

Are school meals a viable and sustainable tool to improve the healthiness and sustainability of children's diet and food consumption? A cross-national comparative perspective

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Abstract

There is little agreement among governments, institutions, scientists and food activists as to how to best tackle the challenging issues of health and sustainability in the food sector. This essay discusses the potential of school meals as a platform to promote healthy and sustainable food behavior. School meal programs are of particular interest for improving public diet because they reach children at a population scale across socio-economic classes and for over a decade of their lives, and because food habits of children are more malleable than those of adults. Current research on the history and health implications of school meal programs is reviewed in a cross-national comparative framework, and arguments explored that speak for the need of a new developmental phase of school meals as an integrative learning platform for healthy and sustainable food behavior. Nutritional, social, practical, educational, economical, political, and cultural perspectives and challenges linked to the implementation of healthy and sustainable school meals are discussed. Finally, the need for long-term interventions and evaluations is highlighted and new research directions are proposed.

Keywords: school meals; food behavior, health, sustainability; learning; children

Introduction: Complex challenges for health and sustainability

Humanity is facing a great challenge with regard to food: it is expected that by 2050, 9 billion people will need to be adequately nourished. It is not clear whether this requirement can be met without severe damage to the environment (Godfray et al., 2010). The world faces somewhat opposite problems: 1) an increase in obesity in emerging and developed countries (Caballero, 2011), and 2) continued food scarcity and malnutrition in developing countries. The reduction of obesity and malnutrition are complex challenges. This essay explores whether pursuing these goals may be aided by the careful promotion of school lunch programs.

A persistent challenge facing obesity-reduction efforts is the excessive availability and consumption of food and an unbalanced composition of diets. During the United Nations (UN) public health meeting in 2011, no UN member states showed major progress in the reduction of obesity (Swinburn et al., 2011). Major areas of concern are the high intake of energy, fat, and sugar-sweetened beverages and low intake of fiber, fruits, and vegetables. This consumption pattern is associated with weight gain in both children and adults (Hays et al., 2002; Veltsista et al., 2009). The availability of snacks and drinks sold in schools is related to higher intakes of total calories, soft drinks and fat, and lower intakes of fruit, vegetables, milk, and key nutrients (Story et al., 2009).

The challenges of sustainability rest in providing high-quality foods in sufficient quantities for current generations while preserving the resources needed globally to enable future generations to do the same. Of special global concern are biodiversity loss, climate change, and imbalances of the nitrogen and phosphorus cycle (Rockström et al., 2009). Food production contributes significantly to these problems, especially via food loss and waste, fresh water usage, and greenhouse gas emissions in farming (especially meat production), and through food processing and transportation over long distances (especially air freight) (Carlsson-Kanyama and Gonzalez, 2009; Garnett, 2011; Reisch et al., 2013). Consumers contribute to these problems through their daily food and nutrition choices, often opting for low-priced and foods with a high environmental impact, and wasting a share of the purchased foods.

The aim of this essay is to highlight relevant research on the history and health implications of school meal programs in a cross-national comparative framework. Specifically, it aims to discuss the current role of school meals as a tool for improving food behaviors and population health in a sustainable way, and to describe challenges and opportunities for further expanding the role of school meals for the development of healthy and sustainable eating behavior. School meal programs are of particular interest as a focus for health improvement because of the time devoted to eating in schools, the potential to form new food habits in schools and the importance of the school social environment as a means of promoting changes in food choice. School meals are a more centralized activity than family meals, and interventions at schools can attempt to uniformly influence the food behaviors of many children simultaneously. In addition, school meals tend to cut across socio-economic classes in a country, at least for younger children, and habits of children are more malleable than those of adults (see Birch, 1999, and Rozin, 2007, for reviews on development of food preferences and general introduction to food choices). This essay does not aim to give a full overview of the existing literature or to provide a systematic review. Rather, it aims to highlight and integrate results from recent relevant

studies, reviews, and policy papers that provide insight into the potential role of school meals as a viable and sustainable tool to improve healthy diet among children.

School meals in the past, present and future

A school meal is defined here as a meal provided to children by the school, though it may be partially funded by the parents. School meals are often lunch, but also include some breakfast programs, as well as one-commodity programs such as school milk or school fruit programs. For example, children in the US who participate in the National school lunch program may consume up to 40% of their daily calories at school (Briefel et al., 2009). Figure 1 provides an illustrative overview of a range of current school meal programs around the world.

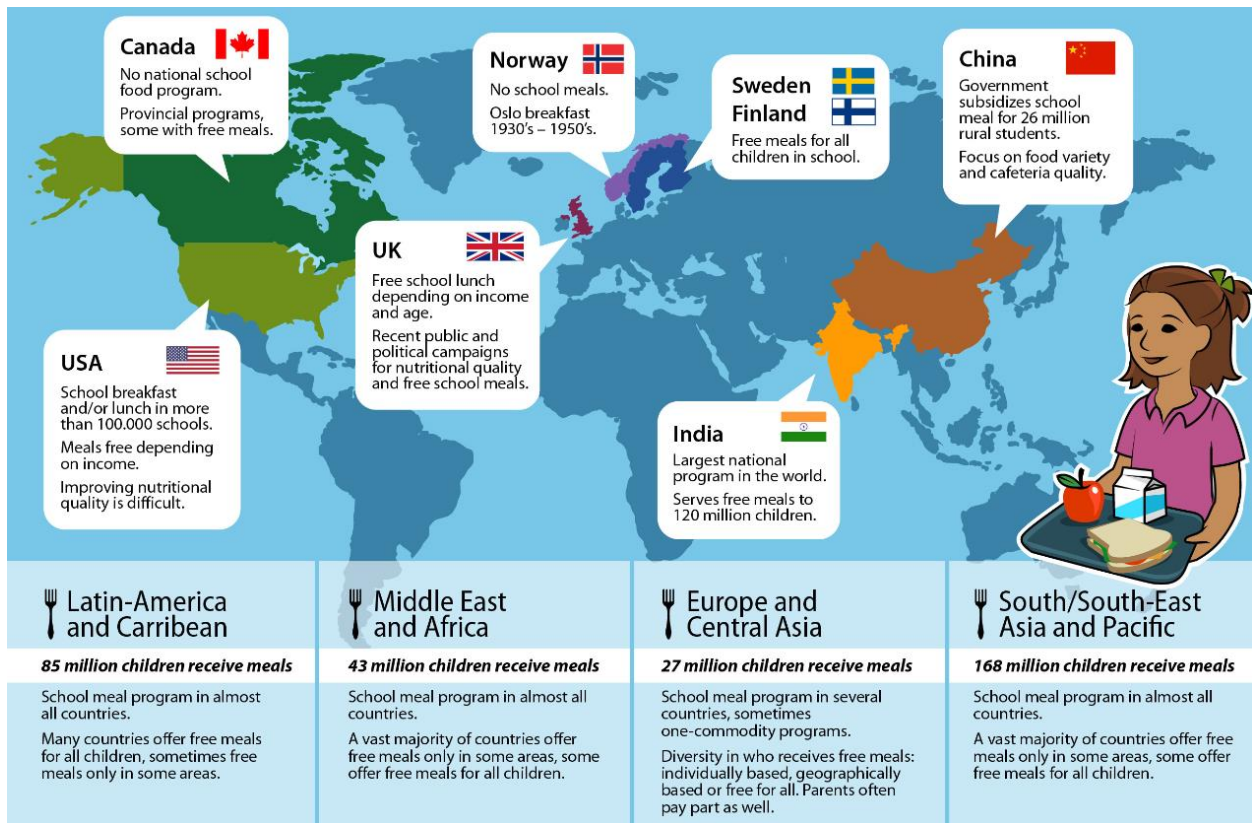


Figure 1 School meals around the world. This map provides a summary of current school meal programs (boxes), and highlights a few countries that are mentioned in this paper (text balloon). Data on children served is extracted from WFP 2013.

