Annual Review of Public Health

Evidence for Policies and Practices to Address Global Food Insecurity

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Annu. Rev. Public Health 2024. 45:23.1–23.26

The *Annual Review of Public Health* is online at publhealth.annualreviews.org

https://doi.org/10.1146/annurev-publhealth-060922-041451

Keywords

global food insecurity, evidence-based policy and practices, agrifood systems, food environment, food availability, affordability, quality, promotion, sustainability

Abstract

Food insecurity affects an estimated 691–783 million people globally and is disproportionately high in Africa and Asia and arising from poverty, armed conflict, and climate change, among other demographic and globalization forces. This review summarizes evidence for policies and practices across five elements of the agrifood system framework and identifies gaps that inform an agenda for future research. Under availability, imbalanced agriculture policies protect primarily staple food producers, and there is limited evidence on food security impacts for smallholder and women food producers. Evidence supports the use of cash transfers and food aid for affordability and school feeding for multiple benefits. Food-based dietary guidelines can improve the nutritional quality of dietary patterns, yet they may not reflect the latest evidence or food supplies. Evidence from the newer food environment elements, promotion and sustainability, while relatively minimal, provides insight into achieving long-term impacts. To eliminate hunger, our global community should embrace integrated approaches and bring evidence-based policies and practices to scale.

Stability: steady access to sufficient food, resilient to sudden shocks or recurrent events

Food security: all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life

> It is important for people to realize that we can make progress against world hunger, that world hunger is not hopeless. The worst enemy is apathy.
>
> —Reverend David Beckmann

INTRODUCTION

Globally, an estimated 691–783 million people were food insecure in 2021 (51). The prevalence of undernourishment increased for the first time after years of stability, from 7.9% to 9.2% in the crush of the COVID-19 pandemic and resulting economic hardships. During the World Food Summit in 1996, global consensus was reached for the definition of food security: "[A]ll people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food that meets their food preferences and dietary needs for an active and healthy life" (41, 42). The agrifood system framework, which encompasses both agricultural and food systems, provides the structural basis for assessing the evidence adapted here to reflect the elements covered in the review (**Figure 1**).

Our overall goal is to summarize the evidence and its shortcomings with a view toward developing comprehensive strategies that accelerate progress to eliminate hunger. In the first section, we describe the problem, vulnerable populations, and contemporary drivers of food insecurity and

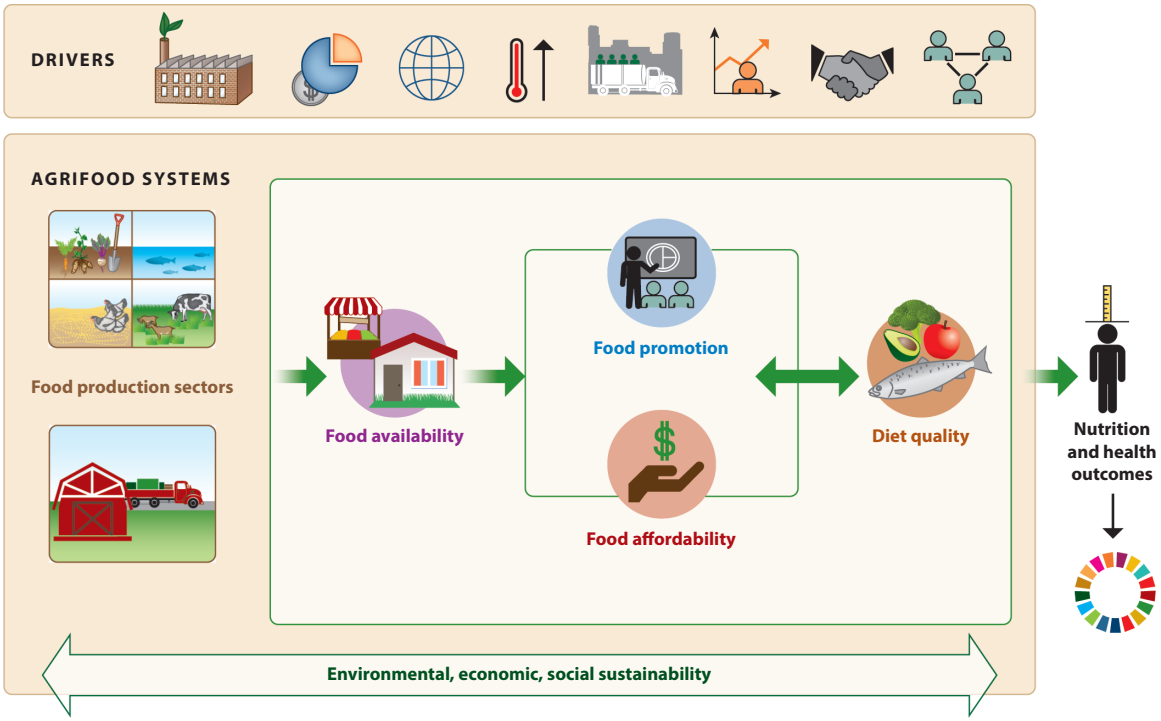

Figure 1

The Agrifood System Framework originated from the High Level Panel of Experts on Food Security and Nutrition of the Committee on World Food Security (75). Here we adapt this framework to highlight the food environment elements of food availability, food affordability, food promotion, diet quality, and sustainability. Sustainability encompasses environmental, economic, and social sustainability underlying various components of the agrifood system. The framework reflects the focus of the article on the four elements that influence the agrifood systems and the nutrition and health outcomes.

malnutrition.[1] The middle section presents evidence about current and potential future policies and practices aimed at tackling food insecurity framed by the following key elements: availability, affordability, promotion, quality, and sustainability (24, 36, 50). We conclude with a summary of evidence and ideas for future research directions under each element.

GLOBAL FOOD INSECURITY SITUATION AND DRIVERS

The Global Food Insecurity Situation

Food insecurity is conventionally indicated by the prevalence of undernourishment: the percent of individuals in a population who are unable to acquire enough food to meet the daily minimum dietary energy requirements over a period of one year. Other forms of malnutrition are integral to the food insecurity concept. In 2022, stunted growth affected 148.1 million children (22.3%) under the age of five years globally with decreasing trends evident; child wasting affected an estimated 45 million young children with only slight decreasing trends, while overweight and obesity in children (5.6%) and adults (13.1%) increased (146). Between 2003 and 2019, more than half (56%) of preschool-aged children and 69% of nonpregnant women of reproductive age around the world experienced one or multiple micronutrient deficiencies in iron, zinc, vitamin A, or folate (140). The consequences of malnutrition may increase risks for both communicable and noncommunicable disease, impair child development and alter brain function, compromise reproductive health, and ultimately lead to mortality. Poor-quality diets and child and maternal malnutrition are among the leading risk factors for mortality and disability-adjusted life years (DALYs) lost in the global burden of disease (112).

