but less nutritious (e.g., high fat and carbohydrates, low vitamins and micronutrients). In turn, poor nutrition has been found to be associated with a higher risk of depression (Li et al., 2017; Rao, Asha, Ramesh, & Rao, 2008; Vafaei et al., 2013). Malnutrition over time can result in poor mental health; notably,

antioxidants (e.g., vitamin C, vitamin E, and other carotenoids compounds) have beneficial protective effects against depression, and their deficiencies may contribute to depression (Li et al., 2017). Second, food insecurity may result in higher levels of stress (e.g., stress in relation to feeding oneself or family) and stress is associated with higher levels of depression, and this can be due to impaired hypothalamic-pituitary-adrenal (HPA) axis function (Mayo Clinic, 2020). Indeed, low SES/poverty has been associated with higher levels of stress hormones (e.g., cortisol, epinephrine) (Cohen, Doyle, & Baum, 2006). Third, food insecurity likely increases feelings of shame and shame may also be associated with a higher risk of depression (Gilbert, 2000). Finally, depression has been found to influence the individual's ability to obtain and retain employment, particularly for individuals with lower education and thus depression per se may increase one's odds of suffering from food insecurity (Kolovos et al., 2020). Indeed, the relationship is likely bidirectional, which has been debated in terms of social causation and social selection/drift (Dohrenwend et al., 1992). In other words, social and economic conditions of poverty (such as food insecurity) increase risk for mental illness (social causation), while people with mental illnesses can 'drift' into poverty (due to disability, stigma, healthcare costs) (Lund & Cois, 2018). Our findings are likely to include all the aforementioned pathways.

Findings from the present study and others suggest that food insecurity may be a risk factor for depression, and that intervention and policy are needed in LMICs to reduce levels of depression among those who suffer from food insecurity. First, in high-income countries, supplemental nutrition programs have been shown to decrease food insecurity (Gundersen, Kreider, & Pepper, 2018) and improve health. Such programs have the potential to even address severe food insecurity (Keith-Jennings, Llobrera, & Dean, 2019). Importantly, by addressing food insecurity, there will likely be a reduction in the associated negative outcomes (e.g., poor nutrition, shame, stress) that can increase risk for depression. However, whether or not

supplemental nutrition programs work in LMIC remains to be seen. Second, countries can increase access to affordable mental health care through the use of lay health counselors, a form of task shifting already shown to be effective in the treatment of common mental disorders in LMICs (Reynolds III et al., 2012). Moreover, literature suggests that psychological interventions, such as cognitive behavior therapy, can effectively reduce symptoms of depression in LMICs (Morina, Malek, Nickerson, & Bryant, 2017). Furthermore, if food insecurity can be proven to be a risk factor for depression in LMICs in future longitudinal and intervention studies, alleviating poverty and hunger or poor nutrition through for example, acquisition of agricultural input, may have a positive impact on individual and population mental well-being in this setting.

It is important to consider the present findings in light of the COVID-19 pandemic. Social distancing measures implemented to reduce and slow the transmission of SARS-CoV-2 have resulted in the closure of workplaces, an increase in unemployment and reduced earnings (International Labour Organization, 2020). This has likely increased the proportion of the global population experiencing food insecurity and subsequent depression. Implementing measures to address food insecurity and depression, such as those discussed above, may now be of high public health importance.

The large representative sample of older adults from multiple LMICs, which collectively comprise nearly half of the worldwide population (Kowal et al., 2012), is a clear strength of the present study. However, it is important to interpret findings in light of the study limitations. First, the present study was cross-sectional in nature and thus it is not possible to determine whether food insecurity leads to depression or whether depression leads to food insecurity. As previously discussed, the association is likely to be bi-directional. Second, our measure of food

insecurity was based on two questions and did not constitute a comprehensive food insecurity measure. Third, both the exposure variable (food insecurity) and the outcome variable (depression) were self-reported, potentially introducing self-report and recall bias into the findings. Finally, although we did adjust for levels of wealth in our study, we cannot preclude the possibility that food insecurity may be a marker of other types of material deprivation (e.g., clothing, treatment for illness), which may not be reflected in our measure of wealth.

CONCLUSIONS

In this large representative sample of older adults from six LMICs, it was found that those with severe food insecurity compared to no food insecurity were over two times more likely to suffer from depression. Utilizing lay health counsellors and psychological interventions may be effective mechanisms to reduce depression among food insecure populations. Furthermore, future studies should assess whether alleviating food insecurity can lead to a lower risk of depression in LMICs.

