Focusing attention on the important association between food insecurity and psychological distress: a systematic review and meta-analysis

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Abstract

Background Food insecurity has involved more than 750 million individuals worldwide. The association of food insecurity with socio-economic factors is also undeniable demand more consideration. Food insecurity will become a global priority by 2030. This systematic review and meta-analysis examined current literature concerning the association between food insecurity and psychological distress.

Methods Relevant researches were identified by searching databases including PubMed, EMBASE, Scopus, and Web of Science, ProQuest, and Cochrane Library up to June 2024 without language limitation. Then a snowball search was conducted in the eligible studies. The quality assessment was made through Newcastle–Ottawa Scale.

Results Data were available from 44 cross-sectional articles for systematic review and 17 eligible articles for meta-analysis with 2,267,012 and 1,953,636 participants, respectively. Findings support the growing segment of literature on the association between food insecurity and psychological distress. The highly represented groups were households with low income. Psychological and diabetic distress was directly associated with food insecurity as it increased the odds of distress to 329% (OR: 3.29; 95% CI: 2.46–4.40). Sleep problems, anxiety, depression, lower life satisfaction, obesity, and a higher rate of smoking were among the secondary outcomes.

Conclusion Food insecurity was a common stressor that can have a negative impact on psychological well-being and even physical health. The findings should be considered in the public health and making policy-making process.

Keywords Food insecurity, Food security, Psychological distress, Stress

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Background

Food and nutrition are among the basic needs of human society and its provision lies in the category of food security. Food security is the access of all people at all times to enough food to live a healthy and active life. Besides, it includes the availability of healthy and nutritionally sufficient food as well the ability and confidence in obtaining foods accepted by society [1]. On the other hand, food insecurity (FI) is a complex and multi-dimensional phenomenon, which apart from quantity and quality, includes social, cultural, and psychological dimensions.

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FI is not limited to individuals who only encounter insufficient nutrients and body reserves. When people do not have the right to choose food, they are afraid of running out of food, or making major changes in their food preferences, it can be admitted that we are facing FI. Also, FI ranges from anxiety about food access at the household level to extreme hunger and disease. Notably, it has profound effects on health [2, 3]. According to the Food and Agriculture Organization (FAO), FI is defined as the insecure availability of food for a healthy and lively life [4]. Unexpected alterations in income, lack of access to common services, exclusion, and high stress can lead to FI [5]. Accordingly, FI has involved about 750 million individuals worldwide. In other words, among 10 individuals, one of them has been handling severe levels of FI. On the other hand, the prevalence of household food insecurity in Iran is between 20 to 60% [6]. Moreover, COVID-19 threatens access to food primarily through loss of income and assets, which impairs the ability to purchase food. The poorest households spend about 70 percent of their income on food and have limited access to financial markets [7].

Inequalities in health outcomes are a common phenomenon among vulnerable individuals and issues such as shelter and income can determine the health-related outcomes [8]. According to psychosocial theories, unpleasant health outcomes are not solely dependent on limited resources and psychological reactions due to the sense of inequality, stress, exclusion and inappropriate social support can lead to negative health outcomes [9].

Notably, it is claimed that adults who experience FI, are more prone to unpleasant health outcomes such as delayed prescription, more hospital stay, and underutilized medication [10–12]. Besides, FI, along with insufficient intake of essential nutrients, causes disturbances in the physical and mental health of children and adults, as well as a decrease in resistance to disease. Also, not being able to buy nutritious and sufficient food has a negative impact on human health from a psychological point of view and leads to the aggravation of the disease. Therefore, FI is indirectly related to adverse health status and both can reinforce each other [13]. For instance, studies have shown that FI is directly in relation to depression, anxiety, and PD [14]. Meanwhile, individuals exposed to FI normally show higher rates of perceived stress [15, 16]. Lack of access to food resources is in relation to a diminished level of energy and inability to make the decision [17]. As well, the perceived stress originating from FI is effective in glycemic control [18]. Even though, it is claimed that alterations in dietary patterns may bring about inflammation and immune responses [19]. Without appropriate food consumption, malnutrition may happen [20]. After leading to the consumption of unhealthy

or insufficient food, FI can also cause sleep problems [21]. Even, FI is not limited to a specific population and can impact academic and educational outcomes among young students with different backgrounds [22]. Notably, hunger in childhood can lead to mental health problems such as ADHD [23] or other negative conditions in adulthood [24]. In addition, FI can may bring worry about the accessibility of food and the requirement to deal with limited food options [25, 26]. Further, FI is considered an obstacle to the treatment of chronic illnesses [27, 28].

It is also hypothesized negative health outcomes that originate from FI may be related to a lack of obedience to medical recommendations such as the inability to buy the required drugs [29]. Interestingly, employment cannot be an indication of food security [30]. Seemingly, FI can have a destructive impact on health care systems around the world [31]. The primary objective of this meta-analysis is to systematically assess and quantify the association between food insecurity and psychological distress by synthesizing empirical evidence from existing studies. Additionally, since no systematic review and meta-analysis has been conducted regarding the relationship between FI and PD, the aim of this study is to provide the pooled magnitude of association between food insecurity and psychological distress. As well, the current study needs to respond to the following question:

- How does the relationship between food insecurity and psychological distress vary by demographic factors such as age, gender and socioeconomic status?
- What are the mediating factors that contribute to the relationship between food insecurity and psychological distress?
- What is the overall magnitude of the association between food insecurity and psychological distress across different populations and settings?
- What are the gaps and limitations in the existing literature on food insecurity and psychological distress that need to be addressed in future research?

Methods

Search strategy

The review was registered in PROSPERO (ID: CRD42022341171) on July 11th, 2022. An inclusive search was performed in databases consisting of Pub-Med, EMBASE, Scopus, and Web of Science, ProQuest, Embase and Cochrane Library up to June 2024 without language limitation. The study protocol was based on the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. The main keywords included "food insecurity" and "psychological distress". To determine the sensitivity of searches, PubMed and NLM Gateway (for MEDLINE), Institute of Scientific

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Information (ISI), and Scopus were searched as the main international electronic data sources (Appendix). Meanwhile, the snowball technique was used to follow the reference list of the included studies. With this method, the number of missed data is usually minimized. Consequently, the data were transferred to EndNote reference management software (X8 version).

Eligible criteria

Finding the related articles was based on PECO: 1) Population: individuals who have experienced FI (cross-sectional studies) that reported the relation between food insecurity and one or more kind of PD; 2) Exposure: any kind of food insecurity; 3) Comparison: individuals who are considered food secure and 4) Outcome: PD. Also, other study designs such as case series, narrative reviews, and commentaries were omitted. However, there was no restriction regarding the age and gender of the target groups. Besides, animal-based studies or those with duplicate citations were also excluded.