Stark disparities prevail across the landscape of global food insecurity. Vulnerability to food insecurity may be broadly characterized by (*a*) stage in the life course, (*b*) geography, and (*c*) marginalization in society. Life stage is relevant because physiological demands for energy and nutrients in the human body vary depending on age, sex, reproductive status, and level of physical activity and may give rise to food insecurity in situations of limited food access. In the first 1,000 days of life, the body has high demands for nutrients and nutrient-dense foods to fuel the normal rapid growth and development that occurs during this period (109, 129). Pregnant and lactating women and older adults also diverge from the general adult population in terms of dietary requirements and vulnerabilities to food insecurity (10, 147).

Geographically, greater than half of all people affected by hunger, or chronic undernourishment, reside in Africa (278 million) and Asia (425 million), though the prevalence in Africa (20.2%) far exceeds that of other regions: Asia (9.1%), Latin America and the Caribbean (8.6%), Oceania (5.8%), and North America and Europe (2.5%) (**Figure 2**) (50). Disparities are also evident in marginalized, oppressed groups who experience hunger at higher levels than does the general population. Some examples today of these populations are Indigenous Peoples, pastoralists, refugees, and other displaced populations such as the Rohingha people, Christians in South Sudan, and Syrian refugees (86, 89, 99, 139). The *Global Report on Food Crises 2023* estimates that 258 million people in 58 territories experienced acute food insecurity in 2022, with more than 40% residing in the Democratic Republic of the Congo, Ethiopia, Afghanistan, Nigeria, and Yemen (55). Gender-based disparities in food insecurity negatively affect girls and women, with strong evidence linking this finding to inequities in land and livestock ownership, empowerment, workload, and education (5, 68, 135, 142).

Agrifood system: the process through which food is produced, distributed, and consumed

Hunger (or undernourishment): experienced when an individual is unable to acquire sufficient food to meet daily minimum dietary energy requirements

Availability: the presence of food items in a given area as influenced by agriculture and food systems. Also considered physical access (proximity)

Affordability: an individual's capacity to purchase food based on their economic and physical resources; other terms used for this element are economic access and physical access

Promotion: the marketing and presentation of food items to impact their appeal; other terms used for this element are nutrition education and social behavioral change

Quality: the nutritional value, safety, and freshness of food items and resulting diet quality in terms of diversity, adequacy, moderation, and overall balance

[1]Malnutrition is defined as the abnormal physiological condition caused by inadequate, unbalanced, or excessive intake of macronutrients and/or micronutrients. Different forms of malnutrition may include stunting, underweight, wasting, overweight, obesity, and nutrient deficiencies.

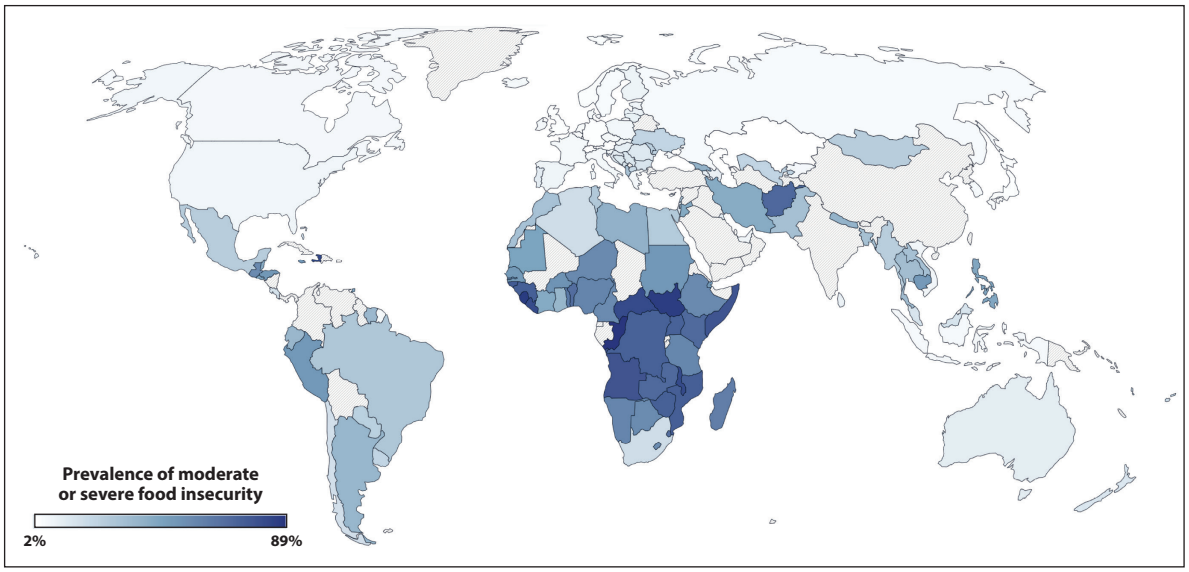

Figure 2

Prevalence of moderate or severe food insecurity (as of 2020). The global map illustrates the prevalence of food insecurity ranging from 2% to 89% in 2020 from the Food Systems Dashboard. Data are collected using experience-based food security measurement questionnaires, and households are classified as food insecure when at least one adult from the household reports having been exposed to low-quality diets or having been forced to reduce the quantity of foods consumed due to a lack of money or other resources (57).

Sustainability: long-term regeneration of natural, social, and economic systems ensuring the food needs of present and future generations

Stunted: low height for age (height-for-age Z score < −2SD), reflecting a sustained past episode or episodes of undernutrition and/or poor health

Overweight and obesity: body weight above normal for height as a result of excessive accumulation of fat, generally resulting from consuming more energy than expended

Key Drivers of Food Insecurity

Food insecurity is a dynamic condition that is responsive to environmental and contextual factors requiring continual monitoring and actions across multiple sectors to mitigate harm. The agri-food system framework identifies key determinants leading to food insecurity. Poverty is one of the more important driver arising from both macro- and microeconomic forces. In 2020, an estimated 3.1 billion people could not afford a healthy diet, a situation exacerbated by food price inflation and the economic repercussions of COVID-19 (50, 123). Economic shocks—including the combined effects of COVID-19 and the global implications of Russia's war in Ukraine—surpassed localized conflicts as the leading cause of acute food insecurity in 2022 (55). While not explicitly identified in the framework, low education levels, notably among women in low- and middle-income countries (LMICs), strongly predict food insecurity (135).

Armed conflict and political instability are leading drivers of food insecurity through multiple pathways of destruction, displacement, or the use of food as a "weapon of war" (54, 84). Countries such as Somalia, Central African Republic, Haiti, Yemen, and Afghanistan with high levels of violence and genocide show the highest prevalence of food insecurity (49). Russia's war on Ukraine directly affects internal populations as well as the food systems of countries dependent on food commodities (wheat, maize, sunflower oil), fuel, and fertilizers from these nations (1). Forced migration arising from armed conflict or climate change has negative health consequences, including food insecurity (95, 106).

