frontiers | Frontiers in Sustainable Food Systems

TYPE Systematic Review
PUBLISHED 16 May 2025
DOI 10.3389/fsufs.2025.1567245

Check for updates

OPEN ACCESS

EDITED BY
Reza Rastmanesh,
American Physical Society, United States

REVIEWED BY
Aida Turrini,
Independent Researcher, Rome, Italy
Amy Lykins,
University of New England, Australia

*CORRESPONDENCE
Edith Monica Esievo
esievoedith@gmail.com

RECEIVED 26 January 2025
ACCEPTED 30 April 2025
PUBLISHED 16 May 2025

CITATION
Esievo EM, Whatford L, Espinosa SN, Awulu OA, Ahmed AN, Murray KA and Ali Z (2025) One Health conceptualization of sustainable diets looking at low- and middle-income settings: a systematic literature review.
Front. Sustain. Food Syst. 9:1567245.
doi: 10.3389/fsufs.2025.1567245

One Health conceptualization of sustainable diets looking at low- and middle-income settings: a systematic literature review

Edith Monica Esievo[1,2,3,4]*, Louise Whatford[1], Sarah Nájera Espinosa[2], Oche Abraham Awulu[1,2], Aliyu Nuhu Ahmed[3], Kris A. Murray[3] and Zakari Ali[3]

[1]Pathobiology and Population Sciences, Royal Veterinary College, University of London, London, United Kingdom, [2]London School of Hygiene and Tropical Medicine, University of London, London, United Kingdom, [3]Centre on Climate Change and Planetary Health, Medical Research Council Unit The Gambia at London School of Hygiene and Tropical Medicine, Banjul, Gambia, [4]College of Veterinary Medicine, Federal University of Agriculture, Zuru, Nigeria

Unhealthy diets are proven risks for non-communicable diseases and mortality globally. Low- and Middle-Income Countries (LMICs) are equally faced with food/nutrition insecurity, poor health outcomes, and the need for sustainable food systems transformation to cater for the growing population within safe planetary boundaries. Despite significant progress globally, persistent challenges necessitate a more holistic and systemic approach to healthy sustainable diets, particularly in LMICs which are often underrepresented in global studies. This review conceptualizes sustainable diets looking at LMICs by assessing sustainability through the One Health approach which considers the interdependencies among humans, animals, plants, and the environment. Using the preferred reporting items of systematic reviews and meta-analyses (PRISMA) guidelines and the checklist for One Health epidemiological reporting of evidence (COHERE) standards, four databases were searched (Embase, Global Health, Web of Science, and Scopus) between 1947 and June 2023. Dietary sustainability was assessed in LMICs by evaluating coverage across the four One Health pillars (human, animal, plant, and environmental health) and five dietary sustainability dimensions (diet/nutrition, health, environment, economic, and social). Extracted data were analyzed qualitatively. The database searches yielded 3,122 studies. After removing duplicates and screening for eligibility, 35 studies were selected for inclusion. Most studies were from upper (77%) and lower (20%) middle-income countries. While 20 studies (57%) assessed human and environmental health, none assessed plant or animal health, nor all four One Health pillars combined. No study assessed all five dietary sustainability dimensions. Most studies assessed two (54%) or three (34%) dimensions, and the most frequently assessed dimension was the environment (71%). Thus, highlighting the non-comprehensive nature and the dearth of research on sustainable diets conducted in LMICs, particularly, low-income countries, and that the research so far mainly focuses on environmental impacts. Overall, studies found that LMICs' diets, particularly middle-income countries, are unsustainable due to low quality, low diversity, and high environmental effects, with associated inequities. The underrepresentation of LMICs, particularly low-income countries, in this review is a wake-up call urging the generation of more country-specific data incorporating more dietary sustainability dimensions and One Health pillars (especially plant and animal health) for progress and monitoring toward attaining global dietary sustainability.

KEYWORDS

One Health, sustainable diets, low- and middle-income countries, food system, dietary, sustainability

1 Introduction

Food systems are failing to deliver on health globally (Willett et al., 2019) with unhealthy diets as a proven risk factor for non-communicable diseases and mortality (Afshin et al., 2019). In addition, poorly managed food systems are responsible for increased food wastes/losses, environmental degradation, and freshwater pollution (FAO, 2013; Kennedy et al., 2020; Crippa et al., 2021). The globally diverse dietary patterns of previous centuries have in recent decades converged into a more unified dietary pattern directly impacting humans' diet and health outcomes (Popkin et al., 2012; Auestad and Fulgoni, 2015). Productivist paradigms (which prioritizes productivity and continuous economic growth as central to societal progress) and unified dietary patterns (driven by monoculture farming) undermine agrobiodiversity and result in reduced plant and animal genetic diversities, disease-resistance, and climate-resilience (Gaitán-Cremaschi et al., 2019; Dave et al., 2023). Low- and middle-income countries (LMICs) are affected by these dietary transitions, as well as infectious diseases, non-communicable diseases, and diet-related mortality (Murray et al., 2020). LMICs are particularly challenged as some traditionally nutrient-dense foods are increasingly being underutilized and/or poorly processed thereby contributing to nutrient inadequacy and low dietary diversity. LMICs are also faced with food-borne illnesses, food allergies, and food-related health issues (Onimawo, 2010; Grace, 2023). In addition, unchecked farming practices, extreme weather events, and the resulting outcomes contribute to food/nutrition insecurity and the loss of associated biodiversity and ecosystem services with great impact on lives and livelihoods (FAO, 2019). As well as the potential for low resource, informal food processing, marketing and preparation methods to increase public health burden of vulnerable population (Waage et al., 2022). These challenges are compounded by rising temperatures, shifting precipitation patterns, and vector population that significantly affect crop yield and nutritional quality of foods (Smith and Gregory, 2013), resulting in health and socioeconomic challenges, particularly in vulnerable groups and those suffering from multiple forms of malnutrition in LMICs (Macdiarmid and Whybrow, 2019). Given these persistent challenges in LMICs, food system sustainability is essential if delivering healthy sustainable diets without jeopardizing the ecosystem is the goal. To provide these diets for a growing population while staying within safe planetary boundaries, food systems transformation is crucial to ensure sustainable production and consumption of food in a manner protective of humans, animals, plants, and the environment (FAO, 2010).

Sustainability, a concept that is central to this paper, is said to traditionally cover three pillars—environment, social, and economic - with varying schools of thought and definitions (Purvis et al., 2019). Sustainability is defined here as the ability of systems and processes to continuously achieve their aims (in this case, the provision of healthy human diets) without depleting resources for present and future generations (Moore et al., 2017). In this review, sustainability encompasses five dimensions – diet/nutrition, health, environment, economics, and social. This stemmed from the definition of sustainable diets as "*diets protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable; nutritionally adequate, safe and healthy; while optimizing natural and human resources*" (FAO, 2010). The food system on the other hand comprises several inputs, actors, activities, and factors interacting within and influencing the ecological and sociocultural environment of food demand and supply, from the point of production, to consumption, and the disposal of food wastes (Gaitán-Cremaschi et al., 2019; HLPE, 2014). This coordinated system aims to ensure that food is optimally utilized for health and wellbeing, while achieving sustainable production and consumption (Ingram et al., 2013).

