

# Integrating nutrition into the education sector in low- and middle-income countries: A framework for a win-win collaboration

Yvonne Yiru Xu<sup>1</sup>  | Talata Sawadogo-Lewis<sup>1</sup>  | Shannon E. King<sup>1</sup>  |  
Arlene Mitchell<sup>2</sup> | Timothy Robertson<sup>1</sup> 

<sup>1</sup>Johns Hopkins Bloomberg School of Public Health, Johns Hopkins University, Baltimore, Maryland, USA

<sup>2</sup>Global Child Nutrition Foundation, Seattle, Washington, USA

## Correspondence

Yvonne Yiru Xu, Johns Hopkins Bloomberg School of Public Health, Johns Hopkins University, Baltimore, MD, USA.  
Email: yvonneyiruxu@gmail.com

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## Abstract

Malnutrition—both undernutrition and overnutrition—is a public health concern worldwide and particularly in low- and middle-income countries (LMICs). The education sector has high potential to improve immediate nutrition outcomes by providing food in schools and to have more long-term impact through education. We developed a conceptual framework to show how the education sector can be leveraged for nutrition. We reviewed the literature to identify existing frameworks outlining how nutrition programs can be delivered by and through the education sector and used these to build a comprehensive framework. We first organized nutrition programs in the education sector into (1) school food, meals, and food environment; (2) nutrition and health education; (3) physical activity and education; (4) school health services; and (5) water, sanitation, and hygiene (WASH) sector. We then discuss how each one can be successfully implemented. We found high potential in improving nutrition standards and quality of school foods, meals and food environment, especially through collaboration with the agriculture sector. There is a need for well-integrated, culturally appropriate nutrition and health education into the existing school curriculum. This must be supported by a skilled workforce—including nutrition and public health professionals and school staff. Parental and community engagement is cornerstone for program sustainability and success. Current monitoring and evaluation of nutrition programming in schools is weak, and effectiveness, including cost-effectiveness, of interventions is not yet adequately quantified. Finally, we note that opportunities for leveraging the education sector in the fight against rising overweight and obesity rates are under-researched and likely underutilized in LMICs.

## KEYWORDS

conceptual frameworks, education, low- and middle-income, nutrition

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## 1 | INTRODUCTION

Malnutrition in childhood, including both undernutrition and overweight and obesity, have an immediate impact on a child's survival, development and, prospectively, impacts their productivity and economic contribution in society later in life (Nugent, Levin, Hale, & Hutchinson, 2020; Victora et al., 2008). As the nutrition sector aims to reduce malnutrition, the education sector shares the same goal that aims to support a child to reach their potential and become productive members of society (Bundy et al., 2009).

The current global nutrition agenda underscores the importance of multi-sectoral approaches to addressing malnutrition (Bezanson & Isenman, 2010; International Food Policy Research Institute [IFPRI], 2011; The World Bank, 2013). There is renewed interest in leveraging the education sector to deliver nutrition interventions (Bundy, de Silva, Horton, Jamison, & Patton, 2018; UNSCN, 2017) and programs with a broadening scope as a double duty action area in low- and middle-income countries (LMICs) to address the double burden of malnutrition (i.e., the existence of both undernutrition, and overweight and obesity within the same population) (Hawkes, Ruel, Salm, Sinclair, & Branca, 2020).

An early global framework linking nutrition and education in the context of LMICs, the Focusing Resources on Effective School Health (FRESH) framework (The World Bank, 2000), was developed in the early 2000s and had a strong focus on addressing undernutrition. Later, the Nutrition Friendly School Initiative (NFSI) (World Health Organization [WHO], 2006) was launched in efforts to address the double burden of malnutrition. The two frameworks have set the foundation for the components of health-promoting schools, which consist of (1) school health policy, (2) nutrition and health promoting school curricula, (3) school meals and feeding programs, (4) school health services, and (5) safe water and sanitation (The World Bank, 2000; WHO, 2006). More recently, frameworks with an expanded focus on addressing overnutrition, increasing physical activity, and the integrating agriculture and food systems have emerged, such as the WHO school policy framework (SPF) (WHO, 2008), home-grown school feeding resource framework (Food and Agriculture Organization [FAO] & World Food Program [WFP], 2018), and School Food and Nutrition Framework (FAO, 2019).

although organizations like the WFP have carried out substantial work in research and implementation of school feeding programs as a means to relieve hunger, the scope is limited. To date, there is no consolidated framework that outlines programmatic pathways in which nutrition programs in LMICs can be delivered through the education sector.

We undertook this review to develop a comprehensive evidenced-based framework pulling knowledge from both scientific literature and available technical guidance documents, to map out program impact pathways within the education sector that can improve nutrition which will serve as a knowledge repository, or as a tool to guide program implementation.

### Key messages

- Well-adapted national policies and guidelines, adequate training of workforce at all levels, and community and parental engagement are paramount to the success of school nutrition programs.
- More research is needed to evaluate the multi-generational and broader societal impact, of school nutrition programs, including on indirect beneficiaries (i.e., food and agriculture workers, women).
- A globally accepted monitoring framework with standard indicators for all program areas is needed to strengthen monitoring and evaluation efforts.
- The education sector is particularly well placed but so far underutilized to play a role in the mitigation and prevention of obesity and overweight.

In this paper, we first describe the five program areas by which nutrition programs can be delivered through the education sector and how each can be strengthened. We then discuss key takeaways from this review, including where gaps in research as well as opportunities for intervention exist.

## 2 | METHODS

We developed our model in three stages: (1) review of the literature, (2) technical document review, and (3) expert review.

First, we searched the PubMed database for studies simultaneously referencing three domains of interest, namely, education, nutrition, and LMIC. We generated related keywords and Medical Subject Headings (MeSH) terms for each. We restricted our search to papers that had the terms either their title or their abstract.

We identified a total number of 10,662 studies. Subsequently, we screened the title and abstract of studies listed by relevancy first, followed by a review of the full text until content areas reached saturation. We excluded studies based on the following exclusion criteria: (1) did not involve responsibilities of the education sector, (2) lack of focus on nutritional issues, (3) studies conducted on animals, (4) laboratory-based studies that did not involve human subjects, or (5) did not take place in the context of LMICs.

We then categorized the relevant studies as either epidemiological associations, measure of prevalence, or program implementation. This process organically informed the structure of the framework as common themes and components began to emerge. We organized components within the education sector at three levels: national,

sub-national, and school level. The school level components were associated with underlying causes or immediate causes and impacted nutritional outcomes and child development. Once we generated the initial draft of the framework, we began an iterative process of framework development.

Subsequently, we searched United Nation (UN) agency websites including the WHO, United Nation's Child Fund (UNICEF), Food and Agriculture of the United Nations (FAO), and WFP in the publication section for "education and nutrition" and "school and nutrition" to identify relevant technical documents. We used the results of this search to further refine our framework, specifically in the selection of terminologies, the organization of major components, and additional elements not initially identified in the literature review.

We convened a meeting of nutrition experts in October 2019 where we presented our framework for review and feedback. From this meeting, two additional subject area experts provided feedback on subsequent iterations of the framework.

### 3 | RESULTS

Figure 1 presents a high-level overview of the components of our comprehensive framework for nutrition and education.

Our framework is based on having available and accessible schools, because schools serve as the vehicle through which nutrition programs are delivered. Without access to school infrastructure and educational activities, the delivery of nutrition and health interventions in this sector become much more challenging and expensive.

Building directly on this foundation of existing school systems, we identified five program components through which nutrition can be improved, namely, (1) school food, meals, and food environment; (2) nutrition and health education; (3) physical activity and education; (4) school health services; and (5) water, sanitation, and hygiene (WASH) in schools (Figure 1).