Climate change increasingly contributes to both moderate and severe food insecurity, although the empirical evidence remains somewhat limited and focused on food availability and production pathways (30, 67, 113). One meta-analysis showed drought conditions significantly predictive of wasting and underweight in young children through food insecurity (96). Weather

extremes, notably the sustained drought in the Horn of Africa, flooding in Pakistan, and tropical storms, cyclones, and drought in Southern Africa were the key determinants of food insecurity for 56.8 million people in 2022 (55).

Other important agrifood system factors giving rise to persistent hunger include migration, increases in population, disrupted supply chains, globalization and trade policies, and limited market access (21, 91, 93, 106).

METHODS

This narrative review examines the evidence for policies and practices addressing global food security issues. For the eligibility criteria, we included peer-reviewed articles and gray literature as relevant to five key elements of food security and the food environment: availability, affordability, promotion, quality, and sustainability. Systematic reviews and meta-analyses were preferentially targeted in the search, followed by scoping and narrative reviews, experimental trials, and observational studies. We prioritized findings from LMICs, though studies focused on food-insecure populations in high-income countries (HICs) were also included. Papers not available in English, published before the year 2000, and without human subjects were excluded.

We searched in three electronic databases (Scopus, MEDLINE via PubMed, and Global Health via EBSCO). **Supplemental Table 1** provides a complete list of search terms. Records obtained from databases were imported into Zotero citation management software. Two coauthors (L.I. and E.K.) independently screened titles and abstracts, the results of which are synthesized in **Table 1** and summarized or cited in the narrative. Other coauthors (C.L., P.F., and S.O.) further screened and added references where appropriate. Gaps in the evidence were identified first by the lead author (L.I.) and confirmed with some additions made by the other coauthors (C.L., P.F., S.O., and E.K.).

EVIDENCE FOR SOLUTIONS: CURRENT AND POTENTIAL FUTURE POLICIES AND PRACTICES

Policies and practices both influence various levels of the agrifood system. The food environment is the space where individuals encounter the wider food system. In this section, we summarize evidence primarily from systematic reviews and meta-analyses (**Table 1**) but acknowledge that, on the horizon, there is a growing body of evidence for other aspects of the food system such as food supply chains and consumer behavior as well as individual factors, which all ultimately influence food security.

Food Availability: Food Production Sectors

Multiple sectors engage in food production: agriculture, horticulture, agroforestry, aquaculture, fisheries, and livestock, among others. Evidence is largely concentrated in the broad category of agriculture, including plant cultivation and animal rearing for food and food security as opposed to these other sectors (2, 126). Furthermore, we found gaps in the literature for women and small-scale enterprises, despite their producing an estimated 75% of food globally (72).

Agriculture policies. Fiscal subsidies and price incentives generally support food producers in middle- and high-income countries (MHICs), while consumer prices have historically been safeguarded by policies (e.g., price controls) in low-income countries (LICs) (53, 122). This finding was underscored by a report examining public spending on agriculture in sub-Saharan Africa (SSA). Despite the Maputo Declaration signed by countries in SSA to allocate 10% of their

Micronutrient deficiencies (also known as hidden hunger): results from inadequate intake of essential vitamins and minerals that the human body requires in small amounts

Healthy diet: dietary pattern that provides enough nutrients without excess to promote health and prevent disease

LMICs: low- and middle-income countries

Wasting: low weight for height (weight-for-height Z score < −2SD), usually resulting from weight loss in a recent period of inadequate dietary intake and/or disease

Underweight: low weight for age (weight-for-age Z score < −2SD), usually resulting from inadequate macro- and/or micronutrient intake and/or poor health

Food environment: the individual interface component of the larger food system that includes five elements covered in this review, i.e., availability, affordability, quality, promotion, and sustainability

HICs: high-income countries

Table 1 Summary of the literature

Food security pillar	Authors and year	Study design	Number of studies included	Main findings
Food availability	Poulsen et al. 2015 (126)	Systematic review	35	Urban agriculture increased access to diverse diets and household income and contributed to women's role in household food availability and economic and social advancement; results showed a lack of supportive policies.
	Abu Hatab et al. 2019 (2)	Systematic review	68	Research on livestock and food security has focused largely on production or consumption, neglecting other parts of the food value chain.
	Bene et al. 2016 (14)	Review of evidence	201	There are substantial evidence gaps for the role of fisheries and aquacultures in poverty alleviation and other macrolevel drivers of food security, such as climate change and demographic transition.
Food affordability	Alagiyawanna et al. 2015 (3)	Systematic review	18	Taxes and subsidies affect consumption of both healthy and unhealthy foods, but taxes were too low to have detectable effects on health outcomes.
	Thow et al. 2010 (143)	Systematic review	38	Larger taxes and subsidies showed significant changes in consumption, body weight, and disease incidence.
	Barlow et al. 2020 (8)	Observational global analysis	132 countries	Liberal trade policy was not associated with moderate-severe/severe food insecurity in households; in HICs there was a 0.07% (95% CI: −0.10 to −0.04) reduction in food insecurity probability associated with liberal trade policy index.
	Hidrobo et al. 2018 (73)	Meta-analysis	75	Social protection programs improved food quality consumed, as indicated by increases in the value of foods by 13% and ASFs consumed or expenditures as well as asset holdings for households.
	Kabeer & Waddington 2015 (82)	Systematic review and meta-analysis	46	Households participating in conditional cash transfer programs showed decreased child labor, increased household consumption and investment, and improved consumption smoothing.
	Manley et al. 2020 (102)	Systematic review and meta-analysis	74	Cash transfers had significant effects on height-for-age Z scores (effect size: 0.03, $p = 0.03$), stunting (−2.11, $p < 0.01$), ASF consumption (4.47, $p < 0.01$), dietary diversity (0.73, $p < 0.01$), and diarrhea incidence (−2.72, $p < 0.05$) and not for weight-for-age Z scores (0.02, $p = 0.41$) or wasting (−1.22, $p = 0.06$).
	Manley et al. 2022 (101)	Systematic review and meta-analysis	129	Cash transfers had modest effects on height-for-age Z scores (effect size = 0.024, $p = 0.019$), stunting (−1.35, $p < 0.01$), wasting (−1.31, $p < 0.01$), ASF consumption (6.72, $p < 0.01$), dietary diversity (0.55, $p < 0.01$), and diarrhea incidence (−1.74, $p < 0.01$); results were nonsignificant for weight-for-age Z scores (0.019, $p = 0.47$) and weight-for-height Z scores (0.028, $p = 0.19$).

