A SYSTEMATIC REVIEW OF THE RELATIONSHIP BETWEEN HOUSEHOLD FOOD INSECURITY AND CHILDHOOD UNDERNUTRITION

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ABSTRACT

Background

This systematic review investigates the association between household food insecurity (HFIS) and undernutrition in children under five years old, informing policymakers on the vital factors needed for tailoring an effective strategy to tackle childhood undernutrition and HFIS.

Methods and Findings

We performed a systematic review that examined household food insecurity among undernourished children aged under five. PubMed, Cochrane, EBSCO Host, Web of Science and Cumulative Index to Nursing and Allied Health Literature (CINHAL) were searched for relevant articles from 1 January 2012 to 1 April 2022. Outcome measures were stunting, underweight or wasting. Of the 2779 abstracts screened, 36 studies which fulfilled the inclusion and exclusion criteria were included. A range of tools were used to measure HFIS, the most common being the Household Food Insecurity Access Scale (HFIAS). HFIS was significantly associated with undernutrition, particularly stunting and underweight. This is observed proportionately across all national income levels.

Conclusions

Sustainable and inclusive economic growth aimed to reduce income, education, and gender inequality, should be a key policy goal in the successful fight against food insecurity and undernutrition. Multisectoral interventions are needed to address these issues.

Keywords: Household Food Insecurity, Stunting, Underweight, Wasting, Undernutrition

AUTHOR SUMMARY

Why was this study done?

- Despite the many strategies employed in tackling undernutrition, its prevalence has increased. There are increasing studies looking into household food insecurity as a factor of undernutrition. No published systematic review has examined this relationship at of time of writing.
- This work seeks to inform policymakers of the role of household food insecurity among the undernourished and its implications for public health nutrition policy.

What did the researchers do and find?

- We systematically reviewed the relationship between HFIS with stunting, being underweight, and wasting and examined how that relationship varies with country wealth.
- HFIS is significantly associated with undernutrition affecting stunting and underweight more than wasting.
- Factors such as lower parental education and socioeconomic status were associated with HFIS and undernutrition. While other factors such as bigger household size, lower maternal body mass index (BMI) and rural residence were not consistently found to be significantly associated with either or both.

What do these findings mean?

- HFIS plays a significant role in childhood undernutrition. Certain factors affect childhood undernutrition directly or indirectly through HFIS.

1. Introduction

The issues of hunger and malnutrition are intertwined. The world is currently not on track to end world hunger and malnutrition in all its forms by 2030 [1]. During the COVID-19 pandemic, an estimated 118 million more people were added to the 650 million people facing hunger in 2019 [2]. The Food and Agriculture Organisation (FAO) first reported the extent of hunger in the world in 1974 by using the prevalence of undernourishment as an indicator. Therefore, "hunger" may also be referred to as undernourishment [2].

In 2006, the United States Department of Agriculture (USDA) recommended using food insecurity instead of hunger as a measure of lack of food. Food security (FS) is the situation whereby "all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" [3]. Thus, food insecurity (FIS) is experienced when uncertainty, insufficiency, and socially unacceptable ways to acquire food occur. FIS can be temporary, seasonal, or chronic, and at the same time, it may affect the household, region, or nation, whereas hunger is an individual experience.

Globally in 2020, 149 million children under five years of age were estimated to be stunted (height-for-age, HAZ <-2 SD), 45 million were wasted (weight-for-height, WHZ <-2 SD), and 38.9 million were projected to be overweight or obese (WHZ >+2 SD) [4]. These indicators are used to measure nutritional inadequacy, which leads to undernutrition (assessed from stunting, wasting and underweight) or overnutrition (overweight/obesity) [5]. One in two deaths among children under five is linked to undernutrition. These mostly occur in low- and middle-income countries. Additionally, there has been a shift where obesity increasingly becomes a burden to the poor, and the social distribution of obesity increasingly mirrors existing social inequality [6]. This has

resulted in many poor and developing countries suffering the double burden of malnutrition [7, 8].

The UNICEF framework classifies the factors of child undernutrition into tiers of immediate causes, underlying causes, and basic causes [9]. The immediate causes include inadequate dietary intake and the risk posed by diseases. This is affected by Household Food Insecurity (HFIS) and inadequate care and feeding practices. HFIS adversely affects nutritional status. Firstly, HFIS affects maternal nutrition leaving a particularly large impact during the first thousand days, resulting in growth-restricted foetuses [10]. Secondly, HFIS results in reduced quantity and quality of food intake among children during the first thousand days and beyond.

HFIS has a detrimental impact on the health and development of young children. This includes stunting, wasting, iron deficiency, and increased hospitalisation developmental and behaviour issues, such as attention deficit disorder, anxiety and depression [11-15]. To our knowledge, this is the first systematic review examining the association between HFIS and undernutrition in children under five.

2. Methods

2.1 Anthropometric Indicator

The anthropometric indicator retained for this systematic review are stunting, underweight and wasting. Nutritional indices in the articles were calculated using the WHO Anthro 3.1.0. The results were classified according to the thresholds of the World Organisation Health 2006 [16]. Children with HAZ, WAZ or WHZ scores greater than or equal to -2SD were considered normal. Children with HAZ score below -2SD (standard deviation) were stunted, children with a WAZ score below -2SD were underweight, and children with a WHZ score below -2SD were wasted.

