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Associations Between Food Insecurity and Depression, Anxiety, and Psychological Distress in Adulthood Across High-Income and Low- to Middle-Income Countries: A Systematic Review of Observational Studies

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Abstract

Background: *Food insecurity (FI) refers to the lack of access to enough food for an active and healthy life. It affects millions, including high-income countries, and is associated with adverse mental health outcomes. Nevertheless, a significant gap remains on the impact socioeconomic context has on this association.*

Aim: *To evaluate the association between FI and depression, anxiety, and stress over the last ten years within high-income and low-income countries.*

Methods: *This systematic review follows Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. Observational studies published from 2014 onwards involving participants aged 18 and older exposed to FI were included. Studies involving coronavirus-19, pregnant individuals, and cancer patients were excluded. A search was conducted in PubMed, Cochrane, and Google Scholar between April and June 2024.*

Results: *871 papers were identified, and 10 met the inclusion criteria, encompassing a combined sample of 329,731 participants. Five studies were conducted in the United States of America, while others included Canada, India, Panama, China, Ghana, South Africa, Mexico, and Russia. FI was assessed using validated scales like the United States Department of Agriculture Adult Food Security Module (US-AFSM) and the Household Food Security Scale (HFSS). 9 articles evaluated depression, 2 articles evaluated anxiety, and 2 articles evaluated Serious Psychological Distress. All articles obtained statistically significant results for the association between food insecurity and mental health.*

Conclusions: *FI is significantly associated with mental health, highlighting the need for targeted interventions and policies to improve food security and mental health, especially for vulnerable populations.*

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Introduction

According to the United States Department of Agriculture (USDA), food insecurity (FI) is defined as limited access to nutritionally adequate and safe food. This condition is a global public health challenge that affects both physical and mental health, contributing to mental health disorders outbreaks (or debut), particularly during adulthood. Although FI is often linked to low- to middle-income countries (LMICs), high-income countries (HICs) are not exempt from this issue. In the USA, for example, approximately 10.5% of households experienced FI in 2020 (Bertoldo et al. , 2022).

Several studies associate FI with increased levels of stress, anxiety, and depression among all age groups, from children to (older adults) the elderly (Myers, 2020; Sabião et al., 2022). In adulthood, the experience of FI, especially during periods of unemployment and low availability of resources, has been associated with anxiety and depression (Ejiohuo et al., 2024; Graham & Ciciurkaite, 2023; Kirkbride et al., 2024). Moreover, among older adults, FI has been associated with increasing stress and worsening health conditions (Osei-Owusu et al., 2024).

Most research has been conducted in countries with high incomes, even though lower-income countries are more exposed to FI. At the same time, it is not clear whether this economic factor influences the relationship between FI and mental health. Therefore, to fill this gap, this systematic review aims to assess the relationship between FI and mental health outcomes, specifically depression, anxiety, and stress, in adults from LMICs and HICs.

Materials and Methods

The PECOTS framework for our primary objective was as follows:
P: Adults aged 18 or older from LMICs to HICs
E: Food insecurity assessed by a validated tool.
C: Individuals not experiencing food insecurity.
O: Association between FI and depression, anxiety, and stress
T, S: Studies assessed were observational studies published in the last 10 years.

We report our results following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) statement (Page et al., 2021). The protocol was registered in OSF Registries and the registration DOI is https://doi.org/10.17605/OSF.IO/9BJZT.

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Inclusion and Exclusion Criteria

The literature search included the most recent papers published in English within the last framework of ten years, as the goal is to capture the most current data; and target population included participants aged 18 years or older experiencing food insecurity measured by any validated tool. The study was restricted to adults, as a recent cross-sectional study from 29 countries stated that the median age of onset for mental disorders for males is 19 years and 20 years for females (McGrath et al., 2023). Within the framework of mental health disorders, we specifically appraised depression, anxiety, and stress due to their impact and association with disability and mortality.

All selected studies used validated questionnaires to assess these outcomes. Additionally, we limited our selection to observational studies to have a broader perspective of the risk factors and effects without any external intervention. Studies focusing on coronavirus disease 2019 (COVID-19), pregnancy, and cancer, which could confound the relationship between food insecurity and mental health outcomes, were excluded.