The standards of program activities are defined and enforced by enabling school policies at the national, sub-national, and school level. Parental and community engagement is both a driver for and a result of effective program implementation. Both enabling policies and

community engagement are cross-cutting themes throughout the framework (Figure 1).

This broad framework aligns with both FRESH and NFSI, with the additional concepts of school food marketing and information, and physical activity and education introduced in the FAO's school food and nutrition and the WHO SPF (FAO, 2019; WHO, 2008).

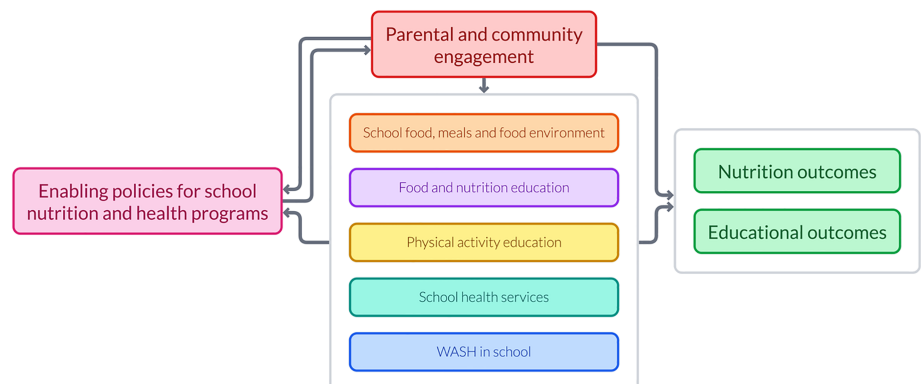
#### 3.1 | School food, meals, and food environment

We define school food, meals, and food environment as not only the food provided directly by or through the school system (i.e., in a canteen or through school vendors on school grounds), but also the foods available near school where students might go to purchase meals and snacks (i.e., street vendors) as presented in Figure 2.

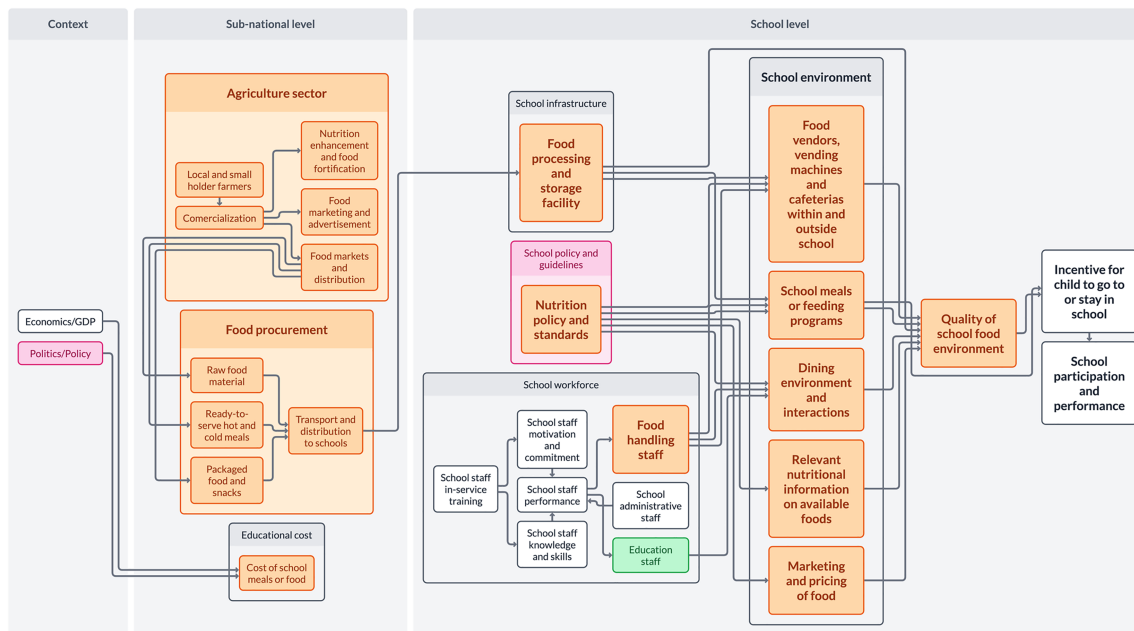
##### 3.1.1 | School feeding programs benefits and structures

School feeding programs are the most widely implemented nutrition programs in school. Evidence from various cross-sectional studies, quasi-experimental designs, and randomized controlled trials have congruously shown that school feeding programs were associated with improved diet diversity, increased dietary intake of essential macronutrients and micronutrients, improved child growth including height-for-age z-score, weight-for-length z-score, body mass index (BMI)-for-age z-score, as well as higher school attendance, lower drop-out rates, and improved school performance and cognitive scores (Abizari et al., 2014; El Harake, Kharroubi, Hamadeh, & Jomaa 2018; Neervoort et al., 2013; Nkhoma et al., 2013; Powell, Walker, Chang, & Grantham-McGregor, 1998; Zenebe, Gebremedhin, Henry, & Regassa, 2018).

School feeding programs where ready-to-serve meals are provided mainly operate through two types of supply systems: a decentralized system (i.e., prepared at the school food preparation facility) and a centralized system (i.e., foods and meals prepared at a public or private run food facility and then distributed to schools



**FIGURE 1** Overview of nutrition programming in the education sector. WASH, water, sanitation, and hygiene



**FIGURE 2** School food, meals, and food environment. GDP, gross domestic product

for consumption) (Abizari et al., 2014; Bhagwat, Sankar, Sachdeva, Joseph, & Sivaranjani, 2014; Delisle, Receveur, Agueh, & Nishida, 2013; Kumar & Rajagopalan, 2007; Masset & Gelli, 2013; Studdert, Soekirman, Rasmussen, & Habicht, 2004; Walker, Powell, Hutchinson, Chang, & Grantham-McGregor, 1998). The choice of system depends on population density, school infrastructure, and supply logistics (Bhagwat et al., 2014).

### 3.1.2 | Collaboration with the agriculture sector

Involving local and smallholder farmers in supplying schools can lead to improved diet diversity, improved food quality, and increased local food consumption in schools. Simultaneously, it can strengthen local agriculture, ensure income security of small farm holders, and reduce food transportation time—which has both environmental and economic benefits (Masset & Gelli, 2013; Soares, Davó-Blanes, Martinelli, Melgarejo, & Cavalli, 2017; Studdert et al., 2004). However, interruptions in the supply chain to bring foods to schools are common issues and can lead to the disruption of school feeding programs (Adams et al., 2017; Walker et al., 1998; Zenebe et al., 2018).

### 3.1.3 | Ensuring the nutritional quality

Providing meals of high nutritional quality at school is a cornerstone of successful school feeding programs to address malnutrition (Abizari et al., 2014). National school nutrition standards often provide guidance on required macronutrient and micronutrient distribution, food diversity, frequency, and timing of meals (Bhagwat et al., 2014; Soares et al., 2017). Purchasing criteria can also be established within the

nutrition standards to guide food procurement of school food and meals (Masset & Gelli, 2013). However, detailed menus can be decided at sub-national or community levels to allow for incorporation of local foods that are most appropriate and accessible while also meeting standards for nutrient composition (Studdert et al., 2004).

The nutritional quality of the foods provided can also be improved by fortifying school meals. This can be accomplished at different levels: (1) utilization of fortified agricultural products, (2) fortification during food preparation, and (3) fortification at point-of-use (Adams et al., 2017; Bhagwat et al., 2014; Kumar & Rajagopalan, 2007). Nutrient stability and availability, operational feasibility, cost, frequency of consumption, quantity, and contextual acceptance must be considered when choosing food vehicles used for fortification (Bhagwat et al., 2014).

