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Beyond the Plate: School-Based Food Policies and the Conditions That Shape Eating Behaviour
A Systematic Review

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Abstract

School food environments shape what children eat, and the policies that govern them have become an increasingly prominent lever for public health nutrition. This systematic review examines the effects of school-based food policies and programmes on the dietary intake of children and adolescents aged 6 to 15, with a focus on food consumption outcomes measured using validated food frequency questionnaires. A systematic search of four databases yielded 17 included studies spanning 12 countries, employing a range of school-based approaches including meal provision, competitive food restrictions, multicomponent interventions, and nutrition education curricula. Risk of bias was assessed using the Risk of Bias (RoB) 2 tool. Findings were mixed but patterned. Multicomponent interventions of at least one year's duration produced the most consistent improvements in dietary outcomes. A recurring asymmetry emerged across study types: reducing unhealthy food and beverage intake proved more tractable than increasing consumption of fruit, vegetables, and other nutritious foods. Knowledge-based interventions reliably improved nutrition knowledge without producing corresponding changes in dietary behaviour. Fruit intake was more responsive to school-based intervention than vegetable intake across multiple study contexts. These findings suggest that school food policy holds genuine potential for improving children's diets, but that structural and sustained approaches are more likely to produce meaningful change than short-term or education-only programmes. The implications of policy design for children's broader relationship with eating are also considered.

Keywords: school-based food policy, dietary intake, children, systematic review, food frequency questionnaire, eating behaviour

Beyond the Plate: School-Based Food Policies and the Conditions That Shape Eating Behaviour - A Systematic Review

What children eat today does not stay in today. Eating behaviours — the patterns of consumption that form during childhood through environmental, social, and biological forces — are among the most consequential habits a person develops, with effects that extend far beyond childhood (Funtikova et al., 2015; Kaikkonen et al., 2014). That starts as a personal pattern rarely stays personal for long — it is absorbed into, and amplified by, the wider food systems around it. Across high-, middle-, and low-income countries alike, shifting food systems have made energy-dense, nutrient-poor diets the path of least resistance (Baker et al., 2020). The result is a global epidemic of childhood overweight and obesity that no longer spares any region or income level (Lobstein et al., 2015). By 2022, more than 390 million children and adolescents between the ages of 5 and 19 were living with overweight, 160 million of whom were classified as obese — a figure projected to climb further if current trends remain unchanged (WHO, 2024; NCD Risk Factor Collaboration, 2024). The consequences of this trajectory are far from trivial. Childhood obesity is a well-established predictor of cardiometabolic risk, encompassing hypertension, dyslipidemia, impaired glucose tolerance, and type 2 diabetes (Chung et al., 2018). Beyond physical health, it carries significant psychosocial burdens that might develop into disordered eating habits: diminished self-esteem, exposure to weight stigma, and elevated rates of depressive symptoms accompany excess weight at every developmental stage (Rankin et al., 2016). Overweight and obesity, however, are not the only nutritional crises children face. In many parts of the world, underweight, stunting, and micronutrient deficiency exist alongside obesity — within the same populations, and sometimes within the same households. This is called the double burden of malnutrition: the presence of undernutrition and overnutrition at the same time, each demanding different policy responses and often pulling in opposite directions (WHO, 2017; Tzioumis & Adair, 2014). Malnourished children face substantially higher rates and severity of infectious disease, and poor dietary patterns in all their forms are among the leading contributors to global morbidity and mortality (Rice et al., 2005; GBD 2015 Risk Factors Collaborators, 2016; Afshin et al., 2019). What unites these crises — overweight, undernutrition, diet-related disease — is that the eating behaviours underlying them are largely established in childhood. That is where both the problem and the opportunity lie.

Longitudinal evidence confirms just how durable early dietary patterns tend to be. Children who follow energy-dense, high-fat, high-sugar diets tend to carry similar patterns into adulthood while those with more balanced diets are more likely to maintain higher diet quality over time (Mikkilä et al., 2005; Northstone & Emmett, 2008; Northstone et al., 2012). Individual trajectories can shift as autonomy grows during adolescence, but the tracking evidence is strong enough to suggest that early intervention matters. Since most non-communicable diseases are strongly shaped by dietary behaviour established in childhood, improving diet quality in young people is increasingly understood as a cornerstone of primary prevention (Norat et al., 2015; Baird et al., 2017; Mikkelsen et al., 2019). Dietary behaviour, however, is not fixed. Eating patterns can be meaningfully shaped by altering the environments in which children live, learn, and play — and this is precisely what makes the developmental window of childhood so important for public health action (Swinburn et al., 2004; Micha et al., 2018). What children eat is partly a product of where they eat it, and who shapes that environment.

The relationship between eating and emotional wellbeing is not incidental. How children relate to food — the habits, associations, and patterns of self-regulation they develop early in life — shapes their psychological health in ways that extend well beyond nutrition (Hornberger et al., 2020). Disordered eating behaviours, including restrictive dieting, binge eating, purging, and other forms of unhealthy weight management, are increasingly observed in child and adolescent populations, and their prevalence appears to be rising (Swanson et al., 2011; López-Gil et al., 2023). These behaviours frequently co-occur with overweight and obesity, creating a clinical picture in which body dissatisfaction and disordered eating reinforce each other rather than presenting as separate concerns (Neumark-Sztainer et al., 2007; Goldschmidt et al., 2008; Stabouli et al., 2021). Body dissatisfaction, when combined with dietary restraint, has emerged as one of the most consistent predictors of later depressive symptoms and disordered eating in both boys and girls (Neumark-Sztainer et al., 2007; Sharpe et al., 2018). The pathway is not difficult to trace. Children who internalise weight-focused norms — whether from media, peers, or home environments characterised by restriction rather than responsive feeding — may enter cycles of emotional overeating followed by guilt, shame, and compensatory restriction; in some, these cycles consolidate into clinical eating disorders (Dakanalis et al., 2014; Dane & Bhatia, 2023; Harris et al., 2024).

The relationship between early dietary experience and long-term eating behaviour is not only psychological. It is also neural. Early dietary exposure, including maternal and periadolescent high-fat diet consumption, has been shown to alter mesolimbic dopamine signalling and food preferences in animal models (Naneix et al., 2017; Teegarden et al., 2009). The mesolimbic dopamine system, a central component of the brain's reward circuitry, is widely implicated in assigning motivational salience to food stimuli, encoding which foods are worth pursuing and with what degree of urgency (Berridge & Robinson, 1998; Berridge, 2018). Within this system, dopamine in the nucleus accumbens mediates "wanting" (incentive salience) separately from "liking" (hedonic impact), such that dopamine signals how strongly a food should be sought rather than how pleasurable it is to consume (Peciña et al., 2003; Castro et al., 2015). Responses to food-associated cues can activate mesocorticolimbic dopamine neurocircuitry and promote food-seeking behaviour (Reichelt et al., 2015). The mesolimbic dopamine system does not mature on a fixed schedule. During childhood and adolescence, it undergoes a prolonged timeline of maturation. Galván (2010) reviewed the evidence showing that the adolescent striatal reward system is hyper-responsive relative to both childhood and adulthood. Murty et al. (2018) added a critical functional dimension: in motivationally relevant contexts, adolescents display heightened coupling between the ventral tegmental area and nucleus accumbens.

The developing brain, in other words, is not a passive recipient of food experiences. It is actively being shaped by them. Restriction tests this principle directly. Fisher and Birch (1999) demonstrated experimentally that when children's access to a palatable food is repeatedly limited, they display increased behavioural responses to that food once it becomes available. The result is the opposite of the intended effect. At the neural level, Cone et al. (2014) showed that food restriction increases the magnitude of phasic dopamine spikes evoked by food in the nucleus accumbens, while Carr (2020) reviewed converging evidence that these neuroadaptations elevate the incentive salience of restricted food stimuli. The restricted food does not become less appealing. It becomes more motivationally wanted. In a developing brain that is particularly sensitive to motivational learning, restriction may amplify exactly the signal it aims to suppress.

The behavioural consequence of this process, eating more of a restricted food when access is restored, has been documented repeatedly in children across multiple experimental studies (Fisher & Birch, 1999; Jansen et al., 2007; Rollins et al., 2014). The effect is not uniform: children lower in inhibitory control and higher in approach tendencies show larger increases in intake following restriction (Rollins et al., 2014). A recent systematic review of school-based health and nutrition policies in the United States identified unintended consequences including disordered weight control behaviours and eating disorder triggers in some students (Turner et al., 2024). Policies that operate primarily through prohibition may, in some children, produce effects that is opposite to their intended purpose. They serve as a reinforcing factor rather than reducing the motivational pull of restricted foods. The evidence also points in a more hopeful direction: supportive feeding environments that prioritise enjoyment of nutritious food and attentiveness to hunger and satiety cues appear to reduce eating pathology, build resistance to body-image pressures, and support emotional resilience (Daniels et al., 2015; Wood et al., 2020; Cerea et al., 2024; Langdon-Daly & Serpell, 2017; Robert et al., 2022).

Several studies have reported a marked rise in early-onset eating disorders among children and adolescents in recent years, a trend that has been partly linked to the disruptions of the COVID-19 pandemic (Chen et al., 2024; Lin et al., 2024). What this picture makes clear is that children's relationship with food is not only a nutritional matter. It intersects with self-esteem, peer relationships, emotion regulation, and cognitive development — trajectories that are shaped simultaneously and, in many cases, in the same institutional settings (O'Neil et al., 2014; Nyaradi et al., 2013). Among those settings, schools occupy a particular position: they reach nearly all children, for a substantial portion of each day, across the years when both dietary habits and psychological relationship with food are most malleable.

Schools as a Nutritional Setting

No single institution reaches more children, for more hours, across more of the developmental years that matter than school. In most countries, school-aged children spend at least one-third of their waking day in formal education, eating at least one main meal there and often additional snacks (Briefel et al., 2009; WHO, 2025). As a result, dietary studies from both high- and middle-income countries consistently show that food consumed during school hours constitutes a substantial portion of children's total daily intake (O'Kane et al., 2023; Losasso et al., 2015). That makes schools not just a venue for learning but one that shapes a significant share of children's relationship with food, whether by design or by default (Cullen & Chen, 2017;

WHO, 2025; UNSCN, 2017). Several theoretical frameworks help explain why. Social cognitive theory holds that behaviour is constructed and sustained through reciprocal relationships between the individual and the environment: what is available, what is modelled, and what is reinforced all matter (Bandura, 1986). Socio-ecological models extend this further, recognising that food availability, pricing, presentation, and institutional norms shape eating behaviour as powerfully as personal habits or knowledge (Story et al., 2008; Townsend & Foster, 2011). Self-determination theory adds a motivational dimension that the other frameworks tend to underweight: the conditions schools create — not only the foods they offer but the degree of autonomy and positive engagement they support — may determine whether the eating behaviours they promote become intrinsically motivated or merely externally compliant (Ryan & Deci, 2000; Verstuyf et al., 2012).

The social dimension of school eating matters too. Through daily interaction with peers and teachers who model eating behaviours, children receive powerful social cues about what is normal, desirable, and acceptable to eat (Bandura, 1986; Birch, 1980; Houldcroft et al., 2015). These cues operate below the level of explicit instruction. They are absorbed through observation, imitation, and the quiet formation of shared norms around food. Repeated exposure to unfamiliar foods, when paired with sensory education or hands-on cooking experience, has been shown to produce meaningful increases in both consumption and food-related knowledge — modest in magnitude but consistent in direction (Ehrenberg et al., 2019; Mustonen & Tuorila, 2010). Nutrition education programmes grounded in social cognitive theory have similarly improved dietary outcomes when delivered alongside modifications to the school food environment, shaping children's self-efficacy and self-regulation around food choices (Kamath et al., 2016). The school food environment is therefore not background noise; it is a primary lever for dietary change, one that operates at population scale and with structural reach that few other settings can match. Taken together, schools are an environment in which children's relationship with food is continuously being formed and that is what makes the design of school food policy consequent ial.