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TABLES AND FIGURES

Table 1 Questions and answer options used for endorsement of DSM-IV depression

1. At least one of the two following symptoms in the last 12 months:
(a) A period, lasting several days, of feeling sad, empty or depressed
(b) A period lasting several days with a loss of interest in most things the participant usually enjoys such as personal relationships, work or hobbies/recreation
AND
2. The period of sadness/loss of interest/low energy lasted for more than two weeks and was most of the day and nearly every day
AND
3. Five or more of the following symptoms:
(a) Loss of appetite
(b) Insomnia (problems falling asleep or waking up too early)
(c) Decreased energy or tiredness all the time
(d) Slowing down in moving around or restless/jittery
(e) Negative feelings/loss of confidence or frequent feelings of hopelessness.
(f) Slowed thinking or difficulties concentrating (e.g., listening to others, working, watching TV, listening to the radio)
(g) Thoughts of death, wishes of own death or suicide attempt
(h) Feelings of sadness, emptiness or depression lasting several days
(i) Anhedonia: loss of interest in things the participant usually enjoys

Table 2 Sample characteristics by country

Characteristic		China	Ghana	India	Mexico	Russia	South Africa
Depression	No	98.9	92.8	87.1	89.2	96.5	97.0
	Yes	1.1	7.2	12.9	10.8	3.5	3.0
Food insecurity	None	98.8	55.4	81.5	64.9	86.1	67.6
	Moderate	0.9	23.5	11.1	15.3	7.7	10.9
	Severity	0.3	21.0	7.5	19.7	6.2	21.5
Age (years)	Mean (SD)	62.6 (16.7)	64.4 (19.9)	61.5 (13.7)	63.0 (18.9)	63.9 (15.4)	61.6 (18.4)
Sex	Male	49.8	52.4	51.0	46.8	38.9	44.1
	Female	50.2	47.6	49.0	53.2	61.1	55.9
Education	Primary	63.0	75.3	76.1	79.6	7.5	71.4
	Secondary	32.5	21.1	18.8	12.3	74.2	22.8
	Tertiary	4.5	3.6	5.1	8.1	18.2	5.7
Physical activity	High	43.6	61.5	52.2	40.0	57.4	27.8
	Moderate	27.5	12.5	22.9	22.4	15.8	12.4
	Low	28.8	26.0	25.0	37.6	26.8	59.8
Smoking	Never	64.1	75.1	45.3	60.7	69.6	66.8
	Current	29.3	10.7	50.0	20.3	21.3	23.8
	Former	6.6	14.2	4.7	19.1	9.0	9.4

Abbreviation: SD Standard deviation
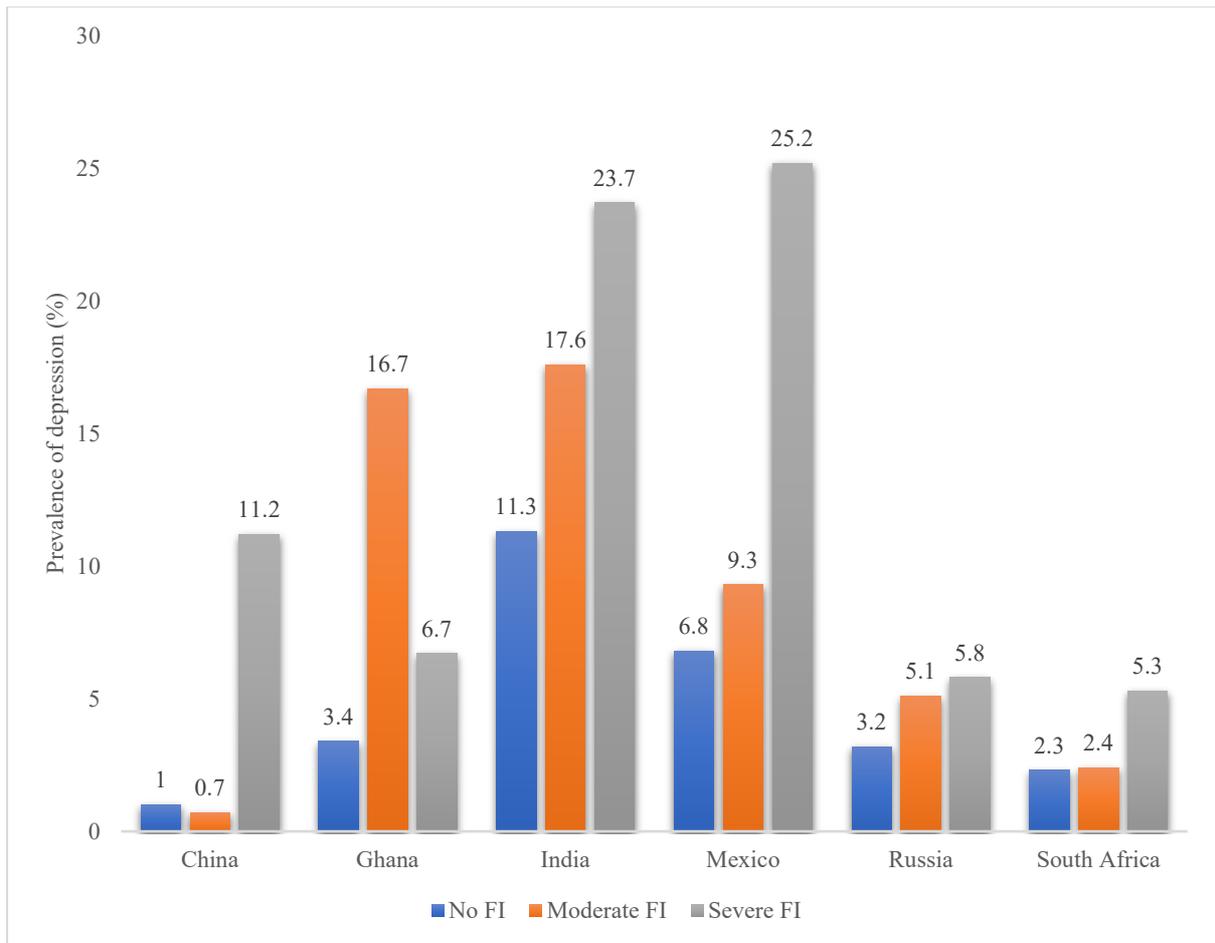Data are % unless otherwise stated.