### 3.1.4 | Food handling infrastructure and workforce

Food handling staff must be trained on appropriate operating standards to ensure the consistency of food fortification programs and quality assurance and control procedures (Bhagwat et al., 2014). However, food handling staff often receive negligible training and have poor food handling practices (Delisle et al., 2013; Sibanyoni & Tabit, 2017). This is exacerbated by the lack of adequate food preparation and storage facilities bound by the lack of potable water systems in schools and even electricity to allow for safe food storage (Torres & Benn, 2017; Zenebe et al., 2018). Basic amenities in schools—or lack thereof—and food safety practices are often overlooked in school feeding planning.

From a workforce perspective, solutions to address these implementations issues include (1) training of staff responsible for

food procurement, handling, and preparation; (2) clearly communicating school nutrition policies and standards; (3) ensuring strong relationships and communications between actors in the food supply chain; and (4) additional training in measuring and accounting (Masset & Gelli, 2013; Soares et al., 2017).

### 3.1.5 | Cost and participation

Costs of school feeding programs account for a much larger proportion of primary education expenditure in low-income countries compared with middle-income countries (Galloway et al., 2009; Gelli & Daryanani, 2013). Long-term sustainability of school feeding programs—especially in lower income countries—are determined by successful transition from external donation to national sources of funding (Bundy et al., 2009). Student participation in school feeding programs is influenced by fees if it is not provided free (Walker et al., 1998).

### 3.1.6 | School food environment

Both the nutrition quality and sanitation and hygiene standards of food vendors that are within or around school grounds must be considered within school policies (Delisle et al., 2013; Walker et al., 1998). Rather than excluding street vendors from consideration, training vendors on food hygiene and educating them on types of foods to sell is an alternative approach (Delisle et al., 2013). Many countries also ban certain foods and drinks from being sold on or near school grounds (Global Child Nutrition Foundation, 2020). In schools

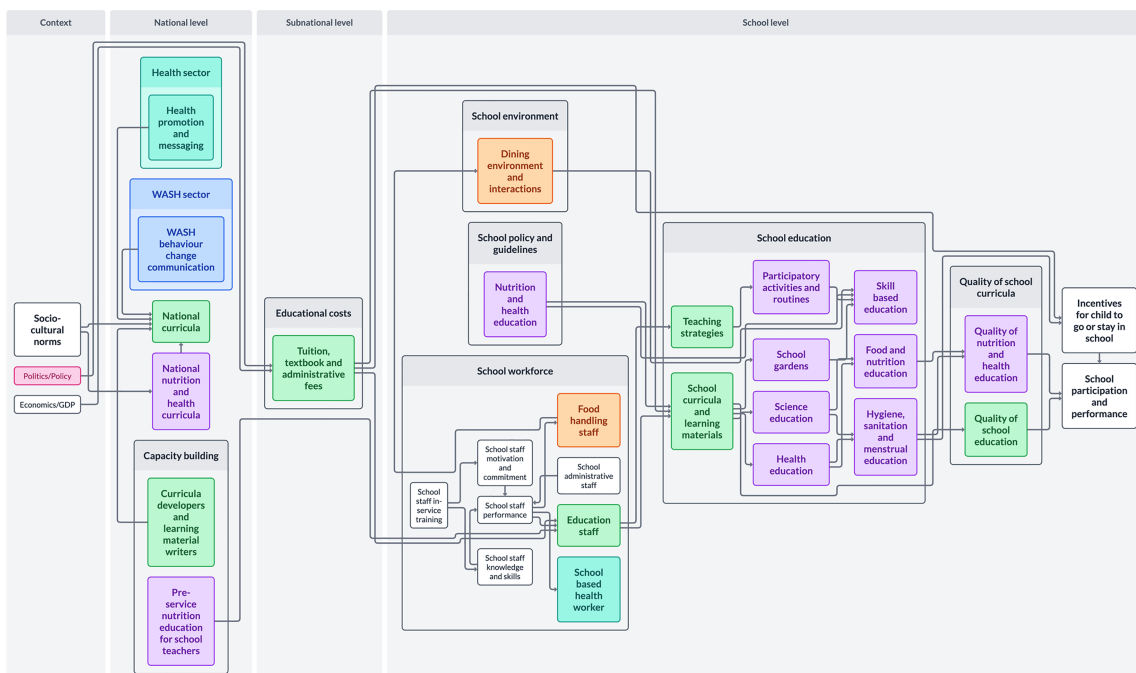
where self-selection of foods are available in a canteen setting, providing nutrition information of foods offered and displaying advertising of foods that are considered nutritious can influence selection (FAO, 2019; Rathi, Riddell, & Worsley, 2018).

## 3.2 | Nutrition and health education

Nutrition and health education in schools (presented in Figure 3) have been shown to improve both nutrition and health knowledge, diet quality and nutrition status among students in randomized control trials (He et al., 2015; Kafatos, Peponaras, Linardakis, & Kafatos, 2004; Mbhatsani, Mbhenyane, & Mabapa, 2017; Rosário et al., 2017). However, differences in the quality of education provided and in methods of delivery across studies are challenges to producing comparable and robust evidence. Nutrition and health education encompass both knowledge-based education on topics of food, nutrition, health and hygiene, and skill-based education by providing practical experience and the development of health-conducive behaviors.

### 3.2.1 | School curricula and teaching material

Nutrition and health curricula are typically developed at the national level by the ministry of education, along with inputs from public health agencies (Mbhatsani et al., 2017; Tamiru et al., 2017). Nutrition and health education have some overlap with general science education and can be partially integrated within the science curricula (Rangel, Nunn, Dysarz, Silva, & Fonseca, 2014).



**FIGURE 3** Nutrition and health education. GDP, gross domestic product; WASH, water, sanitation, and hygiene

Programs that are tailored to cultural context and incorporate local and indigenous foods tend to be more successful (Knoblauch et al., 2017; Mbhatsani et al., 2017). Focusing on food literacy to understand food advertising and labels is essential in setting where unhealthy packaged foods are prevalent (El Harake et al., 2018; Knoblauch et al., 2017; Mbhatsani et al., 2017). Some studies also found that students can serve as a conduit of nutrition and health knowledge and can improve dietary intakes of family members at home (El Harake et al., 2018; Tamiru et al., 2017).

### 3.2.2 | Teaching strategy

The quality of nutrition and health education is impacted both by a well-designed curriculum and by its execution and engagement strategy—both of which are dependent on teachers' motivation, interest, and commitment (Delisle et al., 2013; Kafatos et al., 2004). Teaching plans and strategies must consider the duration of the program, age-appropriate strategies, learning outcomes, assessments, interactive activities, and hands-on learning experiences, which greatly affects student learning and knowledge uptake for nutrition and health information specifically (Knoblauch et al., 2017; Mbhatsani et al., 2017; Rangel et al., 2014).

### 3.2.3 | Education workforce

While health professionals such as nutritionists or nurses provide nutrition- and health-specific expertise, actual teachers are the experts in teaching students (Rangel et al., 2014). Collaborative efforts are therefore necessary. In-service training for education staff is essential to the quality of nutrition education to ensure preparedness in knowledge areas, lesson planning and utilization of behavior change strategies (Delisle et al., 2013; El Harake et al., 2018; Kupolati et al., 2016). Alternatively, increasing the formal qualifications of education staff through either certification programs or by integrating nutrition training into the teaching degree can be viable ways forward (Rangel et al., 2014).

### 3.2.4 | Skill-based education

In addition to classroom-based education, skill-based education that occurs in kitchens, during meal times or in school gardens can also contribute to improving nutrition (Studdert et al., 2004). These venues serve as opportunities for demonstrating biological concepts of foods in a practical way. Education or food handling staff can model healthy eating behaviors, while simultaneously providing information on nutrition composition and its association with health (Rangel et al., 2014; Rathi et al., 2018). Similar learning activities can be carried out in school gardens, focusing in that case on food and agriculture knowledge (Rangel et al., 2014).