Information Sources and Search Strategy

A comprehensive literature review was executed utilizing free/unrestricted access to PubMed, the Cochrane Central Register of Controlled Trials, Google Scholar (because of its broad scope and ability to capture gray literature), and additional sources (i.e., previous reviews). Food insecurity and mental health were treated as separate concepts, and keywords were identified, listed, and combined with Boolean operators. We conducted the literature search from April to June 2024. Our systematic search and the relevant search terms can be found in *Supplementary Material A.*

Selection of studies and data extraction

The selection and assessment of studies were facilitated through the Covidence platform (Veritas Health Innovation, Melbourne, Australia), which supported the screening and elimination of duplicate entries, as well as data extraction, which was performed using customized data extraction forms. Initially, titles and abstracts were independently assessed by two reviewers to determine relevance. Disagreements in the first phase were resolved by consensus or by consulting a third reviewer.

Full texts were then meticulously independently reviewed, and studies not meeting the inclusion criteria were discarded. The outcomes collected were adjusted and unadjusted measures of association (e.g., OR and B coefficient).

Risk of bias assessment

Quality assessment was independently conducted by two reviewers using the Newcastle–Ottawa Scale (NOS) for cohort studies and an adapted version for cross-sectional studies *(Supplementary Material B and C).* Assessments were executed within the Covidence platform, and any discrepancies were resolved through discussion, leading to a consensus on the quality of each study. The scoring system was as follows: studies scoring >7 points are classified as "low risk of bias/good quality"; scores between 2 and 6 indicate "unclear risk of bias/fair quality"; and a score <1 denotes "high risk of bias/poor quality" (Wells et al., 2021).

Results

The screening search included 871 papers: 794 studies identified from Pubmed, 33 from the Cochrane Central Register of Controlled Trials Library, 10 from Google Scholar, and 34 from manual searches and references from other reviews. Covidence removed 253 duplicates. The studies were screened by analyzing their title and abstracts, excluding 572 studies. Of the remaining studies, 36 were excluded due to different reasons such as incorrect outcomes (17 papers), confounding variables like COVID (4 papers), inappropriate exposure (6 papers), inappropriate outcome measurement tools (2 papers), non-eligible population (5 papers) and non-eligible study design (2 papers). Ultimately, 10 studies met the inclusion criteria and were included in the review, as shown in Figure 1.

Population: The studies broadly addressed geographic locations examining adult populations aged 18 to 98 years. Out of the 10 studies included in this review, 5 were conducted in the United States of America. Studies were also conducted in HICs like Canada, Russia, and Panama; and LMICs like India, China, Mexico, Ghana, and South Africa. A country's level of income was determined by the World Bank classification for 2024 to 2025 (Metreau et al., 2024). These studies involved participants from both rural and urban settings. The eligible papers selected were published between 2018 to 2023. Table 1 provides a summary of the characteristics of all selected studies.

Study Design: Among the 10 studies included in the review, all followed a cross-sectional design, as detailed in Table 1.

Exposure Characteristics: FI was assessed through different validated scales and consistently showed a positive relationship with depression, anxiety, and stress across multiple studies. Some of these studies employed the USDA 10-Item Adult Food Security Module (FSSM), which classifies food security into four categories: high, marginal, low, and very low food insecurity. Participants with a score of 0 should be categorized as high food security, 1-2 as marginal food security, 3-5 as low food security, and 6-10 as very low food security. For analysis, some studies converted them into a binary variable: food secure (score 0-2) and food insecure (score 3-10) (e.g., Reeder et al., 2020 & Dong et al., 2018). Other studies utilized modified versions of this scale, adapted for specific contexts or populations (e.g., Joseph et al., 2020; Selvamani & Elgar, 2023; Pengpid & Peltzer, 2023; Nicholson et al., 2021; Shafiee et al., 2021; Smith et al., 2021). Further detail is available in Table 1.

Outcomes:

Depression:

The relationship between FI and depression was assessed in nine out of the ten studies reviewed. Overall, FI was reported as a risk factor for the development of depression. In particular, Oh et al. (2022) reported the smallest statistically significant relationship; when adjusting for age, gender, race, current financial distress, and parental education, individuals with FI had 1.54 times the odds of presenting depression (95%CI: 1.44-1.65, p <0.001). In contrast, Smith et al. (2021) presented the highest statistically significant relationship in the Chinese subpopulation, where the presence of severe FI was associated with 11.33 times the odds of presenting depression when adjusting for age, gender, income, education, physical activity, and smoking (95%CI: 2.94-43.60). Consequently, the studies using multivariate linear regression models also demonstrated a positive association between food insecurity and depression (Walker et al.,2021 & Nicholson et al., 2021).

