Food Security (2023) 15:1313–1344
https://doi.org/10.1007/s12571-023-01385-1

REVIEW

The effectiveness of food system policies to improve nutrition, nutrition-related inequalities and environmental sustainability: a scoping review

Celia Burgaz[1,2] · Vanessa Gorasso[1,3] · Wouter M. J. Achten[2] · Carolina Batis[4] · Luciana Castronuovo[5] · Adama Diouf[6] · Gershim Asiki[7] · Boyd A. Swinburn[8] · Mishel Unar-Munguía[4] · Brecht Devleesschauwer[1,9] · Gary Sacks[10] · Stefanie Vandevijvere[1]

Received: 24 June 2022 / Accepted: 28 June 2023 / Published online: 3 August 2023

Abstract

A global transformation of food systems is needed, given their impact on the three interconnected pandemics of undernutrition, obesity and climate change. A scoping review was conducted to synthesise the effectiveness of food system policies/interventions to improve nutrition, nutrition inequalities and environmental sustainability, and to identify double- or triple-duty potentials (their effectiveness tackling simultaneously two or all of these outcomes). When available, their effects on nutritional vulnerabilities and women's empowerment were described. The policies/interventions studied were derived from a compilation of international recommendations. The literature search was conducted according to the PRISMA extension for scoping reviews. A total of 196 reviews were included in the analysis. The triple-duty interventions identified were sustainable agriculture practices and school food programmes. Labelling, reformulation, in-store nudging interventions and fiscal measures showed double-duty potential across outcomes. Labelling also incentivises food reformulation by the industry. Some interventions (i.e., school food programmes, reformulation, fiscal measures) reduce socio-economic differences in diets, whereas labelling may be more effective among women and higher socio-economic groups. A trade-off identified was that healthy food provision interventions may increase food waste. Overall, multi-component interventions were found to be the most effective to improve nutrition and inequalities. Policies combining nutrition and environmental sustainability objectives are few and mainly of the information type (i.e., labelling). Little evidence is available on the policies/interventions' effect on environmental sustainability and women's empowerment. Current research fails to provide good-quality evidence on food systems policies/interventions, in particular in the food supply chains domain. Research to fill this knowledge gap is needed.

Keywords Global Syndemic · Sustainable food systems · Food policy · Healthy diets · Environmental sustainability

✉ Celia Burgaz
celia.burgaz@sciensano.be

[1] Department of Epidemiology and Public Health, Sciensano, Brussels, Belgium

[2] Department of Geosciences, Environment and Society, Université Libre de Bruxelles, Brussels, Belgium

[3] Department of Public Health and Primary Care, Ghent University, Ghent, Belgium

[4] Center for Nutrition and Health Research, National Institute of Public Health of Mexico, Mexico City, Mexico

[5] FIC Argentina (InterAmerican Heart Foundation Argentina), Buenos Aires, Argentina

[6] Laboratoire de Recherche en Nutrition Alimentation Humaine, Université Cheikh Anta Diop, Dakar, Senegal

[7] Chronic Diseases Management Unit, African Population and Health Research Center, Nairobi, Kenya

[8] School of Population Health, University of Auckland, Auckland, New Zealand

[9] Department of Translational Physiology, Infectiology and Public Health, Ghent University, Ghent, Belgium

[10] Deakin University, Global Centre for Preventive Health and Nutrition (GLOBE), Melbourne, Australia

1 Introduction

Food systems impact both human and planetary health. Nearly one-third of the global population is experiencing some form of malnutrition (underweight, stunting, wasting, micronutrient deficiencies, overweight and obesity) (Abarca-Gómez et al., 2017). In particular, the prevalence of obesity has increased worldwide over the past 50 years, reaching pandemic proportions (Blüher, 2019). According to the latest figures by the Food and Agriculture Organization of the United Nations (FAO), about 13% of the global adult population suffers from it (Food and Agriculture Organization of the United Nations, 2017), and this number is expected to keep increasing to 17.5% by 2030 (Global Obesity Observatory, 2022). This trend is driven by a transition from traditional diets (with a high intake of fibre and grains) towards unhealthy and increasingly ultra-processed food consumption patterns (Baker et al., 2020; Browne et al., 2020), defined by a high consumption of meat, sugar, oils, and fats (Sproesser et al., 2019). Moreover, due to its link to nature, much of the environmental damage related to food systems occurs at the agricultural production stage (Campbell et al., 2017; OECD, 2021), considerably contributing to climate change and environmental degradation (e.g. deforestation, desertification, air, soil and water contamination) (Whitmee et al., 2015). Food systems are also acknowledged to cause 34% (25–42%) of man-made greenhouse gas emissions (GHGE) (Crippa et al., 2021) and 86% of biodiversity loss worldwide (Environment, 2021). Besides, food systems are also acknowledged to contribute to major nutritional inequities for undernutrition and obesity (Swinburn et al., 2019), as lower socio-economic groups are less likely to meet dietary recommendations and are more likely to have overweight or obesity (Løvhaug et al., 2022). Along the same line, vulnerable groups (e.g. migrant populations, Indigenous peoples, elderly populations, pregnant and lactating women, young children, youth…) are more susceptible to food insecurity, poor nutrition/unhealthy diets, and to developing diet-related non-communicable diseases (NCDs) (Devine & Lawlis, 2019; Schipanski et al., 2016). Therefore, the ways in which food is produced, processed, packaged, distributed, labelled, priced, consumed, or wasted represent key areas of potential intervention to reverse current unsustainable production and consumption trends.

The need for an urgent global transformation of current food systems is widely agreed by the scientific community (Swinburn et al., 2019; Willett et al., 2019), as they shall provide food security and nutrition for a world population projected to grow to nearly 10 billion by 2050 (Food and Agriculture Organization of the United Nations, 2017). One of the most promising and impactful ways to address nutrition and health issues, climate change and environmental degradation is by changing the way in which we produce and consume food. Because of their active and key role within the production, provision and consumption of food, women should be at the centre of such transformation (Benítez et al., 2020; Haby et al., 2016). Giner et al. (2022) highlighted that fostering gender inclusion can have positive impacts on the challenge of ensuring food security and nutrition for a growing population, in an environmentally sustainable way. Growing evidence suggests that certain population-level dietary shifts could simultaneously improve human health and environmental sustainability (Aleksandrowicz et al., 2016; Nelson et al., 2016; Perignon et al., 2017; Stewart et al., 2023; Willett et al., 2019). These shifts are necessary to attain Sustainable Healthy Diets, defined as dietary patterns that promote all dimensions of individuals' health and wellbeing; have low environmental pressure and impact; are accessible, affordable, safe and equitable; and are culturally acceptable (FAO & WHO, 2019).

Policy-makers have an impactful role in the promotion of healthy and sustainable food practices (Hawkes et al., 2015; Lybbert & Sumner, 2012), as they are involved in the design and implementation of policies/interventions such as subsidies/incentives for farmers, multilateral agreements, mandatory food labelling, reformulation or taxes, among others. Hence, to transition to healthy and sustainable food systems, it is essential to understand the effectiveness of policies/interventions, and to identify their ability to simultaneously reduce the burden of the "Global Syndemic", a concept was used by Swinburn et al. (2019) to describe the three ongoing pandemics affecting most people in every country and region worldwide: undernutrition, obesity and climate change (Swinburn et al., 2019). Based on this, triple-duty actions for governments were proposed to address them, given that these pandemics share common drivers and solutions. As these policies/interventions may drive positive changes in current food systems, a comprehensive overview of the latest evidence of their effectiveness is needed. While there is evidence on the effectiveness and potential of double- and triple-duty actions specifically targeting children (Venegas Hargous et al., 2023), the effectiveness of food systems policies/interventions across populations, disaggregated by gender or population groups, has not been systematically summarized.

2 Aim

The aim of this scoping review was to identify and synthesize the existing international evidence on the effectiveness of public sector food systems policies and

interventions to improve nutrition, nutrition-related inequalities and environmental sustainability outcomes, and thus identify potential double- or triple-duty policies. A secondary objective was to identify the potential of such policies/interventions to address nutritional vulnerabilities and women's empowerment.

3 Methods

3.1 Compilation of international policy recommendations and definition of policy (sub)domains and outcomes studied

In recent years, scientists, international institutions, global or regional organisations have published an increasing number of recommendations to create sustainable food systems (SFS), with a major focus on policy recommendations for governments. In a first step, a desk review was conducted to identify actions that governments can implement towards SFS. The recommendations were gathered and compiled from key reports, scientific papers and guidelines published by international organisations and academics. Once compiled, the recommendations were classified according to the identified food systems policy areas (divided in "domains" and "(sub)domains"), and were used during the search strategy as keywords for policies/interventions. More information about the search terms is available in Supplementary File 2.

The second step was to define the nutrition-related outcomes, nutrition-related inequalities and environmental sustainability outcomes that can be impacted by the prior-identified recommended food system policies/interventions. These primary outcomes were defined by taking into consideration the global health challenges depicted in the international reports, and approved by experts in public health nutrition (SV) and in environmental sustainability (WA). For nutrition-related inequalities, drawing on previously used definitions (McCartney et al., 2019), we use the term to indicate systematic differences in dietary quality between different population groups, linked either to their gender or to their socio-economic position. In addition, nutritional vulnerabilities and women's empowerment were included as 'secondary outcomes', as they are not direct outcomes of the global Syndemic and not considered when assessing the double- or triple-duty potential of policies/interventions, but in a non-linear way they are simultaneously drivers and outputs common for the three pandemics. The term "nutritional vulnerabilities" refers to indicate those population groups that tend to be more susceptible to the double burden of malnutrition (i.e., children, pregnant/lactating women, ethnic minorities, Indigenous communities, farmers, elderly population). Women's empowerment is used to indicate an increase of women's access to control over the strategic life choices that affect them and to the opportunities that allow them fully to realize their capacities (Y.-Z. Chen & Tanaka, 2014). Lastly, two identified (sub)domains were also included as potential outcomes, as they can be impacted by other food systems policies/interventions: (1) food loss and waste and (2) food composition. A summary of the (sub)domains, the outcomes and their definitions are available in Table 1.

3.2 Protocol and registration

The scoping review followed the Preferred Reporting Items for Systematic Reviews and Meta-Analysis guidance (PRISMA-ScR) using a checklist and explanation from Tricco et al. (2018). As appropriate for a scoping review, the protocol was developed iteratively, informed by the results of initial literature searches and in consultation with international food policy experts. The protocol (osf.io/g8p36) was registered with the Open Science Framework (OSF) on 21st December 2021, prior to undertaking the narrative synthesis.

3.3 Search strategy

The following research question was investigated: "What is the body of evidence on the effectiveness of food system policies and interventions to improve nutrition-related outcomes, nutrition-related inequalities and/or environmental sustainability outcomes?". The term "food system policies" was used in the review to describe public sector policies/interventions impacting the production, processing, transport, consumption and waste of food. The term "sustainable food system" was described using the FAO concept described in 2018, as a food system that delivers food security and nutrition for all in such a way that the economic, social and environmental bases to generate food security and nutrition for future generations are not compromised (FAO & WHO, 2019). In addition, and when identified in the review, synergies (for policies/interventions with double or triple duty potential that have an effect on two or more outcomes) and trade-offs (when a policy/intervention has a positive effect on one outcome but a negative effect in another one) were also considered during the analysis. Given the enormous volume of literature, it was decided that the search would focus on evidence from the following types of peer-reviewed publications: scoping reviews, umbrella reviews, systematic literature reviews (with or without meta-analyses), narrative reviews and policy reviews.

The search strategy was piloted in May 2021 using the electronic database Scopus, within the policy domain of food supply chains. Based on the piloting, parameters such as the timeline were adjusted and the definitive literature search was conducted in July 2021 across four electronic databases (Scopus, Medline, Embase, Web of Science).

Table 1 Classified food policy domains and (sub)domains (extracted from the compilation of policy recommendations addressing food systems), and defined outcomes potentially impacted by food systems policies or interventions

Policy domains	(Sub)domains	Definitions
Food supply chains	Food production	Policies/interventions developed and implemented to ensure that the way in which food is produced aligns with principles of environmentally sustainable agriculture practices (reducing GHGE and the use of natural resources, and respecting biodiversity), and produces healthy and environmentally sustainable foods for present and future generations.
	Food storage, processing, packaging and distribution	Policies/interventions developed and implemented to ensure that food is stored, transformed, packaged and transported following healthy and/or environmental sustainability principles (such as reducing plastic packaging, investing on infrastructure support to prevent food loss, fortify foods with vitamins or minerals).
	Food loss and waste	Policies/interventions developed and implemented to ensure that fewer food is loss during harvest and post-harvest, and that fewer food is wasted at retail level.
	Food trade and investment	Policies/interventions developed and implemented to ensure that trade and investment agreements protect food sovereignty, favour healthy diets/nutrition for the population, and protect environmental sustainability, linking domestic health and agricultural policies in ways which are consistent with healthy and environmentally sustainable objectives.
Food environments	Food composition	Policies/interventions developed and implemented to ensure that processed foods are reformulated to minimise the energy density, the nutrients of concern (salt, saturated fats, trans fats, added sugar) and/or the use of ingredients environmentally unsustainable (e.g. palm oil), where practicable.
	Food labelling	Policies/interventions developed and implemented to ensure that there is a regulatory system for consumer-oriented labelling on food packaging and/or menu boards in restaurants, that enables consumers to easily make informed food choices and to prevent misleading claims.
	Food promotion	Policies/interventions developed and implemented to ensure a reduction of the impact (exposure and power) or promotion/marketing of unhealthy and/or unsustainable foods across all media. The exposure of food marketing concerns the reach and frequency of a marketing message (across media, channels or online), and the creative content of messages (such as cartoons, celebrities).
	Food provision	Policies/interventions developed and implemented to ensure that there are healthy and/or environmentally sustainable food options in public settings (such as schools, universities, hospitals), and/or to ensure that food provision encourages healthier/more environmentally sustainable choices.
	Food retail	Policies/interventions developed and implemented to support the availability of healthier/more environmentally sustainable food options in retail sector and/or limit the availability of unhealthier/less environmentally sustainable foods in communities (outlet density and locations) and in-store (product placement).
	Food prices	Policies/interventions developed and implemented to ensure that food prices (e.g. taxes, subsidies) and/or food benefit programmes or food backs are aligned with health and environmental sustainability outcomes.

Table 1 (continued)

Primary outcomes	
Nutrition-related outcomes	
Undernutrition	Food insecurity Wasting Stunting Underweight Micronutrient (vitamin and/or mineral) deficiencies
Healthy diets	Dietary quality (diversity, variety, indices, patterns) Diet intake/food purchase (Exclusive) breastfeeding in the first six months of life
Obesity/diet-related NCDs	High body mass index (BMI) Overweight prevalence Obesity prevalence Other diet-related non-communicable diseases (NCDs)
Nutrition-related inequalities	
Equity	Socio-economic inequalities in food access/nutrition Gender inequalities in food access/nutrition
Environmental sustainability outcomes	
Environmental sustainability	Vegetation and/or biodiversity loss Greenhouse gas emissions (GHGE) Soil erosion Ecotoxicity Acidification Freshwater use Water scarcity Eutrophication Land use Land degradation and desertification Land use change Deforestation Mineral resources (nitrogen and phosphorus) use
Secondary outcomes	
Nutritional vulnerabilities	Includes: children, pregnant/lactating women, ethnic minorities, Indigenous communities, farmers, elderly population.
Women's empowerment	Refers to the process of increasing women's access to control over the strategic life choices that affect them and access to the opportunities that allow them fully to realize their capacities (Chen & Tanaka, 2014).
Subdomains also evaluated as outcomes	
Food supply chains	Food waste
Food environments	Food composition

The search strategy was created using Scopus as the reference database, and terms and keywords were adapted to be applied in the other databases. More information about the search terms is available in Supplementary File 2. In addition to database searches, seven additional papers were manually added based on co-authors suggestions of online published reviews on the topic.

3.4 Eligibility criteria

Reviews had to assess the impact of food system policies/interventions on nutrition-related outcomes, nutrition-related inequalities and/or environmental sustainability outcomes in order to be eligible. The detailed set of inclusion and exclusion criteria applied is given in Table 2.

3.5 Data selection

All search results were downloaded as reference files and assembled as a final library using *Zotero Reference Manager*. Duplicates were removed across databases. The remaining results were screened in accordance with PRISMA guidelines: first at title and abstract level, then at full-text level.

For the title screening, the reviews identified through the database search were exported to the online bibliographic database *Rayyan* (Qatar Computing Research Institute, Data Analytics, Doha, Qatar). Title and abstract screenings were conducted by one researcher (CB). Any duplicates that were not identified by Zotero's duplicate removal were manually removed. The screening phase entailed careful reading of each individual title and abstract, and then, based on predetermined inclusion criteria the decision whether to include a review or not was made by one researcher (CB). A second researcher (VG) randomly selected 10% of the total number of abstracts identified, and independently screened the title and abstract of the reviews. Disagreements were solved by discussion and assessment by a third researcher (SV). If there was any remaining doubt about eligibility, the study was included in the next step. If after the screening process the eligibility of certain studies remained unclear, it was solved by a discussion with the third researcher (SV).

Full-text reviews of potentially relevant publications were located and appraised by one researcher (CB) to select those meeting the inclusion criteria. The second researcher (VG) randomly selected 10% of the total number of full-text articles identified and independently applied the inclusion criteria. Disagreements were solved by discussion and assessment by the third researcher (SV). If no full text was available, the respective review was excluded from analysis but was included in a list of unobtainable articles [Supplementary File 3].

3.6 Data extraction

Data extraction of all included reviews was conducted by the first author (CB) in an Excel file using a prior defined table, which included the following fields: year, author(s), review type, review aim, study details (population targeted, geographical locations, setting), types of policies/interventions [according to the policy domains and (sub) domains], outcomes measured (primary outcomes, secondary outcomes – if any, double/triple duty potential, synergies and/or trade-offs identified – if any), type of impact (positive, neutral, negative, inconsistent/mixed) on primary and secondary outcomes, quality of the review and additional comments. For the final stage of full text screening, in case of uncertainty, full texts were read and screened by the third author (SV).

3.7 Synthesis of results

A meta-analysis was not possible due to the broad scope of this review and the great variability in analysed policies/interventions, outcomes and quantitative outputs which were not available in a consistent way across reviews. Instead, a qualitative summary of findings was generated using thematic analysis and narrative synthesis. Results are presented by policy (sub)domain and by outcome as defined in Table 1. The summarised information gathered per policy (sub)domain allows the reader to understand the evidence available by policy/intervention areas.

In terms of effectiveness, whenever possible, the overall direction of results for each policy/intervention was described as follows:

a **Positive (⇧)**: the effect of the policy/ intervention contributed to reduce undernutrition and/or obesity/NCDs, to improve nutrition/healthy diets, environmental sustainability, and/or women's empowerment, and/or to reduce inequalities (socio-economic, gender, vulnerable populations) in diets;

b **Neutral (⇔):** there was no statistical difference in effects in outcomes after the policy/intervention implementation, or no effects of the policy/intervention were detected;

c **Negative (⇩):** the effect of the policy/intervention contributed to increase undernutrition and/or obesity/NCDs, to deteriorate nutrition/diets or environmental sustainability and/or women's empowerment, or to increase inequalities (socio-economic, gender, vulnerable populations) in diets;

d **Inconclusive/mixed (~):** the results were inconsistent (mixed results) across the reviews, so conclusions could not be reached in this review.