One Health is the approach which recognizes the vital interdependencies and the optimized benefits of intersectoral and interdisciplinary collaboration in addressing challenges which appear to be sector- and/or discipline-specific (WHO, 2023). Within the food system, challenges range from food safety, zoonosis, vector-borne diseases, non-communicable diseases, antimicrobial resistance, to environmental degradation and biodiversity loss (Waage et al., 2022; WHO, 2023). This One Health approach to sustainable diet assessment demands more attention considering that the food system consists of complex linkages, feedback loops, interconnections, and interactions existing among and between humans, animals, plants, and the environment, in the movement of food from farm to fork and disposal (Fanzo, 2019). It understands the crucial role food plays in individuals' wellbeing, including identity, cultures, traditions, and beliefs (Reddy and Van Dam, 2020). The One Health approach to sustainable diet also considers the contribution land use changes such as, agricultural intensification, forest encroachment, industrialization, and expanding transportation and trade routes add to disturb ecological balance, increase the risk of (re)emerging infections (Waage et al., 2022; WHO, 2023), and strain countries' health systems and economies, particularly food-related illness (World Bank, 2018). This approach therefore seeks to promote a more holistic and systemic thinking, proffer solutions efficiently, cost-effectively, and aims to reduce unintended consequences arising from the food system (Godfray et al., 2010; Macdiarmid, 2013). By prioritizing this joint health of humans, animals, plants, and the environment, through multi- and interdisciplinary coordination, communication, and collaboration (Clonan and Holdsworth, 2012; Baum et al., 2017), health and sociocultural trade-offs between these elements within the food system are more likely to be kept at a minimum (Lang, 2010; Masset et al., 2015).

In recent years, some progress has been made toward achieving sustainable food systems (Lindgren et al., 2018), such as in addressing global hunger and malnutrition to a certain extent (UN, 2021), implementing sustainable food-based dietary guidelines in certain countries (WHO, 2019), and recommending the planetary health reference diet (Willett et al., 2019). However, variations of dietary needs still exist within individuals' age, nutritional status, health, and lifestyle, and the differences in dietary choices by socio-economic status, culture, and geography. Unfortunately, the planetary health plate has been criticized for not considering these aspects (Tulloch et al., 2023; Hirvonen et al., 2020; Beal et al., 2023).

Previous reviews have focused on identifying the metrics and components of dietary sustainability (Jones et al., 2016), the principles and metrics of sustainable healthy diets (Machado et al., 2023), nutritional quality of diets (Dave et al., 2023), and indicators of sustainable diets (Aldaya et al., 2021), but generally with little LMICs focus (Tulloch et al., 2023). It is therefore important to understand the LMIC situation to date by assessing the available evidence on dietary sustainability and equally important to consider this from a One Health perspective. Therefore, this review aims to address this by conducting a systematic literature review and conceptualize dietary sustainability in LMICs using a One Health lens.

2 Methodology

This review was conducted according to the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021). The review also incorporates a One Health analytical lens based on the Checklist for One Health Epidemiological Reporting of Evidence (COHERE) Standards (Davis et al., 2017).

2.1 Search strategy

This review only included peer-reviewed research studies. Four databases (OvidSP Embase, OvidSP Global Health, Web of Science Core Collection, and Scopus) were searched to capture a wide range of publications. Database searches were conducted for the period between 1947 and 24th June 2023. A comprehensive search string (Supplementary material) was developed and optimized including keywords, Medical Subject Headings, and Boolean operators to find studies on "sustainable diets" in LMICs. The search string was adapted to suit the different databases. Librarians experienced in systematic reviews from the Royal Veterinary College and the London School of Hygiene and Tropical Medicine reviewed the search strategy.

2.2 Screening and data extraction

Only published primary research articles were included, excluding reviews, commentaries, and editorials. No language restrictions were applied to the databases searches to ensure that all relevant studies were captured. All search records were exported and managed in a citation manager (EndNote X20) and assessed for relevance and eligibility. After duplicates were removed, titles were screened for relevance against the selection criteria (Table 1) in the first step. Then, abstracts were further screened for relevance. The final step involved assessing the full-texts of included studies. Screening of papers was conducted by EME and ZA. LW settled any disagreements. No quality appraisal was conducted on the studies during this process. Data from included studies were extracted into Microsoft Excel and included:

- Study information (first author, publication year, study country, objective, key findings, and potential limitations).
- Sustainability dimensions assessed under five groups (diet/nutrition, health, environment, economic, and social).
- One Health analysis including human, animal, plant, and environment health considerations were assessed.

The data from the included studies were analyzed qualitatively and critically evaluated. Due to heterogeneity of the included studies, no substantial quantitative analysis or meta-analysis were conducted.

3 Results

3.1 Screening and inclusion of studies

The four database searches yielded 3,122 studies. After excluding duplicates ($n = 631$), 2,491 records were screened for relevance and eligibility by title, abstract, and finally by full-texts. Of the 44 full text articles retrieved and screened, 35 studies were selected for inclusion in the review (Figure 1).

3.2 Study demographics, included pillars and dimensions

Most included studies were from upper-middle income countries ($n = 27$, 77%), followed by lower-middle ($n = 7$, 20%), and least from low-income countries ($n = 1$, 3%) (Supplementary Figure 1). Most studies were from East Asia and Pacific region ($n = 16$, 46%) dominated by studies from China ($n = 11$). Likewise, the Latin America and Caribbean region ($n = 12$, 34%) was represented predominantly by studies from Brazil ($n = 6$). However, regions such as South Asia ($n = 3$, 9%), Middle East and North Africa ($n = 2$, 6%), Sub-Saharan Africa ($n = 2$, 6%), and Europe and Central Asia ($n = 1$, 3%) were underrepresented with fewer studies on dietary sustainability.

TABLE 1 Eligibility criteria.

Inclusion criteria	• Studies assessing sustainable diets in LMICs • Studies that included data from low-income, lower-middle-income and upper-middle-income countries defined by World Bank 2022 ratings (World Bank, 2022) • Studies assessing country diets for sustainability • Studies that included an assessment of at least one dimension of sustainability used in this review (diet/nutrition, health, environment, economic, and social)
Exclusion criteria	• Reviews, editorials, commentaries, and non-peer reviewed studies or documents • Studies on healthy diets that did not assess for sustainability (diet/nutrition, health, environment, economic, and/or social) • Global or regional studies on sustainable diets without LMICs disaggregated data

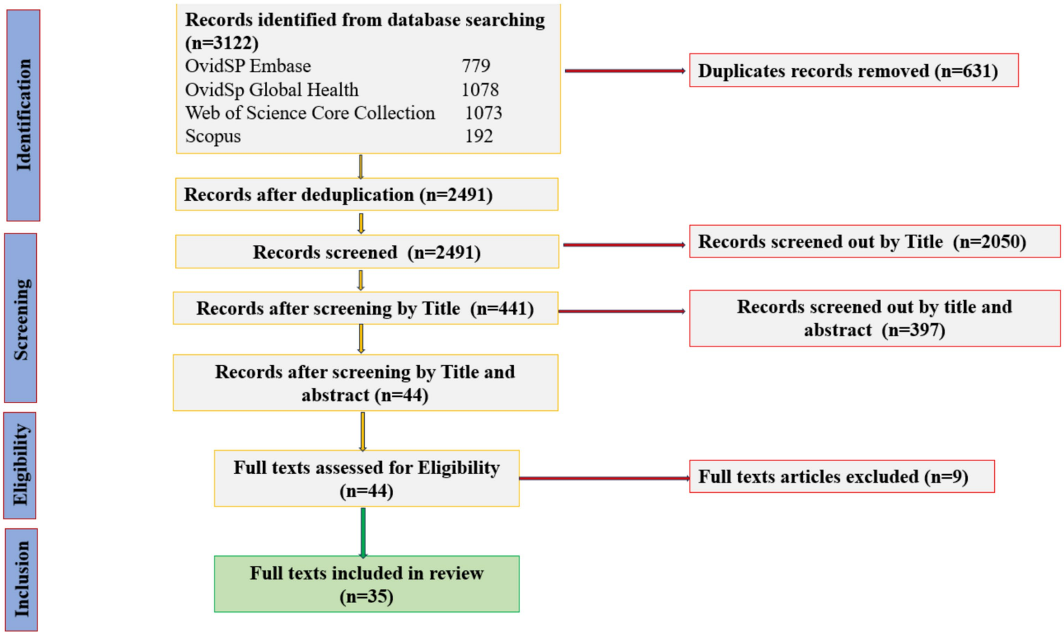

FIGURE 1
PRISMA flow diagram showing identification, screening, eligibility, and inclusion of studies in the systematic review.