Among the studies that included HICs, the majority used a multivariate logistic regression model to calculate the prevalence odds ratio. The exceptions were Nicholson et al. (2021) and Walker et al. (2021), that used a multivariate linear model. The former study concluded that with every additional item answered in the FI assessment tool, there was an increase of 0.68 points in the depression score

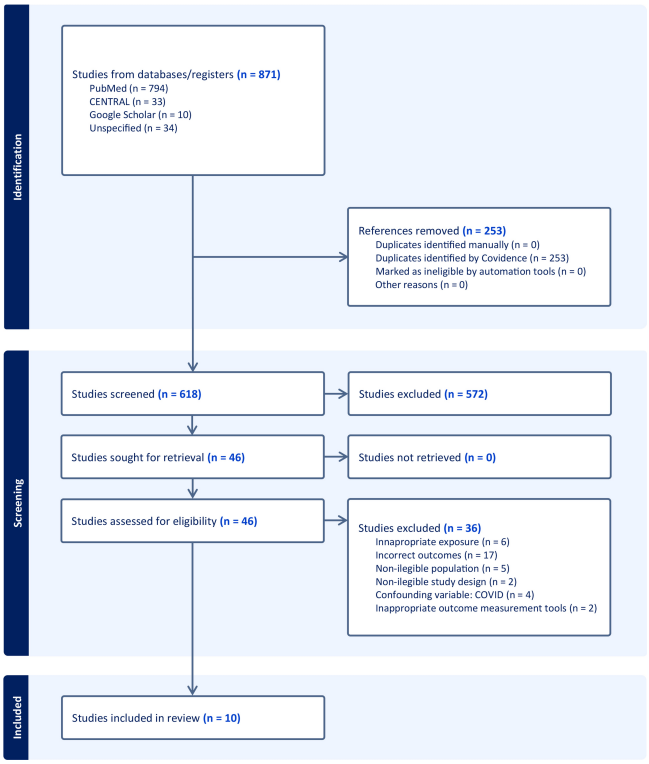

Figure 1: *PRISMA flowchart of study selection.*

(95%CI: 0.272-1.09, p 0.001), while the latter study concluded that the presence of FI was associated with an increase of 0.43 points in the PHQ-9 assessment score (95%CI: 0.03- 0.84, p<0.05). Between the studies that utilized logistic regression, Reeder et al. (2022) reported that presenting VLFS was a risk factor for depression even when adjusting for income, age, race, gender, marital status, educational attainment, smoking status, and BMI (OR 3.50, 95%CI: 2.98–4.12, p <0.05). The previous study applied PHQ-9 to assess depression with a cut-off value of 10. In comparison, Oh et al. (2022) utilized the same questionnaire as the former study but with a cut-off value of 15 and reported a smaller association between FI and depression, this value was adjusted for age, gender, ethnicity, current financial distress, and parental education (OR 1.54, 95%CI: 1.44-1.65, p<0.001). Consequently, Shafiee et al. (2021) concluded that FI was associated with 2.87 times the odds of presenting depression (95%CI: 2.33-3.55), with a cut-off value of 5 for PHQ-9 and adjusting for various covariates found in the footnote of Table 1. The only non-statistically significant relationship was reported in the Russian subpopulation of Smith et al. (2021) study, where moderate FI was associated with 1.57 times the odds of presenting depression (95%CI: 0.64- 3.82), and severe FI was associated with 1.38 times the odds of presenting depression.

In contrast, when evaluating the articles from LMICs, the results varied depending on the country being assessed. Pengpid & Peltzer (2023) and Selvamani & Elgar (2023) both utilized the same national cross-sectional household survey conducted in India between 2017 and 2018. Selvamani & Elgar (2023) concluded that individuals with food insecurity had 2.87 times the odds of presenting depression (95%CI: 2.42-3.39, p<0.001). In comparison, Pengpid & Peltzer (2023) had a similar conclusion for depression, but referred to the outcome as major depressive disorder, even when utilizing the same cut-off value in CIDI-SF (OR 2.37, 95%CI 2.03-2.77, p<0.001). Smith et al. (2021) had statistically significant results when assessing the sample from Ghana, India, South Africa, and the subpopulation with severe FI from China. Particularly, Ghana's sample had a higher association between moderate FI and depression (OR 5.69, 95%CI: 3.81- 8.49) compared with severe FI and depression (OR 1.90, 95%CI:1.17- 3.09).

