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Universal, whole system and settings-based interventions for stabilizing or reducing the prevalence of overweight and obesity.

A review of systematic reviews
Version 1.0



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Universal, whole system and settings-based interventions for stabilizing or reducing the prevalence of overweight and obesity.

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Contents

Key messages.....	5
1 Executive summary.....	7
2 Background and Purpose.....	13
3 Methods	13
3.2 Eligibility Criteria.....	14
3.3 Search methods	15
3.4 Reference management	16
3.5 Selection process.....	16
3.6 Critical appraisal.....	16
3.7 Data extraction & grading	16
3.8 Synthesis	17
4 Results	18
4.1 Study Selection	18
4.2 Study characteristics	19
4.3 Critical appraisal/ Risk of bias in studies.....	19
4.4 Findings.....	20
4.5 Obesity prevention interventions aimed at the general population.....	22
4.5.1 Environmental interventions aimed at reducing sugar sweetened beverage consumption.....	22
4.6 Obesity prevention interventions aimed specifically at adults.....	28
4.6.1 Workplace obesity prevention interventions targeting dietary behaviour.....	28
4.7 Obesity prevention interventions aimed specifically at children	33
4.7.1 Preschool based obesity prevention interventions:	33
4.7.2 Environmental interventions to reduce child overweight and obesity, based within or around schools.	40
4.7.3 School based environmental interventions aimed at reducing sugar sweetened beverage consumption.....	46
4.7.4 School based healthy eating interventions that increase the availability of healthy foods in schools 51	
4.7.5 School based behaviour change interventions (using behavioural insights) aiming to improve diet	58
4.7.6 School based food environment policy level interventions.....	62
4.7.7 School based food and nutrition education interventions	71
4.7.8 School based computer-delivered nutrition interventions.....	77



4.7.9	Interventions aiming to improve home packed food and beverages consumed by children in school.....	81
4.7.10	School gardening programmes.....	85
4.7.11	School based physical activity interventions to improve obesity related outcomes.....	89
4.7.12	School based interventions targeting diet and physical activity to prevent obesity.....	92
4.7.13	School based interventions with implementation strategies.....	103
4.7.14	Home/family and community-based interventions targeting children.....	107
5	Discussion.....	113
5.1	Summary of evidence.....	114
5.1.1	Adults/general population.....	114
5.1.2	Children: preschool settings.....	114
5.1.3	Children: school settings.....	115
5.1.4	Children: home and community settings.....	116
5.2	How does this review of systematic reviews build on previous research?.....	117
6	Limitations.....	119
7	Conclusions.....	121
8	References.....	122
9	Appendix A: Search Strategy.....	126
10	Appendix B: Critical Appraisal Checklist.....	127
11	Appendix C: Data Extraction.....	132
12	Appendix D: Grading Scheme.....	219
13	Appendix E: Groove tool results.....	220



Key messages

Overall, we found the evidence relating to the effectiveness of specific types of universal, whole system or settings based interventions to be generally lacking, inconsistent or not conclusive. Despite this, our review of systematic reviews identified good to moderate quality evidence that:

- School gardening programmes are effective for increasing fibre intake (summary 4.7.10).
- Increasing the availability of low-calorie beverages in homes can reduce sugar sweetened beverage consumption amongst children (summary 4.7.14).
- School based computer delivered nutrition interventions are effective for reducing sugar sweetened beverage intake, but moderate to good quality evidence suggests they are likely to be ineffective for reducing BMI (summary 4.7.8).

In addition, we also identified that:

- In adults, workplace dietary behaviour change interventions with environmental, educational, or behavioural components (or a combination) can increase fruit and vegetable consumption. However, the poor methodological quality of studies exploring these interventions does limit our confidence in this finding (summary 4.6.1).
- In schools, interventions to reduce the availability of sugar sweetened beverages, or interventions to increase the provision of fruit may be effective for reducing sugar sweetened beverage intake. However, this is not conclusive due to small numbers of studies (summary 4.7.3).
- Behaviour change interventions (using behavioural insights) in schools may be effective for increasing children's fruit and vegetable intake. However, this is not conclusive due to poor study quality. There were no significant differences in effectiveness between interventions utilising different behavioural insights (summary 4.7.5).

Generally:

- A range of dietary (such as fruit and vegetable intake or sugar sweetened beverage intake) and anthropometric outcomes (which can be defined as non-invasive quantitative measurements of the body such as BMI, BMI z-score and waist circumference) were measured by the included primary studies. **We observed that often where the evidence suggested an intervention to be effective for changing a particular dietary outcome, the evidence suggested the same intervention had no effect on anthropometric measures.** This could be explained by the fact that in many instances interventions were short in duration or only included a short follow-up period. It may take longer for any short term observed changes in dietary intake to translate



into any meaningful change in anthropometric measures.

- Interventions were complex and variable and included multiple differences in settings, sample sizes and durations. **These factors made it difficult to group studies together to draw firm conclusions.**
- **Many primary studies included in the systematic reviews were assessed by authors as being of poor methodological quality.** This further limits our confidence in their conclusions.
- **Included interventions varied in setting**, with most research examining interventions undertaken in schools. Smaller numbers of studies examined home/family or community interventions, workplace interventions, preschool interventions, or interventions across the general population.
- **Many interventions were multicomponent** and this complexity meant it was often not possible to ascertain which specific component(s) of an intervention made it effective.

1 Executive summary

This review of systematic reviews builds on a previous review of systematic reviews published in 2019 ([Public Health Wales, 2019](#)) to support the Welsh Government's [Healthy Weight: Healthy Wales Strategy](#). It is intended for policy makers and those commissioning interventions, and aims to answer the question:

What universal (population level), whole system or settings based programmes and interventions are effective in stabilizing and reducing the prevalence of overweight and obesity in children, or adults aged 18-65 years?

A comprehensive search for secondary literature published since 2017 was undertaken and 26 systematic reviews (which included a total of 911 unique publications) met the inclusion criteria. These reviews were critically appraised and synthesised to provide **15 intervention summaries giving more detail on the effectiveness of a range of universal, whole system or settings based obesity prevention interventions (sections 4.5 to 4.7 of report)**. These intervention summaries provide detail on intervention effectiveness, aspects to consider and limitations of the evidence. They also include a comprehensive intervention section to provide stakeholders with additional information on the intervention components, where this was described in the systematic reviews. Readers will benefit from exploring the intervention summaries in detail in order to understand the context surrounding the intervention findings in more detail.

Findings:

Overall, **the evidence relating the effectiveness of universal, whole system and settings-based interventions for stabilizing or reducing the prevalence of overweight and obesity is generally lacking, inconsistent, or not conclusive.** This is largely due to the complexity and variability of intervention components, along with multiple differences in settings, sample sizes and intervention durations. These factors make it hard to draw firm conclusions. **No systematic reviews were identified which examined whole of community interventions** (defined as population level multi-strategy interventions delivered across entire communities [Wolfenden L, et al., 2014], comprising of system wide changes).

Included systematic reviews measured a range of dietary outcomes (such as fruit and vegetable intake or sugar sweetened beverage intake) or anthropometric outcomes, which can be defined as non-invasive quantitative measurements of the body (Casadei K, et al. 2022) and include measurements such as BMI, BMI z score and waist circumference. Most of the interventions identified were complex and multicomponent and it was often not possible to ascertain which component made an intervention effective. Intervention detail was often lacking from the systematic reviews,

and consequently groupings for the intervention summaries were generally broad, with some overlap in primary studies across the 15 summaries.

Adults/general population

Two intervention summaries explored interventions focusing either on adults or the general population ([summaries 4.5.1 and 4.6.1](#)). One summary focused on environmental interventions aiming to reduce sugar sweetened beverage intake ([4.5.1](#)), and the second focused on workplace dietary behaviour change interventions ([4.6.1](#)). These included evidence from three systematic reviews (Allan J, et al., 2017; Panchbhaya A, et al., 2022; von Philipsborn P, et al., 2019).

Evidence of effectiveness for environmental interventions aiming to reduce sugar sweetened beverage consumption among the general population was generally lacking, and where there was evidence, this was often inconsistent. Inconsistent findings were due to the variability of intervention components, settings, sample sizes and durations of the interventions. Evidence from one systematic review (von Philipsborn P, et al., 2019) suggests that there is **some evidence supporting the use of government food benefit programmes (which included incentives for buying fruit and vegetables and restrictions on the purchases of sugar sweetened beverages) for reducing sugar sweetened beverage consumption**. However, this is not conclusive due to small numbers of studies.

Evidence from two systematic reviews indicates that **workplace dietary behaviour change interventions** with environmental, educational, or behavioural components (or a combination) **can increase fruit and vegetable consumption**. However, the evidence around whether these interventions can reduce BMI is more inconsistent.

Intervention duration and participant numbers varied greatly across included primary studies targeting adults and/or the general population, and interventions involved a wide range of single or multicomponent elements. Components frequently involved environmental, educational or behavioural change aspects. These included the introduction of policies and programmes, financial incentives, urban planning restrictions, labelling, educational messaging or teaching. Interventions were also delivered in a variety of settings including households, supermarkets, community stores and fast food restaurants. Some systematic reviews included interventions focused on specific populations including those in low-income households, and those focused on adults involved workplace interventions.

Children: preschool settings

One intervention summary ([4.7.1](#)) including evidence from three systematic reviews examined interventions focusing on preschool age children (Ward D, et al., 2017; Yoong S, et al., 2023; Morgan E, et al., 2020). The evidence for the effectiveness of interventions in early years care and education settings that target healthy eating, physical activity and/or screen time was found to be largely

inconsistent.

Some limited evidence was identified suggesting these interventions may have a positive effect on children's overall diet quality and may increase children's consumption of fruit. However, the evidence suggests these interventions may have no effect on anthropometric measures.

Preschool interventions were generally multicomponent consisting of strategies to improve healthy eating and increase physical activity. One systematic review highlighted that **single behaviour interventions in general had higher correlations with anthropometric outcomes than combined diet and physical activity interventions** (Ward D, et al., 2017). This could be related to issues of study power.

Intervention duration and participant numbers varied greatly across included preschool studies. Interventions were generally multicomponent with strategies to improve healthy eating or to improve physical activity. Strategies to improve healthy eating included menu changes, nutrition education, changing meal service approaches, and food tastings (Ward D, et al., 2017). Strategies to improve physical activity included structured physical activity lessons, staff training, and take-home activity cards or resources (Ward D, et al., 2017). Some physical activity interventions also included a caregiver component as part of the intervention. A variety of delivery methods were used including telephone, face-to-face and online. Intervention settings included educational, home and community settings.

Children: school settings

Twenty-three systematic reviews were identified examining school based interventions generating 12 intervention summaries ([sections 4.7.2 to 4.7.13](#)). Of these, one publication incorporated four systematic reviews (section [4.7.12](#); Wethington H, et al., 2020) and one was not synthesised due to complete overlap of primary studies with another systematic review (section [4.7.5](#); Marcano-Olivier M, et al., 2019).

Overall, the diverse components, measurements and target behaviours of the interventions identified make it difficult to form conclusions about their collective effectiveness. **Although findings remain largely inconsistent, not conclusive or lacking, moderate to good quality evidence was identified indicating:**

- Policies focusing on school competitive food and beverage standards (defined as foods and beverages sold outside of school meal programs and competing with school meal programs) are unlikely to be effective at reducing BMI z score ([4.7.6](#))
- **School based computer-delivered nutrition interventions are effective for reducing sugar sweetened beverage intake**, but moderate to good quality evidence suggests they are likely to be ineffective for reducing BMI ([4.7.8](#))

- **School gardening programmes significantly increased fibre intake (4.7.10)**
- A wide range of strategies (such as educational, local consensus process and tailored interventions) to improve the implementation of school based interventions targeting student diet, physical activity, or obesity are unlikely to be effective for reducing BMI (4.7.13)

Intervention duration and participant numbers varied greatly across included school based primary studies and interventions involved a wide range of single or multicomponent elements. Components frequently aimed to change the school environment in some way, elicit behaviour change or provide education. This included introducing policies, improving access or provision, prizes and games, cooking and sports activities, newsletters, and educational sessions. In addition, some interventions also included parental or family elements. Theoretical models were also sometimes utilised to help tailor content and personalise feedback, however systematic review authors generally could not determine whether any positive post-intervention results were due to a particular theoretical model used (Beck-Silva K, et al., 2021).

Children: home and community settings

One intervention summary (4.7.14) including evidence from two systematic reviews (Moss S, et al., 2022 & von Philipsborn P, et al., 2019) examined home, family or community based interventions targeting children. Due to reporting within the systematic reviews, it was not possible to separate the findings out into different summaries for home or community, so findings were synthesised together.

The evidence for the effectiveness of home/family and community based interventions targeting children's BMI or sugar sweetened beverage intake was largely inconsistent. However, **there was good to moderate quality evidence indicating that increasing the availability of low-calorie beverages in homes can reduce sugar sweetened beverage consumption.**

Home/family or community based interventions ranged between 16 weeks to 12 months duration and included between 93 and 2623 participants. The majority of interventions involved a home based component, but some included additional community based aspects. Home based interventions included home delivery of beverages, dietary counselling and video gaming, distribution of educational material or direct contact with parents. Community aspects included assigning parents to social groups for enhanced peer support, informal groups sessions, and peer group activity sessions for children.

Further considerations:

The majority of the evidence was collected from interventions undertaken in the USA, with few identified from the UK, which may limit generalisability. Few systematic reviews undertook additional analyses to investigate effectiveness by gender or specific population groups that may be considered vulnerable, such as those who are marginalised or children from low income families (Morgan E, et al., 2020; Podnar H, et al., 2020; Wolfenden L, et al., 2022).

Although most intervention summaries include assessment of a broad range of anthropometric and dietary outcomes, **where a summary has identified an intervention as effective for improving a particular outcome, evidence for the other outcomes assessed within the same systematic review was often concluded to be inconsistent or in some cases showing the intervention to have no effect, providing a very mixed picture overall.** In many instances, it appeared interventions examined were more often effective for improving dietary related outcomes, but less often effective for anthropometric outcomes. This may be explained by the fact that most interventions were short in duration or only included a short period of follow-up. It could potentially take longer for any short term observed changes in dietary intake to translate into any meaningful change in anthropometric measures. This suggests that careful consideration needs to be given when designing interventions, to ensure they are of a sufficient duration and intensity to be able to produce meaningful results in the outcomes measured as part of the evaluation process.

The majority of diet related outcome data were also obtained by self-reported methods which are inherently subject to recall bias. However, in order to strengthen our certainty of the evidence, where possible, we excluded proxy measures used to estimate consumption (such as sales data). Although these can be useful for estimating overall diet quality, research suggests they are less useful for estimating dietary intake of specific nutrients (Appelhans B, et al., 2017).

Conclusions:

Despite the mixed findings in relation to the effectiveness of universal, whole system and settings-based interventions for stabilizing or reducing the prevalence of overweight and obesity, there are some interesting interventions (as highlighted in the findings section) that could be worthy of further investigation and consideration. This could be achieved via conducting further, more focused reviews of primary evidence as well as further in depth evaluation of interventions. As previously noted, the heterogeneity of interventions made comparisons difficult, and as methodological quality was generally considered poor to moderate, more well conducted studies investigating interventions specific to Wales are needed.

Although this review of systematic reviews confirms that inconsistencies across the evidence base remain, this is likely down to the varied nature of interventions, study aims, populations studied,



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settings and outcomes examined within the included systematic reviews, rather than necessarily a failure of the interventions themselves. Before implementing interventions in Wales, in depth consideration should be given to the transferability of these interventions to the Welsh context, to ensure findings can be reliably extrapolated from the study and applied to settings or contexts other than those in which they were tested. This type of consideration is necessary to maximise an interventions effectiveness and minimise the risk of unforeseen problems that may arise from implementing an intervention in a different context to where it was originally conducted.