Study selection

A systematic search of electronic databases identified 1053 records (PubMed: 379; Scopus: 240; Web of Science: 210; ProQuest: 101; Embase: 81 and Cochrane Library: 42). After removing duplicates and screening titles and abstracts, 637 records proceeded to full-text assessment. Of these, 524 were excluded due to lack of relevance, leaving 113 studies for eligibility evaluation. Following the application of inclusion and exclusion criteria, 69 articles were removed, primarily due to insufficient data on the association between FI and PD. Ultimately, 44 studies met the inclusion criteria and were included in the systematic review and meta-analysis. Disagreements were addressed and resolved by an additional author. This study selection process is summarized in the PRISMA flowchart (Fig. 1).

Quality assessment of articles

The methodological quality and risk of bias for the included studies were evaluated by two independent reviewers using the Newcastle–Ottawa Scale (NOS) [32]. The NOS is designed to appraise the quality of non-randomized studies, including both case–control and cohort studies. It assigns scores based on selection criteria, comparability, and either outcome (for cohort studies) or exposure (for case–control studies), with a maximum possible score of 9. According to the NOS scores, the overall risk of bias for each study was categorized as high, some concerns, or low. A study was considered to have a high overall risk of bias if any of its domains—selection criteria, comparability, or outcome—received a high risk of bias rating (Table 1).

Data extraction

Two authors evaluated the potential scientific publications separately. If there was any disagreement, the third author resolved it. Each study underwent the extraction of these information: author name, publication date, type of study, country, sample size, participants, effect size, and assessment tools dedicated for the measurement of psychological distress and FI as well as their definition and category.
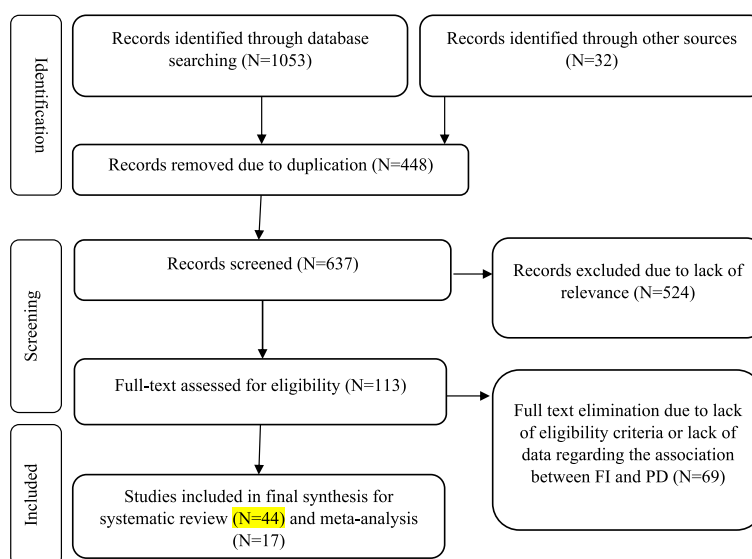

Fig. 1 PRISMA flowchart

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Table 1 Risk of bias assessment using Newcastle–Ottawa score [29, 33–75]

	D1	D2	D3	Overall
Herman et al. (2024) (35)	+	?	+	+
Kopels et al. (2024) (36)	+	?	?	?
Talham and Williams (2023) (37)	+	+	+	+
Dana et al. (2023) (38)	+	?	+	?
Harmel et al. (2022) (39)	+	?	?	−
Malek Rivan et al. (2021) (40)	?	+	+	?
Wolfson et al. (2021) (41)	+	+	+	+
Joseph et al. (2021) (42)				
Kelve et al. (2021) (43)	?	−	+	−
Hossain et al. (2021) (44)	+	+	?	?
Sundermeir et al. (2021) (45)	+	+	+	+
Becerra et al. (2020) (46)	+	+	+	+
Boman-Davis et al. (2020) (47)	?	+	+	+
Kim-Mozeleski et al. (2020) (48)	?	+	+	+
Troxel et al. (2020) (49)	?	+	+	?
Gyasi et al. (2020) (50)	?	−	+	?
Hattangadi et al. (2019) (51)	?	+	?	+
Kim-Mozeleski at al. (2019) (a) (52)	+	+	?	?
Kim-Mozeleski et al. (2019) (b) (53)	?	?	+	?
Hajizadeh et al. (2019) (54)	+	?	+	+
Walker et al. (2019) (55)	+	+	+	+

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Table 1 (continued)

Study	D1	D2	D3	D4
Birhanu et al. (2019) (56)	?	+	+	?
Bradette-Laplante et al. (2019) (57)	+	?	?	−
Hernandez et al. (2019) (58)	+	+	?	?
Sweetland et al. (2019) (59)	+	+	+	+
Allen et al. (2018) (60)	+	+	+	+
Lund et al. (2018) (61)	+	?	?	−
Tseng et al. (2017) (62)	+	?	?	−
Jones et al. (2017) (63)	+	+	+	+
Weigel et al. (2016) (64)	+	?	+	+
Chung et al. (2016) (65)	?	+	+	?
Bermúdez-Millán et al. (2016) (66)	+	?	+	+
Silverman et al. (2015) (67)	+	?	?	−
Becerra et al. (2015) (68)	?	?	+	+
Jebena et al. (2015) (69)	+	+	+	+
Kang et al. (2015) (70)	+	?	?	−
Laraia et al. (2015) (71)	+	?	+	+
Darling et al. (2015) (72)	+	?	+	?
Liu et al. (2014) (73)	+	?	+	+
Seligman et al. (2012) (30)	?	?	?	−
Carter et al. (2011) (74)	+	+	+	+
Anderson et al. (2011) (75)	+	?	−	−
Sharkey et al. (2011) (76)	+	+	?	+
Caron et al. (2007) (77)	+	?	−	−

D1: Bias due to selection – Domain scoring: 0–1 (High); 2 (Some concerns); 3 (Low)

D2: Bias due to comparability – Domain scoring: 0 (High); 1 (Some concerns); 2 (Low)

D3: Bias due to outcome – Domain scoring: 0 (High); 1 (Some concerns); 2 (Low)

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Statistical analyses

Studies presenting ORs with different levels of adjustment were included in the meta-analysis. For the main analysis, we pooled the ORs with the most extensive adjustments from each study. The DerSimonian and Laird random-effects models were applied in this meta-analysis because they account for within-study as well as between-study variability. All data analyses were performed using STATA (StataCorp. 2013. Stata Statistical Software: Release 13. College Station, TX: StataCorp LP). *P* values ≤ 0.05 was considered statistically significant.

