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Making the most of existing research: an evidence gap map of the effects of food systems interventions in low-income and middle-income countries

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ABSTRACT

Objective Identify and describe the available evidence on the effects food systems interventions on food security and nutrition outcomes in low-income and middle-income countries.

Methods An adapted version of the high-level panel of experts food systems framework defined the interventions and outcomes included studies. Included study designs were experimental and quasi-experimental quantitative impact evaluations and systematic reviews. Following standards for evidence gap maps developed by 3ie, a systematic search of 17 academic databases and 31 sector-specific repositories in May 2020 identified articles for inclusion. Trained consultants screened titles/abstracts, then full texts of identified articles. Studies meeting eligibility criteria had meta-data systematically extracted and were descriptively analysed. Systematic reviews were critically appraised.

Results The map includes 1838 impact evaluations and 178 systematic reviews. The most common interventions, with over 100 impact evaluations and 20 systematic reviews each, were: provision of supplements, fortification, nutrition classes, direct provision of foods and peer support/counselling. Few studies addressed national-level interventions or women’s empowerment. The most common final outcomes were: anthropometry, micronutrient status, and diet quality and adequacy. Intermediate outcomes were less studied. Most evaluations were conducted in sub-Saharan Africa (33%) or South Asia (20%). Many studies occurred in lower-middle-income countries (43%); few (7%) were in fragile countries. Among studies in a specific age group, infants were most frequently included (19%); 14% of these also considered mothers. Few evaluations considered qualitative or cost analysis; 75% used randomisation as the main identification strategy.

Discussion The uneven distribution of research means that some interventions have established impacts while other interventions, often affecting large populations, are underevaluated. Areas for future research include the evaluation of national level policies, evaluation of efforts to support women’s empowerment within the food system, and the synthesis of dietary quality. Quasi-experimental approaches should be adopted to evaluate difficult to randomise interventions.

STRENGTHS AND LIMITATIONS OF THIS STUDY

⇒ Broad scope including intermediate outcomes.
⇒ Protocol developed and implemented in a 9-month period drawing on latest advances in synthesis project management.
⇒ Not able to carry out forward citation checking due to high volume of included studies.
⇒ Only included studies published in English; however, research has found that synthesis results are not affected when the effect sizes from non-English studies are removed from the analysis.30

INTRODUCTION

The triple burden of malnutrition refers to the concurrent presence of micronutrient deficiency, insufficient energy intake (ie, underweight) and excessive energy intake (ie, overweight and obesity) in a population.1 Between 720 and 811 million people experience hunger and 2.37 billion lack key vitamins and minerals in their diets.2 Furthermore, worldwide obesity nearly tripled between 1975 and 2014 with over 1.9 billion adults classed as overweight in 2016, of whom 650 million were obese.3 4 The prevalence of the triple burden of malnutrition is highest in low-income and middle-income countries (L&MICs), and especially, in fragile and conflict affected countries.5

The realities and challenges of the triple burden of malnutrition refocused the international community on food systems. Governments are expanding nutrition targets and increasing spending on nutrition-sensitive interventions, as these have the potential to simultaneously address multiple forms of malnutrition.1 The number of interventions implemented and evaluations of these interventions increased substantially in recent years.6–8
As a result, there is an extensive, heterogeneous and rapidly growing body of literature evaluating the effects of food systems interventions on food security and nutrition in L&MICs. There have been several efforts to synthesise portions of this literature to support evidence-informed decision making. Most of the empirical focus has been on nutrition-sensitive agriculture; although, there is growing research on food policy and food systems in general, and development of methods used to study these complex relationships. However, there is a need for a broad, comprehensive overview of the evidence on all types of food systems interventions and their impacts on nutrition and food security.