2 Background and Purpose

The prevalence of overweight and obesity in Wales is rising. Being overweight or obese increases a person's risk of acquiring a range of chronic diseases such as type 2 diabetes, hypertension, and cardiovascular disease. It is estimated that illnesses associated with obesity cost the Welsh NHS £73m a year (Public Health Wales, 2018).

In 2019, the Public Health Wales Evidence Service published a review of systematic reviews examining the effectiveness of universal, whole system and settings based interventions for the prevention of obesity ([Public Health Wales, 2019](#)), in order to support development of the Welsh Governments [Healthy Weight: Healthy Wales Strategy](#). This review of systematic reviews adds to the evidence identified in the 2019 review of systematic reviews, by focusing on similar intervention types and settings.

As overweight and obesity are major risk factors for many of health conditions identified by Public Health Wales' priority disease work (such as diabetes and heart disease), we anticipate that this review of systematic reviews will sit alongside the current priority disease work which highlights the main health conditions with a high prevalence in Wales. Therefore, reviewing what works to stabilize and prevent overweight and obesity in Wales can help to inform interventions, policies and programmes to reduce the burden of disease for some of these conditions.

3 Methods

3.1 Review question

This review of systematic reviews followed a rapid systematic review methodology outlined in a protocol (available on request). The review of systematic reviews aimed to address the following questions:

- 1) What universal (population level), whole system or settings-based programmes and interventions are effective in stabilizing or reducing the prevalence of overweight and obesity in children?
- 2) What universal (population level), whole system or settings-based programmes and interventions are effective in stabilizing or reducing the prevalence of overweight and obesity in adults aged 18-65 years?

3.2 Eligibility Criteria

All systematic reviews identified through a comprehensive search were screened against the selection criteria outlined in table one. Systematic reviews and meta-analyses of interventional studies published since 2017 were eligible for inclusion as the most recent systematic reviews included in our previous work were published in 2017. In addition, subjective measures of weight gain or loss (such as self-weighing for weight loss), and measures of overall energy intake were excluded due to the high likelihood of measurement bias.

Table 1: Review inclusion/exclusion criteria

	Include	Exclude
Study design	Well-designed systematic reviews and meta-analyses of interventional studies. Evidence reviews underpinning NICE guidelines.	Non-systematic literature reviews and primary research including observational studies. Conference abstracts and posters.
Participants	Children. Adults aged 18-65 years.	Studies only considering data on subjects outside of this age group or including only participants with specific health conditions including those targeted wholly at populations who are overweight or obese.
Interventions	Universal, whole system or settings-based interventions ¹ to prevent / stabilise / reduce overweight or obesity in adults.	Other types of interventions such as individual level interventions directed at individual members of targeted groups.
Outcomes	Objective measures of weight gain or weight loss (such as per cent fat content, BMI, ponderal index, skin-fold thickness, waist circumference, waist-to-hip ratio, mid arm circumference). Prevalence of overweight and obesity, Measures that could be conceived as showing an attempt at meeting/ achieving dietary guidelines. E.g., healthier consumption decisions measured by frequency of healthy choices and overall intake, nutritional knowledge/attitude gain, consumption behaviour (fruit/veg etc.)	Subjective measures of weight gain or loss such as those not measured using anthropometric measures. Weight loss (kg) (Self-weighing for weight loss). Energy intake (so not focused on meeting dietary guidelines).

¹ Universal interventions are those that can be applied to an entire population, with inclusion criteria simply being that a person is part of a defined population. Whole system interventions are defined as population level multi-strategy interventions delivered across entire communities, comprising of system wide changes. Settings based interventions are those that take place within a certain defined setting such as within schools or workplaces.



Other	OECD countries (list) . Published 2017 onwards. English language.	Non-English language papers. Published before 2017.
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3.3 Search methods

The following reliable evidence sources (obtained from the Public Health Wales Evidence Service list of reliable secondary evidence sources) were searched as they adhere to robust systematic review principles², along with MEDLINE and healthvidence.org (as per the previous review of systematic reviews).

- [Cochrane Database of Systematic Reviews](#)
- [National Institute for Health and Care Excellence \(NICE\)](#)
- [Joanna Briggs Institute](#)
- [PROSPERO](#)
- [National Institute for Health and Care Research \(NIHR\)](#)
- [The Evidence for Policy and Practice Information and Coordinating Centre \(EPPI-Centre\)](#)
- [Campbell Collaboration Systematic Reviews](#)
- [What Works Centre for Wellbeing](#)
- [What Works for Children's Social Care](#)
- [What Works Clearinghouse](#)
- [Early Intervention Foundation \(EIF\)](#)
- [Health Technology Wales](#)
- [Health Technology Assessments \(Ireland\)](#)
- [National Institute for Health Research \(NIHR\) Health Technology Assessment \(HTA\) Journal](#)
- [Agency for Healthcare Research and Quality \(AHRQ\)](#)
- [Evidence Synthesis Program Reports](#)
- [Scottish Intercollegiate Guidelines Network \(SIGN\) Clinical Guidelines](#)

Sources were searched between the 14th and 20th of July 2023. Searches were date limited to only include research published since January 2017, as the previous review of systematic reviews captured research published prior to this. Language was restricted to secondary level evidence published in English only. There was no attempt to contact authors or topic experts to identify additional evidence.

² Follows core systematic review principles: comprehensive and stated search strategy, selection of sources based on objective criteria, assessment of risk of bias of primary sources and/or is a methodology developed by an expert body e.g. NICE. For a full list of sources searched, please refer to Sources searched section of the report.

The review team conducted a systematic literature search for evidence using a combination of the following search terms: "obesity", "overweight", "weight", "obese", "diet", "nutrition", "intervention", "programme", "policy", "strategy", "whole systems", "universal", "environment" and "setting". A complete search strategy can be found in appendix A. When a review of systematic reviews which met the inclusion criteria was identified, systematic reviews within this were also screened for inclusion.

3.4 Reference management

All search results were exported to Endnote, deduplicated, and transferred to Rayyan for screening.

3.5 Selection process

Systematic reviews were assessed against the inclusion criteria outlined in Section 3.2. Inclusion at title and abstract was undertaken by a single reviewer. A co-reviewer independently screened one third of the systematic reviews considered eligible for inclusion for consistency. Conflicts were resolved by discussion, or with input from a third reviewer.

Full-text screening was undertaken by two reviewers independently in duplicate. Conflicts were resolved by discussion between all reviewers.

3.6 Critical appraisal

Included systematic reviews were critically appraised to assess their methodological quality. Each was critically appraised independently in duplicate by two reviewers, using the systematic review checklist produced by the Public Health Wales Evidence Service (appendix B). Conflicts were discussed and resolved by all reviewers. Any concerns about the methodological quality of a systematic review were highlighted in the 'comments' section of the data extraction table (appendix C).

3.7 Data extraction & grading

Data reporting relevant outcomes was extracted from included systematic reviews by one reviewer into a data extraction table (appendix C). A second reviewer consistency checked the extracted data and disagreements were resolved through discussion. Only variables and outcomes relevant to this review of systematic reviews were extracted into data extraction tables, and data was not interpreted in any way by the Evidence Service team.

The effectiveness of interventions on relevant outcomes from each systematic review were graded using the Public Health Wales Evidence Service simple traffic light grading scheme for systematic reviews (appendix D). This grading scheme uses a pragmatic approach to assess the certainty of the evidence in relation to a specific outcome of interest. Effectiveness, study design and study quality are considered in order to assess whether the interventions examined in the systematic review are supported or not supported by good, moderate or poor quality evidence of effectiveness for a particular outcome measure. Grading decisions are recorded in the data extraction tables (appendix C).

An investigation into the overlap of included primary studies was also undertaken across the systematic reviews. Overlaps were detected/highlighted using the Graphical Representation of Overlap for Overviews (GROOVE) tool, an Excel-based file (Bracchiglione J, et al., 2022). Two reviewers entered the individual primary studies assessed in each systematic review, which were then consistency checked. A graphical representation showing the degree of overlaps was created from the information (Appendix E). The degree of overlaps were categorised as follows:

- <5% similarity represents a slight overlap
- 5% to <10% a moderate overlap
- 10% to <15% a high overlap
- above 15% a very high overlap

Details of primary study overlap are outlined in the intervention summaries displayed in the results section (section 4.5 to 4.7).

3.8 Synthesis

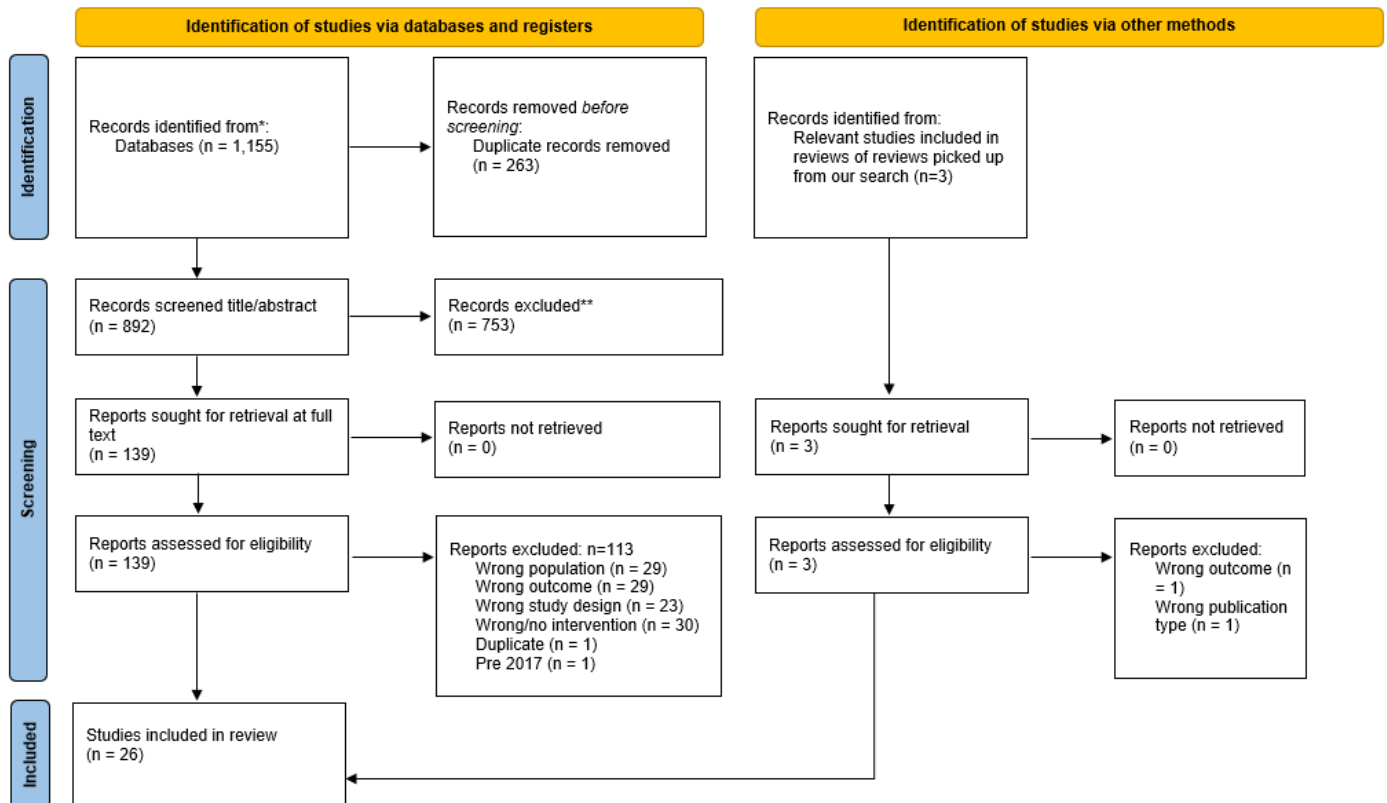
Data from the included systematic reviews were narratively synthesised owing to the heterogeneity of interventions and outcome variables. Systematic reviews were categorised according to population group studied (adults, children or general populations) and then further broken down into broad intervention categories based on the aim of the intervention. 'Intervention summaries' were then produced for each broad intervention category (section 4.5 to 4.7). These consist of narrative synthesis detailing the evidence of effectiveness of the intervention in relation to specific outcomes, intervention detail, and considerations and limitations of the evidence that should be further explored by stakeholders prior to considering implementation of any interventions. Grading statements on the effectiveness of the intervention for each outcome were also incorporated into the overall narrative synthesis

4 Results

4.1 Study Selection

A flow diagram of the literature search and study selection results is shown in figure 1. The search identified a total of 1,155 records, with 892 remaining for title and abstract screening once duplicates were removed. Seven hundred and fifty three records were excluded at title and abstract, leaving 139 papers which were retrieved for full text screening. Of the 139 papers screened at full text, 113 were excluded (figure 1 details exact reasons for exclusion), leaving 25 systematic reviews. An additional systematic review that met our inclusion criteria was identified from the included studies list of a review of systematic reviews picked up via our database search. Therefore, a total of 26 systematic reviews were included in this review of systematic reviews.

Figure 1: PRISMA Flow diagram



From: Page MJ, McKenzie JE, Bossuyt PM, Boutron I, Hoffmann TC, Mulrow CD, et al. The PRISMA 2020 statement: an updated guideline for reporting systematic reviews. *BMJ* 2021;372:n71. doi: 10.1136/bmj.n71. For more information, visit: <http://www.prisma-statement.org/>



4.2 Study characteristics

The included systematic reviews were published between 2017 and 2023 and included a total of 911 unique publications. Varying amounts of overlap of primary studies between systematic reviews were observed, with 146 publications appearing in two systematic reviews, 35 appearing in three systematic reviews and 10 appearing in four systematic reviews. Further detail on overlap is given in the intervention summaries.

A total of 22 systematic reviews met the inclusion criteria for question one, two systematic reviews met the inclusion criteria for question two and two systematic reviews met the inclusion criteria for both questions. Twenty one systematic reviews included studies undertaken in children and/or adolescents (age 0 to 19 years), and one included caregiver-child units (Morgan E, et al., 2020). Two systematic reviews only included studies undertaken in adults (Allan J, et al., 2017; Panchbhaya A, et al., 2022), and two included studies in participants of any age (von Philipsborn P, et al., 2019; Mandracchia F, et al., 2021). Of those focused on children, three focused on preschool aged children (age range 0 to 6 years) (Moss S, et al. 2022; Yoong S, et al., 2023; Ward D, et al., 2017), four on primary school aged children (age range 4 to 12 years) (Nally S, et al., 2021 Podnar H, et al., 2021; Qi Y, et al., 2021; Verjans-Janssen S, et al., 2018) and three on adolescents (age range 10 to 19 years) (Beck Silva K, et al., 2022; Calvert S, et al., 2019; Medeiros G, et al., 2022). The remaining 11 included children/adolescents of any age.

Primary studies included in the systematic reviews were conducted in a variety of countries, but most prominently from the USA and Europe. There was large variation in sample sizes between the included primary studies, and participant numbers varied widely across the primary studies and systematic reviews.

The designs of primary studies included in the systematic reviews also varied, with some systematic reviews restricting their inclusion criteria to only include 'robust' study designs such as randomised controlled trials (RCTs) or other controlled trials, whilst others included a wider range. Those that conducted meta-analysis generally restricted their included study designs to those considered more 'robust', but not always. Conversely, those who narratively analysed data, generally did not limit the included study design.

4.3 Critical appraisal/ Risk of bias in studies

Assessment of the methodological quality of the included systematic reviews revealed some common concerns. Although a criterion for inclusion in this review of systematic reviews was that systematic reviews had to have undertaken some form of quality/risk of bias assessment of their included primary studies, systematic review authors often did not consider the study quality when

formulating their findings and conclusions. In addition, in some systematic reviews, findings were reported selectively (for example, only reporting positive outcomes), or individual study effect sizes or statistical significance were not reported. Where meta-analyses were conducted, heterogeneity across studies was often high. The possibility of publication bias was rarely discussed across the included systematic reviews.