2.2 Search Strategy

The Preferred Reporting Items for Systematic Reviews and Meta-Analyses reporting criteria (PRISMA 2020) were used [17]. This systematic review was designed according to the criteria of PICOS (Participant, Intervention, Comparison, Outcomes, and Study Design) (Table 1). The review protocol (PROSPERO Registration number. CRD42022298878) has been registered with the International Prospective Register of Systematic Reviews. Databases used include the following: PubMed, Cochrane, EBSCO Host, Web of Science and Cumulative Index to Nursing and Allied Health Literature (CINHAL).

Table 1 The PICOS criteria used to construct the systematic review

Terms derived from PICO	Search Terms
Children	(“child” OR “children” OR “childhood” OR “kid” OR “kids” OR “under five”)
Risk Factors	(“risk factors” OR “determinants”)

Food Security	(“food security” OR “food insecurity)
Undernutrition	(“undernutrition” OR “undernourished” OR “malnutrition” OR “malnourished” OR “underweight” OR “stunting” OR “stunted”)

2.3 Inclusion and Exclusion Criteria

The inclusion criteria were: (1) original articles related to the topic of interest of this study; (2) studies evaluating the association between household food insecurity and undernutrition in children under five; (3) studies published between 1 January 2012 to 1 April 2022; (4) cross-sectional, case-control studies, and cohort studies (books, qualitative studies, policy briefs, case studies, and theses were excluded); (5) articles published in English.

Database searches and reviews of inclusion/exclusion criteria were conducted by one independent reviewer and cross-checked by a second reviewer. The words and phrases used to search titles and abstracts within these databases are stated in Table 2. A reverse search was conducted in the bibliographic references of sampled studies. This was to identify additional original published articles that were not initially selected and met the inclusion criteria.

Table 2 Literature review database search criteria

Database	Date searched	Search terms	Paper results
PubMed	6th April 2022	(“child” OR “children” OR “childhood” OR “kid” OR “kids” OR “under five”) AND (“undernutrition” OR “undernourished” OR “malnutrition” OR “malnourished” OR “underweight” OR “stunting” OR “stunted”) AND (“risk factors” OR “determinants”) AND (“food security” OR “food insecurity)	498

Cochrane	6th April 2022	(“child” OR “children” OR “childhood” OR “kid” OR “kids” OR “under five”) AND (“undernutrition” OR “undernourished” OR “malnutrition” OR “malnourished” OR “underweight” OR “stunting” OR “stunted”) AND (“risk factors” OR “determinants”) AND (“food security” OR “food insecurity)	3
EBSCO Host	6th April 2022	(“child” OR “children” OR “childhood” OR “kid” OR “kids” OR “under five”) AND (“undernutrition” OR “undernourished” OR “malnutrition” OR “malnourished” OR “underweight” OR “stunting” OR “stunted”) AND (“risk factors” OR “determinants”) AND (“food security” OR “food insecurity)	142
Web of Science	6th April 2022	(“child” OR “children” OR “childhood” OR “kid” OR “kids” OR “under five”) AND (“undernutrition” OR “undernourished” OR “malnutrition” OR “malnourished” OR “underweight” OR “stunting” OR “stunted”) AND (“risk factors” OR “determinants”) AND (“food security” OR “food insecurity)	577
CINAHL	6th April 2022	(“child” OR “children” OR “childhood” OR “kid” OR “kids” OR “under five”) AND (“undernutrition” OR “undernourished” OR “malnutrition” OR “malnourished” OR “underweight” OR “stunting” OR “stunted”) AND (“risk factors” OR “determinants”) AND (“food security” OR “food insecurity)	2422

2.4 Selection and Data Extraction Process

Articles were chosen in three stages: selection based on titles, abstract consideration, and full-text assessment. The downloaded databases were consolidated in the EndNote library, allowing us to remove all duplicate articles. Two reviewers (C.W. and S.E.) independently performed the data extraction and analysis, cross-checked, and reviewed the results. Any discrepancies were resolved by the third reviewer (H.A.M.).

The following information was extracted from the articles selected: author(s), year, country, number of children, age of children, number of households, sample, location, study purpose, method of HFIS evaluation, and finally, the results (HFIS/stunting, HFIS/underweight, HFIS/wasting, HFIS/malnutrition). The data gathered were then exported to Microsoft Excel.

2.6 Quality Assessment

The quality of the studies was assessed using the Newcastle–Ottawa quality assessment scale [18] adapted for cross-sectional, case-control studies and cohort studies, measuring several specific areas of a study to determine overall quality, namely selection, comparability, and outcomes.

Quality scores were rated “Good,” “Fair” or “Poor” quality. Each study’s risk of bias was independently assessed by two reviewers (C.W. and S.E.), and any disagreements were discussed with the third reviewer (H.A.M.). Of the 36 articles included consists of 33 were graded as good quality, and the other three as fair quality. A detailed summary of the quality appraisal of the studies is illustrated in Tables 3 and 4, respectively.