Results

Search results and selection

At first, 1085 articles were found, and 637 remained after the duplicate exclusion. Then, 524 articles were excluded after assessing the title or abstract. However, all the articles were reviewed based on the inclusion and exclusion criteria. Finally, 44 articles were included in the systematic review, and 17 records were selected for the meta-analysis (Fig. 1).

Overview of included studies

Generally, eligible articles were included in the current study. The characteristics and main findings of included studies are presented in Table 2. Overall, the type of all of the included studies was cross-sectional. The total number of participants in the systematic review and meta-analysis was 2,267,506 and 1,953,636, respectively. The age range of participants was 16 or older. In the order of frequency, the countries where the articles were published in USA (*n*=21), Canada (*n*=4), Ethiopia (*n*=3), Ghana (*n*=2), Brazil (*n*=1), Malaysia (*n*=1), Australia (*n*=1), Bangladesh (*n*=1), Nigeria (*n*=1), Uganda (*n*=1), Denmark (*n*=1), New Zeeland (*n*=1), India (*n*=1), Panama (*n*=1), Ecuador (*n*=1) and South Korea (*n*=1). The population of studies consisted of adolescents, adults, and elders. In addition, four studies were conducted on pregnant women and two studies evaluated university students. Other studies consisted of households from different countries. Interestingly, the type of all included studies was cross-sectional.

Commonly, 6-item and 10-item Kessler Psychological Distress Scale (K6 and K10) and 10-item Perceived Stress Scale (PSS), and The Self-Reporting Questionnaire (SRQ-20) were used to determine the PD. Besides, the U.S. Household Food Security Survey Module (U.S.HFSSM), Household Food Insecurity Access Scale (HFIAS), and self-reported questionnaires were the most frequently employed tools to measure the level of FI.

All the studies in the systematic review showed that there is an association between FI and PD. Also, most of the studies declared that low income is in direct association with FI (32/40). However, an American study in this review claimed that FI and subsequent psychological distress can be witnessed among high income individuals [45].

Psychological distress in various populations

Frequently, the included studies were conducted on households and adults. It was found that both men and women who experience FI, are more prone to psychological distress. However, associations were stronger among men [40, 48, 60, 62]. However, some studies claimed that food-insecure women experience much more psychological distress [42, 52, 72]. Meanwhile, a study claimed that there is no significant difference between men and women [57]. Also, single, divorced, or separated individuals experienced a higher rate of FI with psychological distress [63, 66]. Notably, the prominent role of COVID-19 in the prevalence of FI and subsequent psychological distress should be considered as it is known to be effective [38, 39, 41, 43].

Pregnant women were also widely evaluated. FI affected postpartum stress and even other psychological and psychical problems [69]. Similarly, food-insecure pregnant women also experience higher rates of psychological distress compared with those who are food-secure [67]. Even, mild FI can be effective in the psychological distress of pregnancy [37]. Concerning the maternal population, it should be mentioned that food-insecure mothers are more susceptible to psychological distress [54]. Meanwhile, maternal distress originating from FI can negatively affect children [73].

Diabetic individuals who were food-insecure showed more distress and lower self-efficacy in relation to diabetes [29, 53, 64]. Additionally, diabetes distress was directly associated with FI [65]. Other secondary outcomes such as HbA1c and specific diet were affected by FI [53].

As it seems, psychological distress is more widespread among rural populations than urban residents [74]. Interestingly, FI was even evaluated in individuals with HIV. The lower household assets, the higher rate of FI and subsequent psychological distress. it was proved that FI is more effective than new infections in forming [68]. Students were also evaluated. It was inferred that FI can lead to psychological distress among students due to higher levels of distress in those who experienced FI [44, 49, 70].

Secondary outcomes

There was a direct relationship between FI and sleeplessness and lower subjective quality of sleep. This problem probably originated from psychological distress [47, 64]. It was proved that FI can lead to both psychological distress and higher smoking. Even though, FI can be solely the cause of smoking in individuals with no special psychological distress [46, 50, 51, 71]. Notably, food-insecure individuals may suffer from other problems such as depression, anxiety, lower life satisfaction, or obesity [55, 56, 59, 61].

Table 2 Characteristics of included studies in the systematic review

ID	Author (Year) (Ref)	Region	Sample Size, Gender	Participants	Age (Year)	Distress Assessment Tool	Definition of Distress	Effect Size	FI Assessment Tool	FI Category
1	Herman et al. (2024) [33]	USA	T:7700	Women, Infants, and Children (WIC)-eligible households	18–55	K6	≥ 13	AOR: 1.83	10-item US Adult FS Survey Module	High, marginal, low, very low
2	Kopels et al. (2024) [34]	USA	T:134, M: 32, F: 102	College students	18–64	K6	≥ 13	OR: 8.41	Childhood food insecurity measure	Greater or less
3	Talham and Williams (2023) [35]	USA	T: 5175; M:1877, F:3298	US- and foreign-born adults	≥ 18	PHQ-2	≥ 3	OR: 2.2	US HFSSM	High, low, very low
4	Dana et al. (2023) [36]	Australia	T:149	University Students	26.07 (average)	DASS-21	35–42	AOR = 1.62	USDA HFSSM	High, marginal, low, very low
5	Harmel et al. (2022) [37]	Brazil	T:513	Pregnant women undergoing prenatal care at health units	26.2 (average) (95%CI 25.7, 26.7)	SRQ- 20	≥ 7	PR = 1.71 (1.38–3.91)	EBIA	mild, moderate, or severe Insecurity
6	Malek Rivan et al. (2021) [38]	Malaysia	T:535; M: 238, F: 297	Individuals from the neighborhoods with the highest rate of elderly residents during COVID-19	71.18 ± 5.72	GHQ-12	≥ 4	OR = 17.06 (8.24–35.32)	US HFSSM	High, Low, Very Low
7	Wolfson et al. (2021) [39]	USA	T:1476; M:732, F: 744	Low-income adults during COVID-19	≥ 18	PSS	≥ 3	OR = 10.91 (7.78–15.30)	US HFSSM	High, Marginal, Low, Very low
8	Joseph et al. (2021) [40]	USA	T:6226; M:2461, F:3765	Low-income adults participating in CHIS	> 18	K6	≥ 13	OR = 5.54 (3.11–9.84)	US HFSSM	Food secure, Food insecure without hunger, Food insecure with hunger
9	Kelve et al. (2021) [41]	Australia	T:1005	Women of reproductive age during COVID-19	18–50	K10	≥ 20	OR = 7.06 (3.40–14.66)	US HFSSM	High, Marginal, Low, Very low
10	Hossain et al. (2021) [42]	Bangladesh	T:478; M:309, F:169	Cyclone Amphan survivors	37.0 ± 12.6	BSRS-5	> 14	PR = 1.63 (1.01–2.64)	US HFSSM	Food secure, Mild, Moderately, and Severely food insecure
11	Sundermeir et al. (2021) [43]	USA	T:8355; M:4133, F:4222	Adults participating in national survey	≥ 18	PHQ-4	≥ 6 (moderate or severe)	NR	US HFSSM	High, Marginal, Low, Very low
12	Becerra et al. (2020) [44]	USA	T:302; M:111, F:191	College Students	≥ 18	K6	≥ 13	OR = 3.64	US HFSSM	Food secure and Food insecure

