Public Health Nutrition: 24(13), 4346–4357 doi:10.1017/S1368980021001890

Scoping Review

A scoping review of research on policies to address child undernutrition in the Millennium Development Goals era

Vanessa Pike[1], Beverly Bradley[2], Aviva I Rappaport[3], Stanley Zlotkin[1,4,5] and Nandita Perumal[1,6,*]

[1]Centre for Global Child Health, Hospital for Sick Children, Toronto, Canada: [2]Centre for Global Engineering, University of Toronto, Toronto, Canada: [3]School of Human Nutrition, McGill University, Montreal, Canada: [4]Departments of Paediatrics, Nutritional Sciences, Dalla Lana School of Public Health, and Munk School of Global Affairs and Public Policy, University of Toronto, Toronto, Canada: [5]Division of Gastroenterology, Hepatology, and Nutrition, Hospital for Sick Children, Toronto, Canada: [6]Department of Global Health and Population, Harvard T.H. Chan School of Public Health, 90 Smith Street, 3rd floor, Boston, MA 02215, USA

Submitted 26 August 2020: Final revision received 27 March 2021: Accepted 23 April 2021: First published online 30 April 2021

Abstract

Objective: The breadth of research on the impact of nutrition-specific policies to address child undernutrition is not well documented. This review maps the evidence base and identifies gaps on such policies.

Design: We systematically searched Medline, Embase, PAIS Index for public policy, Scopus and Web of Science databases to identify eligible studies. Key study characteristics, including research design, type of policy, time span of policy before impact assessment, child age at outcome assessment and types of outcomes assessed, were abstracted in duplicate.

Setting: Low-, middle- and high-income countries.

Participants: Studies were eligible for inclusion if they aimed to assess the impact of population-level nutrition-specific policies on undernutrition among children under 10 years of age.

Results: Of the 5646 abstracts screened, eighty-three studies were included. A range of policies to address child undernutrition were evaluated; the majority were related to micronutrient fortification. Most studies were observational, reported on mandatory regional or sub-national polices, were conducted in high-income countries and evaluated policies within 1 year of implementation. A narrow set of health outcomes were evaluated, most commonly iodine deficiency disorders and neural tube defects.

Conclusions: Nutrition policies were commonly associated with improved child nutritional status and health. However, this evidence is primarily based on limited settings and on a limited number of outcomes. Further research is needed to assess the longer-term impact of a broader range of nutrition policies on child health, particularly in low- and middle-income countries.

Keywords
Policy
Nutrition-specific
Child health
Micronutrients
Scoping review

Adequate nutrition in early life is essential for optimal health and development throughout the life course. Dietary deficiencies in macro- and micronutrients in early childhood can lead to poor physical growth, suboptimal neurodevelopment and increased risk of morbidity and mortality throughout the life course[1–5]. An estimated 144 million children under 5 years of age are stunted (low height/length-for-age), and 47 million suffer from wasting (low weight-for-height/length)[1]. In addition, 11 % of school-age children (5–19 years) globally are estimated to be too thin for their age (BMI < −2 SD of the WHO reference population), with a prevalence of up to 25 % in South Asia[6]. The magnitude of the global burden of malnutrition and the long-term consequences of poor nutrition

*Corresponding author: Email nperumal@hsph.harvard.edu

early in life have propelled the global health community to invest substantial political, financial and human resources to address these challenges.

Child undernutrition, in particular, has garnered tremendous political momentum as a global public health problem in the last two decades. Starting in the year 2000, the global community set out to achieve the eight Millennium Development Goals (MDG) by 2015[7], including the goal to 'Eradicate extreme poverty and hunger'. In 2010, the Scaling Up Nutrition movement was born, led by dozens of country governments, with a vision to ensure 'a world free from malnutrition in all its forms' by 2030[8]. Shortly after, in 2012, the World Health Assembly set six global nutrition targets, to be met by 2025[9], to reduce several forms of malnutrition including stunting, wasting and anaemia. In 2015, the Sustainable Development Goals (SDG) were adopted by all UN Member States to ensure a sustainable future for the people and the planet[10], with the second SDG specifically aiming to end hunger and all forms of malnutrition by the year 2030. The UN Standing Committee on Nutrition further declared 2016–2025 the Decade of Action on Nutrition[11], identifying six action areas for nutrition, including sustainable food systems, aligned health systems, social protection, trade and investment, enabling environments, and strengthened governance and accountability.

As a result, since the year 2000, there has been greater political commitment at the national level to improve child nutrition across low- and middle-income countries. Most countries have developed national nutrition policies that outline a set of guidelines, rules, regulations and/or laws to provide key public health interventions to improve child nutritional status. Such policies include, for example, the promotion of exclusive breast-feeding and appropriate complementary feeding, fortification of staple foods and provision of micronutrient and food supplements, among others[12].

Our understanding of the number and breadth of nutrition-specific policies and their impact on child nutritional status at the population level, however, is fragmented. Previous studies have evaluated either one specific policy across multiple countries (e.g. a review of the effect of breast-feeding policies and programmes on breast-feeding trends across six countries[13]); one micronutrient intervention on one outcome across several countries (e.g. a systematic review of the effect of increasing folic acid intake through fortification on neural tube defects[14]) or the effect of multiple nutrition policies over time in one country (e.g. a review of nutrition policies in South Africa from 1994 to 2002[15]). The breadth and scope of nutrition-specific policy research conducted in the MDG era to address child undernutrition is not well-mapped. Identifying the extent of nutrition policy research that specifically addresses child undernutrition will enable a greater understanding of the potential gaps and priority areas for investigation during the remaining years of the SDG. Therefore, we conducted a scoping review to map and describe the evidence base on population-level nutrition-specific policies evaluated in the literature for improving child nutritional status.

Methods

We conducted a scoping review using a systematic search of the literature to map and describe peer-reviewed studies evaluating the impact of population-level nutrition policies to address child undernutrition. Rather than focusing on a specific exposure–outcome association, scoping reviews provide a systematic overview of a broad topic and an understanding of how (and how much) existing research has been conducted on that topic, allowing the assessment and synthesis of existing evidence[16–18]. As such, we identified the types and sources of evidence on nutrition-specific policies to address child undernutrition and the potential research gaps in nutrition-policy evaluation literature to ultimately inform further investigation[19]. We maintained a broad definition of 'policy' to ensure that all relevant studies were captured in the search. This was inclusive of any nutrition-specific policy, strategy, legislation, regulation or guideline applicable at the population level (whether national, state or regional level) that was endorsed by the government. We used the Lancet 2013 Nutrition Series[2] framework to define 'nutrition-specific' as factors that directly contribute to nutritional status, including macro- or micronutrient interventions, breast-feeding, complementary feeding, dietary diversity, feeding behaviours and responsive caregiving, among others. Multisectoral policies or those pertaining to 'nutrition-sensitive' domains, which are indirectly associated with child nutritional status, such as agriculture and food security and social safety nets, were included if they also included nutrition-specific components. Policies related to nationally instituted or mandatory nutrition-specific programs (e.g. the Special Supplemental Nutrition Program for Women, Infants, and Children in the USA) were also included; however, any programmes, trials or interventions tested for efficacy in a sample study population were excluded as our focus was on nutrition-specific policy as a population-level intervention.