Comments on the methodological quality of the individual systematic reviews included in this review of systematic reviews highlighted during quality appraisal can be found in the data extraction tables (appendix C).

4.4 Findings

Interventions across the systematic reviews were very heterogeneous in nature, with a mixture of single or multicomponent interventions targeting aspects such as changes to the physical environment, dietary change and physical activity.

Four systematic reviews included interventions delivered across a broad range of settings including home, school, community, the built environment, or retail (Chambers T, et al., 2021; Bramante C, et al., 2019; Mandracchia F, et al., 2021 & von Philipsborn P, et al., 2019). Two systematic reviews focused on interventions undertaken in workplace settings (Allan J, et al., 2017; Panchbhaya A, et al., 2022), with one of these focused specifically on healthcare workers (Panchbhaya A, et al., 2022). Eighteen systematic reviews were focused exclusively on interventions conducted in education settings (schools/preschools), and one further systematic review focused on interventions to improve home packed food and beverages consumed by children in schools (Nathan N, et al., 2019). Finally, one systematic review focused solely on home, family or community interventions aimed at children, and excluded studies undertaken in schools (Moss, S, et al. 2022). No systematic reviews were identified which examined whole of community interventions.

A variety of outcomes were measured across the systematic reviews. The majority of systematic reviews included both nutritional and anthropometric outcomes (n=17). However, six systematic reviews examined intervention effects solely on nutritional outcomes (Chambers T, et al., 2021; Calvert S, et al., 2019; Chan C, et al., 2022; Mandracchia F, et al., 2021; Marcano-Olivier M, et al., 2020; Mederios G, et al., 2022) and three examined intervention effects solely on anthropometric outcomes (Moss S, et al., 2022; Podnar H, et al., 2021; Yuksel J, et al., 2020). Commonly measured nutritional outcomes included fruit and vegetable intake, fat intake and sugar sweetened beverage intake. Commonly measured anthropometric outcomes included BMI/BMI z score and prevalence of overweight/obesity.

Following data extraction, the included systematic reviews were grouped where potential interventions could be considered based on the population of interest, and then further categorised



by the aim of the intervention. Overviews of the findings for each category were produced to summarise the research evidence identified by this review of systematic reviews. A total of 15 intervention summaries have been produced. Each intervention summary includes:

- ***Directional thinking***, which summarises the systematic review findings for that category.
- ***Intervention detail***, which provides an overview of intervention detail where information is available from the included systematic reviews.
- ***Other things to consider***, which covers other issues identified by review authors that are relevant to interpretation. This includes systematic review authors' comments and relevant and/or additional findings not reflected in directional thinking, as well as a summary of the overlap of included studies with other systematic reviews included in this review of systematic reviews.
- ***Limits to what we know***, which includes limits to the evidence base that systematic review authors or Public Health Wales reviewers have identified.

One systematic review (Marcano-Olivier M, et al. (2019) was not included in the intervention summaries because all primary studies with relevant outcomes were included in the other systematic review in the same summary (Chambers T, et al., 2021). These systematic reviews looked at school based behaviour change (using behavioural insights) interventions and are discussed in section [4.7.5](#).

4.5 Obesity prevention interventions aimed at the general population

4.5.1 Environmental interventions aimed at reducing sugar sweetened beverage consumption

Environmental interventions (such as purchase incentives, or planning restrictions) aimed at reducing sugar sweetened beverage consumption

Directional thinking



Overall, there is a lack of evidence exploring the effectiveness of environmental interventions in reducing sugar sweetened beverage consumption. The evidence that is available is largely inconsistent. One systematic review was identified, which included a total of 58 studies (von Philipsborn P, et al., 2019). Out of these, nine studies described interventions which aimed to reduce sugar sweetened beverage consumption, outside of the school setting. These nine interventions were organised into five categories by the authors and their effects on sugar sweetened beverage consumption are summarised below.

The systematic review by von Philipsborn P, et al. (2019) suggests that there is **some evidence supporting the use of (1) government food benefit programmes which included incentives for buying fruit and vegetables and restrictions on the purchases of sugar sweetened beverages**, with three studies identified. One study showed a significant decrease in sugar sweetened beverage intake (-180 ml/day, 95% CI: -338 to -22). One study showed a non-significant decrease in sugar intake from sugar sweetened beverages (-1g/day/person, 95% CI: -5 to 2). A third study found both significant and non-significant decreases in sugar sweetened beverage intake, depending on the monetary amount of government benefit participants were awarded each month.

The evidence for **(2) government food benefit programmes without incentives for buying fruit and vegetables and restrictions on the purchase of sugar sweetened beverages is inconsistent**, with only two studies found to measure relevant outcomes. One study reported that intake of sugar from sugar sweetened beverages decreased by -0.5g/day (95% CI: -2 to 1) for the comparison of US dollar (USD) 60 versus no USD benefit a month, increased by 1g/day (95% CI: -1 to 3) for the comparison of USD 60 versus USD 30 benefit a month, and decreased by -2g/day (95% CI: -4 to 1) for the comparison of USD 30 versus no USD benefit a month. Another study showed an increase in the median sugar sweetened beverage intake (+34 kcal/day, 95% CI: 7 to 60).

The systematic review also explored the effectiveness of **(3) financial incentives to purchase low-calorie beverages implemented through supermarket loyalty**



cards on sugar sweetened beverage consumption. However, the evidence was found to be inconsistent across two studies. One study found that the share of participants reporting the consumption of any red-labelled beverage each week decreased significantly (-23% in the intervention group versus -2% in the control group, $p=0.01$) during the five-month intervention period. Another study found that self-reported sugar sweetened beverage intake increased by 10ml/day (95% CI: 0 to 20) at three months.

There is a **lack of evidence** regarding the effectiveness of **(4) price discounts on low-calorie beverages in community stores on sugar sweetened beverage consumption**, with only one relevant study identified. This study showed a non-significant increase in sugar sweetened beverage intake per capita during the intervention period (6% increase, 95% CI: -3 to 15) and five month follow-up (6% increase, 95% CI: -7 to 21).

There is also a **lack of evidence** exploring the effectiveness of **(5) urban planning restrictions on new fast food outlets on sugar sweetened beverage consumption**, with only one relevant study found. The authors reported a non-significant decrease in sugar sweetened beverage intake for restricted areas compared with other parts of the city and the county (-0.9, $p>0.05$).

Intervention Detail

The environmental interventions aimed at reducing sugar sweetened beverages consumption described in the systematic review varied widely. Interventions were delivered to either all ages, adults, or households with school age children. Intervention settings varied and included social policy, households, supermarkets, community stores in indigenous communities and fast food restaurants.

Sample sizes amongst the nine studies ranged from 148 to 25,150 participants. Duration of interventions ranged from three months to four years.

Intervention components by category are summarised below.

1. Government food benefit programmes with incentives for buying fruit and vegetables and restrictions on the purchases of sugar sweetened beverages:

Monetary transfers to low-income households with children, which could be used to purchase a limited range of foods and beverages, excluding sugar sweetened beverages. In the summers of 2011-2013, when schools were not in



session, a value of \$60 per eligible child per month was provided on an electronic benefit transfer card.

Monetary transfers, with restrictions on sugar sweetened beverage purchases and incentives for fruit and vegetable purchases. The incentive was 30% of purchase price. The participant was given a debit card and told the dollar amount to be added to the card every four weeks over the 12-week experimental period (three deposits). The amount placed on the card every four weeks was \$152 monthly for a household of one, \$277 monthly for household of two, \$401 monthly for household of three, etc).

Rebates on fruits and vegetables. Over a 12-month period, participants received a 30% rebate for purchases of targeted fruits and vegetables at participating retailers, using SNAP (Supplemental Nutrition Assistance Program) benefits. The rebate was credited to participants' accounts at time of purchase and could be spent on any SNAP-eligible foods and beverages.

2. Government food benefit programmes without incentives for buying fruit and vegetables and restrictions on the purchase of sugar sweetened beverages:

Monetary transfers to low-income households with children, which could be used to purchase foods and beverages including sugar sweetened beverages. In the summers of 2011 and 2012, for households that were randomly selected, a value of \$60 per eligible child per month was provided on an electronic benefit transfer card when schools were not in session (prorated for partial summer months). In 2013, consenting households were randomly selected to receive either the \$60 monthly benefit per eligible child or a \$30 monthly benefit per child.

Supplemental Nutritional Assistance Program (SNAP) benefits were increased by a constant dollar amount according to household size. This increase is equivalent to a 13.6% increase in the maximum allotment for that household size, with proportionally greater increases for families receiving less than the maximum allotment. Also, the three month time limits on programme participation by unemployed, working-age adults with no children was relaxed. In 2009, the average monthly SNAP benefit was \$125 per person, up nearly 22.6% from \$102 in 2008. SNAP benefits could not be used on ready-to-eat hot meals or in restaurants. In 2013, the average monthly SNAP benefit was approximately \$275 per household.

3. Financial incentives to purchase low calorie beverages implemented through supermarket loyalty cards:



Participants received a 20% price discount on target items, which was applied at the checkout on swiping their loyalty card at a specific store for a three month period. Participants were sent a list of discounted items (all fruit and vegetables, including fresh, tinned, and frozen, and diet or low-calorie carbonated beverages or water) at the start of the intervention and midway through the intervention period. This discount was applied over and above any other usual store discounts.

Traffic-light shelf labels were posted for each beverage item in the store to indicate if the beverage was a healthy (green), less healthy (yellow) or unhealthy (red) choice. Intervention group participants received five monthly letters during the intervention period (April to August 2014). The initial monthly letter (April) explained what the red, yellow and green supermarket beverage labels represented and how the participant could earn a \$US 25 incentive each month (in the form of a supermarket gift card) by refraining from purchasing any red-labelled beverages at the store. Each subsequent monthly letter (May–August) provided feedback identifying any red-labelled beverage purchases they made in the previous month and notified them if they earned the \$US 25 gift card. Each of the monthly letters also included a graphic of the in-store traffic-light labels, brief targeted beverage education and a healthy beverage recipe (e.g. seltzer water with fruit). The beverage education topics for each month were: (i) juice and juice drinks; (ii) sports drinks; (iii) milk and flavoured milk; (iv) coffee and tea; and (v) powdered drinks. These topics were chosen based on findings from previous focus groups with non-participant store customers that demonstrated customers were aware that soda was unhealthy, but they had gaps in knowledge about the healthfulness of other sugary beverages, particularly juice, juice drinks and powdered mixes.

4. Price discounts on low-calorie beverages in community stores:

A 20% price reduction for bottled water and diet beverages, applied at the point of sale and the discount promoted in stores. The value of the price discount was reimbursed to the store associations using Australian National Health and Medical Research Council research funding. Promotional materials (large pull-up banner, price tickets, shelf stripping, and fridge stickers) were also used.

5. Urban planning restrictions on new fast food outlets:

A zoning regulation that restricted opening or expanding stand-alone fast-food restaurants in specific areas of Los Angeles, USA.



Other things to consider



- A slight overlap of included studies in the von Philipsborn P, et al. (2019) systematic review and several other systematic reviews included in this review of systematic reviews was identified. However, none of the nine studies discussed in this summary appear in any other systematic reviews.
- This systematic review has been conducted by Cochrane who are known to follow rigorous methodology. It is a very in-depth systematic review and if any aspect is of particular interest, the reader should look at the full systematic review as it is likely to have been discussed in more detail.
- Von Philipsborn P, et al. (2019) conducted a narrative synthesis focused on the existence and the direction of effects, and not on the effect size. Meta-analyses (random-effects models) were conducted for intervention types where two or more studies used the same study design and reported comparable outcome measures.
- Review authors included the following study designs in their systematic review: RCT, controlled interrupted time series, controlled before and after study, interrupted time series, cluster RCT, non-RCT.
- Of the nine relevant included studies, seven were conducted in the USA and two studies were conducted in Australia.
- The systematic review included adult, adolescent and child participants undertaking numerous interventions in a variety of settings.
- The systematic review also measured diet-related anthropometric outcomes amongst children in relation to school or home based interventions aimed at reducing sugar sweetened beverage consumption, which are described in a separate summary in this review of systematic reviews.
- Studies were only considered for inclusion if they included a combined length of intervention and follow-up of at least 12 weeks and at least 20 individuals in each of the intervention and control groups. Multicomponent interventions were excluded.
- Studies on the taxation of sugar-sweetened beverages were excluded, as these are the subject of a separate Cochrane systematic review.
- Interventions targeting 100% fruit juice were not considered based on the sugar content being similar to that of many sugar-sweetened beverages.
- Few studies considered contextual and implementation factors, including barriers to and enablers of implementation. Such information can, however, be important for sustained and scaled-up implementation. Similarly, only a few studies systematically examined target group and stakeholder perceptions, which can be essential for mobilising and sustaining public and political support. Process evaluations and mixed methods approaches, used by several studies in the systematic review, can help to generate evidence on such aspects.
- As well as direct consumption of sugar sweetened beverages, this systematic review included indirect measures of sugar sweetened beverage consumption (e.g. sales). For the purposes of our review of systematic reviews, only those outcomes measuring actual consumption



or intake of sugar sweetened beverages were extracted (whether objectively or via self-report), whereas those that used a proxy measure such as sales to estimate consumption, were not.

- Five studies commented on the long-term effects of the intervention and measured sugar sweetened beverage intake after the study period had ended. This ranged from three months post intervention to four years post intervention.

Limits to what we know



- The nine studies were graded by review authors as being of very low to moderate certainty evidence.
- None of the nine studies were conducted in the UK so generalisability of the findings to Wales should be considered.
- Reporting bias was a major concern of the included studies and publication bias was also highlighted.
- Most of the studies included in the systematic review (39 out of 58) used non-randomised designs, and for most of the intervention types covered by the systematic review (13 out of 24), only non-randomised studies were found. Following GRADE, the authors' initial confidence in the certainty of the effects was therefore low for most intervention types and most outcomes.
- Two authors declared conflicts of interest for this systematic review. One was a consultant working primarily for health insurance companies while the other's institution has received grants from pharmaceutical companies responsible for producing slimming products. The same author has membership on the science advisory boards of Nestle and Danone.

References

1. von Philipsborn P, et al., (2019). Environmental interventions to reduce the consumption of sugar-sweetened beverages and their effects on health. *Cochrane Database of Systematic Reviews*. CD012292.

4.6 Obesity prevention interventions aimed specifically at adults.

4.6.1 Workplace obesity prevention interventions targeting dietary behaviour.

Workplace dietary behaviour interventions with environmental, educational, or behavioural components (or a combination)

Directional thinking



There is some evidence that workplace dietary behaviour change interventions aiming to change the physical environment, or including educational or behaviour change components (or a combination), can increase fruit and vegetable consumption and weight/BMI, but this is not conclusive. Two systematic reviews included a total of 53 unique studies, published across 60 unique articles (Allan J, et al., 2017; Panchbhaya A, et al., 2022). These incorporated total of 26 RCTs and 30 non-RCTs.

Allan J, et al. (2017) evaluated the evidence surrounding the effectiveness of environmental interventions targeting eating behaviour in the workplace, including 22 studies (published in 24 articles) in the narrative analysis. Panchbhaya A, et al. (2022) evaluated the effectiveness of dietary interventions in health care workers, including 34 studies (published in 39 articles) in the narrative synthesis and 18 were suitable for meta-analysis.