Table 3 Summary of quality assessment of the sampled studies using the Newcastle–Ottawa Quality Assessment Scale (cross-sectional studies)

Studies	Selection		Comparability			Outcome		Overall quality
	Representativeness of the Sample	Sample size	Non-respondents	Ascertainment of the exposure (risk factor)	Comparability	Assessment of the outcome	Statistical test	(Good/Fair/Poor)
Donkor et al., 2022	*	*		**	**	**	*	Good
Abedi et al., 2021	*	*		**		**	*	Good
Fufa et al., 2021	*	*	*	**	**	**	*	Good
Berhane et al., 2020	*		*	**	**	**	*	Good
Betebo et al., 2020	*	*	*	**	**	**	*	Good
Dinku et al., 2020	*	*	*	**	**	**	*	Good
Pathak et al., 2020	*	*		**			*	Fair
Mistry et al., 2019	*	*		**		**	*	Good
Praditsorn et al., 2019	*	*		**	**	**	*	Good
Roesler et al., 2019	*	*		**	**	**	*	Good
Shilugu and Sunguya, 2019	*			**	**	**	*	Good
Agho et al., 2018	*	*	*	*	**	**	*	Good
Dorsey et al., 2018	*	*		**	**	**	*	Good
Sinha et al., 2018	*	*		**		**	*	Good
Berra, 2017	*	*	*	**	**	**	*	Good
Choudhury et al., 2017	*	*		**	**	**	*	Good

Dukhi et al., 2017	*	*			**		*	Fair
Gubert et al., 2017	*	*		**	**	**	*	Good
Mulu and Mengistie, 2017	*	*	*	**	**	**	*	Good
Nkurunziza et al., 2017	*	*	*	**	**	**	*	Good
Sarma et al., 2017	*	*			**	**	*	Good
Abdurahman et al., 2016	*	*	*	**	**	**	*	Good
Chowdhury et al., 2016	*	*		*	**	**	*	Good
M'Kaibi et al., 2016	*	*		**		**	*	Good
McDonald et al., 2015	*	*		**	**	**	*	Good
Motbainor et al., 2015	*	*	*	**	**	**	*	Good
Shinsugi et al., 2015		*	*	**	**	**	*	Good
Ali Naser et al., 2014	*	*		**	**	**	*	Good
Eunice et al., 2014	*	*		**	*	**	*	Good
Tiwari et al., 2014	*	*	*	*	**	**	*	Good
Gordon et al., 2013	*	*			**		*	Fair
Saaka and Osman, 2013	*	*		**	**	**	*	Good

Table 4 Summary of quality assessment of the sampled studies using the Newcastle–Ottawa Quality Assessment Scale (case-control and cohort studies)

Case-control Studies	Selection			Comparability	Outcome			Overall Quality
	Definition of Case	Representativeness of the Cases	Selection of Controls	Definition of Controls	Comparability	Ascertainment of Exposure	Same Method for Cases and Control	Non-response Rate	(Good/Fair/Poor)
Dahal et al., 2021	*	*	*	*	**		*	*	Good
Hoq et al., 2019	*	*	*	*	**	*	*		Good
Bukusuba et al., 2017	*	*	*	*	**	*	*		Good

Cohort studies	Selection			Comparability	Outcome			Overall quality
	Representativeness of the exposed cohort	Selection of the non-exposed cohort	Ascertainment of exposure	Outcome of interest was not present at the start of study	Comparability	Ascertainment of outcome	Sufficient follow-up duration	Adequacy of follow-up	(Good/Fair/Poor)
Mutisya et al., 2015	*	*	*		**	*	*	*	Good

3. Results

3.1 Selection of Studies

The article search criteria produced 3642 titles eligible for review across five databases. There were 766 articles identified as duplicates and another 97 records of conference posters and reports. These were all excluded.

In stage two (abstract screening), 2711 records were excluded after applying inclusion/ exclusion criteria, seven were removed as they were written in a foreign language, and another 19 records were not retrievable. Studies were excluded for the following reasons: no specific focus on food insecurity, focus on children overweight or obese, and clinical trials.

A full-text review of the remaining 42 articles in stage three resulted in 10 articles being excluded where food insecurity was not included in the analysis (n = 6) and the age groups were not strictly under five years old (n = 4). Four studies were identified and included from the reverse search of the bibliographic references of the 32 sampled studies, totalling 36 articles for synthesis. The PRISMA flow diagram of the selection process [17] is illustrated in Figure 1.

