

**The Generating Excellent Nutrition in UK Schools (GENIUS) network: working towards a more health-promoting food and nutrition system in UK schools**

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## **Abstract**

School food has a major influence on children's diet quality and has the potential to reduce diet inequalities and non-communicable disease risk. Funded by the UK Prevention Research Partnership (UKRI), we have established a UK school food system network. The overarching aim was to build a community to work towards a more health promoting food and nutrition system in UK schools. The network has brought together a team from a range of disciplines, while inclusion of non-academic users and other stakeholders, such as pupils and parents, has allowed the co-development of research priorities and questions. This network has used a combination of workshops, working groups and pump-priming projects to explore the school food system, as well as creating a systems map of the UK school food system, and conducting network analysis of the newly established network. Through understanding the current food system and building network expertise, we hope to advance research and policy around food in schools. Further funding has been achieved based on these findings, working in partnership with policy makers and schools, whilst a Nutrition Society Special Interest Group has been established to ensure maximum engagement and future sustainability of the network. This review will describe the key findings and progress to date based on the work of the network, as well as a summary of the current literature, identification of knowledge gaps and areas of debate, according to key elements of the school food system.

## Introduction

Diet is a key, modifiable health determinant. UK children's diets contain higher than optimal levels of saturated fats and sugars, and are low in fibre and fruit and vegetables. For example, only 12% of UK 11-18 year olds are meeting the "5-a-day" guideline for fruit and vegetable intake (5 portions equivalent to 400 g/day) (1). Socioeconomic differentials in dietary intake are well known, with those of lower socio-economic status having poorer diets, and such differentials have been enhanced by the recent global pandemic and cost of living crisis (2, 3). Despite long-standing public health interventions aimed at improving children's diets, the extent to which these meet recommendations has remained low (1). We need effective and sustainable ways of helping young people, particularly in areas of socioeconomic disadvantage, access a better diet. Eating habits in childhood impact dental health, excess body fatness and associated physical, mental and emotional problems (4). In addition, dietary habits established during childhood and adolescence are likely to persist into adulthood, impacting long-term health (5). Early modification in eating habits and behaviours provide an opportunity to decrease the risk of developing non-communicable diseases (NCDs), even in childhood (6), throughout adult life (including pregnancy risk factors) and diseases of later life including type 2 diabetes, cardiovascular disease and other cardiometabolic diseases (7).

Schools have the potential to play a crucial role in improving children's health, and are an obvious setting for population-level public health interventions (8). They provide easy, and almost universal, access to pupils of various ages from across the social spectrum, with children spending approximately six hours/day at school. Given this, children's food intake while at school will be a major contributor to overall dietary intake and schools can serve as a setting for addressing inequalities in diet and health. A systematic review of interventions to prevent childhood obesity highlighted that establishing environments and cultural practices within schools that support children eating healthier foods throughout the day could be an effective intervention strategy (9).

Effective and sustainable solutions are required to help young people access a better diet. There is a huge opportunity to better harness school food to improve population health, but regional school food policies have done little to identify and disseminate best practice across the UK. Schools could play an important role in promoting healthy eating habits to children, and should provide healthy, balanced and nutritious food and drink, with the potential to reduce socioeconomic differentials in dietary intake. The Parliamentary Office for Science and Technology highlighted healthy school food as a priority area for briefing Parliament in

2018 (10). However, at that time there was no formalised research, practice or policy network bringing school food stakeholders together to understand and share best practice in the UK.

In 2019, the UK Prevention Research Partnership funded a UK school food system network (GENIUS); the aim of this review is to describe the activities of the GENIUS network and also to summarise current literature regarding the school food system. GENIUS considered the food system in its broadest sense and complexity, across the preschool, primary and secondary settings, and including all school food provision, within canteens, vending machines, shops within the school setting and home-prepared packed lunches, and also the school fringe environment. The overarching aim of the GENIUS network was to build a community to work towards a more health promoting food and nutrition system in UK schools. The network was based on the observation that the UK school food system across the four countries is complex and heterogeneous, and therefore to understand it required innovative approaches, but also that there was much to learn regarding the landscape, identifying the differences, commonalities and areas of good practice, alongside initiatives that could be applied nationwide. Network members included academic researchers active in school food research across a range of disciplines, alongside major non-academic stakeholders in school food, as well as local government, policy development and public health bodies, school stakeholders, including principals and catering staff and specific users, such as pupils and parents. Complexity scientists within the network helped to ensure that the network was underpinned by systems thinking. The networks were not funded to conduct research but to establish the network and infrastructure. Network workstreams were structured around building the network, understanding the current system and then sustaining the network and advancing research, policy and practice around food in schools, driving impact.