The evidence gap map (EGM) presented here provides an overview of the existing literature and identifies evidence gaps to address the need for such a comprehensive overview. EGMs have the twin objectives of making existing evidence more easily available and informing strategic approaches to address extant evidence gaps. Such work assists stakeholders in identifying high-quality evidence and key areas for future research investments. This paper describes the methods and results of the mapping exercise and presents the results related to the distribution of evidence relating interventions within the food system (y-axis) to food security and nutrition outcomes (x-axis).

**METHODS**

We followed standards and methods established by 3ie in this EGM. In doing so, we used a systematic approach to identify, describe and map existing impact evaluations (IEs) and systematic reviews (SRs) assessing food systems interventions to improve food security and nutrition outcomes in L&MICs. The EGM was not registered, but the protocol was published on 3ie’s Development Evidence Portal.

**Defining the intervention-outcome framework**

**Interventions:**

We adapted the high-level panel of experts (HLPE) framework from 201 (extended by the International Food Policy Research Institute (IFPRI)) to define the food system and categorise relevant interventions. The framework includes three domains: the food supply chain, the food environment and consumer behaviour (online supplemental appendix A). They reflect groups of actions and interventions, not a sequential flow of activities leading to one another.

The primary difference between the HLPE/IFPRI framework and our adaptation is that each intervention was assigned to only one domain to facilitate categorisation and maintain visual clarity (figure 1). Each domain was disaggregated into specific intervention groups (table 1). The HLPE/IFPRI framework outlines four activities within the food supply chain: production, storage and distribution, processing and packaging, and food loss and waste management. The food environment domain includes interventions that engage with the physical, economic, political and sociocultural surroundings, opportunities and conditions that shape dietary preferences and choices and nutritional status. These drivers are often exogenous factors in our interventions of interest and are excluded from the scope of this EGM.

**Outcomes:**

All measures of food security and nutrition were included as final outcomes. Intermediate outcomes, measuring steps along the theory of change such as income changes or food loss, were also included (table 2).

**Study inclusion criteria**

We included studies in L&MICs defined by the World Bank classification during the year of publication. Studies in populations with specific health conditions, such as HIV, anaemia or severe malnutrition, were excluded as the nutritional needs of these populations are unique. Included interventions and outcomes are defined above. Included study designs were quasi-experimental or experimental IEs and SRs of studies employing these methods (online supplemental appendix B). Only studies published in or after year 2000 and English language were included. Both ongoing and completed studies were included.

**Search strategy**

We systematically searched for English-language reports in 17 academic bibliographic databases in May 2020: MEDLINE, EMBASE, EconLit, Oxfam Policy, Repec, World Bank eLibrary, Cochrane Library, Agris, CINAHL, CAB Global Health, CAB Abstracts, Agricola, PsycINFO, Africa-Wide Information, Academic Search Complete, Scopus and WHO Global Index Medicus. See online supplemental appendix C for full search strings. We used
| Domain                          | Intervention category | Intervention                                                                 |
|--------------------------------|-----------------------|-------------------------------------------------------------------------------|
| Food supply chain              | Production system     | Provision of improved water access and management systems                      |
|                                |                       | Provision of free or reduced-cost access to improved seed varieties            |
|                                |                       | Provision of free or reduced-cost access to fertiliser                         |
|                                |                       | Provision of free or reduced-cost access to pesticides/herbicides              |
|                                |                       | Provision of free or reduced-cost access to livestock                          |
|                                |                       | Provision of free or reduced-cost access to other/unspecified agricultural inputs |
|                                |                       | Provision of mechanical equipment                                             |
|                                |                       | Education/information—farmer field schools                                     |
|                                |                       | Education/information—agricultural extension programmes                       |
|                                |                       | Education/information—information guidance                                     |
|                                |                       | Education/information—other educational programmes                             |
|                                |                       | Other efforts to improve the production system—insurance                       |
|                                |                       | Other efforts to improve the production system—contract farming                |
|                                |                       | Other efforts to improve the production system—market support                  |
|                                |                       | Other efforts to improve the production system—land markets and management     |
|                                |                       | Other efforts to improve the production system—agricultural credit/savings     |
|                                |                       | Other efforts to improve the production system—other                           |
| Distribution and storage       | Support for creating storage structure at farms                               |
|                                | Trade regulations       |                                                                               |
|                                | Implementation of distribution centres                                       |
|                                | Improved transportation from farms to markets                                 |
|                                | Education regarding improved storage and distribution techniques              |
|                                | Cold chain initiatives      |                                                                               |
| Processing and packaging       | Fortification            |                                                                               |
|                                | Packaging                |                                                                               |
|                                | On farm, postharvest processing                                             |
|                                | Provision of good or services to support food processes of business models   |
|                                | Education regarding improved processing and packaging techniques             |
| Food loss and waste management | Private food donation        |                                                                               |
|                                | Use of and education regarding the use of spoiled, near spoiled, or traditionally uneaten food |
|                                | Composting               |                                                                               |
| Food environment               | Availability             | Designations of space and zoning laws                                          |
|                                | Direct provision of foods                                              |
|                                | Provision or use of supplements                                         |
|                                | Affordability             | Cash-for-food programmes                                                       |
|                                | Governmental price manipulations (excluding tariffs)                      |
|                                | Promotion and labelling                                                | Advertising regulations                                                        |
|                                | Innovative store design                                               |
|                                | Labelling regulations                                                   |
|                                | Quality and safety                                                   | Food safety regulations                                                        |