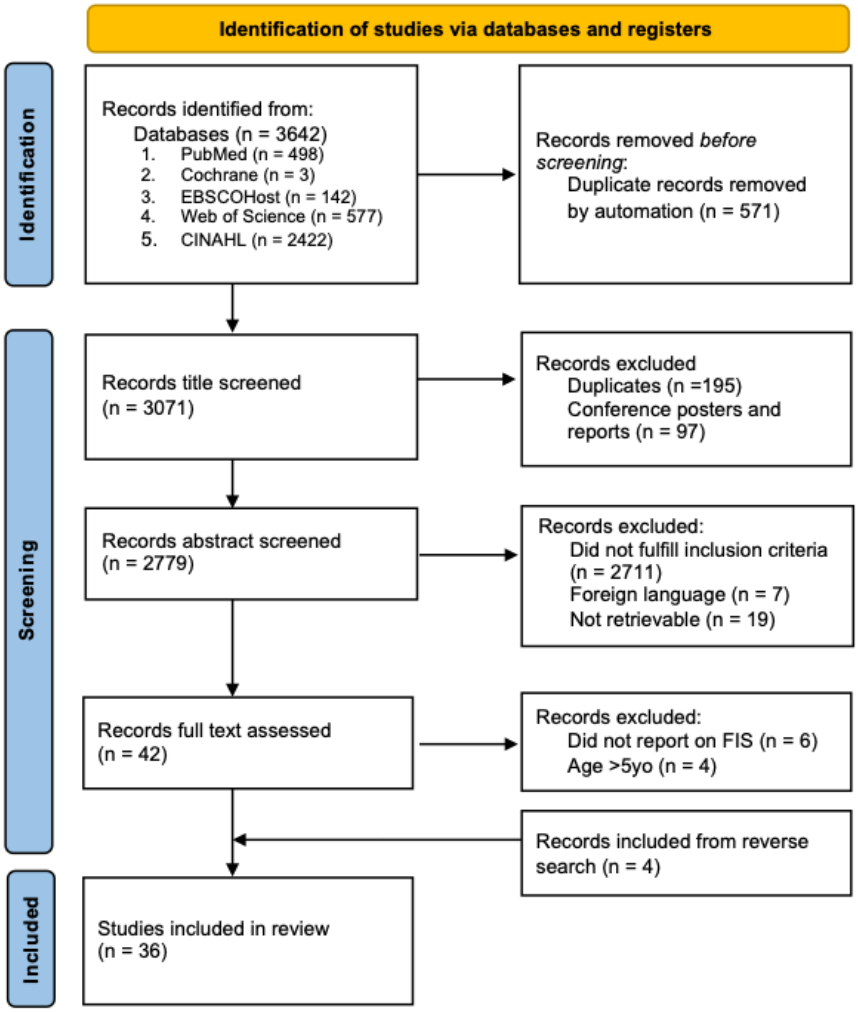

Figure 1 Selection Process

3.2 Household Food Insecurity Indicator

All studies except for three studies used validated instruments to assess food security. The commonest tools used are the Household Food Insecurity Access Scale (HFIAS) (n = 17), Radimer/Cornell Hunger and Food Insecurity instrument (n = 2), Food Consumption Score (FCS) (n = 1), Food Frequency Questionnaire (FFQ) (n = 1), national demographic and health survey (n = 6) and combinations of the tools (n = 6).

3.3 Characteristics of Sampled studies

Among the included articles were 32 cross-sectional, three case-control studies and one cohort study. Six studies were conducted in upper-middle-income countries (UMICs), 18 studies in lower-middle-income countries (LMICs) and 12 studies in low-income countries (LICs), as shown in Figure 2. The studies were conducted mainly in countries in the global south: Ethiopia (n = 8), Bangladesh (n = 5), Kenya (n = 3), India (n = 3), Nepal (n = 3), Malaysia (n = 2), Thailand (n = 2), Burundi (n = 1), Ghana (n = 1), Rwanda (n = 1), Somalia (n = 1), South Africa (n = 1), Tanzania (n = 1), Uganda (n = 1), Brazil (n = 1), Palestine (n = 1), and Cambodia (n = 1).