Decreasing Food Insecurity

School food policies are also, at its core, an equity issue. By providing free or subsidised meals, schools narrow the nutritional gap between children from affluent and disadvantaged families — a gap that is otherwise determined almost entirely by household income and circumstance (Forrestal et al., 2021; Ralston et al., 2017). For some children, the meal provided at school is the only nutritionally complete meal of the day (Huang et al., 2015; Forrestal et al., 2021). The significance of this becomes starkest in the data on summer hunger: food insufficiency rates among children receiving free or reduced-price lunches rise markedly when school is not in session, making the school meal a genuine safety net rather than a supplement (Huang et al., 2015). Universal school meal policies have also been associated with improvements in diet quality and modest reductions in socioeconomic disparities in nutritional intake (Cohen et al., 2021; Parnham et al., 2022). School food policy, in short, is one of the few instruments available to governments for improving child nutrition at scale, across income levels, and without relying on individual or family resources to do the work.

Food Policy Interventions in Schools

School food policies take many forms. At their broadest, they can be defined as systematic actions implemented by school administrators and governments to shape patterns of food and beverage consumption throughout the school day — modifying the availability, composition, pricing, promotion, placement, and provision of food in ways designed to shift dietary behaviour at the population level (Swinburn et al., 2019; WHO, 2023). The specific policy levers available include nutrition education and cooking programmes, restrictions on the sale of competitive foods and beverages, free or subsidised meal provision, and changes to cafeteria design and choice architecture. Each of these approaches has a different mechanism of action, a different evidence base, and different implications for how children relate to food.

Competitive Food and Beverage Policies

Competitive foods — items sold outside school meal programmes, typically high in calories and low in nutritional value — have been the target of some of the most direct school food policy interventions (Gordon et al., 2007; USDA, 2016). Most such policies operate through legislation that sets upper limits on calorie content, fat, saturated fat, added sugars, and sodium per portion during school hours (USDA, 2016). Sugar-sweetened beverages are typically restricted or banned outright; plain milk and unsweetened drinks remain permitted. The effect can be substantial. When California introduced competitive food standards in 2007, middle-school students' purchases of sugar-sweetened beverages fell by 30% and snack purchases by 20% during school hours — with no compensatory increase in consumption at home (Woodward-Lopez et al., 2010). That last detail matters: it suggests the policy was genuinely changing behaviour, not merely displacing it.

What these policies do not address, however, is the mechanism through which restriction operates in the developing brain. The competitive food framework assumes that removing access to energy-dense items will reduce their appeal. Rollins et al. (2014) found that the effects of restriction differ by child temperament: children lower in inhibitory control, higher in approach, and with prior experience of parental restriction showed the largest increases in intake when restricted foods became available. Jansen et al. (2007) demonstrated that even a simple prohibition – telling children not to eat a particular snack – led to relatively higher consumption of that food compared to non-prohibited alternatives. The issue is not whether restriction changes behaviour. It does. The question is whether it changes it in the intended direction.

Food Provision Programs

Where competitive food policies restrict what is sold, provision programmes change what is given. By supplying food directly through free or subsidised school meals, these interventions remove the financial barrier that would otherwise prevent many children from accessing adequate nutrition at school. Evidence from the EU School Fruit and Vegetable Scheme shows that direct provision can increase fruit and vegetable intake, with particularly consistent gains among children from socioeconomically disadvantaged backgrounds (European Commission, 2012; Meshkovska et al., 2023). In Poland, participation was associated with an 18% increase in fruit consumption over three years (Wolnicka et al., 2021). In England and Scotland, the Universal Infant Free School Meal policy improved lunchtime diet quality by reducing consumption of ultra-processed foods (Parnham et al., 2024).

Behavioral Economics and Choice Architecture

A different kind of policy operates not by restricting choice but by restructuring how choices are presented. Choice architecture — the arrangement of options in ways that guide people toward selections without limiting their freedom — has attracted interest as a low-cost, low-resistance tool for school food improvement (Thaler & Sunstein, 2008). In school cafeterias, applications include placing fruit and vegetables at the most visible points of the serving line, using evocative labelling (e.g., “Veggie Crunchers!”), setting healthier defaults such as fruit as the standard side dish, and deploying normative prompts that frame healthy choices as the majority behaviour (Hanks et al., 2012; Just & Price, 2011; Wansink et al., 2012). The evidence is promising: a low-cost “smarter lunchroom” redesign increased both the likelihood of students selecting fruit and their actual consumption of it (Hanks et al., 2013). These interventions work with the grain of human behaviour rather than against it.

Curriculum-Based Nutrition Educations

Curriculum-based nutrition education takes a different approach: rather than changing the environment, it attempts to change what the child knows. Structured classroom programmes, typically grounded in social cognitive theory or related behavioural frameworks, aim to improve nutritional knowledge, attitudes, and self-regulatory skills (Dudley et al., 2015). Experiential approaches — gardening, cooking, and sustainability-focused learning — have shown promise, demonstrating positive effects on children's willingness to try new foods, cooking competence, and nutritional understanding (Charlton et al., 2020). Whether these knowledge gains translate into durable changes in dietary behaviour, however, is a question the evidence answers less confidently — and one that this review examines directly.

Importance of the Study

This review takes both questions seriously: what school food policies do, and the conditions under which they do it. Taken together, the evidence reviewed above indicates that the school food environment is a key, modifiable determinant of children's dietary behaviour — one with consequences that has potential to extend from short-term nutritional status to long-term physical and psychosocial wellbeing. Identifying which categories of school-based food policy is of direct relevance to policymakers and school administrators seeking to allocate limited resources effectively. But the question this review asks is not only which policies produce better dietary outcomes. It is also how they produce them — and what the conditions they create might mean for children's broader relationship with food. In a setting where children spend a significant portion of their formative years, the design of food policy is not a neutral act. Policies built around positive food experiences, autonomy, and access may operate differently than those built primarily around restriction — and that difference, while not directly measurable in the dietary data this review examines, is one the field cannot afford to ignore.

Rationale for This Review

The evidence base for school-based food policy has been reviewed before, and those reviews have contributed meaningfully to what is known. Micha et al. (2018) conducted a systematic review and meta-analysis of school food environment policies, focusing primarily on competitive food restrictions and meal provision programmes and drawing largely on studies from high-income settings. Durão et al. (2023) extended this work by examining both health and non-health outcomes of school food policies and interventions, again without restricting to a specific outcome measurement methodology. Van Cauwenberghe et al. (2010) and Chaudhary et al. (2020) have similarly synthesised evidence from specific regional or methodological perspectives. The present review differs from these prior efforts in several respects. First, it restricts inclusion to studies that measured dietary intake using a food frequency questionnaire or a validated FFQ-based adaptation — a methodological decision that sacrifices breadth for comparability but produces a set of studies that are evaluable against a shared measurement standard. Second, it focuses specifically on food consumption as a behavioural outcome, rather than on attitudes, knowledge, anthropometric measures, or composite health indices. Third, it draws on studies conducted across twelve countries spanning four continents, including low- and middle-income settings that have been underrepresented in previous reviews. Finally, and most distinctively, it brings an interpretive frame to the evidence that prior reviews have not pursued: the question of what school food policies do to children's relationship with food — not only what they do to their nutrient intake — and what the implications of this might be for eating behaviour related problems.

Objectives of the Study

This review aims to examine the effects of school-based food policies and programmes on the dietary intake of children and adolescents aged 6 to 15, across a range of cultural and economic contexts. The focus is specifically on food consumption as a behavioural outcome — how much children actually eat, not only what they know or believe about food — measured through validated dietary assessment tools. The review considers the full spectrum of school-based approaches, from meal provision and competitive food restrictions to nutrition education and multicomponent programmes, assessed against a comparator condition of standard school provision or no intervention. Where the evidence allows, this review also attends to the conditions under which school food policies operate — recognising that the relationship children develop with food in school settings may shape their broader eating behaviour in ways that consumption data alone cannot capture.

Behavioral Outcomes and Measurement

Dietary behaviour is measurable in several ways, and which method is used matters. At the most direct level, researchers track the amount, frequency, and food-group composition of what children consume — in grams, portions, or servings per day of foods such as fruit, vegetables, sugar-sweetened beverages, snacks, or school meals (Micha et al., 2018). Focusing on consumption as the primary outcome, rather than on knowledge or attitudes, reflects a deliberate methodological choice: behaviour is what public health policy ultimately needs to shift, and consumption data, however imperfect, offers the most direct window onto whether it has (Moitra et al., 2021).

Several methods have been used to capture this. Cafeteria sales data offer a practical proxy for dietary intake at school, though they measure selection — what students choose or purchase — rather than consumption: what they actually eat (Machado et al., 2020). Plate waste assessment addresses this gap directly, estimating what was consumed by weighing or photographing what was left (Smith & Cunningham-Sabo, 2014). The 24-hour dietary recall (24hDR), in which trained interviewers guide children through a detailed account of everything they ate the previous day, captures school meal intake within the broader context of the day's eating (Foster & Bradley, 2018). For larger samples and longer time horizons, food frequency questionnaires (FFQs) offer the most practical approach for this review: structured instruments that ask about habitual intake across a defined period, with items, recall windows, and food group. (Buch-Andersen et al., 2016. With these methodological distinctions in mind, the sections that follow examine what the evidence can and cannot tell us about how school-based food policy shapes children's dietary behaviour — and what that evidence, carefully read, might mean for the children these policies are designed to serve.

Method

This systematic review was conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA 2020) guidelines (Page et al., 2021). The review protocol was developed prior to data collection and followed a pre-specified eligibility framework, a structured search strategy, and a staged selection process. Each phase of the review is described in detail below.

Protocol and Registration

This review was not pre-registered in PROSPERO or any other systematic review registry. The absence of a pre-registered protocol is acknowledged as a limitation; however, the eligibility criteria, search strategy, and data extraction procedures were defined prior to data collection and applied consistently throughout the review process.

Eligibility Criteria

Eligibility was assessed using the PICO framework (Population, Intervention, Comparison, Outcomes) (see Table 1). Only experimental studies were considered for inclusion. The criteria were applied hierarchically during screening: a study was excluded at the first unmet criterion without further assessment.

Population

Eligible studies involved school-aged children between 6 and 15 years of age. When age was not explicitly stated, grade-level information was used to estimate participants' approximate ages based on the educational norms of the country in question. Where a reported age range extended marginally beyond the predefined threshold, studies were retained for full-text review to determine whether age-stratified data within the eligible range were available; if so, those data were extracted. Studies were excluded if the population consisted solely of individuals with pre-existing physical conditions (e.g., obesity, overweight, type 2 diabetes) or diagnosed mental health conditions (e.g., autism spectrum disorder), unless a control group without those conditions was present. Studies in which measurements or outcome reports were provided exclusively by parents — even when reporting on behalf of their children — were also excluded. No restrictions were placed on gender or socioeconomic status.

Intervention

Eligible interventions included any formal school-based food policy or programme delivered during school hours and/or within the school environment. This encompassed a broad range of approaches, including nutritional standards for school meals, environmental modifications, food provision programmes, school gardens, behavioural nudges, nutrition education curricula, and multi-component interventions involving both school and home components. When an intervention addressed multiple settings or administrators (e.g., teachers and parents), it was included provided that a school-based component was clearly present and described. Interventions focused exclusively on physical activity or anthropometric outcomes, with no dietary component, were excluded. No restrictions were placed on intervention duration or follow-up timeframe.

Comparison

Studies were required to include a comparator condition, defined as either a control group receiving no intervention or a wait-list control. Mixed designs incorporating repeated pre- and post-intervention measurements alongside a control group were accepted. Studies relying exclusively on within-group designs — that is, those assessing change without a concurrent control group — were excluded, as were reviews, meta-analyses, guidelines, protocols, observational studies, and articles reporting only baseline data.