In general, school meals were (or, in developing countries, are) initiated to alleviate food insecurity among children. In the US, preventing hunger pangs and nervousness related to hunger was a key objective of school meal programs in times of scarcity (Pollitt et al., 1978). In the UK, school meals were considered a matter of national safety, as army recruits tended to be too short and underweight (Levine, 2008). With obesity levels rising globally in recent years, the aim of school meals has changed in the UK and US, and may change elsewhere depending on the situation and priorities in each country (Ng et al., 2014).

Alleviating undernourishment remains a principal aim for developing countries. The World Bank defines the aim of school meal programs in developing countries as “targeted social safety nets that provide both educational and health benefits to the most vulnerable children, thereby increasing enrolment rates, reducing absenteeism, and improving food security at the household level” (World Food Program, 2013; 2015). As local governments often lack the funding to support school meal programs in developing countries, such programs typically start with funding from organizations such as the World Bank (crisis response fund since 2008) or the UN World Food Programme (established in 1961). Ultimately, the aim is to have these programs funded and implemented by the local government (Bundy, 2009). As of 2011, 70 low and low-to-middle income countries had school meal programs (Jomaa et al., 2011), with over 368 million children in all ages being fed at schools worldwide (World Food Program, 2013). The focus of school meals in developed countries has changed over time. A review of the history of school meals to date suggests that meals can be described by two distinct phases of school meal programs in developed countries, with signs of the emergence of a third phase.

Phase I: The establishment of food welfare programs

The first phase, between roughly 1850 and 1950, is primarily defined by the public need to provide sufficient food energy to lower socioeconomic groups. Food security takes priority during this phase, accepting meals high in fat and simple sugars as appropriate and high quality. In parallel with addressing this public need, modern food production and industries in Europe became established, starting around 1860 (Oddy, 2013). Until then, food trades were local, dispersed, and used traditional processes. Following the Second World War food production became more intensive and industrialized, which resulted in a food production surplus. Over time, school meals became an outlet for this surplus (Levine, 2008). This production development reduced the problem of food security, as countries either could produce enough energy per capita or had a strong enough economy to import sufficient amounts of food.

Phase II: A shift towards food quality

Changes in food production during Phase I allowed the focus of school meal programs to shift from food security to food quality in Phase II. In developed countries, this phase emerged around 1970 as a response to increased prevalence of lifestyle diseases resulting from the food production efficiency of Phase I. Obesity among pupils became apparent. Politicians, advised by nutritionists, issued national guidelines to improve nutrition for the general population. These guidelines included a focus on providing more micronutrients per kilocalorie of food and a reduction of energy levels, and have been implemented in school meals in several countries. For example, Finland and France released food quality guidelines for school meals during the 1970s (Pietinen et al., 2010; Hercberg et al., 2008). In contrast, the UK and US did not begin to adapt the national dietary guidelines into school meals until the 1990s and 2000s, with major improvements being made in the 2010s (Caraher et al., 2009; U.S. Department of Agriculture and U.S. Department of Health and Human Services, 2010; Department of Education, 2014). This second phase continues today.

Phase III: Integrating health and sustainability concerns into school meal programs

To date, a focus on food quality during Phase II has been inadequate to resolve the current societal and individual challenges of the reduction of obesity and malnutrition in a sustainable food context. In contrast, the focus in Phase III is upon prioritizing community and societal

impacts of food- and food-related school meal activities. A shift towards this phase is already observable. The following sections discuss: 1) how current school programs in developed countries contribute to improved public health and sustainability; 2) how school meals can further be used as a tool to promote healthy and sustainable food habits, and 3) gaps in evaluating the impact of school meal programs and integrating lessons learned into a sustainability framework.

How are school meals associated with child health and sustainability?

Child health

In developing countries and developed countries where some households are food insecure, school meal programs are primarily aimed at preventing children's undernutrition. When current high-income countries were in a developing phase (Phase I), school meal programs showed positive effects of reducing undernutrition. During the late 19th century, Britain implemented school meals as a means to solve an education issue since teachers observed that undernourished children had difficulties focusing and retaining information (Passmore and Harris, 2004). It has since been documented that severe clinical undernutrition in early childhood is associated with poor cognitive development, behavior problems, and academic performance in later childhood (Grantham-McGregor, 2005). The main success of these school meal programs emerges from the stark difference between children having nearly no food at all, to then receiving sufficient nutrition. Though extensive evaluations of such programs are not available for every country, positive effects on hunger alleviation and improved nutritional quality have been reported as far afield as Bangladesh (Akhter, 2004) and rural China (Education Management Information Center of the Ministry of Education, 2012). A 2007 review of the impact of school meal programs on the physical health of disadvantaged children in developing countries found that, while such programs in low and middle-income countries significantly improve growth and performance among children, programs in higher income countries produce mixed results as countries shift from under- to overnutrition (Kristjansson et al., 2007; Greenhalgh et al., 2007).

Research has investigated whether school meals and policies that govern school meals improve children's nutrition-related health status with respect to reducing children's overweight and obesity rates (Capacci et al., 2012; Chriqui et al., 2014; Jaime and Lock, 2009; Harper and Wells, 2007). In the EU, most school food programs aim to teach children a healthy diet and lifestyle and have policies in place to improve nutritional quality (Storcksdieck gennant Bonsmann et al., 2014). However, in general a lack of program evaluation and measured health parameters such as weight or disease status hinders inferences regarding the effects of school meals on health. A rare systematic review of forty-two interventions to promote healthy diet and obesity prevention provided some insight here (Van Cauwenberghe et al., 2009). Among European children, investigators found strong evidence that multi-component interventions (e.g. food availability, education curriculum integration, and parent involvement) had relatively strong effects on dietary improvements among children, but limited effects among adolescents. Evidence was inconclusive or lacking in terms of effects of interventions on youth anthropometric measures. Another US study recently found that students in schools with stricter nutritional guidelines than those given by the US Department of Agriculture had reduced BMI (Taber et al., 2013).

Instead of program evaluations, studies typically report on indicators such as change in foods sales and intake of certain unfavorable and favorable foods, and several high-quality systematic reviews provide insight here. For example, a 2009 systematic review of 18 studies found that availability and intake of healthier options (often fruit and vegetables) were effectively altered through the introduction of school based food and nutrition policies (Jaime and Lock, 2009). Studies gave most attention to the effect of providing dietary guidelines on school meals, and to the availability of fruit and vegetables and provision of lower-fat meals and snacks. The majority of studies reviewed showed positive changes: decrease of total and saturated fat in foods offered in school meals, and increases of fruit and vegetable availability as well as intake. A different review of 30 studies examining the effectiveness of interventions to promote fruit and/or vegetable consumption in children in schools showed that 70 percent of the interventions increased intake (De Sa and Lock, 2008), and this increased intake seems to be maintained in the long term. However, a more recent meta-analysis using advanced analysis techniques quantified the impact of school-based interventions on fruit and vegetable intake (Evans, et al. 2012). Improvement in intake was mostly seen in fruit, with minimal improvement in vegetable intake. As with other scientific domains, it is likely that school meal interventions with less favorable results exist, but are never published due to publication biases towards positive results.