On One Health pillars, 20 (57%) studies assessed diets across two pillars (human and environment) and two studies (6%) did not assess any pillar despite being assessed for dietary sustainability (Figure 2). No study assessed all four pillars, and none included animal or plant health considerations on sustainable diets.

Across the five sustainability dimensions, most studies (*n* = 19, 54%) focused on two dimensions, largely by assessing the environment-diet/nutrition (*n* = 14, 40%), followed by health-diet/nutrition (*n* = 3, 9%), and the economic-diet/nutrition dimensions (*n* = 2, 6%). More than a third of the included studies (*n* = 12, 34%) assessed three sustainability dimensions, and no included study assessed all five sustainable diet dimensions. The environment was the most assessed dimension after diet/nutrition. Of all the studies assessing the environmental dimension (*n* = 25, 71%), majority (*n* = 16, 46%) included more than one environmental impact measure, while nine (26%) studies assessed only one measure. About a third of the included studies assessed the economic dimension (*n* = 10, 29%), while a small number of studies assessed the health (*n* = 5, 14%) and social dimension (*n* = 3, 9%).

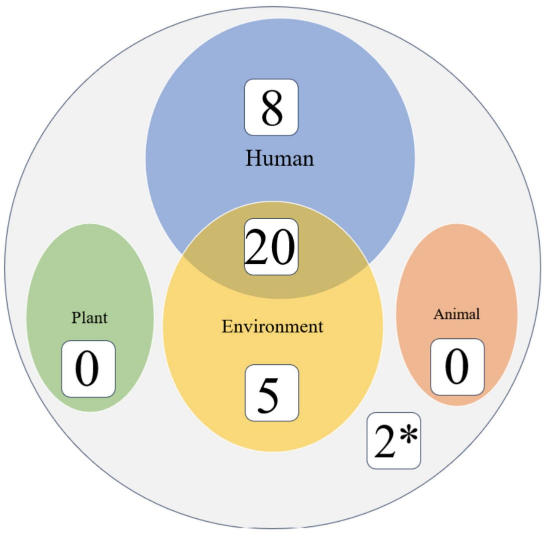

FIGURE 2
Venn diagram showing the components of One Health (humans, animals, plants, and environment health) assessed in the reviewed studies. *Studies assessed at least one sustainability dimension but failed to assess any One Health pillar.

3.3 Sustainability dimensions and impact measures assessed in the reviewed studies

The impact measures under the five dimensions were heterogeneously combined and used to assess the sustainability of diets in LMICs (Figure 3; Supplementary Tables 1, 2). Due to the heterogeneity in study designs and findings, no substantial quantitative analysis or meta-analysis could be done.

3.3.1 Diet/nutrition

The quality of diets was assessed using index scores in 10 studies (29%). These were developed from the EAT-Lancet recommendations (*n* = 5, 14%), national dietary guidelines (*n* = 4, 11%), and global healthy diet recommendations (*n* = 1, 3%). Nutrition specific studies focussed on nutrient adequacy of diets (*n* = 1, 3%), macro- or micronutrient density (*n* = 7, 20%), and micronutrient content of diets (*n* = 2, 6%). Dietary scenarios (*n* = 9, 26%) were utilized to assess the nutritional impacts of potential shifts toward adopting national dietary and EAT-Lancet guidelines (*n* = 3, 9%), changing income and urbanization (*n* = 1, 3%), meeting health/nutritional targets (*n* = 2,

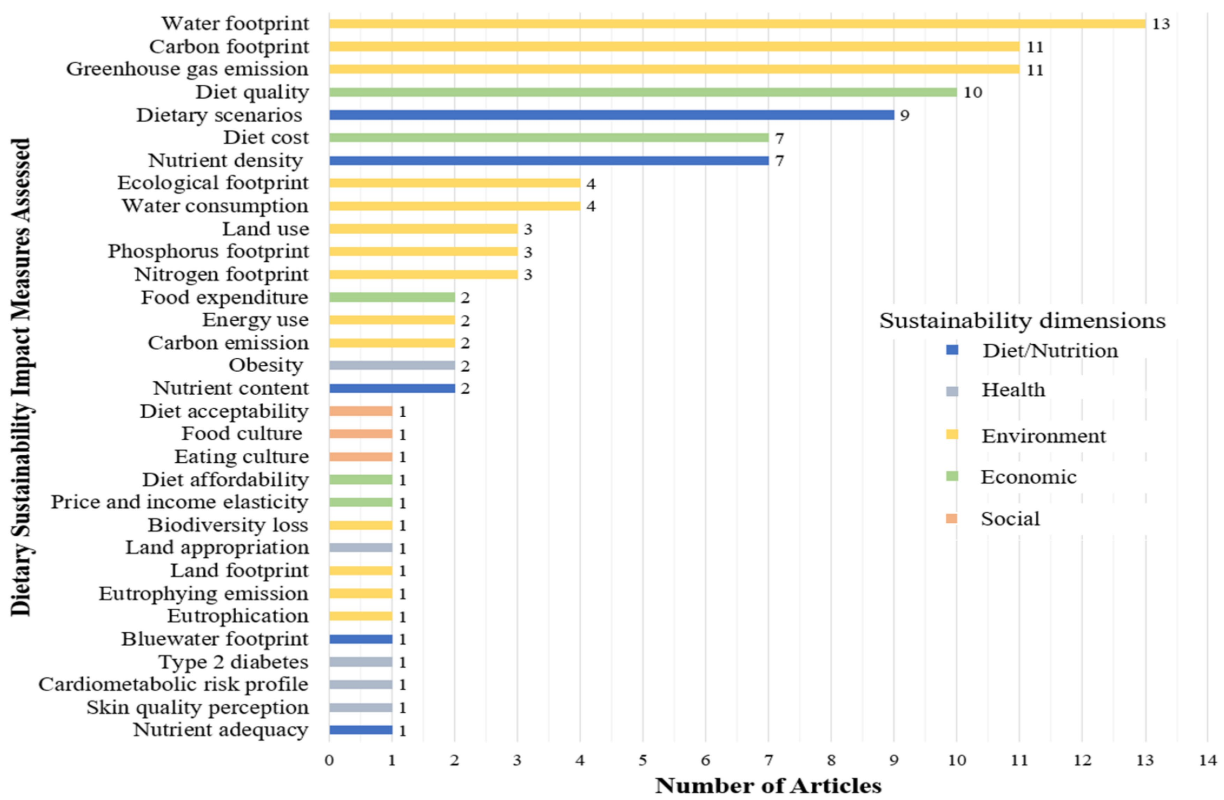

FIGURE 3
The dietary sustainability impact measures identified in the review and the number of articles assessing them.

6%), environmental targets (*n* = 2, 6%), economic and acceptability targets (*n* = 1, 3%).

3.3.2 Human health

Five studies assessed the association between diets and health by assessing dietary impacts on skin quality perception (*n* = 1, 3%), obesity (*n* = 2, 6%), cardiometabolic risk profile (*n* = 1, 3%), and type 2 diabetes incidence (*n* = 1, 3%).