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Table 2 (continued)

ID	Author (Year) (Ref)	Region	Sample Size, Gender	Participants	Age (Year)	Distress Assessment Tool	Definition of Distress	Effect Size	FI Assessment Tool	FI Category
13	Boman-Davis et al. (2020) [45]	USA	T: 1.884.913	Low-income and obese women	≥18	K6	≥13	OR=4.63 (2.30–9.32)	6-item Food Security Status in the Past Year	Food Security, and Food Insecurity with/without Hunger
14	Kim-Mozeleski et al. (2020) [46]	USA	T:7946; M:5587 F:2359,	Households under the supervision of the University of Michigan	≥18	K6	NR	R^2=0.423 and β-coefficient (cross-lagged regression coefficients)=0.08	US HFSSM	Full, Marginal, Low, or Very Low Food Security
15	Troxel et al. (2020) [47]	USA	T:785, M:181, F:604	Low-income and predominantly African American neighborhoods	55.4±16.0	K6	NR	β-coefficient (logistic regression)=0.33	US HFSSM	High, marginal, low, and very low
16	Gyasi et al. (2020) [48]	Ghana	T:1200; M:444 F:756,	Older adults participating in 2016/2017 Ageing, Health, Psychological Well-being and Health-seeking Behavior Study	66.15±11.85	K10	50 (severe distress)	β-coefficient (linear regression)=1.82 and SE=0.28	Self-reported 5-item question	No food insecurity, moderate food insecurity, severe food insecurity
17	Hattangadi et al. (2019) [49]	Canada	T:882; M:193, F:680	Undergraduate students	22.9±5.5	DASS-21	normal, mild, moderate, severe and extremely-severe	OR=2.5 (0.8–9.2)	US HFSSM	High, marginal, moderate and Severe
18	Kim-Mozeleski et al. (2019) (a) [50]	USA	T:3007; M:1496, F:1538	Adult smokers with low income	≥18	K6	≥5	PR=2.06 (1.79–2.36)	US HFSSM	food secure without distress, food secure with distress, food insecure without distress, and food insecure with distress
19	Kim-Mozeleski et al. (2019) (b) [51]	USA	T:9048; M:6297, F:2751	Households with low income	≥18	K6	≥5	Quit Ratio %=40.9 (30.2–51.5)	US HFSSM	food secure without distress, food secure with distress, food insecure without distress, and food insecure with distress

Table 2 (continued)

ID	Author (Year) (Ref)	Region	Sample Size, Gender	Participants	Age (Year)	Distress Assessment Tool	Definition of Distress	Effect Size	FI Assessment Tool	FI Category
20	Hajizadeh et al. (2019) [52]	Canada	T:14410; M: 6510, F:7900	Aboriginal Peoples Survey collected from Indigenous adults living off-reserve in Canada	≥18	K10	50 (Severe distress)	Mean score: 23.7	NR	NR
21	Walker et al. (2019) [53]	Panama	T:615; M:167, F:448	Kuna Indians dwelling in the coast of Panama	61.3±10.9	PSS	≥13	SEM: perceived stress ($r=0.43$), diabetes distress ($r=0.36$) ($p<0.001$)	US HFSSM	food secure vs. food insecure
22	Birhanu et al. (2019) [54]	Ethiopia	T:2992	Mothers in the Tigray and SNNP regions of Ethiopia	25–34	SRQ- 20	≥7	β-coefficient (linear multiple regression)=0.297, $t=16.414$	HFIAS	Rarely, Sometimes, and Often
23	Bradette-Laplante et al. (2019) [55]	Canada	T:212	Members of an ongoing mother–child prospective longitudinal cohort	18.47±1.11	CES-D	NR	β-coefficient (multivariate linear regression)=1.71, SE=0.83, βstand=0.28	US HFSSM	food security, moderate food insecurity and severe food insecurity
24	Hernandez et al. (2019) [56]	USA	T:566; M=362, F=204	Adults from six area shelters in Oklahoma City	43.50±11.99	PC-PTSD	responding yes to three or more items	β-coefficient (logistic regression)=1.08, SE=0.26	6-item Food Security Scale-Short form	Food secure and food insecure
25	Sweetland et al. (2019) [57]	Nigeria, Uganda, Ghana	T:1142	Individuals from three rural village clusters	≥13	K6	NR	β-coefficient (logistic regression)=0.19	Self-report	Insecurity if being unable to eat two square meals per day
26	Allen et al. (2018) [58]	USA	T:556; M:191, F=365	African-American respondents of the California Health Interview Survey	≥18	K6	≥13	OR=1.16 (0.45–3.03)	CHIS	Food security, food insecurity without hunger, food insecurity with hunger
27	Lund et al. (2018) [59]	Denmark	T:1877	Households, mostly from the lowest income quintile	≥18	K6	13–24	RR=8.95 (11.6–36.7)	US HFSSM	Food secure, low food secure, very low food secure
28	Tseng et al. (2017) [60]	USA	T:18,465	Parents living with their children	≥18	K6	≥13	OR=3.1 (2.3–4.0)	US HFSSM	Food secure and food insecure

Table 2 (continued)