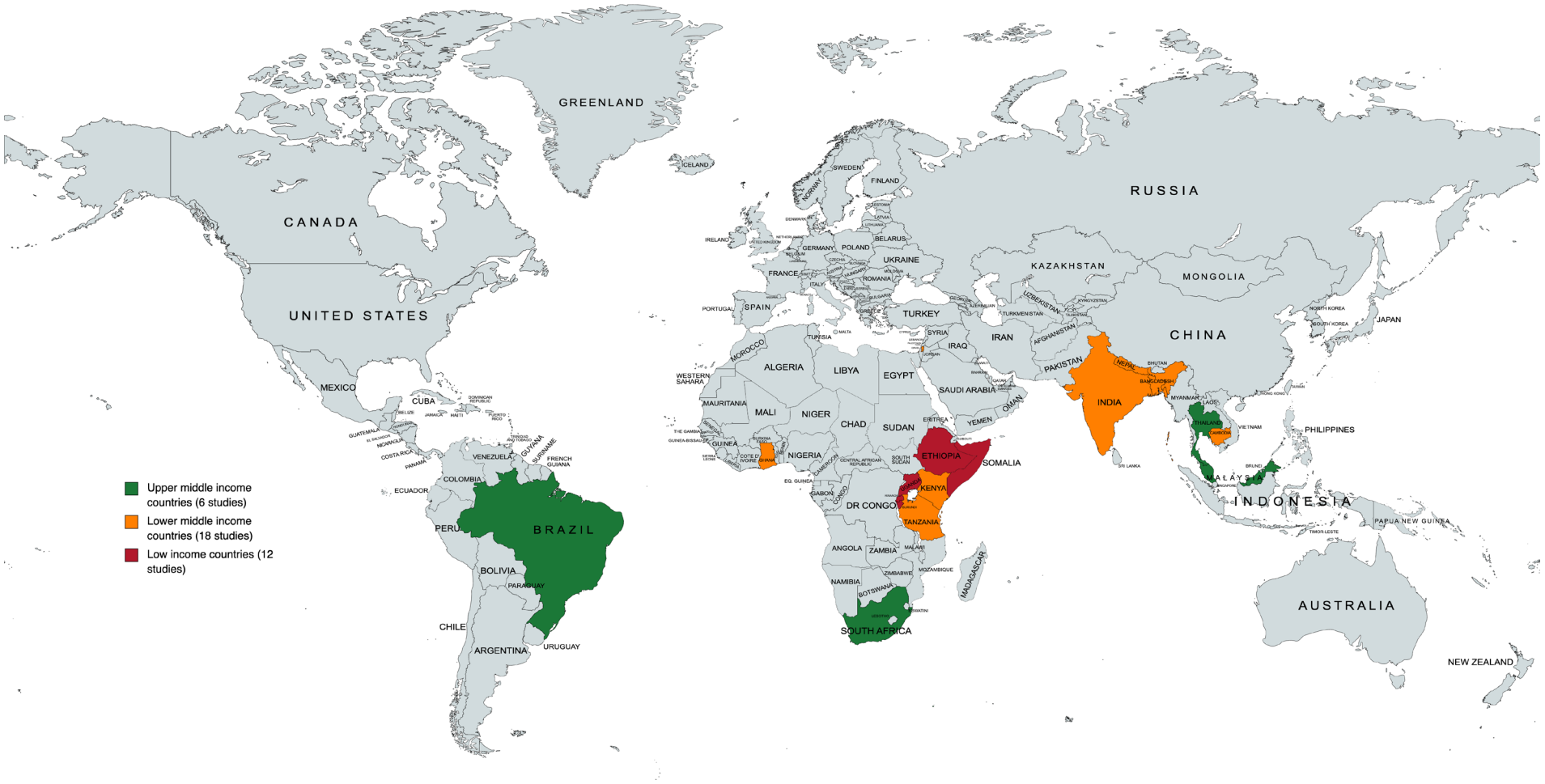

Figure 2 Studies of countries included (stratified by income)

The prevalence of FIS ranged from 20.5% to 89.8%, while the prevalence of stunting, underweight and wasting were 7.2%-61.4%, 9.2%-61% and 2.1%-30.6%, respectively. A total of three studies found a significant association between HFIS with all three indicators of undernutrition [19-21]. Additionally, 22 studies found a significant association between HFIS and some undernutrition [22-43]. Meanwhile, seven studies found no significant association between HFIS and undernutrition [44-50].

There were variations in the use of outcome indicators among the studies. A total of 14 studies measured the associations between HFIS and all indicators of undernutrition (stunting, underweight and wasting), three studies measured the associations between HFIS and stunting and wasting (Table 5), and 15 studies only measured stunting (Table 6). In contrast, four only measured malnutrition in general (Table 7).

Table 5 Summary of associations between household food insecurity and indicators of undernutrition

Author	Location	Study Design	Participants	Tool	Data collection method	Stunting	Underweight	Wasting	Quality
Fufa et al., 2021 [19]	Semien Bench district, Ethiopia	Cross-sectional study	n = 700 mother/child pairs (aged 6-36 months)	HFIAS	Parent interview Direct child assessment	⇧ aOR = 1.9	⇧ aOR = 4.24	⇧ aOR = 10.34	Good
Berhane et al., 2020 [23]	Addis Ababa, Ethiopia	Cross-sectional study	n = 5467 children	HFIAS	Parent interview Direct child assessment	⇧ aOR = 1.42	–	≠	Good
Betebo et al., 2020 [29]	Badawacho, Ethiopia	Cross-sectional study	n = 496 mother/child pairs	HFIAS	Parent interview Direct child assessment	⇧ aOR = 6.7	⇧ aOR = 3.82	≠	Good
Dinku et al., 2020 [44]	Ethiopia	Cross-sectional study	n = 512 mother/child pairs	HFIAS	Parent interview Direct child assessment	≠	≠	≠	Good
Pathak et al., 2020 [20]	Assam, India	Cross-sectional study	n = 510 mother/child pairs	HFIAS	Self-reported questionnaire	⇧	⇧	⇧	Fair
Praditsorn et al., 2019 [46]	Thailand	Cross-sectional study	n = 2,702 children (ages 6 to 59 months)	HHS and FCS	Parent interview Direct child assessment	≠	–	≠	Good
Sinha et al., 2018 [28]	India	Cross-sectional study	n = 2299 mother/child pairs	HFIAS	Parent interview Direct child assessment	⇧	⇧	≠	Good