Five specific interdisciplinary and field-specific electronic databases – Medline, Embase, Web of Science, Scopus and PAIS Index for public policy – were searched using a combination of keywords and MeSH terms for four key concepts: nutrition-specific; policy; children under five or school-age children and child nutritional status outcomes (see online supplementary material, Supplemental Table 1). The search was conducted in September 2017 and was intended to capture research conducted in the MDG period (allowing for a lag of 2 years for publication time). A librarian reviewed the search terms to ensure inclusivity, relevance and robustness of the search.

https://doi.org/10.1017/S1368980021001890 Published online by Cambridge University Press

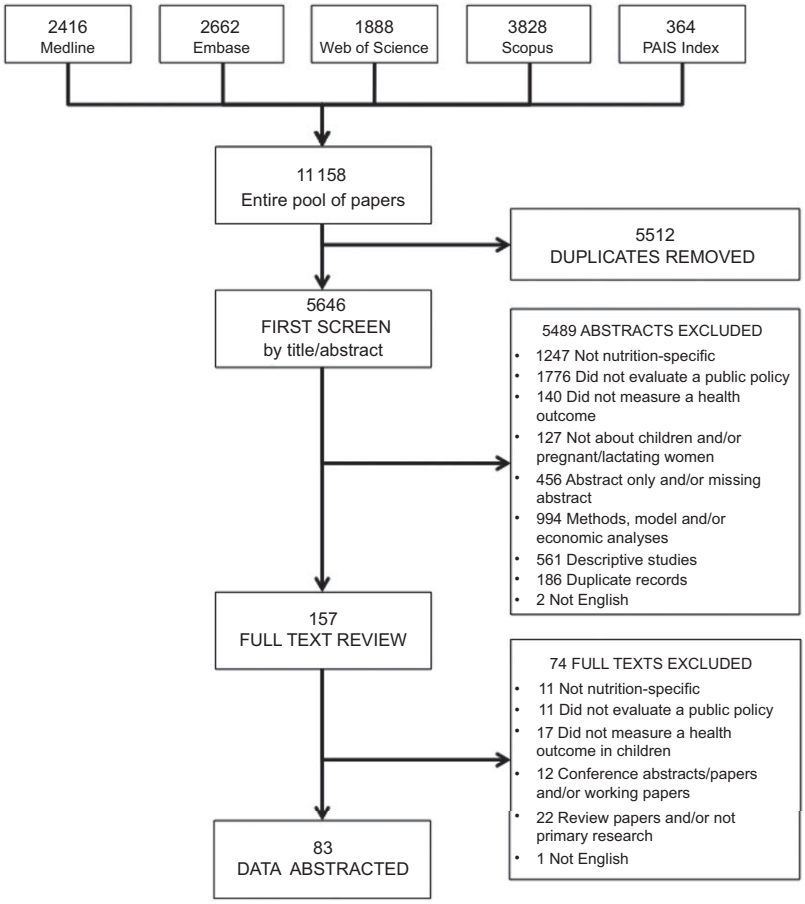

Fig. 1 Study selection process

Titles and abstracts (*n* 5646) were screened in duplicate by authors B.B., A.R., V.P. and N.P. to select studies appropriate for full-text review (Fig. 1). Inclusion and exclusion criteria for title and abstract screening are summarised in Table 1. Importantly, we did not restrict study eligibility by geographic location or country wealth to be able to scope the global evidence base. In addition, we included studies which evaluated health outcomes among children up to 10 years of age so as to not inadvertently exclude any nutrition-specific policies which may typically be evaluated among school-age children (e.g. policies on iodine deficiencies). In cases where the two reviewers did not agree regarding study eligibility, or it was not clear from the abstract whether the study met the inclusion criteria, the study was included for full-text review. A total of 157 studies were selected for full-text review (reasons for exclusion are summarised in Fig. 1).

Two reviewers independently abstracted data from each eligible study onto a standardised abstraction template developed by the authors. Any disagreements in data abstraction were resolved by consensus between two reviewers. Key study characteristics were abstracted, including study objectives, location (city and/or region, country and geographic region based on the World Bank classification), county wealth category (World Bank 2017 income levels), study design, sample size, recruitment method and age range of study population, type of nutrition policy, level of policy implementation (sub-national or national), year of policy implementation, year of outcome assessment, child age and types of health outcomes assessed. Quality of reporting/critical appraisal guidelines for the selected research articles was not used since the objective of this study was to assess the breadth of the evidence base as opposed to evaluating the quality of evidence for a specific research question. The study design, target population, type of nutrition-specific policy evaluated and overall findings were summarised quantitatively across all studies. Data on the time span between policy implementation and outcome assessment, category of the primary outcome assessed and general conclusion of the study regarding the impact of the policy on child nutritional status were post-coded following data extraction.

Results

Of the 5646 abstracts screened, eighty-three studies were included in the review (Fig. 1). The studies included

https://doi.org/10.1017/S1368980021001890 Published online by Cambridge University Press

Table 1 Inclusion and exclusion criteria for study inclusion

A study was included if it:	A study was excluded if it:
Involved a nutrition-specific* policy; • For this study, nutrition-specific policy refers to any policy related to maternal dietary supplementation, micronutrient supplementation and fortification, breast-feeding and complementary feeding, dietary supplementation for children, dietary diversification or treatment of severe acute malnutrition. • Studies about social safety nets that specifically provide food supplements (as opposed to money and social services) were included.	• did not involve nutrition-specific policy • only examined nutrition-sensitive policies, i.e. those that examine the underlying causes of undernutrition, including policies related to agriculture and food security in general, social safety nets, early child development, maternal mental health, women's empowerment, child protection, classroom education, water and sanitation, and health and family planning services.
AND it evaluated a public policy; • The study is evaluating policies/legislation/guidelines that are applicable at the population level (i.e. at the national, state or regional level).	• did not evaluate public policy • examined clinical guidelines alone (i.e. only applicable to patients in a clinical facility)
AND measured nutrition-related health outcome(s) in children from 0 to 10 years based on the WHO criteria for age classifications. • Examples of valid health outcomes include: anthropometry, prevalence of undernutrition, micronutrient status (including biochemical markers), micronutrient deficiencies (including prevalence estimates), micronutrient toxicity and/or neural tube defect, among others. • Studies that examined the effect of a policy during pregnancy or preconceptional maternal health were only included if they also measured birth or postnatal outcomes in children.	• did not measure health outcomes related to child undernutrition as defined in inclusion criteria • only examined health outcomes among pregnant or lactating women, or adolescents (aged 10–19 years) • only measure proxy health outcomes in children, such as quality of diets consumed by children (e.g. measuring micronutrient content of diet as opposed to micronutrient status level in the blood), • only measures of coverage of a policy/programme • only look at adverse health outcomes related to overweight or obesity
AND was a primary research study published in a peer-reviewed journal in English	• was not in English • was a review paper, methodological paper, meeting notes, working paper, conference proceeding or abstract, clinical summary, agency report, position statements/commentaries or statistical models/economic models based on simulated data alone

*Nutrition-specific as defined by Black *et al.* 2013, including: adolescent health and preconception nutrition, maternal dietary supplementation, micronutrient supplementation and fortification, breast-feeding and complementary feeding, dietary supplementation for children, dietary diversification, feeding behaviour and stimulation, treatment of severe acute malnutrition, disease prevention and management, nutrition interventions in emergencies.