Initial aims are described in Woodside et al. (11) but, due to COVID-19 and the cancellation of the planned face to face workshop to kick-off working group activities, aims were revised to be achievable without opportunities to meet and network face-to-face during the global pandemic. The revised aims of the network are demonstrated in Table 1:

The network intended to bring a focus on scalability, implementation and sustainability and effecting an improvement in school food quality and normalisation of evidence-based healthy food practices within school settings and change in school food culture and practice. This would ultimately create healthier school food environments which would be accessible to all, reducing socioeconomic diet-related inequalities, and, consequently, NCD risk. The main

beneficiaries would be families with school-aged children, and both school-based stakeholders (teachers, principals, catering staff), and non-school-based stakeholders, including policymakers.

Network activities included establishment of a website (<https://geniusschoolfoodnetwork.com/>) as a repository for information and tool to encourage communication between network members, a mailing list to encourage sharing of information and development of a social media presence ([twitter.com/GeniusSFN](https://twitter.com/GeniusSFN)). Training in systems thinking was also offered to all members, webinars were hosted, and conference symposia held (e.g. at FENS 2019 and FENS 2023). Four awards of pump-priming funds were made; these were funds to conduct small-scale focussed exploratory or feasibility research to support larger grant applications; all those receiving pump priming awards are co-authors of this review. GENIUS engaged with other groups active in the area, including the All Party Parliamentary Group on School Food, the School Food Plan Alliance and the Global Research Consortium for School Health and Nutrition (12).

The basis of the understanding of the current food system was a school food survey led by GENIUS and the School Food Review (a group reviewing school food policy in England led by School Food Matters, Bite Back 2030 and the Food Foundation). Versions were developed for those involved in operational matters and other stakeholders. The survey was open between July and September 2021 and there were 1280 respondents (teachers, parents, caterers, pupils, policy makers, researchers, nutritionists, etc.). Based on this survey, research priorities were developed according to James Lind Alliance methodologies (<https://www.jla.nihr.ac.uk/>). In brief, ten priorities for school food related research were identified, covering the topics of subsidisation of school meals, implementation of policy and food standards, leadership, inequalities, social norms and nutrition (13). These priorities will help guide policy makers, researchers and others to areas related to school food that are most important to focus on and are likely to make the biggest difference to pupils' diet, health and well-being.

Based on the same survey, areas of good practice and/or concerns of parents were analysed using qualitative methodology (14), while a separate survey of stakeholders formed the first stage of a systems map of the UK school food system in the secondary setting (15), which is complementary to the primary school systems map described later (16).

Beyond the key outputs described above, GENIUS has also led to increased awareness of gaps in knowledge – here we describe a summary of the current literature, identification of knowledge gaps and areas of debate, according to key elements of the school food system.

### **Free School Meals – means-tested and universal provision**

Free School Meal (FSM) provision was originally brought in to alleviate hunger and promote school engagement, and while food insecurity remains a central driver of modern day school food and FSM policy, it now encompasses the broader aims of addressing dietary inequalities and obesity in children (17). Current FSM arrangements are the responsibility of devolved governments across the UK, hence there are different FSM policies across the nations. FSM have a range of eligibility criteria, and therefore range from means-tested to universal provision. For means-tested FSM, the eligibility criteria vary across nations, for example in Northern Ireland, the income threshold for FSM eligibility is approximately double that in England (18,19). Around 24% of school children are currently eligible for FSM in England and 28% in Northern Ireland (20,21). In all UK nations, apart from Northern Ireland, younger children (aged 4-7 years) are universally entitled to FSM. However, there are some regional examples of expanded universal free school meal (UFSM) provision (22), for example, some local authorities in England have extended provision to all primary school-aged children, while Tower Hamlets has implemented UFSM for all secondary school-aged children from September 2023. In Scotland and Wales, UFSM are being rolled out to all primary school aged children (4-11 years) (23,24). Like England and Wales, there is variation in UFSM implementation by local authority. For other school-aged children across the UK, means-tested FSM systems are in place.

Provision of FSM has been associated with a variety of benefits, including improved diet quality, reduced food insecurity, better academic performance, and a reduction in obesity (25,26). There is also evidence to suggest that providing FSM reduces dietary inequalities seen across children from high and low-income families (27,28) and contributes to reduced socioeconomic inequalities in adulthood (29). However, this evidence comes largely from studies of UFSM provision, mostly with younger (primary school) age groups. There is very little evidence of the benefits seen from means tested FSM policies and FSM provision in secondary school age groups.

Not all children who are eligible take up the offer of a FSM, although universal FSM provision is associated with higher uptake (26). Within UK means-tested schemes, there is a

large variation in the proportion of eligible children who actually receive FSMs (20,30). The reasons for this are complex and not fully understood, but factors that have been associated with FSM take-up include school promotion and processes relating to FSM (including maintaining anonymity of FSM eligibility), food quality and choice, ability to eat with friends, and the stigma associated with FSM (31-34). Interventions to increase FSM uptake have been tested with some success (35), and currently there are several local schemes and pilots in England where automatic enrolment of children eligible for FSM has been introduced, thereby removing the need for FSM-eligible families to actively register to receive FSM (22, 36).