School meals allow for greater control over the nutrients provided to and consumed by pupils. A UK study of the effects of school meal programs on diet quality examined nutrient and micronutrient intake before and after introduction of new UK nutrition standards in 2006, finding improvement in diet quality among children eating school lunches (Spence et al., 2013). In the EATWELL project (EU), for example, the aim was to evaluate healthy eating policies (such as nutrient labelling and food education or financial changes). Effect measures of the policies turned out to be of poor quality and not harmonised, which made it difficult to compare results (Pérez-Cueto et al., 2011). Nevertheless, healthy eating policy has been found to be associated with healthy food intake (Greenhalgh et al., 2007), and improved nutritional guidelines for school meals with increased fruit and vegetable selection and consumption (Cohen et al., 2014).

Another way to examine the impact of school food intake with an eye towards possible health consequences is to compare the nutritional quality of packed lunches brought from home with the quality of school-provided meals. A review of seven British studies measuring lunchtime nutrient intake among children aged 5-11 years showed that the nutritional quality of packed lunches in England is poor compared to school-provided meals (Evans et al., 2010). More specifically, energy, sugar, saturated fat, and salt content were higher in packed lunches. In the US, home-brought lunches compared unfavorably with the National School Lunch Program guidelines regarding salt, fruits, vegetables, whole grains and milk content (Caruso and Cullen, 2015).

Longitudinal studies of the relationship between interventions that change school meal composition with health indicators (e.g. BMI, physical activity, and Type 2 diabetes) are still largely missing. A recent study showed that a nutritionally balanced school meal (rich in fibers, vegetables, fish) had positive effects on blood pressure and blood parameters, but at the same time increased BMI slightly (0.03 kg/m^2 , Damsgaard et al., 2014), indicating that a broad range of health parameters should be evaluated at the same time. In addition, parameters such as

depression, anxiety, stress, and dropping out of school should also be taken into consideration when evaluating the implications of school meals on health. .

Nevertheless, the impact of school food is not always positive. A unique study of the US national school lunch program between 1946 and 2013 found that among the entire adult group of 18-64 year olds, school lunch consumption was related to an increased subsequent prevalence of overweight and obesity (Peterson, 2013). However, the effect was not consistent for all different age cohorts within the studied population, possibly owing to secular trends in eating habits and changing national nutrition policies that spanned both Phase I and II of school meal program development.

In sum, although food provided at school can have a strong influence on children's consumption of calories and key nutrients, there is little evidence from developed countries that school food and school food policies significantly improve children's and subsequently adults' physical health status or eating habits. Current barriers to gathering this evidence include a lack of evaluation of both food intake and health indicators, difficulty in implementing randomized study designs, difficulty inferring causal effects from observational (i.e. non-randomized) study designs, and a paucity of interventions that have been sustained over many years.

Sustainability and school meals

Sustainability is not an overarching aim of school meals, but more a condition that may or may not be desired or prioritized by the different stakeholders. It is therefore not easy to answer the question "Do school meals contribute to sustainability?" This will depend on the logistics of the school meal (what foods are served, do these foods have a large carbon footprint, where are the products sourced, did they have to be transported over long distances, are the foods organic, and so forth), as well as consumer behavior (e.g. wasting food) (Nielsen et al., 2009; Løes and Nölting, 2011). As an example, a significant amount of food served in school meals is wasted (12 percent of all calories on the plate on average, with the largest share in vegetables) (Guthrie and Buzby, 2002; Smith and Cunningham-Sabo, 2014). The exact amount wasted may depend on the quality and the palatability of the food, and will need to be compared to food waste by children who do not participate in school meals. School meals may thus not presently directly contribute to this particular element of sustainability.

Matters become more complicated when taking into account the entire food supply chain. The US school lunch program includes usage of nationally produced surplus foods in school meals (see section '*How might implementation challenges be handled*'). This is in principle a resource-efficient practice and preferred over food wastage, and a certain share of food surplus is important for food security (Godfray et al., 2010). However, a high share of production of foods in surplus is not sustainable, and the related intensification of food production uses increased energy and water. Life cycle analyses have been useful in such cases to show the full impact of general food production on the environment (Roy et al., 2009). In some cases, conventional products are actually shown to have less of an environmental impact than locally sourced products (Coley et al., 2009).

An additional issue is that sustainability goals may clash with health goals. Healthier commodities may not be available in sufficient quantities in the local environment and may have to be sourced from distant places. Surplus commodities may not be optimal from a nutritional point of view, but need to be included in school meals for sustainability reasons (Levine, 2008). Children may be motivated to not waste food by finishing the food on their plate, yet this may result in overconsumption (Guthrie and Buzby, 2002). These issues make sustainable food choice and human health two preferred outcomes of school meals that may overlap or clash depending on the context. Opting for organic food might be regarded as a win-win solution as it is expected to allow both improved environmental impact and improved nutritional effects. However, while there is indication for the first (Reganold and Wachter, 2016), the latter is not proven (Smith-Spangler et al., 2012): rather, consumers eating healthy are the ones that choose organic foods more often, but organic consumption does not necessarily result in healthy diets (Kesse-Guyot et al., 2013). Nevertheless, there are indications that the adoption of organic food in schools might have effects on pupil's awareness of healthy eating and habits (He et al., 2012), and coordinators of schools with organic food are more likely engaged in an overall health policy (He et al., 2014).

Despite the complexity of providing healthy, sustainably produced foods, there is a growing interest in improving sustainability within school meal programs. This interest has resulted in several approaches, many of which are focused on improving the food quality in schools. Improvement of food quality has a nutritional aspect, but is also linked to improved sustainability, with less food waste and often an increase in locally sourced and organic food products, where better nutritional quality is assumed (though not proven). Such approaches require an entire-school, and possibly an entire-community approach in order to be effective and financially sustainable (Vallianatos et al., 2004). The community can be engaged to supply and serve the foods at school, and increases local engagement of farmers, schools, children, parents, and local policy makers. Increased local implementation of school meals is accompanied with neo-liberalization of economy and food chains (Morgan and Sonnino, 2008). Farm-to-school is a particular example of local implementation of school meals, with procurement of local and seasonal products that are promoted and served in cafeterias or in taste-tests (though availability will strongly depend on geographic location and season), and can include educational activities and school gardens. Farm-to-school programs, many of which are in the US and Canada, have been linked to improved sustainability in the entire community, with a reduction in food waste and reduced transporting of food products, but also increased economic support for local farmers, and increased food security for low-income areas (Bagdonis et al., 2009; Rojas, 2011; Vallianatos et al., 2004). These programs are also linked to healthier food consumption in low-income areas and an increase in knowledge about agriculture (Jones et al., 2012; Joshi et al., 2008). There needs to be, however, a sufficient logistics network to be able to (cost-) efficiently implement such approaches.

Farm-to-school models can, depending on the location, also include a component of experiential education in the form of school gardens. School garden approaches, such as the well-known Edible Schoolyard program that originally began in Berkeley, California, have been credited with increased sustainable attitudes and ecological understanding of pupils who participate in the gardening. This in turn may result in increased fruit and vegetable intake (Blair, 2009) and positive youth development (Ozer, 2007). Such programs can be expensive

and their cost-effectiveness should be evaluated. Approaches may also allow promoting fruit and vegetables that are organic, or fruit and vegetables that are nutritious, but not optimal in colour and shape (Stone, 2007). While student participation in gardening or farm activities has the potential to affect individual behavior, it is important to match classroom teaching with the teaching in the gardening activities in an integrative approach. This is necessary in order to achieve the potential role of school meals to tackle challenges in health and sustainability in Phase III of the development of school meals.