Dietary outcomes:

Fifteen unique studies across the two systematic reviews examined workplace interventions effects on either fruit intake, vegetable intake or fruit and vegetable intake combined (with one study appearing in both systematic reviews). Three studies from the systematic review by Allan J, et al. (2017) looked at fruit intake (one cluster RCT and two non-RCTs). Two found that the interventions significantly increased fruit intake compared to control and one found no significant difference. Four studies in the systematic review by Allan J, et al. (2017) looked at vegetable intake (two cluster RCTs and two non-RCTs). Three found that the interventions significantly increased vegetable intake compared to control and one found no significant difference between groups. Ten studies across the two systematic reviews examined combined fruit and vegetable intake (three RCTs, three cluster RCTs, one quasi-experimental study, one mixed methods, one multi-level ecological study and one pre-post test pilot study). Seven found that the intervention increased fruit and vegetable intake (however significance was not reported in two) and three reported no change in combined fruit and vegetable intake. The majority of included studies were assessed as having a high or unknown risk of bias. Therefore, **despite the majority of studies showing a positive effect for workplace dietary behaviour change interventions on increasing fruit and/or vegetable intake, the evidence is not conclusive.**



The systematic review authors also explored what particular types of workplace intervention show the most promising effects. They concluded that **most interventions that found significant improvements for fruit and vegetable intake utilised education and/or behavioural elements.**

Ten unique studies across the two systematic reviews examined workplace interventions effects on fat intake (one study appeared in both systematic reviews). Six of these reported that the intervention led to a significant decrease in fat intake (two cluster RCTs, one RCT, one crossover RCT, one quasi-experimental study and one cross sectional study). Three (one cluster RCT and two RCTs) reported no difference in fat intake post-intervention and one further non-randomised study found a decrease in fat intake, but statistical significance was not reported. The systematic review by Panchbhaya A, et al. (2022) was able to pool two studies into a meta-analysis which showed no significant difference in fat intake between groups (MD: -0.39%, 95% CI: -2.95 to 2.17, $p=0.76$, I^2 84%). The majority of studies across both systematic reviews were rated as being at high or unclear risk of bias across several areas, making the findings from the systematic reviews less conclusive.

When exploring what particular types of workplace intervention show the most promising effects, the reviewers concluded **that those primary studies observing significant decreases in fat intake were mainly environmental interventions,** with educational interventions finding more inconsistent effects on fat intake.

Due to inconsistent findings across the two systematic reviews, it is not possible to draw a conclusion on whether workplace dietary behaviour change interventions can reduce fat intake.

Anthropometric outcomes:

Across the two systematic reviews, 21 unique primary studies (three in the systematic review by Allan J, et al. (2017) and 19 in the review by Panchbhaya A, et al. (2022) with one appearing in both systematic reviews) assessed the effect of interventions on either weight change or BMI. The majority of included studies were rated as high or unclear risk of bias. The evidence of effectiveness was inconsistent across the systematic reviews.

BMI was measured in seventeen studies across both systematic reviews, with eight showing a statistically significant decrease in BMI for the intervention, seven showing no significant differences in BMI and one showing the intervention led to a statistically significant increase in BMI. Four RCTs and six



non-RCTs were meta-analysed separately (Panchbhaya A, et al., 2022). Both showed no differences in BMI between groups (RCTs MD: -0.18 , 95% CI: -1.55 to 1.18 , $p=0.79$, I^2 55%; and non-RCTs MD: -0.67 , 95% CI: -1.57 to 0.24 , $p=0.15$, I^2 66%).

Fifteen studies across the two systematic reviews measured weight (kg) with nine showing a significant decrease in weight for the intervention, two showing no significant differences in weight and four which showed decreases in weight, but systematic review authors did not report statistical significance. Seven RCTs and four non-RCTs were meta-analysed separately by Panchbhaya A, et al. (2022) with inconsistent findings. For RCTs, no differences in weight between groups were identified (MD: $+2.24$ kg, 95% CI: -1.34 to 5.82 , $p=0.22$, I^2 23%). For non-RCTs, a statistically significant decrease in weight was observed in the intervention groups (MD: -5.08 kg, 95% CI: -6.25 to -3.91 , $p<0.001$, I^2 3%).

When exploring what particular types of workplace intervention show the most promising effects, the reviewers concluded that **most interventions showing significant improvements for weight or BMI utilised education and/or behavioural elements.**

Due to inconsistent findings across the two systematic reviews, it is not possible to draw a conclusion on whether workplace dietary behaviour change interventions can reduce anthropometric outcomes.

Intervention Detail

All the included studies took place in workplace settings with working age populations. Whilst the systematic review by Allan J, et al. (2017) included various workplaces, Panchbhaya A, et al. (2022) focused on healthcare workers, and included a range of healthcare settings such as public and private hospitals, health centres and clinics, nursing homes, and ambulance stations. Intervention duration varied from two weeks to five years (Allan J, et al., 2017; Panchbhaya A, et al., 2022).

Intervention components varied, with most interventions comprising of multiple components. The systematic review by Allan J, et al. (2017) focused on environmental interventions, although many comprised of multiple elements.

Frequently used intervention components aiming to change the workplace environment included changes to labelling of foods (used in 15 interventions), changes to the availability of healthy foods (used in 15 interventions), point of purchase prompts (used in 13 interventions) and financial elements such as



reducing cost or providing items for free (used in six interventions). Some multicomponent interventions also included other elements alongside environmental changes such as educational messages (Allan J, et al., 2017). Panchbhaya A, et al. (2022) included six studies categorised as educational interventions, eight as environmental, seven as behavioural and 13 as combined (multicomponent).

Educational components included things such as face to face nutrition education programmes or internet education. Environmental components included increasing the availability of healthier food and nutritional information through labelling or signage. Behavioural components included things such as counselling, personalised nutritional feedback, or goal setting (Panchbhaya A, et al., 2022).

Other things to consider



- The two systematic reviews included a total of 53 unique studies, with three studies appearing in both systematic reviews. Alongside this there was slight overlap (< 5%) between both systematic reviews and the systematic review by Beck Silva K, et al. (2021), and between the systematic review by Allan J, et al. (2017) and von Philipsborn P, et al. (2019), which are discussed elsewhere.
- The majority of the included primary studies were RCTs and cluster RCTs.
- The included studies assessed a range of different workplaces from predominantly OECD countries, with the highest number of included studies in each systematic review being from the USA, followed by European countries. Five studies from the UK were included in Panchbhaya A, et al. (2022). The remaining studies across both systematic reviews took place in Denmark, Australia, Brazil, Israel, Japan, the Netherlands, Ireland, Italy, Hong Kong, Malaysia, and Canada.
- There was large variation in sample size between the included studies, with participant numbers ranging from 26 to 3,119.
- Intervention durations varied greatly; therefore, further examination could potentially reveal the optimum length to produce more favourable effects.
- The systematic reviews also assessed other outcomes that were out of the scope of this review of systematic reviews. This included sales data, energy intake, blood pressure and blood lipids outcome measures (Allan J, et al., 2017; Panchbhaya A, et al., 2022).

Limits to what we know

- Meta-analysis was conducted in one systematic review (Panchbhaya A, et al., 2022) where appropriate to do so. However, there was high heterogeneity between studies in some outcomes, and systematic review



authors acknowledged results should be interpreted with caution due to this and self-reported outcome measures.

- Both systematic reviews reported statistical significance in more instances than not. However, the included primary studies were found to be at high or unclear risk of bias across several domains, and therefore the evidence remains not conclusive.
- Publication bias was not reported or analysed in either review.
- Allan J, et al. (2017) reported that weight change and BMI were objectively measured. However, Panchbhaya A, et al., (2022) did not report this information. Although it is likely that BMI and weight change were objectively measured in the RCTs, this is uncertain from the available information in the systematic review, further limiting our ability to make conclusive judgements on the evidence.
- Fruit and vegetable consumption outcome measures were self-reported in both systematic reviews (Allan J, et al., 2017; Panchbhaya A, et al., 2022).

References

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2. Panchbhaya A, et al., (2022). Improving the Dietary Intake of Health Care Workers through Workplace Dietary Interventions: A Systematic Review and Meta-Analysis. *Advances in Nutrition*, 13, 595-620.

4.7 Obesity prevention interventions aimed specifically at children

4.7.1 Preschool based obesity prevention interventions:

Early care and education setting interventions targeting healthy eating, physical activity and/or screen time

Directional thinking



The evidence for the effectiveness of early care and education setting interventions targeting healthy eating, physical activity and/or screen time is largely inconsistent for anthropometric measures and nutritional outcomes. Three systematic reviews examined early care and education interventions targeting healthy eating, physical activity and/or screen time (Ward D, et al., 2017; Yoong S, et al., 2023; Morgan E, et al., 2020).

Anthropometric measures:

Due to inconsistent findings across systematic reviews and reporting of different measures of anthropometrics, **it is not possible to draw a conclusion on whether preschool based obesity prevention interventions targeting healthy eating behaviours are effective at improving anthropometric measures or reducing risk of overweight/obesity.** We were unable to synthesise anthropometric measures (such as BMI) across the three systematic reviews because the systematic review by Ward D, et al. (2017) did not provide more in-depth information on which anthropometric outcomes were measured for those listed as non-significant.

The systematic review by Yoong S, et al. (2023) undertook a meta-analysis of 38 studies and found that **healthy eating interventions delivered in early years settings had no effect on anthropometric measures or risk of overweight/obesity when compared to a control receiving no intervention** (BMI MD: -0.08 , 95% CI: -0.23 to 0.07 , $p=0.30$, I^2 65%; 15 studies [11 low risk of bias and four high risk of bias], 3,932 children. BMI z score MD: -0.03 , 95% CI: -0.09 to 0.03 , $p=0.36$, I^2 0%; 17 studies [ten low risk of bias and seven high risk of bias], 4,766 children. Childhood risk of overweight and obesity RR: 0.81 , 95% CI: 0.65 to 1.01 ; $p=0.07$, I^2 0%; 5 studies [two low risk of bias and three high/unclear risk of bias], 1,070 children).

Narrative synthesis undertaken in the systematic review by Ward D, et al. (2017) found that of the 24 included studies (11 RCTs, 8 cluster RCTs, 4 pre/post and one cohort study) reporting anthropometric outcomes (such as BMI, BMI z score, %BF, waist circumference or skin fold thickness), **ten studies demonstrated that the intervention had a statistically significant effect**



($p < 0.05$) on at least one anthropometric measure. The remaining 14 found no significant effects for any anthropometric measures.

The systematic review by Morgan E, et al (2020) compared the effects of school based interventions with a caregiver component to interventions without a caregiver component and included a total of 23 studies, six of which were physical activity interventions. Only two of the six had outcomes of interest related to this summary, and both were undertaken in preschools.

The two studies measured BMI and were pooled in a meta-analysis, which found no significant difference in BMI between the intervention with a caregiver component group and the intervention without a caregiver component group at the end of the intervention (MD: 0.07, 95% CI -0.21 to 0.35, I^2 37%). It should be noted that one of the two studies pooled in this meta-analysis was also included in the systematic review by Ward D, et al. (2017).

Nutritional outcomes:

Due to inconsistent findings across systematic reviews and across different nutritional outcomes, it is not possible to draw a conclusion on whether preschool based obesity prevention interventions targeting healthy eating behaviours are effective at improving nutritional outcomes. We were unable to synthesise nutritional outcomes across the two systematic reviews (such as fruit and vegetable intake) because the systematic review by Ward D, et al. (2017) did not provide information on which nutritional outcomes were measured for those listed as non-significant.

Ward D, et al. (2017), identified 18 studies reporting a dietary intake measure, 13 of which demonstrated a significant impact for at least one measure of dietary intake. Significant increases in fruit and vegetable intake were recorded in seven studies, with a further study reporting a significant increase in fruit intake only and another in vegetable intake only. In addition, significant increases in milk consumption were identified in three studies. Two studies reported statistically significant decreases in fat intake, and one reported a statistically significant decrease in sugar intake. The quality of the studies was mixed, with 11 of 18 studies rated as being of weak quality, four as moderate quality and three as strong quality.

Meta-analyses in the systematic review by Yoong S, et al. (2023) found inconsistent effects across a range of nutritional outcomes. The systematic review found that healthy eating interventions delivered in early years settings may have a positive effect on children's overall diet quality (SMD: 0.34, 95% CI:



0.04 to 0.65, $p=0.03$, I^2 91%, 6 studies [three low risk, three moderate/unclear risk of bias], 1,973 children) and **may increase children's consumption of fruit** (SMD: 0.11, 95% CI: 0.04 to 0.18, p 0.01, I^2 0%, 11 studies [four low risk of bias and seven high/unclear risk of bias], 2,901 children). However, meta-analysis found **no significant effect for healthy eating interventions in early years settings on increasing vegetable intake** (SMD: 0.12, 95% CI: -0.01 to 0.25, $p=0.08$, I^2 70%, 13 studies [four low risk of bias, nine high risk of bias], 3,335 children), or **reducing consumption of sugar sweetened beverages** (SMD: -0.10, 95% CI: -0.34 to 0.14, $p=0.41$, I^2 45%, 3 studies [two high risk of bias and one moderate risk of bias], 522 children). **As a large proportion of studies were rated as being at high or unclear risk of bias, findings are not conclusive.**

Twenty-five of the 43 interventions in the systematic review by Ward D, et al. (2017) included a parental engagement component with strategies ranging from newsletters, CDs, or other handouts to more active strategies such as parent workshops or cooking. **Correlations of intervention strength scores with anthropometric outcomes were consistently higher when parent engagement scores were included.**

Intervention Detail

Interventions were generally multicomponent with strategies to improve healthy eating or to improve physical activity. Strategies to improve healthy eating included menu changes, nutrition education, changing meal service approaches, and food tastings (Ward D, et al. 2017). Strategies to improve physical activity included structured physical activity lessons, staff training, and take-home activity cards or resources (Ward D, et al., 2017).

The two preschool studies in the systematic review by Morgan E, et al. (2020) that are included here were focused on physical activity only interventions, and both included caregiver components as part of the intervention.

Interventions were delivered by a range of people including healthcare providers, early childhood education and care staff, and researchers (Ward D, et al., 2017; Yoong S, et al., 2023); used different delivery methods (telephone, face-to-face, online, printed materials); and measured results in a variety of ways (e.g., parent or staff surveys, observations of children's eating, and weighing foods before and after meals) (Ward D, et al. 2017; Yoong S, et al., 2023).

Studies in the systematic review by Ward D, et al., (2017) were set in early care and education settings, however studies in the systematic review by Yoong S, et al. (2023) sometimes included elements in other settings such as home ($n=22$ studies) and community settings ($n=3$ studies). Both studies included in Morgan, E, et al. (2020) were conducted in preschool and daycare facilities.



Many included studies took place in childcare settings where many participants were from low to upper middle socioeconomic status (Ward D, et al., 2017).

In one of the studies in the systematic review by Morgan E, et al. (2020), the caregiver component of the intervention was delivered at an individual or family level, whereas in the second study, it was group-based. In one case, this was delivered at school, and in the other, in a combination of media.

Participant ages ranged from six months to six years and the duration of the interventions varied from six days to four years across systematic reviews.

Of the 52 studies investigating 58 interventions in the systematic review by Yoong S, et al. (2023), forty-three interventions (in 39 studies) included curriculum strategies, 56 (in 50 studies) included ethos and environment strategies and 50 (in 47 studies) included partnership strategies. Thirty-eight interventions incorporated all three components.

In the systematic review by Ward D, et al. (2017), Seven of the 43 interventions targeted healthy eating only, 17 targeted only physical activity, nine targeted healthy eating and physical activity, one targeted physical activity and screen time, and nine targeted healthy eating, physical activity, and screen time.

In the systematic review by Yoong S, et al. (2023), the majority of interventions (n=35) targeted multiple risk factors primarily physical activity and 37 interventions also targeted all three Health Promoting Schools' components (health curriculum, ethos and environment, and partnership).

As the duration of the interventions varied greatly, further examination could potentially reveal the optimum length to produce more favourable effects.