Continued
terms for relevant interventions, study designs and publication year. To identify studies taking place in L&MICs, we applied the Cochrane Effective Practice and Organisation of Care Group ‘LMIC Filters’ 2020.

We completed a grey literature search of 31 sector specific databases and websites using basic search strings tailored to each database or website (online supplemental appendix C). We cross-checked all citations from included SRs for inclusion. We requested additional relevant literature from the advisory and policy stakeholder groups and through a blog post on the 3ie website that was promoted using social media; any studies identified before the end of September 2020 were also included.

Screening and data extraction procedure

After we removed duplicates, the research team screened titles and abstracts, followed by eligible full text reports, according to predefined criteria. Single screening with a safety-first approach was carried out; if the first reviewer was uncertain, she marked it for a second review. Periodic meetings were held to discuss and resolve screening decisions for studies marked for a second opinion, for boundary decision examples, see online supplemental appendix D. Full-text reports were single screened using the safety-first approach (70%), with 30% double screening. The EPPI-Reviewer V4 software’s machine learning streamlined the process and efficiently removed clearly irrelevant studies.

All articles on the same intervention and population were linked to avoid over-representing interventions with multiple reports. For example, reports were linked when authors followed a group of participants over time, published multiple versions of the same study in different formats or updated an SR. Descriptive information was only included once for each group of linked publications. Therefore, the presented analysis is reported at the study level, rather than the publication level. However, if there was additional relevant data, such as outcomes, in the linked publications this was added to the record for the main study.

Table 1

| Domain                  | Intervention category                                    | Intervention                                      |
|-------------------------|----------------------------------------------------------|---------------------------------------------------|
| Consumer behaviour      | Efforts to increase women’s decision-making power        | Efforts to increase women’s decision-making power |
| Information/behaviour   | Peer support/counsellors                                 | Peer support/counsellors                          |
| change communication    | Professional services (dieticians/nurses)                | Professional services (dieticians/nurses)         |
|                         | Community meetings                                       | Community meetings                                 |
|                         | Classes                                                  | Classes                                           |
| Healthy food social     | Healthy food social marketing campaigns                  | Healthy food social marketing campaigns           |
| marketing campaigns     |                                                          |                                                  |
| Information/behaviour   | Door-to-door campaigns                                   | Door-to-door campaigns                            |
| change communication    |                                                          |                                                  |

EGM, Evidence Gap Map.

One person systematically extracted data and another person verified the data using a prespecified data extraction tool (online supplemental appendix E). General study characteristics, such as authors, publication date, study location, intervention type, outcomes reported and definition of outcome measures, population of interest and funders, were extracted. Methodological information, including the type of quantitative methods employed and whether any cost or cost-benefit analysis was conducted, was also extracted.