Box 1 School meals as a tool to improve welfare

Although food in general is plentiful in developed countries, school meals are still regarded as a safety net for many children from food insecure and low-income families who are at risk for poor nutritional intake (Alaimo et al., 2011). School meal programs provide opportunities for improvement of the nutritional quality of the diet, either in total energy, compensating for suboptimal foods consumed outside of school meals, and compared to packed lunches from home (Bartfeld and Ahn, 2011; Pilant, 2006; Stevens and Nelson, 2011). Two nation-wide school meal programs in the US – The National School Lunch Program and the School Breakfast Program – are associated with reduced prevalence of nutrient inadequacy among schoolchildren: energy intake is on average 130 kcal higher for School Lunch participants, and intake of magnesium, phosphorus and calcium is more often adequate in School Lunch participants than non-participants (Clark and Fox, 2009). However, school meal participation is also associated with being overweight (through various socio-economic factors) and being nutritionally vulnerable (Kratze et al., 2015). Many of the children participating in these programs receive the meal for free or at a reduced price because they were from low-income families.

However, in some school meal programs, for example in the Free School Meal program in the UK (Kitchen et al., 2010), the percentage of participating children is low: 29 percent of 1.4 million eligible children do not participate (Holford, 2015). This may be associated to their aim of targeting low income children: the charitable program was reported to be considered stigmatizing and embarrassing (Ridge, 2011). In Canada, charitable food programs were also not as well received as intended, with parental resistance to sending children to charitable school food programs in fear of stigmatization of poverty in Canada (Raine et al., 2003; Krikpatrick and Tarasuk, 2009). Free or reduced-price school meals release the financial burden for low-income families, but stigmatization is a general issue that needs to be dealt with when segmenting school meal programs based on the child's financial background. Individualized electronic payment cards, which would be based on the family income but keep this information hidden from other students, is one solution that has been mentioned as an approach to fight the stigmatization around free school meals (Morgan and Sonnino, 2008).

How might school meals contribute to health improvement in a more sustainable way?

School meal programs contribute to teaching children the culinary heritage and norms around consumption, sustainability, and health in their resident country, and they can create a social and physical learning environment around food that may help to tackle current challenges in health and sustainability. In particular, approaches to food education, the school social environment, and the food environment, intersect with school meal programs in important ways (Figure 2).

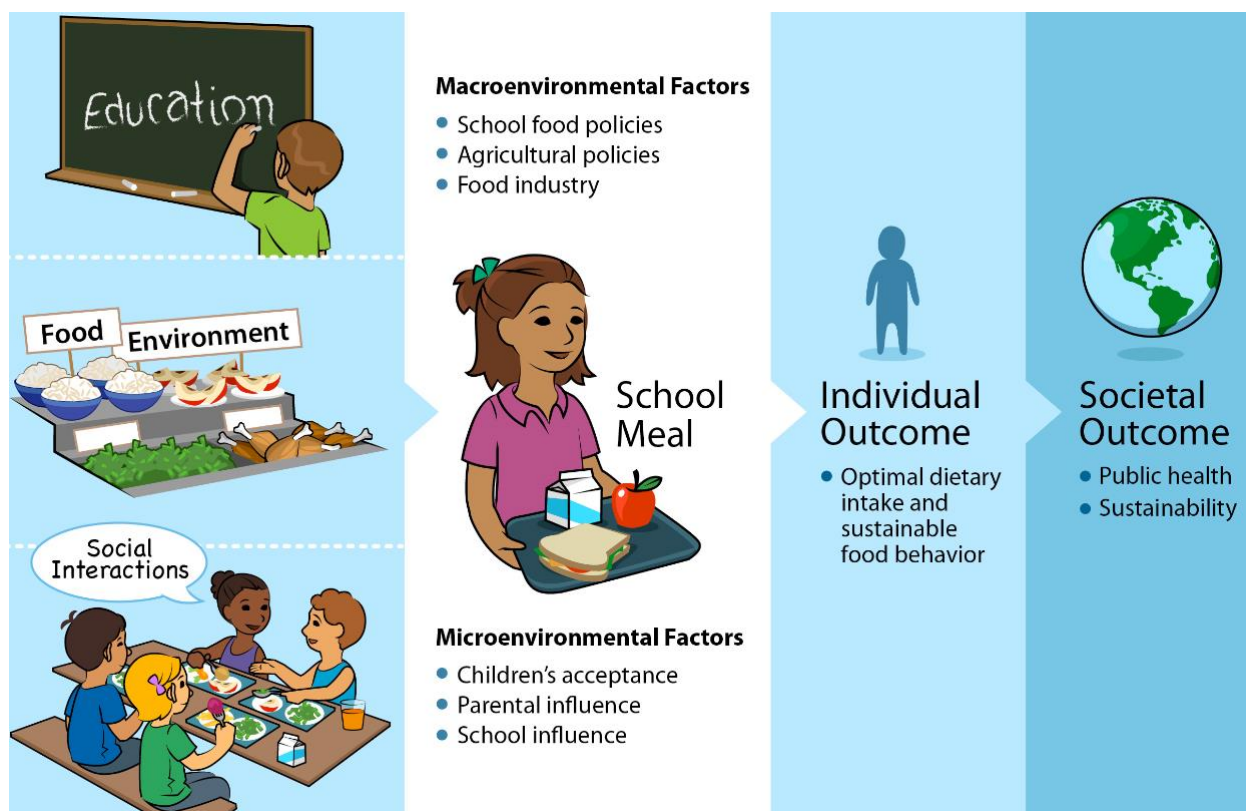


Figure 2. Model of influences and potential outcomes of school meals in Phase III

Approaches to food education

The consumption of daily school meals during approximately 12 years of education represents a huge opportunity for children to learn healthy and sustainable food behaviors, both through food exposure as well as through related education about sustainability while in school. Eating habits develop at an early age and early-learned eating habits are more likely to persist during childhood and become adult behaviors (Nicklaus, 2005; Nicklaus and Remy, 2013). In that regard, pre-school and school canteens can contribute to shaping healthy generations of consumers. In particular, recent European research on pre-schoolers has shown that repeated exposure is a key mechanism in learning to like and eat a wider diversity of vegetables (Caton et al., 2013; de Wild et al., 2015). De Wild and colleagues (2015) reported an intake increase of approximately 300 percent (8 g) in toddlers aged 1.5 to 4 years after a 7-week exposure period of red beet and parsnip crisps. The effect was still persistent in a follow-up test six months afterwards. At the same time, this approach may require sensitivity to socioeconomic context. As recent ethnographic research by Daniel (2016) illustrates, low-income families are often unable to afford the repeated exposures that adoption of new tastes may require.

Potential positive effects of making healthy and sustainable food options available in schools may be reinforced by the promotion of healthy and sustainable food behaviors such as in school garden projects, focusing on sustained intake of healthier foods inside and outside of school (Suarez-Balcazar et al., 2014; Roccaldo et al., 2014). Yet students constantly receive

conflicting signals about nutrition, health, and sustainability in their everyday school environment (Stone, 2007).

The perspective that food can be a tool for education is not yet widespread in mainstream curricula (Weaver-Hightower, 2011) and the school meal is not often enough used as an entrée for teachings on nutrition and sustainability in the context of agricultural, social, and political systems (Stone, 2007). Integration allows for 'the power of doing' to achieve its goal: to involve children in food growing, preparation, and consumption within a culturally relevant setting. Involvement can have beneficial effects on appreciation of food ('the IKEA effect': a higher appreciation of products including food that are produced by the person themselves) (Dohle et al., 2014), and willingness to try unfamiliar healthier options (Morris et al., 2001), which may be first steps towards both healthy and sustainable food behaviors. The emerging Phase III of school meals may productively focus on the integration of school food with learning healthy and sustainable behaviors. There is large variation in the extent to which school food and food education are integrated in school systems in different countries. Generally, there are two approaches to the interface between food education and school food: education separated from school meals, and education integrated into school meals.