Outcomes

The primary outcome of interest was objectively measured or self-reported food consumption. Eligible outcome measures included: total caloric intake across meals; macronutrient and micronutrient distribution (e.g., fat, carbohydrates, protein, fibre); and the frequency, quantity, or total intake of specific food groups — including fruit and vegetables (F&V), whole grains, dairy, meat, legumes, and snacks (e.g., sugar-sweetened beverages, fried snacks, high-fat or high-sugar foods). To ensure measurement reliability, only studies that assessed these outcomes using validated and standardised tools — primarily food frequency questionnaires (FFQs) or their validated adaptations — were eligible. Studies that measured dietary-related constructs other than consumption (e.g., food knowledge, food preferences, or attitudes only) were excluded, as were studies assessing non-dietary impacts of the intervention.

Table 1

PICO Framework: Eligibility Criteria for Study Inclusion

Element	**Description**
Population	School-aged children and adolescents between 6 and 15 years of age, attending formal education in any country.
Intervention	Any formal school-based food policy or programme delivered during school hours or within the school environment.
Comparator	A control group receiving no intervention or standard school provision.

Element	Description
Outcome	Food consumption as a primary or secondary outcome, measured using a food frequency questionnaire (FFQ) or a validated FFQ-based adaptation.

Note. PICO = Population, Intervention, Comparator, Outcome. FFQ = food frequency questionnaire. Eligibility criteria were applied hierarchically during screening; a study was excluded at the first unmet criterion.

Information Sources and Search Strategy

A systematic literature search was conducted across four databases: PubMed, Web of Science, APA PsycINFO, and Scopus. All searches were executed on March 1, 2024, yielding a combined total of 4,415 records (PubMed: 259; Web of Science: 2,130; APA PsycINFO: 1,239; Scopus: 787). Search strings were structured around three conceptual blocks: (1) the target population (e.g., child*, primary school); (2) the intervention type (e.g., school food policy, school intervention, nutrition education, healthy eating intervention); and (3) the outcome domain (e.g., food preferences, food liking, food attitudes, implicit and explicit food preferences). Boolean operators and wildcards were applied throughout to capture relevant term variations. The full search strings for each database are provided in Appendix A.

In addition to database searches, a targeted manual search was conducted to retrieve full-result publications for studies initially identified only in protocol or baseline-data form. Specifically, four protocol-only papers (Scherr et al., 2014; Sutherland et al., 2019; Karpouzis et al., 2021; and Xu et al., 2014) were searched by author and title to locate their corresponding results publications (Scherr et al., 2017; Sutherland et al., 2021; Karpouzis et al., 2024; and Xu et al., 2015, respectively), which were subsequently included in the review. Two additional protocol papers (Pinto et al., 2019; Schuh et al., 2017) were excluded after no full results could be retrieved. No other registers, organisational websites, or grey literature sources were consulted. The search was restricted to articles published in English.

PubMed: (((child*) OR (primary school)) AND ((school intervention) OR (school food program) OR (nutrition education) OR (school food policy) OR (healthy eating intervention)) AND ((healthy food) OR (food preferences) OR (food liking) OR (food attitudes) OR (implicit food preference) OR (implicit attitudes) OR (explicit attitudes) OR (explicit food preferences))).

Web of Science: ((TS=(child*) OR TS=(primary school)) AND (TS=(school intervention) OR TS=(school food program) OR TS=(nutrition education) OR TS=(school food policy) OR TS=(healthy eating intervention)) AND (TS=(healthy food) OR TS=(food preferences) OR TS=(food liking) OR TS=(food attitudes) OR TS=(implicit food preference) OR TS=(implicit attitudes) OR TS=(explicit attitudes) OR TS=(explicit food preferences))).

APA PsycINFO: (((child*) AND ((school intervention) OR (school food program) OR (nutrition education) AND ((healthy food) OR (food preferences) OR (food liking) OR (food attitudes)) AND (primary school)) AND (school food policy) OR (healthy eating intervention)) AND ((implicit food preference) OR (implicit attitudes) OR (explicit attitudes) OR (explicit food preferences))).

Scopus: "child*" OR "primary school" AND "school intervention" OR "school food program" OR "nutrition education" OR "school food policy" OR "healthy eating intervention" AND "healthy food" OR "food preferences" OR "food liking" OR "food attitudes" OR "implicit food preference" OR "implicit attitudes" OR "explicit attitudes" OR "explicit food preferences".

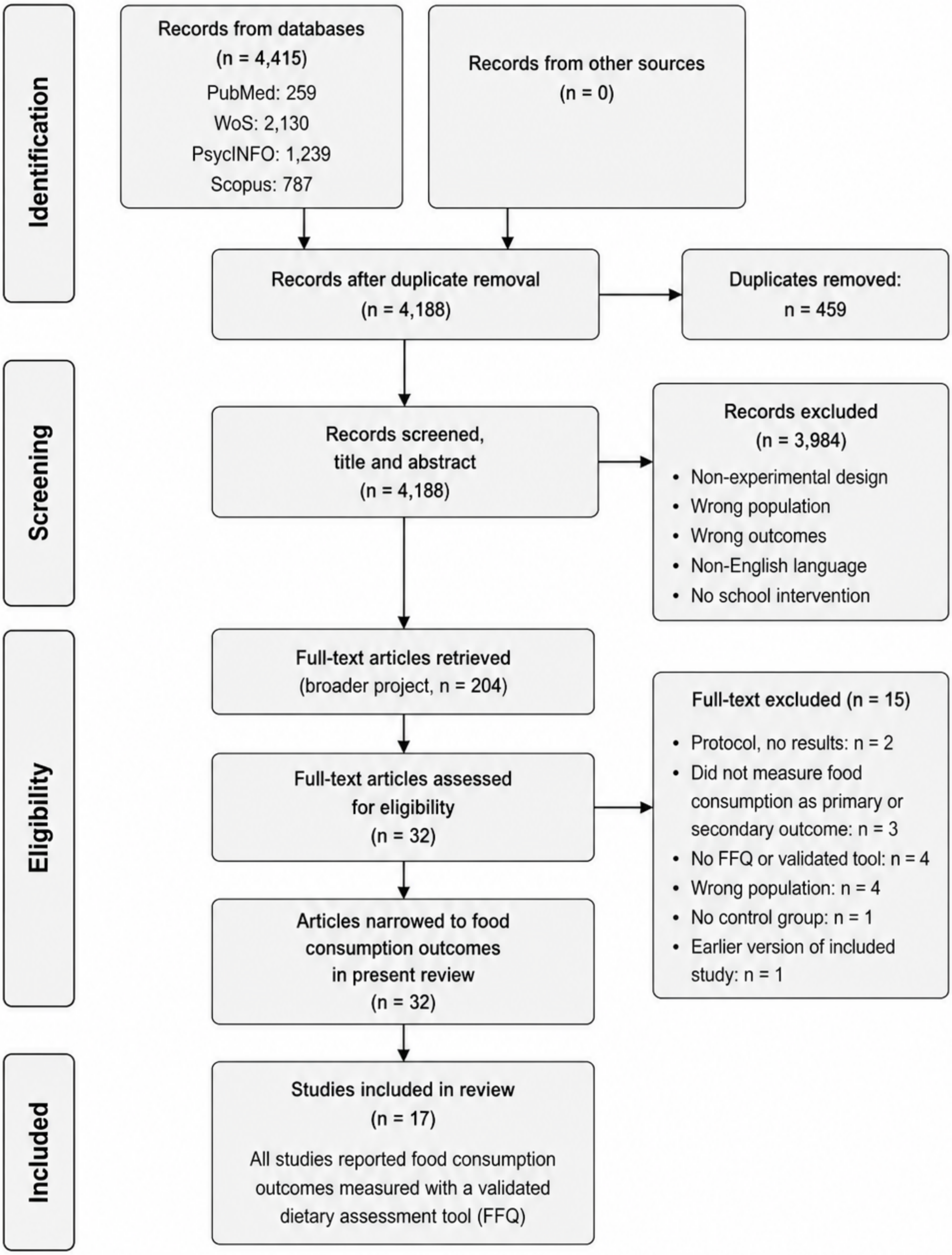
Selection Process

Study selection was carried out in two sequential phases — title and abstract screening, followed by full-text review — using Rayyan, a web-based platform designed for systematic review management (Ouzzani et al., 2016). The process involved three independent researchers throughout. Following database searches, all 4,415 records were imported into Rayyan. The deduplication process identified 459 duplicate records; following manual verification of flagged items (non-duplicates confirmed: n = 7; resolved: n = 225), a total of 4,188 unique records were carried forward to screening.

During title and abstract screening, two researchers independently assessed each record against the hierarchical exclusion criteria. Records were excluded at the first unmet criterion. Disagreements between the two reviewers, and cases where the available abstract did not provide sufficient information to make a clear judgement, were labelled as "maybe" and flagged for resolution. A third independent researcher assisted in resolving these uncertainties through independent review and online consensus meetings held at regular intervals until all discrepancies were settled. Abstract screening proceeded in several iterative rounds. By March 14, 2025, an initial pass had yielded 3,856 exclusions, 251 inclusions, and 81 articles flagged as "maybe." The flagged articles were reviewed by the third researcher; following consensus meetings, 43 were excluded and 15 were included, with the remainder retained pending further discussion due to insufficient information in the abstract. By May 29, 2025, the cumulative counts stood at 3,896 excluded, 265 included, and 27 still unresolved. Abstract screening was completed on June 11, 2025. At this final stage, studies relying exclusively on a within-group design were eliminated, and all remaining ambiguities were resolved through consensus. Across all rounds, a total of 3,984 records were excluded, leaving 204 articles eligible for full-text review.

The 204 articles retrieved for full-text review were part of a broader systematic review project examining multiple dietary outcome domains. For the purposes of the present review, this pool was first narrowed to studies reporting food consumption as a primary or secondary outcome. Studies reporting only dietary knowledge, food attitudes, or preference outcomes — without a direct consumption measure — were excluded at this stage, reducing the pool to 32 articles (172 excluded). Full-text eligibility assessment of these 32 articles began in October 2025. Fifteen articles were excluded: two protocol papers for which full results could not be retrieved; three studies that did not measure food consumption; four studies that did not use an FFQ or equivalent adapted tool; four studies with populations outside the eligible age range and no age-stratified data available; one study without a control group; and one study that was an earlier version of an already-included publication. Following a final consensus review, all remaining uncertainties were resolved by December 15, 2025, and a final set of 17 studies was retained for inclusion in the review. The complete selection process is illustrated in the PRISMA 2020 flow diagram (Figure 1).

Figure 1. PRISMA 2020 Flow Diagram of the Study Selection Process



Note. Database search: March 1, 2024. Abstract screening: June 11, 2025. Full-text eligibility: December 15, 2025. 204 articles were retrieved as part of a broader systematic review project; the present review was restricted to food consumption outcomes.
FFQ = food frequency questionnaire. WoS = Web of Science.

Data Collection and Extraction

A standardised data extraction form was developed prior to data collection and applied consistently across all 17 included studies. The primary author was responsible for the detailed extraction of all included studies; extracted data were subsequently cross-checked by the other team members to verify accuracy. Where specific data points were ambiguous, missing, or difficult to interpret — particularly for primary outcome variables — the research team consulted one another to reach a consensus. The study supervisor was involved when disagreements persisted.

Data collection was conducted in phases, scaled from broad to specific. In an initial phase covering all 204 articles under full-text review, general descriptive information was extracted — including study identification, sample characteristics, and basic intervention details — to facilitate categorisation across the larger dataset. Following this, standardised extraction tables were developed by outcome domain (food consumption, food knowledge, food preference) to guide a more focused synthesis. The final detailed extraction was limited to the 17 included studies and was managed exclusively through shared Google Sheets to enable real-time collaboration and version control among all team members.

The primary outcome domain for this review is food consumption, defined as any directly measured or self-reported change in dietary intake following the intervention. Extraction targeted four measurement dimensions: (a) quantity and volume, including total or mean consumption in grams, ounces, cups, portions, or packages within a given timeframe; (b) nutritional density, encompassing cumulative energy intake and the relative share of specific macronutrients or micronutrients; (c) frequency and variety, captured through daily or weekly average servings and the range of food groups consumed; and (d) category-specific intake, focusing on targeted food groups particularly relevant to the intervention — primarily fruit and vegetables, snacks, and sugar-sweetened beverages.