Figure 1 Prevalence of depression by food insecurity status
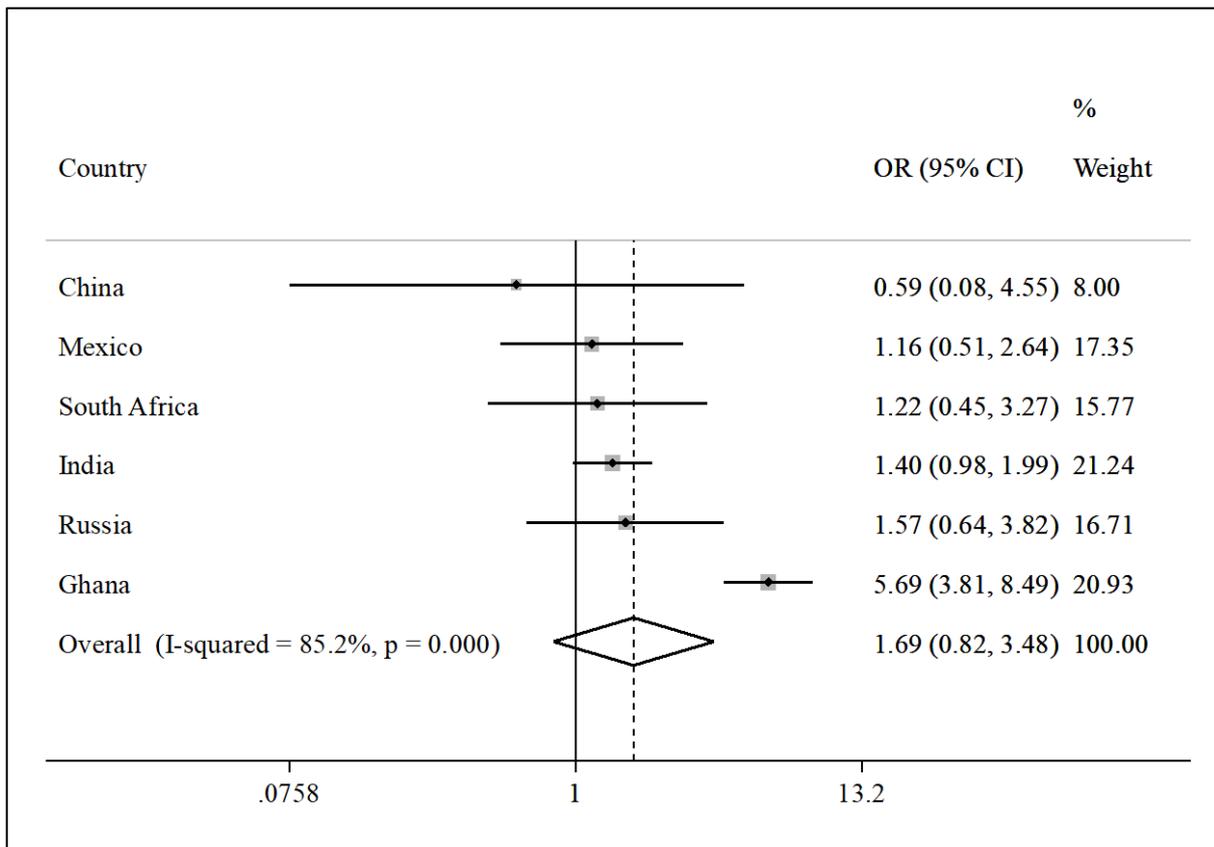Abbreviation: FI Food insecurity