ID	Author (Year) (Ref)	Region	Sample Size, Gender	Participants	Age (Year)	Distress Assessment Tool	Definition of Distress	Effect Size	FI Assessment Tool	FI Category
29	Jones et al. (2017) [61]	USA	T: 190,348; M:96,125, F:94,223	Households participating in Gallup World Poll (GWP)	42 ± 17	NEI	higher values indicating more negative recent experiences	Partial regression coefficients = 24.5 (22.7–26.3)	FIES SM-I	Food secure, mild food insecurity, moderate food insecurity, severe food insecurity
30	Weigel et al. (2016) [62]	Ecuador	T:794	Adult women and their minor children living in low-income neighborhoods in Quito	34 ± 11	MHI-5	≥ 52	OR = 2.14 (1.01–4.65)	US HFSSM	Food secure, low food secure, very low food secure
31	Chung et al. (2016) [63]	South Korea	T:5862; M:2278, F:3584	Households participating in The Fifth Korea National Health and Nutrition Examination Survey	20–64	self-administered health questionnaires	Yes = presence of distress No = Lack of distress	OR = 1.96 (1.08–3.53)	US HFSSM	food-secure, food-insecure without hunger, moderate food-insecure with hunger and severe food-insecure with hunger
32	Bermúdez-Millán et al. (2016) [64]	USA	T: 121; M:31, F = 90	Adult residents of Hartford joining Brownstone Clinic	61 ± 12	PAID-5	Higher scores indicating more distress	Completely standardized IE = 0.06, R² = 2.93, F = 4.20	US HFSSM	Food secure, marginal food insecure, low food insecure, and very low food insecure
33	Silverman et al. (2015) [65]	USA	T:287	Patients with type 2 diabetes join health centers, hospitals or medical center	30–70	17-item validated measure	No low diabetes distress, low diabetes distress, moderate diabetes distress, or high diabetes distress	OR = 2.32 (1.38–3.91)	US HFSSM	Food security vs. food insecurity
34	Becerra et al. (2015) [66]	USA	T:10966; M:4187, F:6779	Hispanic respondents to the California Health Interview Survey with low income	≥ 18	K6	30 = severe distress	OR = 4.43 (3.14–6.24)	CHIS	food secure, food insecure without hunger, and food insecure with hunger
35	Jebena et al. (2015) [67]	Ethiopia	T:642	Pregnant women from 11 health centers and one hospital	25.5 ± 4.9	SRQ-20	≥ 7	OR = 4.15 (1.67–10.32)	HFIAS	food secure, mild, moderately and severely food insecure

Table 2 (continued)

ID	Author (Year) (Ref)	Region	Sample Size, Gender	Participants	Age (Year)	Distress Assessment Tool	Definition of Distress	Effect Size	FI Assessment Tool	FI Category
36	Kang et al. (2015) [68]	India	T:196; M:106, F = 88	Adults with a confirmed HIV-seropositive diagnosis	≥ 18	K6	0 to 24 with higher scores indicating more severe distress	Full regression: 0.340	HFIAS	The higher the score, the more food insecurity of the household
37	Laraia et al. (2015) [69]	USA	T:526	Women from Pregnancy, Infection, and Nutrition (PIN) Study cohort	>16	PSS	NR	β-coefficient with multivariate linear regression = 3.67 (0.94–6.41)	CFSM	Food security, marginally food secure, food insecure
38	Darling et al. (2015) [70]	USA	T:98; M:25, F:73	Students enrolled in postsecondary education institutions	18.23 ± 0.74	DASS	NR	M (SD) = 12.88 (8.70)	2-item question	Often, sometimes, never
39	Liu et al. (2014) [71]	USA	T:68,111; M:25,739, F:42,372	Civilian US adults	≥ 18	BRFSS	Based on questions including stress, depression, and emotional problems	Prevalence as % = 23.5% (21.7–25.3)	Self-reported 1-item question	Food secure vs. food insecure
40	Seligman et al. (2012) [29]	USA	T:711	Patients with type 2 diabetes as part of the Immigration, Culture, and Healthcare Study	54.3 ± 11.4	DDS	Higher scores indicating more distress	OR = 1.48 (1.07–2.04)	US HFSSM	NR
41	Carter et al. (2011) [72]	New Zealand	T:18090; M = 8740, F: 10215	Responding private households participating in SoFIE	≥ 15	K10	≥ 16	OR = 2.6 (2.3–2.8)	NZiDep	Food secure vs. Food insecure
42	Anderson et al. (2011) [73]	Ethiopia	T:936	Data from the census of the population comprising more than 8000 households around the Gilgel Gibe Hydroelectric Dam	26.5 ± 5.6	HSCL	The higher scores, the more probability of emotional distress	OR = 1.48 (1.25–2.05)	Seven-item scale for low-income countries	> 4 = Food insecurity
43	Sharkey et al. (2011) [74]	USA	T:1290	Rural and urban women in Texas	≥ 18	CDCQ	> 14	OR = 2.25 (1.59–3.18)	Radimer-Cornell scale	Food security vs. Food insecurity

Table 2 (continued)

ID	Author (Year) (Ref)	Region	Sample Size, Gender	Participants	Age (Year)	Distress Assessment Tool	Definition of Distress	Effect Size	FI Assessment Tool	FI Category
44	Caron et al. (2007) [75]	Canada	T:528; M:275, F:252	Social assistance recipients	≥18	IDPESQ-14	Scores above the fifth quintile of PD	β-coefficient (Fully adjusted logistic regression) = 0.0098 and R² = 0.008	Radimer/Cornell Hunger and Food Insecurity Measure	NR

T Total, *M* Male, *F* Female, *US HFSSM* U.S.Household Food Security Survey Module, *OR* Odds Ratio, *RR* Relative Risk, *GHQ-12* The Short General Health Questionnaire-12, *SRQ-20* The Self-Reporting Questionnaire, *EBIA* Brazilian Food Insecurity Scale, *PSS* 10-item Perceived Stress Scale, *K6* 6-item Kessler Psychological Distress Scale, *NR* Not Reported, *CHIS* The California Health Interview Survey, *K10* 10-item Kessler Psychological Distress Scale, *BSRS-5* 5-item brief symptom rating scale, *SEM* Structural equation modeling, *DASS-21* Depression, Anxiety and Stress Scale, *HFIAS* Household Food Insecurity Access Scale, *CES-D* Center for Epidemiological Studies-Depression Scale, *PC-PTSD* Primary Care Post-Traumatic Stress Disorder, *NEI* Negative Experience Index, *FIES SM-I* Food Insecurity Experience Scale Survey Module for Individuals, *MHI-5* Mental Health Inventory, *PAID-5* Problem Areas in Diabetes Questionnaire scale, *CFSM* 18-item Core Food Security Module, *DDS* Diabetes Distress Scale, *BRFSS* Behavioral Risk Factor Surveillance System, *NZiDep* 3-item New Zealand-specific measure of individual deprivation, *SoFIE* longitudinal Survey of Families, Income and Employment, *HSCL* Hopkins Symptom Checklist-25, *CDCQ* Centers for Disease Control and Prevention Questionnaire, *IDPESQ-14* the Indice de détresse psychologique –Enquête Santé Québec

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The pooled estimates

The pooled results showed that individuals with food insecurity had 329% (odds ratio, 3.29; 95% CI, 2.46–4.40) increased odds of having psychological, mental, and diabetes distress (Fig. 2). Including only studies that adjusted at least for age, sex, and education reduced the pooled OR (odds ratio, 2.82; 95% CI, 2.08–3.84), (Fig. 3). The measure of heterogeneity in the forest plots is represented by the "I-squared" (I^2) statistic, along with associated *p*-values. The I^2 values of 89.8% and 90.3% indicate a very high level of heterogeneity among the studies included in the analysis. This high heterogeneity suggests that the majority of the variability in the effect size estimates across these studies is not due to random chance but rather to real differences between the studies themselves. These differences could be related to variations in study populations, methodologies, sample sizes, or other factors that can influence the outcomes. The *p*-values, both being 0.000, further confirm that this heterogeneity is statistically significant, meaning it is unlikely that these differences occurred by chance.