Table 2 Inclusion and exclusion criteria applied

	Included	Excluded
Scope	The review assessed the effectiveness of one or more of the identified policies/domains (food supply chains, food environments)	The review did not assess the effectiveness of the identified policies/domains (food supply chains, food environments)
Type of study	Reviews (systematic reviews, scoping reviews/umbrella reviews, narrative reviews, policy reviews) For food supply chains: review may include modelling in addition to empirical studies For food environments: review only includes empirical studies	Primary studies For food environments: results from modelling studies included in the reviews were not considered. If a review was based solely on modelling studies, the review was excluded.
Objective	To investigate the effect of population-level policies or interventions promoting healthy, equal and/or sustainable food systems	To give policy recommendations, analyse implementation challenges of policies, or just analyse policy initiatives but not carrying out a policy evaluation of the effectiveness. To assess food environments or systems and linkages with health/environmental outcomes
Implementation level	Multinational, national, subnational/local, community or settings (schools, universities, healthcare centre, restaurants, stores, households, etc.)	Individual level interventions
Type of interventions	Interventions with a focus on food supply chains or food environments. These include both demand-side as well as supply-side interventions We included environmental interventions, defined as interventions that aim to alter the food and beverage environment in a way which can, in principle, be permanent. Those interventions can include, among others public procurement schemes, fiscal policies (i.e. taxes, subsidies), agricultural policies and practices, macroeconomic policies and trade agreements, environmental interventions that change the context, defaults and norms of production or consumption (i.e. nudge, catering provision, store layouts), school interventions that alter the food environment (i.e. changes in canteen provision), labelling initiatives, food fortification, reformulation (both voluntary or mandatory), and other regulations that have an impact on food consumption or health (i.e. marketing restrictions for unhealthy foods)	Private sector interventions/commitments not implemented or incentivised by public policies (except for: voluntary food reformulation, marketing restrictions and pledges, as those interventions can be promoted or incentivised by the public sector) Media or other mass campaigns Education programs Interventions that alter the food and beverage environment temporarily with the aim of influencing individual preferences (i.e., one-off public media campaigns, educational programmes) were considered as behavioural change theory interventions and therefore were not included in this review.
Population	Groups from the general population (children, adults and elderly) or vulnerable populations (pregnant women, indigenous communities, lower socio-economic groups)	Specific population groups selected on the basis of suffering from diseases or pre-existing comorbidities (i.e. those with type 2 diabetes, hypertension or diet-related cancer)
Language	English	Any other language apart from English
Geographical area	Studies may be from any geographical region or country income group (high, middle and low-income countries)	*No limitation*
Time range	For food supply chains, reviews published online within the last 20 years were considered (2001–2021); for food environments, as we estimate there is enough recent evidence, we limited our search to reviews published online within the last 10 years (2011–2021)	For food supply chains, reviews published before 2001; for food environments, reviews published before 2011
Comparator	Reviews with and without comparators	*No limitation*
Outcomes	All outcomes of interest that fall into the three following categories: nutrition-related outcomes (under-nutrition, over-nutrition, nutrition), diet-related inequalities (socio-economic inequalities), and environmental sustainability outcomes [according to Table 2]	All intervention strategies on food safety, anti-microbial resistance, cost-effectiveness; reviews focused on strategies that targeted the treatment or management of eating disorders (i.e. anorexia nervosa or bulimia) or other diseases; reviews of intervention strategies undertaken only in laboratories or other simulated contexts (i.e. laboratory-based experiments of infant feeding practices) without considering information of real world experiments; and reviews examining intervention mechanisms (i.e. theory-based mechanisms of effect), or in which the effects of intervention components were synthesised at the level of individual behaviour change techniques

e **No data (0):** there is a gap in the literature.

In the cases where final result was "inconclusive/mixed" additional explanations gathered from the results of each review are given to clarify the different effects identified, and potential explanations for each direction.

There was not a set magnitude or intensity of the results defined that must be exceeded for a review of interventions to be considered positive, and the overall decision was made based on the most common reported effect of the policies/interventions and, when results were even, on the reviews that were assessed of high or moderate quality, as explained below.

3.8 Assessment of methodological quality

The methodological quality of included systematic reviews was assessed by one author (CB) using AMSTAR-2, a Measurement Tool to Assess Reviews (Shea et al., 2017). The AMSTAR-2 is a 16-item validated quality assessment tool that allows for inclusion of both randomized and observational studies and as such, is not intended to be scored. For each AMSTAR-2 criterion, a score of one was assigned if 'yes' was the response, otherwise a score of zero was assigned. A study-specific global score, ranging from zero to sixteen, was calculated by summing up scores across all flaws. The quality of a 10% random selection of the total number of articles was evaluated by the second researcher (VG) using AMSTAR-2, randomly selected. Any possible disagreement at this stage was solved by discussion and assessment by a third researcher (SV).

As suggested by Shea et al. (2017), we consider as critical flaw all the indicators proposed by the guidelines, but we decided to count as a critical weakness (instead of just weakness) the criterion 16 ("Did the review authors report any potential sources of conflict of interest, including any funding they received for conducting the review?") as this could be an important aspect to take into account based on the increasing evidence of commercial influences on the development of policies (Lee et al., 2022; Mialon, 2020). The quality appraisal was focused at the review level and not at the individual study level. The quality assessment of each review, based on the scores shown in Table 3, was used to interpret the results of reviews when synthesized and in the formulation of conclusions. Reviews were not included or excluded based on quality.

Table 3 Scores used for determining the quality of the reviews, according to AMSTAR-2 guidelines

	Systematic reviews and meta-analyses		**Other reviews***	
Quality score	*Critical flaws*	*Total flaws*	*Critical flaws*	*Total flaws*
High	*8*	*(16)*	*7*	*(14)*
Moderate	*8*	*(14–15)*	*7*	*(12–13)*
Low	*8/7*	*(≤13)*	*7/6*	*(≤11)*
Critically low	*≤6*	*(≤13)*	*≤5*	*(≤11)*

*systematic reviews, scoping reviews/reviews of reviews, umbrella reviews, narrative reviews, policy reviews

4 Results

4.1 Compilation of international policy recommendations and definition of policy (sub)domains and outcomes studied

A total of 23 global reports, papers and guidelines providing a complete representation of SFS-related policy recommendations for governments were compiled by the first (CB) and the last authors (SV). All the recommendations identified were then classified by policy area, and grouped to define two policy domains and ten (sub) domains. The domain of "food supply chains" included: (1) food production, (2) food storage, processing, packaging and distribution, (3) food loss and waste, and (4) food trade and investment agreements. The domain of "food environments" included: (1) food composition, (2) food labelling, (3) food promotion, (4) food provision, (5) food retail and (6) food prices. The definition of each (sub) domain is included in Table 1. A summary of the number of policy recommendations and their sources is included in Supplementary File 1.

4.2 Data selection and extraction

Initially, 16,221 articles were identified, of which 7000 were removed as duplicates. From the initial 9,228 records screened, 416 were selected for the assessment of eligibility at full-text level. A total of 196 reviews met the inclusion criteria. The agreement between the reviewers during the initial screening of titles and abstracts was fair (87%), while the agreement rate at the full-text stage was excellent (93%). All disagreements were solved by a third researcher (SV). The screening process and results

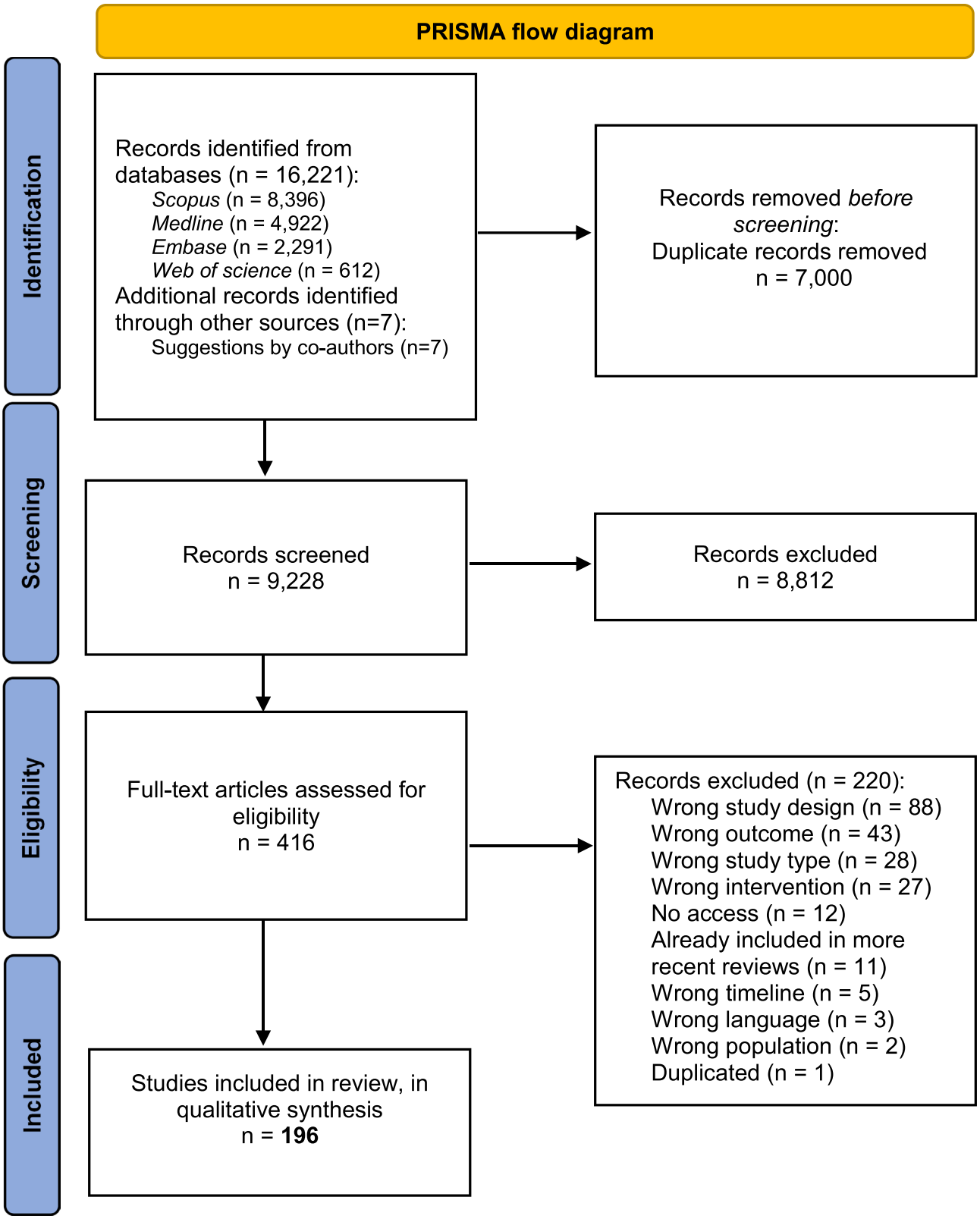

Fig. 1 PRISMA flow diagram. Presentation of the procedure of literature searching and selection with numbers of articles at each stage

are depicted in Fig. 1, and detailed information on the reasons for exclusion of each review is available in the Supplementary File 3.

This scoping review covered worldwide reviews that varied in intervention types, geographic location, setting, population group, study designs, and methods of measuring outcomes. The number of reviews evaluating each policy (sub)domain is presented in Fig. 2. The total number is higher than 196 because 35 reviews included more than one policy (sub)domain and 10 focused on multi-component interventions that allowed for separate (sub)domain analysis. However, 15 reviews on multi-component interventions did not allow for separate (sub) domain analysis.

4.3 Overall summary of the results and quality assessment

A high-level overview of the policies/interventions studied by (sub)domain and their potential effectiveness for the outcomes identified are shown in Table 4. Further details of the characteristics of the included reviews (geographic locations, population studied, settings, objectives, conclusions, number of studies included in each review) can be found in the Supplementary File 3. The agreement between the reviewers for the quality was fair (60%). Disagreements were resolved by the third reviewer (SV). The total quality scores of the reviews included in this scoping review ranged from 2 to 16: 7 reviews were considered as high quality, 36 as moderate, 72 as low, and 81 as critically low quality.

4.4 Food supply chains

We identified 46 reviews analysing policies/interventions within the food supply chains domain. Undernutrition was the most studied outcome (n = 38), followed by nutrition/healthy diets (n = 33). For outcomes related to environmental sustainability (n = 10) and nutrition inequalities (n = 8), the evidence remains scarce. A total of 34 reviews analysed the effects of policies/interventions on nutritionally vulnerable populations, while women's empowerment was included in 8 reviews. More information on study settings, geographic location, parameters measured, and summary tables of each review included on the food supply chains domain is available in the Supplementary File 4.

4.5 Food production

The policies/interventions analysed in the reviews included: agroforestry interventions, home/school gardens, nutrition-sensitive agricultural (NSA) interventions, bio-fortification,

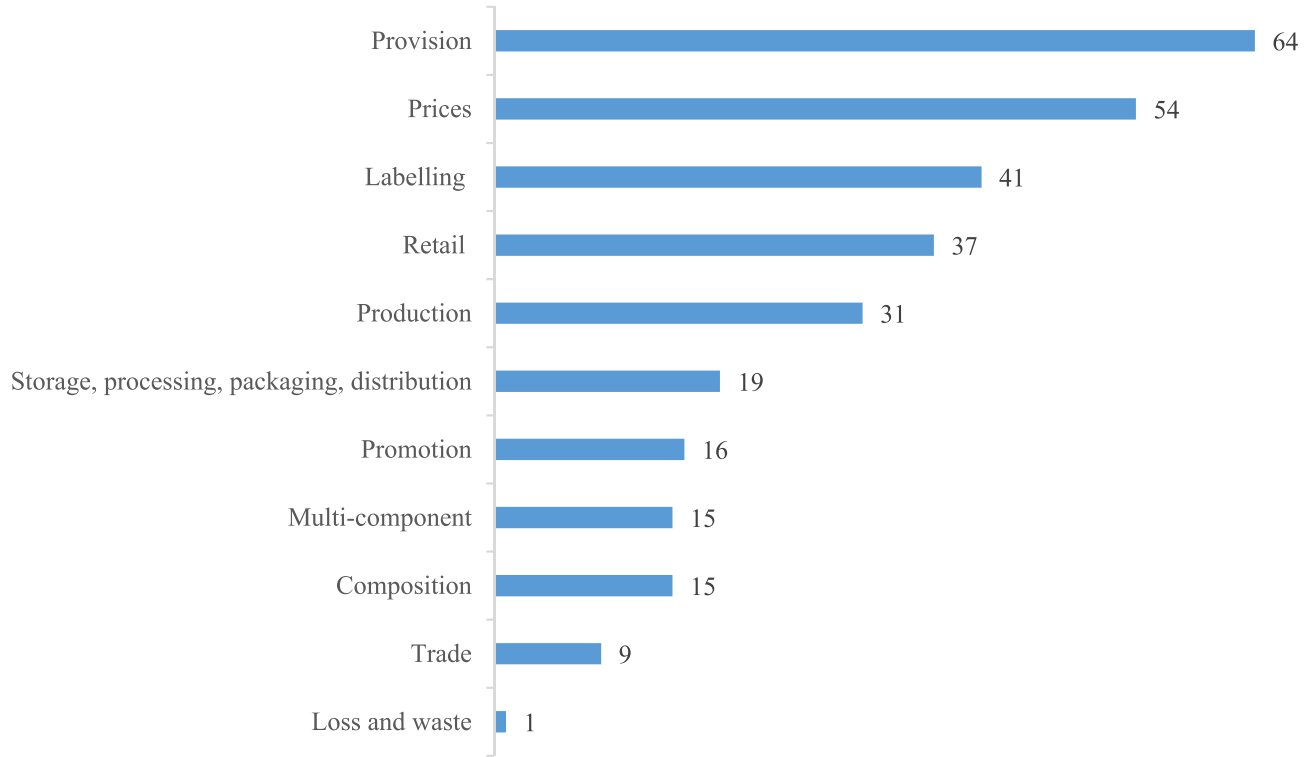

Fig. 2 Overall number of reviews gathered evaluating each policy (sub)domain

Table 4 Summary of evidence per policy (sub)domains and the overall direction of results per outcomes

			Primary outcomes					Secondary outcomes	
			Undernutrition	**Nutrition/ healthy diets**	**Obesity/ NCDs**	**Environmental sustainability**	**Equity**	**Nutritional vulnerabilities**	**Women's empowerment**
Food supply chains	Policy (sub) domains	**Production**	↑	↑	↔*	↑*	0	↑	↑*
		Storage, processing, packaging, distribution	↑	↑*	~	↑*	~	↑	0
		Loss and waste	0	0	0	↑*	0	0	0
Food environments		**Trade and investment**	↓*	~	↓*	0	↓*	~	↓*
		Composition	0	↑	↑*	0	↑*	↑*	0
		Labelling	0	↑	↑*	↑*	↓*	~	0
		Promotion	0	↑*	0	0	0	↔*	0
		Provision	↑*	↑	↑*	↑*	~	↑*	0
		Retail	↑*	↑	↑*	0	~	↑	0
		Prices	↑*	↑	~	0	↑*	↑	0

Legend: ↑: overall positive effect; ↔: overall neutral effect; ↓: overall negative effect; ~: inconclusive/mixed results; 0: no data/literature gap; *: the overall evidence goes towards that direction but the data available based on reviews is still limited. The results from fifteen multi-component interventions are not represented in this table, as the methods used did not allow for separate analyses of outcomes for different intervention components

crop diversification, intercropping, integrating crop and livestock, livestock production and management, specific management strategies to reduce environmental sustainability challenges (e.g. soil erosion, land and water use, biodiversity loss…), agricultural input subsidies, output price policies and urban agriculture programmes.

4.5.1 Primary outcomes: undernutrition, obesity/NCDs, environmental sustainability, nutrition inequalities

The reviews describing the impacts of food production policies/interventions on undernutrition and nutrition/healthy diets reported an overall positive effectiveness, particularly for agroecology, crop diversification, bio-fortification and home/school gardens. Similarly, those reviews analysing the impact on environmental sustainability showed overall positive effects, in particular for no-tillage agriculture interventions. However, from the reviews analysing the effects on obesity/NCDs, one showed positive results (Prescott et al., 2020), two found no effects (Haby et al., 2016; Pullar et al., 2018) and five did not find enough data (Bird et al., 2018; Browne et al., 2020; Holley & Mason, 2019; Naik et al., 2019; Walls et al., 2018). Those including nutrition inequalities in their analysis did not find consistent results either (Black et al., 2017; Haby et al., 2016; Holley & Mason, 2019; Naik et al., 2019).

4.5.2 Secondary outcomes: nutritional vulnerabilities and women's empowerment

Most reviews that reported results on nutritionally vulnerable populations showed an overall positive impact on their nutrition status, except for three that reported insufficient or mixed effects on children, and lactating/pregnant women (Smith et al., 2013; Black et al., 2017; J. L. Finkelstein et al., 2019). All the interventions incentivising garden-based programmes in schools found consistent positive effects among children. From the reviews analysing the impact of policies/interventions on women's empowerment, five found positive results (Castle et al., 2021; Feliciano, 2019; Pandey et al., 2016; Sharma et al., 2021; Walls et al., 2018), one found inconsistent/mixed results (Kadiyala et al., 2014) and another found no data to determine effects (Wordofa & Sassi, 2020).