No restrictions were applied to the timepoints at which outcomes were measured. When a study reported results at multiple timepoints (e.g., post-intervention and follow-up), each was extracted separately to allow for analysis of both immediate and longer-term effects. In studies reporting multiple statistical models, adjusted estimates were preferred over unadjusted or raw data. Due to the heterogeneity in reporting formats across the included literature — which encompassed odds ratios, beta coefficients, mean differences, partial eta squared, and p-values, among others — it was not possible to standardise all results into a single metric. All results were therefore extracted in their original reported format.

The following variables were systematically extracted from each included study:

Study identification: assigned study ID, primary author, year of publication, and title.

Intervention characteristics: description of the intervention and its duration, categorised into three domains — (a) Environmental Change (e.g., physical activity components, behavioural nudges, parental involvement, hands-on cooking, taste tests, gardening); (b) Nutrition Education (e.g., classroom activities, music-based reinforcement, posters, cross-curricular nutrition content); and (c) Meal Provision (e.g., free or subsidised school lunches, fruit and vegetable breaks, organic school meals).

Participant demographics: total sample size, age range, mean age (with SD), and sex distribution, stratified by intervention and control group where available. Grade-level was used to infer approximate age when not reported.

Measurement data: dietary assessment methodology (e.g., FFQ) and randomisation status.

Statistical results: pre- and post-intervention means with SDs for both groups, along with effect estimates in their original reported format.

Risk of Bias Assessment

The methodological quality of each included study was assessed using the Risk of Bias 2 (RoB 2) tool (Sterne et al., 2019), which was developed for randomised trials and applied here across all study designs. Five domains were evaluated: the randomisation process (D1), deviations from intended interventions (D2), missing outcome data (D3), measurement of the outcome (D4), and selection of the reported result (D5). All assessments were made for the intention-to-treat effect. Each domain was rated as low risk, some concerns, or high risk, and an overall bias judgement was assigned accordingly. Assessments were conducted by the primary author and reviewed by team members; disagreements were resolved through discussion. Table 2 presents the main characteristics of the included studies.

Synthesis Methods

Given the considerable heterogeneity across included studies — in terms of intervention type, population characteristics, outcome measures, and the units and formats in which results were reported — a meta-analytic pooling of effect estimates was not feasible. A narrative synthesis approach was adopted instead. Studies were initially grouped according to intervention type to provide a structured framework for comparison. Within each group, individual study findings were examined in relation to the specific dietary outcomes assessed. A second, iterative grouping was then applied based on observed patterns in the results, allowing the emerging evidence to inform the thematic organisation of findings. Results were extracted and reported in their original format — including odds ratios, mean differences, beta coefficients.

Results

Across the 17 included studies, the evidence on school-based food policy and children's dietary outcomes was mixed, context-dependent, and rarely straightforward. Full effect estimates and confidence intervals to our knowledge for each study and outcome are presented in Table 3.

Programmes Targeting Fruit and Vegetable Intake

The longest and most intensive interventions in this category produced the clearest results. The Nutri-školica project (Ilić et al., 2022), a three-year multicomponent programme delivered across primary schools in Zagreb, produced a meaningful net increase in total daily fruit and vegetable intake in the intervention group. The effect was not uniform across food categories, however. Combined measures — fruit with juices, and vegetables with vegetable juices — drove the finding; isolated fruit alone and isolated vegetables alone did not reach significance in the adjusted analyses.

The Canadian APPLE Schools programme (Fung et al., 2012) offered a different picture. Implemented across ten socioeconomically disadvantaged schools over two years, the programme produced gains in daily fruit and vegetable intake among intervention students while the comparison group declined, however, the net difference did not reach conventional significance in terms of fruit and vegetable intake. What the data did show unambiguously was a significant reduction in overall energy intake among intervention students at follow-up. Whether this reflects changes in what children ate or how much they ate overall is difficult to disentangle, but the direction of change was consistently favourable.

Table 2

Characteristics of Included Studies

Study (Author, Year, Country)	Design	N	Population	Intervention	Comparator	Outcome Measures	Assessment Tools	Follow-up	Funding Source
Li et al. (2019), China	Cluster RCT	1,641 (832 int.; 809 ctrl.); 1,586 retained	Grade 1, M age = 6.15 yrs, 54.5% boys; 40 schools, urban Guangzhou	CHIRPY DRAGON: school- and family-based healthy eating & PA programme	Usual provision (no intervention access)	Primary: BMI z-score; Secondary: F&V, SSB, snacks, MVPA, screen time, BP	Measured height/weight; parent-reported diet/activity questionnaires; accelerometers	12 months	Zhejiang Yong Ning Pharmaceutical Co. (donation)
Moitra et al. (2021), India	Cluster RCT	498 completers (292 exp.; 206 ctrl.) of 518	Adolescents 10–12 yrs, grades 6–7, 48% girls; 4 schools, Mumbai	HEAPS: 12-week behaviourally focused nutrition education (Health Belief Model)	No sessions conducted	KAP: knowledge, attitude, dietary and physical activity practices	Validated 84-item KAP survey, baseline and 12-week endline	12 weeks (subsample to 2 mo.)	Not specified
Vik et al. (2020), Norway	Non-randomized trial	164 (55 int.; 109 ctrl.)	Children 10–12 yrs; 2 rural schools, southern Norway	Free healthy school lunch for one school year	Packed lunch from home (no school meal)	Fruit, vegetable, and unhealthy snack intake	5-item child FFQ, baseline, 5 mo., 12 mo.	12 months	University of Agder
Siega-Riz et al. (2011), USA	Cluster RCT	3,908 of 4,603 cohort (85% valid FFQ); 42 schools	Grades 6–8, ages 10–14; >50% minority/free-reduced meals; 7 US centres	HEALTHY: 5-semester multi-component intervention (nutrition, PE, behaviour, marketing)	Regular nutrition curriculum	Energy, macronutrients, F&V, sweets, SSB, grains, legumes, water	Block Kids Questionnaire (~100-item FFQ), baseline and end of study	3 years	NIH/NIDDK
Wadolowska et al. (2019), Poland	Quasi-experimental	464 (319 educated; 145 ctrl.)	Pre-teens 11–12 yrs, 46.6% boys; elementary schools, Poland	ABC of Healthy Eating: 3-week, 15-hour diet/lifestyle education programme	Standard school activities only	Diet quality (pHDI, nHDI), nutrition knowledge, screen time, PA, BMI, WHtR	SF-FFQ4PolishChildren; anthropometric measurement	9 months	ABC of Healthy Eating project; Polish Ministry of Science and Higher Education
Bessems et al. (2012), Netherlands	Cluster RCT	1,875 (1,117 exp.; 758 ctrl.); 24 schools	Students 12–14 yrs, prevocational education; Netherlands	Krachtvoer: 8-lesson healthy diet programme (Self-Regulation Theory)	Regular nutrition lessons	Fruit, fruit juice, breakfast, and snack consumption	Validated fruit/fat FFQ items; breakfast recall	Baseline, 1–4 wk post, 6 mo.	ZonMw; Dutch Heart Foundation
Hovland et al. (2010), USA	Quasi-experimental	138 final analysis (of 238 baseline); 10 test, 2 ctrl. classrooms	3rd graders, ~8–9 yrs; rural Appalachian Ohio	FoodMASTER: 45-lesson hands-on maths/science nutrition curriculum	Regular curriculum (2 classrooms)	Macronutrient, micronutrient, and food-group intake	Block Kids FFQ 2004 (77 items), pretest/posttest	1 school year	NIH Science Education Partnership Award (R25RR020447)

Study (Author, Year, Country)	Design	N	Population	Intervention	Comparator	Outcome Measures	Assessment Tools	Follow-up	Funding Source
Xu et al. (2015), China	Cluster RCT	1,108 completers of 1,182 (93.7%); 8 schools	Grade 4, ~9–10 yrs; urban Nanjing	CLICK-Obesity: 1-year multi-component lifestyle intervention	Routine health education only	BMI, obesity, dietary intake (red meat, F&V, snacks, SSB), PA, screen time	Measured height/weight; self-reported diet/PA/knowledge questionnaire	1 school year	Nanjing Municipal Science & Technique Foundation; NIH (U54HD070725)
He et al. (2012), Denmark	Cross-sectional	165 sixth-graders (2 organic, 2 non-organic schools)	6th grade, ~11–13 yrs; Copenhagen area	Organic school food policy (24–50% organic ingredients)	Non-organic school food provision	School lunch habits, food consumption frequency, attitudes (TPB)	Adapted FFQ (from Pro Children study); focus group interviews	Cross-sectional	Aalborg University Denmark
Scherr et al. (2017), USA	Cluster RCT	409 (2 ctrl. schools n=179; 2 int. schools n=230)	4th graders, 9–10 yrs; northern/central California	SHCP: garden-enhanced education, family/community partnership, lunchroom produce	Matched non-nutrition activity time	BMI, WHtR, nutrition knowledge, vegetable ID/preference, F&V intake	Measured height/weight; knowledge questionnaire; FFQ; vegetable ID test	1 school year	USDA National Institute of Food and Agriculture
Francis et al. (2010), Trinidad and Tobago	RCT (school-level)	579 enrolled, 472 final (224 IVG, 248 NIVG); 12 schools	6th-year primary, ~11–12 yrs; Sangre Grande, NE Trinidad	Multi-component nutrition/PA curriculum (Bloom's mastery model)	No curriculum delivered	F&V, fried foods, HFSS snacks, sodas; knowledge; PA; ChEAT-26	Modified Block FFQ; knowledge test; PA questionnaire; ChEAT-26	Short-term (pre-post)	University of the West Indies; National School Dietary Services Ltd.
Sgambato et al. (2019), Brazil	Parallel cluster RCT	2,749 (1,337 ctrl.; 1,406 int.); 18 schools	Grades 5–6, M age = 11.5 yrs, 52% male; low-SES public schools, Duque de Caxias	PAAPPAS: school primary prevention + home secondary prevention (CHA visits)	No intervention	BMI, %body fat, dietary intake (FFQ score), physical activity	Measured height/weight/BIA; 23-item FFQ; PA questionnaire (PeNSE); 24HR subsample	1 school year	CNPq; FAPERJ
Ilić et al. (2022), Croatia	Quasi-randomized	681 enrolled, 259 per-protocol (143 int.; 116 ctrl.); 14 schools	1st graders, 7–9 yrs; public primary schools, Zagreb	Nutri-školica: 3-year multicomponent intervention (workshops, activities, menu changes)	Control classes, no intervention materials	F&V intake (total and by group); attainment of WHO 400 g/day target	Semi-quantitative FFQ (18 F&V items), baseline and post	3 school years	EU Horizon 2020 Strength2Food; Croatian Science Foundation/ESF
Fung et al. (2012), Canada	Quasi-experimental (pre-post with comparison)	10 schools (293–394/yr) vs. ~150 province-wide schools	Grade 5; 10 APPLE Schools (disadvantaged areas), Alberta	APPLE Schools: Comprehensive School Health, full-time facilitators, nutrition/PA policies	Province-wide grade 5 sample	Diet (F&V, energy, DQI), PA (PAQ-C), obesity (BMI, IOTF)	Harvard Youth/Adolescent FFQ; PAQ-C; measured height/weight	2 years	Alberta Heritage Foundation for Medical Research; CIHR

Study (Author, Year, Country)	Design	N	Population	Intervention	Comparator	Outcome Measures	Assessment Tools	Follow-up	Funding Source
		(3,421 in 2008; 3,398 in 2010)							
Adamo et al. (2013), Canada	Prospective quasi-experimental	807 completers of 942 (450 FF; 357 ctrl.); 14 schools	Grades 1–6, 6–12 yrs; Eastern Ontario	Freggie Friday: launch visit + teacher-led weekly F&V curriculum	6 control schools, no FF curriculum	F&V and snack consumption; knowledge and attitudes toward F&V	Adapted dietary questionnaire (CHMS/NHANES); adapted Pro Children questionnaire	Pre-post (programme duration)	Canadian Produce Marketing Association
Tak et al. (2008), Netherlands	Quasi-experimental (pre-post with control)	771 children (346 int.; 425 ctrl.); 55 schools; 435 parents	4th graders, M age = 9.9 yrs; The Hague/Almelo (int.) vs. Zoetermeer/Leidschendam/Hengelo (ctrl.)	Schoolgruiten: free F&V twice weekly + optional curriculum	Control cities, no free F&V provision	Usual F&V intake (child/parent-reported); taste preferences; knowledge	Pro Children–based FFQ (child and parent), baseline, 1-yr, 2-yr	2 years	ZonMw; World Cancer Research Fund
Ask et al. (2009), Norway	Quasi-experimental (pilot)	150 (58 int.; 92 ctrl.)	9th grade, ~14–15 yrs; southern Norway	Free healthy school lunch, 4 months	Usual packed lunch from home	F&V, whole-grain bread, low-fat milk, unhealthy snacks; BMI; food satisfaction	Self-reported food intake questionnaire; measured height/weight	4 months	Not specified

Note. RCT = randomized controlled trial; F&V = fruit and vegetable(s); SSB = sugar-sweetened beverage(s); HFSS = high fat, sugar, and salt; PA = physical activity; MVPA = moderate-to-vigorous physical activity; BMI = body mass index; WHtR = waist-to-height ratio; FFQ = food frequency questionnaire; TPB = Theory of Planned Behaviour; CHA = community health agent(s); KAP = knowledge, attitudes, and practices; DQI = diet quality index; IOTF = International Obesity Task Force; ChEAT-26 = Children's Eating Attitudes Test–26; PeNSE = Pesquisa Nacional de Saúde do Escolar; 24HR = 24-hour dietary recall.