We critically appraised all included SRs using a standardised appraisal tool (online supplemental appendix F). We considered each review’s search strategy, screening method, risk of bias assessment, data extraction and synthesis methods. SRs were rated as low, medium or high confidence, based on guidance provided in Snilstveit and colleagues. To ensure consistency in the quality appraisal process, a 5% sample of reviews was initially appraised by two researchers, then independently reconciled by an SR expert. Reviewers were provided with feedback. Subsequently, one person appraised each SR, and the SR expert independently reviewed all completed appraisals. IEs were not critically appraised due to timescale and resources.

Developing the interactive EGM

All included studies are presented in an interactive graphic on 3ie’s EGM platform. This matrix presents the food systems interventions as rows and the food security and nutrition outcomes as columns. Within the matrix, grey circles represent IEs. Coloured circles represent SRs. The SRs follow a traffic-light system to indicate confidence in their findings: green for high confidence, orange for medium, red for low. Blue circles are ongoing studies. The size of the bubble indicates the relative size of the evidence base for that intervention-outcome combination. The interactive aspect of the EGM allows users to filter the results based on key characteristics, such as study design, intervention country and age of the
| Stage of theory of change | Outcome group      | Outcome sub-group                                      |
|--------------------------|--------------------|--------------------------------------------------------|
| Intermediate             | Economic           | Income                                                 |
|                          |                    | Assets                                                 |
|                          |                    | Output value                                            |
|                          |                    | Prices received for goods                              |
|                          |                    | Other SES indicators                                    |
|                          |                    | Tax revenue                                             |
|                          |                    | Purchasing behaviour                                   |
| Agricultural             | Water related      |                                                        |
|                          |                    | Animal husbandry                                       |
|                          |                    | Plant/crop production                                  |
|                          |                    | Land related                                            |
|                          |                    | Quality of agricultural inputs                         |
|                          |                    | Agricultural cooperatives                               |
| Nutritional outcomes     | Food nutrient content|                                                        |
|                          |                    | Caloric requirements                                   |
|                          |                    | Nutrient bioavailability                               |
| Advertising and labelling| Exposure to advertisement |                                      |
|                          |                    | Advertisement topics                                   |
|                          |                    | Accuracy of advertisement                              |
| Food distribution        | Import/export      |                                                        |
|                          |                    | Movement of food                                        |
|                          |                    | Location of foods in stores                            |
|                          |                    | Food distribution centres                              |
| Environmental impacts of | Climate impact     |                                                        |
| the food system          |                    | Non-food waste produced                                |
| Food loss                | Time food remains unspoiled |                                      |
|                          | Food spoilage      |                                                        |
|                          | Food loss          |                                                        |
| Intrinsic motivators     | Consumer preferences|                                                        |
|                          | Perceptions        |                                                        |
|                          | Knowledge          |                                                        |
| Women's empowerment      | Decision making    |                                                        |
|                          | Ownership          |                                                        |
|                          | Control of resources|                                                        |
|                          | Self-esteem        |                                                        |
|                          | Time use           |                                                        |
|                          | Other women's empowerment outcome | |
| Regulations              | Violations         |                                                        |
|                          | Fines              |                                                        |
|                          | Other regulation outcome |                                      |
| Economic, social, and    | Economic, social, and political stability | |
| political stability      | Time use           |                                                        |
|                          | Behaviour change   |                                                        |
|                          | Other steps taken due to non-compliance | |

Continued
participants, thereby facilitating efficient, user-friendly identification of relevant evidence.

RESULTS

We identified 142,849 articles through the academic database search; we found an additional 1,590 through the grey literature search (figure 2). Studies with high similarity that potentially could be duplicates were identified by EPPI Reviewer software. Identical studies were automatically assigned as duplicates and the rest of the studies were manually compared by consultants. After removing duplicates, 111,641 studies were screened using title and abstract, and 10,323 screened using full text. Finally, 2,477 papers were included, which correspond to 2016 unique studies (1,838 IEs and 178 SRs) (online supplemental appendix G).