The first approach typically includes an opportunity for food education in a setting such as a home economics class that is removed in time and space from the serving of school food. The school food policy is not directly connected with the classroom curriculum, and thus has the limited aim of serving a (healthy) meal. For example, there is an emphasis on serving schoolchildren a nutritious meal in Sweden, while other aspects of eating (e.g. sustainability teaching, and cultural aspects) are not emphasized during the school meal. Because of this lack of emphasis on all aspects of eating, Swedish school-children view school meals as being an inferior meal to food served in a family setting (Osowski et al., 2010). A British study finds similar results in which the food-related activities in school are thought of as something separate from eating school meals (Morrison, 1995). The study also finds that students often emphasize the low status of home economics, health education, and personal and social education (PSE), which may contribute to a negative attitude towards both teachings of food behavior and towards the school meal itself.

Box 2: The French school meal as an exemplary meal?

Elements of the French school meal are being implemented in the US in the Eatiquette school meal program (<http://www.vetrifoundation.org/what-we-do/eatiquette/>). In this program, students eat a three-course meal together in groups for half an hour, with a focus on making the meal an event for learning, with attention to ambiance and healthy and sustainable food behaviors. The organization of the meal into three courses may have beneficial side effects such as increased vegetable consumption (100 percent of children ate some or all kale salad when fruit was served as a dessert course, compared to 60 percent when the dessert was served at the same time as the main course, Zellner and Cobuzzi, 2016).

Comparable models in the US such as the Edible Schoolyard (<http://www.edibleschoolyard.org>) also highlight the importance of mealtime sociability, sustainability, and provenance of ingredients. However, it seems imprudent to implement the intact French model (or any other) on a global scale. Ensuring that the different elements of the school meal are adapted to the local food culture will aid in successful acceptance and implementation.

The second approach (education integrated with school meals) typically includes the opportunity for students to learn about food and nutrition in the school meal setting, in order to help them to gain both social and practical food skills (Harper and Wells, 2007). In Italy, Finland, and Japan, the emphasis has been on the dining environment from which cultural and social lessons can be learned within the context of school meal provision (see Box 2) (Harper et al., 2008). Along with lessons concerned with the food itself, other lessons include exposure to a set of norms and values related to mealtimes, sociability, and sustainability aspects such as waste. In Italy (and France), for example, school children may be seated at round tables with tablecloths, proper crockery, and cutlery to enhance the learning environment surrounding the meal setting. Italian teachers also reinforce efforts made in school kitchens by linking them to classroom lessons, which includes a number of key areas: food, nutrition and life style, cooking, farming, food quality, and, finally, Italian diet and food culture. This integration also makes use of experiential learning through efforts that include children in the growing and harvesting of produce and the preparation of food (Harper et al., 2008). Schoolteacher experience suggests that activity-based approaches to understanding food origins, production and preparation improve the acceptance of novel foods (Atkins and Atkins, 2010). Farm-to-school projects and school vegetable gardens are also examples of activities that integrate the school meal and teaching about both nutrition and sustainability.

The lack of integration of food education with practice in the first approach results in under-utilization of the full potential of food and eating as source of learning. A possible by-product of this approach is a negative distinction between school meals versus “real” (i.e. family) meals (Höijer et al., 2013). Thus, recently, more and more schools are engaging in the second approach in order to provide children with the opportunity to learn about food and nutrition in the school meal setting, in order to help them to gain both social and practical food skills (Birch, 1980). The third phase of school meal development would adopt this second approach.

The role of the school social environment

School meals are much more than macro and micronutrients: they create a social learning environment and facilitate social interactions that are important for learning about food

behaviors from peers (Birch, 1980; Kubik et al., 2003; Neumark-Sztainer et al., 1999; Shannon et al., 2002). Moreover, abundant research has shown that certain periods during childhood are important for later-life health, and that health development is sensitive to social structuring of environmental exposures and experiences (Halfon et al., 2014), though it is difficult to assess which periods are most consequential for adult behaviors (Lewis, 1997). During adolescence, a host of neurological, affective, emotional, and cognitive changes transpire that inform socialization and propensity to make choices away from parental oversight.

As such, the lunchroom has been extensively targeted as a key site for eating-related interventions in youth (French et al., 2004; Perry et al., 2004; Sallis et al., 2003). Interpersonal social influences shape choices about food intake in adults and children (Higgs and Thomas, 2016; Houldcroft et al., 2014; Robinson et al., 2013; Salvy et al., 2012). Possible mechanisms linking one individual's food intake with the intake of a peer are thought to include: assortative pairing (selecting a peer with similar appetites or preferences), appraising others' behaviors and altering one's intake, conforming to consumption norms, eating in a certain manner in order to ingratiate oneself with a peer or peer group; and imitation of what others are eating. This will also occur in a school breakfast or lunch room, and may be important for shaping healthy and sustainable food behavior in children.

Research on child development suggests that during the onset of adolescence, children begin to pay closer attention to the behaviors of peers relative to those of family members (Dishion and Tipsord, 2011). However, children do not consistently copy either parents' or peers eating practices. There are surprisingly low correlations between adults' food preferences and that of their children, compared with correlations in values about food (Rozin, 1991). Among adolescents between nine and 15 years old, eating with a friend is associated with increased food intake relative to eating with unfamiliar peers (Salvy et al., 2009), which is a similar effect as found in adults (de Castro, 1994; 2000). However, the importance of social influence on meal size and duration may be lower compared to the influence on meal composition when it comes to health. Social network research that identifies effects of specific relationships between peers shows that male adolescents tend to be similar to male friends in terms of fast-food consumption, but females do not seem to emulate other females (de la Haye, 2010). Research on 'junk food', which includes other low-nutrient and energy-dense foods, shows that adolescents tend to emulate each other's junk food consumption over time (de la Haye, 2013). This is in agreement with research among adults showing that both healthy diets and unhealthy diets are linked among socially connected peers (Pachucki et al., 2011), while actual food preferences may show low linkage amongst peers (Rozin et al., 2004).

Educators and school cafeteria staff also have a valuable role in the social school meal environment. Encouragement and praise used by teachers and other staff may positively influence food choices. For example, an intervention carried out at elementary schools in the US showed that 90 percent of the children took a fruit serving (either fruit or fruit juice) when the cafeteria staff encouraged children by asking 'would you like fruit or juice with your lunch?' compared to 60 percent of children in the control schools. In addition, approximately 80 percent of the children in the treatment condition consumed the fruit or fruit juice at their trays (Schwartz, 2007). However, the salary, conditions, and expectations of the role of school cafeteria staff vary considerably, and very often their roles are considered below that of

teachers in the school organizational structure (Pike, 2010; Höijer et al., 2013). This may influence the potential for staff to encourage healthy eating on an everyday basis.

To date, there has been little research to investigate interpersonal social influences on the eating habits of schoolchildren younger than adolescence. It is also not yet clear whether intervening with an entire group of children or intervening with selected friends and peers may promote longer-term change in food behaviors. Some evidence suggests that peer-led or peer-modeled nutrition interventions have greater acceptability among students (French et al., 2004; Lowe et al., 2004; Story et al., 2002). A recent review of associations between obesity and social networks points out that the use of social networks to add an interpersonal component to food or weight-related interventions holds promise, especially among youth (Pachucki and Goodman, 2015). Thus, the potential for improving food behavior through such interventions in the lunchroom should be explored and implemented in Phase III of school meals.