FSM has been a prominent policy issue within the public discourse in the last few years, with increasing interest in UFSM provision as well as extended eligibility. However, given that means-tested FSM is currently the major policy across the UK, there are substantial gaps in our knowledge in terms of influences on access and uptake, and benefits to dietary intake and food insecurity, and these gaps are greatest in the secondary school age-group. To address this, a National Institute for Health and Care Research (NIHR)-funded study, developed as an output from GENIUS, is being undertaken to explore the variation in FSM arrangements in secondary schools and how this impacts on these important outcomes in school pupils. The impact of extending eligibility on diet quality and food insecurity will also be modelled (37,38). This will provide a valuable addition to the existing evidence and inform future FSM policy directions in the UK.

### **School food standards and the challenge of healthy school food provision in the UK**

Quality standards for school food provision are implemented across many high-income countries. They aim to ensure that the foods and drinks pupils consume at school are balanced and nutritious, contributing to improved dietary intakes over the day (39). In the UK, school food standards (SFS) have changed over time and vary across nations. The most recent standards in England (2014) and Northern Ireland (2013) are food-based, with minimum or maximum requirements based on the food type; whilst Scotland (2020) and Wales (2014) use nutrient-based standards alongside food-based standards (40). Although compliance is a legal requirement, there are concerns that schools do not consistently adhere to the SFS (41).

An evaluation of current English SFS in secondary schools (the FUEL study (42)) found that schools were compliant with only 64% of standards on average. Standards that limit foods



and drinks high in fat, sugar or salt showed particularly low compliance. These foods were often most prominent during breakfast and breaktime provision. Similarly, a 2020 report showed that the breaktime offer was compliant in only 60% of schools (41). Qualitative research with secondary schools has revealed that, among other factors, key challenges to SFS implementation include a lack of leadership, oversight, and monitoring on the standards (42). Multiple actions to address SFS compliance have been identified. These include updating the SFS for England (paused at the time of writing (43)), a system of monitoring school compliance with the SFS (already in place in Scotland and currently being piloted by the Food Standards Agency in England (44)), and training for school governing bodies on whole school approaches to food (45-47)

Despite compliance issues, quality standards have the potential to improve nutritional intake in children, influencing dietary elements such as sodium, fat, fruit, and vegetable intakes (48-50). Evaluation of previous iterations of English SFS have demonstrated a positive impact on nutritional intake in younger children (51), however, evidence of impact is less robust in secondary school-aged pupils (52). The FUEL study (42) found that level of compliance with the standards was not associated with improved nutritional intakes in adolescents. This highlights the importance of considering the SFS within the context of wider school food provision. School food provision has to meet the differing needs and preferences of pupils as they grow (53). While primary schools typically serve fewer options which are consumed in the school dining room (54), secondary school canteens serve a wider variety of food. Moreover, food can often be eaten 'on-the-go', reflecting older children's preferences (55,56). These different requirements create further challenges for provision as the food needs to be served quickly, be acceptable to the pupils and minimise waste, whilst meeting the SFS. Across these varied scenarios, it may be difficult for a one-size-fits-all SFS to be consistently followed. Additional support for healthy eating, such as strategies to guide healthy selection by pupils, policies on foods and drinks brought into school, and improving food environments surrounding schools may be required.

Another key challenge to school food provision is funding and resources, which are central to serving high quality food (16). However, rising costs have undermined the complex funding streams for school food (57), which have not kept pace with inflation (58, 59). As such, meeting financial targets is quoted as a barrier to SFS compliance for schools (42, 60). This presents a catch-22 for schools; providing good-value, appealing food is key to driving high



school food uptake and generating revenue (61), yet limited resources may mean it's increasingly difficult for schools to maintain high-quality school food (62).

Furthermore, the current procurement models in schools are complex (11). Responsibility for school food procurement varies from individual schools (20%), local authorities (40%), and external catering companies (40%) (63). The current system is said to prioritise cost over quality (64-66). The procurement process is currently being reviewed and researched (67). It will be essential to understand how different procurement models affect provision and how other factors, such as sustainability, can be given higher priority.

It is important to note however that the average school lunch is still, by many metrics of dietary quality, healthier than the average lunch brought from home (68-70); see **packed lunch** section. While this reflects significant improvements to school food and input from a wide range of stakeholders, challenges persist to school food provision to ensure the best quality of food is available.

While this current achievement should be celebrated, it's critical that the challenges in school food provision are addressed to ensure the best possible food is served.

Whilst quality of food offer will contribute to school meal uptake, other factors will also contribute. For example, much qualitative research has highlighted mealtimes as a stressful experience (time, space, noise), especially in secondary schools (71). Therefore, a range of factors need to be considered when exploring why some schools may have low uptake of school meals and when developing interventions and systems changes to encourage increased school meal uptake.