Table 3

Results of Individual Studies by Outcome

Study	Outcome	Effect Estimate	95% CI	p	Direction
Ilić et al. (2022)	Total daily F&V intake (g/day)	+102 g/day (η^2p = .078)	—	< .001	↑
	Fruit and fruit juices	—	—	< .05	↑
	Vegetables alone	—	—	< .05	↑
	Vegetables + vegetable juices	—	—	< .05	↑
	Isolated fruit intake	—	—	n.s.	↔
	Broader vegetable tier	—	—	n.s.	↔
Fung et al. (2012)	Combined F&V intake (servings/day)	MD = 0.55	[−0.02, 1.13]	n.s.	↔
	Energy intake (kcal/day)	−212 kcal	—	< .05	↓
Li et al. (2019)	F&V intake (servings/day, baseline-adj.)	MD = 0.33	[0.14, 0.52]	< .001	↑
	F&V intake (further-adj.)	MD = 0.34	[0.17, 0.51]	= .001	↑
	≥ 5 daily F&V portions (baseline-adj.)	OR = 2.00	[1.45, 2.76]	< .001	↑
	Unhealthy snacks/SSB (servings/wk, baseline-adj.)	MD = −0.81	[−1.42, −0.20]	= .010	↓
Vik et al. (2020)	Vegetables on sandwiches (times/wk)	B = 1.11	[0.38, 1.85]	sig.	↑
	Other F&V / unhealthy snacks	—	—	n.s.	↔
Tak et al. (2008)	Fruit intake, child-reported (pieces/day)	adj. diff = 0.145	[0.004, 0.286]	sig.	↑
	Fruit intake, parent-reported (pieces/day)	adj. diff = 0.185	[0.030, 0.340]	sig.	↑
	Vegetable intake (child- and parent-reported)	—	—	n.s.	↔

Study	Outcome	Effect Estimate	95% CI	p	Direction
Adamo et al. (2013)	F&V and snack consumption (primary analysis)	—	—	n.s.	↔
	Vegetable liking, baseline (girls vs. boys)	41% vs. 33% (girls higher)	—	< .0001	↑ (girls)
	Daily vegetable bringing (girls vs. boys)	20% vs. 16% (girls higher)	—	= .003	↑ (girls)
Scherr et al. (2017)	Nutrition knowledge & vegetable identification	—	—	sig.	↑
	Fruit intake / daily vegetable consumption	—	—	n.s.	↔
Siega-Riz et al. (2011)	Daily fruit intake (g)	138 vs. 122	—	= .0016	↑
	Water intake (g)	483 vs. 429	—	= .008	↑
	Energy intake (kcal)	1375 vs. 1410	—	= .406	↔
	Vegetable intake (g)	66 vs. 66	—	= .895	↔
Francis et al. (2010)	Fried foods, HFSS snacks, sodas	—	—	< .05	↓
	Fruit / vegetable intake	—	—	n.s.	↔
Xu et al. (2015)	Red meat consumption (OR)	OR = 1.50	[1.15, 1.95]	sig.	↓
	Vegetable consumption (OR)	OR = 1.20	[0.92, 1.55]	n.s.	↔
	Fried snacks / soft drinks	—	—	n.s.	↔
Sgambato et al. (2019)	9 individual food items (daily frequency)	—	—	n.s. (all)	↔
	Healthy/unhealthy composite score, girls	—	—	= .04	↑
	Healthy/unhealthy composite score, boys	—	—	n.s.	↔
Bessems et al. (2012)	Fruit frequency (servings/day)	MD = 0.15	—	< .001	↑
	Fruit juice (short-term only)	MD = 0.05 glasses/day	—	< .05	↑
	Sweets choice, short-term (OR)	OR = 1.36	[1.02, 1.81]	sig.	↑

Study	Outcome	Effect Estimate	95% CI	p	Direction
	Savoury snack choice, short-term (OR)	OR = 1.66	[1.22, 2.26]	sig.	↑
Moitra et al. (2021)	Dietary practice score (Hedges' g)	g = 0.334	—	= .004	↑
	Breakfast / lunch box / vegetable subscales	—	—	< .01–.001	↑
	Fruit, high-fat, high-salt subscales	—	—	n.s.	↔
Wadolowska et al. (2019)	Pro-Healthy Diet Index (pHDI)	—	—	n.s.	↔
	Non-Healthy Diet Index (nHDI) at follow-up	14.0% vs. 16.7%	[12.8, 15.2] vs. [14.7, 18.7]	sig.	↓
	Odds of high nHDI (educated vs. control)	35% lower odds	—	sig.	↓
Ask et al. (2009)	Healthy food score, boys	85 → 80	—	< .05	↓ (both groups)
	Meal frequency (breakfast/lunch/dinner)	—	—	n.s.	↔
Hovland et al. (2010)	Macronutrient, micronutrient, food group intake	—	—	n.s. (all)	↔
He et al. (2012)	School meal purchase frequency (organic vs. non-organic)	—	—	= .012 / < .001	↑
	Attitude → Intention path coefficient	β = .52	—	< .001	↑
	Intention → Behaviour path coefficient	β = .16	—	n.s.	↔

Note. MD = mean difference; OR = odds ratio; SSB = sugar-sweetened beverage(s); HFSS = high fat, sugar, and salt; η^2p = partial eta squared; n.s. = not statistically significant ($p \geq .05$); sig. = statistically significant, exact p not reported in source; — = not reported in source. ↑ indicates a statistically significant change favoring the intervention group (or, for energy/red meat/snack reduction outcomes, a significant decrease); ↓ indicates a significant decrease; ↔ indicates no statistically significant between-group difference.

Food provision programmes produced narrower and more variable effects. The Dutch Schoolgruiten project (Tak et al., 2008) provided free fruit or vegetables twice weekly across two school years and achieved a small but sustained increase in child- and parent-reported fruit consumption at the two-year follow-up. Vegetable intake told a different story: both groups improved at similar rates, and the adjusted between-group difference was negligible.

A year of free healthy school lunches in rural Norway (Vik et al., 2020) produced only one significant dietary change in either direction: children in the intervention group ate more vegetables on their sandwiches. No other food group outcome reached significance at any of the three measurement timepoints. One way to read this is as a null result. Another way is to treat it as evidence of a ceiling effect: children who already bring packed lunches from home may have limited opportunity to substantially alter their dietary intake through school meal provision alone, regardless of the quality of what is offered.

Two curriculum-based interventions produced the weakest findings in this category. The Freggie Friday programme (Adamo et al., 2013), which combined an initial launch event with teacher-led weekly curriculum activities focused on fruit and vegetables, found no significant between-group effects on overall fruit intake, vegetable intake, or snack food consumption in the primary analysis. Exploratory sex-stratified analyses revealed that girls in the intervention group brought vegetables to school more often than boys (20% vs. 16%, $p = .003$) and reported liking vegetables more at baseline (41% vs. 33%, $p < .0001$), but these patterns were not the primary study outcome and should be interpreted with caution. The Shaping Healthy Choices Program (Scherr et al., 2017) produced significant improvements in nutrition knowledge scores and vegetable identification accuracy but these did not translate into changes in what children actually ate at follow-up. Fruit and vegetable intake measured by FFQ was statistically indistinguishable between groups at the end of the school year.

Programmes Targeting Both Healthy and Unhealthy Food Intake

The strongest individual-study evidence in this review came from the CHIRPY DRAGON trial (Li et al., 2019). At the 12-month follow-up, intervention children were significantly more likely to meet the five-portions-per-day fruit and vegetable target than control children, and their weekly intake of unhealthy snacks and sugar-sweetened beverages was significantly lower. Crucially, both effects remained significant after adjustment for baseline characteristics, school clustering, and a range of covariates. Indicating that the observed differences were not an artefact of initial group imbalances. CHIRPY DRAGON is notable in this review for simultaneously improving healthy intake and reducing unhealthy intake, an outcome profile that few other included studies achieved.

The HEALTHY study (Siega-Riz et al., 2011) presents one of the most instructive null results in the entire evidence base. The intervention was among the most intensive and well-resourced in this review. Yet by study end, only two dietary outcomes differed significantly between groups: daily fruit intake and water consumption. Energy intake, vegetable consumption, whole grains, dairy, and all other macronutrient targets were statistically indistinguishable between intervention and control schools.

Several other multicomponent studies in this group produced partial effects, with a pattern that merits particular attention. Francis et al. (2010) significantly reduced intake of sodas, fried foods, and high-fat snacks among intervention students, but found no corresponding improvement in fruit or vegetable consumption. Xu et al. (2015) achieved a significant reduction in red meat consumption among grade-four students in Nanjing but found no significant effects on vegetable intake, fried snacks, or sugar-sweetened beverage consumption. Wadolowska et al. (2019) observed a significant decline in their non-Healthy Diet Index — which captures fast food, energy drinks, and sweets — but found no significant change in their pro-Healthy Diet Index across the nine-month follow-up. The asymmetry between reducing unhealthy intake and increasing healthy intake is one of the most consistent patterns in this review.

The Krachtvoer programme (Bessems et al., 2012), an eight-lesson school-based intervention targeting fruit consumption, breakfast, and snack choices among Dutch prevocational students, produced a more nuanced picture. Fruit frequency and same-day fruit consumption both improved significantly in the short term and remained significant at six months. Snack frequency, however, did not change. Instead, children made healthier selections within existing snack categories. At the short-term post-test, the odds of choosing a healthier snack were significantly elevated in the experimental group for both sweet and savoury categories. By the six-month follow-up, most of these effects had attenuated, with only the sweets category retaining significance.

The PAAPPAS trial (Sgambato et al., 2019) was the largest study included in this review and one of the few to combine school-based primary prevention with a home-based secondary prevention component delivered through community health agent visits. Despite this design, none of the nine individual food items assessed showed a significant between-group difference. The composite food quality score did improve — but only among girls ($p = .04$), with no significant effect observed among boys. The absence of overall dietary change in a trial of this size and scope, conducted in a socioeconomically disadvantaged Brazilian municipality, may reflect the scale of the structural barriers to dietary improvement that extend well beyond what school or home visits can reach.