Berra, 2017 [24]	West Oromia, Ethiopia	Cross-sectional study	n = 525	HFIAS	Parent interview Direct child assessment	⇧ OR = 2.09	⇧ OR = 4.73	≠	Good
Choudhury et al., 2017 [21]	Bangladesh	Cross-sectional study	n = 10291 (aged 0-23 months)	HFIAS	Parent interview Direct child assessment	⇧ Severely food insecure aOR = 1.28	⇧ Moderately food insecure aOR = 1.44	⇧ Moderately food insecure aOR = 1.66 Severely food insecure aOR = 1.34	Good
Mulu and Mengistie, 2017 [33]	Sekela, Ethiopia	Cross-sectional study	n = 555 children	HFIAS	Parent interview Direct child assessment	≠	⇧ aOR = 2.25	≠	Good
Abdurahman et al., 2016 [36]	Ethiopia	Cross-sectional study	n = 453 children (aged 24-59 months)	HFIAS	Parent interview Direct child assessment	≠	⇧ aOR = 2.48	≠	Good
Chowdhury et al., 2016 [37]	Bangladesh	Cross-sectional study	n = 7568 children (under 5 years old)	Bangladesh Demographic and Health Survey 2011	Parent interview Direct child assessment	⇧ Mild food insecure aOR = 1.29 Moderate to severe food insecure aOR = 1.38	⇧ Mild food insecure aOR = 1.28 Moderate to severe food insecure aOR = 1.31	≠	Good
M'Kaibi et al., 2016 [48]	Kenya	Cross-sectional study	n = 525 children (aged 24-59 months)	HFIAS	Parent interview Direct child assessment	≠	≠	≠	Good
McDonald et al., 2015 [49]	Cambodia's Prey Veng province	Cross-sectional study	n = 900 households	HFIAS and HDDS	Parent interview Direct child assessment	≠	–	≠	Good

Motbainor et al., 2015 [38]	Amhara Region, Ethiopia	Cross-sectional study	n = 3964	HFIAS	Parent interview Direct child assessment	≠	≠	⇧ Food insecurity β = - 0.108	Good
Ali Naser et al., 2014 [40]	Kelantan, Malaysia	Cross-sectional study	n = 223 households	Radimer/Cornell Hunger and Food Insecurity instrument	Parent interview Direct child assessment	⇧ OR = 3.04	⇧ OR = 2.44	≠	Good
Eunice et al., 2014 [41]	Sarawak, Malaysia	Cross-sectional study	n = 177 mother/child pairs	Radimer/Cornell Hunger and Food Insecurity instrument	Parent interview Direct child assessment	≠	⇧ Individual Insecure β = -1.985	⇧ Individual Insecure β = -2.059	Good

Newcastle–Ottawa quality assessment scale was used for quality assessment
≠ no statistically significant association
HFIAS: Household Food Insecurity Access Scale
HHS: Household Hunger Scale
FCS: Food Consumption Score
HDDS: Household Dietary Diversity Score

Table 6 Summary of associations between household food insecurity and stunting

Author	Location	Study Design	Participants	Tool	Data collection method	Stunting	Quality
Donkor et al., 2022 [22]	Somalia	Cross-sectional study	n = 1947 children	Somalia Micronutrient Survey (SMS 2019)	Parent interview Direct child assessment	⇧ Severe food insecurity aOR = 1.47 (1.12, 1.93)	Good
Mistry et al., 2019 [45]	Bangladesh	Cross-sectional study	n = 6539 children (aged 0–23 months)	Not specified	Parent interview Direct child assessment	≠	Good
Roesler et al., 2019 [47]	Mae Chaem District, Thailand	Cross-sectional study	n = 208 children (under 5 years of age)	HFIAP	Parent interview Direct child assessment	≠	Good
Shilugu and Sunguya, 2019 [26]	Bukombe, Tanzania	Cross-sectional study	n = 358 mother/child pairs	HFIAS	Parent interview Direct child assessment	⇧ aOR = 3.34	Good
Agho et al., 2018 [25]	Gicumbi, Rwanda	Cross-sectional study	n = 2222 children (aged 6-59 months)	HFIAS	Parent interview Direct child assessment	⇧ Stunted Moderately food insecure aOR = 1.43 Severe food insecurity aOR = 1.35 Severely stunted Moderately food insecure aOR = 2.47 Severe food insecurity aOR = 1.82	Good
Dorsey et al., 2018 [27]	Nepal	Cross-sectional study	n = 4,943 children (6–59 months)	FFQ	Parent interview Direct child assessment	⇧ Moderately food insecure aOR = 1.44-1.48 Severe food insecurity aOR = 1.39	Good
Bukusuba et al., 2017 [30]	Uganda	Case-control study	n = 56 cases and 112 controls mothers of the selected children (aged 6 to 59 months)	FCS	Parent interview Direct child assessment	⇧ OR = 2.4	Good

Dukhi et al., 2017 [31]	KwaZulu-Natal province, South Africa	Cross-sectional study	n = 572 children	Not specified	Questionnaire Direct child assessment	⇧ aOR = 1.69	Fair
Gubert et al., 2017 [32]	Brazil	Cross-sectional study	n = 4299 mother/child pairs	Brazilian HFI Measurement Scale	Secondary data	⇧ aOR = 3.33 for double burden of malnutrition (DBM)	Good
Nkurunziza et al., 2017 [34]	Burundi	Cross-sectional study	n = 6199 children (6 to 23 months)	HFIAS	Parent interview Direct child assessment	⇧ OR = 1.4 more odds of stunting OR = 1.6 more odds of severe stunting	Good
Sarma et al., 2017 [35]	Bangladesh	Cross-sectional study	n = 7647 children	Bangladesh Demographic and Health Survey 2011	Parent interview Direct child assessment	⇧ Mildly food insecure aOR = 1.18 Moderately food insecure aOR = 1.27	Good
Mutisya et al., 2015 [39]	Kenya	Cohort study	n = 6858 children	Not specified	Parent interview Direct child assessment	⇧ HR = 1.12-1.15	Good
Shinsugi et al., 2015 [50]	Kenya	Cross-sectional study	n = 404 children (less than 5 years old)	HFIAS	One-on-one interview	≠	Good
Tiwari et al., 2014 [42]	Nepal	Cross-sectional study	n = 2380 children (aged 0–59 months) and child's guardian/mother	Nepal Demographic and Health Survey 2011	Parent interview Direct child assessment	⇧ Moderately food insecure aOR = 1.37 Severely food insecure aOR = 1.67	Good
Gordon et al., 2013 [43]	Palestine	Cross-sectional study	n = 9,051 children (under the age of five)	2006–2007 cross-sectional survey data collected by the Palestine Central Bureau of Statistics	Secondary data	⇧ aOR = 1.13	Fair