(*Continued*)

Table 1 (*Continued*)

Food security pillar	Authors and year	Study design	Number of studies included	Main findings
	Pega et al. 2017 (121)	Systematic review	21	Unconditional cash transfers improved household access to food, household dietary diversity (MD = 0.59 food categories, 95% CI: 0.18 to 1.01), and school attendance (RR = 1.06, 95% CI: 1.03 to 1.09).
	Little et al. 2021 (97)	Systematic review & meta-analysis	17	Cash + food transfer reduced the odds of stunting (OR = 0.82, 95% CI: 0.74 to 0.92, $p = 0.01$); neither weight-for-age Z scores nor weight-for-height Z scores added impact compared with cash alone; cash + primary health care reduced mortality; behavior change, psychosocial stimulation, and child protection showed no impact.
	Doocy & Tappis 2017 (35)	Systematic review	113	Unconditional cash transfers and vouchers increased food security; cash transfers improved dietary diversity more than food transfers; food transfers increased per capita caloric intake; and cash transfers were most cost-effective.
	Fuller et al. 2022 (56)	Systematic review	23	In Canada, cash transfers were associated with child (decreased rates of low birthweight and preterm birth and improved developmental, mental health, and behavioral outcomes) and parental health outcomes (improved mental health and decreased rates of overweight and obesity among mothers).
	Reeves et al. 2021 (128)	Multilevel regression analysis	139 countries	The probability of food insecurity was 0.10 lower (95% CI: 0.02 to 0.18) in countries with collective bargaining compared with those with little or no minimum wage; full-time workers saw greater reductions in food insecurity than did those who were unemployed.
	Das et al. 2019 (28)	Systematic review and meta-analysis	17	Lipid-based nutrient supplements + complementary feeding led to a reduction in moderate stunting (RR = 0.93, 95% CI: 0.88 to 0.98), severe stunting (RR = 0.85, 95% CI: 0.74 to 0.91), and anemia (RR = 0.79, 95% CI: 0.69 to 0.90); lipid-based nutrient supplements + complementary feeding were more effective at reducing moderate stunting (RR = 0.89, 95% CI: 0.82 to 0.97) and wasting (RR = 0.64, 95% CI: 0.73 to 0.91) than were fortified blended foods.
	Black et al. 2012 (17)	Systematic review	14	Food subsidy program participants had 10–20% increased intake of targeted food; results were seen mainly for pregnant and postnatal women; evidence for men and children was lacking; results showed an increase in mean birthweight (23–29 g).

(*Continued*)

Table 1 (*Continued*)

Food security pillar	Authors and year	Study design	Number of studies included	Main findings
	Moslehi et al. 2021 (110)	Systematic review	27	Common challenges of food aid to mitigate food insecurity in emergencies include food aid access by vulnerable groups, quantity and quality of food aid, inappropriate financial management, and availability of local foods.
	Visser et al. 2018 (148)	Overview of systematic reviews	8 reviews	Supplementary feeding during pregnancy had impacts on birthweight (MD 40.96 g, 95% CI: 4.66 to 77.26) and small for gestational age (RR 0.79, 95% CI 0.69 to 0.90); greater effects on younger children; and increased weight (MD 0.12 kg, 95% CI: 0.05 to 0.18) and height (MD 0.27 cm, 95% CI: 0.07 to 0.48) for children.
	Bazerghi et al. 2016 (11)	Systematic review	35	Food banks can provide a short-term solution to severe food deprivation but have limitations in terms of providing nutrient-dense, perishable foods such as dairy, vegetables, and fruits.
	Dewey et al. 2021 (34)	Meta-analysis	14 RCTs	Children receiving lipid-based nutrient supplements had a 12–14% reduction in stunting, wasting, and underweight; 16% lower anemia and 64% lower iron-deficiency anemia; and 16–19% likelihood of improved developmental outcomes.
	Kristjansson et al. 2015 (87)	Systematic review and meta-analysis	32	Supplementary feeding increased growth in children by an average of 0.12 kg (95% CI: 0.09 to 0.39) over 6 months and increased hemoglobin levels (SMD 0.49, 95% CI: 0.07 to 0.91) and psychomotor development (SMD 0.41, 95% CI: 0.10 to 0.72); it was more effective in children under age 2.
	Wang et al. 2021 (149)	Systematic review and meta-analysis	57	There were significant increases in height (MD = 0.32 cm, 95% CI: 0.03 to 0.61, $p = 0.032$) and weight (MD: 0.58 kg, 95% CI: 0.22 to 0.93, $p = 0.001$) among school feeding participants over 12 months; results also showed increased attendance among school feeding participants (2.6%, 95% CI: 1.2% to 3.9%, $p < 0.001$).
	Kristjansson et al. 2007 (88)	Systematic review and meta-analysis	18	School feeding children had increased weight [0.39 kg over 19 months (95% CI: 0.11 to 0.67)], attendance (4–6 days a year), and math performance (SMD 0.66, 95% CI: 0.13 to 1.18) for LMICs.
	Cohen et al. 2021 (26)	Systematic review	47	School feeding programs in HICs showed improved food security, diet quality, and academic performance; findings for attendance were mixed.
	Evans et al. 2012 (39)	Systematic review and meta-analysis	27	School feeding programs in HICs increased intake by 0.25 portions daily (95% CI: 0.06 to 0.43) for fruits and vegetables (excluding juice), with fruits mostly driving the effect.

(*Continued*)

Table 1 (*Continued*)

Food security pillar	Authors and year	Study design	Number of studies included	Main findings
Diet quality	FAO 2023 (48)	Review of FBDGs	123 FBDGs	Recommendations (325 guidelines) did not always consider life course: 164 related to infants and young children, 34 to pregnant and lactating women, 23 to women of reproductive age, 94 to school-age children, 64 to adolescents, and 34 to older adults; most did not propose consumption levels to address insufficient or excessive intakes.
	Herforth et al. 2019 (71)	Review of FBDGs	90 countries	Recommendations were nearly universal: Consume a variety of foods, including some foods, such as fruits and vegetables, legumes, and ASFs, in higher proportions; limit sugar, fat, and salt.
	Leme et al. 2021 (94)	Systematic review	49	Adherence [measured differently across studies (e.g., number of servings or quantity consumed)] to guidelines for dairy, red meat, fats and oils, and nuts was ~60% globally; fruits and vegetables had the highest adherence (7–67.3%); and grains and animal foods (red meat) exceeded recommendations.
	Panjwani & Heidkamp 2017 (120)	Systematic review and meta-analysis	16	Food supplementation in food-insecure populations had significant effects on length-for-age Z scores (SMD: 0.08, 95% CI: 0.04 to 0.13) and weight-for-length Z scores (0.05, 95% CI: 0.01 to 0.08); education had growth effects in food-secure populations.
	Shapiro et al. 2019 (131)	Systematic review	21	Increased consumption of ASFs was found to significantly decrease stunting in 4 out of 5 studies; study designs showed substantial heterogeneity and findings for child anthropometry were mixed.
	Eaton et al. 2019 (37)	Systematic review	6	3 out of 5 studies measuring height-for-age Z scores and weight-for-age Z scores found significant increases in children consuming ASFs compared with cereal-based foods or no intervention.
	de Beer 2012 (32)	Systematic review and meta-analysis	12	Moderate-quality evidence indicates that dairy product supplementation increases height (0.4 cm growth per annum per capita 245 ml of daily milk intake).
	da Silva Lopes et al. 2021 (27)	Overview of systematic reviews	75 reviews	Daily iron supplementation in infants, preschool and school-aged children, and women (pregnant and nonpregnant) led to increased hemoglobin and decreased anemia risk.
	Ohly et al. 2016 (117)	Systematic review	40	Evidence on the impact of school gardening on fruit and vegetable consumption was limited; community involvement and integration into the school curriculum aided success.
	Chan et al. 2022 (22)	Systematic review	35	School garden–based programs showed positive impacts on children's attitudes toward, acceptability of, and consumption of fruits and vegetables; nutritional knowledge; and dietary diversity.