Discussion

This study was aimed to assess association between food insecurity and psychological distress. Studies showed that food insecurity and psychological distress are associated. There are studies at the single level, but to our knowledge, this systematic review and meta-analysis is the first of its kind that assessed association between food insecurity and psychological distress. In this study, the pooled effect size of association between food insecurity and psychological distress is reported.The forest plots in Figs. 2 and 3 illustrate a significant association between household FI and PD in adults. Figure 2 presents odds ratios (ORs) from cross-sectional studies, indicating a clear link between FI and increased risk of PD. This finding is consistent with previous research that highlights the negative impact of FI on mental health. For instance, a study found that FI is associated with higher levels of psychological distress and depressive symptoms, particularly among low-income individuals [76]. Similarly, other researchers confirmed that FI is a consistent risk factor for mental health issues, including anxiety and depression, across various studies [77]. The significant association between FI and PD, aligns with existing literature highlighting FI as a robust risk factor for mental health problems. This consistency reinforces the need for effective interventions to address food insecurity and mitigate its adverse effects on mental health.

Further analysis in Fig. 3, which presents ORs adjusted for age, sex, and education, supports the robustness of the relationship between FI and PD. This adjustment is crucial, as it addresses potential confounding variables that could influence the observed association. Meanwhile, a study emphasizes the importance of controlling for demographic factors to clarify the direct impact of FI on mental health [61]. In line with this, another study demonstrated that FI
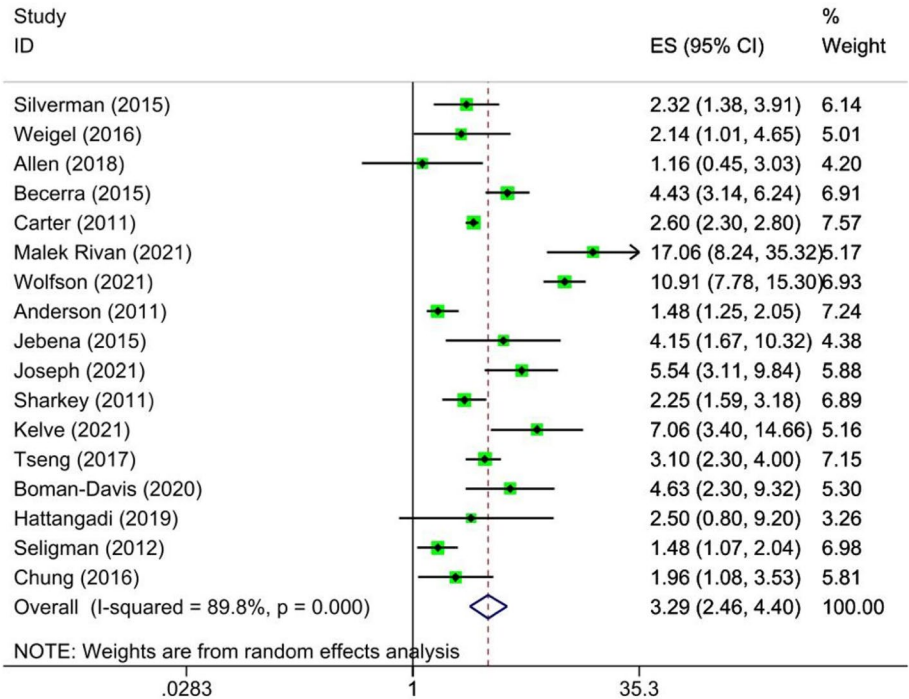

Fig. 2 Forest plot of the odds ratios (ORs) with the corresponding 95% confidence intervals (CIs) of cross-sectional studies on the association of household food insecurity with the risk of psychological distress in adults
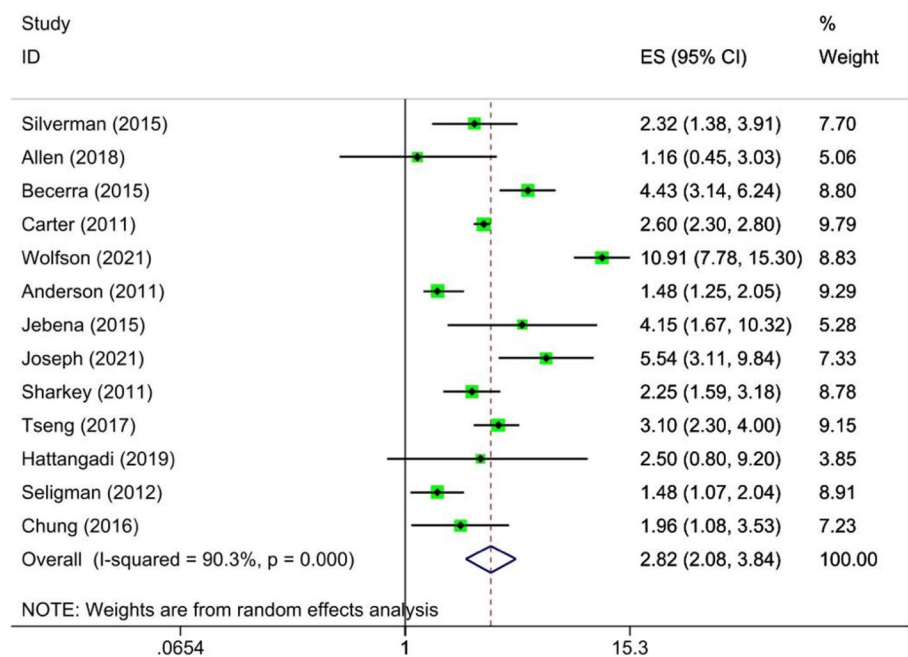
Fig. 3 Forest plot of the odds ratios (ORs) with the corresponding 95% confidence intervals (CIs) from cross-sectional studies adjusted for age, sex, and education on the relationship between household food insecurity and psychological distress

remains a significant predictor of mental health outcomes even after accounting for socio-economic variables [78]. However, there are also studies that present a more nuanced view. For example, a study found that while food insecurity is linked to increased psychological distress, the strength of this association can vary significantly depending on regional and contextual factors [79]. This suggests that while there is a general trend linking FI with PD, local conditions and resources may influence the degree of impact. Additionally, it's been reported that FI is more strongly associated with PD in certain demographic groups, such as single-parent households, which may account for some variability in the observed effects [80]. Conversely, there are studies that have found less pronounced or inconsistent associations. For instance, a study observed that while FI is correlated with higher levels of PD, the effect size was relatively small in their sample. This could be attributed to differences in study design, population characteristics, or measurement tools used, highlighting the need for careful consideration of these factors when interpreting results [36].