In conclusion, the relationship between FI and depression is present even when adjusting for confounding variables, but its statistical significance can vary due to the severity of FI or geographic region.

Anxiety:

Anxiety was evaluated in two studies, both conducted in the United States, thus providing evidence of a significant association between this disorder and FI in the HIC context. The first study by Oh et al.

Author, Year of Publication	Countries included in study	Period of Data collection	Design	Sample Size (n)	Food Insecurity Measurement	Prevalence of Food Insecurity in study sample (n(%))	Mental Health Assessment tool	Prevalence of mental health disorder in Food insecure population (%,weighted/unweighted)	Measure of association (OR(95% CI)(p-value))* (B-coefficient(95%CI)(p-value)++
Reeder et al. 2022	USA	2005-2016	Cross-Sectional	28.448	US FSSM	5452 (19.2)*	PHQ-9 (cut off value of 10)	**Depression** **LFS** 14.7, weighted **VLFS** 25.8, weighted	**Depression** **LFS** Unadjusted: 3.23(2.75–3.80)(<0.05)* Multivariate-adjusted[a]: 1.88(1.58–2.24)(<0.05)* **VLFS** Unadjusted: 6.51(5.61–7.55)(<0.05)* Multivariate-adjusted[a]: 3.50 (2.98–4.12)(<0.05)*
Josep et al. 2022	USA	2017	Cross-Sectional	6.266	USDA Six-Item SFFSM	**LFS** 1783 (28.6) **VLFS** 800 (12.9)	K6 (cut off value of 13)	**Serious Psychological Distress** **LFS** 9.5, weighted **Serious Psychological Distress** **VLFS** 18.6, weighted	**Serious Psychological Distress** **LFS** Multivariate-adjusted[b]: 3.03(1.78–5.18)(<0.05)* **Serious Psychological Distress** **VLFS** Multivariate-adjusted[b]: 5.54(3.11–9.84)(<0.05)*
Oh, et al 2022	USA	2020-2021	Cross-Sectional	96.379	Two- item questionnaire**	29729 (30.8)	PHQ-9 (cut off value of 15)	**Depression** 35.74, weighted	**Depresion** Multivariate-adjusted[c] 1.54(1.44–1.65)(<0.001)*
							GAD-7 (cut off value of 11)	**Anxiety** 49.68, weighted	**Anxiety** Multivariate-adjusted[c] 1.41(1.33–1.49)(<0.001)*
Selvamani & Elgar 2023	India	2017-2018	Cross-Sectional	77.250	US-HFSS	4838 (8)	CIDI- SF (cut off value of 3)	**Depression** 19.5, weighted	**Depression** Multivariate-adjusted[d] 2.87(2.42–3.39)(<0.001)*
Pengpid & Peltzer. 2023;	India	2017-2018	Cross-Sectional	72.262	US-HFSS	9.7%	CES-D-10 (cut of value of 4)	**Depressive symptoms** 16.9,not specified	**Depressive symptoms** Unadjusted: 2.68(2.32–3.08)(<0.001)* Multivariate-adjusted[e] 2.21(1.97–2.48)(<0.001)*
							CIDI-SF (cut off value of 3)	**Major depressive disorder** 23.7, not specified	**Major depressive disorder** Unadjusted 2.90(2.46–3.41)(<0.001)* Multivariate-adjusted[e] 2.37(2.03–2.77)(<0.001)*
Nicholson et al. 2021	USA	Not specified	Cross-Sectional	366	USDA SAFSS	Was not provided	WHO-5 (cut off value of 12)	**Depression** 46/ 42.4/ 34.1[g] weighted	**Depression** Multivariate-adjusted[h] 0.681(0.272–1.09) (0.001)++
							GAD-7 (cut off value of 10)	**Anxiety** 42.1/ 49.4/ 20[g] weighted	**Anxiety** Multivariate-adjusted[h] 0.669 (0.217–1.12) (0.001)++
Shafiee et al. 2021	Canada	2015-2016	Cross-Sectional	19.118	HFSSM (cut off value of 2)	8.3%	PHQ-9 (cut off value of 5)	**Depression** 52, weighted[i]	**Depression** Unadjusted: 4.67 (3.94–5.53) (<0.001)* Multivariate-Adjusted[i] 2.87 (2.33–3.55)*
Dong et al. 2018	USA	2016	Cross-Sectional	304	USDA 10-Item AFSM	214 (70)	CES-D-10 (cut off value of 15)	**Depression** 81, unspecified	**Depression** Unadjusted: 3.22 (1.93–5.39)* Multivariate-adjusted[k] 3.33 (1.89–5.86)*