3.3.3 Environment

These impacts were categorized into global warming potential of greenhouse gasses, water use, land use, energy use, resource scarcity, acidification and eutrophication potential (Huijbregts et al., 2017), and expressed using synonyms. They include; greenhouse gas emissions (*n* = 11, 31%), carbon footprint (*n* = 11, 31%), carbon emissions (*n* = 2, 6%); water footprint (*n* = 13, 37%), water consumption (*n* = 4, 11%), blue water footprint (*n* = 1, 3%); ecological footprint (*n* = 4, 11%), land use (*n* = 3, 9%), land appropriation (*n* = 1, 3%), land footprint (*n* = 1, 3%); energy use (*n* = 2, 6%); biodiversity loss (*n* = 1, 3%); nitrogen footprint (*n* = 3, 9%), phosphorus footprint (*n* = 3, 9%); eutrophying emissions (*n* = 1, 3%), and eutrophication (*n* = 1, 3%). They differed slightly due to varying scope and systems boundaries in their Life Cycle Impact Assessments.

3.3.4 Economic

Dietary cost (*n* = 7, 20%), food expenditure (*n* = 2, 6%), price and income elasticity (*n* = 1, 3%), and affordability (*n* = 1, 3%) were used to assess the economic impact of diets.

3.3.5 Social

Three studies assessed eating culture (*n* = 1, 3%), food culture (*n* = 1, 3%), and diet acceptability (*n* = 1, 3%), while others (*n* = 19, 54%) focused on the association of diets among socio-economic and demographic groups, for example, socio-economic status, household status, age, sex, and area of residence.

Of the 35 studies included in this review, only 7 (20%) assessed the deviation/adherence of country's diet to the EAT-Lancet diet (*n* = 4, 11%) and the association with diseases (*n* = 3, 9%).

3.4 Summary of the included studies

There were heterogeneous results from the included studies due to their varying objectives and methodologies (Supplementary Tables 1, 2). From the included studies and the impact measures used, diets in LMICs were reported to be unhealthy and unsustainable. For example, The Gambia's diet was reported to have low dietary diversity with strong deviation from the EAT-Lancet targets, which was significantly associated with socio-economic status (Ali et al., 2022). A population-based study in Brazil showed a low diet quality and poor adherence to the EAT-Lancet diet (Marchioni et al., 2022), similar to the Brazilian nationwide studies (Cacau et al., 2021; Cacau et al., 2022). Argentina's diet was found to have a low healthy eating index with inadequate intake of several nutrients like calcium and vitamin b-12 (Arrieta et al., 2022). Current Turkish diets had the highest greenhouse gas emissions (GHGE) when compared with other modeled diets (Bayram and Ozturkcan, 2022). Mexican diets had a low diet quality (Curi-Quinto et al., 2022), with inadequate consumption of foods considered healthy such as, fruits and vegetables, below the EAT-Lancet recommendations, and overconsumption of foods considered less healthy like, added sugars (Castellanos-Gutiérrez et al., 2021). Similar consumption pattern of fruits and vegetables were observed in Bangladesh (Divya et al., 2022) and in China (He et al., 2019; Wang et al., 2020), which had low diet quality (Hu et al., 2022), and deviated considerably from the recommended diet (Wang et al., 2020). Indonesian's current diet failed to meet nutrient needs and environmental GHGE target (De Pee et al., 2021), while in Iran, only a small percentage (7.5%) of the study population consumed a more sustainable diet (Eini-Zinab et al., 2021). The diet quality of Mexicans was positively associated with bluewater footprint, but inversely associated with carbon footprint and biodiversity loss (Curi-Quinto et al., 2022).

Studies which utilized modeling techniques to assess the populations' potential in achieving sustainability reported plant-based diets as less expensive with lowest overall environmental impact in Argentina (Arrieta et al., 2022) and having the least GHGE in Turkey (Bayram and Ozturkcan, 2022). Adopting Argentina's food-based dietary guidelines was reported to have the highest dietary cost (Arrieta et al., 2022). Although optimized diets were healthier, they were more expensive than Brazilian's (Verly-Jr et al., 2022) and Argentina's (Arrieta et al., 2022) current diets.

Sustainability assessments by food groups showed varying environmental impact and nutrient quality. In Columbia, beef had the highest carbon and water footprint, total fat and cholesterol compared to red bean and lentils (Blanco-Murcia and Ramos-Mejía, 2019). In Vietnam and Kenya, beef contributed the highest GHGE, while cereals and grains dominated water use to the diet (Heller et al., 2020). Indonesian diets showed similar results with animal-based foods having higher GHGE than plant-based foods (excluding rice) (Rahmi et al., 2020). In China, food waste from animal-sourced foods were smaller than from plant-sourced foods (Wang et al., 2020).

Additionally, healthy eating culture was positively associated with better health perception (Amrinanto et al., 2019). By adhering to the EAT-Lancet recommendations, higher Planetary Health Diet Index score was reported to be inversely associated with overweight and obesity (Cacau et al., 2021), and significantly associated with lower blood pressure, total cholesterol, and better cardiovascular health in Brazil (Cacau et al., 2022). In Mexico, adhering to the EAT-Lancet commission recommendations for a Healthy Reference Diet for red meat, legumes, and fish had lower incidence of type 2 diabetes, while adhering to the added sugars and dairy products recommendations were associated with increased risk (López et al., 2023).

This review identified rural Chinese diets to be severely imbalanced deviating strongly from healthy diets and with high environmental impacts (water, carbon, and ecological footprint) (Han et al., 2023). Likewise in Mexico, rural dwellers consumed less fruits (Castellanos-Gutiérrez et al., 2021). Although the diets of socially disadvantaged groups had lower GHGE; characterized by lower beef intake and higher intake of corn products and tortillas, they were not necessarily healthier (López-Olmedo et al., 2022). This contrasted with the high environmental impacts of the urban and rich Chinese diets (He et al., 2019), and the higher income Brazilian groups (Hase Ueta et al., 2023).

The reviewed studies had some limitations ranging from the methodologies used to data limitations and lack of generalizability of results (Supplementary Tables 1, 2).

4 Discussion

The main finding in this review is the identification of the limited number of studies on sustainable diets in LMICs and the dearth of information from low-income countries (Tulloch et al., 2023) addressing this pressing issue in an already nutritionally and environmentally vulnerable setting. Most of the studies were conducted in upper-middle-income countries such as, China, Brazil, and Mexico. This limited research in LMICs is consistent with the generally low representation of LMICs in global research on sustainable diets (Tulloch et al., 2023; Jones et al., 2016; Aldaya et al., 2021).

The differences in the studies' objectives and results re-iterates the significant variations that exist within and across countries, and their potential in setting research boundaries. Although, a detailed understanding of the weight of specific challenges may necessitate setting research boundaries to identify specific priorities, a system thinking approach to inform intervention strategies helps to minimize the unintended consequences felt elsewhere within a complex system like the food system (WHO, 2023; Godfray et al., 2010; Macdiarmid, 2013; Lang, 2010; Masset et al., 2015; Curi-Quinto et al., 2022; Harrison et al., 2022). Most individual studies did not use a holistic approach and hence were more likely to report a reductionist view of dietary impact if taken solely, but when combined, contribute to a contextual understanding of dietary impacts (Aldaya et al., 2021) as is the case of this review.