4.5.3 Food production: synergies and trade-offs

Double-duty policies/interventions were identified in some reviews (Castle et al., 2021; Feliciano, 2019; Kadiyala et al., 2014; Sharma et al., 2021). NSA, crop diversification and agroforestry interventions may have a positive effect both for undernutrition and environmental sustainability (soil erosion), and are potentially beneficial for women's empowerment. School garden interventions have a positive impact on both undernutrition (micronutrient deficiencies) and nutrition/healthy diets (diet intake and variety) among children (Masset et al., 2012). Two trade-offs were identified across outcomes: (1) water desalination strategies can increase GHGE despite being beneficial for freshwater use (El Chami et al., 2020); (2) school garden-based interventions may increase food waste, despite improving nutritional outcomes (Prescott et al., 2020).

4.6 Food storage, processing, packaging and/or distribution

The vast majority of the reviews included in this sub(domain) analysed policies/interventions related to food processing, most of them on food fortification (increasing the nutrient value of foods by fortifying them with vitamins and minerals) or supplementation, either mandatory or voluntary, and one on source of the ingredients replacement towards organic products. One review (Browne et al., 2020) also included food distribution interventions, focusing on improved food and water supply (transport) to underserved community settings. Food packaging interventions was evaluated in one review that included changes in types of packaging and in the estimations of food portion sizes (Almiron-Roig et al., 2020). None of the reviews focused on food storage policies/interventions.

4.6.1 Primary outcomes: undernutrition, obesity/NCDs, environmental sustainability, nutrition inequalities

Most of the reviews on the impacts of policies/interventions on undernutrition, focusing on micronutrient deficiencies (mainly on vitamin A, iron, iodine, folate and zinc; and less commonly on vitamin D and calcium), stunting, wasting and birthweight, found overall positive effects (Almiron-Roig et al., 2020; Best et al., 2011; Browne et al., 2020; Das et al., 2013; Dewi & Mahmudiono, 2021; Iglesias Vázquez et al., 2019; Menon & Peñalvo, 2019a, 2019b; Mithra et al., 2021; Morilla-Herrera et al., 2016; Poscia et al., 2018; Pratt, 2015; Tam et al., 2020). Nutrition/healthy diets was assessed in reviews describing the effects of policies/interventions related to food fortification programmes and food packaging and portion size, showing overall positive effects (Browne et al., 2020; Campos Ponce et al., 2019; Morilla-Herrera et al., 2016; Poscia et al., 2018), while the effects on obesity/NCDs from distribution and food processing interventions remain mixed/inconsistent (Browne et al., 2020; Menon & Peñalvo, 2019b; Poscia et al., 2018; Thomson et al., 2018). The review on ingredients replacement found positive effects on environmental sustainability (Takacs & Borrion, 2020). From the reviews evaluating nutrition

inequalities associated to food fortification programmes, one found positive effects (Iglesias Vázquez et al., 2019) while the other, more detailed and of higher quality, showed mixed results (Thomson et al., 2018).

4.6.2 Secondary outcomes: nutritional vulnerabilities and women's empowerment

The majority of the reviews analysing effects on nutritionally vulnerable populations reported an overall positive impact on their nutrition status, except for three that reported no effects on children (Gera et al., 2019; Pachón et al., 2015; Sguassero et al., 2012), and one that found lack of evidence for mandatory fortification in HICs (Thomson et al., 2018). None of the reviews analysed the impact on women's empowerment.

4.6.3 Food storage, processing, packaging and distribution: synergies and trade-offs

One review (Poscia et al., 2018) suggested that micronutrients supplementation could be beneficial to prevent undernutrition and obesity/NCDs in elderly populations, as it ameliorates the intake of protein and energy, improving weight-related outcomes. For this (sub)domain, no trade-offs were identified.

4.7 Food loss and waste

None of the reviews evaluated in isolation the effectiveness of policies/interventions implemented to tackle food loss and/or waste. Only one review of critically low quality (Takacs & Borrion, 2020), analysed the impact of mandatory food waste prevention measures undertaken in catering settings, involving the optimisation of the planning system to reduce overproduction, and the donation of leftovers to food banks. The results showed an overall positive effect of such interventions on environmental sustainability parameters, but with lower improvement potential when compared to other interventions, such as the replacement of ingredient sources (included under food processing).

4.7.1 Food waste as an outcome

Food waste was evaluated as an outcome in some reviews. Within food prices, subsidy programmes (vouchers) in LMICs may be a strategy to reduce waste during the highest seasons of food insecurity (Urgell-Lahuerta et al., 2021). Within food provision, some policies/interventions to improve children or adults' dietary diversity in public settings have shown to increase food waste (Brennan & Browne, 2021; Metcalfe et al., 2020; Prescott et al., 2020). However, a similar intervention was linked to a reduction of the food wasted (Mansfield & Savaiano, 2017).

4.8 Food trade and investment

The food trade policies/interventions analysed in the reviews included: global trade policies, regional trade agreements, output price policies (OPP), trade liberalisation policies (such as tariffs removal, border liberalisation, elimination of quantitative restrictions, reduction of input and production subsidies, liberalisation of agricultural markets) and public distribution system policies (PDSP).

4.8.1 Primary outcomes: undernutrition, obesity/NCDs, environmental sustainability, nutrition inequalities

Most of the reviews describing the effect of trade on undernutrition found overall negative impacts of current food trade policies, reporting that the main regulatory framework of such policies focuses on economic growth (Kadiyala et al., 2014; Loewenson et al., 2010), increasing the prices of food commodities leading to higher numbers of undernutrition in some areas (Kadiyala et al., 2014; Loewenson et al., 2010). In this line, some reviews linking trade agreements with nutrition/healthy diets, reported an increase of the intake of unhealthy products [i.e., processed foods and sugar-sweetened beverages (SSBs)] (Barlow et al., 2017; Turner et al., 2019). However, the overall effects of such policies on nutrition/healthy diets remain mixed, as other reviews included found positive or mixed effects (Hyseni, Atkinson, et al. 2017; Naik et al., 2019). The reviews reporting the effects of trade policies on obesity/NCDs did not find enough data, except for one that reported negative impacts (Barlow et al., 2017). Similarly, those reviews evaluating the nutrition inequalities of trade policies/interventions found negative effects across socio-economic groups (Dangour et al., 2013; Naik et al., 2019). No data was found on environmental sustainability outcomes (Haby et al., 2016).

4.8.2 Secondary outcomes: nutritional vulnerabilities and women's empowerment

The reviews including nutritionally vulnerable populations (i.e., children, women, farmers) reported mixed results (Dangour et al., 2013; Kadiyala et al., 2014; Turner et al., 2019). Two reviews analysed the impact of trade policies on women's empowerment, one found mixed results (Kadiyala et al., 2014),whereas the other reported an overall negative impact, explaining that globalisation-related economic and trade policies have been associated with shifts in women's

occupational roles and resources that contribute to documented poor nutritional outcomes (Loewenson et al., 2010).

4.8.3 Food trade and investment: synergies and trade-offs

No synergies or trade-offs were identified.

5 Food environments

We identified 164 reviews analysing policies/interventions on food environments. Nutrition/healthy diets was the most studied outcome (n = 154), followed by obesity/NCDs (n = 72) and nutritional inequalities (n = 11). The evidence remains scarce on environmental sustainability outcomes (n = 3). The effects on nutritionally vulnerable populations were analysed on 34 reviews, while none of the reviews analysed the impacts of policies/interventions on women's empowerment. More information on study settings, geographic locations, parameters measured, and summary tables of each review included on the food environments domain is available in the Supplementary File 5.

5.1 Food composition

The policies/interventions analysed included food reformulation strategies, either mandatory or voluntary. Most of the reviews analysed the impact of general reformulation strategies for food high in fat, sugar and salt (HFSS) or calories, two focused on sodium (Hyseni, Elliot-Green, et al., 2017; Santos et al., 2021), two on trans-fatty acids (TFA) (Hyseni, Bromley, et al., 2017b) and one on sugar reformulation strategies (von Philipsborn et al., 2019). Only three reviews allowed to make a distinction on the differences in effectiveness between mandatory and voluntary reformulation, concluding that mandatory reformulation generally achieves larger reductions in population-wide intake consumption than voluntary initiatives (Hyseni, Elliot-Green, et al., 2017; Hyseni, Bromley, et al., 2017; Hendry et al., 2015).

5.1.1 Primary outcomes: undernutrition, obesity/NCDs, environmental sustainability, nutrition inequalities

The reviews describing the effect of food reformulation on undernutrition did not find any evidence (Browne et al., 2020; Thomson et al., 2018). All the reviews (n = 15) described the effect of composition on nutrition/healthy diets, linking reformulation strategies with intake of specific nutrients (i.e., sodium, sugar, TFA, calories, fibre, or several HFSS nutrients simultaneously) or specific foods (i.e., whole grains, processed foods, sugar sweetened milks), and reported intake reductions of those nutrients/foods showing overall positive effects. From the reviews analysing the effects on obesity/NCDs, two found positive results (Gressier et al., 2021; Hyseni, Elliot-Green, et al., 2017) while the rest found no evidence (Bonab et al., 2020; Browne et al., 2020; Hyseni, Bromley, et al., 2017; Løvhaug et al., 2022). The review aiming to analyse their impact on environmental sustainability did not find enough information (Temme et al., 2020). Socio-economic inequalities linked to reformulation were analysed in three reviews that found no data (Hendry et al., 2015; Løvhaug et al., 2022; Temme et al., 2020; Thomson et al., 2018), while one found positive effects concluding that mandatory reformulation was equitably distributed among population groups (Hendry et al., 2015). Regarding gender inequalities, no evidence was available (Gressier et al., 2021).

5.1.2 Secondary outcomes: nutritional vulnerabilities and women's empowerment

With regard to nutritionally vulnerable populations (i.e., children, women, low-income, Indigenous populations), two reviews reported positive results (Bonab et al., 2020; Browne et al., 2020) while one reported no effect (Thomson et al., 2018). None of the reviews analysed the impact of reformulation on women's empowerment.

5.1.3 Food composition: synergies and trade-offs

No synergies or trade-offs were identified.

5.1.4 Food composition as an outcome

Food composition was evaluated as an outcome in some reviews related to food labelling (Cawley & Wen, 2018; Hillier-Brown et al., 2017; Rincón-Gallardo Patiño et al., 2020; Russo et al., 2020; Shangguan et al., 2019; Sisnowski et al., 2017) showing positive impacts of front-of-pack nutrition labelling (FOPNL) and menu labelling on food reformulation by the industry.

5.2 Food labelling

The policies/interventions analysed included different food labelling strategies, overall divided into FOPNL (n = 26) and menu labelling (n = 15), either mandatory or voluntary. Reviews described the effectiveness of labels such as nutrition claims, calorie or sugar labelling, warning messages/signs or graphical depictions (i.e., the health star rating, traffic light labelling, high sugar symbol labels, carbon labelling, etc.), but some reviews did not specify the type of food labelling intervention evaluated. Only four reviews (Rincón-Gallardo Patiño et al., 2020; Shangguan et al., 2019; Temme et al., 2020; Tseng et al., 2018) allowed to differentiate between mandatory labelling policies and

voluntary strategies, finding mixed results as some authors suggested that information-based policies/interventions have been found to be much less effective than other influencing directly the structure of food environments (Temme et al., 2020), while others suggested that no significant heterogeneity was identified by voluntary or legislative approaches to food labels (Shangguan et al., 2019).

5.2.1 Primary outcomes: undernutrition, obesity/NCDs, environmental sustainability, nutrition inequalities

The reviews aiming to describe the effect of food labelling on undernutrition did not find sufficient data (Moran et al., 2020; Thomson et al., 2018). Most reviews described the effect of labelling on nutrition/healthy diets, linking consumer's information strategies with diet intake or food purchase (in particular foods or beverages high in energy, fats or sugar), and reported overall positive impacts. The majority of the reviews aiming to report the effects of labelling on obesity/NCDs did not find sufficient information, and only two found positive effects (S. Cawley & Wen, 2018; Roberts et al., 2019). From the reviews analysing the impact of labelling on environmental sustainability, two suggested an overall positive effects (Potter et al., 2021; Takacs & Borrion, 2020), while one found no evidence (Temme et al., 2020). The reviews evaluating nutrition inequalities associated to labelling showed overall negative impacts of these interventions as their effects varied across populations groups. Most of the reviews suggested that labels had positive effects of greater magnitude among participants with higher incomes and/or that females were influenced more positively than males (Cecchini & Warin, 2016; Feteira-Santos et al., 2020; Lobstein et al., 2020; Potter et al., 2021; Temme et al., 2020; Thomson et al., 2018), whereas one found mixed results (Hartmann-Boyce et al., 2018) and one did not find differences across socio-economic groups (Løvhaug et al., 2022).

5.2.2 Secondary outcomes: nutritional vulnerabilities and women's empowerment

With regard to nutritionally vulnerable populations, two reviews reported mixed results (Sisnowski et al., 2017; Thomson et al., 2018), one did not find enough data (Vargas-Garcia et al., 2017), and one reported positive effects (Browne et al., 2020). None of the reviews analysed the impact of food labelling on women's empowerment.

5.2.3 Food labelling: synergies and trade-offs

For this (sub)domain, no synergies were reported. However, a potential trade-off identified was that the positive effects of labelling on diet intake/food purchase were of greater magnitude among participants with higher incomes and among women, suggesting an overall negative impact on inequalities (Cecchini & Warin, 2016; Feteira-Santos et al., 2020; Lobstein et al., 2020; Potter et al., 2021; Temme et al., 2020). This negative effect was also reported among children (Thomson et al., 2018).

5.3 Food promotion (marketing)

The policies/interventions analysed in the reviews included marketing restrictions of unhealthy foods for the general population (n = 7), and more than half of the reviews analysed their effect on children (n = 9). The policies/interventions linked marketing strategies with reduction of unhealthy food advertising from different sources (radio, TV, social media), or broadcast marketing policies with unhealthy food intakes or purchases. The policies/interventions analysed were either mandatory or voluntary. Five reviews reported results separately for voluntary and mandatory policies/interventions (Chambers et al., 2015; Galbraith-Emami & Lobstein, 2013; Kovic et al., 2018; Ronit & Jensen, 2014; Taillie et al., 2019; Temme et al., 2020) and all concluded that voluntary marketing restrictions by the food industry are less effective than mandatory government regulations. According to the results, only countries that enacted statutory regulation saw a decrease in sales per capita, while there was an increase in sales of those products in countries with only self-regulatory policy (Kovic et al., 2018). Taillie et al. (2019) reviewed the impact of restrictions on marketing of unhealthy foods and on marketing of all commercial products (including food) and concluded that there is a small or no effect from such strategies, partly because marketing is shifted to other programs or venues (Taillie et al., 2019). Overall, current advertisement bans and statutory regulations seem hard to evaluate, but the evidence suggests that even if bans have little effect in comparison with other policies/interventions, they are estimated to be very cost-effective (Cawley & Wen, 2018). A growing body of literature using laboratory controlled trials shows that advertisements for foods marketing restrictions for unhealthy foods to children impacts food intake, but evidence remains scarce on the differential impact of advertising to children across social groups, as few of these studies consider participants' demographic differences (Lobstein et al., 2020). None of the reviews analysed the effectiveness of marketing restrictions for breastfeeding substitutes.

5.3.1 Primary outcomes: undernutrition, obesity/NCDs, environmental sustainability, nutrition inequalities

When analysing policies/interventions related to food promotion none of the reviews included undernutrition. The majority of the reviews describing the effect on nutrition/

healthy diets reported overall positive effects (Lobstein et al., 2020; Russo et al., 2020; Pérez-Ferrer et al., 2019; Kovic et al., 2018; Hillier-Brown et al., 2017; Chambers et al., 2015;), concluding that government regulations were more effective than voluntary pledges. However, some reviews reported neutral effects (Galbraith-Emami & Lobstein, 2013; Ronit & Jensen, 2014; Taillie et al., 2019). The reviews aiming to analyse the effects of marketing restrictions of unhealthy products on obesity/NCDs, environmental sustainability and nutrition inequalities did not find sufficient data.

5.3.2 Secondary outcomes: nutritional vulnerabilities and women's empowerment

With regard to nutritionally vulnerable populations (i.e., children, Indigenous populations) the results are mixed as some reviews reported overall positive results on nutrition/diets (Chambers et al., 2015; Pérez-Ferrer et al., 2019; Russo et al., 2020), while other reported neutral effects (Galbraith-Emami & Lobstein, 2013; Taillie et al., 2019), or found no evidence of effects of the intervention on their nutritional status or exposure to unhealthy diets/products (Aceves et al., 2020; Browne et al., 2020; Cawley & Wen, 2018; Pérez-Cueto et al., 2012). None of the reviews analysed the impact of food promotion policies/interventions on women's empowerment.

5.3.2.1 Food promotion: synergies and trade-offs No synergies or trade-offs were identified.

5.4 Food provision

The policies/interventions analysed included strategies in different food provision locations (i.e., preschools, schools, childcare settings, universities, public setting canteens, healthcare settings and workplaces). The policies/interventions analysed could be categorised overall in two groups, the majority of them providing healthy food provision or reducing the provision of unhealthy foods, while some also used nudging strategies changing the physical food microenvironments to encourage the selection of healthier products or discourage unhealthier ones. The policies/interventions analysed were either mandatory or voluntary.

5.4.1 Primary outcomes: undernutrition, obesity/NCDs, environmental sustainability, nutrition inequalities

From the reviews considering undernutrition as an outcome (n = 9), and only a few found sufficient information, of which the majority reported overall positive effects (Cohen et al., 2021; Colley et al., 2019; Holley & Mason, 2019; Menon & Peñalvo, 2019a, b). The vast majority of the reviews (n = 62) described the effect of food provision policies/interventions on nutrition/healthy diets, linking the strategies with positive effects such as reductions of unhealthy foods (mainly SSBs) or increase of healthy food intakes or purchases [mainly fruits and vegetables (F&Vs) and water intake, and in some cases whole grains, milk and fish]. The majority of reviews analysing the effects of the policies/interventions on obesity/NCDs reported overall positive effects (Naicker et al., 2021a, b; Singhal et al., 2021; von Philipsborn et al., 2020; Browne et al., 2020; Carducci et al., 2020; McHugh et al., 2020; Wethington et al., 2020; Adom et al., 2019; Poscia et al., 2018; Bird et al., 2018; Meiklejohn et al., 2016; Avery et al., 2015; Kumanyika et al., 2014; Driessen et al., 2014; M. Niebylski et al., 2014; Sreevatsava et al., 2013; De Bourdeaudhuij et al., 2011), even if the need for more evidence on long-term effects was highlighted (von Philipsborn et al., 2020). The reviews aiming to analyse the impact of policies/interventions on environmental sustainability found overall positive results (Brennan & Browne, 2021; Takacs & Borrion, 2020; Temme et al., 2020). The results from the reviews analysing nutrition-inequalities were mixed, as the majority reported positive effects (Black et al., 2017; Holley & Mason, 2019; Kirkpatrick et al., 2018; Kumanyika et al., 2014), but some of higher quality found negative effects associating the interventions with impacts among higher socio-economic groups (Amini et al., 2015; Thomson et al., 2018). Other reviews found no evidence (Temme et al., 2020; Tseng et al., 2018).

5.4.2 Secondary outcomes: nutritional vulnerabilities and women's empowerment

Most reviews reported overall positive results linking the policies/interventions to either an improvement on diets or on nutrition parameters of nutritionally vulnerable populations. However, two reviews reported no changes following the intervention (Aldwell et al., 2018; Tseng et al., 2018) while others reported mixed effects (Vargas-Garcia et al., 2017; Hyseni, Atkinson, et al., 2017; Poscia et al., 2018; Thomson et al., 2018). None of the reviews analysed the impact of food provision policies/interventions on women's empowerment.