were conducted across thirty-seven countries (see online supplementary material, Supplemental Figure 1 and Table 2). The included studies were in seven geographical areas (based on The World Bank classifications): eighteen in East Asia and the Pacific[20–37], seventeen in North America[38–54], thirteen in Latin America and the Caribbean[55–67], ten in South Asia[68–77], seven in Europe and Central Asia[78–84], seven in Sub-Saharan Africa[85–91], six in Middle East and North Africa[92–97] and five were multi-region[98–102]. The majority of studies were conducted in upper-middle or high-income countries (66 %, 54 studies); approximately 48 % (40 studies) were conducted in just five countries: the USA, China, India, Canada and Brazil. Only 7 studies (8·4 %) were from low-income countries. Most studies were published from 2010 to 2017, evaluated policies at the regional/sub-national level, assessed outcomes among children under 5 years of age and were based on community- or school-based populations (Table 2). In high-income countries, data from national registries were commonly used (e.g. registries of birth defects to examine the effect of folic acid interventions) or from national programmes such as the Special Supplemental Nutrition Program for Women, Infants, and Children in the USA which serves as a contact point for large numbers of mothers and children. The sample sizes of such registry-based studies are notably larger than studies directly sampling from the population base (see online supplementary material, Supplemental Table 2). Cross-sectional (49 %, 41 studies) and pre-/post-design (19 %, 16 studies) were the most commonly used study designs (Table 2). Iodine deficiency disorders (40 %, 33 studies) and neural tube defects (19 %, 16 studies) were the most assessed child nutrition outcomes (Table 2). The impacts of policy interventions on outcomes such as low birth weight, breast-feeding rates, vitamin A deficiencies and child growth were less frequently assessed. Nonetheless, child growth was an important primary outcome evaluated in the context of a wide range of broad, multi-sectoral and food provision strategies (see online supplementary material, Supplemental Table 3).

The most common type of policies evaluated were food fortification policies (52 %, 43 studies), followed by food provision with nutrition education (10 %, 8 studies) and supplementation policies (8·4 %, 7 studies) (Table 3). These policies were largely established between 1991 and 2000 (48 %, 40 studies); the majority of studies evaluated impact within a year (28 %, 23 studies) or within 2–5 years since policy implementation (14 %, 12 studies). Studies typically evaluated policies that were mandatory

https://doi.org/10.1017/S1368980021001890 Published online by Cambridge University Press

Table 2 Characteristics of studies included in the scoping review

	All studies (*n* 83)		Low and lower middle-income countries† (*n* 25)		Upper middle-income countries (*n* 22)		High-income countries (*n* 32)		Multiple wealth quintiles (*n* 4)	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Study publication period*										
1981–1990	1	1·2	1	4·0	0	0	0	0	0	0
1991–2000	6	7·2	3	12	0	0	2	6·3	1	25
2001–2010	35	42	10	40	7	32	17	53	1	25
2011–2017	41	49	11	44	15	68	13	41	2	50
Study designs										
Cohort study	9	11	1	4·0	2	9·0	6	19	0	0
Cross-sectional study	41	49	19	76	11	50	8	25	3	75
Pre-/Post-design	16	19	2	8·0	3	14	11	34	0	0
Quasi-experimental study	2	3·4	0	0	1	5·0	1	3·1	0	0
Randomised controlled trial	1	1·2	0	0	1	5·0	0	0	0	0
Other‡	14	17	3	12	4	18	6	19	1	25
Study base										
Community-based	22	27	13	52	6	27	3	9·4	0	0
Healthcare facility	17	20	4	16	3	14	10	31	0	0
School-based	24	29	6	24	11	50	7	22	0	0
Other§	20	24	1	4·0	2	9·0	13	41	4	100
Population representativeness										
National	27	33	10	40	4	18	9	28	4	100
Regional/sub-national	56	67	15	60	18	82	23	72	0	0
Population age group‖										
Infants	26	31	1	4·0	3	14	20	63	2	50
Children < 2 years	2	2·4	2	8·0	0	0	0	0	0	0
Children < 5 years	18	22	12	48	4	18	2	6·3	0	0
Between 5 and 10 years	37	45	10	40	15	68	10	31	2	50
Outcomes assessed¶										
Birth outcomes**	7	8·4	0	0	0	0	7	22	0	0
Breast-feeding rates	6	7·2	2	8·0	2	9·0	1	3·1	1	25
Child growth††	9	11	8	32	1	5·0	0	0	0	0
Iodine deficiency disorders‡‡	33	40	10	40	14	64	7	22	2	50
Neural tube defects	16	19	0	0	1	5·0	14	44	1	25
Vitamin A deficiency§§	4	4·8	4	16	0	0	0	0	0	0
Other‖‖	8	9·6	1	4·0	4	18	3	9·4	0	0

*Percentages do not always total to 100 % due to rounding.
†Low-income countries (*n* 7), lower middle-income countries (*n* 18).
‡Other study designs include: repeated cross-sectional (*n* 7), time trend analysis (*n* 5) and case–control (*n* 2).
§Other study bases include: registry-based (*n* 5), multiple (*n* 4), national surveys (*n* 3), health record review (*n* 2), not recorded (*n* 2), surveillance system (*n* 1), day care centre (*n* 1), convenience sample (*n* 1) and other longitudinal study (*n* 1).
‖If children were recruited across our predefined age bands, the oldest category was selected. For example, if a study included children aged 4–7 years, it was placed in the 5–10 category.
¶Outcomes assessed were post-coded according to the main outcome assessed.
**Studies evaluating the effect of nutrition policies on 'birth outcomes' included: birth weight (*n* 5), fetal growth restriction (*n* 1) and preterm birth (*n* 1).
††Studies evaluating the effect of nutrition policies on 'child growth' included: chronic and acute malnutrition (*n* 3), height-for-age *z*-score (HAZ) < –2SD (stunting) (*n* 2), weight-for-height *z*-score (*n* 1), HAZ (*n* 1), growth velocity (*n* 1) and underweight (*n* 1).
‡‡Studies evaluating the effect of nutrition policies on iodine deficiency includes: urinary iodine concentration (*n* 27), iodine deficiency diseases such as goitre prevalence (*n* 6).
§§Studies evaluating the effect of nutrition policies on vitamin A deficiency included: xerophthalmia (*n* 2) and serum retinol (*n* 2).
‖‖Other types of child outcomes assessed included: anaemia (*n* 1), congenital heart defect (*n* 1), cognitive development (*n* 1), morbidity (*n* 1), care-seeking (*n* 1), folate status (*n* 1), micronutrient deficiency (*n* 1) and mortality (*n* 1).

(71 %, 59 studies, spread evenly across all income categories). Sixteen studies (19 %) did not specify whether policies being evaluated were mandatory or voluntary. Studies examining food provision and nutrition education were found only in high-income countries, whereas in low- and middle-income countries, nutrition policies were primarily related to micronutrient food fortification or supplementation.

Although we did not aim to assess the effectiveness of policies, it is worth noting that over two-thirds of the studies included in this review concluded that the policy in question had a positive impact on child nutritional status (see online supplementary material, Supplemental Supplementary Table 2).