## 3.3 | Physical activity education

Although the evidence of the effectiveness of school-based interventions for physical activity education in LMICs are scant, the WHO SPF highlights physical activities in school as a major intervention (WHO, 2008). These include physical education classes, leisure activities, and extra-curricular activities (WHO, 2008) To support these activities, equipment and resources should be made available on school grounds. These can be as simple and low cost as skipping ropes, hula hoops, and balls (El Harake et al., 2018). However, the safety of students must be ensured by providing safe equipment and, if activities occur outside of school grounds, adequate supervision is needed to prevent unintentional injuries. Figure 4 presents program components required for physical education in schools.

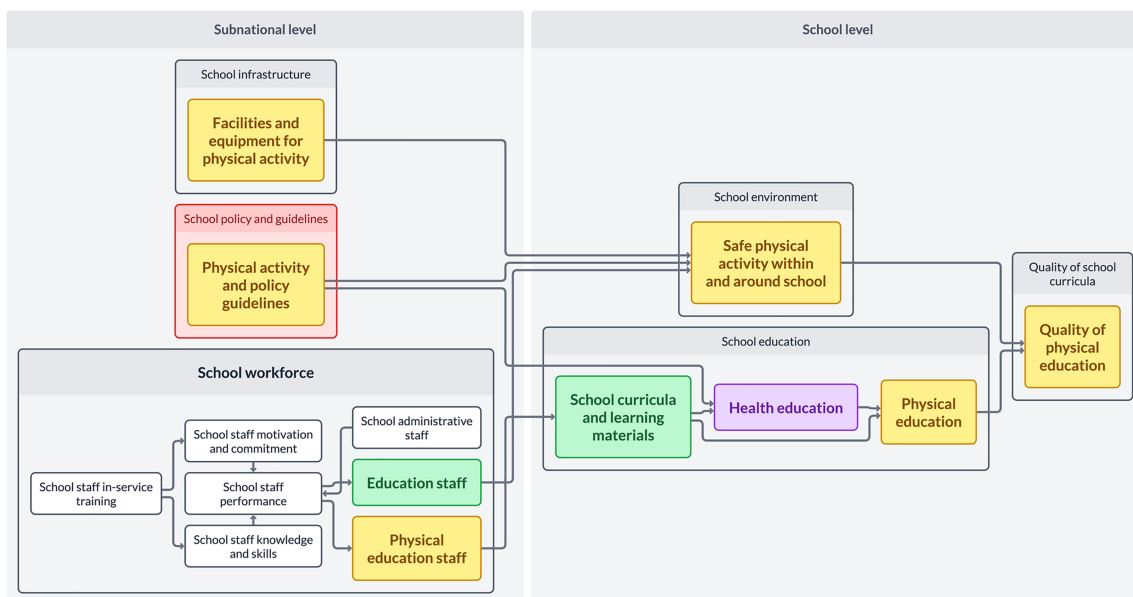
## 3.4 | School health services

School health services include (1) health service outreach activities that occur in schools periodically, (2) the presence of a school-based health clinic or service, and (3) basic health assessments carried out by trained education staff or health professional. Nutrition-related health services in schools include vitamin A and iron supplementation, growth monitoring, and deworming interventions for students (Bhagwat et al., 2014; Studdert et al., 2004). The health sector is however responsible for providing or approving the intervention as well as coordinating the procurement, supply, and proper use of medical commodities distributed to schools.

Common effective low-cost supplementary interventions such as deworming can be easily delivered alongside school feeding programs to reduce helminth infections in children that lead to malnutrition in children (Galloway et al., 2009; Knoblauch et al., 2017; Monse et al., 2013; Neervoort et al., 2013). Having permanent school-based health staff—a model more common in high-income countries—may not always be feasible in LMICs. Some countries have therefore leveraged trained education staff to conduct some nutrition-related tasks, such as yearly growth monitoring of students (Delisle et al., 2013). Additionally, nutrition and health counseling services—currently rarely implemented in LMIC—should be considered as part of school health services as suggested by the SPF (WHO, 2008). Finally, health services in schools, such as access to appropriate menstrual hygiene management, are important ways to address gender equity in in school access and keeping girls in school (Hennegan & Montgomery, 2016; UNSCN, 2017).

## 3.5 | Water, hygiene, and sanitation

Poor hygiene behaviors and sanitary facilities increase the transmission of disease and bacteria that are associated with malnutrition (Esrey, 1996; Torlesse, Cronin, Sebayang, & Nandy, 2016). Therefore, promotion of handwashing practices and safe sanitary practices prior



**FIGURE 4** Physical activity programs

to and after mealtimes are common behavior modeling components in schools (Knoblauch et al., 2017; Studdert et al., 2004). However, hygiene and sanitation practices are often constrained by the lack of availability of drinking water and sanitary facilities within schools (Knoblauch et al., 2017).

We note that recent evidence suggests a lack of effectiveness of traditional WASH interventions on nutritional outcomes (Pickering et al., 2019). The current state of the evidence suggests that the types and combination of effective interventions in school settings that produce improved nutritional outcomes have yet to be fully identified.

### 3.6 | Enabling policies

School health policies serve as a guide for standardized implementation of nutrition programs in schools. WHO's SPF provides comprehensive guidance on policy development in detail on the five main components of our framework (WHO, 2008). Such policies are more commonly developed and adopted at the national level and must then be integrated into existing education systems.

#### 3.6.1 | Developing successful national school policies

Drafting a national school health policy requires critical input from the public health and nutrition workforce (Khandelwal, Dayal, Jha, Zodpey, & Reddy, 2012). Although some countries partner with international organizations to develop such policies, building a local workforce is fundamental for context-appropriate school nutrition

programs and their successful implementation (Delisle et al., 2013; Khandelwal et al., 2012). In some countries, attempts to create individual school-level policies have failed due to lack of capacity and experience (Delisle et al., 2013). Therefore, a nationally disseminated policy that is culturally adapted and championed by local actors has the highest potential for success.

#### 3.6.2 | Building country public health and nutrition expertise

This can be addressed by ensuring that sufficient numbers of education and training programs nationwide, often at tertiary level education with specialization in public health nutrition, are available and accessible, which creates a dedicated workforce that serve as local advocates for pushing the country's nutrition agenda forward (Delisle et al., 2013; Khandelwal et al., 2012).

#### 3.6.3 | Role of legislation

Establishing national-level school policies also require political commitment from national stakeholders. They can be further supported by passing legislation that mandates school nutrition programs. Legislation can even go as far as impacting food procurement processes within school meal programs by imposing regulations on how national funding is utilized, as was done for school feedings in Brazil (Schwartzman, Mora, Bogus, & Villar 2017).

Finally, national accreditation systems have been proposed as a way to build commitment within local stakeholders and gain recognition as proposed by the NFSI (WHO, 2006).

### 3.7 | Parental and community engagement

Regardless of the intervention or program component, abundant evidence highlights the importance of parental and community engagement. It is a measure of both quality and success throughout the framework at every level. It impacts policy development, ensures school and government accountability, and improves the quality of implementation and monitoring.

#### 3.7.1 | Engagement and policies

First, parental involvement can push for establishing of school nutrition policy and standards in cases where there are none (Rathi et al., 2018). Conversely, policies must be intentionally designed to ensure sustained community engagement. When Ecuador's school feeding program—initiated by WFP—was scaled up and transitioned to a state-owned program, components involving community engagement, school gardens, and linkages with local farmers were removed (Torres & Benn, 2017). School teachers became overburdened as they took over community responsibilities in school meal preparation, while maintaining in-school education activities related to nutrition. The burnout of staff and lack of community participation ultimately led to program failure (Torres & Benn, 2017).