The results show a significant growth in literature over time (figure 3). In 2000, there were 17 IEs and 0 SRs, while in 2020 there were a total of 1,838 IEs and 178 SRs. Growth in the literature base was especially high for IEs of food supply chain and consumer behaviour interventions. Half of the IEs were published between 2015 and 2019.

Characteristics of the evidence base

Interventions

There was an uneven distribution in the frequency with which interventions were evaluated. Certain nutrition-specific interventions were evaluated in over 100 IEs and 20 SRs: provision of supplements (SR 67; IE 369), fortification (SR 23; IE 245), direct provision of foods (SR 24; IE 205) and peer support and counselling in the consumer behaviour domain (SR 22; IE 130; figure 4).

Although at least one IE was identified for most of the interventions in the framework, we did not identify any IEs of interventions related to advertising regulations, food waste education or the packaging of food. Several intervention types had fewer than five evaluation studies: food safety regulations (1), cold chain initiatives (1), composting education (3), labelling regulations (3), door-to-door behaviour change communication campaigns.

| Stage of theory of change | Outcome group         | Outcome sub-group                  |
|---------------------------|-----------------------|------------------------------------|
| Final                     | Anthropometric        | Linear growth                      |
|                           |                       | Weight                             |
|                           |                       | Relative weight                    |
|                           |                       | MUAC                               |
|                           |                       | Birth outcomes                     |
|                           |                       | Anthropometric other               |
| Developmental outcomes    | Physical              |                                    |
|                           | Other developmental outcomes |
| Micronutrient status      | Iron                  |                                    |
|                           | Iodine                |                                    |
|                           | Vitamin A             |                                    |
|                           | Zinc                  |                                    |
|                           | Other micronutrient status outcome |
| Diet quality and adequacy| Breast feeding        |                                    |
|                           | Dietary diversity     |                                    |
|                           | Insufficient diet     |                                    |
|                           | Micronutrient intake  |                                    |
|                           | Other diet quality and adequacy |
| Food safety               | Food toxins           |                                    |
|                           | Food borne illness    |                                    |
|                           | Other food safety outcome |
| Food affordability and availability | Food access          |
|                           | Food availability and supply |
|                           | Affordability         |                                    |
|                           | Food insecurity measures |
|                           | Food stressed households |

EGM, evidence gap map; MUAC, mid-upper arm circumference; SES, socioeconomic status.
(4), provision of goods and/or services to support food processing (4), on-farm and post-harvest processing (4); and access to pesticides (4).

Many interventions were associated with multiple IEs but only one or no SRs: agricultural extension (SR, 1; IE, 112), provision of free or reduced cost access to other/unspecified agricultural inputs (SR, 1; IE, 65), agricultural information provision (SR, 0; IE, 27), government manipulations of price (SR, 1; IE, 22) and agricultural insurance (SR, 1; IE, 22).

Some evaluations considered programmes with multiple components that spanned the interventions in the framework. Common groupings of interventions that were implemented and evaluated jointly in at least five IEs included: fortification and the direct provision of food, nutrition classes and healthy food marketing campaigns, and peer support and nutrition classes. In addition, 11 IEs considered multicomponent programmes with activities that fell into five or more interventions. Most of these included at least one food supply chain intervention. Eight SRs considered interventions that fell into five or more categories. Evaluations of common intervention packages are represented in the corresponding intervention package (eg, fortification and direct provision of food) while less common intervention packages are represented alongside each intervention component they implemented.

Outcomes

Almost three-quarters of studies evaluated at least one final outcome (SR 170; IE 1,353; figure 5). The most common final outcomes were anthropometry (SR 111; IE 671), micronutrient status (SR 78; IE 530) and diet quality and adequacy (SR 51; IE 555). The specific final outcomes that were most commonly examined in IEs were linear growth (433), weight (395) and relative weight (377).