Newcastle–Ottawa quality assessment scale was used for quality assessment
≠ no statistically significant association
HFIAS: Household Food Insecurity Access Scale; HFIAP: Household Food Insecurity Access Prevalence; FFQ: Food Frequency Questionnaire; FCS: Food Consumption Score; HDDS: Household Dietary Diversity Score

Table 7 Summary of associations between household food insecurity and malnutrition

Author	Location	Study Design	Participants	Tool	Data collection method	Malnutrition	Quality
Abedi et al., 2021 [51]	Aligarh, India	Cross-sectional study	n = 815 children	HFIAS	One-on-one interview	⇧	Good
Dahal et al., 2021 [52]	Jhapa, Nepal	Case-control study	n = 50 cases n =100 controls	HFIAS	Parent interview Direct child assessment	⇧ OR = 4.272	Good
Hoq et al., 2019 [53]	Kurigram, Bangladesh	Case-control study	n = 52 cases n = 95 controls	HFIAS, HHS, FCS	Parent interview Direct child assessment	⇧ OR = 2.57	Good
Saaka and Osman, 2013 [54]	Ghana	Cross-sectional study	n = 337 mother/child pairs	HFIAS, FCS, HDDS	Parent interview Direct child assessment	⇧	Good

Newcastle–Ottawa quality assessment scale was used for quality assessment
HFIAS: Household Food Insecurity Access Scale
HHS: Household Hunger Scale
FCS: Food Consumption Score
HDDS: Household Dietary Diversity Score

3.3 HFIS and Child Nutritional Status

From the 14 studies examining the association between HFIS and underweight, 11 found a significant association (UMICs n = 2 [40, 41]; LMICs n = 4 [20, 21, 28, 37]; and LICs n = 5 [19, 24, 29, 33, 36]). The adjusted odds ratio (aOR) ranged between 1.44−6.70 (Table 5).

Concerning the 16 studies investigating the relationship between HFIS and wasting, five studies found a significant association (UMICs n = 1 [41]; LMICs n = 2 [20, 21]; and LICs n = 2 [19, 38]). The adjusted odds ratio (aOR) ranged between 1.34−10.34 (Table 5). Whereas the 11 studies with no significant findings were respectively from UMICs n = 2 [40, 46], LMICs n = 3 [37, 48, 49], and LICs n = 6 [23, 24, 29, 33, 36, 44].

The studies assessing the association between HFIS and stunting were 32 (Tables 5 and 6). Twenty-one studies that found significant association were, namely UMICs n = 3 [31, 32, 40]; LMICs n = 10 [20, 21, 26-28, 35, 37, 42, 43, 55]; and LICs n = 8 [19, 22-25, 29, 30, 34]. The adjusted odds ratio (aOR) ranges between 1.13−6.70. In contrast, the 11 studies that did not find significant association were, respectively, UMICs n = 3 [41, 46, 47]; LMICs n = 4 [45, 48-50]; and LICs n = 4 [33, 36, 38, 44].

3.4 HFIS and Undernutrition and Sociodemographic Characteristics

Several sociodemographic factors that were significantly associated with HFIS and undernutrition have been summarised in Table 8.

Table 8 Summary of factors associated with food insecurity and undernutrition

Factors	Food Insecurity		Undernutrition								
			Stunting			Underweight			Wasting		
	Yes	No	Yes	No	Others	Yes	No	Others	Yes	No	Others
Lower maternal education	3	2	7	3	—	3	0	—	1	2	—
Lower paternal education	3	2	5	0	—	0	0	—	0	1	—
Lower SES	4	1	9	3	—	1	0	—	0	0	—
Bigger household size	2	1	3	1	—	0	1	—	0	0	—
Lower maternal BMI	0	1	1	1	2[a]	2	0	1[b]	1	1	1[c]
Rural residence	0	0	3	1	2[d]	0	0	1[e]	0	0	1[f]

SES

BMI

[a]1 study demonstrated that higher maternal BMI was associated with a lower risk of stunting,
1 study demonstrated that higher maternal BMI was associated with a higher risk of stunting

[b]1 study demonstrated that higher maternal BMI was associated with a lower risk of underweight

[c]1 study demonstrated that higher maternal BMI was associated with a lower risk of wasting

[d]1 study demonstrated that rural residency was associated with a lower risk of stunting,
1 study demonstrated that urban residency was associated with a higher risk of stunting

[e]1 study demonstrated that urban residency was associated with a lower risk of underweight

[f]1 study demonstrated that urban residency was associated with a lower risk of wasting

Relationship between Parental Education and HFIS and Undernutrition

Lower parental education was significantly associated with HFIS [20, 40, 44] and undernutrition [19, 21, 23, 24, 27, 32, 34, 35, 37, 42, 43]. Notably, the proportion of children with undernutrition was higher among fathers with less education (83.3%) [32, 34, 35, 37, 42] as compared to lower maternal education (64.7%) [19, 21, 23, 24, 27, 35, 37, 42, 43].