(*Continued*)

Table 1 (*Continued*)

Food security pillar	Authors and year	Study design	Number of studies included	Main findings
Food promotion	Murimi et al. 2018 (111)	Systematic review	41	Nutrition education interventions were more successful if they engaged parents, ensured fidelity, were longer than 6 months in duration, and had a multicomponent approach.
	Mertens et al. 2022 (107)	Meta-analysis	212	Effects of SBC techniques such as nudges are limited to the context with little/insufficient evidence in LMICs.
	Mahumud et al. 2022 (100)	Systematic review and meta-analysis	80	The SBC intervention showed significant effects for exclusive breastfeeding (OR = 1.73, 95% CI: 1.35 to 2.11, $p < 0.001$) and child height-for-age Z scores (SMD = 0.19, 95% CI: 0.17 to 0.21, $p < 0.001$), weight-for-height Z scores (SMD = 0.02, 95% CI: 0.004 to 0.04, $p < 0.001$), and weight-for-age Z scores (SMD = 0.04, 95% CI: 0.02 to 0.06, $p < 0.001$).
	Graziose et al. 2018 (66)	Systematic review	18	In 15 studies, improvements in breastfeeding and/or complementary feeding were seen from mass media and education interventions.
	Goudet et al. 2019 (64)	Systematic review and meta-analysis	15	Education interventions (2 studies) among pregnant women versus standard of care or no intervention had a positive impact on low birthweight (MD = 478.44 g, 95% CI: 423.55 to 533.32).
Sustainability	Ezekekwu et al. 2022 (40)	Systematic review	22	Programs with multiple interventions to address food insecurity, compared with one intervention, reported a 50% decrease in very low food insecurity and a 40% increase in nutritious food intake.
	Edmond et al. 2017 (38)	Review of evidence	60	There is a lack of evidence surrounding the impact of food security and nutrition on biodiversity and health outcomes in population, health, and environment programming.
	Yavinski et al. 2015 (152)	Review of evidence	43	Population, health, and environment projects implementing nutrition or food security components do not use consistent, standardized indicators and measurements, which makes comparison difficult.

Abbreviations: ASFs, animal source foods; CI, confidence interval; FBDGs, food-based dietary guidelines; HICs, high-income countries; LMICs, low- and middle-income countries; MD, mean difference; OR, odds ratio; RCTs, randomized controlled trials; RR, relative risk; SBC, social behavioral change; SMD, standardized mean difference.

MHICs: middle- and high-income countries

LICs: low-income countries

SSA: sub-Saharan Africa

national budgets to agriculture, this milestone has not been realized by most countries (122). The Food and Agriculture Organization (FAO)'s analysis found that there have been larger investments in social protection, such as cash transfer and school feeding programs, compared with agriculture inputs, extension services, or research and development. However, spending has increased for infrastructure, irrigation, and climate adaptation and mitigation in agriculture. Historically, buffer stocks (e.g., grain reserves) have been used in SSA with limitations in terms of high storage costs, spoilage, and use for political manipulation.

Staple foods such as maize, wheat, rice, roots, and tubers are protected globally through national policies, with adverse consequences for the availability of higher-quality foods (108, 124). Similarly, research and development concentrate on staple foods, with negative implications for human nutrition and the environment (e.g., monoculture) (33, 108, 124). A joint United Nations agency analysis by the FAO, the United Nations Development Program (UNDP), and the United Nations Environment Program (UNEP) concluded that support to agricultural producers (fiscal subsidies and price incentives targeting specific commodities) is distorted and imbalanced (53). Evidence suggests benefits to food security and nutrition by redirecting agricultural policy (trade barriers, subsidies, and price supports) to the sustainable production of fruits, vegetables, and animal source foods (ASFs) in LMICs (108). The use of nontimber forest products including fruit trees and wild foods offers similar advantages for diet diversity and quality but lacks policy support and has risks associated with unsustainable commercialization.

FAO: Food and Agriculture Organization

ASFs: animal source foods

Other food production sectors. Other sectors and scales of production show potential for influencing food availability, but evidence remains limited. The fisheries and aquaculture sector has grown substantially since 1960, coinciding with large increases in human consumption of aquatic foods (47). Fisheries resources, however, are declining due to poor management and a lack of regulatory policies against pollution and overfishing. There is also consensus around the lack of public sector support for small-scale fishers and livestock production systems and inputs directed to women involved in the sector (116, 132). Women are often underappreciated for their dominant role in postharvest aquaculture activities, such as processing and selling, despite comprising as much as 60% of seafood marketing in western Africa and Asia (43). Pastoralism, still practiced on 25% of Earth's land area and supporting the livelihoods of 200 million households globally, has also been largely neglected by policy support with increasing hardships from climate change and losses in herding land (42, 145).

Digital platforms. Digital platforms and more specifically the use of mobile phones have great potential to expand timely access to agricultural and market information, enabling efficiencies in producing food and bringing food to markets, particularly among small landholders (118). Using emerging technologies developed for mobile phones, long-standing asymmetries in information regarding prices of seeds, fertilizers, market prices, and access to credit can be greatly diminished or even eliminated (79). A study across nine emerging economies found the median percent of adults owning a phone was 45%, indicating that timely access to information through mobile technology has the potential to increase productivity and, thus, food availability (134). Evidence, however, remains limited for impacts on food security.

Food Affordability: Food Prices and the Ability of Households to Purchase Foods

Food affordability has long been recognized as a crucial driver of food insecurity. One comprehensive analysis showed that policies supporting consumer affordability—border measures influencing trade such as tariff reductions, market price controls, and fiscal subsidies that target healthy foods—would result in greater food security and overall better nutrition outcomes compared with other policy types (50). Policies such as price controls, however, can have unintended consequences. Although they improve the affordability of food in the short term by making it less expensive to purchase, such policies can work to lower production in the long term. Farmers may be less likely to increase production or may reduce production if their expenses cannot be met or if they cannot expect to receive a reasonable return on their investment and labor.