Composite Diet Quality and Behavioural Practice Scores

Three studies in this review assessed dietary change using composite scores rather than individual food items, offering a different kind of outcome evidence. The HEAPS intervention (Moitra et al., 2021), a 12-week behaviourally focused programme delivered across four

Mumbai schools, produced a statistically significant improvement in overall dietary practice score in the experimental group, with a moderate effect size (Hedges' $g = 0.334$, $p = .004$). Subscale analyses identified the sources of this improvement with some precision: breakfast frequency, lunchbox-carrying behaviour, and vegetable intake all improved significantly, as did green leafy vegetable consumption. Intake of chocolate and carbonated beverages declined. Fruit intake, high-fat food consumption, and high-salt food consumption showed no significant change. The pattern is consistent with a school-based intervention having the most traction over behaviours that are directly observable and reinforceable within school hours, while behaviours anchored in the home environment prove more resistant.

Wadolowska et al. (2019) evaluated dietary quality using two complementary indices across a nine-month follow-up among Polish pre-adolescents. The pro-Healthy Diet Index, which captures intake of fruit, vegetables, whole grains, fish, and dairy, showed no significant improvement in the educated group relative to controls. The non-Healthy Diet Index, which tracks fast food, energy drinks, sweets, and other unhealthy items, declined significantly in the educated group, with follow-up scores indicating a meaningful between-group difference in unhealthy food frequency. Logistic regression indicated that educated students had approximately 35% lower odds of falling into the high non-Healthy Diet Index category at follow-up. This asymmetry between the two indices is consistent with the broader pattern observed across the review: reducing unhealthy dietary habits appears more tractable than building healthy ones.

Ask et al. (2009) found no improvement in healthy food scores after four months of free school lunch provision in Norwegian ninth-graders. Scores declined across both groups between baseline and follow-up. The authors note that follow-up data were collected in late May, a period associated with national celebrations during which atypically unhealthy eating is culturally normative in Norway.

Overall Nutrient Intake and Attitude–Behaviour Outcomes

Two studies in this review took approaches distinct from the majority, examining broader nutritional status or attitude–behaviour relationships rather than specific food group intake. Hovland et al. (2010) assessed macronutrient, micronutrient, and food group intake among third-grade students in rural Appalachian Ohio using the Block Kids FFQ before and after a year-long hands-on nutrition and science curriculum. No significant differences emerged between intervention and control classrooms on any dietary outcome. What the data documented with unusual clarity, however, was the depth of baseline nutritional inadequacy in the study population: most children failed to meet recommended intakes for fibre, calcium, iron, and vitamins A and E, and sweets accounted for approximately one-fifth of total daily kilocalorie intake. In this context, the absence of a detectable intervention effect may reflect the scale of structural food environment constraints that a classroom curriculum alone cannot address.

He et al. (2012) examined whether participation in organic school food provision in Denmark was associated with healthier eating behaviour, using a cross-sectional design that compared pupils across schools with and without organic food policies. Students in organic schools purchased school meals more frequently than their peers in non-organic schools, a finding that suggests organic food policy may increase engagement with the school food offer. Using a Theory of Planned Behaviour framework, He et al. found that students' positive attitudes toward organic food and health predicted their intention to eat organically, and intentions predicted reported frequency of organic food purchase. However, neither attitudes nor intentions predicted significant differences in actual food consumption between organic and non-organic school students. The gap between what students intended to do and what they ate mirrors findings from curriculum-based education studies in this review, where improvements in knowledge and attitudes consistently failed to translate into measurable dietary change.

Figure 2

Risk of Bias Assessment: Traffic Light Plot

Study	D1	D2	D3	D4	D5	Overall
Bessems et al. (2012)	High	Low	Low	Some	Low	Some
Li et al. (2019)	High	Low	Low	Some	Some	Some
Moitra et al. (2021)	Some	Low	Low	Some	Low	Some
Vik et al. (2020)	High	Some	High	High	High	High
Siega-Riz et al. (2011)	Low	Some	Low	Low	Low	Some
Wadolowska et al. (2019)	High	Low	Low	Some	Low	Some
Hovland et al. (2010)	High	Low	High	High	Low	Some
Xu et al. (2015)	Low	Low	Low	Low	Low	Some
He et al. (2012)	High	Low	Low	Low	Some	High
Francis et al. (2010)	Some	Low	Some	Some	Low	Some
Sgambato et al. (2019)	Low	Low	Low	Low	Low	Low
Ilić et al. (2022)	High	High	High	High	Some	High
Fung et al. (2012)	High	Low	Some	Low	Low	Some
Ask et al. (2009)	Low	Low	Low	Low	Low	Low
Scherr et al. (2017)	High	High	Some	Low	Low	High
Tak et al. (2008)	High	Low	High	Some	Low	High
Adamo et al. (2013)	High	Low	Low	Some	Some	Some

Low risk Some concerns High risk

Domain key:

D1 Randomisation process

D2 Deviations from intended interventions

D3 Missing outcome data

D4 Measurement of the outcome

D5 Selection of the reported result

Note. Risk of bias assessed using RoB 2 (Sterne et al., 2019) for intention-to-treat effect. D1 = randomisation process; D2 = deviations from intended interventions; D3 = missing outcome data; D4 = measurement of the outcome; D5 = selection of the reported result. Low = low risk; Some = some concerns; High = high risk of bias.

Overall Bias

Two studies were rated as low overall risk of bias: Sgambato et al. (2019) and Ask et al. (2009). Most studies — ten in total — raised some concerns, and five were rated as high overall risk: Vik et al. (2020), He et al. (2012), Ilić et al. (2022), Scherr et al. (2017), and Tak et al. (2008).

The distribution reflects the methodological diversity of the evidence base. No single domain drove the overall ratings uniformly; instead, the high-risk and some-concerns judgements accumulated across different combinations of domains for different studies.

D1: Randomisation Process

This was by far the most problematic domain. Nearly two thirds of studies (64.7%) were rated as high risk — the highest proportion of any domain. The explanation is largely structural. Many included studies used quasi-experimental designs in which schools or school classes were allocated to conditions by administrators, principals, or geographic convenience rather than through a formal randomisation procedure. This was true of Hovland et al. (2010), Fung et al. (2012), Adamo et al. (2013), Tak et al. (2008), Wadolowska et al. (2019), Bessems et al. (2012), and Li et al. (2019), among others. He et al. (2012) is a special case: the assignment to organic versus non-organic school food was a pre-existing institutional policy, not a study-level allocation at all, making this domain effectively inapplicable under RoB 2. Studies that achieved low-risk ratings here — Siega-Riz et al. (2011), Xu et al. (2015), Sgambato et al. (2019), and Ask et al. (2009) — all implemented formal cluster randomisation with adequate allocation concealment.

D2: Deviations from Intended Interventions

The picture was considerably more favourable here. Over three quarters of studies (76.5%) were rated as low risk, reflecting the structured, school-level delivery context common to most included interventions. When an intervention is delivered to entire classrooms or schools, opportunities for crossover or co-intervention are limited by design. Vik et al. (2020) and Siega-Riz et al. (2011) raised some concerns, primarily around potential contamination between conditions or inconsistency in delivery fidelity across sites. Ilić et al. (2022) and Scherr et al. (2017) were rated as high risk, with evidence of meaningful deviations from the intended protocol across clusters.

D3: Missing Outcome Data

Missing data was handled adequately in most studies, with 64.7% rated as low risk. The four high-risk cases — Vik et al. (2020), Hovland et al. (2010), Ilić et al. (2022), and Tak et al. (2008) — shared a common feature: either attrition was substantial relative to the analytic sample, or the pattern of dropout appeared differential between groups without adequate statistical handling. Francis et al. (2010) and Fung et al. (2012) were assigned some concerns, reflecting incomplete follow-up data or limited transparency in reporting dropout reasons.

D4: Measurement of the Outcome

Nearly half of all studies (47.1%) raised some concerns in this domain, and this is not surprising given the nature of dietary assessment. Self-reported food frequency questionnaires and short dietary recalls — the dominant tools across this literature — are vulnerable to social desirability bias and recall error, particularly when administered to children. The problem is not unique to any single study; it is structural. Outcome assessors were rarely blinded to intervention status, and the age-related limits of children's self-reporting capacity compound measurement uncertainty further. Three studies were rated as high risk (Vik et al., 2020; Hovland et al., 2010; Ilić et al., 2022), where differential misreporting between groups or particularly limited measurement approaches added a specific concern beyond the general limitations of self-report. The six low-risk studies in this domain tended to employ more standardised or objective protocols — including measured dietary recalls, validated instruments administered by trained researchers, and in one case direct cafeteria observation.

D5: Selection of the Reported Result

This was the second most favourable domain overall, with 70.6% of studies rated as low risk. Most studies pre-specified their primary dietary outcomes and reported them in full. Four studies raised some concerns — He et al. (2012), Francis et al. (2010), Li et al. (2019), and Adamo et al. (2013) — largely because subgroup analyses or secondary outcomes appeared to have been emphasised in reporting in ways that were not clearly pre-specified. Vik et al. (2020) was the only high-risk rating in this domain: the single significant dietary finding (vegetables on sandwiches) appeared to be selected from a broader set of non-significant outcomes, raising the possibility of outcome reporting bias.

Taken together, the RoB 2 assessments reveal a methodologically heterogeneous evidence base. The randomisation domain stands out as the primary source of risk, though this reflects the pragmatic reality of school-based research rather than poor study conduct per se. Measurement limitations are pervasive and worth keeping in mind when interpreting effect estimates. The implications of these findings for the overall confidence in the evidence are discussed in the Discussion section.

Discussion

Summary of Main Findings

The findings of this systematic review are not easily summarized. Across 17 studies, school-based food policy interventions produced effects on children's dietary intake that were real but selective, promising but inconsistent, and deeply dependent on context. That is the central finding, and it demands explanation rather than dismissal.

The hypothesis guiding this review posited that school-based food policy would increase children's consumption of fruit, vegetables, and other nutritious foods. This hypothesis received partial support. Several interventions — particularly those that were multicomponent in design and sustained over more than one school year — did produce meaningful improvements in dietary intake, most notably in fruit consumption and in the reduction of unhealthy snack and beverage intake (Ilić et al., 2022; Li et al., 2019; Tak et al., 2008). Others, including programmes delivered over shorter timeframes or relying primarily on classroom-based nutrition education, yielded limited or no effects on consumption behaviour, even when improvements in nutrition knowledge were observed (Scherr et al., 2017; Hovland et al., 2010; Adamo et al., 2013).

A pattern emerged that cuts across intervention types and populations. Reducing unhealthy food and beverage intake — snacks high in fat, sugar, or salt; sugar-sweetened beverages; processed foods — appeared more tractable than increasing healthy food intake, particularly vegetables. This asymmetry is not incidental. It reflects something structural about how dietary behaviour is formed and how school environments can and cannot reach it. Equally striking was the gap between knowledge and behaviour: some programmes successfully shifted what children knew about nutrition without shifting what they ate (Scherr et al., 2017; Xu et al., 2015; Moitra et al., 2021). Cognitive change, it seems, is a necessary but insufficient condition for behavioural change in this domain.

What these patterns collectively suggest is that the effectiveness of school food policy cannot be evaluated in isolation from the broader ecological context in which children eat. Family food environments, cultural meal norms, the physical design of school food spaces, and the social dynamics of peer groups all shape dietary behaviour in ways that any single school-based intervention must compete with or, ideally, work alongside.

What Works and Why: Intervention Type and Duration

Not all school-based food policy interventions are equivalent. Treating them as such would obscure the most important lesson this evidence has to offer. The clearest signal in the data is this: multicomponent interventions, those that combined nutrition education with changes to the food environment, family engagement, or structural modifications consistently outperformed single-component programmes. Nutri-školica, which integrated classroom activities, cross-curricular tasks, parental involvement, and school meal modifications over three school years, produced a net gain of approximately 102 grams per day in total fruit and vegetable intake (Ilić et al., 2022). CHIRPY DRAGON, combining school and family components over 12 months, simultaneously increased fruit and vegetable consumption and reduced intake of unhealthy snacks and sugar-sweetened beverages (Li et al., 2019). Neither result is replicable by a classroom lesson alone.