Other things to consider



- Slight levels of primary study overlap (< 5%) were observed between the Morgan E, et al. (2020) systematic review and the systematic reviews by both Ward D, et al. (2017) and Yoong S, et al. (2023). There was however high overlap (12.9%) in primary studies between Ward D, et al. (2017) and Yoong S, et al. (2023), with eleven studies appearing in both systematic reviews.
- All three systematic reviews contained a slight overlap of included primary studies with a number of other systematic reviews. Yoong S, et al. (2023) and Ward D, et al. (2017) also had moderate overlap with Moss S, et al. (2022), while Morgan E, et al. (2020) had a moderate overlap of primary studies with Beck-Silva K, et al. (2022).
- The systematic review by Yoong S, et al. (2023) included only RCTs, whereas the systematic review by Ward D, et al., (2017) included a range of study designs such as RCT, non-experimental pre-post, subject cross-over,

and two longitudinal follow-ups to RCTs. Both relevant studies in the review by Morgan E, et al. (2020) were cluster RCTs.

- Studies included in the two systematic reviews came from a range of countries, with the highest numbers in each systematic review being from the USA, followed by Australia. Two studies from the UK were included in the systematic review by Yoong S, et al. (2023) whereas only one UK study (no overlap with Yoong S, et al., 2023) was included in the systematic review by Ward D, et al. (2017). Neither of the two relevant studies in the systematic review by Morgan E, et al. (2020) were from the UK. The remaining studies took place in Germany, Switzerland, Chile, Israel, Belgium, the Netherlands, Norway, Greece, Spain, Colombia, China, Italy, Turkey, Canada, Switzerland, Finland, and Mexico.
- There was a large amount of variation in sample size between the included studies, with participant numbers ranging from 23 to 2,062 (Ward D, et al., 2017; Yoong S, et al., 2023; Morgan E, et al., 2020).
- Only one primary study was included that considered intervention effectiveness among children aged between six months and two years (Yoong S, et al., 2023), with the remainder considering children aged two years and upwards. Therefore, the impact of the interventions on children aged six months to two years remained unknown in these systematic reviews.
- The systematic reviews also assessed other outcomes that were out of the scope of this review of systematic reviews and therefore not covered here. This included outcomes such as non-core foods (i.e., less healthy, or discretionary) consumption, physical activity, and screen time (Ward D, et al. 2017; Yoong S, et al., 2023).

Limits to what we know



- Consideration should be given to the generalisability of findings considering the limited number of studies conducted within the UK and given the wide range of countries interventions were conducted in.
- The majority of the included studies were assessed as being poor in quality. Yoong S, et al. (2023) highlighted that most studies were judged to be at high risk of performance and detection bias, whereas Ward D, et al. (2017) did not report the reasons of poor quality.
- One of the relevant studies in the systematic review by Morgan E, et al. (2020) was at high risk of bias for three domains (incomplete outcome data, selective reporting and other sources of bias), the second was at high risk of bias for two domains (incomplete outcome data and loss of clusters).
- Attrition bias also appears prevalent across studies, particularly for measures of dietary intake (Yoong S, et al., 2023).
- Several factors were reported by Yoong S, et al., (2023) as potentially limiting the certainty of the evidence. The most common reasons for downgrading was due to studies assessed as high risk of bias overall, inconsistency and publication bias.



- Ward D, et al. (2017) identified that included studies often lacked detailed intervention strategy information and implementation of strategies was rarely reported.
- Yoong S, et al. (2023) mentioned that confidence in the evidence is low because the healthy eating programmes were conducted, delivered, and assessed in different ways across the studies.
- Ward D, et al. (2017) mentioned that confidence in the main findings with anthropometric outcomes should be tempered by inconsistencies across the two methods of quantifying outcomes.
- As many of the systematic review authors also undertake primary research related to the review topic, it is possible that they have interpreted the results to be more positive (Yoong S, et al., 2023).
- Studies captured dietary intake using objective methods, such as plate waste audits or direct observations, as well as subjective methods (e.g., parent-reported dietary intake), such as short diet questions, food frequency questionnaires, food diaries and 24-hour recalls (Yoong S, et al., 2023).
- Ward D, et al. (2017) highlighted that the strength of single behaviour interventions in general had higher correlations with anthropometric outcomes than did the combined diet and physical activity interventions, which could be related to issues of study power. Systematic review authors highlight that although their assessment of intervention strength was innovative and could add to the research literature, questions remain about their scoring.
- Ward D, et al. (2017) data extraction stated “NS” for non-significant outcomes, and no further detail was provided relating specific measures related to that outcome. Therefore, it is not clear which outcomes the studies were measuring for those which yielded non-significant results.
- Due to the small number of studies with long-term follow-up ($n = 10$) and the variation in the follow-up time period (3 months to 3 years), only outcomes at the end of the intervention were able to be analysed in the systematic review by Ward D, et al. (2017). Measuring dietary and physical activity behaviours in young children is very challenging, so measurement limitations could explain some of the inconsistent and unexpected findings.
- In addition, the authors highlight low statistical power across correlations due to the small number of studies (Ward D, et al., 2017).
- Most of the studies included in the Yoong S, et al. (2023) systematic review targeted multiple risk factors, primarily physical activity (35 interventions, 60%). Therefore, the effects of interventions that target healthy eating in isolation remain unknown.



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4.7.2

Environmental interventions to reduce child overweight and obesity, based within or around schools.

Environmental interventions to reduce child overweight/obesity, based within or around schools.

Directional thinking



Two systematic reviews aimed to assess the effectiveness of environmental interventions to reduce child overweight/obesity (Mandracchia F, et al., 2021 and Pineda E, et al., 2021). The systematic reviews evaluated the effectiveness of school food environment interventions on the prevention of childhood obesity (Pineda E, et al., 2021) and the promotion of healthy meals, predominantly in schools (Mandracchia F. et al., 2021). Both systematic reviews conducted a meta-analysis (Mandracchia F, et al., 2021 and Pineda E, et al., 2021).

There is some evidence that environmental interventions based within or around schools may be effective at reducing BMI/ BMI z score or fruit and vegetable intake, but this was not conclusive, largely due to the authors assessing the studies as poor quality.

Narrative synthesis from Pineda E, et al. (2021) identified that 31 single-component interventions (of a total of 63 looking at all outcomes) were effective at reducing BMI or increasing intake of fruits and/or vegetables, whereas 21 multicomponent interventions (of a total of 37 looking at all outcomes) were effective in reducing BMI or increasing intake of fruits and/or vegetables. It was not possible to differentiate which studies looked at BMI or intake of fruit and/or vegetables from the systematic review.

Overall, 51% of all interventions included in the systematic review (Pineda E, et al., 2021) were found to reduce BMI or improve dietary intake; however, only 24% of these showed a sustained improvement regarding the reduction of BMI/BMI z score after the intervention had concluded. Of the 25 school based food environment interventions that looked at BMI, 12% were effective and 3% had a partial effect in the reduction of BMI.

A meta-analysis from the same systematic review that pooled five studies demonstrated a statistically significant association between the implementation of school food environment interventions and a reduction in BMI z score (standard mean difference [SMD] between the intervention group and control: -0.12, 95% CI: -0.15 to -0.10, I^2 74.9%) (Pineda E, et al., 2021).



Both systematic reviews examined dietary outcomes, including fruit and vegetable intake. The systematic reviews were not reported in a way that allowed for direct comparison, and so findings have been reported separately below.

The first systematic review (Pineda E, et al., 2021) identified that 49% (n=31) of single-component interventions were effective at increasing fruit and/or vegetable intake, whereas for multicomponent interventions it was not possible to establish which had been effective.

The overall effect of a meta-analysis from the same systematic review pooling 13 study results showed no significant effect between the implementation of school food environment interventions and increased vegetable intake (SMD: 0.01, 95% CI: -0.00 to 0.02, I² 68%). It should be noted that two studies contributing to this outcome were included in both systematic reviews.

The overall effect of pooling 22 studies showed a statistically significant effect between the implementation of school food environment interventions and increased fruit consumption (portions per day, SMD: 0.19, 95% CI: 0.16, 0.22, I² 68.9%). It should be noted that one study contributing to this outcome was included in both systematic reviews.

The second systematic review (Mandracchia F, et al., 2021) included predominantly school based interventions, but also included four work based interventions aimed at adults. However, it was not possible to separate findings.

Meta-analysis of nine studies from the systematic review by Mandracchia F, et al. (2021) found that the intervention significantly increased servings/day of healthy food groups (fruit, vegetables, whole grains, lean meat and dairy and alternatives, combined) by 0.24 (95% CI: 0.16 to 0.32, p<0.001) compared to control.

Individual analyses of each food group are as follows:

- Fruit servings/day: MD 0.13 (95% CI: -0.14 to 0.30, p=0.12, I² 100%, 7 studies).
- Vegetables servings/day: MD 0.17 (95% CI: -0.00 to 0.34, p=0.06, I² 100%, 7 studies).
- Whole grains servings/day: MD 0.60 (95% CI: 0.30 to 0.90, p<0.01, I² 100%, 4 studies).



- Lean meat and alternatives serving/day: MD 0.20 (95% CI: -0.11 to 0.50, $p=0.20$, I^2 100%, 3 studies).
- Dairy food items and alternatives servings/day: MD 0.21 (95% CI: 0.01 to 0.40, $p=0.04$, I^2 100%, 3 studies).

Meta-analysis of five studies in the systematic review by Mandracchia F, et al. (2021) found the intervention significantly increased fibre intake by 0.50g/day (95% CI: 0.08 to 0.92, $p=0.02$). However, when non-RCTs were excluded from the meta-analysis, the effectiveness was no longer statistically significant.

Meta-analysis of five studies from the same systematic review found the intervention significantly decreased the dietary intake of saturated fat, fat and added sugar by 4.17g/day (95% CI: -5.43 to -2.92, $p<0.001$, I^2 14%). Individual analyses of each nutrient are as follows:

- Saturated fat intake: MD -4.64g/day (95% CI: -7.21 to -2.08, $p<0.05$, I^2 99%, 3 studies).
- Fat intake: MD -8.95g/day (95% CI: -14.56 to -3.34, $p<0.05$, I^2 100%, 5 studies).
- Sugar intake: MD -0.60g/day (95% CI: -14.42 to 13.23, $p=0.93$, I^2 99%, 3 studies).

Systematic review authors assessed the quality of the included studies as mostly weak, due to no blinding, poor data collection, selection bias or confounders. Therefore, **where there is evidence supporting the use of this intervention for improving dietary outcomes, it is not conclusive.**

Intervention Detail

The majority of interventions were set in schools, but some also incorporated community settings or were set solely within the community. Community settings included sports clubs or after-school programmes in churches or schools (Mandracchia F, et al., 2021). In addition, four studies included in the same systematic review were workplace interventions. It was not possible to differentiate these within the findings laid out above. Pineda E, et al. (2021) included only interventions within the school food environment.

School settings varied across systematic reviews, but predominantly included primary and secondary or elementary, middle and upper schools; few were set in early childcare centres. A small number of studies included interventions within and around the school environment (Pineda E, et al., 2021).



There were a mix of single and multicomponent interventions across the included systematic reviews.

Environmental interventions across the systematic reviews involved the food/beverage environment, built environment or choice architecture. In addition, some also included nutritional education, behavioural change and policy components.

Intervention components included relative availability, positioning and presentation of certain foods, direct provision of food (e.g., breakfast, lunch, snacks, or fruit and vegetables), introduction or modification of dietary guidelines in schools. Some interventions addressed aspects of the school food environment other than meals, such as the regulation of vending machines and kiosks or food stores, introduction of cafes, snack bars, or fruit and vegetable buffets.

Although the majority of interventions addressed diet, physical activity was also sometimes addressed (Pineda E, et al., 2021). However physical activity outcomes have not been reported here as they do not meet the inclusion criteria for this review of systematic reviews.

Study samples were at the setting, rather than individual level, and ranged from between two and 70 individual schools, nine and 431 individual childcare centres, and seven and 30 community settings (such as school groups, after-school programmes or recreation centres) (Mandrachia F, et al., 2021).

The duration of interventions varied, ranging from between one week and seven years. Both systematic reviews included interventions that tended to last months or years, with only a small number lasting a few weeks.

Other things to consider



- There was a slight overlap in primary studies across the two systematic reviews (2.9%). Four primary studies were included in both systematic reviews. These all examined fruit and vegetable outcomes, however only one or two were included in the meta-analyses conducted in both systematic reviews.
- The systematic review by Mandracchia F, et al. (2021) includes slight overlap with 10 other included systematic reviews, however the percentage of overlap did not exceed 5% in any instance.
- The systematic review by Pineda E, et al. (2021) included overlap of primary studies with 15 other systematic reviews. In 12 instances overlap did not exceed 5%. However, in three instances it was slightly higher. Moderate overlap of 7.7% was found between the studies included in Pineda E, et al. (2021) and Wethington H, et al. (2020). Similarly moderate overlap of 5.6% was found between Pineda E, et al. (2021) and Bramante C, et al. (2019).

- A high overlap level of 13.9% was identified between Pineda E, et al. (2021) and Micha R, et al. (2018). This equates to 21 identical studies, which are included in both systematic reviews. The systematic review by Micha R, et al. (2018) focused on policy interventions only, whereas the systematic review by Pineda E, et al. (2018) which is discussed here looked at a broader range of intervention types.
- Across the two systematic reviews, the majority of primary studies were conducted in the USA, but the systematic reviews also included a number from Australia and the UK, and generally one or two primary studies from Belgium, Brazil, Ecuador, Latin America, Lebanon, Malaysia, Mexico or Norway.
- A range of study designs were included in the two systematic reviews, including: 35 RCTs/cluster RCTs and 6 non-RCTs in the systematic review by Mandracchia F, et al. (2021) and 34 RCTs, 64 quasi-experimental studies, one observational study and one where the study design was not reported in the systematic review by Pineda E, et al. (2021).
- Intervention populations included a mix of control and intervention groups, or the same population were compared to baseline data. Those included studies looking at control and intervention groups often involved the same students with the intervention taking place on certain days, and the control on others.

Limitations



- Despite using different quality or risk of bias assessment tools, the majority of studies across the two systematic reviews were deemed to be of low quality or medium to high risk of bias. Pineda E, et al. (2021) identified that the majority of studies assessed as being low risk of bias were non-RCTs. Reasons for poor quality in the RCTs included no blinding, poor data collection methods, selection bias or confounders.
- Data collection methods were not provided in Mandracchia F. et al. (2021). Pineda E, et al. (2021) outlined that data were generally collected via self-reported methods, such as food frequency questionnaire, 24-hour recall and food diaries.
- Considerable (Mandracchia F, et al., 2021) and moderate to high (Pineda E, et al., 2021) heterogeneity was observed across the meta-analyses. Pineda E, et al., (2021) observed that the robustness of pooled analyses was greatly limited by the heterogeneity of food environment exposures and diet-related health outcomes measured across the studies.
- Follow-up was poorly reported across systematic reviews. Sustained intervention effectiveness was only narratively examined for BMI (Pineda E et al., 2021) with less than half demonstrating sustained intervention effectiveness.
- The majority of studies included interventions conducted in school age children, so it is not known if findings can be applied to younger aged children.



- Findings may only be generalisable to the settings and populations in which they were conducted and generalisability should be considered further before implementing any interventions identified here.
- None of the included systematic reviews discussed effectiveness across different ethnic populations. Although Pineda E, et al. (2021) identified that sociocultural and political factors could influence food preference and choice, but this was in the context of food stores.

References

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2. Pineda E, et al., (2021). Improving the school food environment for the prevention of childhood obesity: What works and what doesn't. *Obesity Reviews*, 22, e13176.

4.7.3 School based environmental interventions aimed at reducing sugar sweetened beverage consumption

School based environmental interventions aimed at reducing sugar sweetened beverage consumption

Directional thinking



The evidence for the effectiveness of school based environmental interventions aimed at reducing sugar sweetened beverages is largely not conclusive. One systematic review was identified that included a total of 58 primary studies, 20 of these focused on interventions implemented within schools, and 11 studies included outcome measures relevant to this review of systematic reviews (von Philipsborn P, et al., 2019). The systematic review classified interventions using the NOURISHING framework covering seven environmental intervention areas. Only the nutritional standards in public institutions category contained outcomes relevant to this section and we have used the same sub-categories as the systematic review authors to report findings below:

1. *Interventions to reduce the availability of sugar sweetened beverages in schools*

There is some evidence supporting the use of interventions to reduce the availability of sugar sweetened beverages in schools, but it is not conclusive. Five controlled before and after studies including 18,238 students from 240 schools within the USA showed a decrease in sugar sweetened beverage intake. Three of these were statistically significant decreases (95% CI excludes 0) and two were non-significant decreases in sugar sweetened beverage intake (95% CI includes 0).