Less than half of all included studies evaluated at least one intermediate outcome (SR 38; IE 848). The most common intermediate outcome categories were economic (SR 18; IE 350), agricultural (SR 13; IE 309) and intrinsic motivational outcomes (SR 16; IE 302). The specific intermediate outcomes that were most commonly examined were behaviour change (269), knowledge (238), income (225) and plant production (222).

The location of foods in stores, climate impact, non-food waste produced, import/export, agricultural cooperative performance, women’s self-esteem, food spoilage...
or loss and economic, social and political stability were each considered in fewer than five studies.

Intervention-outcome combinations
The most common interventions (fortification, supplementation, the direct provision of food and nutrition classes) tended to be evaluated against iron status and various anthropometrics. Evaluations of the impacts of fortification considered iron status (170), linear growth (118), weight (100) and relative weight (78). Evaluations of supplementation programmes considered iron status (150), linear growth (125), weight (117) and relative weight (88). Evaluations of the direct provision of food also measured linear growth (81) and weight (74). While the evaluations of nutrition classes followed a similar pattern in outcome measurement as the others, they also tended to evaluate impacts on knowledge (91).

Other characteristics
IEs were primarily located in Sub-Saharan Africa (648), South Asia (367) and East Asia and the Pacific (324). IEs have been conducted in 25 (out of 36) fragile and conflict affected countries, as defined by the World Bank: mostly in sub-Saharan Africa (87) and the Middle East and North Africa (15).25

IEs mostly included both sexes and populations with a wide age range; however, few considered those over 60 years old (59). The most commonly isolated age group was infants (497). Among studies evaluating infant outcomes, 14% (70) also looked at outcomes for mothers. About 25% (405) of included studies focused on women of reproductive age, most commonly pregnant women (214), postpartum (86) and lactating women (68). Over half of the interventions were conducted in rural areas. Most interventions were implemented locally (1401). Only 175 interventions were conducted and evaluated at the national or transnational level. The most common intervention setting was in the household (627). Over 1300 of the included studies did not specify the programme funding agency type or name.

About three-quarters of the IEs were randomised controlled trials (RCTs) (1390). Quasi-experimental studies mainly used statistical matching (242) and difference-in-differences (136). Just over 10% of the IEs adopted mixed methods approaches (186). There were 173 IEs that reported cost data or presented cost analysis in some form; 103 of these presented detailed budget information or attempted to make some comparison between the costs of a programme and the associated benefits.

In total, 95 of the reviews were appraised as low confidence, 46 were rated medium confidence and 34 were rated high confidence. The high confidence SRs were mostly published more recently, with 75% published in or after 2015 (26), compared with 60% of low and medium quality reviews published in or after 2015. Reviews rated with high confidence predominantly focused on synthesising the effects of the provision or use of supplements on birth outcomes (10), iron or anaemia status (7) and the effect of fortification on iron status (6).

DISCUSSION
There is significant variation in the intensity of research by intervention and outcome type, in addition to other characteristics of interest such as setting, population and research method. The most well-researched interventions are nutrition-specific and include fortification, supplementation, the direct provision of food and nutrition classes. These interventions easily lend themselves to experimental IE designs. Positive impacts are consistently observed in short time scales using easily quantified metrics. Key evidence gaps included the evaluation of national level policies and efforts to support women’s empowerment.

However, not all evidence gaps must be filled in our framework. In some cases, there is no theoretical reason to expect a relationship between an intervention and an outcome. In others, relationships may already have been (dis)proven. In both instances, additional research is not needed. For example, an evaluation of the impacts of breastfeeding peer-support groups on environmental outcomes is not theoretically sound. While the re-evaluation of certain interventions in new contexts may be necessary for external validity,26 additional evaluations of the impacts of established interventions, such as fortification and supplementation interventions, are not necessarily beneficial unless they consider unique context. The generalisable impacts of these interventions were established as far back as the 2013 Lancet series on Maternal and Child Nutrition.27 However, the evaluation of intervention-outcome relationships that are theoretically sound and not well established represent valuable practical contributions to the adoption of evidence supported interventions and policies.