### **Packed lunches**

In the UK, school children have the choice of a school meal served on school premises (and prepared either at school or in a central kitchen) or taking in a packed/bagged lunch to school. As already discussed, there are regional standards applied to school food served at school, both at lunchtime and at other times during the school day including breakfast and break time; but fewer restrictions are applied to packed lunches brought from home. Some schools apply their own restrictions on what can be brought into school such as prohibiting sugary drinks, confectionery and/or savoury snacks (72). In the UK, a packed lunch typically includes a sandwich, savoury snack, a drink and a sweet snack such as a yogurt or a

biscuit/cookie (72, 73). Fewer than 1 in 5 children include vegetables in their packed lunch and approximately half of children typically include fruit (74).

Existing research indicates that diet quality while at school and over the whole day is worse for children who have packed lunches compared to those that have a school meal; particularly for primary school children aged 5 to 12 years. For example, analysis of data from children aged 6 to 8 years reported that children having packed lunches had lower daily intakes of water and vegetables (69) and higher daily intakes of sugars and salt (69) including sugary drinks and snacks. Analysis of British children from 5 to 18 years reported children having packed lunches consumed more ultra processed foods (73). Similar findings are reported from the US (75). Data from older children attending secondary school are less consistent. Analysis of diet quality of British children aged 11 to 18 years concluded that children in this age group consuming a packed lunch had a higher quality diet than children having a hot school meal (76), reflecting lower adherence to SFS in secondary schools as previously described. There is evidence of a negative impact of packed lunches on health outcomes such as unhealthy weight gain in younger children. Evaluation of universal infant FSM in England which resulted in far fewer children consuming a packed lunch reported lower mean BMI for children receiving FSM between 4 and 7 years, albeit with small effects (25). Published evaluations outside the UK such as in Japan have also reported healthier weights with higher consumption of school meals compared with food brought into school (77).

Improving quality of packed lunches with interventions aimed at families is challenging and has had limited success (78). Organisations interested in children's health such as School Food Matters ([schoolfoodmatters.org/](http://schoolfoodmatters.org/)) support the funding of FSM for all primary school children; and in the absence of a national policy, some cities and regions are funding and implementing such policies themselves, as already discussed. Careful evaluation of these policies is needed to clarify the impact on children's health and wellbeing and to provide sufficient information to help other regions follow suit; in particular, to identify any unintended consequences such as increases in inequalities in diet and health. Evaluation of quality and implementation of standards for food taken to day-care centres by pre-school children is an additional area in need of research and regulation.

## **Holiday clubs and Holiday Activity and Food programmes**

Although holiday schemes that provide food and activities for children and young people are not new in the UK (79), it is only since 2010 that this issue has received public attention (80). While support is available to children from lower-income families through universal or means-tested FSM offerings, and physical activity sessions during term time, concerns over “holiday hunger” and a lack of free or low-cost activities provided during the school holidays led to a Parliamentary Inquiry and a School Holidays (Meals and Activities) Bill (81). In 2018, the DfE launched the Holiday Activity and Food (HAF) Programme, with nationwide roll-out across all local authorities in England in 2021 (82).

Non-HAF funded holiday clubs do not have to follow SFS (83,84), although many may have chosen to (85). Under the HAF Programme, clubs are legally obliged to follow SFS in the same way that most schools in the UK should (83). Alongside issues that other institutions have in adhering to SFS, HAF holiday clubs work under additional constraints that may affect food provision. Some clubs run in schools aim to meet SFS through their standard food provision routes. Other clubs may not have a physical building or site at which they serve food. While a central catering provision may exist through the local council, other clubs may have food delivered from external caterers or provide food based on charitable donations (86). In both of these last instances, cold food offerings may be more likely in order to be realistic and adhere to food safety requirements. Clubs are also expected to provide culturally appropriate foods and ensure food allergies and other specific dietary requirements are catered for (82). These and other issues stretch the already economically lean model that most holiday clubs have to adhere to (87), with additional challenges to also deliver nutritional education noted (88).

Despite these challenges, findings to date broadly suggest that holiday clubs are successful across many outcomes. A recent evaluation of the largest HAF programme in England noted benefits in terms of mental health improvements in both attendees and their parents alongside benefits in relation to childcare provision and ability of parents to work (89). Dietary intake at Kitchen Social hubs was closer to the ideals of UK nutritional guidelines on attendance days than days young people did not attend (83). Recent HAF menu quality evaluation suggested that clubs on average adhered to approximately 70% of all SFS. However, an evaluation of lunch quality against energy and age-adjusted nutrient provision highlighted multiple areas for improvement, particularly in food provision for older attendees (90).

The next steps in progressing food provision in holiday clubs will ideally be informed by club providers and those involved in food provision, to ensure that realistic strategies are developed to tackle the areas for improvement noted to date. For older age groups, novel “HAF+” models (codesigned with young people) are currently being trialled across England, with some programmes opting for a model that promotes young people’s choice and independence, supported by free transport and drop-in activities (91). Early indications highlight positive uptake of the new scheme, with the likelihood of novel approaches required to ensure SFS are met (92).