2. *Interventions to improve access to drinking water in schools*

The evidence of effectiveness for improved access to drinking water in schools in relation to sugar sweetened beverage intake and weight change is inconsistent, and it is not possible to draw a conclusion. Three studies (one controlled before and after [CBA], one cluster RCT and one non-RCT) looked at the interventions effect on **sugar sweetened beverage intake**. A total of 11,253 students from 62 schools participated in the intervention and follow-up ranged from three to 13 months. The cluster RCT study found a significant decrease in the number of students consuming sugar sweetened beverages every day (-190ml/day 95% CI: -280 to -100), the non-RCT found a non-significant decrease in sugar sweetened beverage intake (95% CI crosses 0).



Lastly, the CBA found no significant effect on sugar sweetened beverage intake (effect size not reported).

Three studies (cluster RCT, non-RCT and a CBA design) assessed the interventions effect on **weight change** as an outcome. Intervention durations were between 10 months and five years. Two studies (non-RCT and CBA) assessed BMI z score as an outcome and found no significant effects for the intervention on BMI z score (95% CI crosses 0). The same two studies also assessed the number of students with overweight and obesity. One CBA found a significant reduction in the share of male students who were overweight or obese (-1.2 percentage points 95% CI: -1.9 to -0.5), but a non-significant decrease in the share of females who were overweight or obese (-0.6 95% CI: -1.3 to 0.1). The second, a non-RCT found a significant decrease in the overall number of students with overweight or obesity (OR 0.69, 95% CI: 0.48 to 0.99) at 10 months. However, a final study (cluster RCT) found a non-significant increase in the share of students with overweight and obesity at 11 months (OR 1.27 95% CI 0.78 to 2.07).

3. Fruit provision programmes in schools

There is some evidence supporting the use of fruit provision programmes in schools for sugar sweetened beverage intake, but it is not conclusive. Two studies (cluster RCT and CBA) investigated fruit provision in schools. Both studies found that the intervention led to a decrease in sugar sweetened beverage intake ($p < 0.05$).

4. Interventions with small prizes for the selection of healthier beverages

The evidence about the effectiveness of small prizes for the selection of healthier beverages in school cafeterias is lacking. One RCT from the USA reported a significant decrease in the number of meals with unhealthy beverages per week ($p = 0.000$).

Intervention Detail

Interventions were classified in the systematic review using the NOURISHING framework which covers seven environmental intervention areas: labelling interventions, nutrition standards in public institutions, economic tools, advertisement and marketing regulation, whole food supply interventions, retail and food service interventions, and intersectoral approaches. Only interventions classified in the nutritional standards in public institutions category contained outcomes relevant to this summary.



Interventions focusing on sugar sweetened beverages were all conducted in the USA between 2004 and 2009 and examined mandatory government regulation, government pilot projects as well as interventions initiated by study investigators.

Interventions focusing on improved access to drinking water included installation of water jets in schools, distribution of re-useable water bottles or provision of water jugs in classrooms and 'water breaks' during physical educational activities.

Small prizes for the selection of healthier beverages in schools involved children receiving token rewards for selecting healthy beverages (defined as skimmed milk, 1% or 2% low-fat white milk, 100% fruit juice, and water). Rewards included pens, notebooks, modelling clay or stickers. Another study involved an intervention called 'power plates' where healthy food and beverage items available in the school cafeteria were labelled as a 'power plate'. Children who selected these were offered small rewards on certain days which included bracelets, stickers and temporary tattoos.

Some interventions involved improved placement of healthier beverages in school cafeterias, with 'healthier' options placed in front of the less healthy option (sugar-sweetened milk).

Fruit provision interventions involved weekly deliveries of seasonal fruit in addition to several promotional and educational activities focused on fruit consumption. Other interventions included a free fruit provision scheme and a fruit subscription programme (with parental payment).

Outcome measure data was often collected via survey or by trained observers.

The length of intervention follow-up ranged between three months and five years.

Other things to consider



- Primary studies in the systematic review by von Philipsborn P, et al. (2019) overlap slightly (< 5%) with seven other systematic reviews included elsewhere in this review of systematic reviews. There is also moderate overlap with one systematic review (Micha R, et al., 2018; 5.8% overlap). The review by Micha R, et al. (2018) looks at a range of school based policies and is discussed in section [4.7.6](#).
- This systematic review has been conducted by Cochrane who are known to follow rigorous methodology. It is a very in-depth systematic review and if any aspect is of particular interest, the reader should look at the full systematic review as it is likely to have been discussed in more detail.
- This systematic review included adult, adolescent and child participants

undertaking numerous interventions in a variety of settings. For the purposes of this summary, only those conducted with adolescents or children in schools with outcomes relevant to this review of systematic reviews have been included here. This included a total of 11 primary studies.

- Seven studies were conducted in the USA, one in the Netherlands, one in Brazil, one in Germany, and one in Norway.
- Studies were only considered for inclusion if they included a combined length of intervention and follow-up of at least 12 weeks and at least 20 individuals in each of the intervention and control groups. Multicomponent interventions were excluded from this systematic review.
- Studies on the taxation of sugar sweetened beverages were excluded, as these are the subject of a separate Cochrane systematic review.
- Interventions targeting 100% fruit juice were not considered based on the sugar content being similar to that of many sugar sweetened beverages.
- Few studies considered contextual and implementation factors, including barriers to and enablers of implementation. Such information can, however, be important for sustained and scaled-up implementation. Similarly, only a few studies systematically examined target group and stakeholder perceptions, which can be essential for mobilising and sustaining public and political support. Process evaluations and mixed methods approaches, used by several studies in the systematic review, can help to generate evidence on such aspects.
- As well as direct consumption of sugar sweetened beverages, this systematic review included indirect measures of sugar sweetened beverages consumption (e.g. sales). For the purposes of our review of systematic reviews, these outcomes have not been extracted.
- This systematic review also measured diet-related anthropometric outcomes amongst adults in relation to interventions aimed at reducing sugar sweetened beverage consumption, which are described in a separate summary in this review of systematic reviews ([4.5.1](#)).

Limits to what we know



- Authors judged most studies to be at high or unclear risk of bias in at least one domain, and most studies used non-randomised designs.
- Reporting bias was reported as a major concern of included studies and publication bias was also highlighted.
- The majority of included studies were conducted in USA, or high-income countries, therefore generalisability of the findings to Wales should be considered.
- Confidence in the certainty of effects as reported by Cochrane systematic review authors following GRADE assessment, is low to moderate for most of these interventions and in relation to most outcomes, and true effects may be substantially different from those reported in this systematic review.
- In some studies, intervention and control groups were overlapping, and



there is potential for some control group participants to have received or been exposed to similar interventions during the study period.

- In many countries, sugar sweetened beverage consumption is higher among disadvantaged population groups than among the general population. The studies in this systematic review provide only limited evidence on the potential moderation of intervention effects by social disadvantage. Interventions may or may not be more or less effective among disadvantaged population groups than among the general population.
- Authors commented that data collection methods for outcome assessment varied among studies and may increase the risk of bias being introduced to the findings. Systematic review authors noted that most diet related data collection was undertaken using self-report measures. Where it was possible to differentiate, diet-related outcomes collected using proxy measures such as electronic sales data were not included in this summary.
- Two authors declared conflicts of interest for this systematic review. One was a consultant working primarily for health insurance companies while the other's institution has received grants from pharmaceutical companies responsible for producing slimming products. The same author has membership on the science advisory boards of Nestle and Danone.

References

1. von Philipsborn P, et al., (2019). Environmental interventions to reduce the consumption of sugar-sweetened beverages and their effects on health. *Cochrane Database of Systematic Reviews*. CD012292.

4.7.4 School based healthy eating interventions that increase the availability of healthy foods in schools

Healthy eating and drinking interventions that increase the availability of healthy food in schools

Directional thinking



One publication was identified which examined the effectiveness of interventions to increase the availability of healthy food in schools on dietary habits and weight status (Wethington H, et al., 2020). The publication reports the findings of four Community Guide systematic reviews, which examine four distinct groups of interventions to increase the availability of healthy foods and beverages in schools:

1. School meal or fruit and vegetable snack interventions that aim to increase the availability of healthier foods and beverages offered in schools

There is some evidence suggesting the use of school meal or fruit and vegetable snack interventions aiming to increase availability may be effective for increasing children's fruit and vegetable intake, but this is not **conclusive**. The first systematic review included 17 relevant studies (including 18 study arms) reporting fruit and vegetable outcomes. Of these, eight studies (nine study arms) reported a median relative increase in total daily fruit and vegetable intake of 20% (IQI: 4.3% to 38.5%). Six studies reported total daily fruit and vegetable intake that could not be plotted:

- One study reported an increase in fruit and vegetable consumption
- One study reported no change in fruit consumption but an increase in vegetable consumption
- One study reported an increase in fruit consumption but no change in vegetable consumption
- One study reported no change in fruit consumption but did not assess vegetable consumption
- One study reported an increase in fruit and vegetable consumption among students with low access to fruit and vegetables
- One study reported that fruit and vegetable consumption increased in rural areas but not city or suburban areas.
- The remaining three study arms were not reported in the systematic review.

The evidence for school meal or fruit and vegetable snack interventions aiming to increase availability is inconsistent for anthropometric outcomes. A total of three studies from the first systematic review reported BMI z score, with a median increase of 0.01 (range: 0.14 to 0.03). A total of six studies reported



change in obesity, or overweight and obesity prevalence combined. Obesity prevalence was reported in one study, with a percentage change decrease of 7.7%. A total of five studies with a baseline median combined overweight and obesity prevalence of 32.9% reported a percentage change decrease of 9.6% (IQR: -10.7 to -1.6). Results were similar regardless of whether the focus of the intervention was a school meal or fruit and vegetable programme.

2. Interventions supporting healthier snack food and beverages sold or offered in schools:

There is some evidence suggesting that interventions supporting healthier snack food and beverages sold or offered in schools are ineffective at reducing intake of sugar sweetened beverages, but it is not conclusive. Intake of sugar sweetened beverages was reported by seven studies from the second systematic review. Three studies reported a non-significant median change increase of 0.03 sugar sweetened beverage servings per day (range: -0.33 to 0.08). Information on four studies reporting sugar sweetened beverages could not be plotted owing to the use of various measures.

The evidence for effectiveness of interventions supporting healthier snack food and beverages sold or offered in schools for reducing overweight and obesity is inconsistent, and it is not possible to draw a conclusion. A total of three studies from the second systematic review reported overweight or obesity prevalence following the CDC definition. One study reported a significantly decreased probability of being overweight in states with strong laws for competitive food nutrition content, but no association with the probability of having obesity. One study examined the association between competitive food and beverage laws and overweight or obesity by school level. For the elementary level, strong laws were associated with reduced odds of having obesity compared to states with no laws (four or more strong laws OR: 0.57, 95% CI: 0.34 to 0.97; two to three strong laws OR: 0.57, 95% CI: 0.36 to 0.90). No change was identified for middle and high schools. Finally, one study reported that students in states with strong school competitive food and beverage laws reported no change in odds of overweight and obesity combined compared with students living in states with no laws.

3. Multicomponent interventions to increase the availability of healthy foods and beverages in schools:

There is some evidence suggesting that multicomponent interventions to increase the availability of healthy foods and beverages in schools may be effective at increasing children's fruit and vegetable intake, and reducing children's sugar sweetened beverage intake, but it is not conclusive. Four studies from the third systematic review reported a median relative total daily



fruit and vegetable intake increase of 15% (IQR: 1.0% to 45.0%). Two primary studies reported a decrease in sugar sweetened beverages (range: -0.3 to -0.2).

However, **evidence for the effectiveness of multicomponent interventions to increase the availability of healthy foods and beverages in schools on children's BMI z scores, or prevalence of overweight and obesity, is inconsistent and it is not possible to draw a conclusion.** Two studies from the third systematic review reported BMI z score. One study reported a BMI z score decrease of 0.01 and one study reported no intervention effects. Six studies (in five publications) from the third systematic review reported overweight or obesity prevalence following CDC or International Obesity Task Force definitions. Four reported overweight and obesity prevalence combined. In two large U.S. studies, the average odds of overweight and obesity prevalence combined were no longer increasing during the post-policy period, and there were population-level improvements in overweight and obesity trends (data not shown). The remaining two studies reported no change in overweight and obesity prevalence. One study reported obesity prevalence only and identified a reduction of 1.0% after the intervention, and another study reported reduced odds of being overweight (OR: 0.85, 95% CI: 0.59 to 1.20) or obese (OR: 0.92, 95% CI: 0.73 to 1.16), but neither were statistically significant.

4. *Interventions to increase access to water in schools:*

Evidence for the effectiveness of interventions to increase access to water in schools on reducing sugar sweetened beverage intake is lacking. Intake of sugar sweetened beverages was reported in one cluster RCT from Europe in the fourth systematic review. No change in soft drink consumption was identified after the intervention.

There is some evidence for the effectiveness of interventions to increase access to water on reducing BMI z-score and overweight and obesity prevalence combined, but it is not conclusive. Two studies (one cluster RCT and one repeat cross-sectional with comparison group) from the fourth systematic review reported a small decrease in BMI z score, overweight and obesity prevalence combined, after increasing access to water. The range of BMI z score reduction was the only effect size reported (range: -0.004 to -0.016).

Overall, **the evidence for healthy eating and drinking interventions that aim to increase the availability of healthier foods and beverages offered in schools is not conclusive or inconsistent.** This is in part because it was not possible to ascertain the quality of individual studies. In addition, systematic review authors noted it was not possible to plot several studies contributing to some outcomes



and it is apparent some studies that reported relevant outcomes were not included in the synthesis.

Intervention Detail

Primary studies were included if they were aimed at obesity prevention or healthy weight promotion in the general student population. Interventions took place in kindergarten through high school and reported a dietary or weight-related outcome estimated to be at least 6 months after the intervention program or policy began. No information was provided on primary study sample sizes or the duration of the interventions across any of the four systematic reviews. Detail on the interventions is provided below:

1. School meal or fruit and vegetable snack interventions that aim to increase the availability of healthier foods and beverages offered in schools:

This included school meal policy interventions which ensured school breakfasts or lunches met specific nutrition requirements (e.g., School Breakfast Program and National School Lunch Program) or fruit and vegetable programs that provided fresh fruit and vegetables to students during lunch or as a snack. Interventions also included healthy food/beverage marketing and healthy eating learning opportunity components. Some fruit provision in the intervention arms were paid for and some were free.

Interventions were primarily undertaken in schools across a variety of geographic areas including rural areas (n=2), urban or suburban areas (n=7) and mixed geographical areas (n=7).

2. Interventions supporting healthier snack food and beverages sold or offered in schools:

This included interventions that made changes to foods and beverages sold during the school day outside of school meal programmes (but excluding fruit and vegetable programs, which were included in the first intervention category), or changes to rules or policies for celebrations/events. Policies required foods and beverages sold outside of school meal programs to meet established nutritional standards or guidelines. These were often referred to as competitive foods and beverages because they were sold in competition with school meal programs, such as via in-school fundraisers, vending machines, school stores, snack bars or à la carte food options. Celebration rules or policies encouraged serving healthy foods and beverages during classroom celebrations, parties, and special events or encouraged rewards of non-food items for academic achievement or good behaviour. They also included healthy food/beverage marketing and/or healthy eating learning opportunities.

Eleven of the interventions reported being undertaken in mixed geographical settings (urban/rural etc.), and one reported being undertaken in an urban or suburban area.