Interventions which are difficult to evaluate due to long time frames (eg, land markets and management interventions), inability to randomise (eg, trade regulations or a national food policy) and difficulty in outcome measurement (eg, efforts to increase women’s decision making) are not often evaluated. As a result, multicomponent interventions, national policies and agricultural interventions are understudied. There has been a shift in the rhetoric surrounding the evaluation of these interventions in recent years, but this is not yet apparent in the literature base.28 The field of economics has taken on the challenge of identifying causal impacts in difficult contexts and developed new approaches for the evaluation of policy. In 2019 and 2021, the Nobel Prize in economics was awarded to researchers who developed innovative approaches to evaluate these difficult to study interventions.29 There have been recent advancements in measuring benefits that happen far down the causal chain,13 which could be useful in considering the impacts of agricultural interventions on final outcomes. The synthetic control method is becoming more widely
accepted and allows for the evaluation of national policies (e.g., labelling regulations) and other interventions with only one treatment group (e.g., designations of space and zoning). Other approaches, such as adaptive trials, factorial designs and qualitative comparative analysis, for evaluating complex interventions are also being widely adopted. Mixed-methods approaches for evaluating complexity-informed interventions are now well established. Complexity-informed evaluation designs may be of particular interest to evaluators in the food system seeking to untangle the web of dependencies and driving forces that act on the complex system.

Opportunities for future research

Mixed-methods approaches and cost evidence are under-represented in the literature base and could provide valuable insights to the field. In both cases, the higher costs of these evaluations can prevent them from being implemented. Differences between qualitative and quantitative research approaches can make cohesive mixed-methods evaluations challenging. Many ‘mixed-methods’ evaluations more closely resemble two separate evaluations (one quantitative and one qualitative) than a single, cohesive evaluation where each component is integrated within and builds off the other. One potential explanation for the limited cost evidence is that it is not, and should not be, conducted for evaluations that show null results. In addition, economic analysis can be challenging for studies that have heterogeneous effects (e.g., only work for the poorest participants) as it is difficult to determine how participant selection could affect future cost-effectiveness.

We have identified several widely implemented interventions that have not been well studied and, therefore, provide promising opportunities for future research. Taxes on sugar-sweetened beverages and labelling regulations for unhealthy foods have not been evaluated for their impacts on weight, yet more than 40 countries (many L&MICs) have implemented these interventions to fight the obesity epidemic. Mexico has successfully evaluated the impacts of their tax on some intermediate outcomes, implying that it is possible to conduct these evaluations, even if challenging. Many stakeholders are supporting post-harvest processing initiatives, but have not yet established how far down the causal chain these interventions provide impact. Evaluations of these interventions have the potential to impact policies that affect the lives of millions of people worldwide. As the reach and resource requirements of an intervention increase, so does the ethical imperative to evaluate it.

The 400 studies that used ‘other dietary quality and adequacy’ outcomes represent an exciting gap for evidence synthesis. Often, these outcomes were the intakes of specific foods or food groups. While providing a wealth of information, the variation in outcomes makes drawing conclusions across studies challenging. By developing novel synthesis methods, the evidence across these different metrics could be used in new ways, reaching new conclusions and adding rich detail to existing work. There have been some recent efforts to collate the available methods for measuring diet, such as the INDDEX Project’s Data4Diets tool and IMMANA’s Innovative Metrics, Tools and Methods Evidence Gap Map. However, tools for synthesising across metrics are not yet available.