5.4.3 Food provision: synergies and trade-offs

Some food provision policies/interventions have shown double-duty potential. For instance, universal free school meals/breakfast programs have positive effects on improving nutrition and/or reducing undernutrition, and nutrition inequalities (Cohen et al., 2021; Colley et al., 2019; Holley & Mason, 2019; Menon & Peñalvo, 2019a, b). In addition, one

review suggested potential synergic effects combining provision and retail policies, as interventions in schools combined with regulations in the surrounding stores were effective in improving nutrition and reducing nutritional inequalities (Ewart-Pierce et al., 2016). Some trade-offs were identified, as there may be a link between provision of healthy food and an increase of food waste (Metcalfe et al., 2020). On the other hand, another review reported that healthy food provision programmes that improve dietary quality were associated with food waste reductions (Mansfield & Savaiano, 2017), and another review analysing this same outcome reported positive results in restaurants, but mixed effects in school settings (Brennan & Browne, 2021).

5.5 Food retail

The policies/interventions analysed in the reviews included multiple strategies across diverse locations (i.e., supermarkets/stores, vending machines, food services, university/school surroundings, online shops). The types of policies/interventions analysed were categorised in two main groups. The first and main one was nudging strategies, modifying the context, defaults or norms of consumption by changing the physical food micro-environments to encourage the selection of healthier products, or to discourage unhealthier ones. In addition, included variations in at point-of-purchase on product placement, shelf space, accessibility, distance/proximity, availability, portion, prices (e.g. discounts, monetary incentives…), swaps (changing the shelf disposition or offering consumers the opportunity to replace their usual product for a healthier alternative), and/or promotions in stores or supermarkets. The second group were policies/interventions related to food infrastructure accessibility, such as community-based programmes for farmer's markets in the neighbourhoods, creation of new food stores and/or improvement of existing ones, supermarket tax or grant incentives to independent grocery stores, or zoning laws (such as bans on new fast-food chain outlets).

5.5.1 Primary outcomes: undernutrition, obesity/NCDs, environmental sustainability, nutrition inequalities

The effects on undernutrition were described in one review (Sirasa et al., 2019) which found positive effects related to accessibility/availability of food stores within the surrounding environment. All of the thirty-six reviews (n = 36) described the effect of policies/interventions on nutrition/healthy diets, of which the majority found positive effects in the reduction of unhealthy food or in the increase of healthy food intakes or purchases (mainly for SSBs and F&Vs), particularly for those interventions involving prices or the 4Ps of marketing (influencing the product, price, promotion and/or placement). The reviews analysing the effects of policies/interventions on obesity/NCDs reported overall positive effects (Bird et al., 2018; Gittelsohn et al., 2012; Luongo et al., 2020; S. Roberts et al., 2019; Shaw et al., 2020). No information was available on the impact of policies/interventions environmental sustainability (Temme et al., 2020). The reviews including nutrition inequalities reported mixed results and the overall direction could not be determined (Fergus et al., 2021; Hartmann-Boyce et al., 2018; Temme et al., 2020; Tseng et al., 2018).

5.5.2 Secondary outcomes: nutritional vulnerabilities and women's empowerment

The majority of the reviews reported overall positive effects on the nutrition/healthy diets of nutritionally vulnerable populations (i.e., children, Indigenous populations, low-income) (An et al., 2019; Browne et al., 2020; Fergus et al., 2021; Gittelsohn et al., 2012; Luongo et al., 2020; O'Dare Wilson, 2017; Sirasa et al., 2019; Temme et al., 2020). However, some reported mixed results (Løvhaug et al., 2022; Smith et al., 2013; Turner et al., 2019), one neutral effects (Tseng et al., 2018) and other reviews found no evidence of beneficial effects of the interventions on the purchase of healthier items/products (Kumanyika et al., 2014; Sisnowski et al., 2017; von Philipsborn et al., 2020). None of the reviews analysed the impact of food retail policies/interventions on women's empowerment.

5.5.3 Food retail: synergies and trade-offs

A synergic effect identified the beneficial effect of combining food prices and retail policies/interventions, as the placement of healthier foods together with subsidy programmes may have a positive effect on consumers' purchases (Gittelsohn et al., 2017). Similarly, one review suggested potential synergic effects when combining provision and retail policies, as interventions in schools with regulations in the surrounding stores were effective in improving nutrition and reducing nutritional inequalities (Ewart-Pierce et al., 2016). No trade-offs were identified.

5.6 Food prices

The food prices policies/interventions analysed included fiscal measures by national, regional or local governments, subdivided in two main categories: (1) taxes and levies (e.g. for fast-foods, TFA, SSBs…) and (2) subsidies [e.g. value-added tax (VAT) reduction/removal for F&Vs, vouchers, food banks, food benefit programmes…].

5.6.1 Primary outcomes: undernutrition, obesity/NCDs, environmental sustainability, nutrition inequalities

The reviews analysing the impact of the policies/interventions on undernutrition showed overall positive effects (in particular for subsidies) (Durao et al., 2020; Holley & Mason, 2019; A. J. Moran et al., 2020; Verghese et al., 2019). Most of the reviews (n = 51) described the effect on nutrition/healthy diets, showing an overall positive effect both for taxes and subsidies (Browne et al., 2020; Durao et al., 2020; Hillier-Brown et al., 2017; Lhachimi et al., 2020; Naik et al., 2019; Pfinder et al., 2020; von Philipsborn et al., 2019, 2020; Wolfenden et al., 2021). Those reviews analysing the effects of fiscal measures on obesity/NCDs showed mixed results, as some could find data on purchase changes but not enough on obesity prevalence (Pfinder et al., 2020; Lhachimi et al., 2020; Verghese et al., 2019; Roberts et al., 2017; E. A. Finkelstein et al., 2014). In addition, other reviews reported a positive effect on body mass index (BMI) reduction but no data on obesity prevalence or diet-related NCDs (Afshin et al., 2017; Park & Yu, 2019). The reviews describing the impact of fiscal measures on environmental sustainability did not find sufficient data (Haby et al., 2016; Temme et al., 2020), whereas those analysing nutrition inequalities were numerous (n = 16) and showed overall positive effects (Kirkpatrick et al., 2018; Løvhaug et al., 2022; Naik et al., 2019; Powell et al., 2013; Temme et al., 2020). However, one review concluded that taxes on SSBs were more effective among lower socio-economic groups (Lobstein et al., 2020).

5.6.2 Secondary outcomes: nutritional vulnerabilities and women's empowerment

The effects of fiscal measures were overall positive among nutritionally vulnerable populations (i.e., children, women, Indigenous populations, low-income groups) (An, 2013; Browne et al., 2020; Durao et al., 2020; Holley & Mason, 2019; Schultz et al., 2015; Sisnowski et al., 2017; Thomson et al., 2018; Verghese et al., 2019; Wolfenden et al., 2021). However, some reviews reported mixed results (Dangour et al., 2013; Pullar et al., 2018; von Philipsborn et al., 2020), and one found no evidence of beneficial effects of the intervention (V. H. Moran et al., 2015). None of the reviews analysed the impact of fiscal measures on women's empowerment.

5.6.3 Food prices: synergies and trade-offs

The results of the reviews suggest that fiscal measures can have double-duty potential, as they may reduce nutrition inequalities while improving population's nutrition. Moreover, subsidies have shown to contribute to the double burden of malnutrition, being effective both for undernutrition and healthy dietary intakes (Durao et al., 2020; Verghese et al., 2019). A synergic effect identified is the beneficial effect of combining fiscal measures with retail policies/interventions, as the placement of healthier foods in combination with subsidy programmes may have a positive effect on consumers' purchases (Gittelsohn et al., 2017). A potential trade-offs may be the unintended compensatory purchasing resulting from subsidies, which may lead to additional unhealthy food purchase with the money saved (Dangour et al., 2013; Dodd et al., 2020).

5.7 Summary per (sub)domain: multi-component policies and interventions

The so-defined group of "multi-component" included those reviews that analysed the impact of policies/interventions when implemented in combination with others considered to have a potential synergic effects. Twenty-five reviews on multi-component policies/interventions did not use methods that allowed for separate analyses of outcomes per intervention component, so they were classified according to the (sub)domains included in the multi-component policies/interventions and described more into detail in the Supplementary File 6. However, 10 reviews allowed for a separate analysis of each included intervention, and their effect on the outcomes were described under the corresponding (sub) domain paragraph, and their overall direction is included in Table 4.

Four reviews analysed the impact of interventions combining reformulation with labelling. Those reviews reported effects on nutrition, but the results were mixed. Those that also focused on the impact on obesity/NCDs suggested a positive effect on NCDs (Musicus et al., 2020) or did not find enough data (Hyseni, Bromley, et al., 2017). Another review reported a positive impact on nutrition inequalities, suggesting that the multi-component intervention was pro-equity (Hendry et al., 2015). However, a review summarising the effect of combining food labelling and composition, together with education campaigns (a type of intervention not included in this scoping review – see Table 3), reporting an overall neutral effect on nutrition inequalities (Thomson et al., 2018). In this same line, another study concluded that multi-component interventions combining labelling, reformulation, healthy food provision and promotion or reformulation, labelling and promotion had positive effects on nutrition/healthy diets (Hyseni, Atkinson, et al., 2017). A similar study reported a positive effect both on nutrition/healthy diets and in obesity/NCDs indicators when combining food reformulation, labelling, healthy food provision and taxes on foods high in sodium (Hyseni, Elliot-Green, et al., 2017).

Another set of three reviews analysed the impact of policies/interventions combining food provision and food retail

in children (Bramante et al., 2019; Pineda et al., 2021) and in the general population (Ewart-Pierce et al., 2016), showing positive effects on obesity/NCDs and both for gender and socio-economic groups, and overall mixed effects for nutrition/healthy diets. Other reviews summarized the impact of multi-component interventions combining reformulation, marketing, labelling, healthy food provision, in-stores nudging strategies or fiscal measures, reporting overall positive effects and suggesting that taxes and subsidies in combination with nudging strategies may incentivise the purchase of healthier foods and the reduction of unhealthier ones (Hillier-Brown et al., 2017; Russo et al., 2020).

The reviews summarising the effects of combining food production (garden-based strategies) and food provision (increasing the availability and provision of healthier options), suggested an overall positive impact both for nutrition and obesity/NCDs indicators in children (Bleich et al., 2013; Chaudhary et al., 2020). Other reviews described the impact of combining labelling and food provision policies/interventions in nutrition/healthy diets among school-aged children, one reporting mixed results (Nørnberg et al., 2016), whereas the other suggested an overall positive effect (Wang & Stewart, 2013). Similarly, reviews focusing on the impact of combining food labelling-provision-retail strategies showed a positive effect on nutrition/healthy diets (Naicker et al., 2021a; Roy et al., 2015). However, when analysing the impact on obesity/NCDs, one did not find enough information to reach a conclusion (Naicker et al., 2021a), whereas the other study suggested an overall positive effect on BMI and overweight prevalence (Roy et al., 2015).

When it comes to synergies related to multi-component interventions involving prices, Noy et al. (2019) reported positive effects both for undernutrition and nutrition when combining garden interventions with tax incentives to increase access to food (Noy et al., 2019). An overall positive effect on nutrition/healthy diets was found both for subsidies alone or in combination with increased availability of healthy foods in school environments (Jensen et al., 2011). Another review reported positive effects on nutrition/healthy diets for prices alone or in combination with food labelling and/or nudging interventions in the physical environment of retail shops. However, the results did not find any consistent effects on BMI changes of the population studied (Gittelsohn et al., 2017).

6 Discussion

6.1 Summary of main findings

This scoping review found substantial evidence of the effectiveness of food system policies/interventions in improving population nutrition and environmental sustainability, and addressing nutrition-related inequalities.

Overall, the majority of the evidence included in the review reported a positive effect on the outcomes studied. Within the domain of food supply chains, the interventions related to food production (such as agroecology, crop diversification, bio-fortification or school gardens) and those on food processing (such as fortification) showed positive results tackling undernutrition and food insecurity, across different population groups. Similarly, for the domain of food environments the evidence available showed positive effects of food provision policies/interventions (universal free school meals and breakfast programmes), food retail (accessibility/availability of stores within the surrounding environment) and food prices (subsidies for F&Vs, vouchers, food banks, food benefit programmes) in tackling undernutrition and food insecurity.

The effects of policies/interventions on healthy diets/nutrition have been synthesized for all the (sub)domains reviewed (with the only exception of food loss and waste) and showing mostly positive effects. For the particular case of food labelling, the overall direction of results shows the positive impact of labels reducing population's dietary intake of selected nutrients, while it tends to influence industry food reformulation practices. However, despite the evidence available, the effectiveness of labels toward healthier or more environmentally sustainable food purchases remains mixed and inconclusive (An et al., 2021; Anastasiou et al., 2019; Temme et al., 2020; Moran et al., 2020; Hyseni, Atkinson, et al., 2017). The inconclusiveness of results may be explained by the diversity of food labelling policies, as they include different types of FOPNL graphic designs or types of menu labelling.

For the outcome of obesity/diet-related NCDs, evidence available on the effectiveness of interventions remains scarce as, even if some reviews analysed the impact of policies on BMI, their long-term effect on obesity prevalence and diet-related NCDs has not been demonstrated by many studies. The limited evidence available suggests positive effects from all the policies/interventions implemented within the domain of food environments, and for food production.

Just 21 reviews aimed at evaluating the effectiveness of policies/interventions on environmental sustainability, of which six did not find consistent results, so overall fewer information was gathered for this outcome. Food production policies/interventions (such as crop and livestock diversification strategies, agroecology practices, provision of agricultural technology) showed positive effects on soil erosion, biodiversity loss and water use (El Chami et al., 2020; Feliciano, 2019; McElwee et al., 2020; Nasir Ahmad et al., 2020). For the (sub)domain of food provision, two reviews (Brennan & Browne, 2021; Takacs & Borrion, 2020) found

positive effects of food waste/portion reduction strategies in different settings (such as schools, restaurants, workplaces).

In the particular case of women's empowerment, however, no information could be found for the majority of the (sub)domains, with the exception of food production and food trade and investment agreements. The question that may arise from this result is whether the information was not found due to a lack of research in the area and requires further studies, or because it lacks of applicability, the latter meaning that some (sub)domain may do not have a link to women's empowerment. This lack of evidence may also be because women's empowerment is a variable very difficult to measure. In addition, in this scoping review, women's empowerment was considered as an outcome but in some studies the framework may have been different and it was considered as the driver to achieve an action.

6.2 Research implications

Current evidence remains highly heterogeneous across types of policies/interventions, making it often incomplete when it comes to the food system perspective. The scientific evidence available until the date tends to analyse the impact of different agriculture, health or food policies for a single outcome. In addition, there are remaining gaps in the literature. There is a number of food system policies/interventions whose effect on undernutrition, obesity and/or climate change has not been properly evaluated in systematic reviews**.** One example is the (sub)domain of food loss and waste, which remains underexplored despite its strong link with undernutrition and environmental sustainability (C. Chen et al., 2020). Other understudied (sub)domains are (1) food storage, processing, packaging and distribution (as the majority of the reviews were on the food processing aspect and consisted on fortification interventions), and (2) food trade and investment agreements.

For other (sub)domains, such as food composition, the evidence available is still limited, and to date only its link with nutrition/healthy diets has been assessed. However, strong government leadership and its mandatory implementation seem to be critical success factors (Jones et al., 2016; Kleis et al., 2020). Similarly, for food promotion (marketing), despite the limited evidence available, policies/interventions banning or limiting the exposure to unhealthy food products show a slight positive impact on improving diets. This weak evidence may be due to lack of adherence from the industry, from a lack of resources available to proper monitoring and enforcement (Aceves et al., 2020), or because the policies may not be comprehensive/extensive enough when mandatory, as marketing is then shifted to other programs or venues (Taillie et al., 2019). However, data available in reviews was scarce, and some recent evidence suggests that food marketing policies may result in reduced purchases of unhealthy foods (Boyland et al., 2022).

The evidence available for other aspects analysed in this scoping review is still very limited, such as the effects that agriculture and food policies/interventions have on different indicators of environmental sustainability, on gender equality and on women's empowerment. Nevertheless, the evidence available per outcome depends on each domain or even (sub)domain. For instance, the outcomes of obesity/NCDs, environmental sustainability and nutrition-related inequalities have been understudied within the domain of food supply chains, and in the reviews where they were included, the evidence available was not strong enough to be significant. However, within the domain of food environments, the outcomes that were understudied were undernutrition, environmental sustainability and nutrition-related inequalities. In addition, enough reviews across domains reported results in nutritionally vulnerable populations, but it was not the same for women's empowerment.

In the case of obesity/NCDs, evidence may be scarce because research in this area is still recent and there is a lack of information available for the long-term impact of policies/interventions implemented. In the case of environmental sustainability, evidence is only available for food production strategies, and overall scarce due to lack of reviews analysing the effectiveness of sustainable agriculture policies/interventions. These results are in line with previous research in this area (Haby et al., 2016), which highlights that agricultural practices are rarely studied in the area of food policy, despite its link with environmental sustainability. The impact of policies/interventions on socio-economic inequalities is generally not reported, with the exception of the reviews on taxes and subsidies. Therefore, the effects for other (sub)domains is still uncertain. Even if more research specific on the impact of nutrition-related inequalities is needed, some recent reviews on food composition and food labelling have started to provide the results divided by gender and socio-economic status, which allow to determine the overall direction of the effect.

6.3 Policy implications

Prior, during and after the Food Systems Summit in 2021, a global call for more and better-quality research on policy solutions towards SFS has taken place. Acting on flawed or incomplete information can have costs if the policies implemented are not evaluated properly, or if their repercussions and trade-offs have not been properly considered. However, delaying the policies/interventions while waiting for more and better-quality research in all these areas has also a big cost, not only for the research it would require, but more importantly for the cost of not acting. We, therefore, argue

for governments to implement policies with proven double- or triple-duty potential, as they have shown their effectiveness tackling malnutrition in all its forms and/or climate change. In this day and age, a careful implementation of policies/interventions likely to make a positive impact combined with thorough monitoring and evaluation is urgent.

For instance, in the domain of food supply chains, an important lesson learnt is the high potential that agricultural policies/interventions have not only to tackle food insecurity but far beyond, given its double-duty potential. Agroecology is a sustainable approach that has been applied for decades in family farmers' practices around the globe, combining traditional knowledge with scientific evidence, and has shown benefits helping farmers diversify their production, having positive impacts on the diets of the local communities while also strengthening women's empowerment (Walls et al., 2018). In this line, recent evidence shows its positive effects on gender equality (Benítez et al., 2020), as they increase the inclusion of women developing and implementing in-farm innovations, help strengthen the self-confidence for female farmers and farm-family members, ameliorate productive diversification on family farms and increase employment and household income through women-led micro-industry projects that facilitate of commercialization opportunities. Even if the evidence included in this scoping review is still limited, some studies on agricultural practices have also shown positive links with obesity prevention through healthier diets (Deaconu et al., 2021), suggesting its triple-duty potential.