3. *Multicomponent interventions to increase the availability of healthy foods and beverages in schools:*

This included multicomponent healthier meal or snack interventions which included a mix of the components mentioned across categories 1 and 2 above.

Ten of the interventions were solely conducted within the school setting, but two included a home component. Four interventions reported being undertaken across multiple geographical areas (urban/rural etc), four reported an urban or suburban setting, and one rural.

4. *Interventions to increase access to water in schools:*

Water interventions involved increasing access to water across the school environment and were conducted across elementary, middle and high schools in urban or suburban geographical areas. One study included healthy heating learning opportunities.

Other things to consider



- The systematic reviews by Wethington H, et al. (2020) overlap slightly (< 5%) in primary studies with nine other systematic reviews included elsewhere in this review of systematic reviews. However, there was also moderate and large levels of overlap between this study and the systematic reviews by Pineda E, et al. (2020) (7.7% overlap) and Micha R, et al. (2018) (22% overlap). This overlap is likely due to the fact that all three systematic reviews were investigating aspects of the school food environment and all included policy level interventions to some degree.
- It was not possible to establish the exact study designs of studies with outcomes relevant to this review of systematic reviews due to how the systematic review had reported this information. Of the 51 included primary studies in the systematic review, nine were group RCTs, 14 were cross sectional studies with comparison groups, 11 were repeat cross sectional designs, three were repeat cross sectional with comparison groups, eight were before and after study designs, two were group non

RCTs, two were other designs with concurrent comparison, one was a time series and one was a prospective cohort.

- Systematic review one included 14 studies from the USA, 13 were conducted in Europe, Australia, Canada, Taiwan and the UK. Fourteen studies reported ethnicity amongst participants and ten studies were conducted in low socioeconomic populations.
- Systematic review two included 13 studies, all conducted within the USA. Twelve studies reported on ethnicity, and two studies were conducted in low socioeconomic populations.
- Systematic review three included twelve studies. Six were conducted in the USA, three in Canada and three in the UK. Five studies reported ethnicity, and authors did not report if any were conducted among low socioeconomic populations.
- Systematic review four included two studies, one from Europe and one from the USA. Both studies reported around half of their study population was female.
- The systematic reviews also assessed some outcomes that did not meet the inclusion criteria for this review of systematic reviews (such as low nutrient food intake). Data was not extracted for these outcomes.

Limits to what we know



- A limited number of studies across the four systematic reviews were conducted in the UK, with those from systematic review two (snack food and beverages interventions) entirely conducted within the USA. Careful consideration of the generalisability of findings should be given to interventions undertaken in other countries where different educational and government policies exist.
- Methodological limitations were not reported at the individual study level, but at systematic review level. It is unclear which tool was used, but systematic review authors describe aspects investigated. Studies included in the first systematic review appear to have had the most limitations, and across all systematic reviews, most had issues with sample and exposure.
- Studies with limited quality of execution (defined as having five or more threats to validity) were excluded from the analyses. The systematic review authors identified findings to be applicable to male and female students within the USA and other high-income countries, urban and suburban populations, diverse races and ethnicities, and various income statuses. Authors identified school meal or fruit and vegetable interventions to be applicable to students in elementary, middle, and high schools, and multicomponent healthier meal and snack interventions were found to be applicable to students in elementary and middle schools (no studies included high school students only). Consideration should be given to other population groups.
- Evidence gaps appear to be cross-cutting and intervention-specific. Systematic review authors mention it remains unclear if similar interventions would be successful in rural settings.



- Systematic review authors acknowledge that there is potential for publication bias as most articles were from peer-reviewed literature.
- A formal meta-analysis was not possible, given the varied study designs, with only few studies reporting confidence intervals or standard errors and reported measures being heterogeneous.
- Not all studies included a pre-intervention measure and a small number of were observational studies of existing laws.
- No investigation into the longer term effects of the interventions appears to have been considered. Authors highlight that the data point closest to the conclusion of the intervention was used because too few studies reported maintenance. Therefore, maintenance or improvement is unknown.
- Consideration should be given to differences across study populations. Although the majority of studies came from comparable countries to the UK, some were conducted in remote First Nation nationals from Canada and Australia.
- Most dietary outcomes are based on self-reported data (validated instruments were used but the psychometrics of the instruments were often not reported). Authors report most weight data was objectively measured.
- A discrepancy in the reporting of obesity and overweight prevalence was identified in systematic review two. The effect sizes reported in the narrative and table 2 are opposite, so the narrative states the effect size for obesity, but in the table the same effect size is reported for overweight prevalence and vice versa.

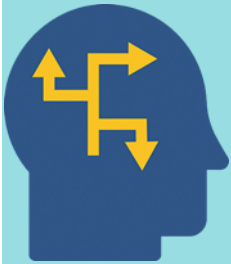
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4.7.5 School based behaviour change interventions (using behavioural insights) aiming to improve diet

School based behaviour change interventions (using behavioural insights) aiming to improve diet in children

Directional thinking



There is some evidence supporting the use of behaviour change interventions (using behavioural insights) for increasing fruit and vegetable intake, but it is **not conclusive**. Two systematic reviews were identified that investigated interventions that influence children's food consumption behaviour (Chambers T, et al., 2021 and Marcano-Olivier M, et al., 2019). However, the systematic review by Marcano-Olivier M, et al. (2019) included fifteen primary studies with relevant outcomes, all of which were included in the systematic review conducted by Chambers T, et al. (2021). Therefore, the decision was made to include only the findings from Chambers T, et al. (2021) in this summary. Further information on Marcano-Olivier M, et al. (2019) is available in the data extraction tables (appendix C).

The systematic review (Chambers T, et al., 2021) narratively assessed the effectiveness and equity potential of 108 studies investigating 137 interventions using behavioural insights to improve children's diet related outcomes. **Ninety-nine primary studies measured fruit and vegetable intake as an outcome, 73 of them found a significant difference at $p < 0.05$ level.**

Further in-depth analysis identified differential effects by one or more sociodemographic characteristic (including sex, age, BMI, socioeconomic status, and ethnicity). **There was some evidence showing slight differences by age, sex, socioeconomic status, and ethnicity**, but not for BMI. However systematic review authors did not investigate this in more depth in the publication.

Effectiveness of interventions using behavioural insights to influence children's diet-related outcomes were stratified by behavioural insight. **There were no statistically significant differences in effectiveness between interventions utilising different behavioural insights ($p = 0.119$)**, including between those using multiple insights and those using single insights. However, information provision when used in isolation was identified as the least effective approach when compared to the others.

Although there is some evidence suggesting that school based interventions that have modified behaviour may be effective for increasing children's fruit



and/or vegetable consumption, the evidence is not conclusive due to the majority of studies measuring this outcome being assessed as moderate to poor quality and the lack of effect sizes being reported.

Intervention Detail

Systematic review authors categorised interventions by behavioural insights. This is a broad term encapsulating how human beings make choices (behave) given individual endowments, experiences and external influences. Behavioural Insights draw on a range of theoretical frameworks from behavioural economics and psychology and other social sciences. Typically, interventions using behavioural insights influence an individual's behaviour through subtle changes to the social and physical environment without actively restricting available options (Chambers T, et al., 2021).

Implementing changes to the physical environment was the most common intervention category (n=41, 30%) followed by multiple behavioural insights (n=38, 28%), salience (n=26, 19%) and incentives (n=20, 14%). Other categories included defaults and information provision. The most promising approaches involved using incentives, changing defaults, and modifying the physical environment. Information provision alone was the least effective approach.

Educational settings were the most common setting for each intervention, covering 78% (n=107). These included primary, secondary schools and early childhood settings. Some studies were conducted outside the school setting, including in food retail, community venues, lab and home settings.

There was a large amount of variation in intervention duration, ranging from less than one week to 104 weeks. Forty percent of studies lasted less than one week and 92% lasted less than 6 months.

Other things to consider

- Fifteen primary studies were identified with relevant outcomes in the systematic review conducted by Marcano-Olivier M, et al. (2019). As all these were also included in the systematic review by Chambers T, et al. (2021) a decision was made to only include findings from Chambers T, et al. (2021) in this summary.
- The systematic review by Chambers T, et al. (2021) also included slight amounts of overlap (< 5%) with eight other reviews included in this review of reviews. This generally consisted in one or two unique primary studies being included in two or more systematic reviews.



- Fifty-three studies were RCTs, 25 were before and after studies, 19 were controlled before and after studies and 11 were non-RCTs.
- Seventy-six studies were conducted in the USA, 11 in the UK, seven in the Netherlands, four in Belgium, and one each in Denmark, Mexico, Portugal, Canada, Ireland, Singapore, Cyprus, Italy and China. One further study took place in both Belgium and the Netherlands.
- Individual participant numbers ranged between 15 and 8,000 people. Some studies did not report individual participant numbers, but rather reported numbers of schools, meal orders, or observations made.
- All included studies involved healthy children aged below 18 years of age.
- Only a small proportion of primary studies included a follow-up period (15%), with about half of these identifying sustained effectiveness. Further, just under half of the interventions failing to show effects at follow-up had initially demonstrated effectiveness post intervention. Authors comment on applying caution to the interpretation of the efficacy of behavioural insight interventions without follow-up measurements.
- The systematic review authors chose to exclude multicomponent interventions that included a non behavioural insights aspect, such as an education curriculum as they could not isolate the effect of the behavioural insights components from the other intervention components.
- Authors also commented that changes in diet during a 1-week intervention are unlikely to have lasting effects on children's dietary behaviour when the intervention is removed or perhaps even during a longer exposure to the intervention (as behaviour change may be initially driven by a novelty effect). Further investigation should be undertaken to establish the longer-term effectiveness of these interventions.

Limits to what we know



- It is unclear from the systematic review how outcome measures were obtained (self-reported or objectively measured), which may limit the reliability of the findings.
- Most RCTs were identified as having many sources of potential bias. The greatest risk of bias came from the randomisation procedure (87% of studies graded high or unclear risk), attrition bias (59% graded high or unclear risk) and knowledge allocation (100% graded high or unclear risk). For non-RCTs, 41 out of 58 studies were graded with a high risk of bias (29 of these were before and after studies) and 17 graded as low risk of bias. Most (66%) were graded as high risk for not appropriately adjusting for common confounders, or extra confounders (81%). Attrition bias was also an issue in 39 studies (67%).
- Meta-analysis was not conducted as authors reported heterogeneity in outcomes, their measurements and reporting across included studies.
- There was limited evidence identified on long-term effectiveness and cost-effectiveness of the interventions which limits what can be inferred for policymakers.
- Systematic review authors had to categorise intervention effectiveness into a binary variable due to heterogeneity between studies. This may



overstate the effectiveness of some studies, and without intervention effect sizes, authors lacked precision on the magnitude of the intervention effectiveness.

- This systematic review excluded multicomponent studies that included a non-behavioural insight aspect, such as curriculum education. Systematic review authors highlighted that as obesity is a complex problem, it is likely effective obesity prevention interventions must include multiple policy approaches and that interventions using behavioural insights alone are insufficient to make substantial changes in rates of children with obesity.

References

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2. Marcano-Olivier M, et al., (2020). Using Nudges to Promote Healthy Food Choices in the School Dining Room: A Systematic Review of Previous Investigations. *The Journal of School Health*, 90, 143-157.



4.7.6 School based food environment policy level interventions

School food environment policies

Directional thinking

The evidence for the effectiveness of school food environment policies is largely not conclusive. Two systematic reviews were identified investigating the effectiveness of school food environment policies (Bramante C, et al., 2019 and Micha R, et al., 2018). The first assessed the effectiveness of environmental interventions on childhood obesity prevention and control, evaluated by natural experiments (Bramante C, et al., 2019). Findings were classified by environmental focus (food/beverage, physical activity, or both) and stratified by setting (school, community or both). Only school related interventions are included here. The second investigated the effects of school food environment policies on children's dietary behaviour (Micha R, et al., 2018). Findings were divided into three policy categories: direct provision, competitive food and beverage standards and school meal standards. As both systematic reviews utilised different categories to present outcomes, it was not appropriate to merge findings.

1. School environment policies focusing on physical activity/built environment

The evidence that school environment policies focusing on physical activity/built environment is effective at reducing BMI and sugar sweetened beverage intake is inconsistent or lacking. Narrative analysis found that three out of six studies achieved statistically significant ($p < 0.05$) effects in reducing BMI and three demonstrated no evidence of effect. One study identified no effect on sugar sweetened beverage intake (Bramante C, et al., 2019).

2. School environment policies focusing on the food and beverage environment

There is evidence that school environment policies focusing on the food and beverage environment are effective for reducing BMI and sugar sweetened beverage intake. However, the evidence of effectiveness for fruit and vegetable intake is inconsistent. Narrative analysis found that eight of the 14 school based studies focusing on the food and beverage environment achieved statistically significant ($p < 0.05$) effects in reducing BMI. Three studies were unfavourable and three showed no effect (Bramante C, et al., 2019).



Three of the four school based policy interventions focusing on the food and beverage environment showed a statistically significant reduction in sugar sweetened beverage intake ($p < 0.05$). These three studies evaluated state- or school-wide policies to decrease access to sugar sweetened beverages. The remaining study showed no effect (Bramante C, et al., 2019).

Of the three food and beverage policy focused interventions, only one showed a statistically significant increase in fruit and vegetable intake ($p < 0.05$), with one showing no effect and one showing unfavourable effects on fruit and vegetable consumption (Bramante C, et al., 2019).

3. School environment policies with multiple foci

There is evidence that school environment policies with multiple foci are effective for reducing BMI. All four studies with multiple foci achieved statistically significant ($p < 0.05$) effects in reducing BMI. Two of these four studies also focused on healthy messaging and achieved the largest improvements in BMI (Bramante C, et al., 2019).

4. Combined school and community policies

There is evidence that interventions including multiple settings with various foci, may be effective for reducing BMI. However, the evidence relating to fruit and vegetable intake and sugar sweetened beverage intake is inconsistent. All four interventions including multiple settings with multiple foci identified a statistically significant effects in reducing BMI ($p < 0.05$) (Bramante C, et al., 2019).

One of the two interventions including multiple settings with multiple foci measuring fruit and vegetable intake showed a statistically significant increase ($p < 0.05$). Of the four school based interventions including a community focus, two had multi foci, and two had a food and beverage focus. All found inconsistent results in relation to sugar sweetened beverage intake (Bramante et al, 2019).

5. School BMI screening policies (parental awareness)

There is evidence that school BMI screening policies aimed at increasing parental awareness of their child's BMI is ineffective at reducing BMI and increasing fruit and vegetable intake, but it is not conclusive. Both



interventions identified that aimed to increase parental awareness of their child's BMI showed no effect on BMI. Only one study looked at fruit and vegetable intake, but found no effect (Bramante C, et al., 2019).

6. Policies focusing on direct provision of healthful foods and beverages

There is some evidence supporting the use of direct provision of healthful foods and beverages policies for increasing fruit consumption, and fruit and vegetable consumption combined, but it is not conclusive. Meta-analysis of 15 studies (six RCTs, nine quasi-experimental studies; seven high and eight low quality) found these interventions (with average duration of 12 months) had a significant effect on habitual fruit intake (SE servings/d: 0.27, 95% CI: 0.17 to 0.36, I^2 78.3%). Three studies assessed sustainability at 6 weeks or 12 months after direct provision was removed, and no significant effect was seen (-0.18, 95% CI: -0.51 to 0.15) (Micha R, et al., 2018).

Meta-analysis of six RCTs and ten quasi-experimental studies (six high quality and ten low quality) found these policies (with average duration 15.4 months) had a significant effect on combined fruit and vegetable intake (SE servings/d: 0.28, 95% CI: 0.17 to 0.40, I^2 90.2%). One study identified sustained benefits for both in-school fruit and vegetable intake at three years and habitual intake at three and seven years, although this weakened over time (Micha R, et al., 2018).