Traditionally, women are significant actors within food systems; however, relatively few studies examined interventions supporting women’s decision-making or measured outcomes regarding women’s empowerment. The studies we identified typically viewed women as cooks and mothers rather than independent actors within the food system. One-quarter of studies focused on women of reproductive age, especially perinatal women. More interventions including women as independent actors within the food system could lead to promising new avenues to address Sustainable Development Goals 2 and 5 at the same time.

Implications for research and policy

This review of the evidence base highlights some ways that policy and research could be adopted to make the most of limited resources. Efforts need to move away from re-evaluating the impacts of established interventions, such as fortification, supplementation, the direct provision of food, and nutrition classes, to considering scaling and sustainability through process evaluation and implementation research. Now that these interventions are widely adopted, we must consider how to implement them effectively at population level and in diverse contexts. Future studies could provide new insights by incorporating process evaluations, mixed-methods approaches and cost evidence to understand the mechanisms through which changes may occur and how limited resources can be best allocated.

The adoption of standardised measures of diet quality and adequacy would aid comparison and improve evidence synthesis efforts. Policy-makers, implementers and researchers must continue working together to develop measures of diet that balance ease of use, linkage to disease and standardisation across context in order to allow for the effective comparison of results. A new diet quality questionnaire may represent a productive way to systematised diet data; however, due to its novelty, it is unclear as of yet if it will be adopted. Although measures of dietary diversity are relatively common (150 studies in our map), these metrics do not always capture sufficient information for detailed nutritional analysis. A recent synthesis of metrics found that among 19 common dietary metrics, most were not validated against health outcomes and none were designed to measure the double burden of malnutrition.

Decision-makers and practitioners are encouraged to use relevant existing high-quality SRs as identified through this mapping exercise. They may consider funding studies in under-researched areas and exercise caution and consideration prior to implementing under-researched interventions. However, because only IEs and SRs of
IEs were included in this EGM, policy-makers should strengthen any decisions made using this map with the following information sources:

- Existing or planned research and interventions by government agencies and development partners.
- Other forms of evidence, including implementation research, process evaluations, qualitative studies and programming administrative and monitoring information.
- Existing theories of change and logical frameworks.
- Formative work and local knowledge.

Strengths and limitations of research

There are several strengths and limitations of this research. Strengths include having a broad scope, considering a range of intermediate outcomes and reviewing a vast amount of the food security and nutrition intervention literature. The review protocol was developed and implemented in a 9-month period drawing on the latest advances in synthesis project management. Another strength is that this map was commissioned by a global health donor (GIZ), indicating a direct policy and planning need in the field. Due to the high volume of included studies, forward citation checking was beyond the scope of this EGM. Only studies published in English were included; however, research has found that synthesis results are not affected when the effect sizes from non-English studies are removed from the analysis.48 This decision was meant to limit scope, but some studies may be omitted. EGM do not provide synthesis of the findings of IEs, rather they are intended to make these more easily available. Users of the map are expected to reference the included articles to make this judgement based on their unique interests and needs or use the EGM as a starting point for syntheses that do make these judgements.

CONCLUSION

Addressing the triple burden of malnutrition in a way that also considers the interactions of the food system with the ongoing climate crisis is one of the major challenges of our era. Increasing, but still limited, funding is dedicated to addressing this challenge it is important that decisions about policies and programmes are informed by the best available evidence. This EGM highlights a significant and growing evidence base on food systems and nutrition that could and should be used to support effective strategies. Decision makers and practitioners can use the EGM to access existing evidence on interventions. Commissioners of research and researchers themselves can use the EGM findings to prioritise the funding and conduct of new research.

The findings show that there is a substantial imbalance in evidence on this topic, with interventions that lend themselves to RCTs being studied more frequently than interventions that cannot be randomised or take a long time to realise results. Researchers and policy-makers may consider the evaluation of national, widely implemented interventions with limited evidence and studies focusing on women as decision-makers. Future research should also assess the examine the intermediate steps in a theory of change.

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Correction: Making the most of existing research: an evidence gap map of the effects of food systems interventions in low-income and middle-income countries

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