Another action that has shown to be promising in many countries and regions worldwide is related to food provision in schools. Nutrition programmes have a positive effect on healthy diets, also improving the BMI of children in the long term. These programmes are also powerful tools to reduce micronutrient deficiencies (Colley et al., 2019), food insecurity (Cohen et al., 2021) and nutrition inequalities (Løvhaug et al., 2022), and have shown favourable economic benefits (Ekwaru et al., 2021). These benefits, that go in line with similar research in the field (Venegas Hargous et al., 2023), should not be underestimated by governments. However, some strategies that increase the acceptability of healthier food groups (such as F&Vs), have been suggested to increase the amount of food wasted (Metcalfe et al., 2020; Prescott et al., 2020). This could be prevented by re-designing programmes that minimise food waste, such as awareness and education campaigns, which have proven to be effective (Soma et al., 2020). Overall, due to its positive effects in reducing micronutrient deficiencies and overweight, food provision policies/interventions may have double-duty potential, and may be beneficial for reducing nutrition-related inequalities. However, more research is needed to fully understand their effects on environmental sustainability.

When it comes to food price policies/interventions, the evidence shows that food subsidies and social programmes have a relative large impact on food purchases and healthier diets (Wolfenden et al., 2021; Zhang et al., 2020). In the countries or regions in which taxes on SBBs have been implemented, such as Mexico (Aceves et al., 2020), South Africa (Hofman et al., 2021), or the United Kingdom (Pell et al., 2021), taxes have shown a positive impact on the transition towards healthier habits, showing significant drops on their purchases. Interestingly, a recent study suggests that taxes may incentivise food reformulation across manufacturers (Scarborough et al., 2020), a similar phenomenon to the one results from food labelling. In addition, going beyond sugary drinks, taxes implemented in red and processed meat products may have double-duty potential (improving health and environmental sustainability), as suggested by some studies (Broeks et al., 2020; Springmann et al., 2018; Wirsenius et al., 2011). Even if none of the reviews included described food pricing strategies on red or processed meats.

Information-type interventions, such as food labelling and food retail, have shown to be effective of in improving nutrition/healthy diets. Recent evidence shows positive results on healthier choices or purchases made by consumers in different parts of the world and settings in particular for menu labelling in quick-service restaurants. This type of intervention could have double-duty potential, as environmental sustainability labels have been associated with the selection and purchase of more sustainable food products (Potter et al., 2021) representing a key area to explore further. Moreover, an additional synergy for food labelling is its impact on food composition, as industry and retail services tend to use reformulation as to improve the labelling of products or menus (Russo et al., 2020; Shangguan et al., 2019). However, when it comes to nutrition-related inequalities, there is evidence that certain types of labels may be more effective among women and among higher-income and education groups. This aspect should be taken into account to prevent inequalities, ensuring that food labels are easily understood by all [for instance by prioritising the use of colour-coded traffic-light instead of numerical format, as suggested by Lobstein et al. (2020) and Cecchini and Warin (2016)]. Also, when designing policies/interventions in these areas, monitoring programmes should be in place to quantify possible negative or unintended effects, and implement solutions.

Current trade and investment agreements need urgent revision due to their negative effects on various outcomes, as these policies were not designed taking into consideration the healthiness of populations diets or environmental sustainability, but rather to satisfy the global demand for products and ensure food security. As this requires action at global scale, with the results of this scoping review we urge policymakers to implement nutrition, health and

environmental impact assessments when designing food trade policies and international agreements.

It is important to highlight that the overall results from this scoping review should be seen as an overall summary of evidence-based effects of food systems policies, but should be contextualised and adapted to each context and situation. The effects and effectiveness of certain policies/interventions may vary based on the specific geographic region, on the setting (urban, peri-urban or rural), or many other environmental, economic, social and cultural factors that were not analysed in detail in this review, given its broad scope.

Another aspect worth mentioning, as it was reported by the majority of the authors that did multi-intervention analyses (Brambila-Macias et al., 2011; Naicker et al., 2021a, 2021b; Perez-Cueto, 2019; Temme et al., 2020), was the fact that in general the measures that support informed choices (such as labelling, promotion or retail), have mixed results and limited record of success, whereas the ones that target the market environment (such as food reformulation standards or fiscal measures), tended to be more effective, even if they were more intrusive.

6.4 Strengths and limitations

To the best of our knowledge, this is the first scoping review mapping and comprehensively summarising the effectiveness of food system policies/interventions on nutrition, nutrition-related inequalities and environmental sustainability, and identifying their repercussions on nutritionally vulnerable groups and women's empowerment.

The review followed a published protocol with a thorough data search strategy in different scientific databases, and guided by PRISMA framework for scoping reviews and the AMSTAR-2 quality tool. Publication bias could not be assessed quantitatively as meta-analyses could not be conducted due to the high heterogeneity across analyses and policies/interventions across the reviews. The quality of the included reviews was, in addition, generally low, as 78% of the reviews included were assessed as of low or critically low quality. Even if preference was given to those results from recent, robust, high quality systematic reviews, the confidence and reliability of the effects described in this review should be considered when interpreting the results. An additional limiting aspect in this regard is the broadness of the topic reviewed, as it considered different aspects within food and outcomes from various fields of expertise. Another limiting factor to consider may be the timeline needed to identify the effects and effectiveness levels of the policies/interventions ever since their implementation date (this is particularly relevant for those outcomes that need longer follow-up periods to be analysed, such as environmental sustainability, and obesity or diet-related NCDs).

Another important limitation is the fact that the policies/interventions included in this scoping review were limited to those for which a systematic review had been conducted, meaning that even if primary studies could be available, they were not taken into account, given the broadness of the topic reviewed. Furthermore, there might be a big overlap in the studies included in each review, as it was not possible to report on each primary study that every review included.

Another limitation was the inclusion criteria used for the types of intervention, as there is no official framework that can be applied to SFS. Even if the criteria used could be perceived as subjective and towards the field of public health nutrition, the effort to use of a multidisciplinary group of researchers that included experts with content knowledge the other outcomes (nutrition-related inequalities and environmental sustainability) should be taken into account. However, it is important to mention that there are other potential parameters (e.g. plastic packaging waste, effects of agrochemical use on the environment…) (Béné et al., 2020; Fanzo et al., 2021) that have been proposed in the literature to analyse environmental sustainability, and that were not included in this review. These aspects that were not included could and should be considered for future research in this area.

Also, the conceptualization of this scoping review may present potential limitations, as the policies/interventions analysed were gathered from a compilation of international policy recommendations, meaning that there may be additional policies that have beneficial effects on nutrition, inequalities and environmental sustainability that were not included in the research strategy. An additional possible limitation is that some policies/interventions, such as those related to education, competition or finance, may have important influences on nutrition and environmental sustainability outcomes, but may not have been found by the search because we explicitly focused on "food systems policies". Similarly, during the search strategy we did not explore in depth those social protection policies that in their title or abstract not included the term "food".

7 Conclusions

The present scoping review has summarized the effectiveness of public policies/interventions that improve population's nutrition outcomes, nutrition-related inequalities, and environmental sustainability outcomes, and highlighting those with double- and triple-duty potential. Conclusions that can be drawn are that sustainable agriculture practices and school food programmes represent examples of triple-duty interventions, while food labelling, reformulation, in-store nudging interventions and fiscal measures have shown to positively

impact the double burden of malnutrition. Multi-component interventions were found to be the most effective to improve nutrition and inequalities. In summary, the existing literature provides some promising indications in terms of the potential of role of governments in improving nutrition and dietary patterns among the population. However, little evidence is available with regard to policies/interventions that have beneficial effects in environmental sustainability or nutrition-related inequalities. There is still a lack of high-quality evidence addressing the complex system and context within which food policies/interventions are implemented and evaluated, and little is known about their effectiveness in the long term. Policy (sub)domains presently under-explored are: (1) food storage, processing, packaging and distribution, (2) food loss and waste, (3) food trade and investment agreements, (4) food composition and (5) food promotion. More research is needed on the impact of food systems policies/interventions on environmental sustainability, nutrition inequalities and women's empowerment.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s12571-023-01385-1.

Author contributions Celia Burgaz: Developed the protocol and search strategy. Ran the data search, 100% data screening of title and abstract, 100% data screening at full-text level, 100% data abstraction table, 100% reviews quality assessment. Prepared the manuscript and adapted the comments on all the versions. Vanessa Gorasso: Random 10% data screening of title and abstract, random 10% data screening at full-text level, random 10% reviews quality assessment. Revised the second draft. Wouter M.J. Achten: Provided assistance during the development of the protocol and the search strategy. Supervision of the process. Critically revised and provided comments for the second draft. Carolina Batis: Critically revised and provided comments for the first and second drafts. Luciana Castronuovo: Critically revised and provided comments for the first and second drafts. Adama Diouf: Critically revised and provided comments for the first and second drafts. Gershim Asiki: Critically revised and provided comments for the first and second drafts. Boyd A. Swinburn: Critically revised and provided comments for the first and second drafts. Mishel Unar-Munguia: Critically revised and provided comments for the first and second drafts. Brecht Devleesschauwer: Critically revised and provided comments for the first draft. Gary Sacks: Critically revised and provided comments for the second draft. Stefanie Vandevijvere: Acquired the funding. Provided assistance during the development of the protocol. Was consulted throughout the process to solve doubts/discrepancies, during data screening at title and abstract, data screening at full-text level, data abstraction table process and for quality assessment. Supervision of the process. Critically revised and provided comments for the first and second drafts.

Funding This work was supported by the International Development Research Centre (IDRC) [109472–001].

Data availability All the data presented in this study are available upon reasonable request from the corresponding author.

Declarations

Competing interest Some authors have participated in reviews that were included in the scoping review, however screening, data extraction and risk of bias assessments of these reviews were conducted by reviewers that had no involvement in the conduct or publication of the reviews. Otherwise, authors declare they have no conflicts of interest. Authors have not received any benefit, in cash or kind, any hospitality, or any subsidy derived from the food industry or any other source perceived to have any interest in the outcome of the review.

References

Abarca-Gómez, L., Abdeen, Z. A., Hamid, Z. A., Abu-Rmeileh, N. M., Acosta-Cazares, B., Acuin, C., Adams, R. J., Aekplakorn, W., Afsana, K., Aguilar-Salinas, C. A., Agyemang, C., Ahmadvand, A., Ahrens, W., Ajlouni, K., Akhtaeva, N., Al-Hazzaa, H. M., Al-Othman, A. R., Al-Raddadi, R., Buhairan, F. A., & Ezzati, M. (2017). Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: A pooled analysis of 2416 population-based measurement studies in 128·9 million children, adolescents, and adults. *The Lancet*, *390*(10113), 2627–2642. https://doi.org/10.1016/S0140-6736(17)32129-3

Aceves, B., Ingram, M., Nieto, C., de Zapien, J. G., & Rosales, C. (2020). Non-communicable disease prevention in Mexico: Policies, programs and regulations. *Health Promotion International, 35*(2), 409–421. https://doi.org/10.1093/heapro/daz029

Adom, T., De Villiers, A., Puoane, T., & Kengne, A. P. (2019). School-Based Interventions Targeting Nutrition and Physical Activity, and Body Weight Status of African Children: A Systematic Review. *Nutrients, 12*(1), 95. https://doi.org/10.3390/nu12010095

Afshin, A., Peñalvo, J. L., Del Gobbo, L., Silva, J., Michaelson, M., O'Flaherty, M., Capewell, S., Spiegelman, D., Danaei, G., & Mozaffarian, D. (2017). The prospective impact of food pricing on improving dietary consumption: A systematic review and meta-analysis. *PLoS ONE*, *12*(3), e0172277. https://doi.org/10.1371/journal.pone.0172277

Aldwell, K., Caillaud, C., Galy, O., Frayon, S., & Allman-Farinelli, M. (2018). Tackling the Consumption of High Sugar Products among Children and Adolescents in the Pacific Islands: Implications for Future Research. *Healthcare, 6*(3), 81. https://doi.org/10.3390/healthcare6030081

Aleksandrowicz, L., Green, R., Joy, E. J. M., Smith, P., & Haines, A. (2016). The Impacts of Dietary Change on Greenhouse Gas Emissions, Land Use, Water Use, and Health: A Systematic Review. *PLoS ONE*, *11*(11), e0165797. https://doi.org/10.1371/journal.pone.0165797

Almiron-Roig, E., Forde, C. G., Hollands, G. J., Vargas, M. Á., & Brunstrom, J. M. (2020). A review of evidence supporting current strategies, challenges, and opportunities to reduce portion sizes. *Nutrition Reviews, 78*(2), 91–114. https://doi.org/10.1093/nutrit/nuz047

Amini, M., Djazayery, A., Majdzadeh, R., Taghdisi, M.-H., & Jazayeri, S. (2015). Effect of school-based interventions to control childhood

obesity: A review of reviews. *International Journal of Preventive Medicine*, *2015*(AUGUST). Scopus. https://doi.org/10.4103/2008-7802.162059

An, R. (2013). Effectiveness of subsidies in promoting healthy food purchases and consumption: A review of field experiments. *Public Health Nutrition, 16*(7), 1215–1228. https://doi.org/10.1017/S1368980012004715

An, R., Shi, Y., Shen, J., Bullard, T., Liu, G., Yang, Q., Chen, N., & Cao, L. (2021). Effect of front-of-package nutrition labeling on food purchases: A systematic review. *Public Health, 191*, 59–67. https://doi.org/10.1016/j.puhe.2020.06.035

An, R., Wang, J., Liu, J., Shen, J., Loehmer, E., & McCaffrey, J. (2019). A systematic review of food pantry-based interventions in the USA. *Public Health Nutrition, 22*(9), 1704–1716. https://doi.org/10.1017/S1368980019000144

Anastasiou, K., Miller, M., & Dickinson, K. (2019). The relationship between food label use and dietary intake in adults: A systematic review. *Appetite, 138*, 280–291. https://doi.org/10.1016/j.appet.2019.03.025

Avery, A., Bostock, L., & McCullough, F. (2015). A systematic review investigating interventions that can help reduce consumption of sugar-sweetened beverages in children leading to changes in body fatness. *Journal of Human Nutrition and Dietetics: THe Official Journal of the British Dietetic Association, 28*(Suppl 1), 52–64. https://doi.org/10.1111/jhn.12267

Baker, P., Machado, P., Santos, T., Sievert, K., Backholer, K., Hadjikakou, M., Russell, C., Huse, O., Bell, C., Scrinis, G., Worsley, A., Friel, S., & Lawrence, M. (2020). Ultra-processed foods and the nutrition transition: Global, regional and national trends, food systems transformations and political economy drivers. *Obesity Reviews*, *21*(12). https://doi.org/10.1111/obr.13126

Barlow, P., McKee, M., Basu, S., & Stuckler, D. (2017). The health impact of trade and investment agreements: A quantitative systematic review and network co-citation analysis. *Globalization and Health, 13*(1), 13. https://doi.org/10.1186/s12992-017-0240-x

Béné, C., Fanzo, J., Prager, S. D., Achicanoy, H. A., Mapes, B. R., Toro, P. A., & Cedrez, C. B. (2020). Global drivers of food system (un) sustainability: A multi-country correlation analysis. *PLoS ONE*, *15*(4), e0231071. https://doi.org/10.1371/journal.pone.0231071

Benítez, B., Nelson, E., Romero Sarduy, M. I., Ortíz Pérez, R., Crespo Morales, A., Casanova Rodríguez, C., Campos Gómez, M., Méndez Bordón, A., Martínez Massip, A., Hernández Beltrán, Y., & Daniels, J. (2020). Empowering Women and Building Sustainable Food Systems: A Case Study of Cuba's Local Agricultural Innovation Project. *Frontiers in Sustainable Food Systems*, *4*. https://www.frontiersin.org/article/.https://doi.org/10.3389/fsufs.2020.554414

Best, C., Neufingerl, N., Del Rosso, J. M., Transler, C., van den Briel, T., & Osendarp, S. (2011). Can multi-micronutrient food fortification improve the micronutrient status, growth, health, and cognition of schoolchildren? A systematic review: Nutrition Reviews© Vol. 69(4): 186–204. *Nutrition Reviews*, *69*(4), 186–204. https://doi.org/10.1111/j.1753-4887.2011.00378.x

Bird, E. L., Ige, J. O., Pilkington, P., Pinto, A., Petrokofsky, C., & Burgess-Allen, J. (2018). Built and natural environment planning principles for promoting health: An umbrella review. *BMC Public Health, 18*(1), 930. https://doi.org/10.1186/s12889-018-5870-2

Black, A. P., D'Onise, K., McDermott, R., Vally, H., & O'Dea, K. (2017). How effective are family-based and institutional nutrition interventions in improving children's diet and health? *A Systematic Review. BMC Public Health, 17*(1), 818. https://doi.org/10.1186/s12889-017-4795-5

Bleich, S. N., Segal, J., Wu, Y., Wilson, R., & Wang, Y. (2013). Systematic Review of Community-Based Childhood Obesity Prevention Studies. *Pediatrics, 132*(1), e201–e210. https://doi.org/10.1542/peds.2013-0886

Blüher, M. (2019). Obesity: Global epidemiology and pathogenesis. *Nature Reviews Endocrinology, 15*(5), 5. https://doi.org/10.1038/s41574-019-0176-8

Bonab, A. M., Kalantari, N., Zargaraan, A., Roudsari, A. H., & Pourmoradian, S. (2020). Can food reformulation policy reduce calorie intake and tackle childhood obesity? *Iranian Journal of Pediatrics*, *30*(6), 1–9. *Scopus*. https://doi.org/10.5812/ijp.98985

Boyland, E., McGale, L., Maden, M., Hounsome, J., Boland, A., & Jones, A. (2022). Systematic review of the effect of policies to restrict the marketing of foods and non-alcoholic beverages to which children are exposed. *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity*, e13447. https://doi.org/10.1111/obr.13447

Bramante, C. T., Thornton, R. L. J., Bennett, W. L., Zhang, A., Wilson, R. F., Bass, E. B., & Tseng, E. (2019). Systematic Review of Natural Experiments for Childhood Obesity Prevention and Control. *American Journal of Preventive Medicine, 56*(1), 147–158. https://doi.org/10.1016/j.amepre.2018.08.023

Brambila-Macias, J., Shankar, B., Capacci, S., Mazzocchi, M., Perez-Cueto, F. J. A., Verbeke, W., & Traill, W. B. (2011). Policy interventions to promote healthy eating: A review of what works, what does not, and what is promising. *Food and Nutrition Bulletin, 32*(4), 365–375. https://doi.org/10.1177/156482651103200408

Brennan, A., & Browne, S. (2021). Food Waste and Nutrition Quality in the Context of Public Health: A Scoping Review. *International Journal of Environmental Research and Public Health, 18*(10), 5379. https://doi.org/10.3390/ijerph18105379

Broeks, M. J., Biesbroek, S., Over, E. A. B., van Gils, P. F., Toxopeus, I., Beukers, M. H., & Temme, E. H. M. (2020). A social cost-benefit analysis of meat taxation and a fruit and vegetables subsidy for a healthy and sustainable food consumption in the Netherlands. *BMC Public Health, 20*(1), 643. https://doi.org/10.1186/s12889-020-08590-z

Browne, J., Lock, M., Walker, T., Egan, M., & Backholer, K. (2020). Effects of food policy actions on Indigenous Peoples' nutrition-related outcomes: A systematic review. *BMJ Global Health*, *5*(8), e002442. https://doi.org/10.1136/bmjgh-2020-002442

Campbell, B. M., Beare, D. J., Bennett, E. M., Hall-Spencer, J. M., Ingram, J. S. I., Jaramillo, F., Ortiz, R., Ramankutty, N., Sayer, J. A., & Shindell, D. (2017). Agriculture production as a major driver of the Earth system exceeding planetary boundaries. *Ecology and Society*, *22*(4), art8. https://doi.org/10.5751/ES-09595-220408