The review did not identify studies focusing on how diets impact plant and animal health (and vice versa) in LMICs, and hence neglected their functions in ecological balance and the provision of ecosystem services such as, nutrient and water cycling, weeds, pests, and diseases regulation, which are affected by LMICs' agri-food systems (Waage et al., 2022; Jones et al., 2016). Likewise, the interactions and roles animals play in human livelihood, cultures, traditions, agriculture, soil fertility, crop productivity (Adesogan et al., 2020), zoonoses (impacting human and animal health in both directions), antimicrobial resistance, and in animal welfare and ethics (Waage et al., 2022; Muñoz-Ulecia et al., 2022) were unaccounted for in the studies. The One health approach to sustainable diet research aims to ensure the joint health of humans, animals, plants, and the environment as they are inextricably connected (WHO, 2023). Therefore, undermining the health of plants and animals, while prioritizing human and environmental health overlook their importance in food composition and de-emphasize important areas such as, food security, safety, and wholesomeness (Grace, 2023), which are seldomly incorporated in dietary sustainability research in LMICs. The literature on dietary sustainability thus far does not incorporate food safety discussions (Dave et al., 2023; Jones et al., 2016; Machado et al., 2023; Aldaya et al., 2021), which still remains a challenge in low resources settings in most LMICs (Grace, 2023). While the health dimension of sustainable diet is mostly focused on non-communicable disease (Cacau et al., 2021; Cacau et al., 2022; López et al., 2023), infectious and other food-related diseases are continually being neglected, yet they account for increased public health burden on these vulnerable population with higher out-of-pocket healthcare expenditure (Springmann et al., 2021). An implication of overlooking One Health in dietary sustainability research in low resource setting could potentially increase the risk of foodborne illnesses if the encouragement to consume more fresh fruits and vegetables due to their health and nutritional benefits (Willett et al., 2019), are not combined with concurrent health and safety interventions across the One Health pillars (humans, plants, animals, and the environment) (Grace, 2023). Likewise, while siloed public health research are important in identifying high risk areas, policies that safeguard One Health would benefit from reduced externalities and economic cost on already burdened population (WHO, 2023). This calls for much greater attention on the neglected areas of dietary impacts if the food systems were to be truly sustainable to safeguard human, plant, animal, and planetary health.

Some studies likely introduced trade-offs to sustainability discussions and interventions in LMICs as the assessments rarely covered multiple dimensions of sustainable diets (diet/nutrition, health, environment, economic, and social) (Lang, 2010). The studies largely focused on only a few dimensions, with more attention for environmental impacts, particularly GHGE. The increased focus on the environment maybe due to the more apparent implications of food systems and diets on the environment (Willett et al., 2019; Watts et al., 2015; Costello et al., 2009) when compared to other dimensions, especially the social dimension with challenging definitions and measurements resulting in reduced research (Meybeck and Gitz, 2017; Comerford et al., 2020).

The studies reported current diets as unsustainable due to their low diet diversity (Ali et al., 2022), inadequate nutrient consumption (Arrieta et al., 2022), low diet quality, and significant deviation from reference diets (such as the EAT-Lancet diet) (Marchioni et al., 2022; Curi-Quinto et al., 2022), or national dietary guidelines (Wang et al., 2020; Hu et al., 2022), and high environmental impacts (Han et al., 2023). In some instance, adopting the EAT-Lancet diet or dietary guidelines was more expensive despite being healthier (Arrieta et al., 2022; Verly-Jr et al., 2022). Although plant-based diets were reported to have had lower environmental and economic cost (Arrieta et al., 2022; Bayram and Ozturkcan, 2022), they were not assessed for micronutrient adequacy which is particularly important in these populations already suffering from micronutrient deficiencies, and have the potential to suffer adversely from intervention strategies like fortification programs without close monitoring (Baye, 2019).

Addressing sustainable diets in LMICs are likely to widen socioeconomic inequities if not carefully carried out (Hirvonen et al., 2020). The papers included in this review identified that diets of urban residents and individuals from higher income groups had higher environmental impacts compared to the rural residents and those from lower income groups, due to the significant contribution of beef and other animal-sourced foods to their diets (He et al., 2019; Hase Ueta et al., 2023). Yet the low environmental impact diets of the socially disadvantaged group were not healthier (López-Olmedo et al., 2022), but characterized with reduced intake of fruits (Castellanos-Gutiérrez et al., 2021). Additionally, when assessing diet/nutrition, caloric needs were not always considered.

The increased literature on environmental impact of animal-sourced foods and recommendations to reduce meat and dairy intake, as is in the EAT-Lancet recommendations (Willett et al., 2019), likely pre-informed some studies' design on dietary scenarios comparing the nutrient adequacy and efficiency of animal-based to plant-based diets (Arrieta et al., 2022; Bayram and Ozturkcan, 2022). In addition, the EAT-Lancet diet was found to fall short of multiple key micronutrients and constituting a substantial public health burden (Beal et al., 2023). Although plant-based diets were reported to have varied environmental impacts, often focusing on GHGE, they were not assessed across sociodemographic groups for affordability and equity in the studies (Arrieta et al., 2022; Bayram and Ozturkcan, 2022). Hence, the results and recommendations requiring a dramatic shift from current dietary patterns may be less likely to be accepted in LMICs (Harrison et al., 2022). Likewise, Einarsson et al. (2019) stated that the current planetary health boundaries are likely incompatible with some countries' prosperity level. Nevertheless, a win-win situation can be achieved if dietary patterns in LMICs are compensated and the food systems transformed to sustainably reduce food wastes and losses, among other key areas like lowering food prices, production cost, while respecting ethical and societal factors (Hirvonen et al., 2020). Therefore, LMICs are encouraged to acknowledge and design studies adapted to address their context-specific priorities and identify areas with great potential for change (Aldaya et al., 2021), else they are likely to introduce the risk of increased disease burden, higher healthcare costs (Springmann et al., 2021), and economic stress, especially on increased-needs population such as, the elderly, women of reproductive age, and children (Beal et al., 2023; Jones et al., 2016).

Besides the fact that most of the studies used diverging methodologies and impact measures to assess dietary sustainability, uncertainties arose from limited country-specific data, lack of recent data, use of estimates from global, regional, other countries or reviewed studies. Some of the studies lacked generalizability and were less likely to apply to specific vulnerable groups like the elderly, pregnant and lactating women, and children. Misestimation from the use of food supply data as proxy to consumption data, varying quality of data, and the lack of holistic approach in study design and conduct were likely to introduce bias and/or present a reductionist view of the real situation in LMICs. However, this narrative of LMICs context is important in understanding and identifying specific constraints, it highlights the increased benefit of generating more country-specific data in LMICs through focused and holistic research to inform appropriate policies and pathways toward achieving dietary sustainability for present and future generations.

4.1 Strengths and limitations

This review has multiple strengths, such as, the use of four databases with no language restrictions applied to the search string and hence was more likely to capture all relevant published studies in LMICs. Considering a One Health perspective was useful in highlighting neglected areas requiring further research. However, the review had some limitations. The exclusion of gray literature likely omitted relevant in-country data that may not be published in peer-reviewed journals. The included studies did not undergo quality appraisal, and risks including biased studies that may skew the findings. Nevertheless, the review shines light on the current narrative of dietary sustainability in LMICs and calls for more funding and research in this area.

5 Conclusion

This review assessed the sustainability of diets looking at LMICs by using a multidimensional One Health perspective across five key considerations for dietary sustainability. A key finding is the significant gap in research on sustainable diets in LMICs, particularly in low-income countries. The review highlights the clear lack of research incorporating all five dietary sustainability dimensions and all four One Health pillars, particularly plant and animal health. As well as the increased focus of research on dietary sustainability on environmental impacts thereby undermining the other important sustainability dimensions. Emphasized in this review is the need for more comprehensive and inclusive assessments of dietary sustainability which would benefit from more country-specific generated data to reflect LMICs context. Furthermore, this review finds that current reported diets in LMICs are largely unhealthy and unsustainable due to low diversity, low quality, high environmental impacts, and high inequities. Considering the state of the economy, livelihood, healthcare systems, and prevailing disease burden, LMICs stand the chance of benefitting more from adopting a more holistic One Health approach to research on dietary sustainability to provide a more robust understanding of sustainable diets, aid in evidence-based interventions of minimal unintended consequences, and contribute toward achieving an equitable and sustainable food system.