Relationship between Socioeconomic Status and HFIS and Undernutrition

There is evidence of an association between poorer SES with HFIS [20, 40, 44] and undernutrition [21, 22, 24, 27, 34, 35, 37, 39, 42, 52]. In contrast, three studies demonstrate no association between lower SES and stunting [45, 47, 50].

Relationship between other factors and HFIS and Undernutrition

Bigger household size was significantly associated with HFIS [40, 53] and undernutrition [27, 42, 43]. While several studies showed no association between household size and undernutrition [38, 46].

Lower maternal BMI was significantly associated with HFIS [53] and undernutrition [21, 27, 28]. In contrast, one study found that higher maternal BMI was associated with a lower risk of stunting, being underweight and wasting [37].

Rural place of residence was significantly associated with stunting [27, 37, 42], while one study demonstrated a lower risk of stunting among rural dwellers [43]. One study found that urban areas had a lower risk of being underweight and wasting [38]. Another study found a higher risk of stunting among the urban poor (slums) [45].

4. Discussion

4.1 Discussion

From this systematic review, HFIS was associated with indicators of undernutrition, affecting stunting and underweight more than wasting. Being underweight and wasting are indicators of acute undernutrition, while stunting reflects chronic undernutrition [4]. Stunting is more reflective of long-term inadequate food intake [56, 57] and hence a better outcome measure when HFIS is persistent in that population. This may explain why more studies studied the association between HFIS with stunting compared to other forms of malnutrition. In cases where a child is suffering from both stunting and being underweight, wasting may not be obvious as it is a ratio between height and weight. Therefore, mid-upper arm circumference may be a more sensitive measure for undernutrition.

The studies included in this review were from low-middle-income countries, while none were from high-income countries. Those studies revealed that the prevalence of obesity is highest among the poor in high-income countries [59]. This may be partly due to the lower prevalence of undernutrition in high-income countries [58]. Therefore, more research has focused on overweight and obesity instead. Nonetheless, HFIS is a universal factor in malnutrition.

Parental education influences food security and child undernutrition, whereby higher education significantly reduces the risk of HFIS and child undernutrition [60, 61]. The evidence suggests that maternal education has a significantly larger impact on nutrition than paternal education [62, 63]. Several advantages of an educated mother include having (1) a better understanding of nutritional conditions for her children and better child feeding practices [64, 65], (2) the ability to earn more money and therefore may have more opportunity to invest in the health of their children [66], (3) more likely

to have better health-seeking behaviour for their children [67] and, to make efficient use of family resources and more willing to utilise family planning [62, 63].

This review found that regions like sub-Saharan Africa and South Asia have a higher prevalence of HFIS and childhood undernutrition. This observation highlights the unwanted consequences of poverty and unsafe water, sanitation, and hygiene (WASH). WASH interventions address two pillars of food security: the availability of food and the utilisation of food [68, 69]. Water is important for domestic activities such as drinking and cooking and for food production such as agriculture, poultry, and livestock. Furthermore, good nutrition requires more than just having enough food. Changing behaviours related to feeding and childcare and having access to and correctly using safe WASH is also required.

Conventionally, rural areas are more likely to be FIS. However, a study conducted in Palestine (a country in protracted conflict) revealed that rural Palestinians were less likely to be undernourished [43]. It may result from conflict and active intervention conducted in rural areas. The two active programmes, i.e. (1) the Resilient Land and Resource Management Project (RELAP) supporting increased land tenure for smallholders and promoting climate-resilient land development activities [70] and (2) the Palestinian Women Empowerment in Rural Areas focussing on capacity building and economic empowerment of rural women [71] are making a difference in the war-torn region. Relating to the current Ukrainian crisis, in this interlinked and interdependent world, certain shocks, including droughts or civil conflicts, may disrupt the food supply chain, which worsens FIS or creates new FIS [72, 73].

4.2 Study Strengths and Limitations

This is the first systematic review that examines the association between HFIS and childhood undernutrition. It has also highlighted the lack of studied factors of paternal

involvement in household food security and child undernutrition. Meanwhile, the limitations include the inability to determine causality and meta-analysis was not conducted as most studies included are cross-sectional studies. The study cannot determine the temporality in terms of the duration of food insecurity required to result in undernutrition.

5. Conclusion and Recommendations

Many studies have investigated undernutrition and HFIS; however, there is still inadequate information to guide meaningful decisions and strategies. Sustainable and inclusive economic growth, which aims to reduce income, education, and gender inequality, should be a key policy goal in minimising food insecurity and undernutrition.

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