Campos Ponce, M., Polman, K., Roos, N., Wieringa, F. T., Berger, J., & Doak, C. M. (2019). What Approaches are Most Effective at Addressing Micronutrient Deficiency in Children 0–5 Years? A Review of Systematic Reviews. *Maternal and Child Health Journal, 23*(S1), 4–17. https://doi.org/10.1007/s10995-018-2527-9

Carducci, B., Oh, C., Keats, E. C., Roth, D. E., & Bhutta, Z. A. (2020). Effect of Food Environment Interventions on Anthropometric Outcomes in School-Aged Children and Adolescents in Low- and Middle-Income Countries: A Systematic Review and Meta-Analysis. *Current Developments in Nutrition*, *4*(7), nzaa098. https://doi.org/10.1093/cdn/nzaa098

Castle, S. E., Miller, D. C., Ordonez, P. J., Baylis, K., & Hughes, K. (2021). The impacts of agroforestry interventions on agricultural productivity, ecosystem services, and human well-being in low- and middle-income countries: A systematic review. *Campbell Systematic Reviews*, *17*(2). https://doi.org/10.1002/cl2.1167

Cawley, J., & Wen, K. (2018). Policies to Prevent Obesity and Promote Healthier Diets: A Critical Selective Review. *Clinical Chemistry, 64*(1), 163–172. https://doi.org/10.1373/clinchem.2017.278325

Cecchini, M., & Warin, L. (2016). Impact of food labelling systems on food choices and eating behaviours: A systematic review and

meta-analysis of randomized studies: Impact of food labelling. *Obesity Reviews, 17*(3), 201–210. https://doi.org/10.1111/obr.12364

Chambers, S. A., Freeman, R., Anderson, A. S., & MacGillivray, S. (2015). Reducing the volume, exposure and negative impacts of advertising for foods high in fat, sugar and salt to children: A systematic review of the evidence from statutory and self-regulatory actions and educational measures. *Preventive Medicine, 75*, 32–43. https://doi.org/10.1016/j.ypmed.2015.02.011

Chaudhary, A., Sudzina, F., & Mikkelsen, B. E. (2020). Promoting Healthy Eating among Young People—A Review of the Evidence of the Impact of School-Based Interventions. *Nutrients, 12*(9), 2894. https://doi.org/10.3390/nu12092894

Chen, C., Chaudhary, A., & Mathys, A. (2020). Nutritional and environmental losses embedded in global food waste. *Resources, Conservation and Recycling*, *160*, 104912. https://doi.org/10.1016/j.resconrec.2020.104912

Chen, Y.-Z., & Tanaka, H. (2014). Women's Empowerment. In A. C. Michalos (Ed.), *Encyclopedia of Quality of Life and Well-Being Research* (pp. 7154–7156). Springer Netherlands. https://doi.org/10.1007/978-94-007-0753-5_3252

Cohen, J. F. W., Hecht, A. A., McLoughlin, G. M., Turner, L., & Schwartz, M. B. (2021). Universal School Meals and Associations with Student Participation, Attendance, Academic Performance, Diet Quality, Food Security, and Body Mass Index: A Systematic Review. *Nutrients, 13*(3), 911. https://doi.org/10.3390/nu13030911

Colley, P., Myer, B., Seabrook, J., & Gilliland, J. (2019). The Impact of Canadian School Food Programs on Children's Nutrition and Health: A Systematic Review. *Canadian Journal of Dietetic Practice and Research, 80*(2), 79–86. https://doi.org/10.3148/cjdpr-2018-037

Crippa, M., Solazzo, E., Guizzardi, D., Monforti-Ferrario, F., Tubiello, F. N., & Leip, A. (2021). Food systems are responsible for a third of global anthropogenic GHG emissions. *Nature Food, 2*(3), 198–209. https://doi.org/10.1038/s43016-021-00225-9

Dangour, A. D., Hawkesworth, S., Shankar, B., Watson, L., Srinivasan, C. S., Morgan, E. H., Haddad, L., & Waage, J. (2013). Can nutrition be promoted through agriculture-led food price policies? A systematic review. *BMJ Open*, *3*(6), e002937. https://doi.org/10.1136/bmjopen-2013-002937

Das, J. K., Salam, R. A., Kumar, R., & Bhutta, Z. A. (2013). Micronutrient fortification of food and its impact on woman and child health: A systematic review. *Systematic Reviews, 2*(1), 67. https://doi.org/10.1186/2046-4053-2-67

De Bourdeaudhuij, I., Van Cauwenberghe, E., Spittaels, H., Oppert, J.-M., Rostami, C., Brug, J., Van Lenthe, F., Lobstein, T., & Maes, L. (2011). School-based interventions promoting both physical activity and healthy eating in Europe: A systematic review within the HOPE project: School-based nutrition and PA interventions. *Obesity Reviews, 12*(3), 205–216. https://doi.org/10.1111/j.1467-789X.2009.00711.x

Deaconu, A., Berti, P. R., Cole, D. C., Mercille, G., & Batal, M. (2021). Agroecology and nutritional health: A comparison of agroecological farmers and their neighbors in the Ecuadorian highlands. *Food Policy*, *101*, 102034. https://doi.org/10.1016/j.foodpol.2021.102034

Devine, A., & Lawlis, T. (2019). Nutrition and Vulnerable Groups. *Nutrients, 11*(5), 1066. https://doi.org/10.3390/nu11051066

Dewi, N. U., & Mahmudiono, T. (2021). Effectiveness of Food Fortification in Improving Nutritional Status of Mothers and Children in Indonesia. *International Journal of Environmental Research and Public Health, 18*(4), 2133. https://doi.org/10.3390/ijerph18042133

Dodd, R., Santos, J. A., Tan, M., Campbell, N. R. C., Ni Mhurchu, C., Cobb, L., Jacobson, M. F., He, F. J., Trieu, K., Osornprasop, S., & Webster, J. (2020). Effectiveness and Feasibility of Taxing Salt and Foods High in Sodium: A Systematic Review of the Evidence. *Advances in Nutrition, 11*(6), 1616–1630. https://doi.org/10.1093/advances/nmaa067

Driessen, C. E., Cameron, A. J., Thornton, L. E., Lai, S. K., & Barnett, L. M. (2014). Effect of changes to the school food environment on eating behaviours and/or body weight in children: A systematic review: Effect of changing school food environment. *Obesity Reviews, 15*(12), 968–982. https://doi.org/10.1111/obr.12224

Durao, S., Visser, M., Ramokolo, V., Oliveira, J., Schmidt, B.-M., Balakrishna, Y., Brand, A., Kristjansson, E., & Schoonees, A. (2020). Community-level interventions for improving access to food in low- and middle-income countries. *Cochrane Database of Systematic Reviews*, *8*. https://doi.org/10.1002/14651858.CD011504.pub3

Ekwaru, J. P., Ohinmaa, A., Dabravolskaj, J., Maximova, K., & Veugelers, P. J. (2021). Cost-effectiveness and return on investment of school-based health promotion programmes for chronic disease prevention. *European Journal of Public Health, 31*(6), 1183–1189. https://doi.org/10.1093/eurpub/ckab130

El Chami, D., Daccache, A., & El Moujabber, M. (2020). How Can Sustainable Agriculture Increase Climate Resilience? *A Systematic Review. Sustainability, 12*(8), 3119. https://doi.org/10.3390/su12083119

Environment, U. N. (2021, February 3). *Food system impacts on biodiversity loss*. UNEP - UN Environment Programme. http://www.unep.org/resources/publication/food-system-impacts-biodiversity-loss

Ewart-Pierce, E., Mejía Ruiz, M. J., & Gittelsohn, J. (2016). "Whole-of-Community" Obesity Prevention: A Review of Challenges and Opportunities in Multilevel. *Multicomponent Interventions. Current Obesity Reports, 5*(3), 361–374. https://doi.org/10.1007/s13679-016-0226-7

Fanzo, J., Haddad, L., Schneider, K. R., Béné, C., Covic, N. M., Guarin, A., Herforth, A. W., Herrero, M., Sumaila, U. R., Aburto, N. J., Amuyunzu-Nyamongo, M., Barquera, S., Battersby, J., Beal, T., Bizzotto Molina, P., Brusset, E., Cafiero, C., Campeau, C., Caron, P., & Rosero Moncayo, J. (2021). Viewpoint: Rigorous monitoring is necessary to guide food system transformation in the countdown to the 2030 global goals. *Food Policy*, *104*, 102163. https://doi.org/10.1016/j.foodpol.2021.102163

FAO and WHO. (2019). Sustainable healthy diets: Guiding principles. *FAO and WHO*. https://doi.org/10.4060/CA6640EN

Feliciano, D. (2019). A review on the contribution of crop diversification to Sustainable Development Goal 1 "No poverty" in different world regions. *Sustainable Development*, *27*(4), 795–808. Scopus. https://doi.org/10.1002/sd.1923

Fergus, L., Seals, K., & Holston, D. (2021). Nutrition Interventions in Low-Income Rural and Urban Retail Environments: A Systematic Review. *Journal of the Academy of Nutrition and Dietetics, 121*(6), 1087–1114. https://doi.org/10.1016/j.jand.2020.12.018

Feteira-Santos, R., Fernandes, J., Virgolino, A., Alarcão, V., Sena, C., Vieira, C. P., Gregório, M. J., Nogueira, P., Costa, A., Graça, P., & Santos, O. (2020). Effectiveness of interpretive front-of-pack nutritional labelling schemes on the promotion of healthier food choices: A systematic review. *International Journal of Evidence-Based Healthcare, 18*(1), 24–37. https://doi.org/10.1097/XEB.0000000000000214

Finkelstein, E. A., Strombotne, K. L., Zhen, C., & Epstein, L. H. (2014). Food Prices and Obesity: A Review. *Advances in Nutrition, 5*(6), 818–821. https://doi.org/10.3945/an.114.007088

Finkelstein, J. L., Fothergill, A., Hackl, L. S., Haas, J. D., & Mehta, S. (2019). Iron biofortification interventions to improve iron status and functional outcomes. *Proceedings of the Nutrition Society, 78*(02), 197–207. https://doi.org/10.1017/S0029665118002847

Food and Agriculture Organization of the United Nations (Ed.). (2017). *The future of food and agriculture: Trends and challenges*. Food and Agriculture Organization of the United Nations.

Galbraith-Emami, S., & Lobstein, T. (2013). The impact of initiatives to limit the advertising of food and beverage products to children: A systematic review: Initiatives to limit advertising to children. *Obesity Reviews, 14*(12), 960–974. https://doi.org/10.1111/obr.12060

Gera, T., Shah, D., & Sachdev, H. S. (2019). Zinc Supplementation for Promoting Growth in Children Under 5 years of age in Low- and Middle-income Countries: A Systematic Review. *Indian Pediatrics, 56*(5), 391–406.

Giner, C., Hobeika, M., & Fischetti, C. (2022). *Gender and food systems: Overcoming evidence gaps* (OECD Food, Agriculture and Fisheries Papers No. 184; OECD Food, Agriculture and Fisheries Papers, Vol. 184). https://doi.org/10.1787/355ba4ee-en

Gittelsohn, J., Rowan, M., & Gadhoke, P. (2012). Interventions in small food stores to change the food environment, improve diet, and reduce risk of chronic disease. *Preventing Chronic Disease, 9*, E59.

Gittelsohn, J., Trude, A. C. B., & Kim, H. (2017). Pricing Strategies to Encourage Availability, Purchase, and Consumption of Healthy Foods and Beverages: A Systematic Review. *Preventing Chronic Disease*, *14*, 170213. https://doi.org/10.5888/pcd14.170213

Global Obesity Observatory, W. O. F. (2022). *Obesity Atlas 2022*. World Obesity Federation Global Obesity Observatory. https://data.worldobesity.org/publications/?cat=15

Gressier, M., Swinburn, B., Frost, G., Segal, A. B., & Sassi, F. (2021). What is the impact of food reformulation on individuals' behaviour, nutrient intakes and health status? A systematic review of empirical evidence. *Obesity Reviews*, *22*(2). https://doi.org/10.1111/obr.13139

Haby, M. M., Chapman, E., Clark, R., & Galvão, L. A. C. (2016). Agriculture, food, and nutrition interventions that facilitate sustainable food production and impact health: An overview of systematic reviews. *Revista Panamericana De Salud Publica = Pan American Journal of Public Health*, *40*(1), 48–56.

Hartmann-Boyce, J., Bianchi, F., Piernas, C., Riches, S. P., Frie, K., Nourse, R., & Jebb, S. A. (2018). Grocery store interventions to change food purchasing behaviors: A systematic review of randomized controlled trials. *The American Journal of Clinical Nutrition, 107*(6), 1004–1016. https://doi.org/10.1093/ajcn/nqy045

Hawkes, C., Smith, T. G., Jewell, J., Wardle, J., Hammond, R. A., Friel, S., Thow, A. M., & Kain, J. (2015). Smart food policies for obesity prevention. *The Lancet, 385*(9985), 2410–2421. https://doi.org/10.1016/S0140-6736(14)61745-1

Hendry, V. L., Almíron-Roig, E., Monsivais, P., Jebb, S. A., Benjamin Neelon, S. E., Griffin, S. J., & Ogilvie, D. B. (2015). Impact of Regulatory Interventions to Reduce Intake of Artificial Trans-Fatty Acids: A Systematic Review. *American Journal of Public Health, 105*(3), e32–e42. https://doi.org/10.2105/AJPH.2014.302372

Hillier-Brown, F. C., Summerbell, C. D., Moore, H. J., Routen, A., Lake, A. A., Adams, J., White, M., Araujo-Soares, V., Abraham, C., Adamson, A. J., & Brown, T. J. (2017). The impact of interventions to promote healthier ready-to-eat meals (to eat in, to take away or to be delivered) sold by specific food outlets open to the general public: A systematic review: Promoting healthier food outlet meals. *Obesity Reviews, 18*(2), 227–246. https://doi.org/10.1111/obr.12479

Hofman, K. J., Stacey, N., Swart, E. C., Popkin, B. M., & Ng, S. W. (2021). South Africa's Health Promotion Levy: Excise tax findings and equity potential. *Obesity Reviews*, *22*(9). https://doi.org/10.1111/obr.13301

Holley, C. E., & Mason, C. (2019). A Systematic Review of the Evaluation of Interventions to Tackle Children's Food Insecurity. *Current Nutrition Reports, 8*(1), 11–27. https://doi.org/10.1007/s13668-019-0258-1

Hyseni, L., Atkinson, M., Bromley, H., Orton, L., Lloyd-Williams, F., McGill, R., & Capewell, S. (2017). The effects of policy actions to improve population dietary patterns and prevent diet-related non-communicable diseases: Scoping review. *European Journal of Clinical Nutrition*, *71*(6), 694–711. Scopus. https://doi.org/10.1038/ejcn.2016.234

Hyseni, L., Bromley, H., Kypridemos, C., O'Flaherty, M., Lloyd-Williams, F., Guzman-Castillo, M., Pearson-Stuttard, J., & Capewell, S. (2017). Systematic review of dietary trans-fat reduction interventions. *Bulletin of the World Health Organization, 95*(12), 821-830G. https://doi.org/10.2471/BLT.16.189795

Hyseni, L., Elliot-Green, A., Lloyd-Williams, F., Kypridemos, C., O'Flaherty, M., McGill, R., Orton, L., Bromley, H., Cappuccio, F. P., & Capewell, S. (2017). Systematic review of dietary salt reduction policies: Evidence for an effectiveness hierarchy? *PLoS ONE*, *12*(5), e0177535. https://doi.org/10.1371/journal.pone.0177535

Iglesias Vázquez, L., Valera, E., Villalobos, M., Tous, M., & Arija, V. (2019). Prevalence of Anemia in Children from Latin America and the Caribbean and Effectiveness of Nutritional Interventions: Systematic Review and Meta-Analysis. *Nutrients, 11*(1), 183. https://doi.org/10.3390/nu11010183

Jensen, J. D., Hartmann, H., de Mul, A., Schuit, A., Brug, J., & on behalf of the ENERGY Consortium. (2011). Economic incentives and nutritional behavior of children in the school setting: A systematic review: Nutrition Reviews©, Vol. ●●, No. ●●. *Nutrition Reviews*, *69*(11), 660–674. https://doi.org/10.1111/j.1753-4887.2011.00422.x

Jones, A., Magnusson, R., Swinburn, B., Webster, J., Wood, A., Sacks, G., & Neal, B. (2016). Designing a Healthy Food Partnership: Lessons from the Australian Food and Health Dialogue. *BMC Public Health, 16*(1), 651. https://doi.org/10.1186/s12889-016-3302-8

Kadiyala, S., Harris, J., Headey, D., Yosef, S., & Gillespie, S. (2014). Agriculture and nutrition in India: Mapping evidence to pathways. *Annals of the New York Academy of Sciences, 1331*, 43–56. https://doi.org/10.1111/nyas.12477

Kirkpatrick, S., Raffoul, A., Maynard, M., Lee, K., & Stapleton, J. (2018). Gaps in the Evidence on Population Interventions to Reduce Consumption of Sugars: A Review of Reviews. *Nutrients, 10*(8), 1036. https://doi.org/10.3390/nu10081036

Kleis, L. D., Schulte, E. A., & Buyken, A. E. (2020). Reformulation across Europe. Results from strategies implemented in European countries other than Germany and identification of factors contributing to their success – part 2. *Ernahrungs Umschau*, *67(11)*, 200–205. https://doi.org/10.4455/eu.2020.053

Kovic, Y., Noel, J. K., Ungemack, J. A., & Burleson, J. A. (2018). The impact of junk food marketing regulations on food sales: An ecological study: Junk food marketing regulations & sales. *Obesity Reviews, 19*(6), 761–769. https://doi.org/10.1111/obr.12678

Kumanyika, S. K., Swank, M., Stachecki, J., Whitt-Glover, M. C., & Brennan, L. K. (2014). Examining the evidence for policy and environmental strategies to prevent childhood obesity in black communities: New directions and next steps: Environmental and policy changes. *Obesity Reviews, 15*, 177–203. https://doi.org/10.1111/obr.12206

Lee, K., Freudenberg, N., Zenone, M., Smith, J., Mialon, M., Marten, R., Lima, J. M., Friel, S., Klein, D. E., Crosbie, E., & Buse, K. (2022). Measuring the Commercial Determinants of Health and Disease: A Proposed Framework. *International Journal of Health Services, 52*(1), 115–128. https://doi.org/10.1177/00207314211044992

Lhachimi, S. K., Pega, F., Heise, T. L., Fenton, C., Gartlehner, G., Griebler, U., Sommer, I., Bombana, M., & Katikireddi, S. V. (2020). Taxation of the fat content of foods for reducing their consumption and preventing obesity or other adverse health outcomes. *Cochrane Database of Systematic Reviews*. https://doi.org/10.1002/14651858.CD012415.pub2

Lobstein, T., Neveux, M., & Landon, J. (2020). Costs, equity and acceptability of three policies to prevent obesity: A narrative review to support policy development. *Obesity Science & Practice, 6*(5), 562–583. https://doi.org/10.1002/osp4.423

Loewenson, R., Nolen, L. B., & Wamala, S. (2010). Review Article: Globalisation and women's health in Sub-Saharan Africa: Would paying attention to women's occupational roles improve nutritional outcomes? *Scandinavian Journal of Public Health*, *38*(4_suppl), 6–17. https://doi.org/10.1177/1403494809358276