Duration matters — but not in the way one might expect. Longer interventions did not automatically produce stronger effects. The three-year HEALTHY study yielded significant differences only for fruit intake and water consumption; vegetable intake and overall energy balance remained unchanged across groups (Siega-Riz et al., 2011). What duration appears to do, rather, is create the conditions under which a well-designed programme can consolidate behavioural change and prevent the fade-out that plagued shorter efforts. The Krachtvoer programme achieved significant short-term improvements in fruit consumption and snack quality, but most snack-related effects had dissipated by the six-month follow-up (Bessems et al., 2012). Four months of free school lunch provision produced no improvement in healthy food scores at all (Ask et al., 2009). Duration, in other words, is a necessary but not sufficient condition for lasting dietary change. Content and delivery determine whether that time is well spent.

Within this picture, the contrast between fruit and vegetable outcomes deserves particular attention. Fruit intake proved consistently more responsive to school-based intervention than vegetable intake. The Dutch Schoolgruiten project achieved a significant sustained increase in fruit consumption at two-year follow-up while vegetable intake showed no meaningful change in either child- or parent-reported data (Tak et al., 2008). Siega-Riz et al. (2011) replicated this pattern: fruit intake differed significantly between groups, while both groups reported an identical daily vegetable average by study end. Tak et al. offer a context-specific explanation. In the Netherlands, vegetables are predominantly consumed at home during the evening meal, placing them structurally outside the reach of school-hour provision.

Fruit, by contrast, is more commonly eaten as a snack and therefore more amenable to substitution by what is offered at school. This finding recurs across multiple studies in the review and appears to reflect a genuine ecological constraint rather than a design failure. This is not a failure of the intervention. It is a boundary condition. Where a food is typically eaten shapes whether a school-based programme can meaningfully influence how much of it is consumed.

Patterns by gender and developmental stage were less consistent and should be interpreted with caution. Girls appeared more responsive to dietary interventions in several studies — Sgambato et al. (2019) found significant composite diet score improvements among female students only, and Adamo et al. (2013) reported sex-differentiated effects in vegetable-related behaviours — though the small number of studies reporting these differences limits any firm conclusions. The evidence base is also weighted heavily toward primary school-aged children, with few studies targeting older adolescents. Where adolescent populations were included, the developmental context of this period — increasing autonomy, heightened peer influence, and expanding access to food choices outside school — may partly account for attenuated effects (Siega-Riz et al., 2011). These remain open questions that future research would do well to address directly.

The Case for Autonomy-Supportive Approaches

One of the more striking patterns in this review is not about what interventions achieved, but about the shape of what they changed. Across several studies, reducing unhealthy food and beverage intake proved more tractable than increasing healthy food consumption — and this asymmetry is not easily explained by intervention quality alone. Francis et al. (2010) reduced intake of sodas, fried foods, and high-fat snacks without moving fruit or vegetable consumption. Wadolowska et al. (2019) lowered their non-Healthy Diet Index significantly while the pro-Healthy Diet Index remained unchanged. Xu et al. (2015) achieved a significant reduction in red meat consumption but found no significant effect on vegetable intake. The pattern is consistent enough to warrant a question: are we looking at two distinct behavioural mechanisms, not one?

There is good reason to think so. Removing or restricting access to an unhealthy food operates largely through environmental control — the food is simply no longer available, or its availability is reduced. Increasing healthy food intake requires something different: repeated positive exposure, sensory familiarity, and some degree of internal motivation. A child who has never enjoyed eating vegetables will not begin to do so because a policy document says they should. What changes eating behaviour in the long term is not knowledge of what is healthy, but a relationship with food that makes choosing it feel natural. Self-determination theory (Deci & Ryan, 2000) offers a useful lens here: behaviours that are internally motivated — driven by interest, enjoyment, or personal value — are more likely to be sustained than those driven by external control or obligation. Applied to nutrition, this suggests that interventions designed to build intrinsic motivation around food — through exploration, cooking, gardening, or social eating — may have a fundamentally different ceiling than those that merely restrict choice.

This distinction matters not only for effectiveness, but for something the nutrition intervention literature has largely left unexamined: what kind of relationship with food are we building in children? An intervention that tells children what not to eat, or that frames certain foods as dangerous or forbidden, may produce short-term reductions in unhealthy intake — but it also risks creating an evaluative relationship with food organised around guilt, prohibition, and self-surveillance. Research on the development of disordered eating has consistently identified early exposure to restrictive food environments — whether at home or at school — as a risk factor for the later emergence of maladaptive eating patterns (Birch & Fisher, 1998;

Neumark-Sztainer et al., 2006). Parental restriction of food, for instance, has been associated with increased rather than decreased consumption of the restricted foods, particularly in girls (Fisher & Birch, 1999). If the same dynamic operates in school settings, then policies built primarily around restriction may be working against their own long-term goals.

Autonomy-supportive approaches work differently. Rather than positioning the adult or the institution as the authority who determines what is acceptable to eat, they create conditions in which children can develop their own relationship with food through guided exploration. The research on restrictive feeding offers a useful reference point here: Fisher and Birch (1999) found that restricting children's access to palatable foods produced the opposite of the intended effect, increasing rather than moderating intake of the restricted foods, particularly in girls. If the same dynamic operates in school settings — and there is no strong reason to assume it does not — then policies built primarily around restriction may be inadvertently reinforcing the very relationship with food they are trying to correct. Translated to school food policy, this points toward approaches that expand access to diverse, nutritious foods and create repeated positive experiences of eating them, rather than approaches that constrain choice in ways children may experience as controlling. The multicomponent interventions that performed best in this review — Nutri-školica (Ilić et al., 2022) and CHIRPY DRAGON (Li et al., 2019) — both included elements of positive food exposure, hands-on engagement, and family involvement. Neither was organised primarily around prohibition.

It is worth being precise about what this argument does and does not claim. It does not suggest that school food policies should be permissive or that restricting access to highly processed foods in school settings is inherently harmful. There is reasonable evidence that reducing the availability of sugar-sweetened beverages and energy-dense snacks in schools can shift consumption patterns, at least within the school day (Woodward-Lopez et al., 2010). What the argument does suggest is that restriction alone is unlikely to produce the kind of durable, intrinsically motivated dietary behaviour that the field is ultimately trying to achieve — and that when restriction is the primary or sole mechanism, it may carry risks that the literature has not yet adequately tracked. The most compelling school food programmes in this review were those that offered children something — new foods, new skills, new social contexts for eating — rather than simply taking something away.

Beyond the Classroom: Family and Social Context

The studies that produced the strongest dietary effects in this review — Nutri-školica and CHIRPY DRAGON — both actively involved families. But the picture is more complicated than a simple family-involvement-equals-success story. Several other programmes also included parental or community components: PAAPPAS (Sgambato et al., 2019) incorporated home visits by community health agents, the Shaping Healthy Choices Program (Scherr et al., 2017) included family and community partnerships, and APPLE Schools (Fung et al., 2012) engaged parents alongside school-level changes. None of these produced consistently strong dietary effects. PAAPPAS, which had the most intensive home-based component of any study in this review, yielded null results on individual food items and significant composite score improvements only among girls. The lesson is not that family involvement guarantees better outcomes. It is that the absence of family involvement may place a ceiling on what school-based programmes can achieve — while its presence is no guarantee of success if other conditions are not met.

Children eat at school for perhaps one-third of their waking day. The rest happens at home, in transit, at friends' houses, in corner shops. Dietary behaviour that is not reinforced across these settings — that exists only within the bounded context of the school — faces an uphill consolidation problem. Self-determination theory is instructive here: behaviours that are supported by multiple environments are more likely to become autonomously regulated over time, while those that remain context-specific tend to fade when the supporting context is removed (Ryan & Deci, 2000). This may partly explain the fade-out observed in Bessems et al. (2012), where significant short-term improvements in snack choice quality had largely dissipated by the six-month follow-up — a programme delivered in school, with no systematic home component, produced gains that the home environment was not equipped to sustain.

The home food environment is not simply a backdrop to children's eating; it is the primary context in which most dietary behaviour is formed and repeated. Tak et al. (2008) made this explicit: vegetables, they noted, are predominantly consumed in the Dutch home during the evening meal, which is why a school-based provision programme could shift fruit intake without moving vegetable intake at all. Wadolowska et al. (2019) arrived at a similar conclusion from a different direction, observing that improving pro-healthy dietary habits — in contrast to reducing unhealthy ones — appeared to require conditions of access and modelling that schools alone could not provide. When the foods children are encouraged to eat at school are not available, modelled, or culturally normalised at home, the school's influence on total dietary intake remains structurally limited.

The school is not only a place where children eat. It is a place where they eat together. That distinction matters more than it might initially appear. Social learning theory predicts that children's food choices are shaped substantially by the observed choices of peers and adults around them — through modelling, reinforcement, and the formation of shared norms about what constitutes acceptable or desirable eating (Bandura, 1977). Eating alongside peers who select certain foods, in an environment where those foods are presented as normal and appealing, is a form of repeated social exposure that nutrition education delivered in a classroom cannot replicate. This may be one reason why interventions that modified the school meal environment — as in the Nutri-školica programme — produced more durable effects than those that changed only what children were told about food.

A related possibility, which the data in this review do not directly test but which the theoretical literature supports, concerns the role of teachers and school staff as behavioural models. Adults who eat alongside children, who speak about food with curiosity and enjoyment rather than caution and restriction, and who treat mealtimes as social occasions rather than nutritional compliance exercises, may contribute to a school food culture that does more than any single lesson could. This is speculative in the context of the present evidence, and it should be read as such. But it points toward a dimension of school food policy that is rarely measured and almost never reported in intervention studies: not what children are taught about food, but what they absorb from the living food environment around them. Future research that attempts to capture this dimension — through systematic observation of school mealtime environments, for instance, or through measures of school food culture — would add meaningfully to what is currently understood.

Equity and Cultural Considerations

Before asking whether school food policies work, it is worth asking what they are for. The answer is not only nutritional. Schools are one of the few institutional settings in which children from vastly different socioeconomic backgrounds are brought together and offered, in principle, the same food environment. For children whose home food environments are constrained by poverty, food insecurity, or limited access to fresh produce, a school meal may represent the most nutritious eating opportunity of their day. This is not an argument that depends on the intervention evidence reviewed here. It holds regardless of effect size. Structural access to adequate nutrition is a matter of equity before it is a matter of efficacy — and any evaluation of school food policy that ignores this frame is answering a narrower question than the one that matters most.

With that said, the evidence reviewed here does suggest that socioeconomic context shapes not only who receives school food interventions, but how much they benefit from them. The APPLE Schools programme (Fung et al., 2012) was implemented across ten elementary schools, most of which were located in socioeconomically disadvantaged neighbourhoods in Alberta — settings where baseline diet quality was poor and structural constraints on healthy eating were more prevalent. The intervention produced modest improvements in fruit and vegetable intake and energy consumption compared to the province-wide comparison group, a finding that takes on added significance given the baseline conditions. PAAPPAS (Sgambato et al., 2019) operated in Duque de Caxias, one of the poorest municipalities in the state of Rio de Janeiro. The protocol study for this trial reported a family food insecurity prevalence of 36% in the region, and most students attending the participating public schools came from low socioeconomic backgrounds (Sgambato et al., 2016). Against that backdrop — where nutritious food was frequently inaccessible at home, not merely unfamiliar — the null result on individual food items becomes harder to read as a straightforward failure of the intervention. It may reflect, instead, a structural ceiling: what any school-based programme can realistically achieve when the food environment children return to each afternoon actively works against the habits being built each morning.

The studies in this review span twelve countries across four continents, and the diversity of contexts they represent is both a strength and a complication. A nutrition intervention that makes sense in urban Guangzhou does not automatically translate to rural Appalachian Ohio. What children eat, when they eat it, who prepares it, and what it means to them are culturally specific in ways that generic dietary guidelines rarely acknowledge. The contrast between Tak et al.'s (2008) Dutch findings — where vegetables are structurally embedded in the family evening meal and therefore resistant to school-level intervention — and the Croatian Nutri-školica findings, where a sustained multicomponent effort did shift combined fruit and vegetable intake, illustrates how the same target behaviour can operate through entirely different mechanisms in different cultural contexts. Treating ‘vegetable intake’ as a stable, culture-independent outcome variable risks misreading what the data actually show.