Table 1: *Included observational studies were published between 2018 and 2023 and evaluated the impact of food insecurity on mental health.*

Walker et al. 2021	Panama	2013	Cross-Sectional	209	USDA Six-Item SFFSM	83.3 %	PHQ-9 (cut off value of 10)	**Depression** Unspecified	**Depression** Unadjusted 0.44 (0.10–0.78) (<0.05)[++] Multivariate-adjusted[l] 0.43 (0.03–0.84) (<0.05)[++]
							K6 (cut off value of 13)	**Serious Psychological Distress** Unspecified	**Serious Psychological Distress** Unadjusted 0.54(0.23–0.85) (<0.05)[++] Multivariate-adjusted[l] 0.68 (0.30–1.07) (<0.05)[++]
							PSS-4	**Perceived stress** Unspecified	**Perceived stress** Unadjusted –0.06(–0·24-0·12) (>0.05)[++] Multivariate-adjusted[l] -0.15 (-0.38- 0.08) (>0.05)[++]
Smith et al. 2021	China Ghana India Mexico Russia South Africa	2007-2010	Cross-Sectional	**Overall** 34.129 **China** 13.175 **Ghana** 4.305 **India** 6.560 **Mexico** 2.313 **Russia** 3.938 **South Africa** 3.838	Two-item questionnaire***	**Overall** Moderate FI: 6.7% Severe FI: 5.1% **China** Moderate FI: 0.9% Severe FI:0.3% **Ghana** Moderate FI: 23.5% Severe FI: 21.0% **India** Moderate FI: 11.1% Severe: 7.5% **Mexico** Moderate FI: 15.3% Severe FI: 19.7% **Russia** Moderate FI: 7.7% Severe FI: 6.2% **South Africa** Moderate FI: 10.9% Severe FI: 21.5%	DSM-IV depression/Kessler****	**Depression** **Overall** 60 **China** Moderate FI: 0.7 Severe FI:11.2 **Ghana** Moderate FI: 16.7 Severe FI: 6.7 **India** Moderate FI: 17.6 Severe FI: 23.7 **Mexico** Moderate FI: 9.3 Severe FI: 25.2 **Russia** Moderate FI: 5.1 Severe FI: 5.8 **South Africa** Moderate FI: 2.4 Severe FI: 5.3 weighted	**Depression** Multivariate-adjusted[m] **Overall** Moderate FI: 1.69 (0.82–3.48) Sever FI: 2.43 (1.65–3.57) **China** Moderate FI: 0.59 (0.08–4.55) Severe FI: 11.33 (2.94–43.60) **Ghana** Moderate FI: 5.69 (3.81–8.49) Severe FI: 1.90 (1.17–3.09) **India** Moderate FI: 1.40 (0.98–1.99) Severe FI: 2.08 (1.33–3.26) **Mexico** Moderate FI: 1.16 (0.51–2.64) Severe FI: 2.39 (0.85–6.69) **Russia** Moderate FI: 1.57 (0.64–3.82) Severe FI: 1.38 (0.29–6.58) **South Africa** Moderate FI: 1.22 (0.45–3.27) Severe FI: 3.38 (1.35–8.42)

Legend: United States Food Security Survey Model (US FSSM), Patient Health Questionnaire-9 (PHQ-9), Low Food Security (LFS), Very Low Food Security (VLFS),United States of America (USA) United States Department of Agriculture Six-Item Short Form Food Security module (USDA Six-Item SFFSM), Kessler 6 Psychological Distress Scale (K6), General Anxiety Disorder-7(GAD-7),Veterans Rand 12-Item Health Survey (VR-12), US Household Food Security Survey Module (US-HFSS), Composite International DiagnosticInterview Short Form(CIDI- SF), Patient Health Questionnaire 2-item (PHQ2), Who Five Well Being Index (WHO-5), USDA Self-Administered Food Security Survey Module for Children Ages 12 Years and Older (USDA SAFSS) Center for Epidemiological Studies Depression Scale (CES-D-10), Household Food Security Survey Module (HFSSM), USDA 10-Item Adult Food Security Module (USDA 10-Item AFSM), 4-item perceived stress scale (PSS-4) Food Insecurity (FI)

+A logistic regression model was used and the results are interpreted as a prevalence odds ratio.

++Model used is a linear regression model

*Individuals with marginal food security were considered food secure and are not part of this measurement.