Overall, the consistency of the association between FI and PD across various studies supports the conclusion that food insecurity is a significant risk factor for PD. This alignment with existing literature underscores the importance of addressing FI as part of mental health interventions and policies. Future research should aim to explore this relationship further through longitudinal studies and investigate how contextual factors might influence the strength of the association. This would provide a more detailed understanding of the causal mechanisms and help in developing targeted interventions to mitigate the impact of FI on mental health.

Our findings align with existing literature highlighting the broad impact of FI on pregnant women. For instance, research has consistently shown that FI significantly contributes to postpartum stress and various psychological and physical problems [69]. This is corroborated by our results, which reveal that FI exacerbates PD during and after pregnancy. Food-insecure pregnant women experience notably higher levels of PD compared to their food-secure counterparts [67]. This is consistent with evidence suggesting that even mild FI can significantly affect psychological well-being during pregnancy. Additionally, our findings echo the observation that food-insecure mothers are particularly vulnerable to PD, as they face unique stressors that exacerbate their mental health challenges [81]. This increased susceptibility to PD among food-insecure mothers has been well-documented, illustrating the intersection of socioeconomic factors and mental health. Moreover, it is crucial to consider the broader implications of maternal distress related to FI. Research has demonstrated that maternal PD stemming from FI can have detrimental effects on child development [14]. Our findings support this notion, emphasizing the importance of addressing food insecurity not only for the well-being of the mother but also for the potential long-term effects on the child's health and development.

Overall, the current study contributes to a growing body of evidence indicating that FI has a profound

impact on both maternal and child health. Addressing food insecurity should be an integral part of public health strategies aimed at improving the overall well-being of pregnant women and their children.

Regarding the secondary outcomes, it should be noted that the direct relationship between FI and sleeplessness, along with lower subjective quality of sleep, underscores a critical area of concern in public health. This relationship is likely rooted in psychological distress, a well-documented consequence of FI [82]. Psychological distress associated with FI has been shown to disrupt sleep patterns, as stress and anxiety can lead to difficulties falling and staying asleep [83]. Additionally, FI-related psychological distress may interfere with sleep quality by heightening cortisol levels and sympathetic nervous system activity, both of which are known to impair sleep [84].

In addition to the direct impacts of FI on psychological well-being and sleep problems, individuals experiencing FI are also at heightened risk for a range of other problems. Previous research has established strong links between FI and various adverse outcomes, including depression, anxiety, and lower life satisfaction [85]. Moreover, FI has been associated with higher rates of obesity, likely due to the consumption of lower-cost, energy-dense foods which are less nutritious [86]. These findings suggest a broad spectrum of negative health implications related to FI, reinforcing the need for comprehensive interventions to address both the immediate and downstream effects of food insecurity.

Probably, ambiguity regarding appropriately preparing food is one of the principal reasons for forming PD [17]. Meanwhile, other researchers claim that individuals with limited options for food experience double stress and anxiety. In addition, undependable food resources can bring about enduring distress [87, 88].

All of the studies conducted in this field are cross-sectional. However, further research should focus on various experiences of FI throughout the whole life of an individual. Also, FI is a multi-factorial feature that cannot be measured easily [89]. Notably, most of the studies took advantage of HFSSM as a tool to determine the level of FI. Besides, it is generally used in North America in researched and surveillance [90]. However, HFSSM mainly focuses on the relation between economy and food and does not consider issues such as the way of food acquisition.

The effect of COVID-19 on FI has been evaluated in many countries. Australian research concluded that FI has increased since COVID-19 [91]. Another study in the USA proved that the increased level of FI can be felt among the low-income and minority citizens [92]. Similarly, another American research demonstrated FI has increased after the incidence of COVID-19 [93]. A survey in Canada revealed that the worst form of FI is observed in the country during the pandemic, as one in seven citizens suffered from FI [94]. Interestingly, a recent study showed that owning something such as a house or not having financial-related distress can lead to a diminished chance of having a mental disorders during COVID-19 [95]. Since FI is directly associated with stress, anxiety, depression, and PD [48, 61], it is recommended to develop supportive programs for impoverished families [96]. Unfortunately, FI and mental disorders are correlated with the COVID-19 pandemic [97, 98]. Besides, the efficacy of such programs for the improvement of mental health has been proved [99]. With the advent of the COVID-19 pandemic, many services helped families in desperate need of mental support [100].

Moreover, food insecure individuals usually do not have enough fiber intake, and it is claimed that fruits and vegetables containing fiber can impact mental health by forming distress, stress, depression, and negative effect on mood and quality of life [101]. Therefore, the fiber intake for improving mental health and diminishing mental disorders symptoms should not be underestimated [102, 103]. Moreover, excessive cortisol intake is the result of FI and a low-quality diet that can harm brain organization. Subsequently, cognitive impairments may be witnessed [104]. Likewise, hunger and insufficient intake are in relation to cognitive problems, especially among older adults [105]. Still, insufficient intake of calories can weaken the ability of the brain to react to stress and result in depression or suicidal ideation [106]. On the contrary, eating breakfast and intake of carbohydrates can diminish the level of cortisol and lead to a decrease in stress levels. Then, carbohydrates change into glucose to have tryptophan produced, which prevents depression and cognitive impairment [107]. Notably, financial problems and PD originating from FI can force the household to buy foods that have a limited amount of nutrients, which in line with a lack of psychical activity, can lead to weight gain [108]. In addition, cortisol can cause the accumulation of fat [109].

Some experiences regarding FI are common among different nations. For instance, gaining food in unpleasant manners, a shift in the quality and quantity of food, the specific culture of a region and the way of food supply are among the common factors [110]. Then, such experiences can lead to the conditions associated with PD or related social hints [111]. On the other hand, it is proved that PD is In line with the prevalence of other mental disorders such as anxiety, and FI can fortify this relationship [112]. Otherwise, FI can bring about more severe mental health conditions. In other words, the higher level of FI becomes, the more chance individual has regarding getting a mental disorder [110]. Therefore, PD should be considered as a feature that can lead to mental disorders or cause the improvement of psycho-emotional conditions [113].

Meanwhile, it is hypothesized that the gender of individuals can alter the correlation between FI and mental health and FI is more prevalent among women [114]. However, most of the studies concentrated on female samples, and the differences between males and females in relation to FI and mental health cannot be firmly determined [5]. On the contrary, some studies showed that women are constantly supported and can easily seek help and feel loved more than men, which prevents the incidence of FI among women [115, 116]. Furthermore, age was another covariate of the included studies. Increasing age is correlated with an unpleasant mental health conditions [117]. Additionally, older people are more prone to FI owing to their restricted ability to move, other illnesses, or financial problems [118, 119].