Discussion

To the best of our knowledge, this is the first exercise to map the diversity of research on the impact of nutrition-specific policies to address child undernutrition at the population level globally. Our findings suggest that a

https://doi.org/10.1017/S1368980021001890 Published online by Cambridge University Press

https://doi.org/10.1017/S1368980021001890 Published online by Cambridge University Press

Table 3 Key characteristics of policies examined in studies reviewed

	All studies (*n* 83)		Low and lower middle-income countries* (*n* 25)		Upper middle-income countries (*n* 22)		High-income countries (*n* 32)		Multiple wealth quintiles (*n* 4)	
	n	%	*n*	%	*n*	%	*n*	%	*n*	%
Policy implementation										
Mandatory	59	71	17	68	18	82	23	72	1	25
Voluntary	8	10	0	0	3	14	4	13	1	25
Not specified	16	19	8	32	1	4·5	5	16	2	50
Policy type										
Micronutrient-specific policies										
Food fortification	43	52	9	36	16	73	17	53	1	25
Supplementation	7	8·4	3	12	0	0	3	9·4	1	5
Both food fortification and supplementation	5	6·0	2	8·0	0	0	3	9·4	0	0
Multisectoral nutrition and health strategy	7	8·4	5	20	2	9·1	0	0	0	0
Breast-feeding promotion	5	6·0	2	8·0	2	9·1	0	0	1	25
Food provision and income supplementation	3	3·6	1	4·0	2	9·1	0	0	0	0
Food provision and nutrition education	8	9·6	0	0	0	0	8	25	0	0
National Nutrition Plan	2	2·4	2	8·0	0	0	0	0	0	0
Other†	3	3·6	1	4·0	0	0	1	3·1	1	25
Year of policy publication‡										
1930–1970	6	7·2	1	4·0	2	9·1	3	9·4	0	0
1971–1980	8	9·6	4	16	1	4·5	3	9·4	0	0
1981–1990	7	8·4	4	16	1	4·5	2	6·3	0	0
1991–2000	40	48	8	32	15	68	15	47	2	50
2001–2010	5	6·0	3	12	1	4·5	0	0	1	25
2011–2017	2	2·4	1	4·0	0	0	1	3·1	0	0
Not specified	15	18	4	16	2	9·1	8	25	1	5
Time between publication and outcome assessment§										
0–1 years	23	28	4	16	6	27	13	41	0	0
2–5 years	12	14	6	24	1	4·5	4	13	1	25
6–10 years	4	4·8	1	4·0	3	14	0	0	0	0
11–15 years	2	2·4	0	0	2	9·1	0	0	0	0
16–20 years	10	11	4	16	3	14	3	9·4	0	0
21–25 years	0	0	0	0	0	0	0	0	0	0
>26 years	8	9·6	2	8·0	3	14	3	9·4	0	0
Not specified	24	29	8	32	4	18	9	28	3	75

*Low-income countries (*n* 7), lower middle-income countries (*n* 18).
†Other types of policies included: international resolutions (*n* 1), school lunch programme (*n* 1) and infant feeding guidelines (*n* 1).
‡These data reflect the earliest policy mentioned and the earliest year of implementation. The year of policy implementation was post-coded and represents the year the policy was first implemented, as reported by the paper. If the paper did not report a year, it was coded as 'not specified'.
§The duration of time between implementation and outcome assessment is reported as the earliest year that outcome data were collected on the policy being evaluated. If the year was not reported or the study was across multiple countries, it was recorded as data unavailable.

wide range of regional and sub-regional nutrition policies for child undernutrition have been evaluated. Most studies were observational in design, examined health outcomes in children 5–10 years of age as opposed to younger children and were conducted in high-income countries. The impact of policy interventions on low birth weight, breast-feeding rates, vitamin A deficiencies and child growth was assessed less frequently than those relating to iodine and folic acid. There were relatively few studies evaluating the impact of national-level policies; the majority focused on regional and sub-regional policies. In addition, there was a notable scarcity of studies evaluating nutrition-specific policies in countries in Africa, where the burden of maternal and child undernutrition is greatest.

The nutrition policy agenda has evolved dramatically in the last 50 years. Starting from a focus on the socio-economic causes of protein–energy malnutrition (namely poverty) in the 1970s to community programmes to alleviate micronutrient malnutrition in the 1980s, global nutrition was only placed at the forefront of international agenda when it was recognised as a human rights issue during a series of high-level global meetings in the 1990s[103]. This heightened visibility of undernutrition contributed to the inclusion of 'zero hunger' as one of the central goals in the MDG. Since then, the influential Lancet Nutrition Series[12,104,105] have systematically quantified the burden of maternal and child undernutrition to measure global progress, identified evidence-based interventions to tackle undernutrition in early life and advocated for policy reforms to incorporate nutrition as a key priority in agenda-setting at the national level. Importantly, the Lancet Nutrition Series also framed optimal nutrition from the life course perspective, highlighting its relevance at all stages of the life cycle. Global nutrition policy has therefore evolved from focusing on singular issues, such as the elimination of extreme hunger, to framing nutrition as a development goal, thereby mainstreaming nutrition in the priorities set forth by the SDG[103]. However, the scope of research evaluating the effectiveness of global nutrition policy to improve population-level health and nutrition governance has been unclear[106].

Governments can use a myriad of different instruments to enact nutrition policies[107]. The findings of this review show that the type of nutrition policies that have been implemented over time in the context of undernutrition and the studies examining the effectiveness of these policies at the national level have focused primarily on micronutrient deficiencies. This may be in part because most studies included were conducted in high- and middle-income countries where the relative prevalence of stunting and underweight is low compared with lower-income countries. It may also in part be because of the nature of policies themselves. Micronutrient fortification, for example, is relatively well-defined, often implemented at the national level, requires limited cultural market adaptation (e.g. language or visual packaging adaptations) and is more likely to be a mandatory policy. In addition, an essential element in studying the impact of any nutrition policy on health outcomes is the availability of nationally representative data on health outcomes that are comparable across countries. Cross-national data on nutritional outcomes of young children are limited. The types of policies studied and gaps among the papers included in this review therefore reflect the potential downstream effects of complexities and financial barriers to collecting health outcome data at the national level. Unlike high-income settings where data on health and food systems are frequently collected, monitored and evaluated, such information systems are not readily available in low- and middle-income countries, making it challenging to study policy impact.

Nevertheless, in any discussion of nutrition policy, it is important to note that irrespective of proven policy efficacy, a number of implementation factors can limit effectiveness in achieving public health impact[108]. Such factors include coverage (whether the policy is implemented at scale and to what extent); distribution and supply chain challenges; uptake at the community, institutional and individual/household levels; and enforcement. Governments are often constrained by resource limitations for implementation. For example, despite salt iodisation being one of the most successful public health nutrition interventions and currently mandated in 118 countries worldwide[109] (86 % of households worldwide and 70 % in low- and middle-income countries access iodised salt[110,111]), the number of households actually consuming it is estimated to be as low as 20 % for countries such as India[111]. This highlights the importance of measuring indicators of nutrition policy implementation, such as availability, access and consumption, in addition to measured nutrition outcomes at the population level. Such process evaluations could advance our context-specific understanding of bottlenecks and specific inhibitors to policy effectiveness. Standardised tools, such as the 'Fortification Assessment Coverage Toolkit' (FACT)[112], can be used to guide consistent and effective implementation evaluation of nutrition-specific policies in this way. In addition, as noted in a recent real-time analysis of advocacy efforts for infant and young child feeding in Southeast Asia, strong policy advocacy can be a key driver to overcoming challenges experienced in translating policies into action[113].