Løvhaug, A. L., Granheim, S. I., Djojosoeparto, S. K., Harrington, J. M., Kamphuis, C. B. M., Poelman, M. P., Roos, G., Sawyer, A., Stronks, K., Torheim, L. E., Twohig, C., Vandevijvere, S., van Lenthe, F. J., & Terragni, L. (2022). The potential of food environment policies to reduce socioeconomic inequalities in diets and to improve healthy diets among lower socioeconomic groups: An umbrella review. *BMC Public Health, 22*(1), 433. https://doi.org/10.1186/s12889-022-12827-4

Luongo, G., Skinner, K., Phillipps, B., Yu, Z., Martin, D., & Mah, C. L. (2020). The Retail Food Environment, Store Foods, and Diet and Health among Indigenous Populations: A Scoping Review. *Current Obesity Reports, 9*(3), 288–306. https://doi.org/10.1007/s13679-020-00399-6

Lybbert, T. J., & Sumner, D. A. (2012). Agricultural technologies for climate change in developing countries: Policy options for innovation and technology diffusion. *Food Policy, 37*(1), 114–123. https://doi.org/10.1016/j.foodpol.2011.11.001

Mansfield, J. L., & Savaiano, D. A. (2017). Effect of school wellness policies and the Healthy, Hunger-Free Kids Act on food-consumption behaviors of students, 2006–2016: A systematic review. *Nutrition Reviews, 75*(7), 533–552. https://doi.org/10.1093/nutrit/nux020

Masset, E., Haddad, L., Cornelius, A., & Isaza-Castro, J. (2012). Effectiveness of agricultural interventions that aim to improve nutritional status of children: Systematic review. *BMJ*, *344*(jan17 1), d8222–d8222. https://doi.org/10.1136/bmj.d8222

McCartney, G., Popham, F., McMaster, R., & Cumbers, A. (2019). Defining health and health inequalities. *Public Health, 172*, 22–30. https://doi.org/10.1016/j.puhe.2019.03.023

McElwee, P., Calvin, K., Campbell, D., Cherubini, F., Grassi, G., Korotkov, V., Le Hoang, A., Lwasa, S., Nkem, J., Nkonya, E., Saigusa, N., Soussana, J., Taboada, M. A., Manning, F., Nampanzira, D., & Smith, P. (2020). The impact of interventions in the global land and agri-food sectors on Nature's Contributions to People and the UN Sustainable Development Goals. *Global Change Biology, 26*(9), 4691–4721. https://doi.org/10.1111/gcb.15219

McHugh, C., Hurst, A., Bethel, A., Lloyd, J., Logan, S., & Wyatt, K. (2020). The impact of the World Health Organization Health Promoting Schools framework approach on diet and physical activity behaviours of adolescents in secondary schools: A systematic review. *Public Health, 182*, 116–124. https://doi.org/10.1016/j.puhe.2020.02.006

Meiklejohn, S., Ryan, L., & Palermo, C. (2016). A Systematic Review of the Impact of Multi-Strategy Nutrition Education Programs on Health and Nutrition of Adolescents. *Journal of Nutrition Education and Behavior, 48*(9), 631-646.e1. https://doi.org/10.1016/j.jneb.2016.07.015

Menon, S., & Peñalvo, J. L. (2019a). Actions Targeting the Double Burden of Malnutrition: A Scoping Review. *Nutrients, 12*(1), E81. https://doi.org/10.3390/nu12010081

Menon, S., & Peñalvo, J. L. (2019b). Actions Targeting the Double Burden of Malnutrition: A Scoping Review. *Nutrients, 12*(1), 81. https://doi.org/10.3390/nu12010081

Metcalfe, J. J., Ellison, B., Hamdi, N., Richardson, R., & Prescott, M. P. (2020). A systematic review of school meal nudge interventions to improve youth food behaviors. *The International Journal of Behavioral Nutrition and Physical Activity, 17*(1), 77. https://doi.org/10.1186/s12966-020-00983-y

Mialon, M. (2020). An overview of the commercial determinants of health. *Globalization and Health, 16*, 74. https://doi.org/10.1186/s12992-020-00607-x

Mithra, P., Khatib, M. N., Sinha, A. P., Kumar, N., Holla, R., Unnikrishnan, B., Vijayamma, R., Nair, N. S., Gaidhane, A., & Quazi Zahiruddin, S. (2021). Interventions for Addressing Anemia Among Children and Adolescents: An Overview of Systematic Reviews. *Frontiers in Pediatrics*, *8*, 549549. https://doi.org/10.3389/fped.2020.549549

Moran, A. J., Gu, Y., Clynes, S., Goheer, A., Roberto, C. A., & Palmer, A. (2020). Associations between Governmental Policies to Improve the Nutritional Quality of Supermarket Purchases and Individual, Retailer, and Community Health Outcomes: An Integrative Review. *International Journal of Environmental Research and Public Health, 17*(20), 7493. https://doi.org/10.3390/ijerph17207493

Moran, V. H., Morgan, H., Rothnie, K., MacLennan, G., Stewart, F., Thomson, G., Crossland, N., Tappin, D., Campbell, M., & Hoddinott, P. (2015). Incentives to Promote Breastfeeding: A Systematic Review. *Pediatrics, 135*(3), e687–e702. https://doi.org/10.1542/peds.2014-2221

Morilla-Herrera, J. C., Martín-Santos, F. J., Caro-Bautista, J., Saucedo-Figueredo, C., García-Mayor, S., & Morales-Asencio, J. M. (2016). Effectiveness of food-based fortification in older people a systematic review and meta-analysis. *The Journal of Nutrition, Health & Aging, 20*(2), 178–184. https://doi.org/10.1007/s12603-015-0591-z

Musicus, A. A., Kraak, V. I., & Bleich, S. N. (2020). Policy Progress in Reducing Sodium in the American Diet, 2010–2019. *Annual Review of Nutrition, 40*(1), 407–435. https://doi.org/10.1146/annurev-nutr-122319-040249

Naicker, A., Shrestha, A., Joshi, C., Willett, W., & Spiegelman, D. (2021a). Workplace cafeteria and other multicomponent interventions to promote healthy eating among adults: A systematic review. *Preventive Medicine Reports*, *22*, 101333. https://doi.org/10.1016/j.pmedr.2021.101333

Naicker, A., Shrestha, A., Joshi, C., Willett, W., & Spiegelman, D. (2021b). Workplace cafeteria and other multicomponent interventions to promote healthy eating among adults: A systematic review. *Preventive Medicine Reports*, *22*, 101333. https://doi.org/10.1016/j.pmedr.2021.101333

Naik, Y., Baker, P., Ismail S. A., Tillmann, T., Bash, K., Quantz, D., Hillier-Brown, F., Jayatunga, W., Kelly, G., Black, M., Gopfert, A., Roderick, P., Barr, B., & Bambra, C. (2019). Going upstream – an umbrella review of the macroeconomic determinants of health and health inequalities. *BMC Public Health, 19*(1), 1678. https://doi.org/10.1186/s12889-019-7895-6

Nasir Ahmad, N. S. B., Mustafa, F. B., Muhammad, S., Yusoff @ Y., & Didams, G. (2020). A systematic review of soil erosion control practices on the agricultural land in Asia. *International Soil and Water Conservation Research, 8*(2), 103–115. https://doi.org/10.1016/j.iswcr.2020.04.001

Nelson, M. E., Hamm, M. W., Hu, F. B., Abrams, S. A., & Griffin, T. S. (2016). Alignment of Healthy Dietary Patterns and Environmental Sustainability: A Systematic Review. *Advances in Nutrition: An International Review Journal, 7*(6), 1005–1025. https://doi.org/10.3945/an.116.012567

Niebylski, M., Lu, T., Campbell, N., Arcand, J., Schermel, A., Hua, D., Yeates, K., Tobe, S., Twohig, P., L'Abbé, M., Liu, P. (2014). Healthy Food Procurement Policies and Their Impact. *International Journal of Environmental Research and Public Health, 11*(3), 2608–2627. https://doi.org/10.3390/ijerph110302608

Nørnberg, T. R., Houlby, L., Skov, L. R., & Peréz-Cueto, F. J. A. (2016). Choice architecture interventions for increased vegetable

intake and behaviour change in a school setting: A systematic review. *Perspectives in Public Health, 136*(3), 132–142. https://doi.org/10.1177/1757913915596017

Noy, S., Patrick, R., Henderson-Wilson, C., Nuttman, S., & Ryan, I. (2019). New frontiers in community initiatives to increase vegetable consumption. *Health Promotion Journal of Australia, 30*(S1), 52–61. https://doi.org/10.1002/hpja.207

O'Dare Wilson, K. (2017). Community food environments and healthy food access among older adults: A review of the evidence for the Senior Farmers' Market Nutrition Program (SFMNP). *Social Work in Health Care, 56*(4), 227–243. https://doi.org/10.1080/00981389.2016.1265631

OECD. (2021). *Making better policies for food systems*. Organisation for Economic Co-operation and Development. https://www.oecd-ilibrary.org/agriculture-and-food/making-better-policies-for-food-systems_ddfba4de-en

Pachón, H., Spohrer, R., Mei, Z., & Serdula, M. K. (2015). Evidence of the effectiveness of flour fortification programs on iron status and anemia: A systematic review. *Nutrition Reviews, 73*(11), 780–795. https://doi.org/10.1093/nutrit/nuv037

Pandey, V. L., Mahendra Dev, S., & Jayachandran, U. (2016). Impact of agricultural interventions on the nutritional status in South Asia: A review. *Food Policy, 62*, 28–40. https://doi.org/10.1016/j.foodpol.2016.05.002

Park, H., & Yu, S. (2019). Policy review: Implication of tax on sugar-sweetened beverages for reducing obesity and improving heart health. *Health Policy and Technology, 8*(1), 92–95. https://doi.org/10.1016/j.hlpt.2018.12.002

Pell, D., Mytton, O., Penney, T. L., Briggs, A., Cummins, S., Penn-Jones, C., Rayner, M., Rutter, H., Scarborough, P., Sharp, S. J., Smith, R. D., White, M., & Adams, J. (2021). Changes in soft drinks purchased by British households associated with the UK soft drinks industry levy: Controlled interrupted time series analysis. *BMJ*, *372*, n254. https://doi.org/10.1136/bmj.n254

Perez-Cueto, F. J. A. (2019). An Umbrella Review of Systematic Reviews on Food Choice and Nutrition Published between 2017 and-2019. *Nutrients, 11*(10), E2398. https://doi.org/10.3390/nu11102398

Pérez-Cueto, F. J., Aschemann-Witzel, J., Shankar, B., Brambila-Macias, J., Bech-Larsen, T., Mazzocchi, M., Capacci, S., Saba, A., Turrini, A., Niedzwiedzka, B., Piorecka, B., Kozioł-Kozakowska, A., Wills, J., Traill, W. B., & Verbeke, W. (2012). Assessment of evaluations made to healthy eating policies in Europe: A review within the EATWELL Project. *Public Health Nutrition, 15*(8), 1489–1496. https://doi.org/10.1017/S1368980011003107

Pérez-Ferrer, C., Auchincloss, A. H., De Menezes, M. C., Kroker-Lobos, M. F., Cardoso, L. D. O., & Barrientos-Gutierrez, T. (2019). The food environment in Latin America: A systematic review with a focus on environments relevant to obesity and related chronic diseases. *Public Health Nutrition*, *22*(18), 3447–3464. Scopus. https://doi.org/10.1017/S1368980019002891

Perignon, M., Vieux, F., Soler, L.-G., Masset, G., & Darmon, N. (2017). Improving diet sustainability through evolution of food choices: Review of epidemiological studies on the environmental impact of diets. *Nutrition Reviews, 75*(1), 2–17. https://doi.org/10.1093/nutrit/nuw043

Pfinder, M., Heise, T. L., Hilton Boon, M., Pega, F., Fenton, C., Griebler, U., Gartlehner, G., Sommer, I., Katikireddi, S. V., & Lhachimi, S. K. (2020). Taxation of unprocessed sugar or sugar-added foods for reducing their consumption and preventing obesity or other adverse health outcomes. *Cochrane Database of Systematic Reviews*. https://doi.org/10.1002/14651858.CD012333.pub2

Pineda, E., Bascunan, J., & Sassi, F. (2021). Improving the school food environment for the prevention of childhood obesity: What works and what doesn't. *Obesity Reviews*, *22*(2). https://doi.org/10.1111/obr.13176

Poscia, A., Milovanovic, S., La Milia, D. I., Duplaga, M., Grysztar, M., Landi, F., Moscato, U., Magnavita, N., Collamati, A., & Ricciardi, W. (2018). Effectiveness of nutritional interventions addressed to elderly persons: Umbrella systematic review with meta-analysis. *European Journal of Public Health, 28*(2), 275–283. https://doi.org/10.1093/eurpub/ckx199

Potter, C., Bastounis, A., Hartmann-Boyce, J., Stewart, C., Frie, K., Tudor, K., Bianchi, F., Cartwright, E., Cook, B., Rayner, M., & Jebb, S. A. (2021). The Effects of Environmental Sustainability Labels on Selection, Purchase, and Consumption of Food and Drink Products: A Systematic Review. *Environment and Behavior, 53*(8), 891–925. https://doi.org/10.1177/0013916521995473

Powell, L. M., Chriqui, J. F., Khan, T., Wada, R., & Chaloupka, F. J. (2013). Assessing the potential effectiveness of food and beverage taxes and subsidies for improving public health: A systematic review of prices, demand and body weight outcomes: Review of prices, demand and weight. *Obesity Reviews, 14*(2), 110–128. https://doi.org/10.1111/obr.12002

Pratt, O. (2015). A review of the strategies used to reduce the prevalence of iron deficiency and iron deficiency anaemia in infants aged 6–36 months. *Nutrition Bulletin, 40*(4), 257–267. https://doi.org/10.1111/nbu.12170

Prescott, M. P., Cleary, R., Bonanno, A., Costanigro, M., Jablonski, B. B. R., & Long, A. B. (2020). Farm to School Activities and Student Outcomes: A Systematic Review. *Advances in Nutrition, 11*(2), 357–374. https://doi.org/10.1093/advances/nmz094

Pullar, J., Allen, L., Townsend, N., Williams, J., Foster, C., Roberts, N., Rayner, M., Mikkelsen, B., Branca, F., & Wickramasinghe, K. (2018). The impact of poverty reduction and development interventions on non-communicable diseases and their behavioural risk factors in low and lower-middle income countries: A systematic review. *PLoS ONE, 13*(2), e0193378. https://doi.org/10.1371/journal.pone.0193378

Rincón-Gallardo Patiño, S., Zhou, M., Da Silva Gomes, F., Lemaire, R., Hedrick, V., Serrano, E., & Kraak, V. I. (2020). Effects of Menu Labeling Policies on Transnational Restaurant Chains to Promote a Healthy Diet: A Scoping Review to Inform Policy and Research. *Nutrients, 12*(6), 1544. https://doi.org/10.3390/nu12061544

Roberts, K. E., Ells, L. J., McGowan, V. J., Machaira, T., Targett, V. C., Allen, R. E., & Tedstone, A. E. (2017). A rapid review examining purchasing changes resulting from fiscal measures targeted at high sugar foods and sugar-sweetened drinks. *Nutrition & Diabetes, 7*(12), 302. https://doi.org/10.1038/s41387-017-0001-1

Roberts, S., Pilard, L., Chen, J., Hirst, J., Rutter, H., & Greenhalgh, T. (2019). Efficacy of population-wide diabetes and obesity prevention programs: An overview of systematic reviews on proximal, intermediate, and distal outcomes and a meta-analysis of impact on BMI. *Obesity Reviews, 20*(7), 947–963. https://doi.org/10.1111/obr.12821

Ronit, K., & Jensen, J. D. (2014). Obesity and industry self-regulation of food and beverage marketing: A literature review. *European Journal of Clinical Nutrition, 68*(7), 753–759. https://doi.org/10.1038/ejcn.2014.60

Roy, R., Kelly, B., Rangan, A., & Allman-Farinelli, M. (2015). Food Environment Interventions to Improve the Dietary Behavior of Young Adults in Tertiary Education Settings: A Systematic Literature Review. *Journal of the Academy of Nutrition and Dietetics, 115*(10), 1647-1681.e1. https://doi.org/10.1016/j.jand.2015.06.380

Russo, R., Li, Y., Chong, S., Siscovick, D., Trinh-Shevrin, C., & Yi, S. (2020). Dietary policies and programs in the United States: A narrative review. *Preventive Medicine Reports*, *19*, 101135. https://doi.org/10.1016/j.pmedr.2020.101135

Santos, J. A., Tekle, D., Rosewarne, E., Flexner, N., Cobb, L., Al-Jawaldeh, A., Kim, W. J., Breda, J., Whiting, S., Campbell, N., Neal, B., Webster, J., & Trieu, K. (2021). A Systematic Review

of Salt Reduction Initiatives Around the World: A Midterm Evaluation of Progress Towards the 2025 Global Non-Communicable Diseases Salt Reduction Target. *Advances in Nutrition (Bethesda, Md.)*, nmab008. https://doi.org/10.1093/advances/nmab008

Scarborough, P., Adhikari, V., Harrington, R. A., Elhussein, A., Briggs, A., Rayner, M., Adams, J., Cummins, S., Penney, T., & White, M. (2020). Impact of the announcement and implementation of the UK Soft Drinks Industry Levy on sugar content, price, product size and number of available soft drinks in the UK, 2015–19: A controlled interrupted time series analysis. *PLoS Medicine*, *17*(2), e1003025. https://doi.org/10.1371/journal.pmed.1003025

Schipanski, M. E., MacDonald, G. K., Rosenzweig, S., Chappell, M. J., Bennett, E. M., Kerr, R. B., Blesh, J., Crews, T., Drinkwater, L., Lundgren, J. G., & Schnarr, C. (2016). Realizing Resilient Food Systems. *BioScience, 66*(7), 600–610. https://doi.org/10.1093/biosci/biw052

Schultz, D. J., Byker Shanks, C., & Houghtaling, B. (2015). The Impact of the 2009 Special Supplemental Nutrition Program for Women, Infants, and Children Food Package Revisions on Participants: A Systematic Review. *Journal of the Academy of Nutrition and Dietetics, 115*(11), 1832–1846. https://doi.org/10.1016/j.jand.2015.06.381

Sguassero, Y., de Onis, M., Bonotti, A., & Carroli, G. (2012). Community-based supplementary feeding for promoting the growth of children under five years of age in low and middle income countries. *Cochrane Database of Systematic Reviews*, *6*. https://doi.org/10.1002/14651858.CD005039.pub3

Shangguan, S., Afshin, A., Shulkin, M., Ma, W., Marsden, D., Smith, J., Saheb-Kashaf, M., Shi, P., Micha, R., Imamura, F., Mozaffarian, D., & Food PRICE (Policy Review and Intervention Cost-Effectiveness) Project. (2019). A Meta-Analysis of Food Labeling Effects on Consumer Diet Behaviors and Industry Practices. *American Journal of Preventive Medicine, 56*(2), 300–314. https://doi.org/10.1016/j.amepre.2018.09.024

Sharma, I. K., Di Prima, S., Essink, D., & Broerse, J. E. W. (2021). Nutrition-Sensitive Agriculture: A Systematic Review of Impact Pathways to Nutrition Outcomes. *Advances in Nutrition, 12*(1), 251–275. https://doi.org/10.1093/advances/nmaa103

Shaw, S. C., Ntani, G., Baird, J., & Vogel, C. A. (2020). A systematic review of the influences of food store product placement on dietary-related outcomes. *Nutrition Reviews, 78*(12), 1030–1045. https://doi.org/10.1093/nutrit/nuaa024