### **Sustainable school food**

Sustainable school meals with lower carbon footprint and less food waste have the potential to improve environmental footprint of children’s diets (17). The World Health Organization prescribes promotion of healthy and sustainable food systems (93), although school food systems are not specifically mentioned in this report. The research consortium of the School Meals Coalition (<https://schoolmealscoalition.org/>) has recently drafted a white paper on sustainable school food systems titled “School Meals and Food Systems: Rethinking the consequences for climate, environment, biodiversity, and food sovereignty” which is likely to become a useful resource for policy makers (94). Existing SFS in the UK currently focus on health; promoting nutrient dense foods such as fruit and vegetables and restricting nutrient poor foods such as snacks foods high in fats, sugars and/or salt; but do not consider environmental factors. The National Food Strategy, an independent review of the food system for government highlighted the importance of health, environment and equity (<https://www.nationalfoodstrategy.org/>) and it is likely that over the next decade there will be more of a focus on standards that combine metrics for promoting health and sustainability in schools. Whilst there is overlap in the recommendations for human and planetary health, for example fruits and vegetables promote health whilst having low Green House Gas Emissions (GHGE), there are other foods that are not well aligned. Moderate amounts of red meat and dairy foods are needed to provide iron and calcium for growing children however animal-based foods have high carbon footprints. Additional environmental metrics such as water footprint and biodiversity impact also need to be considered rather than carbon footprint alone (95, 96). This is due to challenges in balancing different environmental metrics, for example plant-based diets have lower GHGE but a higher water footprint (95).

Some countries, such as Sweden, are already making progress in taking a more holistic approach. The city of Uppsala in Sweden, has set targets to reduce food waste in schools (97). A school-based intervention, also in Sweden, successfully replaced some of the red meat within meals with pulses whilst maintaining adherence to nutrition standards and without increasing food waste (98). Reducing meat and dairy waste is particularly important according to the Intergovernmental Panel on Climate Change (IPCC) (<https://www.ipcc.ch/report/sixth-assessment-report-cycle/>) as, although there is more waste from plant based foods in school meals (99) the majority of food waste emissions come from animal based food waste. It will be challenging for schools to implement guidelines that focus on both the environment and health. Published research from Vancouver emphasizes the importance of a systems approach in schools in order to successfully combine different and, perhaps at times, competing priorities (100).

In summary, there are challenges ahead for schools in balancing a complex range of requirements for both children and planet. Good leadership and guidance will be needed to implement comprehensive SFS that take account of benefits and downsides of foods and nutrients, inevitably involving some trade-offs to optimise both planet and human health. It is a potential opportunity that, in contrast to health, there is often a substantial 'pull' from children and young people to improve the environment and combat climate change. This offers opportunities to introduce meaningful and acceptable change.

### **School food policy and food curriculum**

Food education has become a critical area for policy reform and this has become evident following the publication of the Levelling Up white paper (45). The white paper described action in four ways, 1) schools will be encouraged to publish statements on the arrangements for their 'whole school approach' to school food, 2) the Department for Education (DfE) will work with the Food Standards Agency (FSA) to pilot measures for greater compliance with standards, 3) offer of training and support to schools, 4) funding of £5 million to support food teachers so that children leave school with knowledge of how to cook. The school curriculum often focuses on cooking and health topics, but reportedly less so on the social-cultural issues which also include inequity and sustainability (101). Whilst research on food literacy (101) has been explored comparatively in the form of policy analysis (102), little attention has been given to conceptualising food education (103).

Food education has become an umbrella term covering a broad range of facets of our relationship with food (104). The definition of ‘food education’ that is adopted here is: ‘education that supports learning about food, nutrition, and the role that food plays in one’s life, relationships, culture, communities, environment, and in history and society’ (105). A whole school food approach can include food education to support the other aspects of the school environment, leading, ultimately, to a school where food can be grown, harvested, cooked, taught, consumed and where food waste is considered. Discourses on food in schools centre around the nutritional purpose it serves (106), and the sensory-centred perspective is less dominant. For example, taste education is particularly emphasised within a whole school food approach (107) (discussed further in the next section). Learning about taste means that food choice is more than just making healthier choices, and a focus on taste can help develop children’s ability to make critical food choices and help them lead a life where they can make their own choices (108). Food education shares similar thinking with ‘pedagogic meal’, ‘taste education’ and ‘food literacy’, and these have come to be used synonymously but all have their function in time, space and place. The term pedagogic meal refers to potential for school meals to be used as a teaching occasion which children learn about food and meals, particularly in a Swedish context (109). Inspired by the SAPERE method which was developed in the 1970s out of a concern for children and their limited palates and diets (110), taste education was developed to give children opportunities to explore food, using all five senses (sight, smell, touch, sound, taste) and their own personal food preferences (111). It aims to capture children’s curiosity and gives them the opportunity to discover new foods which they may not have tried at home in a non-pressured environment. By food literacy, Truman et al. (112) describe the idea of proficiency in food related skills and knowledge. Within the UK, school food policy and a comprehensive food curriculum needs further work at both conceptual and the operational levels (<https://www.nationalfoodstrategy.org/>).