Data availability statement

The original contributions presented in the study are included in the article/Supplementary material, further inquiries can be directed to the corresponding author.

Author contributions

EE: Conceptualization, Data curation, Formal analysis, Resources, Writing – original draft, Writing – review & editing, Investigation, Project administration, Validation, Visualization. LW: Conceptualization, Project administration, Supervision, Writing – original draft, Writing – review & editing, Formal analysis, Resources, Validation, Visualization. SE: Writing – review & editing, Validation. OA: Writing – review & editing, Resources, Validation, Visualization. AA: Writing – review & editing, Resources, Visualization. KM: Writing – review & editing, Resources, Visualization. ZA: Conceptualization, Project administration, Supervision, Writing – original draft, Writing – review & editing, Formal analysis, Resources, Validation, Visualization.

Funding

The author(s) declare that financial support was received for the research and/or publication of this article. This work was supported by the Diversifying Gambian Diets for Health and Environmental Sustainability (DiGES) project funded by Science for Africa Foundation (Grant No. GCRA-R14-06).

Conflict of interest

The authors declare that the research was conducted in the absence of any commercial or financial relationships that could be construed as a potential conflict of interest.

Generative AI statement

The authors declare that no Gen AI was used in the creation of this manuscript.

Publisher's note

Supplementary material

The Supplementary material for this article can be found online at: https://www.frontiersin.org/articles/10.3389/fsufs.2025.1567245/full#supplementary-material

References

Adesogan, A. T., Havelaar, A. H., McKune, S. L., Eilittä, M., and Dahl, G. E. (2020). Animal source foods: sustainability problem or malnutrition and sustainability solution? Perspective matters. *Glob. Food Secur.* 25:100325. doi: 10.1016/j.gfs.2019.100325

Afshin, A., Sur, P. J., Fay, K. A., Cornaby, L., Ferrara, G., Salama, J. S., et al. (2019). Health effects of dietary risks in 195 countries, 1990–2017: a systematic analysis for the global burden of disease study 2017. *Lancet* 393, 1958–1972. doi: 10.1016/S0140-6736(19)30041-8

Aldaya, M. M., Ibañez, F. C., Domínguez-Lacueva, P., Murillo-Arbizu, M. T., Rubio-Varas, M., Soret, B., et al. (2021). Indicators and recommendations for assessing sustainable healthy diets. *Food Secur.* 10:999. doi: 10.3390/foods10050999

Ali, Z., Scheelbeek, P. F. D., Felix, J., Jallow, B., Palazzo, A., Segnon, A. C., et al. (2022). Adherence to EAT-lancet dietary recommendations for health and sustainability in the Gambia. *Environ. Res. Lett.* 17:104043. doi: 10.1088/1748-9326/ac9326

Amrinanto, A. H., Hardinsyah, H., and Palupi, E. The eating culture of the Sundanese: does the traditional salad (Lalapan) improve vegetable intake and blood β-carotene concentration? (2019). Available online at: https://kobra.uni-kassel.de/handle/123456789/11419 (Accessed January 10, 2025).

Arrieta, E. M., Fischer, C. G., Aguiar, S., Geri, M., Fernández, R. J., Coquet, J. B., et al. (2022). The health, environmental, and economic dimensions of future dietary transitions in Argentina. *Sustain. Sci.*, 1–17. doi: 10.1007/s11625-021-01087-7

Auestad, N., and Fulgoni, V. L. (2015). What current literature tells us about sustainable diets: emerging research linking dietary patterns, environmental sustainability, and economics. *Adv. Nutr.* 6, 19–36. doi: 10.3945/an.114.005694

Baum, S. E., Machalaba, C., Daszak, P., Salerno, R. H., and Karesh, W. B. (2017). Evaluating one health: are we demonstrating effectiveness? *One Health* 3, 5–10. doi: 10.1016/j.onehlt.2016.10.004

Baye, K. (2019). Maximising benefits and minimising adverse effects of micronutrient interventions in low- and middle-income countries. *Proc. Nutr. Soc.* 78, 540–546. doi: 10.1017/S0029665119000557

Bayram, H. M., and Ozturkcan, S. A. (2022). Greenhouse gas emissions in the food system: current and alternative dietary scenarios. *Mediterr. J. Nutr. Metab.* 15, 463–477. doi: 10.3233/MNM-220006

Beal, T., Ortenzi, F., and Fanzo, J. (2023). Estimated micronutrient shortfalls of the EAT–lancet planetary health diet. *Lancet Planet Health* 7, e233–e237. doi: 10.1016/S2542-5196(23)00006-2

Blanco-Murcia, L., and Ramos-Mejía, M. (2019). Sustainable diets and meat consumption reduction in emerging economies: evidence from Colombia. *Sustain. For.* 11:6595. doi: 10.3390/su11236595

Cacau, L. T., Benseñor, I. M., Goulart, A. C., Cardoso, L. O., Lotufo, P. A., Moreno, L. A., et al. (2021). Adherence to the planetary health diet index and obesity indicators in the Brazilian longitudinal study of adult health (ELSA-Brasil). *Nutrients* 13:3691. doi: 10.3390/nu13113691

Cacau, L. T., Benseñor, I. M., Goulart, A. C., Cardoso, L. D. O., Santos, I. D. S., Lotufo, P. A., et al. (2022). Adherence to the EAT-lancet sustainable reference diet and cardiometabolic risk profile: cross-sectional results from the ELSA-Brasil cohort study. *Eur. J. Nutr.* 62, 807–817. doi: 10.1007/s00394-022-03032-5

Castellanos-Gutiérrez, A., Sánchez-Pimienta, T. G., Batis, C., Willett, W., and Rivera, J. A. (2021). Toward a healthy and sustainable diet in Mexico: where are we and how can we move forward? *Am. J. Clin. Nutr.* 113, 1177–1184. doi: 10.1093/ajcn/nqaa411

Clonan, A., and Holdsworth, M. (2012). The challenges of eating a healthy and sustainable diet. *Am. J. Clin. Nutr.* 96, 459–460. doi: 10.3945/ajcn.112.044487

Comerford, K., Arndt, C., Drewnowski, A., Ericksen, P., Griffin, T., Hendrickson, M., et al. (2020). Proceedings of a workshop on characterizing and defining the social and economic domains of sustainable diets. *Sustain. For.* 12:4163. doi: 10.3390/su12104163

Costello, A., Abbas, M., Allen, A., Ball, S., Bell, S., Bellamy, R., et al. (2009). Managing the health effects of climate change. *Lancet* 373, 1693–1733. doi: 10.1016/S0140-6736(09)60935-1

Crippa, M., Solazzo, E., Guizzardi, D., Monforti-Ferrario, F., Tubiello, F. N., and Leip, A. (2021). Food systems are responsible for a third of global anthropogenic GHG emissions. *Nat. Food.* 2, 198–209. doi: 10.1038/s43016-021-00225-9

Curi-Quinto, K., Unar-Munguía, M., Rodríguez-Ramírez, S., Rivera, J. A., Fanzo, J., Willett, W., et al. (2022). Sustainability of diets in Mexico: diet quality, environmental footprint, diet cost, and sociodemographic factors. *Front. Nutr.* 9:855793. doi: 10.3389/fnut.2022.855793