The role of the food and eating environment

Nutrition-related behaviors acquired at school are strongly influenced by a broad class of environmental factors, which can be organized into the food environment and the eating environment (Wansink, 2004). The food environment includes all factors that directly relate to the way the food is provided, such as portion sizes, presentation and visual appeal. Small changes in the food environment – such as the order of foods in a lunch line – can influence food choices, often without people’s awareness. The eating environment refers to factors independent of the food, but associated with eating. Examples include ambiance, social interactions and encouragement, distractions, and time available for eating. For example, overcrowded dining halls and truncated eating time has been found to create time pressure on children (Moore et al., 2010). This, in turn, can negatively influence the eating experience due to hastiness (Cohen et al., 2016), and reduces the possibility for learning during the meal.

Hence, interest is growing in creating school environments that facilitate healthy and sustainable food behaviors. Popular policy measures include school nutrition legislation, such as mandatory nutritional standards for school meals (French and Story, 2013), restricting marketing to children in schools, providing nutrition and sustainability information, sorting waste, and eliminating unhealthy foods from vending machines. Nudging interventions have been advocated as particularly promising in optimally re-engineering the school environment to encourage healthy eating habits (Wansink and Chandon, 2014).

Inspired by insights from psychology and behavioral economics, such interventions are built on the premise that individuals react against being forced to eat healthy foods. Rather, a behavioral nudge preserves the freedom to choose but gives a small push in the right direction by increasing the attractiveness, convenience, and normative nature of healthy foods in the school environment (Hanks et al., 2012; Hansen et al., 2016; Skov et al., 2013). Although many nudging studies address adult decision making, some recent intervention studies have addressed the question how children can be encouraged to make healthier choices themselves by changing the design of lunchrooms or the way food is presented. For example, Hanks et al., 2012 showed that introducing a convenience line into a cafeteria with only healthier foods, resulted in an increase of sales of healthier items by 18 percent, in addition to an increase in flavoured milk sales. Van Kleef and colleagues (2014) showed that presenting whole wheat

bread in a fun shape (compared to a regular shape) almost doubled consumption during a breakfast event at primary schools, and in this way encouraged children to try a healthier food option. Results of these nudges are promising, although critics argue that policies that are more forceful are necessary, such as banning certain foods from the lunch meal (Liu et al., 2014; Roberto et al., 2014). Children may be particularly susceptible to difficulties with self-control and may be less able to resist temptations of indulging in unhealthy but tasty foods. For them, improving the food environment by restricting access to certain foods and beverages may be a better policy direction. The food environment may also be improved by making healthy foods more accessible or top of mind. For example, placing salad items in a cafeteria setting in a more accessible place increased intake by 13 percent (Rozin et al., 2011), but is also linked to more fruit and vegetable wastage (Adams et al., 2015). A recent experiment at a number of elementary and middle schools in the US examined the effect of nudges during the pre-ordering process of lunch. When students selected their meals and did not choose a healthy component, they received a personalized message to urge them to add it to their meal. This intervention influenced intake substantially: for example, students selected 27 percent more fruits relative to students in the control group (Miller et al., 2016). Nevertheless, not all interventions are effective, as a recent review on free distribution of vegetables in a school setting did not show a significant effect on intake levels (Nornberg et al., 2015). Restriction versus freedom of choice is a critical issue, particularly in the American public health landscape, as self-determination represents a central national value. Nudging may be a more acceptable way of shaping food behavior in schoolchildren than restriction of options, both in school cafeterias and in vending machines (see Box 3). Designing a school food environment that makes it easier for children to make healthier and more sustainable food choices is beginning to be increasingly emphasized in Phase III of school meal development.

Box 3: The issue with vending machines

Even when school meals are perfectly arranged, presented, and made ‘ideal’ in terms of nutritional composition, the desired individual food behavior and societal outcomes may not be achieved. Vending machines typically stock competitive food products with strong brands, which have the potential to shift children’s choices from healthy school meal options to attractive unhealthy options in the vending machine. Therefore, there is increasing attention by policy makers towards vending machine content. Several countries now have policies in place that regulate the content of vending machines, limit, or even forbid their presence in school (more often in primary schools than in high schools). A review assessing 24 studies published between 2005 and 2013 focused on policies targeting as vending machines, showed the importance of such policies for improving healthy food intake. For example, one study showed that California students consumed on average 158 calories less after state laws that regulated the content of vending machines were implemented, compared to other states without such regulations. These reductions were related to in-school consumption. A recent review of nutrition interventions in vending machines showed that reducing price or increasing the availability of healthier snacks are effective in improving the nutritional quality of foods and beverages purchased from vending machines (Grech and Allman-Farinelli, 2015). However, vending machine regulation is not a uniform phenomenon and it is likely that many schools will continue to have vending machines because of demand from both children (preferred products) and schools (source of income). Replacement of unhealthy products with healthier options has resulted in resistance from the children. Yet there are opportunities for food companies for innovative healthy snacks in vending machines. These include fresh salads that are suitable for vending machines, (Brones, 2014; Farmer’s Fridge, 2015) but may not be limited to the fruit and vegetable category.

Discussion: What can be achieved in Phase III of school meal development?

School meals are of major importance in many countries worldwide. This essay synthesizes a broad base of evidence, including both systematic and non-systematic reviews and a variety of research studies, and joins those who suggest that school meal programs help to prevent undernutrition. However, we observe that less evidence is available on whether school meal programs help the current problems of over- and unsustainable consumption. The previous sections of this essay have described how school meals in developed countries have begun to shift from Phase II, which focused upon food quality, to a third phase, which highlights the promotion of healthy and sustainable food behaviors. This emerging integration of school meals with classroom curricula aligned with food cultural learning and establishing an optimal food and social environment may facilitate learning of healthy and sustainable food behaviors. Although it is difficult to provide evidence for the effects of school meals on health behaviors and sustainability, the complexity of the school meal system may allow enough flexibility to make significant changes that benefit all stakeholders. In this section, we discuss what can be done today, opportunities for and constraints to implementation, and possibilities for future research.

How can impact be evaluated?

The project of integrating school meals with learning healthy and sustainable food behaviors is relatively new, has been implemented in very few cases, and thus has not been extensively studied. It is therefore difficult to estimate the extent of the gains that might be expected in

Phase III of the development of school meal programs. The effects of school meals have been evaluated for undernutrition in both developing and developed countries, although even there the evaluations are often sparse or one-dimensional, yet such evaluation is insufficient when it comes to overconsumption. The same applies to sustainability: while certain elements of school meals may contribute to more knowledge of sustainable food consumption, it appears that there has not yet been a systematic evaluation of school meals on sustainability. Lack of a clear definition or disagreement on what healthy and sustainable means will be challenging during any attempt to evaluate impact of school meals.

In addition, there are three major issues when it comes to evaluation: 1) the expected outcome needs to be formulated clearly, 2) the expected outcomes need to be measurable, and 3) establishing the presence of an effect and quantifying its magnitude. School meal programs currently do not formulate clear endpoints or expected outcomes that relate to societal issues beyond broad goals of welfare and food security. Short-term outcomes may be easier to evaluate, such as actual fruit and vegetable consumption, number of children of low-income families participating, percentage of waste reduction, or percentage of organic produce. However, evaluations often settle for measurements such as vegetables served or self-reported intake, which may be poorly related to actual vegetable intake, which typically requires more cumbersome methods such as weighing plates or waste. How these short-term outcomes relate to long-term outcomes, such as overweight / obesity and type 2 diabetes incidence, or ecological footprint is not always clear. Only extended interventions and evaluations may be able to show that more fully embracing a focus on healthy behaviors and sustainability in the current phase of school meal development is beneficial for tackling societal health challenges. There is a need for harmonised and verifiable outcome indicators that can be used to evaluate and compare the success of interventions aimed at healthier eating, as also proposed by Pérez-Cueto et al. (2011).