**The questionnaire included these questions, "Within the past 12 months I was worried whether our food would run out before we got money to buy more" and "Within the past 12 months the food I bought just didn't last and I didn't have money to get more."

***The questionnaire included these 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?" 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

****The exact questionnaire is provided in the supplementary material

[a]Adjusted for poverty-to-income ratio, age, race, gender, marital status, educational attainment, smoking status, and BMI.

[b]Adjusted for age, gender, race/ethnicity, birthplace, highest educational attainment, employment, annual household income, and family type.

[c]Adjusted for age, gender, race/ethnicity, current financial distress, and parental education.

[d]Adjusted for age, gender, marital status, place of residence, education, material wealth, multimorbidity and states/provinces

[e]Adjusted for sex, education, age, receipt of health insurance, marital and residential status, subjective economic status,caste, and social participation

[f]Adjusted for baseline outcome, age, gender, race/ethnicity, education, health insurance, and family size.

[g] Results reported as middle-adult households without children/ middle-adult households with children/ late adults.

[h] Adjusted for self-reported health status.

[i] Weighed to the Canadian population.

[j]Adjusted for location of residence, gender, age, marital status, education level,employment status, total household income, Immigrant status, physical activity level, Body mass index (BMI), smoking status, passive smoking exposure, type of drinker, illicit drug use, and number of chronic disease

[k]Adjusted for gender, race/ethnicity, age, income, and being homeless.

[l]Adjusted for age, gender, marital status, education and income.

[m]Adjusted for age, sex, wealth, education, physical activity, and smoking.

Table 1: *(continued) Included observational studies were published between 2018 and 2023 and evaluated the impact of food insecurity on mental health.*

(2022) included 96,379 young adult college students aged 18-34 years old who were assessed for anxiety using the validated General Anxiety Disorder – 7 (GAD-7) scale. In this study, the GAD-7 scores were transformed into a dichotomous variable to refer to the presence of moderately severe or severe anxiety. Remarkably, this outcome was present in 35.85% of the participants (34,551), from which 14,768 (49.68%) were experiencing FI. Through a multivariate logistic regression model, the authors found that FI was significantly associated with increased odds for anxiety (OR 1.41, 95%CI 1.33-1.49, p<0.001), even when adjusting for age, gender, race/ethnicity, financial distress, and parental education. The second study, by Nicholson et al. (2021), investigated 366 adults receiving food from support programs. In this study, anxiety was also measured using GAD-7, but the scores were analyzed as a continuous variable. They used two linear regression predictive models, and they evaluated the association between FI and anxiety, considering the main effects of age (dichotomized as middle or late adulthood) or household composition (dichotomized as with or without children). In the first analysis, comparing middle and late adults without children, FI was found to be a significant predictor of anxiety regardless of age ($R^2 = 0.231$, $F(4, 178) = 13.374$, $p < 0.001$). On the other hand, the second analysis, comparing middle adults with and without children, showed a lack of a predictive interaction for anxiety when accounting for household composition, even though a significant effect of FI on anxiety was found ($R^2 = 0.241$, $F(4, 156) = 12.411$, $p < 0.001$). Importantly, both studies highlight the significant negative impact FI exerts on the risk of anxiety in adults living in HICs.

Stress:

Stress was only evaluated in two studies conducted in HICs. Joseph et al. (2022) demonstrated that food insecurity correlated with higher levels of severe psychological distress. This association persisted even after adjustments for sociodemographic and health factors. Walker et al. (2021) found that the presence of food insecurity was associated with an increase of 0.68 points in the Serious Psychological Distress scale (95%CI 0.30, 1.07, p <0.05) when adjusting for covariates. The description of adjusted covariates can be found in Table 1.

Assessment of risk of bias in individual studies:

The risk of bias in each study was evaluated using the Newcastle–Ottawa Quality Assessment Scale for non-randomized studies; the grading criteria can be found in Supplementary Material B & C.