Dave, L. A., Hodgkinson, S. M., Roy, N. C., Smith, N. W., and McNabb, W. C. (2023). The role of holistic nutritional properties of diets in the assessment of food system and dietary sustainability. *Crit. Rev. Food Sci. Nutr.* 63, 5117–5137. doi: 10.1080/10408398.2021.2012753

Davis, M. F., Rankin, S. C., Schurer, J. M., Cole, S., Conti, L., Rabinowitz, P., et al. (2017). Checklist for one health epidemiological reporting of evidence (COHERE). *One Health.* 4, 14–21. doi: 10.1016/j.onehlt.2017.07.001

De Pee, S., Hardinsyah, R., Jalal, F., Kim, B. F., Semba, R. D., Deptford, A., et al. (2021). Balancing a sustained pursuit of nutrition, health, affordability and climate goals: exploring the case of Indonesia. *Am. J. Clin. Nutr.* 114, 1686–1697. doi: 10.1093/ajcn/nqab258

Divya, M., Junying, T., Felipe, D., and Saskia, D. P. Healthy and sustainable diets in Bangladesh. Policy research working paper - World Bank; (2022). Available online at: https://documents1.worldbank.org/curated/en/099250009012254667/pdf/IDU06764ba7f056d80448e0a10409985341922cd.pdf.

Einarsson, R., McCrory, G., and Persson, U. M. (2019). Healthy diets and sustainable food systems. *Lancet* 394:215. doi: 10.1016/S0140-6736(19)31116-X

Eini-Zinab, H., Shoaibinobarian, N., Ranjbar, G., Norouzian Ostad, A., and Sobhani, S. R. (2021). Association between the socio-economic status of households and a more sustainable diet. *Public Health Nutr.* 24, 6566–6574. doi: 10.1017/S136898002100402X

Fanzo, J. (2019). Healthy and sustainable diets and food systems: the key to achieving sustainable development goal 2? *Food Ethics* 4, 159–174. doi: 10.1007/s41055-019-00052-6

FAO. Sustainable diets and biodiversity: Directions and solutions for policy, research and action. Rome; (2010). Available online at: https://www.fao.org/3/i3004e/i3004e00.htm; https://www.fao.org/3/i3004e/i3004e.pdf.

FAO. Food wastage footprint: Impacts on natural resources. Report of the food and agriculture Organization of the United Nations (FAO) (2013). Available online at: https://www.fao.org/3/i3347e/i3347e.pdf?70ef0ed6_page=2.

FAO. The state of the world's biodiversity for food and agriculture. J. Bélanger and D. Pilling, editors. Rome: FAO Commission on Genetic Resources for Food and Agriculture Assessments; (2019). 572. Available online at: http://www.fao.org/3/CA3129EN/CA3129EN.pdf.

Gaitán-Cremaschi, D., Klerkx, L., Duncan, J., Trienekens, J. H., Huenchuleo, C., Dogliotti, S., et al. (2019). Characterizing diversity of food systems in view of sustainability transitions. A review. *Agron. Sustain. Dev.* 39:1. doi: 10.1007/s13593-018-0550-2

Godfray, H. C. J., Crute, I. R., Haddad, L., Lawrence, D., Muir, J. F., Nisbett, N., et al. (2010). The future of the global food system. *Philos. Trans. R. Soc. B Biol. Sci.* 365, 2769–2777. doi: 10.1098/rstb.2010.0180

Grace, D. (2023). Burden of foodborne disease in low-income and middle-income countries and opportunities for scaling food safety interventions. *Food Secur.* 15, 1475–1488. doi: 10.1007/s12571-023-01391-3

Han, A., Chai, L., and Liu, P. (2023). How much environmental burden does the shifting to nutritional diet bring? Evidence of dietary transformation in rural China. *Environ. Sci. Pol.* 145, 129–138. doi: 10.1016/j.envsci.2023.04.001

Harrison, M. R., Palma, G., Buendia, T., Bueno-Tarodo, M., Quell, D., and Hachem, F. (2022). A scoping review of indicators for sustainable healthy diets. *Front. Sustain. Food Syst.* 5:822263. doi: 10.3389/fsufs.2021.822263

Hase Ueta, M., Tanaka, J., Marchioni, D. M. L., Verly, E., and Carvalho, A. M. D. (2023). Food sustainability in a context of inequalities: meat consumption changes in Brazil (2008–2017). *Environ. Dev. Sustain.* 26, 6377–6391. doi: 10.1007/s10668-023-02967-x

He, P., Baiocchi, G., Feng, K., Hubacek, K., and Yu, Y. (2019). Environmental impacts of dietary quality improvement in China. *J. Environ. Manag.* 240, 518–526. doi: 10.1016/j.jenvman.2019.03.106

Heller, M. C., Walchale, A., Heard, B. R., Hoey, L., Khoury, C. K., De Haan, S., et al. (2020). Environmental analyses to inform transitions to sustainable diets in developing countries: case studies for Vietnam and Kenya. *Int. J. Life Cycle Assess.* 25, 1183–1196. doi: 10.1007/s11367-019-01656-0

Hirvonen, K., Bai, Y., Headey, D., and Masters, W. A. (2020). Affordability of the EAT–lancet reference diet: a global analysis. *Lancet Glob. Health* 8, e59–e66. doi: 10.1016/S2214-109X(19)30447-4

HLPE. Food losses and waste in the context of sustainable food systems. Report by the high level panel of experts on food security and nutrition of the committee on world food security; (2014). Available online at: https://www.fao.org/3/i3901e/i3901e.pdf

Hu, Y., Su, M., Sun, M., Wang, Y., Xu, X., Wang, L., et al. (2022). Environmental footprints of improving dietary quality of Chinese rural residents: a modeling study. *Resour. Conserv. Recycl.* 179:106074. doi: 10.1016/j.resconrec.2021.106074

Huijbregts, M. A. J., Steinmann, Z. J. N., Elshout, P. M. F., Stam, G., Verones, F., Vieira, M., et al. (2017). ReCiPe2016: a harmonised life cycle impact assessment method at midpoint and endpoint level. *Int. J. Life Cycle Assess.* 22, 138–147. doi: 10.1007/s11367-016-1246-y

Ingram, J. S. I., Wright, H. L., Foster, L., Aldred, T., Barling, D., Benton, T. G., et al. (2013). Priority research questions for the UK food system. *Food Secur.* 5, 617–636. doi: 10.1007/s12571-013-0294-4

Jones, A. D., Hoey, L., Blesh, J., Miller, L., Green, A., and Shapiro, L. F. (2016). A systematic review of the measurement of sustainable diets. *Adv. Nutr.* 7, 641–664. doi: 10.3945/an.115.011015

Kennedy, E., Raiten, D., and Finley, J. (2020). A view to the future: opportunities and challenges for food and nutrition sustainability. *Curr. Dev. Nutr.* 4:nzaa035. doi: 10.1093/cdn/nzaa035

Lang, T. Sustainable diets and biodiversity: the challenge for policy, evidence and behaviour change. In: B. Burlingame and S. Dernini, editors. Sustainable diets and biodiversity: Directions and solutions for policy, research and action. Rome; (2010). p. 20–26. Available online at: https://www.fao.org/3/i3004e/i3004e.pdf.