Some strengths of this review include the systematic approach taken in searching for, screening and extracting data from articles, as well as the global nature and broad scope of the search to identify studies of nutrition-specific policies for undernutrition. Although overnutrition is an increasingly important health concern as the double burden of malnutrition grows[114], particularly in high- and middle-income countries, overweight and obesity were not included in this review. We further restricted

https://doi.org/10.1017/S1368980021001890 Published online by Cambridge University Press

the scope of this review to nutrition-specific policies to comprehensively map the heterogeneity in policies and nutritional outcomes evaluated in the context of immediate causes of child undernutrition; a similar exercise to map the breath and scope of the evidence to evaluate nutrition-sensitive policies that indirectly affect child undernutrition is needed. Policies which aim to influence the underlying determinants of undernutrition[115] have the potential to have large impacts on both maternal and child nutritional status. Only peer-reviewed research published in English was included in this review. We were additionally unable to account for the extent to which policies are implemented. For example, written policy statements (even mandatory ones) may not reflect the reality of what is practiced, funded, promoted or enforced; the latter can be most effectively assessed in country-case studies using qualitative methods. While the diversity of studies captured in this scoping review reflects the breadth of the research on nutrition policies on undernutrition in the MDG era, it was difficult to group policies perfectly based on predefined characteristics. For example, some studies evaluated policies targeting the age group of interest (children under 10 years) but with a wider age range (e.g.: ages 8–12 years). Other studies evaluated a multi-component policy intervention or the effects of two simultaneous policy interventions (e.g. nutrition education alongside provision of food supplements to the same beneficiaries). As a recent study by Chen *et al.* (2019) demonstrated, even differences in phrasing of the same policy can translate into differences of implementation and outcome (in this case, a nutrition subsidy policy with the goal phrased either in a specific ('anemia reduction') or general ('malnutrition reduction'))[116]. Policies in the same 'categories' can vary widely, and these variations should be examined in future reviews. The heterogeneity across policies and studies highlights the complexity of policy design in nutrition and points to the need for common guidance on the collection of optimal indicators of nutrition policy.

As one of the Scaling Up Nutrition movement's strategic objectives is to 'institutionalize effective actions that contribute to good nutrition,' including policies[3], evaluating the long-term impact of nutrition policies is essential. Data on population health and nutritional status are needed to advocate for and inform policy design, and rigorous evaluations must be planned before the introduction of new nutrition policies[111,117,118]. This highlights the importance of increasing the capacity for policy monitoring and evaluation longitudinally, including gathering evidence in comparable non-policy areas where possible[118]. As called for by the 2020 Global Nutrition Report, in addition to monitoring and evaluating policies moving forward, it is imperative to examine nutrition inequities and to implement evidence-based, equity-sensitive nutrition policies to address such inequities[114]. Future evaluations of population-level nutrition policies should therefore examine policy impacts disaggregated by sub-national parameters, such as rural/urban divide and wealth quintile, to better understand inequities and to enable appropriate resources to target marginalised populations[119]. Finally, evaluating the political economy of a given policy to better understand the role of power, incentives, institutions and ideas on shaping policies will be equally important to inform and support nutrition security through policy efforts in the long run[120].

In summary, while the studies included in this review suggest that nutrition-specific policies contribute to improvements in child nutritional status, the scope of the current nutrition policy research evidence base is limited. Most studies were conducted in high-income settings at the sub-national level and evaluated the role of micronutrient-specific nutrition policies on a narrow set of health outcomes. Further research is needed to assess the impact of a broader range of policies (including those related to nutrition education and infant and young child feeding practices); disentangle the complexity of nutrition policy design; and present a nuanced view of policy impact considering sociodemographic inequities. In addition, measures of child nutrition, such as dietary diversity, dietary/nutrient intake data and intervention coverage, may provide useful proxy measures of child nutritional status to assess policy impact in settings where population-level data are sparse. Importantly, nutrition policy research in low-income countries is particularly scarce and should be a research priority. Tangible evaluations of the political commitments to improve nutrition through policy provide an invaluable avenue for accountability to achieving the global targets for malnutrition reduction set in the 2012 World Health Assembly, the SDG, and those which will undoubtedly be set forth in the future.

Acknowledgements

Acknowledgements: The authors gratefully acknowledge Thomasin Adams-Weber for support designing the literature search and Grace Regent for research support. *Financial support:* This work was supported by the 2017 Catalyst Grant awarded by the Centre for Global Child Health, Hospital for Sick Children, Toronto, Canada. The funder had no role in the study design, data collection or analysis. *Conflict of interest:* There are no conflicts of interest. *Authorship:* N.P., B.B. and S.Z. formulated the research question and designed the study. B.B., A.R., V.P. and N.P. screened articles, extracted data and compiled research results. V.P. drafted the manuscript, and all authors critically reviewed the manuscript for intellectual content and approved the final version. *Ethics of human subject participation:* Not applicable.

Supplementary material

For supplementary material accompanying this paper visit https://doi.org/10.1017/S1368980021001890