Shea, B. J., Reeves, B. C., Wells, G., Thuku, M., Hamel, C., Moran, J., Moher, D., Tugwell, P., Welch, V., Kristjansson, E., & Henry, D. A. (2017). AMSTAR 2: A critical appraisal tool for systematic reviews that include randomised or non-randomised studies of healthcare interventions, or both. *BMJ*, j4008. https://doi.org/10.1136/bmj.j4008

Singhal, J., Herd, C., Adab, P., & Pallan, M. (2021). Effectiveness of school-based interventions to prevent obesity among children aged 4 to 12 years old in middle-income countries: A systematic review and meta-analysis. *Obesity Reviews*, *22*(1). https://doi.org/10.1111/obr.13105

Sirasa, F., Mitchell, L. J., Rigby, R., & Harris, N. (2019). Family and community factors shaping the eating behaviour of preschool-aged children in low and middle-income countries: A systematic review of interventions. *Preventive Medicine*, *129*, 105827. https://doi.org/10.1016/j.ypmed.2019.105827

Sisnowski, J., Street, J. M., & Merlin, T. (2017). Improving food environments and tackling obesity: A realist systematic review of the policy success of regulatory interventions targeting population nutrition. *PLOS ONE*, *12*(8), e0182581. https://doi.org/10.1371/journal.pone.0182581

Smith, D., Miles-Richardson, S., Dill, L., & Archie-Booker, E. (2013). Interventions to improve access to fresh food in vulnerable communities: A review of the literature. *International Journal on Disability and Human Development*, *12*(4). https://doi.org/10.1515/ijdhd-2013-0203

Soma, T., Li, B., & Maclaren, V. (2020). Food Waste Reduction: A Test of Three Consumer Awareness Interventions. *Sustainability, 12*(3), 3. https://doi.org/10.3390/su12030907

Springmann, M., Mason-D'Croz, D., Robinson, S., Wiebe, K., Godfray, H. C. J., Rayner, M., & Scarborough, P. (2018). Health-motivated taxes on red and processed meat: A modelling study on optimal tax levels and associated health impacts. *PLoS ONE*, *13*(11), e0204139. https://doi.org/10.1371/journal.pone.0204139

Sproesser, G., Ruby, M. B., Arbit, N., Akotia, C. S., dos Alvarenga, M., & S., Bhangaokar, R., Furumitsu, I., Hu, X., Imada, S., Kaptan, G., Kaufer-Horwitz, M., Menon, U., Fischler, C., Rozin, P., Schupp, H. T., & Renner, B. (2019). Understanding traditional and modern eating: The TEP10 framework. *BMC Public Health, 19*(1), 1606. https://doi.org/10.1186/s12889-019-7844-4

Sreevatsava, M., Narayan, K. M. V., & Cunningham, S. A. (2013). Evidence for Interventions to Prevent and Control Obesity Among Children and Adolescents: Its Applicability to India. *The Indian Journal of Pediatrics, 80*(S1), 115–122. https://doi.org/10.1007/s12098-012-0881-y

Stewart, K., Balmford, A., Scheelbeek, P., Doherty, A., & Garnett, E. E. (2023). Changes in greenhouse gas emissions from food supply in the United Kingdom. *Journal of Cleaner Production*, *410*, 137273. https://doi.org/10.1016/j.jclepro.2023.137273

Swinburn, B. A., Kraak, V. I., Allender, S., Atkins, V. J., Baker, P. I., Bogard, J. R., Brinsden, H., Calvillo, A., De Schutter, O., Devarajan, R., Ezzati, M., Friel, S., Goenka, S., Hammond, R. A., Hastings, G., Hawkes, C., Herrero, M., Hovmand, P. S., Howden, M., & Dietz, W. H. (2019). The Global Syndemic of Obesity, Undernutrition, and Climate Change: The Lancet Commission report. *The Lancet*, *393*(10173), 791–846. https://doi.org/10.1016/S0140-6736(18)32822-8

Taillie, L. S., Busey, E., Stoltze, F. M., & Dillman Carpentier, F. R. (2019). Governmental policies to reduce unhealthy food marketing to children. *Nutrition Reviews, 77*(11), 787–816. https://doi.org/10.1093/nutrit/nuz021

Takacs, B., & Borrion, A. (2020). The Use of Life Cycle-Based Approaches in the Food Service Sector to Improve Sustainability: A Systematic Review. *Sustainability, 12*(9), 3504. https://doi.org/10.3390/su12093504

Tam, E., Keats, E. C., Rind, F., Das, J. K., & Bhutta, Z. A. (2020). Micronutrient Supplementation and Fortification Interventions on Health and Development Outcomes among Children Under-Five in Low- and Middle-Income Countries: A Systematic Review and Meta-Analysis. *Nutrients, 12*(2), 289. https://doi.org/10.3390/nu12020289

Temme, E. H. M., Vellinga, R. E., de Ruiter, H., Kugelberg, S., van de Kamp, M., Milford, A., Alessandrini, R., Bartolini, F., Sanz-Cobena, A., & Leip, A. (2020). Demand-Side Food Policies for Public and Planetary Health. *Sustainability, 12*(15), 5924. https://doi.org/10.3390/su12155924

Thomson, K., Hillier-Brown, F., Todd, A., McNamara, C., Huijts, T., & Bambra, C. (2018). The effects of public health policies on health inequalities in high-income countries: An umbrella review. *BMC Public Health, 18*(1), 869. https://doi.org/10.1186/s12889-018-5677-1

Tricco, A. C., Lillie, E., Zarin, W., O'Brien, K. K., Colquhoun, H., Levac, D., Moher, D., Peters, M. D. J., Horsley, T., Weeks, L., Hempel, S., Akl, E. A., Chang, C., McGowan, J., Stewart, L., Hartling, L., Aldcroft, A., Wilson, M. G., Garritty, C., & Straus, S. E. (2018). PRISMA Extension for Scoping Reviews (PRISMA-ScR): Checklist and Explanation. *Annals of Internal Medicine*, *169*(7), 467–473. https://doi.org/10.7326/M18-0850

Tseng, E., Zhang, A., Shogbesan, O., Gudzune, K. A., Wilson, R. F., Kharrazi, H., Cheskin, L. J., Bass, E. B., & Bennett, W. L. (2018).

Effectiveness of Policies and Programs to Combat Adult Obesity: A Systematic Review. *Journal of General Internal Medicine, 33*(11), 1990–2001. https://doi.org/10.1007/s11606-018-4619-z

Turner, C., Kalamatianou, S., Drewnowski, A., Kulkarni, B., Kinra, S., & Kadiyala, S. (2019). Food Environment Research in Low- and Middle-Income Countries: A Systematic Scoping Review. *Advances in Nutrition*, nmz031. https://doi.org/10.1093/advances/nmz031

Urgell-Lahuerta, C., Carrillo-Álvarez, E., & Salinas-Roca, B. (2021). Interventions on Food Security and Water Uses for Improving Nutritional Status of Pregnant Women and Children Younger Than Five Years in Low-Middle Income Countries: A Systematic Review. *International Journal of Environmental Research and Public Health, 18*(9), 4799. https://doi.org/10.3390/ijerph18094799

Vargas-Garcia, E., & j., Evans, C. e. l., Prestwich, A., Sykes-Muskett, B. j., Hooson, J., & Cade, J. e. (2017). Interventions to reduce consumption of sugar-sweetened beverages or increase water intake: Evidence from a systematic review and meta-analysis. *Obesity Reviews, 18*(11), 1350–1363. https://doi.org/10.1111/obr.12580

Venegas Hargous, C., Strugnell, C., Allender, S., Orellana, L., Corvalan, C., & Bell, C. (2023). Double- and triple-duty actions in childhood for addressing the global syndemic of obesity, undernutrition, and climate change: A scoping review. *Obesity Reviews: An Official Journal of the International Association for the Study of Obesity*, *24*(4), e13555. https://doi.org/10.1111/obr.13555

Verghese, A., Raber, M., & Sharma, S. (2019). Interventions targeting diet quality of Supplemental Nutrition Assistance Program (SNAP) participants: A scoping review. *Preventive Medicine, 119*, 77–86. https://doi.org/10.1016/j.ypmed.2018.12.006

von Philipsborn, P., Stratil, J. M., Burns, J., Busert, L. K., Pfadenhauer, L. M., Polus, S., Holzapfel, C., Hauner, H., & Rehfuess, E. (2019). Environmental interventions to reduce the consumption of sugar-sweetened beverages and their effects on health. *Cochrane Database of Systematic Reviews*. https://doi.org/10.1002/14651858.CD012292.pub2

von Philipsborn, P., Stratil, J. M., Burns, J., Busert, L. K., Pfadenhauer, L. M., Polus, S., Holzapfel, C., Hauner, H., & Rehfuess, E. A. (2020). Environmental Interventions to Reduce the Consumption of Sugar-Sweetened Beverages: Abridged Cochrane Systematic Review. *Obesity Facts, 13*(4), 397–417. https://doi.org/10.1159/000508843

Walls, H. L., Johnston, D., Tak, M., Dixon, J., Hanefeld, J., Hull, E., & Smith, R. D. (2018). The impact of agricultural input subsidies on food and nutrition security: A systematic review. *Food Security, 10*(6), 1425–1436. https://doi.org/10.1007/s12571-018-0857-5

Wang, D., & Stewart, D. (2013). The implementation and effectiveness of school-based nutrition promotion programmes using a health-promoting schools approach: A systematic review. *Public Health Nutrition, 16*(6), 1082–1100. https://doi.org/10.1017/S1368980012003497

Wethington, H. R., Finnie, R. K. C., Buchanan, L. R., Okasako-Schmucker, D. L., Mercer, S. L., Merlo, C., Wang, Y., Pratt, C. A., Ochiai, E., & Glanz, K. (2020). Healthier Food and Beverage Interventions in Schools: Four Community Guide Systematic Reviews. *American Journal of Preventive Medicine, 59*(1), e15–e26. https://doi.org/10.1016/j.amepre.2020.01.011

Whitmee, S., Haines, A., Beyrer, C., Boltz, F., Capon, A. G., de Souza Dias, B. F., Ezeh, A., Frumkin, H., Gong, P., Head, P., Horton, R., Mace, G. M., Marten, R., Myers, S. S., Nishtar, S., Osofsky, S. A., Pattanayak, S. K., Pongsiri, M. J., Romanelli, C., & Yach, D. (2015). Safeguarding human health in the Anthropocene epoch: Report of The Rockefeller Foundation–Lancet Commission on planetary health. *The Lancet*, *386*(10007), 1973–2028. https://doi.org/10.1016/S0140-6736(15)60901-1

Willett, W., Rockström, J., Loken, B., Springmann, M., Lang, T., Vermeulen, S., Garnett, T., Tilman, D., DeClerck, F., Wood, A., Jonell, M., Clark, M., Gordon, L. J., Fanzo, J., Hawkes, C., Zurayk, R., Rivera, J. A., De Vries, W., Majele Sibanda, L., & Murray, C. J. L. (2019). Food in the Anthropocene: The EAT–Lancet Commission on healthy diets from sustainable food systems. *The Lancet*, *393*(10170), 447–492. https://doi.org/10.1016/S0140-6736(18)31788-4

Wirsenius, S., Hedenus, F., & Mohlin, K. (2011). Greenhouse gas taxes on animal food products: Rationale, tax scheme and climate mitigation effects. *Climatic Change, 108*(1–2), 159–184. https://doi.org/10.1007/s10584-010-9971-x

Wolfenden, L., Barnes, C., Lane, C., McCrabb, S., Brown, H. M., Gerritsen, S., Barquera, S., Véjar, L. S., Munguía, A., & Yoong, S. L. (2021). Consolidating evidence on the effectiveness of interventions promoting fruit and vegetable consumption: An umbrella review. *International Journal of Behavioral Nutrition and Physical Activity, 18*(1), 11. https://doi.org/10.1186/s12966-020-01046-y

Wordofa, M. G., & Sassi, M. (2020). Impact of agricultural interventions on food and nutrition security in Ethiopia: Uncovering pathways linking agriculture to improved nutrition. *Cogent Food & Agriculture, 6*(1), 1724386. https://doi.org/10.1080/23311932.2020.1724386

Zhang, Q., Alsuliman, M. A., Wright, M., Wang, Y., & Cheng, X. (2020). Fruit and Vegetable Purchases and Consumption among WIC Participants after the 2009 WIC Food Package Revision: A Systematic Review. *Advances in Nutrition, 11*(6), 1646–1662. https://doi.org/10.1093/advances/nmaa060

Celia Burgaz is a PhD candidate in environmental sciences at the Free University of Brussels (ULB) in collaboration with Sciensano, the Federal Institute of Public Health in Belgium. Her PhD project, part of the INFORMAS network, consists on creating a policy index towards healthier, more sustainable and equal food systems. She is a nutritionist and public health specialist with a background in prevention interventions and public policy. Celia is interested in food systems and their policy framework, agroecology, shorter food supply chains, obesity, food security and sustainable adaptation. Her long-term career goal is to promote healthy diets from sustainable food systems to jointly address malnutrition in all its forms and climate change.

Vanessa Gorasso is a doctoral fellow in public health at Ghent University in collaboration with Sciensano, the Federal Institute of Public Health in Belgium. Her thesis focuses on the health and economic burden of overweight and obesity in Belgium, with a final focus on health impact assessment of interventions aiming to reduce this burden. She has a background in health economics and econometrics with some experience in economic evaluation techniques. Her interest are broad in the field of burden of disease and cost of illness, as well as comparative risk assessment.

Wouter Achten bio-engineer land and forest management by formation, holds a chair "Environmental impact management" at the Free University of Brussels (ULB). In the Master on Environmental Science and Management he mainly covers the impact assessment and management aspects of the curriculum, both in specific as multidisciplinary courses. His research activities are mainly focused on life cycle thinking, where he supports a research group covering both applied (environmental impact assessment of circular economy, food systems, waste management, bioenergy, etc.) as methodological research (LCA, LCSA, consequential LCA, S-LCA, IOLCA, Territorial LCA, etc.). Currently Wouter is also the program director of the Master on Environmental Science and Management, and is advisor to the vice-rectorate of Sustainable Development of the ULB. Starting from the interest on environmental impact assessment and sustainability evaluation, mainly through life cycle thinking, I mainly aim to contribute to continuous environmental impact management and sustainable transitions at different levels of activities: products, companies, regions and economies. This translates in both applied as methodological research.

Carolina Batis Ph.D., Co- Investigator (3 calendar months effort), Carolina is a CONACyT researcher at the Health and Nutrition Research Center at INSP. She is a nutritional epidemiologist with expertise in the evaluation and characterization of dietary intake. Her research focuses on understanding the determinants of dietary intake related to obesity, including sociodemographic, individual, behavioral, and environmental factors. She has lead the INFORMAS food prices module in Mexico.

Luciana Castronuovo PhD in Social Sciences from University of Buenos Aires, BA in Sociology (Universidad del Salvador, Buenos Aires). Luciana is professor of research methodology in graduate and postgraduate programs in different Universities (Universidad de Buenos Aires-UBA; Facultad LatinoAmericana de Ciencias Sociales-FLACSO, Universidad del Salvador-USAL). Researcher at the Food Policy Department at FIC Argentina since 2010. Luciana has been working in social science research for the last fifteen years. She has a wide experience in the design and conduction of policy oriented research projects and grant management.

Adama Diouf is a Professor of nutrition and physiology, senior lecturer-researcher and member of the Research Team on Food and Human Nutrition (LARNAH) of the Faculty of Science and Technology of the University Cheikh Anta Diop de Dakar (UCAD). She coordinates several research projects related to the management of malnutrition, micronutrients deficiencies, obesity. Adama was the PI of the Food-EPI project in Senegal on the evaluation of public policies on healthy food environment in Senegal and actually leads the IDRC funded regional project in west african french speaking countries on FoodEPI analysis and exposure of children and Senegalese population to food advertising. She is a member of several technical committees in the implementation of the nutrition policies in Senegal and a nutrition experts/consultant for national and international organizations. With more than 15 years of experience in the field of nutrition and public health, it is strongly committed to the prevention of malnutrition in all its forms and related non-communicable diseases, particularly in Africa.

Gershim Asiki is a research scientist (Epidemiologist)leading the Non-Communicable Diseases (NCDs) research program at the African Population and Health Research Center (APHRC). His main research focus is on NCDs entailing both epidemiology and implementation research among populations in Kenya and in other African countries. As PI or co-Investigator on several research projects, he has grown relevant experience and expertise for administering projects. Gershim is the lead investigator for an ongoing multi-country project funded by IDRC "Developing a package of effective regulatory interventions for healthier food environment in Kenya, Tanzania and Uganda and as well as a Co-Investigator on the Ghana MEALS4NCD project measuring the healthiness of Ghanaian children's food environments to prevent obesity and NCDs.

Boyd Swinburn is Professor of Population Nutrition and Global Health in the School of Population Health, University of Auckland. He trained as an endocrinologist but is now a public health physician and conducts research on community and policy actions to prevent childhood and adolescent obesity, and reduce, what he has coined, the 'obesogenic' food environment. He is Co-Chair of World Obesity's Policy & Prevention section and Co-Chair of the Lancet Commission on Obesity. Boyd established the World Health Organisation's first Collaborating Centre for Obesity Prevention, at Deakin University in Melbourne and has also contributed to over 30 WHO consultations and reports on obesity. He leads an international network (INFORMAS) in over 30 countries to monitor and benchmark the healthiness of food environments and the implementation of food policies and actions to reduce obesity.

Mishel Unar Sc.D., Co-investigator (3 calendar months effort), she is a health economist with a Sc.D in public nutrition with expertise in estimating food and diet cost using household food expenditure surveys and food prices surveys. She is interested in the analysis of economic factors associated to all forms of malnutrition and the estimation of the economic burden of malnutrition. Currently, Mishel is estimating the sustainability of diets in Mexico considering three dimensions: the environmental impact of food consumption (GHGE, water footprint, land use and biodiversity loss), the quality of diet and the economic cost of diets.

Brecht Devleesschauwer is a senior epidemiologist at Sciensano and head of the Service Lifestyle and chronic diseases. He is also appointed as visiting professor in Risk Analysis at Ghent University. He conducts policy-driven public health research in the domain of composite measures of population health and health inequalities. As a member of the World Health Organization Foodborne Disease Burden Epidemiology Reference Group (WHO/FERG), he contributed to the estimation of the global burden of foodborne disease. Currently, he is coordinating the Belgian National Burden of Disease Study, and chairing the European Burden of Disease Network (COST Action CA18218). Brecht holds PhD degrees in Public Health and Veterinary Sciences, and MSc degrees in Biostatistics and Veterinary Medicine.

Gary Sacks is an Associate Professor at the Global Obesity Centre (GLOBE) at Deakin University in Australia. He leads the private sector module for INFORMAS. He also led the implementation of the Food-EPI in Australia in 2017 and 2019. Gary has published multiple papers on the strategies used by the food industry to influence policy in Africa. He has also facilitated WHO Regional workshops in Africa regarding obesity prevention and nutrition.

Stefanie Vandevijvere is a senior scientist in public health nutrition at Sciensano, the Federal Institue of Public Health in Belgium. She has expertise in dietary assessment, nutrition policies, food environments, monitoring and accountability and obesity and NCD prevention. Stefanie several capacity building workshops in relation to the implementation of the Food-EPI worldwide, in particular in Europe and low- and middle-income countries (LMICs).