Fiscal measures. Evidence on fiscal measures, or the use of government spending and taxation to affect the economy, comes primarily from MHICs and focuses on incentivizing the consumption

of healthy foods. An ex-post evaluation of the effectiveness of policies after implementation using counterfactual analyses found suggestive-to-strong levels of evidence indicating that changing prices is highly effective for influencing consumption (103). In terms of trade policies, one analysis of trade reforms carried out by the World Bank examined the indirect effects of changes in household income on food security. Investigators found that elimination of agriculture tariffs increased income by 2.5 percentage points, while import tariffs showed gains for within-country trade of 1.0 percentage point (4). The impacts of fiscal policies on food security for highly vulnerable groups such as women and children with regard to the consumption of fruits and vegetables and the sustainability of strategies are less well studied (3, 8, 17, 143).

Social protection policies and programs. Evidence collectively supports the use of social protection—policies and programs designed to reduce poverty, vulnerability, and exclusion—for mitigating food insecurity globally (73, 119, 128). Cash transfer programs are one form of social protection in which money is provided to households with (conditional) or without (unconditional) stipulations (e.g., attending well-baby clinic visits for vaccinations and growth monitoring). The last two decades has seen a proliferation of cash transfer programs with fairly consistent findings for positive effects on improving food quality and reducing food insecurity, though the results for health outcomes and social determinants of health are mixed (9, 35, 56, 62, 82, 101, 102, 121). Cash transfer programs can strengthen local markets but do not necessarily account for inflation and the seasonality of prices.

Region- and country-specific evidence also undergirds support for the effectiveness of cash transfers for food security. In SSA, a cross-country analysis showed that when funds from cash transfer programs are consistent and generous, food insecurity is reduced (144). Several countries in Latin America have incorporated large-scale conditional cash transfer programs to motivate uptake of health (e.g., immunizations) or education (e.g., school attendance) services. For example, Brazil's Bolsa Família Program is one of the largest and most widely studied conditional cash transfer programs in the world. Following implementation of the program, the incidence of under-five mortality due to malnutrition—defined in this study as undernutrition—decreased by 58.2% (127).

Food aid. Globally, supplemental food aid programs, referring to in-kind food commodities delivered to populations at risk of food insecurity, are commonly used to address access constraints to improve food security. While single-nutrient or multinutrient supplementation (28), micronutrient powders, food fortification, and biofortification programs (29) are among the "nutrition-specific interventions" used to address primarily deficiencies in essential vitamins and minerals (micronutrient deficiencies), here we focus on food-based strategies as a holistic approach to addressing food insecurity (18). Food aid programs provide varying types and quality of foods (e.g., single foods or food baskets) through different platforms (e.g., community programs, school feeding, and home-based delivery). Evidence shows that the effectiveness of supplemental food programs varies by age of target population, level of food insecurity, and context (110).

At the national level, there has been a shift in national and global food aid programming to secure food locally, for example in the World Food Programme's Food for Progress projects. Uncertainties about the overall availability of local foods, however, have been identified as a key challenge in food aid programming.

Community-level supplemental feeding programs might include clinic-based distribution, day care, or food banks (11, 34, 87, 148). Small-quantity lipid-based supplements are a fortified peanut butter paste that was originally developed to treat severe acute malnutrition primarily in clinical settings, and these supplements have been reformulated to prevent malnutrition during the first 1,000 days of life (34).

School feeding programs are pervasive globally and represent one of the largest public investments in nutrition and food security among children (26, 39, 88, 149, 151). Empirical evidence of impacts on child health in LICs is limited, due in part to the heterogeneity in study design. Local food procurement for school feeding may indirectly impact the food security of communities but has been minimally studied. Institutional demand and food purchases may be another mechanism for influencing food security, particularly for smallholder producers, but limited evidence is not yet available in support of this approach (114).

FBDGs: food-based dietary guidelines

Diet Quality: Nutritional Value of Foods and Quality of Diets Through the Life Course

Diet quality refers to the overall nutritional value, safety, and freshness of food items in a diet. Here we cover the evidence for food-based dietary guidelines (FBDGs), applied largely at national levels to guide food policies and improve the quality of diets, and the importance of diet quality in different phases of the life course.

Food-based dietary guidelines. Four elements are usually reflected in FBDGs: health considerations, nutrient intakes, energy intakes, and dietary behaviors (13, 71). Others may be absent though considered important in the development of future FBDGs: sustainability (environmental and social aspects), foodborne contaminants, relevance to specific population groups, and individualization (48, 94). Dietary guidelines should follow systematic and transparent methods and be informed by the best available evidence, while considering important contextual factors and managing conflicts of interest such as the influence of the food industry (19). FBDGs have been found to misalign with food supply. One descriptive time-series analysis from 1961 to 2013 found misalignment across national and international FBDGs with locally available food supply, persisting across five decades in some cases and likely affecting population adherence to recommendations (25).

Dietary quality over the life course. High-quality foods to support physiological processes, such as child growth or pregnancy and lactation, are particularly important during certain periods in the life course. As one example, the complementary feeding period (6–23 months of age), referred to as the period when breast milk or another milk source are no longer adequate to meet nutritional requirements, is considered a highly vulnerable time for malnutrition and food insecurity especially in low-resource settings (98). In the evidence base, interventions during this phase have been studied to consider the independent and combined effects of nutrition education or counseling and food supplementation (15, 16, 22, 27, 120).

Complementary foods should be nutrient dense and diverse, including ASFs, fruits and vegetables, nuts, pulses, and legumes, and, to a lesser degree, cereals and tubers. ASFs, containing highly bioavailable nutrients, have been studied to a greater extent than fruits and vegetables and other high-quality foods. Two reviews concluded high degrees of heterogeneity across study designs in this evidence base and mixed findings in terms of child anthropometry (37, 131). In view of positive findings in certain contexts for eggs (77), meat (115), fish (23), and milk (32), this area needs further study. Insects are also considered to fall into this category but have been studied to a lesser extent. Dietary diversity more broadly is critical as a dietary pattern for all population groups to ensure food security, but consideration of this factor is limited in the literature (59).

Food Promotion: Messaging and Education for Improved Food Choices and Behaviors

A complex array of factors intertwined with cultural and religious practices influence food choices and behaviors, complicating efforts to scale healthy dietary patterns. We overview two approaches

applied to change health behaviors: first, public information campaigns and marketing, generally targeting populations; and, second, social behavior change communication, at the individual level.