This has direct implications for how the findings of this review should and should not be used. The evidence does not support universal recommendations about which type of school food policy is most effective. What it supports, more modestly, is a set of conditional observations: multicomponent approaches appear more promising than single-component ones; longer interventions appear more likely to consolidate change than shorter ones; and programmes that engage the home food environment appear better positioned to produce durable effects than those that do not. Whether any of these observations holds in a specific school, city, or country depends on conditions the current evidence base does not fully capture. A systematic review of 17 studies, however carefully conducted, cannot substitute for context-sensitive implementation research.

Implications for Eating Disorder Prevention

Systematic reviews of school-based food policy rarely ask what kind of relationship with food they are helping to build. They ask whether children eat more vegetables, fewer chips, less sugar. These are legitimate and important questions. But they leave a parallel question largely unexamined: whether the mechanisms through which school food policies operate — restriction, reward, prohibition, provision — have consequences for how children relate to food over time, beyond what they happen to consume this week. This review cannot answer that question directly. What it can do is bring it into view and situate it within a body of evidence that the nutrition intervention literature has been slow to engage with.

The developmental literature on children’s eating is unambiguous on one point: restrictive food environments do not produce the relationship with food they are designed to produce. Birch et al. (2003) demonstrated that maternal use of restrictive feeding practices — controlling what children could and could not eat — promoted eating in the absence of hunger, particularly in girls. Fisher and Birch (1999) found that restricting access to palatable foods increased rather than decreased intake of those foods when access was later granted. These are not marginal findings. They have been replicated across multiple study designs and populations, and they point consistently in the same direction: externally imposed restriction tends to undermine children's capacity for internal self-regulation around food, replacing hunger and satiety cues with vigilance, preoccupation, and disinhibited eating when the restriction is lifted.

This pattern matters for eating disorder prevention because the same psychological processes are implicated in the early development of disordered eating. Neumark-Sztainer et al. (2006) followed a large cohort of adolescents over five years and found that dieting, itself a form of self-imposed restriction, was associated with increased risk of binge eating, extreme weight control behaviours, and clinical eating disorder outcomes. In a later longitudinal analysis, the same research group showed that disordered eating behaviours established in adolescence tended to persist into young adulthood, underscoring the developmental significance of early eating patterns (Neumark-Sztainer et al., 2011). A food environment that teaches children to be vigilant about what they eat, rather than attentive to how they feel, may be preparing the ground for precisely the kind of eating pathology that public health nutrition is trying to prevent.

None of this is an argument for permissiveness. The question is not whether schools should shape the food environment. They already do, inevitably, but how. What the evidence suggests is that approaches oriented around positive food experience, autonomy, and intrinsic motivation are likely to produce a fundamentally different relationship with food than those oriented around prohibition and external control. A child who learns to enjoy eating vegetables because they grew them in a school garden, prepared them in a cooking class, or shared them in a social meal with peers is acquiring something qualitatively different from a child who avoids certain foods because they have been categorised as bad. The first is building a relationship; the second is navigating a rule. Rules can be broken. Relationships persist.

There is a final dimension of this argument that concerns measurement rather than mechanism. The dominant outcome metric in school-based obesity prevention research is BMI or BMI z-score — a standardised, population-level index of body weight relative to height. As a public health tool, BMI has real utility. But as a proxy for the quality of a child's relationship with food and their own body, it is a poor substitute. BMI does not capture whether a child eats with anxiety or enjoyment, whether they are developing a flexible or a rigid relationship with eating, or whether the changes a programme has produced will persist beyond the intervention period. Each child's body, family, and food culture is distinct in ways that a population-level index cannot accommodate. If the field is serious about eating disorder prevention — not only obesity prevention — it needs outcome measures that are serious about the psychological and relational dimensions of eating. Consumption frequency and body weight are not enough.

Strengths

Several features of this review strengthen confidence in its findings, though none of them resolves the methodological heterogeneity that runs through the evidence base as a whole. The decision to restrict inclusion to studies that measured dietary intake using a food frequency questionnaire or a validated FFQ-based adaptation was the most consequential of these. Without this constraint, comparing effect estimates across studies would have been methodologically indefensible.

A second strength is the geographic and cultural range of the included studies. Twelve countries across four continents are represented, from urban China to rural Norway, from low-income Brazil to affluent Canada. This does not resolve the generalisation problem — if anything, it sharpens it, by making clear how much context shapes what interventions can achieve. But it does mean that the patterns identified here are not artefacts of a single cultural or educational system. When the same asymmetry between fruit and vegetable outcomes appears in Croatia, the Netherlands, and the United States, that convergence carries more weight than if it had emerged from a geographically homogeneous sample.

Third, this review treated its outcome domains separately rather than aggregating them into a single effectiveness judgment. Fruit intake, vegetable intake, unhealthy food and beverage consumption, dietary quality scores, and knowledge and attitude outcomes were tracked and reported individually. This disaggregation revealed patterns: the asymmetry between reducing unhealthy intake and increasing healthy intake, the fruit-vegetable distinction, the knowledge-behaviour gap; that a simpler analytical framework would have obscured. Heterogeneous results are not a failure of the evidence; they are information, and this review tried to take them seriously as such.

Finally, existing systematic reviews of school-based food policy have not examined implications for children's long-term relationship with food or for eating disorder prevention. Reviews addressing eating disorders in school settings have focused either on the unintended consequences of obesity prevention programmes — asking what harm these policies might inadvertently cause (Turner et al., 2024) — or on dedicated eating disorder prevention curricula, leaving a gap between the two streams of literature. The present review begins to address that gap from a different angle: not by cataloguing potential harms, but by asking what a food policy environment designed with children's psychological relationship with food in mind might look like, and whether the existing evidence points in that direction.

Limitations

The overall risk of bias across the included studies is high. Only two of the 17 studies achieved a low overall bias rating, and 64.7% were rated as high risk on the randomisation domain alone. This reflects a structural feature of school-based intervention research. Randomising at the school level — the only defensible unit of allocation when an intervention reshapes an entire food environment — requires sustained cooperation from administrators, local authorities, and families over extended periods, which few research teams can guarantee. Blinding was equally impossible: teachers, parents, and children all know which schools are receiving the intervention, and allocation concealment could not be maintained when changes involve visible modifications to school menus, meal provision, or curriculum. The consequence for interpretation is significant. Effect estimates from this literature should be read as associative rather than causal, and any conclusions about what 'works' must be held with corresponding uncertainty.

All included studies relied on self-reported dietary assessment, and self-report is an imperfect measure of what children actually eat. Food frequency questionnaires respondents to recall and estimate their food intake over a defined period, a task that is cognitively demanding for adults and more so for children. Memory limitations, difficulty estimating portion sizes, and the tendency to report socially desirable behaviour all introduce noise into the data. Children who have received a nutrition intervention may report eating more healthily than they do, inflating apparent effect sizes. The RoB 2 assessment captured this: nearly half of all included studies raised some concerns on the outcome measurement domain, and three were rated as high risk. The reported dietary changes should be understood as upper-bound estimates of the true effect.

The included studies are too heterogeneous for direct comparison. They differ in intervention type, duration, target age group, country, and the specific dietary outcomes assessed. Even the shared methodological feature — use of an FFQ — masks considerable variation: the questionnaires differed in length, food item coverage, and recall period across studies. This heterogeneity is why a narrative synthesis was adopted rather than a meta-analytic pooling of effect estimates, and it means that the patterns identified here are tendencies rather than reliable generalisations. Any conclusion about which type of intervention works must be understood as conditional on context, population, and outcome domain.

Two further limitations concern what the evidence base can and cannot show. The proportion of null results here is higher than in many comparable reviews, but this does not eliminate the possibility that less favourable findings remain unpublished. Second, the evidence base cannot speak reliably to long-term dietary change. Follow-up durations ranged from a single post-intervention assessment to two years, with most studies falling toward the shorter end. Without longer follow-up, it is impossible to determine whether the changes observed reflect durable behavioural shifts or temporary effects that fade once the programme ends — a distinction that matters greatly for anyone considering whether to invest in school food policy at scale.

Implementation fidelity, the degree to which interventions were delivered as intended, was rarely reported in sufficient detail to assess. When a programme produces no effect, it is impossible to determine whether the intervention itself was ineffective or whether it simply was not implemented consistently enough to produce one. This ambiguity affects several studies in this review, particularly those delivered through classroom teachers without structured monitoring or training protocols. The geographic diversity of the included studies, while a strength in some respects, also limits generalisation. The 17 studies span twelve countries across four continents, and the cultural, economic, and institutional conditions that shape children's eating habits vary substantially across these contexts. Findings from urban China do not straightforwardly apply to rural Norway, and patterns observed in high-income settings may not replicate in low- and middle-income ones. This review can identify broad patterns; it cannot specify the conditions under which those patterns will hold in any given setting. Finally, two procedural limitations should be noted. The scope of this review was narrowed during the selection process: of 204 articles retrieved as part of a broader systematic review project, only those reporting food consumption outcomes measured with a validated FFQ were retained, yielding a final sample of 17 studies. The findings therefore do not encompass the full range of outcomes — including nutritional knowledge, food attitudes, and anthropometric measures — that the wider literature has examined. The review was also not pre-registered, which limits transparency around the a priori specification of eligibility criteria and analysis decisions.

Future Research Directions

Several gaps in the current evidence base point toward priorities for future research. Most immediately, the field needs studies with longer follow-up periods. The majority of included studies assessed dietary outcomes at a single post-intervention timepoint, making it impossible to determine whether observed changes represent durable shifts in eating behaviour or temporary effects of the programme. Longitudinal designs that track dietary outcomes one, two, and five years after intervention completion would substantially strengthen what is currently a short-sighted evidence base.

Beyond these methodological priorities, there are two substantive directions that the literature has not yet adequately pursued. The first is the relationship between school food environments and children's psychological relationship with food. No existing study in this review assessed whether interventions changed how children feel about eating, how they respond to food cues, or whether the approach taken — restrictive or autonomy-supportive — influenced longer-term eating patterns or disordered eating risk. Developing and validating outcome measures that capture these dimensions — beyond consumption frequency and body weight — is a prerequisite for research that takes eating disorder prevention seriously as a goal. The second is cultural specificity. School food policy research has produced an international evidence base, but the interventions themselves are rarely designed with local food cultures in mind. What children eat, how food is prepared, who prepares it, and what eating together means vary enormously across the settings represented in this review. Future interventions that build from these local realities — rather than importing generic programmes and hoping they travel — are more likely to produce changes that are both meaningful and sustained.

Conclusion

School-based food policies can change what children eat. The evidence reviewed here confirms this — cautiously, conditionally, and with important qualifications about which kinds of change, in which populations, under which conditions. The strongest effects emerged from interventions that were multicomponent in design, sustained over more than one school year, and attentive to the food environments that children inhabit beyond the school day. Single-component programmes, short-term interventions, and approaches relying primarily on nutrition education produced weaker and less consistent results. Knowing something about food, it turns out, is not the same as eating differently.

What the evidence cannot yet tell us — and what this review argues it urgently needs to — is what these policies do to children's relationship with food over time. The question of whether school food environments build or undermine children's capacity for autonomous, enjoyable, and sustainable eating has not been systematically studied. It should be. The developmental literature on restrictive feeding suggests that how food is framed and controlled matters as much as what is provided — and that approaches built primarily around prohibition may produce short-term dietary shifts at the cost of longer-term relational ones. For a field that ultimately cares about children's health across the lifespan, this is not a peripheral concern. It is central.

School food policy is, at its best, a structural commitment to the idea that all children — regardless of family income, cultural background, or postcode — deserve access to nutritious food and the conditions in which to develop a healthy relationship with eating. The evidence reviewed here suggests that realising that commitment requires more than changing what is served at lunchtime. It requires sustained, multicomponent efforts that engage families, respect cultural food practices, create positive rather than restrictive food experiences, and take seriously the psychological dimensions of eating alongside the nutritional ones. That is a more demanding ask than most current school food policies meet. It is also, the evidence suggests, where the most consistent results have been found.

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