However, it may not be possible to measure directly how healthy and sustainable behaviors relate to improvement of societal challenges, due to the multi-factorial nature of food behaviors, only one of which is the school meal. Policy makers are often interested in measuring the success of policies in terms of financial benefit, yet this may be very difficult indeed, due to the complexity of school meals. In addition, it is necessary to conduct and to measure the effects of interventions over a significant amount of time, in order to detect effects on population level (e.g. Cohen et al., 2015). Thus, a third and final issue when it comes to evaluation is the challenges of establishing the presence of an effect and quantifying its magnitude, which can be challenging due to a host of practical and statistical reasons. These issues notwithstanding, it seems prudent to serve children healthier and sustainable foods that accord with the country's food production and culture, and to promote healthier and sustainable food behaviors, so that they accept this food not only during the school meal, but because they will also grow into adult consumers.

How might implementation challenges be handled?

An obvious challenge with implementing changes in school meals is that meals and the factors that shape them look very different by country, and it is not feasible, nor necessarily desirable to have one school meal policy that fits all. The factors that shape the school meal include the different groups that have a stake at both macro- and micro environmental levels.

Macro-environmental influences

Macro-environmental characteristics, as well as public/private partnerships, are associated with successful initiatives aiming at healthier diets, and may contribute to the engagement and empowerment of society and the target group, and in adoption by citizens (Aschemann-Witzel et al., 2012). Many of the macro-environmental influences that shape school meals are tied to school meal funding. Government support is one obvious source, yet such programs are costly (e.g. in the US, costs of school meals were 11.6 billion USD in 2012, United States Department of Agriculture, Food and Nutrition Service, 2013). National and municipal school food policies play an important role in deciding school meal funding allocations, if any, and how additional resources can be obtained. Some agricultural policies include school meals as an outlet for food surplus production. Meat, eggs, milk, fruits, and vegetables can be sold to school meal programs for bottom prices, which ensures that farmers were paid for their surplus production, and that schools are able to acquire produce at low cost (Levine, 2008). There is also evidence that some processed surplus food is used in school meals. The use of surplus foods in school meals affects the composition of school meals and the foods that children are exposed to, as well as a potential mechanism for the food industry to expose children to brands and establish loyalty at an early age (Weaver-Hightower, 2011). Commercialization and privatization of school meals and cafeterias can contribute to an affordable school meal program in the third phase, under the condition that the products and brands fit with healthy and sustainable food behaviors. Food producers and industry may find business opportunities whose revenue stream can be built upon exposing children to new healthier and sustainable foods and brands (see Andersen et al., 2015 for an example of opportunities for new food products within school meals).

While there are opportunities for government and policy makers, conflict may also arise between agricultural policies and the food industry. For example, it is not possible to use a country's food agriculture surplus in school meals unless there is political consent for this policy. Conflict may also arise around dietary guidelines, as guidelines can restrict the inclusion of certain food commodities into the school meal and rank some foods as better than other foods, such as: "eat yellow, orange, and red colored fruits and dark green vegetables". Such expressions can create the impression that that companies not producing fruit and vegetables according to the guidelines produce bad food. Food producers that do not benefit from the proposed dietary guidelines may try to oppose them (Nestle, 2013). However, there are also examples of successful collaborations between the different stakeholders that influence school meals on a macro-environmental level. The success of the reform of the school meal program in Rome has been attributed to a tight collaboration between the municipality, city council, business world, trade associations, and the public, which was possible due to a common motivation to improve well-being for the larger community (Sonnino, 2009). The Rome school meal program is now a more sustainable program that focuses on local and organic food as attributes of improved food quality.

Implementation of school meal interventions may not only affect the target group, but also the various actors that have to make changes in their routines and practices in order to facilitate the implementation, such as caterers, parent social networks, and peer groups. One of the few papers that evaluated a school meal intervention in Phase III found that children exposed to a

multi-level integrated intervention in UK primary schools (Food for Life Partnership Program), which focused on healthy and sustainable eating, had higher self-reported fruit and vegetable intake (0.31 portions). In addition, the implementation of the program itself resulted in school reforms beyond the program and synergy between various actors, which may positively affect students beyond the intended aim of the intervention (Jones et al., 2012).

Micro-environmental influences

The factors that shape the school meal include the different groups that have an interest in the school meals. The children's interests when implementing changes to the school meal should be central, yet the idea of what is beneficial for the children may not be shared by the children themselves. The question of whether unhealthy options should be restricted may be answered differently by parents and policy makers (yes) than by children and food industry (no) (Gustafsson, 2002; Pike, 2010). For example, removing meat and fish from the school meal on some days per week in Finland has been shown to reduce participation rate with seven percent and nineteen percent less food on the plate, and a sixty percent increase in plate waste, at least on the short term (Lombardini and Lankoski, 2013). However, in Belgium (De Keyzer et al., 2012), serving vegetarian food did not affect plate waste for main courses, only for soups and desserts, when compared to conventional food.

Since children's acceptance of the changes to be implemented is crucial for success, it is important to focus on more subtle changes (e.g. nudging), providing healthy options at reduced costs or reducing the time needed to stand in line (e.g. engineering cafeteria layout) (Hanks et al., 2012). It is also important not to forget the palatability of the food offered, as well as working against the consideration of school meals as second-class meals. Actively involving children and giving them autonomy to make their own choices may have broader positive effects beyond influencing children's food behaviors. For example, providing free fruits to the youngest Norwegian pupils increased these pupils' intake of fruits with 25 percent compared to pupils who did not receive this offer. More surprisingly, the parents' intake increased with 12.5 percent as well (Øvrum and Bere, 2014). Adoption of health interventions/changes as 'main stream' by a small population (e.g. children accept "Thursday Veggieday" without problems (De Keyzer et al., 2012)), may eventually result in adoption by the general public as well. While the effects for individuals of such interventions may be small, there is potential for significant effects for the society as a whole (Rose et al., 2008).

Parents obviously have a large stake in school meals too, as they in effect outsource part of their meal responsibilities to schools (Schwartz and Brownell, 2007). Parents have also been actively involved in shaping school lunch programs by individual actions that provoked collectivistic interventions to improve availability of healthy foods and restrict unhealthy foods (Suarez-Balcazer et al., 2007). Clear and ongoing communication between parents and schools is necessary to coordinate learning healthy and sustainable food behaviors at both home and schools. New technologies are being implemented to facilitate better synergy between schools and parents regarding school food. In Sweden, for example, an app is available for parents to see what their child was served for the school meal, so that they can avoid serving the same food for dinner (Persson, 2012).

Educators, school cafeteria staff, and school administrators have a valuable role in the school meal environment, both in terms of the social and physical environment. School administrators may be reluctant to evolve the school meal education and implement programs if potential extra costs are not compensated. Improving kitchen facilities, managing unfavorable bids from healthy food suppliers, or meeting the requirement of extra staff can all be costly. School curricula may not currently be flexible enough to allow for better integration of school food with education. Schools need to seek and receive more information about practices that yield significant results, in addition to technical and financial assistance to implement changes (Story et al., 2009; Belansky et al., 2010).