Table 2 showed that among the 10 studies, 8 presented an overall low risk of bias. These studies were considered high quality for using validated tools to assess the exposure (food insecurity) and the outcomes (depression, anxiety, and/or stress) with a sample representative of the population. Two studies displayed an unclear overall risk of bias (Nicholson et al., 2021; Oh et al., 2022), suggesting that these findings could be uncertain and could affect their validity. Nicholson et al. (2021) had an unclear risk of bias due to limitations in sample representativeness and confounding factors. Although participants were receiving food assistance, making the sample somewhat representative, the lack of information on the response rate and non-responders limited the generalizability of the findings. Moreover, important confounders such as age and gender were not adequately controlled, and the heavy reliance on self-reported outcomes, paired with insufficient statistical detail, contributed to the high risk of bias. In the case of Oh et al. (2022), the unclear risk of bias occurred due to the low response rate (14%) and the absence of details on non-responders, this raised concerns about the representativeness of the sample. Additionally, the use of self-reported outcomes, without validation from external sources, introduced uncertainty regarding the accuracy of the results despite a robust statistical analysis.

Discussion

Mental health disorders, particularly depression, anxiety, and psychological distress, are increasingly recognized as critical consequences of food insecurity (Wolfson et al., 2021). The nutritional quality of meals in food-insecure households impacts mental health, with nutrient-poor diets affecting brain function and increasing risks of mental health issues (Eicher-Miller et al., 2023; Zielińska et al., 2023; Carvajal-Aldaz et al., 2022).

In this systematic review, we aimed to assess the association FI had on the prevalence of important mental disorders in adults aged 18 years across low to high-income countries. Even though the literature search criteria considered studies published from 2014 to 2024, all included papers were published between 2018 and 2023, which highlights the relevance and the increasing scientific interest on the topic in recent years. Importantly, to eliminate a potential confounding effect, we excluded all papers related to the COVID-19 pandemic since its association with both an increase in FI and the development of mental diseases has already been demonstrated (Fang et al., 2021; Wolfson, 2021). This review also considers the association between the outcomes in

Study ID	Selection	Comparability	Outcome	Overall Quality Assessment
Dong 2018	★★★★	★	★★	Low
Joseph 2022	★★★★	★	★★★	Low
Nicholson 2022	★★★	★	★	Unclear
Oh 2022	★★	★	★★	Unclear
Pengpid 2023	★★★★★	★	★★★	Low
Reeder 2022	★★★★★	★	★★★	Low
Selvamani 2023	★★★★★	★	★★	Low
Shafiee 2021	★★★★	★	★★★	Low
Smith 2021	★★★★	★	★★★	Low
Walker 2021	★★★★	★	★★★	Low

Table 2: *Quality assessment of included studies.*

both HICs and LMICs, thereby offering a comprehensive understanding of geographic and socioeconomic factors. The inclusion of data from diverse regions enriches the findings and enhances their generalizability across various cultural and socioeconomic contexts.

The current literature search resulted in the selection of 10 papers and a total of 329,731 subjects from 9 countries, including the U.S.A, Canada, Panama, India, China, Ghana, Mexico, Russia, and South Africa. Our findings indicate that FI is associated with an increased risk for anxiety, depression, and stress, similar to other studies in the literature. Furthermore, this association with depression was constant across countries with varying levels of income. The systematic review and meta-analysis conducted by Pourmotabbed et al. (2020) revealed that FI was associated with an increased risk for depression and stress, but not for anxiety. Subgroup analysis showed that participants aged 65 years or older, as well as males, presented a higher risk for depression, with a greater risk for stress and anxiety observed for insecure households from North America. In comparison to Pourmotabbed et al. (2020) study, the present review included studies published after 2019 that described an association between FI and anxiety (Oh et al., 2022; Nicholson et al., 2021).

Additionally, Osei-Owusu et al. (2024) performed a systematic review with data from 12 cross-sectional studies, which showed that FI was significantly associated with the worsening of mental health in adults aged 50 years old and over. Also, the systematic review and meta-analysis by Arenas et al. (2019) evaluated cross-sectional data from 57 studies related to depression, 13 studies on anxiety and psychological distress, and 8 studies on sleep disorders. The meta-analysis performed with this dataset revealed that food insecurity was strongly associated with a higher risk of mainly depression and anxiety, but also of sleep disorders. Contrary to this, our review excludes studies involving specialized populations, including cancer patients, pregnant individuals, and cases specifically related to COVID-19. All this is to minimize potential confounding factors that may influence mental health independently of food insecurity, which could lead to a greater number of studies and the introduction of confounding effects.