#### 3.7.2 | Direct engagement in school nutrition programs

In some settings, parents and community members directly participate in school nutrition programs. Depending on the context, their participation may be in exchange for cash compensation, in-kind contributions, or on a purely voluntary basis (Delisle et al., 2013; Masset &

Gelli, 2013; Torres & Benn, 2017). However, the workforce is most commonly comprised of women who typically receive training but without financial remuneration (Bhagwat et al., 2014; Global Child Nutrition Foundation, 2020).

#### 3.7.3 | Ownership and accountability

Diversion of funds is a concern for the implementation of school feeding programs. A successful strategy has been implemented in Indonesia, where village leaders, village midwives, and heads of the local women's and school parents' associations not only are responsible for the development of the menu and participate in school meal preparations but also monitor funding allocation and program implementation to prevent fund mismanagement (Studdert et al., 2004).

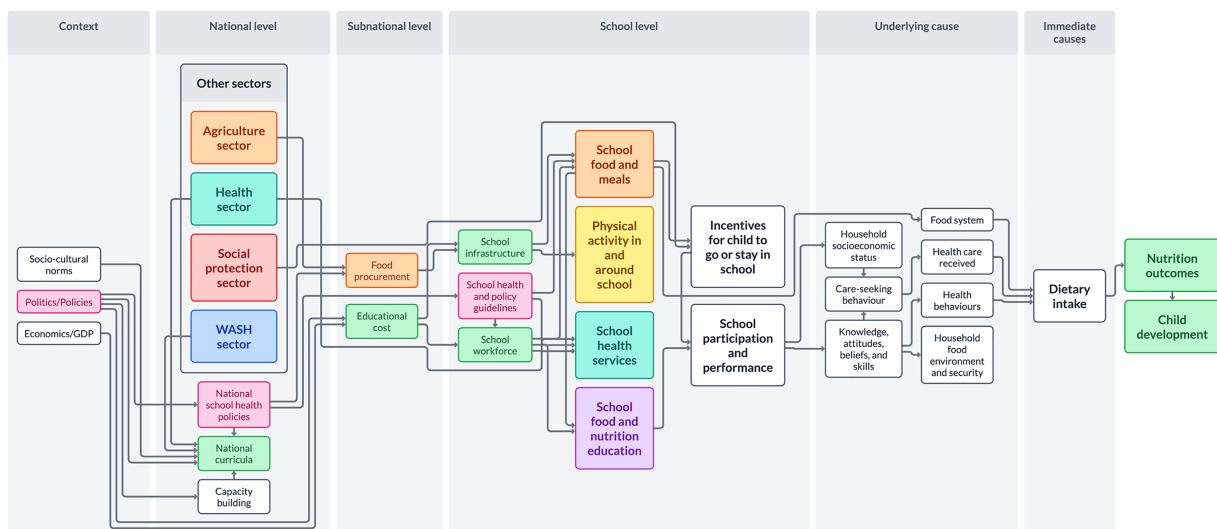
Similar mechanisms to organize, collaborate in the development of, or monitor school nutrition and health policy implementation through the creation of steering committees, advisory groups and school councils involving relevant stakeholders including parents exist in several countries (Global Child Nutrition Foundation, 2020; Masset & Gelli, 2013; Schwartzman et al., 2017; Soares et al., 2017).

Figure 5 summarizes how the major nutrition programming components presented above are interwoven and ultimately lead to improved nutrition outcomes.

## 4 | DISCUSSION

### 4.1 | Impact of school-based nutrition programs

Our review maps out the many ways of how the integration of nutrition into the education sector can benefit both nutritional and



**FIGURE 5** Program impact pathways of major nutrition components in the education sector. GDP, gross domestic product; WASH, water, sanitation, and hygiene



educational outcomes. School-based nutrition programs address child malnutrition in LMICs through (1) direct provision of foods that provides adequate calories and improve dietary quality, (2) improving nutrition knowledge and establishing behaviors conducive to better health outcomes, and (3) providing access to basic nutrition and health services. Additionally, food provision in school can have an impact on educational outcomes increasing school participation, enrollment, and performance through providing incentives and alleviating hunger and providing nutrients needed for development (Kumar & Rajagopalan, 2007; Levinger, 2005; McCoy, Zuilkowski, & Fink, 2015; Powell et al., 1998; Zenebe et al., 2018).

Furthermore, the delivery of nutrition interventions when well-designed can improve gender equity by keeping more girls in school. Ensuring that schools take into account the needs of vulnerable populations are also a key recommendation from the School as a System to Improve Nutrition report (UNSCN, 2017). Reaching and keeping girls in school can lead to (1) delayed marriage and pregnancy, which in turns prevent adolescent pregnancies that are associated with poor birth outcomes (Psaki, 2014), (2) mothers who have higher levels of education are more likely to feed and care for child appropriately (Ruel & Alderman, 2013), and (3) mothers who are educated are more likely to send their children (including their girls) to school (Ruel & Alderman, 2013). Children whose parents are better educated have better nutrition outcomes and are more likely to keep their children in school (Khanam, Nghiem, & Rahman, 2011; Neervoort et al., 2013). Therefore, from a life cycle perspective, food provision in schools serves as social protection for children and families and helps keep children in schools, which can have positive multi-generational impact.

Finally, at the community level, nutrition programming in the education sector can benefit the local agriculture workforce, who are commonly women through providing opportunities for income generation and autonomy. Women's empowerment through agriculture has been shown to improve child nutrition outcomes (Heckert, Olney, & Ruel, 2019).

## 4.2 | Gaps in existing research

From our review, the most under-studied nutrition programs in LMICs are (1) food marketing and information in schools, (2) physical education programs, and (3) nutrition and health education. While these programs are a part of the WHO School Health Policy framework, much of the evidence are from high-income countries (WHO, 2008). Limited literature on these topics can be explained by the fact that these are emerging topics in LMICs. However, given the fact that overweight and obesity is and has been rising rapidly in LMICs—particularly in urban settings—more research on leveraging the education sector to address this rising crisis is urgently required to inform effective program design for these settings.

Furthermore, research designs and methods on these topics must be improved. Due to the multicomponent nature of school-based programs, it is challenging to draw quantifiable associations to specific

intervention components and outcomes. We also did not identify any studies that evaluated long-term outcomes beyond 6 months of either nutrition status, nutrition knowledge, or education performance and outcomes, which hinges on cost-effectiveness studies.

Existing cost-effectiveness evaluation is limited to school feeding programs, and despite variable costs by country context, total benefits are generally positive (Bundy et al., 2018; Galloway et al., 2009; Gelli et al., 2011; Gelli & Daryanani, 2013; WFP, 2013). A more recent review by the World Bank also highlighted the combination of other school-based interventions such as health services including deworming, vaccines, and nutrient supplementation along with school-feeding programs increase the benefit–cost ratio (Bundy et al., 2018). There is also a large gap in cost evaluations for nutrition and health education programs as a result of lack of efficacy studies. Finally, the full range of benefits that extends beyond immediate child outcomes has yet to be studied.

## 4.3 | Key factors requiring attention for program success

Our review also illuminated some key factors identified from nutrition programs in various countries that were either program bottlenecks or enabling factors for success. These can serve as valuable lessons and also warrant further attention in research and program evaluation.

First, national level commitments to capacity building of experts in public health and nutrition enables the establishment school health policies that address context-specific nutrition concerns and allows for national funding and implementation guidance. It is therefore necessary to ensure that a pipeline for training these professionals is created and maintained.