Individuals with chronic diseases such as HIV and diabetes view FI as an obstacle toward totheir therapy and self-management [120, 121]. Moreover, even among opioid users, FI can cause chronic pain more powerfully than lack of social support or inappropriate income [122]. Likewise, it is proved that housing and food insecurity are strongly associated with the prevalence of chronic diseases such as diabetes, hypertension, or asthma [123, 124]. Risky sexual attempts are more widespread among individuals with FI. Thus, HIV/ADIS patients are more vulnerable [125]. These patients also have some other stressors such as the shame that prevents them to be present in the community [126]. However, community-based practices can alter mental health outcomes [127].

Two studies in this review were related to students, which is in line with other studies regarding the presence of PD among college students [128, 129]. However, the number of studies conducted on this population is restricted. In addition, students experience a new and unique atmosphere that is an underlying reason for experiencing emotional and financial crises in this transitional period of their life [130, 131]. It is noteworthy that students usually try to act without paying attention to their parent's recommendations, which is mainly under the influence of new experiences [132].

Limitations

Despite the efforts to perform a perfect study, some limitations should be considered. First of all, there were various tools for the measurement of both PD and FI. On the other hand, the authors aimed to consider ethnicity, but the limited number of studies in this regard made it almost impossible to estimate it firmly. Besides, there may be some missed articles owing to the restricted search options. Furthermore, all included studies were cross-sectional and hence, it is an indication of correlations but not causality. Therefore, the directionality of the association of FI and PD cannot be demonstrated.

Many researches were based on self-reported questionnaires and it may create bias, especially since the principal topic was regarding PD, as it is considered a stigma in many communities. Similarly, some studies utilized single-question tools to assess FI, and hence, it may influence the results in some perspectives. Eventually, the quality assessment was conducted by one of the authors. Although the assessment was based on some obvious principles and was carefully done, there may be some dissimilarities in the final score of the two authors. Despite the potential limitation, this systematic review and meta-analysis provide useful data for the global mental health as it determines the association between FI and PD.

Language bias is another concern, as the review may have missed relevant studies published in languages other than English, potentially limiting the breadth of the findings. The quality of data across studies varies, with discrepancies in outcome measurements and reporting that could affect the accuracy of the conclusions. Furthermore, the inclusion criteria for selecting studies may have inadvertently excluded relevant research, such as those published in non-peer-reviewed sources or those not meeting specific methodological standards.

Temporal factors also pose a limitation, as some of the included studies may be outdated, impacting the relevance of the findings to current contexts. Small sample sizes in some studies could reduce the statistical power of the analyses, making it more difficult to detect significant effects. The meta-analysis might also be susceptible to overfitting if combining too many studies with varying methodologies leads to potentially misleading conclusions. Additionally, confounding variables not accounted for in the included studies could influence the observed relationship between FI and PD.

Conclusion

This systematic review underscores a robust association between food insecurity FI and PD across diverse populations. Our analysis reveals that FI significantly heightens the odds of experiencing PD, with a pooled odds ratio of 3.29, underscoring the severe impact of FI on mental health. This relationship persists across various demographic groups, including men, women, and individuals from different income levels, though the strength of the association can vary. Notably, while low income is commonly linked with both FI and PD, evidence also points to distress among higher-income individuals facing FI, suggesting a complex interplay between economic status and mental health.

The review highlights that FI is a critical factor contributing to psychological distress, which can manifest through increased stress, depression, anxiety, and impaired life satisfaction. This relationship extends to specific groups such as pregnant women, diabetics, and

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rural populations, each experiencing unique challenges and exacerbated distress due to FI. The COVID-19 pandemic's influence on both FI and PD emphasizes the need for targeted interventions during such crises.

For future research, it is crucial to further explore the mechanisms linking FI to psychological distress and the potential moderating effects of socioeconomic factors. Policymakers should consider integrating mental health support into food assistance programs to address the psychological ramifications of FI. Practitioners working with food-insecure populations should be vigilant about the heightened risk of mental health issues and incorporate strategies to mitigate distress. Overall, addressing FI is essential not only for ensuring food security but also for improving overall mental well-being across affected populations.

Appendix

The search strategy of the association of food insecurity with psychological distress according to study characteristics

Pubmed

(((("Food Insecurity"[Title/Abstract]) OR "Food security"[Title/Abstract]) OR "Food Insecurities"[Title/Abstract]) AND Humans[Mesh])) AND Humans[Mesh])) AND (((("Mental Health"[Mesh] OR "Psychlogical distress"[Title/Abstract]) OR mental distress [Title/Abstract]) OR mental health[Title/Abstract]) AND Humans[Mesh])) AND Humans[Mesh])

Scopus

((TITLE-ABS-KEY ("Food Insecurity") OR TITLE-ABS-KEY ("Food security") AND ((TITLE-ABS-KEY (mental health) OR TITLE- ABS-KEY (P distress *))) AND (LIMIT-TO (DOCTYPE, "ar") OR LIMIT-TO (DOCTYPE, "re")) AND (LIMIT-TO (SRCTYPE, "j"))

ISI/WOS

TOPIC: ("Food Insecurity") OR TOPIC: ("Food security")
Indexes = SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH, ESCI Timespan = All years
TOPIC: (mental health) OR TOPIC: (mental distress *) OR TOPIC: ("Psych-logical distress ")
Indexes = SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH, ESCI Timespan = All years #2 AND #1
Indexes = SCI-EXPANDED, SSCI, CPCI-S, CPCI-SSH, ESCI Timespan = All years

EMBASE

('food insecurity' OR 'food insufficiency' OR 'food deprivation' OR 'food scarcity' OR 'nutritional insecurity') AND ('psychological distress' OR 'mental distress' OR 'emotional distress' OR 'depression' OR 'anxiety' OR 'stress' OR 'mental health' OR 'psychological well-being' OR 'psychopathology')

Cochrane

("food insecurity" OR "food insufficiency" OR "food deprivation" OR "food scarcity" OR "nutritional insecurity") AND ("psychological distress" OR "mental distress" OR "emotional distress" OR "depression" OR "anxiety" OR "stress" OR "mental health" OR "psychological well-being" OR "psychopathology")

ProQuest

("food insecurity" OR "food insufficiency" OR "food deprivation" OR "food scarcity" OR "nutritional insecurity") AND ("psychological distress" OR "mental distress" OR "emotional distress" OR "depression" OR "anxiety" OR "stress" OR "mental health" OR "psychological well-being" OR "psychopathology")

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