Lindgren, E., Harris, F., Dangour, A. D., Gasparatos, A., Hiramatsu, M., Javadi, F., et al. (2018). Sustainable food systems—a health perspective. *Sustain. Sci.* 13, 1505–1517. doi: 10.1007/s11625-018-0586-x

López, G. E., Batis, C., González, C., Chávez, M., Cortés-Valencia, A., López-Ridaura, R., et al. (2023). EAT-lancet healthy reference diet score and diabetes incidence in a cohort of Mexican women. *Eur. J. Clin. Nutr.* 77, 348–355. doi: 10.1038/s41430-022-01246-8

López-Olmedo, N., Stern, D., Bakhtsiyarava, M., Pérez-Ferrer, C., and Langellier, B. (2022). Greenhouse gas emissions associated with the Mexican diet: identifying social groups with the largest carbon footprint. *Front. Nutr.* 9:791767. doi: 10.3389/fnut.2022.791767

Macdiarmid, J. I. (2013). Is a healthy diet an environmentally sustainable diet? *Proc. Nutr. Soc.* 72, 13–20. doi: 10.1017/S0029665112002893

Macdiarmid, J. I., and Whybrow, S. (2019). Nutrition from a climate change perspective. *Proc. Nutr. Soc.* 78, 380–387. doi: 10.1017/S0029665118002896

Machado, P., McNaughton, S. A., Livingstone, K. M., Hadjikakou, M., Russell, C., Wingrove, K., et al. (2023). Measuring adherence to sustainable healthy diets: a scoping review of dietary metrics. *Adv. Nutr.* 14, 147–160. doi: 10.1016/j.advnut.2022.11.006

Marchioni, D. M., Cacau, L. T., De Carli, E., Carvalho, A. M. D., and Rulli, M. C. (2022). Low adherence to the EAT-lancet sustainable reference diet in the Brazilian population: findings from the National Dietary Survey 2017–2018. *Nutrients* 14:1187. doi: 10.3390/nu14061187

Masset, G., Vieux, F., and Darmon, N. (2015). Which functional unit to identify sustainable foods? *Public Health Nutr.* 18, 2488–2497. doi: 10.1017/S1368980015000579

Meybeck, A., and Gitz, V. (2017). Sustainable diets within sustainable food systems. *Proc. Nutr. Soc.* 76, 1–11. doi: 10.1017/S0029665116000653

Moore, J. E., Mascarenhas, A., Bain, J., and Straus, S. E. (2017). Developing a comprehensive definition of sustainability. *Implement. Sci.* 12:110. doi: 10.1186/s13012-017-0637-1

Muñoz-Ulecia, E., Rodríguez Gómez, M., Bernués Jal, A., Benhamou Prat, A., and Martín-Collado, D. (2022). Do animal source foods always ensure healthy, sustainable, and ethical diets? *Animal* 16:100643. doi: 10.1016/j.animal.2022.100643

Murray, C. J. L., Aravkin, A. Y., Zheng, P., Abbafati, C., Abbas, K. M., Abbasi-Kangevari, M., et al. (2020). Global burden of 87 risk factors in 204 countries and territories, 1990–2019: a systematic analysis for the global burden of disease study 2019. *Lancet* 396, 1223–1249. doi: 10.1016/S0140-6736(20)30752-2

Onimawo, I. Traditional food Systems in Assuring Food Security in Nigeria. In: B. Burlingame and S. Dernini, editors. Sustainable diets and biodiversity; directions and solutions for policy, research, and action. Rome: Proceedings of the International Scientific Symposium; (2010). p. 182–196. Available online at: https://www.fao.org/3/i3004e/i3004e.pdf.

Page, M. J., McKenzie, J. E., Bossuyt, P. M., Boutron, I., Hoffmann, T. C., Mulrow, C. D., et al. (2021). The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 29:n71. doi: 10.1136/bmj.n71

Popkin, B. M., Adair, L. S., and Ng, S. W. (2012). Global nutrition transition and the pandemic of obesity in developing countries. *Nutr. Rev.* 70, 3–21. doi: 10.1111/j.1753-4887.2011.00456.x

Purvis, B., Mao, Y., and Robinson, D. (2019). Three pillars of sustainability: in search of conceptual origins. *Sustain. Sci.* 14, 681–695. doi: 10.1007/s11625-018-0627-5

Rahmi, R. N., Poolsawad, N., and Sranacharoenpong, K. (2020). Environmental impacts related to food consumption of Indonesian adults. *J. Nutr. Sci. Vitaminol. (Tokyo)* 66, S149–S154. doi: 10.3177/jnsv.66.S149

Reddy, G., and Van Dam, R. M. (2020). Food, culture, and identity in multicultural societies: insights from Singapore. *Appetite* 149:104633. doi: 10.1016/j.appet.2020.104633

Smith, P., and Gregory, P. J. (2013). Climate change and sustainable food production. *Proc. Nutr. Soc.* 72, 21–28. doi: 10.1017/S0029665112002832

Springmann, M., Clark, M. A., Rayner, M., Scarborough, P., and Webb, P. (2021). The global and regional costs of healthy and sustainable dietary patterns: a modelling study. *Lancet Planet Health* 5, e797–e807. doi: 10.1016/S2542-5196(21)00251-5

Tulloch, A. I. T., Borthwick, F., Bogueva, D., Eltholth, M., Grech, A., Edgar, D., et al. (2023). How the EAT–lancet commission on food in the Anthropocene influenced discourse and research on food systems: a systematic review covering the first 2 years post-publication. *Lancet Glob. Health* 11, e1125–e1136. doi: 10.1016/S2214-109X(23)00212-7

UN. (2021). Tokyo nutrition for growth summit and UN food systems summit joint statement. United Nation. Available online at: https://nutritionforgrowth.org/wp-content/uploads/2021/09/N4G_UN_FoodSysSummit_9.23.pdf.

Verly-Jr, E., De Carvalho, A. M., Marchioni, D. M. L., and Darmon, N. (2022). The cost of eating more sustainable diets: a nutritional and environmental diet optimisation study. *Glob. Public Health* 17, 1073–1086. doi: 10.1080/17441692.2021.1900315

Waage, J., Grace, D., Fèvre, E. M., McDermott, J., Lines, J., Wieland, B., et al. (2022). Changing food systems and infectious disease risks in low-income and middle-income countries. *Lancet Planet Health* 6, e760–e768. doi: 10.1016/S2542-5196(22)00116-4

Wang, L., Gao, B., Hu, Y., Huang, W., and Cui, S. (2020). Environmental effects of sustainability-oriented diet transition in China. *Resour. Conserv. Recycl.* 158:104802. doi: 10.1016/j.resconrec.2020.104802

Watts, N., Adger, W. N., Agnolucci, P., Blackstock, J., Byass, P., Cai, W., et al. (2015). Health and climate change: policy responses to protect public health. *Lancet* 386, 1861–1914. doi: 10.1016/S0140-6736(15)60854-6

WHO. Sustainable healthy diets: guiding principles. World Health Organization; (2019). Available online at: https://www.who.int/publications/i/item/9789241516648.

WHO. One health. World Health Organization (2023). Available online at: https://www.who.int/news-room/fact-sheets/detail/one-health.

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., et al. (2019). Food in the Anthropocene: the EAT–lancet commission on healthy diets from sustainable food systems. *Lancet* 393, 447–492. doi: 10.1016/S0140-6736(18)31788-4

World Bank. Food-borne illnesses cost US$ 110 billion per year in low- and middle-income countries. World Bank Group; (2018). Available online at: https://www.worldbank.org/en/news/press-release/2018/10/23/food-borne-illnesses-cost-us-110-billion-per-year-in-low-and-middle-income-countries.

World Bank. World Bank country and lending groups – World Bank data help desk. (2022). Available online at: https://datahelpdesk.worldbank.org/knowledgebase/articles/906519-world-bank-country-and-lending-groups.