Second, school meal and feeding programs must move beyond solely providing adequate calories, but also ensure nutritional quality of foods. This means adequate nutrients and diversity, guided by clear school nutrition standards and food purchasing and sourcing criteria. It also means investment in the identification and/or production of affordably priced nutritious food items. Lack of focus on hygienic food preparation and food safety practices in schools prompt increased the need for in-service training for food handling staff. Ensuring a streamlined food supply chain and distribution system is tied with parental confidence in school meal programs, which can be a particular challenge for rural schools most in need.

Third, nutrition and health curricula must be developed using a collaborative process and integration of nutrition and health topics into other basic subject matters. Qualified nutrition and health professionals provide relevant content, which is then packaged by education experts into culturally relevant and digestible teaching materials and plans to ensure engagement and effective learning among the targeted age group. This also includes adequate pre- or in-service training for education staff responsible teaching the material.

Fourth, community engagement—particularly the engagement of parents—must be fostered at all levels of implementation, both to

reflect the needs of the community in children's education and health and to extend impact and benefits of the program to the community while holding the implementing agency or office accountable.

Finally, several studies discuss the importance of a coordinating body or committee consisting of stakeholders from both the education sector and the nutrition and health sector that can articulate responsibilities of each player to ensure accountability and commitment—perhaps even share costs—at the national level (Masset & Gelli, 2013; Schwartzman et al., 2017; Soares et al., 2017; Studdert et al., 2004). Our review also emphasizes the role of other sectors, specifically the agriculture, health, WASH, and social protection sectors that are involved in various programs, as shown in the frameworks presented in Figures 5 and S1.

#### 4.4 | Global indicators for progress and accountability

There is a need for globally recognized frameworks of indicators for comprehensive school-based nutrition and health program to track progress and improve monitor and evaluation of implementation efforts. The WFP and the World Bank have collected country-level data on a set of high-level school feeding indicators and presented these results in two reviews (Drake, Woolnough, Burbano, & Bundy, 2016; WFP, 2013). The FRESH framework working group also proposed eight national-policy-level indicators to support monitoring and evaluation efforts (The FRESH M&E Coordinating Group, 2014). However, comprehensive standardized frameworks with detailed indicators at the school level of all school-based programs are limited (Gelli & Espejo, 2013). Recently, the Global Child Nutrition Foundation put out a 2019 Global Survey of School Meal Programs (Global Child Nutrition Foundation, 2020) which collected comprehensive, multi-sector data from more than 80 countries, and survey reports are expected to be issued later in 2020 (Global Child Nutrition Foundation, 2020). This in-depth, non-evaluative description of the school food situation should add significantly to the knowledge base and provide insights for further research.

#### 4.5 | School access, availability, emergencies, and its challenges

Despite the positive impacts the education sector can have, there are limitations to nutrition programs implemented in schools. For example, the ongoing COVID-19 pandemic has unfortunately caused mass disruption and closure of schools around the world (World Bank Group, 2020). It is estimated that 350 million children worldwide have lost their access to regular school feeding programs and nutrition services as a result (WFP/FAO/UNICEF, 2020). The current situation has put the importance of school feeding programs in high-needs settings under the spotlight. It also underscores that access and availability to schools is a key part of school-based nutrition and health interventions. It also challenges the global community to

develop emergency planning to ensure that programs retain their function to avoid exacerbating existing vulnerabilities in nutrition health and food security among populations most in need. The WFP, FAO, and UNICEF joint report has operational guidance to schools during the pandemic and suggested active distribution and delivery of school foods to those in need; expanding services to reach a larger population; innovative partnerships with postal services and local farmers; and securing food safety practices (WFP/FAO/UNICEF, 2020).

Concerns of accessibility, availability and attendance of schools are still common even outside of a global pandemic. In many LMICs, school-aged children spend less than half of their time on school grounds and do not attend school all year round. Some children attend split session with even less time spent at school. Attendance rates are still low, particularly in low-income environments, and too many children do not attend school at all. We believe this work can be helpful to policy makers and program implementers as they consider options for continuing to deliver important nutrition-related interventions to school-age children in a changed educational environment.

#### 4.6 | Study limitations

This study is not a systematic review of all existing literature. The quality of studies was not considered as an exclusion criterion as we aimed to highlight all program impact pathways currently found in the literature. The arrows linking various components in the program framework do not reflect direction or strength of association.

### 5 | CONCLUSION

Although malnutrition is an issue requiring the coordinated action of multiple sectors, the education sector has an important role to play in improving both immediate and long-term nutritional outcomes with generational and societal impact in LMICs. To carry forward current efforts in school nutrition programs, quality of program implementation from national to school levels must be enhanced with consideration of multi-sectoral collaboration, parental and community engagement, and gender equity.

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#### CONFLICTS OF INTEREST

The authors declare no conflicts of interest.

## CONTRIBUTIONS

YYX, SK, and TSL designed the analysis. YYX carried out the review of the literature. YYX, SK, and TSL developed the framework. AM reviewed a draft version of the framework. YYX and TSL wrote the first draft of the manuscript. TR, AM, and SK provided comments on the draft versions of the manuscript. All authors have reviewed and approve of the final version of the manuscript.

## DATA AVAILABILITY STATEMENT

Data sharing not applicable to this article as no datasets were generated or analyzed during the current study.