References

1. UNICEF Data (2019) Malnutrition. https://data.unicef.org/topic/nutrition/malnutrition/ (accessed December 2019).
2. Black RE, Victora CG, Walker SP *et al.* (2013) Maternal and child undernutrition and overweight in low-income and middle-income countries. *Lancet* **382**, 427–451.
3. SUN Movement (2016) SUN MOVEMENT Strategy and Roadmap (2016–2020). https://scalingupnutrition.org/wp-content/uploads/2016/09/SR_20160901_ENG_web_pages.pdf (accessed January 2020).
4. Gillespie S, Menon P, Heidkamp R *et al.* (2019) Measuring the coverage of nutrition interventions along the continuum of care: time to act at scale. *BMJ Global Health* **4**, e001290.
5. Martins VJB, Toledo Florêncio TMM, Grillo LP *et al.* (2011) Long-lasting effects of undernutrition. *Int J Environ Res Public Health* **8**, 1817–1846.
6. UNICEF (2019) *The State of the World's Children 2019. Children, Food and Nutrition: Growing well in a Changing World*. New York: UNICEF.
7. United Nations (2015) The Millennium Development Goals Report 2015. https://www.un.org/millenniumgoals/2015_MDG_Report/pdf/MDG%202015%20rev%20(July%201).pdf (accessed May 2020).
8. Scaling Up Nutrition (2015) Scaling up nutrition vision. scalingupnutrition.org (accessed June 2020).
9. World Health Organization (n.d.) Global Targets 2025. https://www.who.int/nutrition/global-target-2025/en/ (accessed November 2019).
10. WHO (2015) Transforming our world: the 2030 Agenda for Sustainable Development: sustainable Development Knowledge Platform. https://sustainabledevelopment.un.org/post2015/transformingourworld (accessed November 2019).
11. United Nations (n.d.) United Nations Decade of Action on Nutrition 2016–2025. https://www.un.org/nutrition/about (accessed May 2020).
12. The Lancet (2013) Executive Summary of The Lancet Maternal and Child Nutrition Series. Lancet. https://www.thelancet.com/pb/assets/raw/Lancet/stories/series/nutrition-eng.pdf (accessed November 2019).
13. Mangasaryan N, Martin L, Brownlee A *et al.* (2012) Breastfeeding promotion, support and protection: review of six country programmes. *Nutrients* **4**, 990–1014.
14. Heseker HB, Mason JB, Selhub J *et al.* (2009) Not all cases of neural-tube defect can be prevented by increasing the intake of folic acid. *Br J Nutr* **102**, 173–180.
15. Labadarios D, Steyn NP, Mgijima C *et al.* (2005) Review of the South African nutrition policy 1994–2002 and targets for 2007: achievements and challenges. *Nutrition* **21**, 100–108.
16. Munn Z, Peters MDJ, Stern C *et al.* (2018) Systematic review or scoping review? Guidance for authors when choosing between a systematic or scoping review approach. *BMC Med Res Methodol* **18**, 143.
17. Peterson J, Pearce PF, Ferguson LA *et al.* (2017) Understanding scoping reviews. *J Am Assoc Nurse Pract* **29**, 12–16.
18. Peters MDJ, Marnie C, Tricco AC *et al.* (2021) Updated methodological guidance for the conduct of scoping reviews. *JBI Evid Implement* **19**, 3–10.
19. Daudt HML, Van Mossel C & Scott SJ (2013) Enhancing the scoping study methodology: a large, inter-professional team's experience with Arksey and O'Malley's framework. *BMC Med Res Methodol* **13**, 48.
20. Li S, Fan Y, Chen H *et al.* (2010) Is the current iodine content in edible salt appropriate for eliminating iodine deficiency in China. *Asia Pac J Clin Nutr* **19**, 231–235.
21. Yang J, Zhu L, Li X *et al.* (2016) Iodine status of vulnerable populations in Henan province of China 2013–2014 after the implementation of the new iodized salt standard. *Biol Trace Elem Res* **173**, 7–13.
22. Pedro MRA, Madriaga JR, Barba CVC *et al.* (2004) The National vitamin A supplementation program and subclinical vitamin A deficiency among preschool children in the Philippines. *Food Nutr Bull* **25**, 319–329.
23. Pries AM, Huffman SL, Mengkheang K *et al.* (2016) Pervasive promotion of breastmilk substitutes in Phnom Penh, Cambodia, and high usage by mothers for infant and young child feeding. *Matern Child Nutr* **12**, 38–51.
24. Tang KT, Pan WH, Wang FF *et al.* (2014) Iodine status of Taiwanese children before the change in national salt iodization policy: a retrospective study of the nutrition and health survey in Taiwan 2001–2002. *Asia Pac J Clin Nutr* **23**, 481–487.
25. Wang P, Sun H, Shang L *et al.* (2015) Low goiter rate associated with small average thyroid volume in schoolchildren after the elimination of iodine deficiency disorders. *PLoS One* **10**, 1–11.
26. Zhao J & van der Haar F (2004) Progress in salt iodization and improved iodine nutrition in China, 1995–99. *Food Nutr Bull* **25**, 337–343.
27. Zou Y, Lou X, Ding G *et al.* (2014) Iodine nutritional status after the implementation of the new iodized salt concentration standard in Zhejiang Province, China. *BMC Public Health* **14**, 1–5.
28. Zou Y, Lou X, Ding G *et al.* (2014) A cross-sectional comparison study on the iodine nutritional status between rural and urban residents in Zhejiang Province, China. *BMJ Open* **4**, e005484.
29. Zou Y, Lou X, Ding G *et al.* (2014) An assessment of iodine nutritional status and thyroid hormone levels in children aged 8–10 years living in Zhejiang Province, China: a cross-sectional study. *Eur J Pediatr* **173**, 929–934.
30. Djokomoeljanto R, Setyawan H, Dramaix M *et al.* (2001) The thyromobil model for standardized evaluation of iodine deficiency disorder control in Indonesia. *Thyroid* **11**, 365–372.
31. Huang W, Peng C, Huang H *et al.* (2013) Control of iodine-deficiency disorders following universal salt iodization in Shenzhen, China, 1997–2011. *Food Nutr Bull* **34**, 331–337.
32. Kohri T, Kaba N, Itoh T *et al.* (2016) Effects of the national school lunch program on bone growth in Japanese elementary school children. *J Nutr Sci Vitaminol* **62**, 303–309.
33. Kondo A, Morota N, Date H *et al.* (2015) Awareness of folic acid use increases its consumption, and reduces the risk of spina bifida. *Br J Nutr* **114**, 84–90.
34. Laillou A, Sophonneary P, Kuong K *et al.* (2016) Low urinary iodine concentration among mothers and children in Cambodia. *Nutrients* **8**, 1–11.
35. Li WH, Dong BS, Li P *et al.* (2012) Benefits and risks from the national strategy for improvement of iodine nutrition: a community-based epidemiologic survey in Chinese schoolchildren. *Nutrition* **28**, 1142–1145.
36. Lv SM, Xie LJ, Zhou RH *et al.* (2009) Control of iodine deficiency disorders following 10-year universal salt lodization in Hebei province of China. *Biomed Environ Sci* **22**, 472–479.
37. McNair R & Learoyd D (1989) An assessment of the nutritional status of preschool children in Western Province,