Essentially, all these findings, alongside those from our work, highlight the impact of food insecurity on mental health conditions such as anxiety, depression, and stress. Nonetheless, the eligibility criteria applied in this systematic review aimed to select studies that could provide reliable and robust conclusions; the diverse context found in the studies was an important challenge of this study. An important heterogeneity was observed mainly regarding the population and the outcomes measurement, as seen in Table 1. The differences in outcome measurement tools and FI assessment tools can pose a limitation to the interpretability of the review. Furthermore, other sources of variability may have influenced our findings. For instance, Reeder et al. (2022) used data from the National Health and Nutrition Examination Survey (NHANES), employing a consistent measure of food insecurity. In contrast, Oh et al. (2022) focused on young adult college students (18-34 years), using a targeted survey to measure food insecurity. Joseph et al. (2022) evaluated low-income adults in California using a state-specific survey, while Dong et al. (2018) studied adults on probation in Rhode Island, a unique and high-risk population. Walker et al. (2021) conducted their research in a remote Indigenous community in Panama, reflecting unique cultural and environmental factors. Finally, Smith et al. (2021) leveraged the Global Ageing and Adult Health (SAGE) survey, comparing food insecurity across multiple countries and cultural contexts. Additionally, Walker et al. (2021) and Dong et al. (2018)

did not focus as much on racial differences but highlighted other demographic factors such as age and community status. Regarding socioeconomic status, Joseph et al. (2022) specifically studied low-income populations and Medicaid beneficiaries, highlighting the socioeconomic dimension of food insecurity. Smith et al. (2021) included broader socioeconomic variables such as insurance status, residence, and education levels. With respect to control of confounders, Reeder et al. (2022) adjusted for a broad range of sociodemographic factors, including age, race, gender, marital status, educational attainment, smoking status, and BMI, whilst Oh et al. (2022) analyzed the influence of gender and race more deeply, emphasizing differences between cis-gender, transgender/nonbinary, and various racial/ethnic groups. Joseph et al. (2022) focused on psychological distress levels and adjusted for sociodemographic variables, and Walker et al. (2021) and Dong et al. (2018) included unique community-specific variables, such as age and probation status. The geographical and cultural context also played a significant role. Smith et al. (2021) provided a cross-national perspective, comparing food insecurity and depression across countries like China, Ghana, India, Mexico, Russia, and South Africa. Walker et al. (2021) offered insights from a Panamanian indigenous, a unique cultural and environmental setting. The included studies represent various regions, thus enhancing the generalizability of the findings across different populations. However, an important limitation is that all studies included in this review are cross-sectional, and causation cannot be determined. In addition, there is a clear gap in information regarding demographic groups such as American Indians, young adults not attending university, and people living with disabilities, according to Odoms-Young et al. (2024). The current review does partially address these limitations by including studies with individuals with no university degree (Reeder et al., 2022; Joseph et al., 2022; Selvamani & Elgar, 2023; Pengpid & Peltzer, 2023; Nicholson et al. 2021; Dong et al., 2018; Walker et al., 2021) and studies with varied ethnic group representation (Reeder et al., 2022; Joseph et al., 2022; Nicholson et al., 2021).

Despite the mentioned limitations, this systematic review provides valuable evidence, including food insecurity data from publicly available databases, as seen in the study published by Smith et al. (2021) and Reeder et al. (2022), encompassing a diverse range of geographical regions. Also, regardless of the variety of scales used, many studies applied validated questionnaires to measure mental health outcomes, such as the Patient Health Questionnaire-9 (PHQ-9), to inquire about the level of depression, and the General Anxiety Disorder-7 (GAD-7) to help determine the presence of anxiety.

Importantly, the risk of bias was carefully assessed, which significantly strengthened the conclusions of our study, providing a deeper evaluation and understanding of the findings. From the 10 studies included, none were classified as having a high risk of bias, allowing reliability to our results. Two studies were classified as unclear risk of bias, evidencing the need for robust studies in this field. Finally, additional research is needed to deepen knowledge regarding the association between food insecurity and mental disorders development, such as longitudinal studies for establishing a temporal relationship.

Conclusion

This systematic review found an association between FI and anxiety, depression, and stress that was disclosed across low-, middle- and high-income countries, affecting both economically disadvantaged groups and financially stable individuals. Our findings support the relevant negative effect that food insecurity exerts on mental health, especially focusing on globally common conditions such as anxiety, depression, and stress. It is important to mention the crucial need for policy-making and educational interventions to enhance food security around the globe, consequently improving the mental health status of vulnerable populations.

Supplementary Materials

Search Strategy
Newcastle-Ottawa Quality Assessment Form for cohort studies
Adapted Newcastle-Ottawa Assessment Form for cross-sectional studies
Assessment tool for depression used by Smith et al. 2021 study

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Conflicts of Interest

The authors declare no conflict of interest.

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