## ORCID

Yvonne Yiru Xu  <https://orcid.org/0000-0001-5078-0111>

Talata Sawadogo-Lewis  <https://orcid.org/0000-0002-0541-1859>

Shannon E. King  <https://orcid.org/0000-0001-9709-3562>

Timothy Roberton  <https://orcid.org/0000-0001-6413-2289>

## REFERENCES

- Abizari, A.-R., Buxton, C., Kwara, L., Mensah-Homiah, J., Armaklemesu, M., & Brouwer, I. D. (2014). School feeding contributes to micronutrient adequacy of Ghanaian schoolchildren. *British Journal of Nutrition*, 112(6), 1019–1033. <https://doi.org/10.1017/S0007114514001585>
- Adams, A. M., Ahmed, R., Latif, A. H. M. M., Rasheed, S., Das, S. K., Hasib, E., ... Faruque, A. S. G. (2017). Impact of fortified biscuits on micronutrient deficiencies among primary school children in Bangladesh. *PLOS One*, 12(4), e0174673. <https://doi.org/10.1371/journal.pone.0174673>
- Bezanson, K., & Isenman, P. (2010). Scaling up nutrition: A framework for action. *Food and Nutrition Bulletin*, 31(1), 178–186. <https://doi.org/10.1177/156482651003100118>
- Bhagwat, S., Sankar, R., Sachdeva, R., Joseph, L., & Sivaranjani (2014). Improving the nutrition quality of the school feeding program (mid-day meal) in India through fortification: A case study. *Asia Pac J Clin Nutr*, 23(Suppl 1), S12–S19. <https://doi.org/10.6133/apjcn.2014.23.s1.01>
- Bundy, D., Burbano, C., Grosh, M. E., Gelli, A., Juke, M., & Lesley, D. (2009). Rethinking school feeding: social safety nets, child development, and the education sector. The World Bank. <https://doi.org/10.1596/978-0-8213-7974-5>
- Bundy, D. A. P., de Silva, N., Horton, S., Jamison, D. T., & Patton, G. C. (2018). Re-Imagining School Feeding: A High-Return Investment in Human Capital and Local Economies. *Disease Control Priorities 3rd ed.*, 8. <https://www.wfp.org/publications/re-imagining-school-feeding-high-return-investment-human-capital-local-economies>
- Delisle, H. F., Receveur, O., Agueh, V., & Nishida, C. (2013). Pilot project of the Nutrition-Friendly School Initiative (NFSI) in Ouagadougou, Burkina Faso and Cotonou, Benin, in West Africa. In *Global health promotion*. UK: London, England: Sage. <https://doi.org/10.1177/1757975913476907>
- Drake, L., Woolnough, A., Burbano, C., & Bundy, D. (2016). *Global School Feeding Sourcebook: Lessons from 14 countries*. London, UK: Imperial College Press.
- El Harake, M., Kharroubi, S., Hamadeh, S., & Jomaa, L. (2018). Impact of a pilot school-based nutrition intervention on dietary knowledge, attitudes, behavior and nutritional status of Syrian refugee children in the Bekaa, Lebanon. *Nutrients*, 10(7), 913. <https://doi.org/10.3390/nu10070913>
- Esrey, S. A. (1996). Water, waste, and well-being: A multicountry study. *American Journal of Epidemiology*, 143(6), 608–623. <https://doi.org/10.1093/oxfordjournals.aje.a008791>
- FAO, & WFP. (2018). *Home-grown school feeding resource framework—Technical document*. Rome, Italy: The Food and Agriculture Organization & the World Food Programme.
- FAO, WFP, & UNICEF (2020). Interim guidance note: Mitigating the effects of the COVID-19 pandemic on food and nutrition of schoolchildren. <https://www.wfp.org/publications/mitigating-effects-covid-19-pandemic-food-and-nutrition-schoolchildren>
- Food and Agriculture Organization. (2019). *School food and nutrition framework*. Rome, Italy: The Food and Agriculture Organization.
- Galloway, R., Kristjansson, E., Gelli, A., Meir, U., Espejo, F., & Bundy, D. (2009). School feeding: Outcomes and costs. *Food and Nutrition Bulletin*, 30(2), 171–182. <https://doi.org/10.1177/15648265090300209>
- Gelli, A., Cavallero, A., Minervini, L., Mirabile, M., Molinas, L., & de la Mothe, M. R. (2011). New benchmarks for costs and cost-efficiency of school-based feeding programs in food-insecure areas. *Food and Nutrition Bulletin*, 32(4), 324–332. <https://doi.org/10.1177/156482651103200403>
- Gelli, A., & Daryanani, R. (2013). Are school feeding programs in low-income settings sustainable? Insights on the costs of school feeding compared with investments in primary education. *Food and Nutrition Bulletin*, 34(3), 310–317. <https://doi.org/10.1177/156482651303400303>
- Gelli, A., & Espejo, F. (2013). School feeding, moving from practice to policy: reflections on building sustainable monitoring and evaluation systems. *Public Health Nutrition*, 16(6), 995–999. <https://doi.org/10.1017/s1368980012003989>
- Global Child Nutrition Foundation. (2020). 2019 Global Survey of School Meal Programs.
- Hawkes, C., Ruel, M. T., Salm, L., Sinclair, B., & Branca, F. (2020). Double-duty actions: Seizing programme and policy opportunities to address malnutrition in all its forms. *The Lancet*, 395(10218), 142–155. [https://doi.org/10.1016/S0140-6736\(19\)32506-1](https://doi.org/10.1016/S0140-6736(19)32506-1)
- He F. J., Wu Y., Feng X.-X., Ma J., Ma Y., Wang H., ... MacGregor G. A. (2015). School based education programme to reduce salt intake in children and their families (School-EduSalt): cluster randomised controlled trial. *BMJ*, 350, (mar18 13), h770–h770. <https://doi.org/10.1136/bmj.h770>
- Heckert, J., Olney, D. K., & Ruel, M. T. (2019). Is women's empowerment a pathway to improving child nutrition outcomes in a nutrition-sensitive agriculture program?: Evidence from a randomized controlled trial in Burkina Faso. *Social Science & Medicine*, 233, 93–102. <https://doi.org/10.1016/j.socscimed.2019.05.016>
- Hennegan, J., & Montgomery, P. (2016). Do menstrual hygiene management interventions improve education and psychosocial outcomes for women and girls in low and middle income countries? A systematic review. *PLOS One*, 11(2), e0146985. <https://doi.org/10.1371/journal.pone.0146985>
- IFPRI. (2011). *Working multisectorally in nutrition principles, practices, and case studies*. Washington, DC: International Food Policy Research Institute. <https://doi.org/10.2499/9780896291812>
- Kafatos, I., Peponaras, A., Linardakis, M., & Kafatos, A. (2004). Nutrition education and Mediterranean diet: Exploring the teaching process of a school-based nutrition and media education project in Cretan primary schools. *Public Health Nutrition*, 7(7), 969–975. <https://doi.org/10.1079/PHN2004565>
- Khanam, R., Nghiem, H. S., & Rahman, M. M. (2011). The impact of childhood malnutrition on schooling: Evidence from Bangladesh. *Journal of Biosocial Science*, 43(4), 437–451. <https://doi.org/10.1017/S0021932011000149>
- Khandelwal, S., Dayal, R., Jha, M., Zodpey, S., & Reddy, K. S. (2012). Mapping of nutrition teaching and training initiatives in India: The need for