### **Whole School Approaches to Food**

Schools are often described as unique settings to optimise diet quality, eating behaviours and food literacy. While this may be true, interventions that fail to consider the wider context or ‘school system’ are less likely to succeed than those that adopt multiple approaches to influence many factors that influence what and how children eat at school (16, 113-115).

The WHO describes schools that deliver whole school approaches as ‘Health Promoting Schools’ (HPS) with key attributes that input into the school curriculum, change school ethos,

improve school environments and engage with families and communities. This is not solely focused on the food, though is often operated via interventions that change school food environments and outcomes that are focused on diet and nutrition. Evidence on the effectiveness of HPS is inconsistent, with reviews highlighting a lack of robust methods and limited long term data. Within these, studies that choose to focus on a single component of change often produce minimal effects (e.g. promotion of diet quality through only changing types of food on offer). Likely impact may differ depending on the setting, with one review (116) showing that studies that optimised their school food environment had limited effect on fruit and vegetable intake; whereas another review of both primary and secondary schools demonstrated an effect (117,118).

Whole school approaches to food are not a new phenomenon (though perhaps only more recently coined in this way). In 2006, the UK School Food Trust was tasked with transforming school food and food skills so that they met SFS, increased school meal uptake, reduced diet related inequalities and improved skill and food education. Wide partnerships were developed across multiple stakeholders to offer the best chance of making system level changes in schools. These were mapped out into four key areas: 1) positive customer experience, 2) positive mindset, 3) economic viability of services and 4) positive infrastructure and capacity. Evidence on the impact of these has since been tested using a range of methods, with observational data showing effects, particularly on school meal uptake and randomized controlled trial data indicating that positive food experiences at lunch time leads to improved performance and behaviour (114,119).

As public health capitalises more and more on systems science (120, 121) (through our understanding of the complexity of behaviour change and a greater understanding of the multiple factors that interrelate to influence appetite regulation), our ability to understand the school food system improves and provides opportunities to engage across the whole system in a disruptive way that doesn't result in equilibrium (where one policy is diluted by other counter active actions (balancing feedback loop)). This understanding has the potential to develop interventions that can influence at levels that have the greatest chance of impact (though reinforcing feedback loops and a focus on key areas of change (leverage points)). However, while these approaches continue to be advocated in policy (e.g. UK government Levelling up White paper, (45)) they are rarely implemented in practice and not mandated, or indeed monitored. To have the potential for demonstrable effects, there is a clear need for a better understanding of local and wider influences on the school food system, and how these



might enable or limit the potential of whole school approaches to food to promote healthy food choices by children across the school day. Recent evidence provides insights into primary school food systems through a study that co-designed a primary school systems map; highlighting key leverage points with the greatest chance of enacting change (16). For example, by identifying and acknowledging the wider external factors that influence school leadership prioritisation of school food (e.g. governors, Ofsted), there are opportunities to develop and evaluate interventions that can lead to positive system disruption. Based on this systems map (16), the CONNECTS-Food website has been developed as a free resource to help primary schools develop their whole school approach to food policy ([www.connects-food.com](http://www.connects-food.com)). The resource was developed by researchers working in partnership with GENIUS.

While the SFS offer an avenue for schools to consider school food provision (43), this is often conceptualised as ensuring compliance with the food offer and less about delivering whole school approaches to food. At the time of writing, a pilot study is underway in 18 local authorities across England to determine the ability of environmental health officers to monitor school food with a focus on adherence to SFS (122), but this is therefore very much school canteen-focused and not yet considering whole school approaches to food. UK government provides guidance to support school leaders to consider wider areas, such as contracting, staff involvement at lunch time, improving environments and general advice on whole school approaches to food; yet, without a mandate (and under competing priorities within schools) these are unlikely to be embedded into school food policies and unlikely to have an appreciable population-level impact.

### **School food system components not yet considered**

The school food system, as considered by GENIUS, did not consider the school fringe environment. However, the food environment beyond the school gate will also have an influence on the dietary intake of children, particularly in older children, those who can leave the school grounds at lunch time and in those who travel to and from school independently (123,124). Planning restrictions to reduce fast food outlets close to schools have been discussed and implemented by some UK local authorities and regions (125,126); any such changes need to be carefully evaluated. GENIUS considered the school food in nursery, primary and secondary settings, but focused principally on primary and secondary settings in mainstream schools, and there were other parts of the education system that were completely

unexplored. These include the food offering and opportunities for intervention in further and higher education; important settings as they can involve students living independently for the first time. Similarly, schools that are not mainstream, for example, specialist schools, recently highlighted by a main funder (127), have yet to be explored regarding school food provision and opportunity for intervention. Likewise, experiences of children with special education needs within mainstream education, for whom mealtimes can be quite a stressful experience, are relatively understudied.