SBC: social and behavior change

Ecosystem services: the benefits provided to humans by the natural environment, such as food, water, pollination, soil formation, and disease regulation, among many other functions

Public information campaigns and marketing. Most public campaigns have been designed with the assumption that the provision of generic information will lead to long-lasting behavior change. Evidence from LMICs on the impacts of public information campaigns is limited, though studies suggest that improving the overall food environment, including the affordability of foods, can be more impactful (65, 90, 107, 111). Campaigns may be ineffective if households are unable to afford healthy diets and may even instill guilt in caregivers who desire to protect family nutrition. In addition, significant private-sector funding is directed to advertising and promoting highly processed foods and sugar-sweetened beverages, more recently through the use of social media (105, 130). While it is beyond the scope of this review, commercial marketing is considered part of the food environment element. The World Health Organization (WHO) guidelines for countries to make mandatory policies to restrict food marketing address the need to mitigate the harms commonly associated with commercial marketing to children in particular (150).

Social behavioral change communication. Social behavioral change (SBC) is an integrated approach used to improve nutrition and health outcomes through communication strategies that seek to promote positive behaviors. Before developing the SBC strategy further, formative research would help investigators understand barriers to and opportunities for improvement. Such research also seeks to understand the channels through which people receive nutrition and health information. SBC can take different forms, such as individual counseling, group counseling, and mass media (television, print, voice, text messages), and may be implemented as a standalone intervention or as a component of an integrated program that includes other interventions, such as food supplements or cash transfers. Several systematic reviews have examined the effects of SBC and mass media interventions on infant and young child feeding practices, child growth, and nutritional status and have indicated positive outcomes (64, 66, 100, 111).

Sustainability: Environmental, Economic, and Social Sustainability of Long-Term Food Security

Although sustainability has not historically been part of food security definitions and frameworks, we include it as fundamental to ensuring the future of healthy food environments and climate change mitigation (36, 44, 45). The global food landscape currently relies on 12 crops and 5 animal species to provide 75% of the world's food supply, contributing to losses in biodiversity and unsustainable unhealthy diets (75). Diets in LICs contain fewer calories from ASFs than do those in HICs, but estimated emissions are higher due to less efficient production systems (125, 137). Small-scale food producers (small farmers) and their families depend on local ecosystem services (benefits from nature such as water, fertile soil, or pollination) for livelihoods and are among the most vulnerable to food insecurity.

Indigenous territories cover only 28% of the world's land surface but harbor 80% of the planet's biodiversity (58, 136). Failure to consider Indigenous Peoples' food systems among others in policy not only often results in the reduction of biodiversity and access to natural resources but also affects Indigenous Peoples livelihoods, culture, and well-being (76).

Agroecology and biodiversity. Evidence shows how other food production systems beyond traditional agriculture (e.g., staple plant cultivation)—agroforestry, aquaculture and fisheries, and livestock production—can be leveraged to ensure food security through sustainable practices.

Trees and forests provide nutrient-rich foods, incomes for food security, and ecosystem services, while protecting biodiversity and carbon sequestration, which is the process of capturing and storing atmospheric carbon dioxide (78). Sustainable fisheries and aquaculture contribute significantly to food security and economic development (14) and can have a lower environmental footprint than other ASFs (74). Small fish (grown to maturity, not including juvenile fish), in particular, offer potential as a sustainable contribution to healthy diets (83). Finally, livestock production has been implicated for its contribution to the emission of greenhouse gases (GHGs) such as methane and unsustainable land use and water retrievals, but there is also evidence for sustainable production systems and increased efficiencies to achieve food security (12).

GHG: greenhouse gas

Agricultural biodiversity initiatives have a small but consistent association with more diverse household- and individual-level diets (81, 133). Greater on-farm crop species richness has been associated with small, positive increments in young child linear stature (81). The small effect size, however, suggests the need for farms to produce multiple additional crops or livestock species to increase dietary diversity by just a single food group. This kind of strategy may have limitations in terms of protecting smallholder diets and nutrition (133). Protecting genetic biodiversity more broadly across plant, livestock, and aquatic species can increase food systems' resilience to temperature and precipitation change, weather shocks, and pests and disease while also increasing accessibility to a diversity of foods for healthy diets, although impacts may be context specific (31, 85). Soils play a crucial role in storing or releasing carbon, depending on land use or cropping practices (46). Agriculture and land-use intensification reduces biodiversity above and below ground, leading to the decreased resilience of food webs (7, 52, 63).

Food policies. A policy analysis by FAO found that 16 out of the 140 national documents related to food policy consider climate, biodiversity, and nutrition, although none of these were designed to affect these challenges jointly (45). Thus, despite the recognized potential for implementing projects with environmental, socioeconomic, and health cobenefits, the operational evidence is very limited (6, 40).

Agriculture subsidies to protect the environment and mitigate climate change can have both positive and negative implications for food security. Significant improvements in efficiency in terms of higher yields and lower emission intensities (92) while equally considering the micronutrient enrichment of staples commonly consumed by the poorest rural households are key to achieving the goals of both sustainability and food security to enhance nutrition cobenefits (69). Agriculture subsidies directed to healthy foods with beneficial health and environmental characteristics (e.g., fruits and vegetables) combined with more equal distribution globally could lead to reductions in GHG emissions and improvements in nutrition without reductions in economic welfare (138).

Food loss and waste. Reducing food loss and waste by both producers and consumers is another critical practice within agrifood systems under the sustainability element. Approximately 30% of all food worldwide is wasted and contributes an estimated 8–9% of GHG emissions (80, 104). Creative solutions to reduce postharvest losses and methane emissions from organic landfill wastes will increase food availability (44).

Integrated Approaches

Evidence for policies and practices was summarized in this review under distinct food environment elements; however, many policies and practices targeted more than one element, leveraging the opportunity for synergies (e.g., nutrition education with food aid or conditional cash transfers with vaccines and well-baby care). Integrated approaches offer a unique opportunity to address several

dimensions of food security (24). System-wide impacts require integrated approaches that consider the entire food system as well as other systems such as health, water, hygiene, and sanitation (WASH) and social protection.

MELA: monitoring, evaluation, learning, and adaptation

Integrated approaches have been conceptualized in different ways; the term integrated has been used inconsistently in the literature. The phrase integrated strategies often refers to those that have combined multiple interventions or sectors (97). Many development agencies recognize the opportunity for synergies by including family planning, environmental conservation, and WASH in food security programming. A well-documented example of an integrated intervention was the Malawi Early Childhood Development Program case study, which combined nutrition behavior change communication activities with food production diversification to increase community capacity to provide nutritious foods in community-based childcare centers all year round and to improve feeding practices. The program was evaluated for cost-effectiveness (60, 61). While substantial anecdotal, expert-opinion, and single-experiment evidence has supported multisectoral integration, meta-analyses and methodologies are limited (38, 70, 152).