- Public Health Nutrition. *Public Health Nutrition*, 15(11), 2020–2025. <https://doi.org/10.1017/S1368980011003016>
- Knoblauch, A. M., Utzinger, J., Cissé, G., Leuenberger, A., Diabougba, S., Tarnagda, G., ... Schindler, C. (2017). School children's intestinal parasite and nutritional status one year after complementary school garden, nutrition, water, sanitation, and hygiene interventions in Burkina Faso. *The American Journal of Tropical Medicine and Hygiene*, 97(3), 904–913. <https://doi.org/10.4269/ajtmh.16-0964>
- Kumar, M. V., & Rajagopalan, S. (2007). Multiple micronutrient fortification of salt and its effect on cognition in Chennai school children. *Asia Pacific Journal of Clinical Nutrition*, 16(3), 505–511.
- Kupolati, M. D., Gericke, G. J., MacIntyre, U. E., Ferreira, R., Fraser, W., & Du Toit, P. (2016). Nutrition education practices of primary school teachers in a resource-constrained community in Gauteng, South Africa. *Ecology of Food and Nutrition*, 55(3), 279–291. <https://doi.org/10.1080/03670244.2016.1161615>
- Levinger, B. (2005). School Feeding, School Reform, and Food Security: Connecting the Dots. *Food and Nutrition Bulletin*, 26, (2\_suppl2), S170–S178. <https://doi.org/10.1177/15648265050262s207>
- Masset, E., & Gelli, A. (2013). Improving community development by linking agriculture, nutrition and education: Design of a randomised trial of “home-grown” school feeding in Mali. *Trials*, 14(1), 55. <https://doi.org/10.1186/1745-6215-14-55>
- Mbhatsani, V. H., Mbhenyane, X. G., & Mabapa, S. N. (2017). Development and Implementation of nutrition education on dietary diversification for primary school children. *Ecology of Food and Nutrition*, 56(6), 449–461. <https://doi.org/10.1080/03670244.2017.1366319>
- McCoy, D. C., Zuilkowski, S. S., & Fink, G. (2015). Poverty, physical stature, and cognitive skills: Mechanisms underlying children's school enrollment in Zambia. *Developmental Psychology*, 51(5), 600–614. <https://doi.org/10.1037/a0038924>
- Monse, B., Benzian, H., Naliponguit, E., Belizario, V., Schratz, A., & van Palenstein Helderma, W. (2013). The fit for school health outcome study—A longitudinal survey to assess health impacts of an integrated school health programme in the Philippines. *BMC Public Health*, 13(1), 256. <https://doi.org/10.1186/1471-2458-13-256>
- Neervoort, F., von Rosenstiel, I., Bongers, K., Demetriades, M., Shacola, M., & Wolffers, I. (2013). Effect of a school feeding programme on nutritional status and anaemia in an urban slum: A preliminary evaluation in Kenya. *Journal of Tropical Pediatrics*, 59(3), 165–174. <https://doi.org/10.1093/tropej/fms070>
- Nkhoma, O. W. W., Duffy, M. E., Cory-Slechta, D. A., Davidson, P. W., McSorley, E. M., Strain, J. J., & O'Brien, G. M. (2013). Early-stage primary school children attending a school in the Malawian School Feeding Program (SFP) have better reversal learning and lean muscle mass growth than those attending a non-SFP school. *The Journal of Nutrition*, 143(8), 1324–1330. <https://doi.org/10.3945/jn.112.171280>
- Nugent, R., Levin, C., Hale, J., & Hutchinson, B. (2020). Economic effects of the double burden of malnutrition. *The Lancet*, 395(10218), 156–164. [https://doi.org/10.1016/S0140-6736\(19\)32473-0](https://doi.org/10.1016/S0140-6736(19)32473-0)
- Pickering, A. J., Null, C., Winch, P. J., Mangwadu, G., Arnold, B. F., Prendergast, A. J., ... Humphrey, J. H. (2019). The WASH benefits and SHINE trials: Interpretation of WASH intervention effects on linear growth and diarrhoea. *The Lancet Global Health*, 7(8), e1139–e1146. [https://doi.org/10.1016/S2214-109X\(19\)30268-2](https://doi.org/10.1016/S2214-109X(19)30268-2)
- Powell, C. A., Walker, S. P., Chang, S. M., & Grantham-McGregor, S. M. (1998). Nutrition and education: A randomized trial of the effects of breakfast in rural primary school children. *The American Journal of Clinical Nutrition*, 68(4), 873–879. <https://doi.org/10.1093/ajcn/68.4.873>
- Psaki, S. (2014). Addressing early marriage and adolescent pregnancy as a barrier to gender parity and equality in education. Background paper for the 2015 UNESCO Education for All Global Monitoring Report. Population Council: New York.
- Rangel, C. N., Nunn, R., Dysarz, F., Silva, E., & Fonseca, A. B. (2014). Teaching and learning about food and nutrition through science education in Brazilian schools: An intersection of knowledge. *Ciência & Saúde Coletiva*, 19(9), 3915–3924. <https://doi.org/10.1590/1413-81232014199.12552013>
- Rathi, N., Riddell, L., & Worsley, A. (2018). Barriers to nutrition promotion in private secondary schools in Kolkata, India: Perspectives of parents and teachers. *International Journal of Environmental Research and Public Health*, 15(6), 1139. <https://doi.org/10.3390/ijerph15061139>
- Rosário, R., Araújo, A., Padrão, P., Lopes, O., Moreira, A., Pereira, B., & Moreira, P. (2017). Health Promotion Intervention to Improve Diet Quality in Children. *Health Promotion Practice*, 18, (2), 253–262. <https://doi.org/10.1177/1524839916634096>
- Ruel, M. T., & Alderman, H. (2013). Nutrition-sensitive interventions and programmes: How can they help to accelerate progress in improving maternal and child nutrition? *The Lancet*, 382(9891), 536–551. [https://doi.org/10.1016/S0140-6736\(13\)60843-0](https://doi.org/10.1016/S0140-6736(13)60843-0)
- Schwartzman, F., Mora, C. A. R., Bogus, C. M., & Villar, B. S. (2017). Antecedentes e elementos da vinculação do programa de alimentação escolar do Brasil com a agricultura familiar. *Cadernos de Saúde Pública*, 33(12). <https://doi.org/10.1590/0102-311x00099816>
- Sibanyoni, J. J., & Tabit, F. T. (2017). Assessing the food safety attitudes and awareness of managers of school feeding programmes in Mpumalanga, South Africa. *Journal of Community Health*, 42(4), 664–673. <https://doi.org/10.1007/s10900-016-0303-6>
- Soares, P., Davó-Blanes, M. C., Martinelli, S. S., Melgarejo, L., & Cavalli, S. B. (2017). The effect of new purchase criteria on food procurement for the Brazilian school feeding program. *Appetite*, 108, 288–294. <https://doi.org/10.1016/j.appet.2016.10.016>
- Studdert, L. J., Soekirman, Rasmussen, K. M., & Habicht, J.-P. (2004). Community-based school feeding during Indonesia's economic crisis: Implementation, benefits, and sustainability. *Food and Nutrition Bulletin*, 25(2), 156–165. <https://doi.org/10.1177/156482650402500208>
- Tamiru, D., Argaw, A., Gerbaba, M., Ayana, G., Nigussie, A., & Belachew, T. (2017). Effect of integrated school-based nutrition education on optimal dietary practices and nutritional status of school adolescents in Southwest of Ethiopia: A quasi-experimental study. *International Journal of Adolescent Medicine and Health*, 29(6). <https://doi.org/10.1515/ijamh-2016-0015>
- The FRESH M&E Coordinating Group. (2014). Monitoring and Evaluation Guidance for School Health Program. [https://hivhealthclearinghouse.unesco.org/sites/default/files/resources/FRESH\\_M%26E\\_CORE\\_INDICATORS.pdf](https://hivhealthclearinghouse.unesco.org/sites/default/files/resources/FRESH_M%26E_CORE_INDICATORS.pdf)
- The World Bank. (2000). Focusing resources on effective school health: A FRESH start to enhancing the quality and equity of education (No. 23026). The World Bank. Retrieved from The World Bank website: <http://documents.worldbank.org/curated/en/722511468740994206/Focusing-resources-on-effective-school-health-a-FRESH-start-to-enhancing-the-quality-and-equity-of-education;jsessionid=CgEmr6gHG-jOMD9mE7wtYmZ>
- The World Bank. (2013). Improving nutrition through multisectoral approaches. <http://documents.worldbank.org/curated/en/2013/01/17211210/improving-nutrition-through-multisectoral-approaches>
- Torlesse, H., Cronin, A. A., Sebayang, S. K., & Nandy, R. (2016). Determinants of stunting in Indonesian children: Evidence from a cross-sectional survey indicate a prominent role for the water, sanitation and hygiene sector in stunting reduction. *BMC Public Health*, 16(1), 669. <https://doi.org/10.1186/s12889-016-3339-8>
- Torres, I., & Benn, J. (2017). The rural school meal as a site for learning about food. *Appetite*, 117, 29–39. <https://doi.org/10.1016/j.appet.2017.05.055>
- UNSCN. (2017). School as a system to improve nutrition—A new statement for school-based food and nutrition interventions.
- Victora, C. G., Adair, L., Fall, C., Hallal, P. C., Martorell, R., Richter, L., & Sachdev, H. S. (2008). Maternal and child undernutrition: Consequences for adult health and human capital. *The Lancet*, 371(9609), 340–357. [https://doi.org/10.1016/S0140-6736\(07\)61692-4](https://doi.org/10.1016/S0140-6736(07)61692-4)

- Walker, S. P., Powell, C. A., Hutchinson, S. E., Chang, S. M., & Grantham-McGregor, S. M. (1998). Schoolchildren's diets and participation in school feeding programmes in Jamaica. *Public Health Nutrition*, 1(1), 43–49. <https://doi.org/10.1079/PHN19980007>
- World Bank Group. (2020). The Covid-19 pandemic: Shocks to education and policy responses. The World Bank Group.
- World Food Program. (2013). State of school feeding worldwide. World Food Program.
- World Health Organization. (2006). Report of the brainstorming meeting on the development of a framework on the Nutrition Friendly School Initiative. Montreux, Switzerland: Geneva, Switzerland: WHO.
- World Health Organization. (2008). WHO School policy framework. World Health Organization. Retrieved from <https://www.who.int/dietphysicalactivity/schools/en/> (Original work published)
- Zenebe, M., Gebremedhin, S., Henry, C. J., & Regassa, N. (2018). School feeding program has resulted in improved dietary diversity, nutritional

status and class attendance of school children. *Italian Journal of Pediatrics*, 44(1), 16. <https://doi.org/10.1186/s13052-018-0449-1>

#### SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section at the end of this article.

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