Papua New Guinea, 1978 to 1986. *Papua New Guinea Med J* **32**, 129–137.
38. Bitler MP & Currie J (2005) Does WIC work? The effects of WIC on pregnancy and birth outcomes. *J Policy Anal Manag* **24**, 73–91.
39. Joyce T, Gibson D & Colman S (2005) The changing association between prenatal participation in WIC and birth outcomes in New York City. *J Policy Anal Manag* **24**, 661–685.
40. Kowaleski-Jones L & Duncan G (2000) Effects of participation in the WIC food assistance program on children's health and development: evidence from NLSY children. *J Chem Inf Model* **53**, 1689–1699.
41. McNeely PD & Howes WJ (2004) Ineffectiveness of dietary folic acid supplementation on the incidence of lipomyelomeningocele: pathogenetic implications. *J Neurosurg* **100**, 98–100.
42. Ray JG, Meier C, Vermeulen MJ *et al.* (2002) Association of neural tube defects and folic acid food fortification in Canada. *Lancet* **360**, 2047–2048.
43. Richards R, Merrill RM, Baksh L *et al.* (2011) Maternal health behaviors and infant health outcomes among homeless mothers: U.S. Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) 2000–2007. *Prev Med* **52**, 87–94.
44. Shaw GM, Carmichael SL, Nelson V *et al.* (2004) Occurrence of low birthweight and preterm delivery among California infants before and after compulsory food fortification with folic acid. *Public Health Rep* **119**, 170–173.
45. Williams LJ, Mai CT, Edmonds LD *et al.* (2002) Prevalence of spina bifida and anencephaly during the transition to mandatory folic acid fortification in the United States. *Teratology* **66**, 33–39.
46. Williams J, Mai CT, Mulinare J *et al.* (2015) Updated estimates of neural tube defects prevented by mandatory folic acid fortification – United States, 1995–2011. *MMWR Morb Mortal Wkly Rep* **64**, 1–5.
47. Joyce T, Racine A & Yunzal-Butler C (2008) Reassessing the WIC effect: evidence from the pregnancy nutrition surveillance system. *J Policy Anal Manag* **27**, 277–303.
48. Agha MM, Glazier RH, Moineddin R *et al.* (2016) Congenital abnormalities in newborns of women with pregestational diabetes: a time-trend analysis, 1994 to 2009. *Birth Defects Res Part A – Clin Mol Teratol* **106**, 831–839.
49. De Wals P, Tairou F, Van Allen MI *et al.* (2008) Spina bifida before and after folic acid fortification in Canada. *Birth Defects Res Part A – Clin Mol Teratol* **82**, 622–626.
50. De Wals P, Van Allen MI, Lowry RB *et al.* (2008) Impact of folic acid food fortification on the birth prevalence of lipomyelomeningocele in Canada. *Birth Defects Res Part A – Clin Mol Teratol* **82**, 106–109.
51. Figlio D, Hamersma S & Roth J (2009) Does prenatal WIC participation improve birth outcomes? New evidence from Florida. *J Public Econ* **93**, 235–245.
52. Gai Y & Feng L (2012) Effects of federal nutrition program on birth outcomes. *Atl Econ J* **40**, 61–83.
53. Ionescu-Ittu R, Marelli AJ, Mackie AS *et al.* (2009) Prevalence of severe congenital heart disease after folic acid fortification of grain products: time trend analysis in Quebec, Canada. *BMJ* **338**, 1261.
54. Jackson MI (2015) Early childhood WIC participation, cognitive development and academic achievement. *Soc Sci Med* **126**, 145–153.
55. Martorell R, Ascencio M, Tacsan L *et al.* (2015) Effectiveness evaluation of the food fortification program of Costa Rica: impact on anemia prevalence and hemoglobin concentrations in women and children. *Am J Clin Nutr* **101**, 210–217.
56. Bicalho-Mancini PG & Velásquez-Meléndez G (2004) Exclusive breastfeeding at the point of discharge of high-risk newborns at a Neonatal Intensive Care Unit and the factors associated with this practice. *J Pediatr* **80**, 241–248.
57. De Oliveira Campos R, Reboucas SCL, Beck R *et al.* (2016) Iodine nutritional status in schoolchildren from public schools in Brazil: a cross-sectional study exposes association with socioeconomic factors and food insecurity. *Thyroid* **26**, 972–979.
58. Carvalho AL, De Souza Meirelles CJC, Oliveira LA *et al.* (2012) Excessive iodine intake in schoolchildren. *Eur J Nutr* **51**, 557–562.
59. García-Parra E, Ochoa-Díaz-López H, García-Miranda R *et al.* (2016) Are there changes in the nutritional status of children of Oportunidades families in rural Chiapas, Mexico? A cohort prospective study. *J Heal Popul Nutr* **35**, 1–8.
60. Carrillo B, Iglesias WJ & Trujillo JC (2015) Attainments and limitations of an early childhood programme in Colombia. *Health Policy Plan* **30**, 906–916.
61. de Carvalho ML, Boccolini CS, de Oliveira MIC *et al.* (2016) The baby-friendly hospital initiative and breastfeeding at birth in Brazil: A cross sectional study. *Reprod Health* **13**, 207–215.
62. Heidkamp RA, Ayoya MA, Teta IN *et al.* (2015) Complementary feeding practices and child growth outcomes in Haiti: an analysis of data from Demographic and Health Surveys. *Matern Child Nutr* **11**, 815–828.
63. Hertrampf E & Cortés F (2008) National food-fortification program with folic acid in Chile. *Food Nutr Bull* **29**, S231–S237.
64. Huerta MC (2006) Child health in rural Mexico: has progresa reduced children's morbidity risks? *Soc Policy Adm* **40**, 652–677.
65. Lander RL, Bailey KB, Lander AG *et al.* (2014) Disadvantaged pre-schoolers attending day care in Salvador, Northeast Brazil have a low prevalence of anaemia and micronutrient deficiencies. *Public Health Nutr* **17**, 1984–1992.
66. Ricks DJ, Rees CA, Osborn KA *et al.* (2012) Peru's national folic acid fortification program and its effect on neural tube defects in Lima. *Rev Panam Salud Publica/Pan Am J Public Heal* **32**, 391–398.
67. Cortés F, Mellado C, Pardo RA *et al.* (2012) Wheat flour fortification with folic acid: changes in neural tube defects rates in Chile. *Am J Med Genet Part A* **158**, 1885–1890.
68. Jaiswal N, Melse-Boonstra A, Sharma SK *et al.* (2015) The iodized salt programme in Bangalore, India provides adequate iodine intakes in pregnant women and more-than-adequate iodine intakes in their children. *Public Health Nutr* **18**, 403–413.
69. Bhasin SK, Bhatia V, Kumar P *et al.* (2001) Long term nutritional effects of ICDS. *Indian J Pediatr* **68**, 211–216.
70. Bloem MW, Hye A, Wijnroks M *et al.* (1995) The role of universal distribution of vitamin A capsules in combatting vitamin A deficiency in Bangladesh. *Am J Epidemiol* **142**, 843–855.
71. Dutta A & Ghosh S (2017) Impact of integrated child development scheme on child malnutrition in West Bengal, India. *Matern Child Nutr* **13**, 1–8.
72. Gelal B, Aryal M, Das Lal BK *et al.* (2009) Assessment of iodine nutrition status among school age children of Nepal by urinary iodine assay. *Southeast Asian J Trop Med Public Health* **40**, 538–543.
73. Kandpal E (2011) Beyond average treatment effects: distribution of child nutrition outcomes and program placement in India's ICDS. *World Dev* **39**, 1410–1421.
74. Khandait DW, Vasudeo ND, Zodpey SP *et al.* (1999) National vitamin A prophylaxis programme : need for change in current age strategy. *Indian J Pediatr* **66**, 825–829.

https://doi.org/10.1017/S1368980021001890 Published online by Cambridge University Press