Figure 2 Country-wise association between moderate food insecurity (vs. no food insecurity) estimated by multivariable logistic regression
Abbreviation: OR Odds ratio; CI Confidence interval
Models are adjusted for age, sex, wealth, education, physical activity, and smoking.
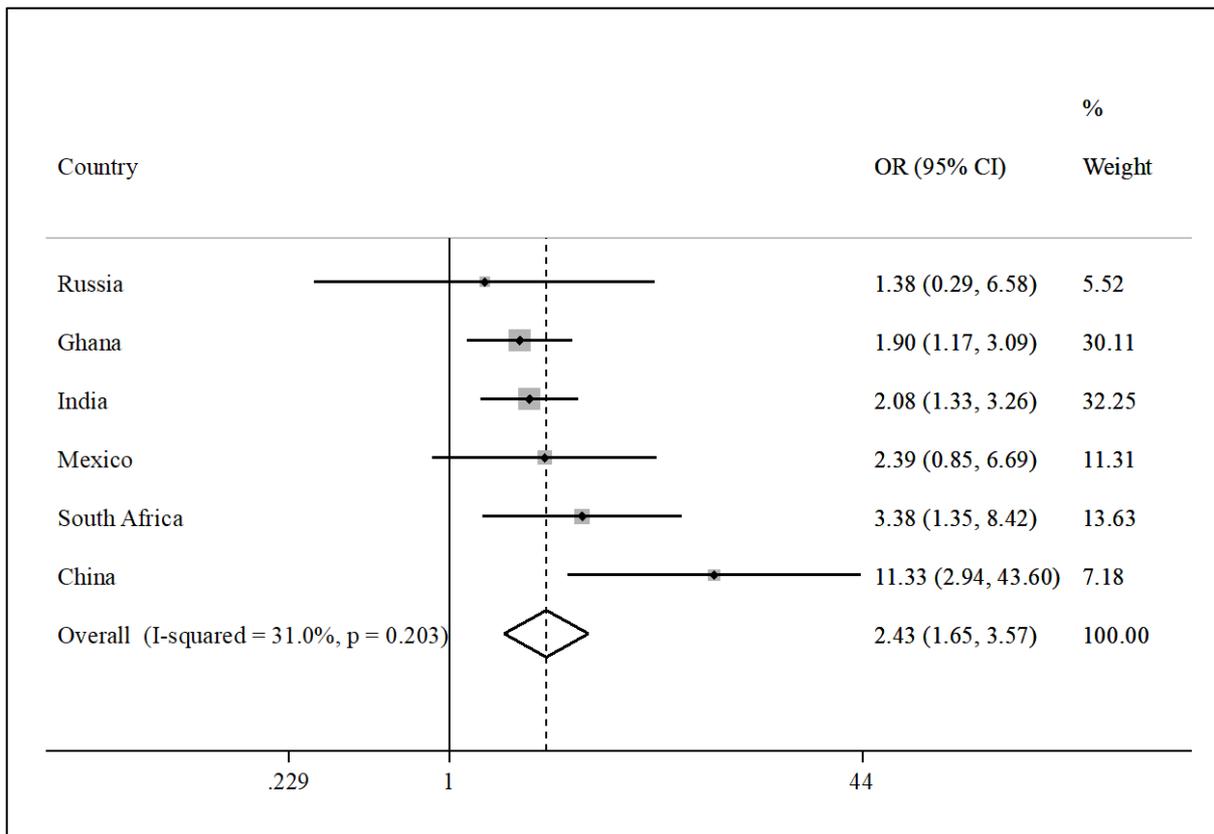Overall estimate was obtained by meta-analysis with random effects.

Figure 3 Country-wise association between severe food insecurity (vs. no food insecurity) estimated by multivariable logistic regression
Abbreviation: OR Odds ratio; CI Confidence interval
Models are adjusted for age, sex, wealth, education, physical activity, and smoking.
Overall estimate was obtained by meta-analysis with random effects.