Box 4: How school meal programs affect organization of daily and family life

Providing welfare through school meals indeed affects child well-being, but may also influence family life in general. In particular, it affects the composition and organization of meals, and may even influence the division of labor and income provision within the family. School meals contribute to shaping everyday food life, including meal timing and meal composition. Standardized schedules of school and work reshaped daily rhythms of middle-class families in the US in the 1850-60s, and a carefully ordered progression of breakfast, lunch, and dinner emerged (Cinotto, 2006). In Norway, an important goal of the provision of school meals that occurred in the 1930-1950s, the so-called Oslo breakfast, was not only to provide nutritious food for poor children, but also to influence domestic eating habits (Lyngø, 1998; 2003; Kjærnes and Døving, 2009). Based on the latest knowledge on nutrition at the time, in particular regarding vitamins, it was concluded that the hot meal during the day was inappropriate and even detrimental to the well-being, health, and development of schoolchildren. The composition of the Oslo breakfast, which consisted of slices of bread with margarine, cheese, liver pate, served with a fruit or vegetable, a glass of milk and cod oil during the winter months, represents an example of how school meal programs can form new ways of eating for a whole nation. Today, this lunch menu not only dominates lunch at school, but also the lunch meal at work, but instead of being served it is prepared at home as a packed lunch ('matpakken') (Kjærnes and Døving, 2009; Bugge, 2010).

School meal arrangements may also affect parental possibilities to organize family and occupational lives. To illustrate, in Switzerland, nearly all schoolchildren go home for lunch and return to school in the afternoon. This discontinuous school day represents a huge obstacle to the occupational pursuits of many Swiss women (Buchmann and Charles, 1995; Cooke, 2010). The school meal offers an opportunity for parents to outsource one meal per day, which may enable greater workforce participation. The increase in the participation of women in the labor force is one of the most notable social structural developments in the last decades in all developed industrialized societies (Haller and Hoellinger, 1994). In the US, children whose mothers work are more likely to participate in school lunch, but less likely to participate in school breakfast programs. Mothers seem to prefer to outsource meal preparation for lunch, but to sustain nutritional control and family time by serving their children breakfast (Datar and Nicosia, 2012).

Conclusion

This essay aimed to highlight relevant research on the history and health implications of school meal programs in a cross-national comparative framework, and to discuss the current and potential future role of school meals as a tool for improving food behaviors and population health in a sustainable way. The literature addressed in this review was used to underline opportunities and challenges, rather than to precisely and systematically estimate the impact of school meals, in all countries, resulting in a description of the issues that need to be considered. In addition, there is a limitation to the comparability of the different studies highlighted here, due to the heterogeneity in research methods and design. Rather, this essay indicates the range of potential effects that school meals could have in the current era, and discusses the challenges with evaluation and implementation of school meals as a tool for healthier and sustainable food behaviors.

Humanity is facing both health and sustainability challenges in the food sector. This essay suggests that school meal programs are valuable tools towards healthy and sustainable societies in the future. Three distinct phases have been distinguished in this paper: Phase I; the phase in which school meals were seen as a welfare program, Phase II; the food quality phase as a response to nutrition-related diseases that became apparent in the 1970s, and Phase III; an emerging phase in which increasing attention is being paid to both healthy and sustainable eating. The current state of literature is explored in terms of 1) whether school meals currently contribute to healthy diets and sustainable behaviors, and 2), how and in which way school meals can improve both.

With regard to the first question, evidence suggests that food provided at school can have strong short-term influences on children's consumption of calories and key nutrients, but there is little evidence for a long term effect. So far, little research has been done that studied and could prove that school meals have an impact on sustainability. Various studies exist for single-issues, however, and they show positive indications but also highlight trade-offs that need solving. As conclusions to the second question, it is argued that school meals might be integrated in food education, and might influence healthy and sustainable consumption patterns via the social environment or the food environment. It is found that, firstly, food education is connected to school meals in some but not all countries, with apparent cultural differences. Secondly, both the school and the food and eating environment have been extensively studied, with results indicating that the school food environment can have a strong influence on pupils on the short term, but long-term influences are largely unknown.

For policy makers, the results imply that improving healthy diets and sustainable consumption via school meals provides an excellent opportunity, but requires long-term dedication and holistic approaches, as the target group is young, and effects (on health, the environment, and on preventing societal costs related to these contexts) may not be visible for many years. This is difficult to achieve in typically short-termed policy cycles. However, if evaluations are conducted early on indicating favorable results, it is more likely that the activities can be continued, if enough financial and other type of investments (incentives, logistics, etc.) can be obtained and utilized.

Meaningful ways to modify the role of school meals could include education about principles and benefits of healthy and sustainable consumption patterns (within and outside school meal contexts), implementing policies and practices that leverage social support, and improvement of the school food environment using principles from behavioral sciences. Through utilizing well-designed school meal programs, there is considerable potential to move towards an integration of teaching health and sustainability with school meals and to promote healthy and sustainable food behaviors, which most countries only recently started to do.

Outlook on future evaluations and research

Although there is little evidence thus far that school food and school food policies significantly improve child and subsequent adult physical health, it is important to acknowledge the limits of research designs to evaluate these effects (e.g. randomized controlled trials). Given the complex nature of poor diets and sustainability, the difficulties inherent in obtaining this evidence should not stand in the way of preliminary steps towards a closer alignment of school curricula with school meals around healthy choices and sustainability. The history of school meal development suggests that years or even decades are necessary to transform the school meal landscape and to establish new policies and practices that enable children to eat healthfully at school.

Nevertheless, there is a need for future research related to successful use of school meals in Phase III. Tractable designs can focus on further investigating how to implement strategies that suggest promising potential, such as changes in the social and food environment. Interactions between the different factors, such as the micro environment (school meal environment) and the macro environment (competitive foods, marketing, and food eaten outside the school), and role models within school (teachers, cafeteria staff) and outside (parents) have been given less attention (Stephens and Shanks, 2015). Increasingly relevant are the contexts of the school meal and the complex social forces that interact with food systems at a national level. It is relevant to know what strategies can be implemented within the school that are still efficient in promoting healthy and sustainable food behavior despite the many factors that influence the school meal. As discussed above, an evaluation of strategies is only possible if expected outcomes are clearly formulated and tested.

Another issue related to successful implementation that may require further research, is aligning the best approach for a given target age. Children may go to school anytime between three years of age up to 18 years of age, depending on the country. The age will determine the capacity to learn healthy and sustainable food behaviors through different human developmental stages. For example, it is difficult to teach a four-year old child what health and sustainability are, but he or she may be very sensitive to peer and adult modelling when it comes to fruit and vegetable intake or their waste behavior. As many of the studies mentioned in this paper focus within age groups rather than across them, it is challenging at this stage to compare the effectiveness of strategies for children of different ages, and more research is needed. Adapting concepts such as how food interacts with the social environment, and integration of nutrition/sustainability and food culture learning with the school meal seems plausible for all age groups. Yet research is needed to test the efficacy of adapting these concepts in different ways to the target age group.

There is also a need for further research on how to achieve an optimal integration of healthy and sustainable behavior learning with school meals as an organizing principle. It has been difficult to show that increasing nutrition and sustainability education in classrooms results in improved health and sustainable food behaviors. One element that has been vital for successful education strategies has been integration of different components, including teaching in the classroom, food availability, hands-on experience, and involvement of parents. Yet this makes education strategies very intensive and potentially costly (Harris et al., 2012). Not many intervention studies include a specific role for the school meal beyond an increase of availability of one commodity (e.g. free fruit or free milk). A (cost-) efficient and effective way to integrate education with the school meal is likely of great importance for successfully broadening health and sustainability concerns surrounding the school meal in Phase III, yet what this will look like will likely vary widely by country. Based upon the research reviewed in this essay, it seems most productive to have a close fit between the integration of learning healthy and sustainable food behaviors with the school meal, and the values of the national or regional culture in which the change is implemented. In this way, the integration of learning and the school meal can transform normative school practice and policy around food behaviors in a healthier direction.

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