The network has focused on food, food in schools and dietary intake of pupils; but this needs to be considered alongside other lifestyle behaviours, e.g. physical activity with the International Society for Physical Activity and Health (ISPAH) recognising whole school approaches as one of the ‘eight investments that work for physical activity’ and the school environment as an ideal setting in which to increase physical activity and reduce time in sedentary behaviours (128). A systematic review and meta-analysis by Jacob et al. (129) found that health education interventions delivered within the school-setting which target the biological, psychosocial, environmental and behavioural have the potential to positively influence health behaviours such as diet and physical activity (129). Such combined health education approaches ultimately fulfil and embed the Health Promoting Schools ethics in the UK system.

Finally, literature on the legacy of the COVID-19 pandemic is only starting to emerge (40). COVID-19 affected children’s eating habits due to a change in routine e.g. due to being home-schooled or a change to eating times in schools and classroom bubbles. The variety of foods available was reduced as direct response to the restrictions in schools. Many adaptations due to the COVID-19 pandemic caused changes to working practices, such as kitchen bubbles, and kitchen operations, e.g. increased cleaning and staff-pupil interactions. The classroom bubbling system changed where children and staff ate in schools, which meant that social interactions changed. The various changes also impacted staff working in schools, leading to stress and anxiety. Positives were that schools and regions provided various forms of support for pupils (e.g. through voucher schemes). Teamwork and communication amongst staff in and out of schools improved and agile working, flexibility and pragmatic decisions were required (130).

## Sustaining the GENIUS network

The final workstream of the original plan was to sustain the network. To facilitate this, social network analysis methods were used to visualise the interactions and engagements among the co-investigators of the GENIUS network, to provide an indication of the success of the network in forming new relationships and collaborations within school food. An online survey was disseminated among named co-Is from the original GENIUS proposal in September 2022. Participants were asked to identify other names of co-Is they engage with and estimate how long they had had a working relationship with regarding school food. Duration of relationships was summarised, and online mapping software (<https://kumu.io/>) was used to input survey data to map the network; an illustration of the approach is shown in Figure 1.

Such an approach suggested that 50.4% of all relationships identified were formed within the timeline of the GENIUS project (<5 years), suggesting an impact of the network on networking activity.

Going forward, feedback was also sought from network members about future plans (n=39); 68.4% of respondents stated that participation in the GENIUS network had helped them develop new relationships or collaborations in the area of school food. Interacting and networking with individuals in roles and institutions similar to and different from their own and accessing new resources, information, knowledge, expertise and training were considered the most useful opportunities for members. In the interim period, a Nutrition Society Special Interest Group has been established to allow the ongoing networking activities, alongside ongoing social media and email circulation but, in the longer term, an online knowledge hub is planned to allow ease of networking, maintain the sense of community, allow ample participation and distributed management, and host curated information that anyone can access and use. This is not yet funded, but any developments will be announced via GENIUS communications and updated on the website (<https://geniusschoolfoodnetwork.com/>). In the meantime, a series of research grants been achieved (e.g. <https://www.qub.ac.uk/research-centres/CentreforPublicHealth/Research/PublicHealthNutrition/CANTEENStudy/> and <https://www.connects-food.com/>), some of which have been alluded to within this review. The scoping review of school-based intervention outcomes used is in progress (and the review protocol has been registered with PROSPERO, the International Prospective Register of Systematic Reviews (CRD42021240446)). Once this is completed, that will be the basis

of the core outcome set development and accompanying intervention development and evaluation framework outlined as medium-term objectives within Table 1, although these are funding dependent.

### **Summary and conclusion**

In the short-term, the formation of the GENIUS network has built capacity across all sectors both regionally and UK-wide in the areas of school food thus ensuring the academic and non-academic sector are better equipped with the knowledge and skills and networks to create better school food environments.

Working with both users and stakeholders, a situational analysis of the current school food system has been undertaken, using both established and novel methodologies. The network and this knowledge have then been used to scope a programme of future work, based on systems thinking approaches to food in schools, directed at improving and reducing disparities in nutrition. All activity has been aimed at improving health and well-being and reducing future NCD risk. The network has tried to break down boundaries between disciplines, sectors, and UK nations to promote enhanced connectedness and shared learning. GENIUS network activities will continue via its existing online, mailing and social media presence, the newly funded research projects and through development of an online knowledge hub, thus ensuring achievement of the longer-term objectives set out at the time the network was established.

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## Declaration of interests

The author(s) declare none

## Authorship

All authors contributed to the conception and drafting of the article and its critical revision.

All authors approved the final version to be published.