The concept of integrated approaches also refers to integration across different scales of food security programming: local, national, and global (50). Although global efforts have aimed to scale successful models and food security policies and practices, evidence for effective processes and approaches still remains limited. Dissemination and implementation science could be more widely applied to contribute to this evidence base (20, 141). Finally, tools and methodologies for monitoring, evaluation, learning, and adaptation (MELA) can also reflect and capture impacts of integrated approaches. Several examples linking biodiversity, climate, and nutrition such as the Tool for Agroecology Performance Evaluation and the Sustainable Assessment of Food and Agriculture Systems Tool 3.0 are important for blending food security elements (45).

SUMMARY AND CONCLUSIONS

After nearly two decades of progress, the world has experienced substantial increases in the prevalence of food insecurity since 2019, owing to the hardships of the COVID-19 pandemic, among other drivers. This review summarizes the evidence for policies and practices that address five elements of the food environment, a domain where humans interact with food systems and where there may be the greatest potential for impacts on food security. Our findings revealed a concentration of research in the traditional pillars of food security that have shaped the policy discourse for the past 50 years: availability, access/affordability, and utilization/quality. For the newer elements of the food environment framework, promotion and sustainability, evidence while minimal is growing. We found that the literature reflects the global community's emphasis on the importance of nutrition in the first 1,000 days of life and, to a lesser extent, school-age children and adolescents. More information is needed on youth, men, and older adults. As is often the case in public health, context matters for the effectiveness of policies and practices to achieve food security. In our view, this notion points to the vital importance of formative and implementation research, as well as adaptation and flexibility in intervention and trial design.

In summary, with regard to food availability, we found that agriculture policies generally support food producers in LMICs, while social protection and consumer price supports have been applied more often in LICs. Investments in staple foods, including maize, wheat, rice, and roots and tubers, have been made preferentially over investments in fruits and vegetables and other types of healthy foods, with implications for both human nutrition and the environment. More research is needed to understand and enhance the contribution of other food production sectors (agroforestry, fisheries/aquaculture, horticulture) and the contributions of smallholders and women. Successful approaches need to be identified for safeguarding high-quality, perishable foods,

including ASFs and fruits and vegetables across the value chain. Digital platforms are available for the diffusion of information on agriculture and market information, though we know little about the impacts on food security and nutrition.

Substantial evidence exists for practices and policy measures that influence food affordability. Social protection policies are effective for mitigating food insecurity but do not always account for inflation and price seasonality. More studies are needed on impacts on micronutrient adequacy and health outcomes for other population groups, such as youth and older adults. There is a robust literature on the effectiveness of food aid that targets pregnant women and young children. Impacts on child growth are greater when food aid is directed to younger children in less well-nourished populations. Furthermore, school feeding programs in both HIC and LMIC contexts show multiple benefits related to food security. Gaps remain in the literature on cost-effectiveness and the feasibility of sourcing local foods and perishable foods.

FBDGs can guide food policies to improve the quality of diets, though there has been misalignment between the best evidence for nutritious foods and food supply. Research is needed to understand and improve the processes for developing FBDGs, for translating guidelines into policy, and for incorporating considerations of environmental sustainability, foodborne contaminants, and target group segmentation. ASFs have effectively addressed food insecurity during vulnerable periods of the life course with the influence of context to varying degrees. A broader range of ASFs should be investigated as well as other high-quality foods, including fruits and vegetables, neglected and underutilized crops, wild foods, and those belonging to the Indigenous Peoples' food systems.

Behavior change endeavors to achieve food security are challenging, given the broad array of factors that influence food choices and dietary patterns. SBC strategies and mass media impact child feeding practices and nutrition outcomes when there is careful consideration of external factors that impact consumers' behaviors, including availability, accessibility, and affordability. Commercial food marketing, while not covered in this review, can have a powerful effect on food choice and dietary intakes. Mandatory policies that restrict food marketing to children in particular are recommended to reduce exposure.

We found limited but increasing evidence for the sustainability element. Efforts to increase agricultural biodiversity and mitigate climate change show mixed findings on food security outcomes. Synergies could be realized through improved yield efficiencies and lower emission intensities. Nutrients per hectare yield and nutrition-sensitive water management in agriculture are areas for further exploration. Climate-smart agriculture approaches, including the recognition of the importance of healthy soils and other types of agroecological food production in the domains of agroforestry, aquaculture and fisheries, and small livestock production, also require more inquiry. Paradigms (e.g., One Health, planetary health), tools, and methodologies (e.g., life cycle assessment, species abundance indicators) that combine food security and dietary indicators with environmental sustainability need wider application.

Packages and MELA tools that integrate the various food environment elements can accelerate progress toward addressing food insecurity. Integrated approaches have also been used to scale effective solutions from local to global (e.g., Scaling Up Nutrition Movement); cost-effectiveness data would enhance our understanding of these strategies. Finally, we recommend combining dissemination and implementation science with MELA tools to augment our understanding of the food security impacts emerging from integration and scaling.

World food insecurity is trending in the wrong direction for the first time in almost two decades, with widening disparities in agrifood systems. We must draw on evidence for various policies and programs to act immediately, while continuing to generate novel food environment solutions and provide the operational evidence necessary for wide-scale application.

SUMMARY POINTS

1. Global food insecurity shows worsening trends after nearly two decades of progress in the wake of the COVID-19 pandemic and has been exacerbated by humanitarian crises and climate change.
2. In the agrifood systems framework, evidence-based policies and practices across food environment elements—availability, affordability, quality, promotion, and sustainability—provide the opportunity for action to alleviate food insecurity.
3. Agriculture policies tend to safeguard food producers in MHICs and concentrate on staple foods, while social protection of consumers is more often used in LICs, with underrepresentation of smallholder producers and women globally.
4. Evidence supports the use of cash transfers and food aid programming for achieving food security, though impacts on micronutrient adequacy and nutrition outcomes for some vulnerable groups (e.g., youth, older adults) remain largely unknown.
5. FDBGs, the primary tool designed to influence nutritional quality and diversity of diets, may be misaligned with food supplies and the best evidence for healthy diets; more evidence is needed on the processes of FBDG development and translation into food policy.
6. There is a growing evidence base for food promotion (social behavior change) and sustainability (agroecological food production and biodiversity) elements as critical to achieving long-term impacts and multiple benefits.
7. Multisectoral approaches and the integration of evidence-based interventions across various food environment elements are needed, while application of implementation science could better inform the scaling of successful models for global food security impacts.

DISCLOSURE STATEMENT

The authors are not aware of any affiliations, memberships, funding, or financial holdings that might be perceived as affecting the objectivity of this review.

ACKNOWLEDGMENTS

The authors are grateful for the helpful comments on the manuscript outline by Dr. Ross Brownson, and for assistance from Veronica Vargas and Arianna Boshara in developing the figures.

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