75. Tripathy R & Das MM (2000) Growth in the first year in children following IAP policy on infant feeding. *Indian Pediatr* **37**, 1051–1059.
76. Vir SC, Kalita A, Mondal S *et al.* (2014) Impact of community-based mitanin programme on undernutrition in rural Chhattisgarh State, India. *Food Nutr Bull* **35**, 83–91.
77. Kapil U (2009) Urinary iodine excretion levels amongst schoolchildren in Haryana. *Indian Pediatr* **46**, 57–59.
78. Rossi L & Branca F (2003) Salt iodisation and public health campaigns to eradicate iodine deficiency disorders in Armenia. *Public Health Nutr* **6**, 463–469.
79. Willgerodt H, Keller E, Perschke C *et al.* (1997) The status of iodine nutrition in newborn infants, schoolchildren, adolescents and adults in former East Germany. *Endocrinol Diabetes* **105**, 38–42.
80. Als C, Haldimann M, Minder C *et al.* (2004) Pilot study of urinary iodine concentration and of biochemical thyroid parameters before and after cautious public health intervention on salt iodide content: the Swiss longitudinal 1996–2000 iodine study. *Eur J Clin Nutr* **58**, 1201–1210.
81. Andersson M, Berg G, Eggertsen R *et al.* (2009) Adequate iodine nutrition in Sweden: a cross-sectional national study of urinary iodine concentration in school-age children. *Eur J Clin Nutr* **63**, 828–834.
82. Çetin H, Kisioglu AN, Gursoy A *et al.* (2006) Iodine deficiency and goiter prevalence in Turkey after mandatory iodization. *J Endocrinol Invest* **29**, 714–718.
83. Leite JC, Keating E, Pestana D *et al.* (2017) Iodine status and iodised salt consumption in Portuguese school-aged children: the iogeneration study. *Nutrients* **9**, 458.
84. Vaish S, White M, Daly L *et al.* (2016) Synthetic folic acid intakes and status in children living in Ireland exposed to voluntary fortification. *Am J Clin Nutr* **103**, 512–518.
85. Agaba E, Pomeroy-Stevens A, Ghosh S *et al.* (2016) Assessing progress in implementing Uganda's nutrition action plan: district-level insights. *Food Nutr Bull* **37**, S142–S150.
86. Amouzou A, Habi O & Bensaïd K (2012) Reduction in child mortality in Niger: a Countdown to 2015 country case study. *Lancet* **380**, 1169–1178.
87. Assey VD, Peterson S, Kimboka S *et al.* (2009) Tanzania national survey on iodine deficiency: impact after twelve years of salt iodation. *BMC Public Health* **9**, 3.
88. Bimenya GS, Kaviri D, Mbona N *et al.* (2002) Monitoring the severity of iodine deficiency disorders in Uganda. *Afr Health Sci* **2**, 63–68.
89. Debela BL, Shively G & Holden ST (2015) Does Ethiopia's productive safety net program improve child nutrition? *Food Secur* **7**, 1273–1289.
90. Kafwembe EM, Chipipa J, Njunju E *et al.* (2009) The vitamin A status of Zambian children in a community of vitamin A supplementation and sugar fortification strategies as measured by the Modified Relative Dose Response (MRDR) test. *Int J Vitam Nutr Res* **79**, 40–47.
91. Sebotsa MLD, Dannhauser A, Jooste PL *et al.* (2005) Iodine status as determined by urinary iodine excretion in Lesotho two years after introducing legislation on universal salt iodization. *Nutr* **21**, 20–24.
92. Abbag FI, Abu-Eshy SA, Mahfouz AA *et al.* (2015) Iodine-deficiency disorders in the Aseer region, south-western Saudi Arabia: 20 years after the national survey and universal salt iodization. *Public Health Nutr* **18**, 2523–2529.
93. Al-Dakheel M, Haridi H, Al-Bashir B *et al.* (2016) Prevalence of iodine deficiency disorders among school children in Saudi Arabia: results of a national iodine nutrition study. *East Mediterr Heal J* **22**, 301–308.
94. Alasfoor D, Elsayed MK & Mohammed AJ (2010) Spina bifida et accouchement avant et après l'instauration de la farine enrichie en fer et en acide folique à Oman (Spina bifida and birth outcome before and after fortification of flour with iron and folic acid in Oman). *East Mediterr Heal J* **16**, 533–538.
95. Doggui R, El Ati-Hellal M, Traissac P *et al.* (2017) Adequacy assessment of a universal salt iodization program two decades after its implementation: a national cross-sectional study of iodine status among school-age children in Tunisia. *Nutrients* **9**, 1–17.
96. Kousha A, Hakimi S, Soleimanzadeh G *et al.* (2010) Monitoring and enforcement of the salt iodization programme in Tabriz, Islamic Republic of Iran: a successful experience. *East Mediterr Heal J* **16**, 528–532.
97. Zlotogora J, Amitai Y & Leventhal A (2006) Surveillance of neural tube defects in Israel: the effect of the recommendation for periconceptional folic acid. *Isr Med Assoc J* **8**, 601–604.
98. Andersson M, Karumbunathan V & Zimmermann MB (2012) Global iodine status in 2011 and trends over the past decade. *Nutr Epidemiol* **142**, 744–750.
99. Botto LD, Lisi A, Robert-Gnansia E *et al.* (2005) International retrospective cohort study of neural tube defects in relation to folic acid recommendations: are the recommendations working? *Br Med J* **330**, 571–573.
100. Heymann J, Raub A & Earle A (2013) Breastfeeding policy: a globally comparative analysis. *Bull World Health Organ* **91**, 398–406.
101. Horton S & Miloff A (2010) Iodine status and availability of iodized salt: an across-country analysis. *Food Nutr Bull* **31**, 214–220.
102. Rosano A, Smithells D, Cacciani L *et al.* (1999) Time trends in neural tube defects prevalence in relation to preventive strategies: an international study. *J Epidemiol Community Health* **53**, 630–635.
103. Nomura M, Takahashi K & Reich MR (2015) Trends in global nutrition policy and implications for Japanese development policy. *Food Nutr Bull* **36**, 493–502.
104. The Lancet (2008) Maternal and child undernutrition. https://www.thelancet.com/series/maternal-and-child-undernutrition (accessed December 2020).
105. The Lancet (2021) Maternal and child undernutrition progress series. https://www.thelancet.com/series/maternal-child-undernutrition-progress (accessed March 2021).
106. Bump JB (2018) Undernutrition, obesity and governance: a unified framework for upholding the right to food. *BMJ Glob Heal* **3**, e000886.
107. Mozaffarian D, Angell SY, Lang T *et al.* (2018) Role of government policy in nutrition-barriers to and opportunities for healthier eating. *BMJ* **361**, k2426.
108. World Health Organization (2011) Guideline. Intermittent iron and folic acid supplementation in menstruating women. https://www.who.int/nutrition/publications/micronutrients/guidelines/guideline_iron_folicacid_suppl_women/en/ (accessed November 2019).
109. Global Fortification Data Exchange Interactive Map: Fortification Legislation Providing actionable food fortification data. http://www.fortificationdata.org (accessed November 2019).
110. UNICEF DATA (2008) Sustainable Elimination of Iodine Deficiency. https://data.unicef.org/resources/sustainable-elimination-of-iodine-deficiency/ (accessed November 2019).
111. Mason JB, Shrimpton R, Saldanha LS *et al.* (2015) The first 500 days of life: policies to support maternal nutrition. *Glob Health Action* **7**, 23623.
112. Global Alliance for Improved Nutrition (GAIN) (2019) Oxford Policy Management Fortification assessment coverage toolkit (FACT) manual. https://www.gainhealth.org/resources/reports-and-publications/fortification-assessment-coverage-toolkit-fact (accessed January 2020).

https://doi.org/10.1017/S1368980021001890 Published online by Cambridge University Press

113. Michaud-Létourneau I, Gayard M & Pelletier DL (2019) Strengthening advocacy and policy change for infant and young child feeding. *Matern Child Nutr* **15**, e12683.
114. Global Nutrition Report (2020) 2020 Global Nutrition Report. https://globalnutritionreport.org/ (accessed May 2020).
115. Ruel MT & Alderman H (2013) Nutrition-sensitive interventions and programmes: how can they help to accelerate progress in improving maternal and child nutrition? *Lancet* **382**, 536–551.
116. Chen Q, Pei C, Bai Y *et al.* (2019) Impacts of nutrition subsidies on diet diversity and nutritional outcomes of primary school students in rural northwestern china—do policy targets and incentives matter? *Int J Environ Res Public Health* **16**, 2891.
117. Wirth JP, Laillou A, Rohner F *et al.* (2012) Lessons learned from national food fortification projects: experiences from Morocco, Uzbekistan, and Vietnam. *Food Nutr Bull* **33**, 281–292.
118. Mason J, Deitchler M, Mathys E *et al.* (2004) Lessons from successful micronutrient programs Part III : program impact. *Food Nutr Bull* **25**, 53–78.
119. Goh CC (2002) Combating iodine deficiency: lessons from China, Indonesia, and Madagascar. *Food Nutr Bull* **23**, 280–291.
120. Reich MR & Balarajan Y (2014) Political economy analysis for nutrition policy. *Lancet Glob Heal* **2**, e681–e682.

Public Health Nutrition

https://doi.org/10.1017/S1368980021001890 Published online by Cambridge University Press