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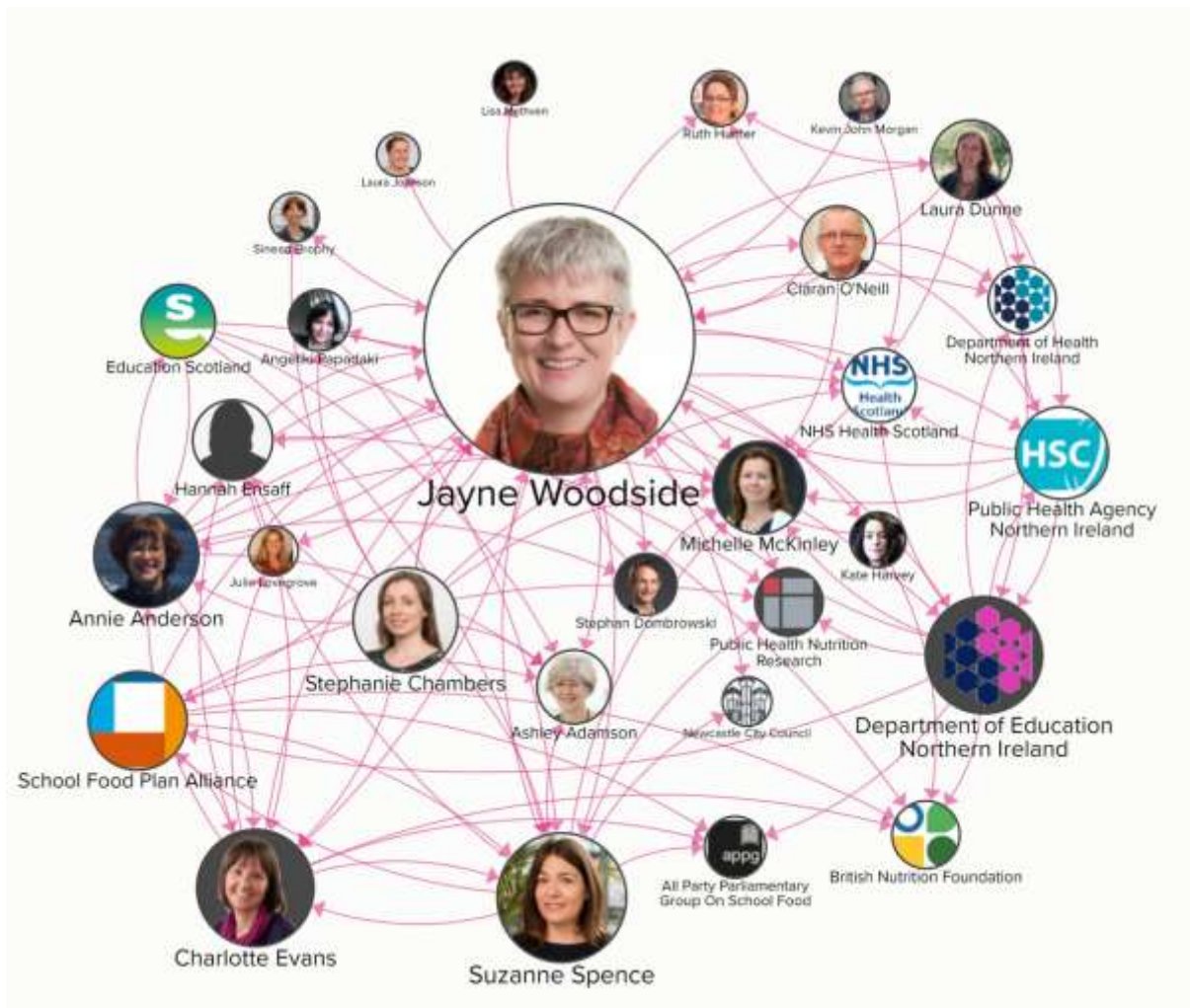
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Table 1 Workstreams and objectives of the GENIUS network

Short-term objectives of the GENIUS network according to workstreams	
Workstream	Objectives
<b>WS1 : Building the network</b>	<ul style="list-style-type: none"> <li>• Build a network of researchers and non-academic stakeholders working within the UK food and school systems</li> <li>• Facilitate interactions that do not currently exist</li> <li>• Build research capacity regionally and UK-wide</li> </ul>
<b>WS2: Understanding the current system</b>	<ul style="list-style-type: none"> <li>• Gather data regarding the school food system in the four different UK nations</li> <li>• Use innovative research methodologies to understand how the school food system operates as a complex adaptive system and how the network develops and functions</li> <li>• Identify areas of best practice that may lead to more evidence-based practice and policies in relation to school food</li> <li>• To co-produce, with project partners and stakeholders, key priorities in terms of changes to practice to be recommended to schools</li> </ul>
<b>WS 3: Sustaining the network and driving impact</b>	<ul style="list-style-type: none"> <li>• Co-produce, with project partners and stakeholders, key priorities in terms of research questions</li> <li>• Use pump-priming funds to support data collection and develop larger scale funding applications co-produced with decision makers and users</li> </ul>
Medium-long term objectives of the GENIUS network	
	<ul style="list-style-type: none"> <li>• Collate and evaluate tools currently used by practitioners and within interventions (a scoping review is in progress as a basis of this objective), develop a theory-based toolkit to support intervention development in the school system, and a framework for evaluation of those interventions, including a core outcome set for school food interventions; such a core outcome set could potentially improve the quality and comparability of school food-based research.</li> <li>• Build a sustainable community of practice focused on the school food system</li> </ul>





**Figure 1:** Illustration of the interactions within the GENIUS network.

Each element/circle is a named co-I; arrows/connections indicate relationship; size of image determined by degree (i.e., number of connections)