There is some evidence suggesting that the use of policies focusing on direct provision of healthful foods and beverages are ineffective for increasing vegetable consumption and improving adiposity and metabolic measures, but it is not conclusive. Meta-analysis of three RCTs and eight quasi-experimental studies (four high and seven low quality) found these policy interventions (with average duration of 13.4 months) had no effect on habitual vegetable intake (SE servings/d: 0.04, 95% CI: 0.00 to 0.08, I^2 23.4%) (Micha R, et al., 2018).

Additional analysis was undertaken on four studies combining provision of fruits and vegetables with additional competitive food/beverage standards to evaluate overweight or obesity. Meta-analysis of two studies identified **no improvements in the odds of overweight/obesity** (OR 1.04, 95% CI: 0.91 to 1.19; 2 RCTs, both high quality) or **odds of overweight** (OR 1.03, 95% CI: 0.94 to 1.12; 1 quasi-experimental study, low quality). However, meta-analysis of two studies (one RCT, high quality and one quasi-experimental study, low quality) identified **a small improvement in odds of obesity** (OR 1.25, 95% CI: 1.07 to 1.46). Heterogeneity and p values were not reported (Micha R, et al., 2018).



Meta-analysis of three studies (two RCTs and one quasi-experimental study; two high quality and one low quality) found **no intervention effect on BMI** (0.19 kg/m², 95% CI: -0.12 to 0.50). Similarly meta-analysis of two high quality RCTs found **no intervention effect on BMI z score** (0.01, 95% CI: -0.04 to 0.05). Heterogeneity and p values were not reported (Micha R, et al., 2018).

7. Policies focusing on competitive food and beverage standards

There is some evidence supporting the use of policies focusing on competitive food and beverage standards for reducing habitual intake of sugar sweetened beverages, but it is not conclusive. Meta-analysis of three low quality quasi-experimental studies found a significant intervention effect on habitual intake of sugar sweetened beverages (ES: -0.18 servings [12 oz]/d, 95% CI: -0.31 to -0.05, I² 73.7%) (Micha R, et al., 2018).

There is some evidence suggesting the use of policies focusing on competitive food and beverage standards for reducing in-school intake of sugar sweetened beverages, in-school lunch intake total fat, saturated fat and reducing odds of or prevalence of childhood overweight, obesity, overweight and obesity combined and BMI (kg/m²) are ineffective, but it is not conclusive. Meta-analysis of four quasi-experimental and one RCT (one high and four low quality), found no intervention effect on in-school sugar sweetened beverage intake (ES: -0.02 servings [12 oz]/d, 95% CI: -0.04 to 0.01, I² 59.6%). Authors reported no significant sources of heterogeneity (Micha R, et al., 2018).

Meta-analysis of two quasi-experimental studies and one RCT (all low quality) found no intervention effect on in-school lunch total fat intake (-0.55 g/d, 95% CI: -3.31 to 2.22). Similarly, meta-analysis of two studies found no effect of the policy on in-school lunch saturated fat intake (-0.20 g/d, 95% CI: -2.10 to 1.70). Heterogeneity and p values were not reported (Micha R, et al., 2018).

Several studies assessed adiposity and metabolic measures with intervention durations ranging from 2.3 to 69 months (mean 31.5 months) and none significantly reduced any of these measures. It was not possible to identify the study design or quality. Meta-analysis found no intervention effect for change in childhood overweight prevalence (five studies), odds of childhood overweight (four studies), obesity prevalence (nine studies), odds of childhood obesity (six studies), overweight/obesity prevalence (five studies), odds of overweight/obesity (two studies) or BMI (five studies) (Micha R, et al.,



2018).

There is moderate to good quality evidence that policies focusing on competitive food and beverage standards are unlikely to be effective at reducing BMI z score. Three RCTs and two quasi-experimental studies (three high and two low quality) assessed BMI z score and found no evidence of intervention effectiveness (-0.01, 95% CI: -0.03 to 0.02, I^2 54.4%) (Micha R, et al., 2018).

8. Policies focusing on school meal standards

There is some evidence supporting the use of policies focusing on school meal standards for increasing habitual intake of fruit, but this is not conclusive. However, there is evidence that these interventions may be ineffective for intake of vegetables, and of fruit and vegetable intake combined, but it is not conclusive. Meta-analysis of two RCTs (both high quality) found a significant intervention effect on habitual fruit intake, with fruit intake increasing by 0.76 servings/d (95% CI: 0.37 to 1.16). Heterogeneity and p values were not reported (Micha R, et al., 2018). Meta-analysis found no intervention effect on habitual vegetable intake or fruit and vegetable consumption (Micha R, et al., 2018).

There is some evidence supporting the use of policies focusing on school meal standards for reducing dietary fat intake, sodium intake and BMI percentile, but it is not conclusive. Six studies (two RCTs and four quasi-experimental) assessed habitual total fat (-1.49 %E/d, 95% CI: -2.42 to -0.57; I^2 90.9%) and four studies (three quasi-experimental and one RCT) assessed habitual saturated fat, (-0.93 %E/d, 95% CI: -1.15 to -0.70, I^2 0.0%), both showing a statistically significant decrease. Similar results were identified for in-school total fat intake and in-school saturated fat intake (Micha R, et al., 2018).

Target levels for sodium content in school meals varied across studies, ranging from 200 to 1200 mg/meal. School meal standards was assessed in four studies (three quasi-experimental and one RCT) and found a decreased habitual intake of sodium (-170 mg/d, 95% CI: -242 to -98). Similarly, in-school lunch intake of sodium was assessed in six studies (five quasi-experimental and one RCT) and found to decrease significantly (-227 mg/d, 95% CI: -384 to -69). Again, in-school meal (lunch and breakfast) sodium intake also reduced (-221 mg/d, 95% CI: -371 to -71, seven studies). No significant sources of heterogeneity were identified (Micha R, et al., 2018).



Two quasi-experimental studies (both low quality) assessed changes in BMI percentile, which significantly decreased (ES: -1.01, 95% CI: -1.62 to -0.39) while other adiposity measures (obesity prevalence and odds, overweight prevalence, prevalence of overweight and obesity combined) remained unchanged (Micha R, et al., 2018).

Bramante C, et al. (2019) also conducted additional analysis on BMI outcomes by age of participants by stratifying all 33 included studies into those that focused on children in elementary school and younger, compared with those whose participants were mostly middle school and older. Sixty-six percent of studies focused on the younger age group had favourable effects on BMI, compared with 54% of studies focused on the older age group. Of the four studies that included only high school children, 50% had favourable effects on BMI.

Intervention Detail

Interventions included national law, local or national policy, local and state-wide programs and USA/Federal-level and non-governmental policies (Micha R, et al., 2018; Bramante C, et al., 2019). All interventions were set in schools (Micha R, et al., 2018), but Bramante C, et al. (2019) also assessed policies covering both school and community settings. Community settings included sports clubs, after-school programmes in churches, communities and schools.

In the systematic review by Micha R, et al. (2018) 47 studies were implemented in primary schools, 27 in secondary schools, one in preschool, and 13 in mixed schools; one did not specify a setting. Bramante C, et al. (2019) also included a mix of school settings: 12 (50%) included elementary school, 13 (54%) included middle school, and 11 (46%) included high school. One study was conducted in an early childcare setting.

Intervention duration varied across studies, ranging from between one and 96 months. The intervention duration did not consider periods that schools were closed (such as holidays) (Micha R, et al., 2018; Bramante C, et al., 2019). The longest follow-up was 47 months in randomised controlled trials and 60 months in quasi-experimental interventions (Micha R, et al., 2018).

Around half of interventions (N=49, 54%) included in the systematic review by Micha R, et al. (2018) were multicomponent. The relative contribution of the food environment policy component ranged from 30% to 100% of the total intervention. Additional intervention components in multicomponent strategies included education (nutrition curricula), promotion/marketing, family/parent outreach, point-of-purchase labelling (Micha R, et al., 2018).



Interventions providing healthful foods and beverages were mainly in classrooms (direct provision) or via increased availability in cafeterias, tuck shops or vending machines (indirect provision) (Micha R, et al., 2018).

Competitive food and beverage policies generally targeted sugar sweetened beverages and unhealthy snacks. Strategies included product specific restrictions, standards on nutrients, calories and/or portion sizes (Micha R, et al. 2018).

Policies on school meal standards generally targeted lunch standards for fruit and vegetables, dietary fats, and sodium. Five of the studies on school meal standards evaluated implementation of the 2012 US school lunch guidelines (Micha R, et al. 2018).

Other things to consider

- There was a small amount of overlap of primary studies across these systematic reviews, with four primary studies identified that were included in both systematic reviews.
- Slight overlap (< 5%) in primary studies was observed between Bramante C, et al. (2019) and three other systematic reviews included in this review of systematic reviews. Slight overlap is also observed between Micha R, et al. (2018) and nine other systematic reviews.
- Moderate levels of overlap (5.6%) were observed between the systematic reviews by Pineda E, et al. (2021) and Bramante C, et al. (2019).
- The systematic review by Micha R, et al. (2018) also included moderate levels of overlap (5.8%) with the systematic review by von Philipsborn P, et al. (2019) and high or very high overlap levels with the systematic reviews by Pineda E, et al. (2021) (13.9%) and Wethington H, et al. (2020) (22%). This overlap is largely due to the multicomponent nature of interventions, with many including some type of policy component.
- Ninety-one (39 RCTs and 52 quasi-experimental with or without external control) studies were included in the systematic review by Micha R, et al. (2018) and 33 natural experiments in the systematic review by Bramante C, et al. (2019).
- The majority of studies in both systematic reviews were conducted in the USA. However, studies from the UK, the Netherlands, Norway, Canada, South Korea, Sweden, Germany, Finland, Denmark, France, New Zealand, Iran and Australia were also included.
- Visual inspection of funnel plots, and Eggers tests identified no evidence of publication bias (Micha R. et al., 2018).
- Few studies investigated sustained effectiveness. Those that did, suggest dietary improvements are hard to sustain. Further examination into



intervention durations may reveal an optimum length to produce more favourable lasting effects (Micha R, et al., 2018).

- The contribution of the policy component varied. This was not investigated by either systematic review but was highlighted as an evidence gap.
- The larger of the two systematic reviews (Micha R, et al., 2018) did not conduct sub-group analysis at school setting level, which have revealed additional differences in effectiveness across a range of outcome measures, as seen in the systematic review by Bramante C, et al. (2019).

Limits to what we know

- Quality assessment in the systematic review by Micha R, et al. (2018) categorised studies as either high or low quality using an unnamed, non-standard assessment tool. Forty-three studies were rated as high quality and 48 as low quality.
- Bramante C, et al. (2019) used the Effective Public Health Practice Project tool to assess risk of bias. The majority of studies (76%, 25/33) had an overall high risk of bias (indicating a low-quality study) because of high rates of withdrawal and dropouts (24/33 studies) and low quality of the study design (17/33). Seven studies had a medium risk of bias, and one study had a low risk of bias.
- There is a possibility of unmeasured heterogeneity due to variations in the educational systems and schools within and across countries (Micha R, et al., 2018).
- Socioeconomic indicators, cost and effectiveness were not reported in the included studies (Micha R, et al., 2018).
- Authors noted that the intervention periods of identified publications largely preceded widespread implementation of the new US school lunch standards, Smart Snacks Standards, FFVP, or revised UK school meal standards (Micha R, et al., 2018).
- Systematic review authors did not comment on data collection methods (e.g. self-report, objective etc.) (Micha R, et al., 2018). However, Bramante C, et al. (2019) outlined data was generally collected via self-reported methods such as food frequency questionnaire, 24-hour recall and food diaries. Data on weight was directly measured by trained staff in the majority of studies (64%), but it was unclear how the measures were obtained (Bramante C, et al., 2019).
- A small discrepancy in the systematic review by Micha R, et al. (2018) was identified. Authors quoted a 95% confidence interval in the narrative section regarding vegetable consumption as 0.01 to 0.08: However, the figure quotes it 0.00 to 0.08.

References

1. Bramante C, et al. (2019). Systematic review of natural experiments for childhood obesity prevention and control. *American Journal of Preventive Medicine*, 56, 147-158.



GIG
CYMRU
NHS
WALES

Iechyd Cyhoeddus
Cymru
Public Health
Wales

2. Micha R, et al., (2018). Effectiveness of school food environment policies on children's dietary behaviors: A systematic review and meta-analysis. *PloS one*, 13, e0194555.

4.7.7 School based food and nutrition education interventions

School based food and nutrition education interventions

Directional thinking



The evidence for the effectiveness for school based food and nutrition education interventions is inconsistent. Three systematic reviews were identified (Medeiros G, et al., 2022; Calvert S, et al., 2018; Morgan E, et al., 2020). The systematic reviews covered both single and multicomponent interventions aiming to improve diet and healthy eating. All comparisons reported in the systematic review by Morgan E, et al. (2020) were between groups receiving an intervention with a caregiver component, and groups receiving an intervention without a caregiver component. Not all studies included across the three systematic reviews examined interventions or outcomes of interest to this summary.

Two systematic reviews included studies which measured fat intake, and found inconsistent results (Calvert S, et al., 2018; Morgan E, et al., 2020). Calvert S, et al. (2018) narratively reported on three studies, two of which had significant effects ($p < 0.05$) on fat intake. Morgan E, et al. (2020) reported on one additional study which found no difference in the percentage of total energy intake from either saturated fat (percentage of total energy intake from saturated fat MD: -0.42% , 95% CI: -1.25 to 0.41) or fat (MD: -0.34% , 95% CI: -2.10 to 1.42) between a group receiving a dietary intervention with a caregiver component and one receiving a dietary intervention without a caregiver component.

Evidence is also inconsistent across systematic reviews for the effectiveness of school based food and nutrition education interventions on fruit and vegetable intake. Twenty-six unique studies across the three systematic reviews measured either fruit intake ($n=14$), vegetable intake ($n=10$), or combined fruit and vegetable intake ($n=8$). Six studies measured both fruit and vegetable intake separately. Study quality was mixed, with 11 of the studies judged as being of weak quality or high risk of bias.

Where combined fruit and vegetable intake was measured, the systematic review by Medeiros G, et al. (2022) found no statistically significant intervention effect from meta-analysis of four studies (SMD: 0.00 , 95% CI: -0.11 to 0.11). However, the systematic review by Calvert S, et al. (2018) included five studies (four of which were unique) measuring combined fruit and vegetable consumption. Narrative analysis found all had a significantly positive effect for the intervention on increasing intake. A further five studies included in the systematic review by Calvert S, et al. (2018) which aimed to



look at increased fruit and vegetable consumption identified no significant effect between the intervention and control. However, it was not possible to determine if these five studies were looking at fruit and vegetable consumption combined, or separately.

Where fruit and vegetables were measured separately, the evidence was more consistently in favour of the intervention's effectiveness across systematic reviews. For vegetable intake, meta-analysis of two studies from the systematic review by Medeiros G, et al. (2022) found a significant effect for the intervention for increasing vegetable consumption (MD times/week: 0.59, 95% CI: 0.15 to 1.03). Calvert S, et al. (2018) also included six studies measuring vegetable consumption, all of which found significant positive effects for the intervention. The systematic review by Morgan E, et al. (2020) identified a further two studies comparing interventions with caregiver components to those without a caregiver component. Both found that vegetable intake was significantly higher in the intervention with caregiver component groups than the intervention without caregiver component groups.

Meta-analysis of five studies from the systematic review by Medeiros G, et al. (2022) found a significant effect for the intervention for increasing fruit consumption (MD servings/d: 0.09, 95% CI: 0.05 to 0.14). Additionally, seven studies identified in the systematic review by Calvert S, et al. (2018) also found significant positive effects for the intervention on fruit intake, although in one study, the effect was only seen in girls. The systematic review by Morgan E, et al. (2020) identified a further two studies comparing interventions with caregiver components to those without caregiver components. One found no significant difference between the two groups (effect size not reported), and one found higher fruit intake in the intervention with caregiver component arm at the end of the intervention (MD servings/d: 1.19, 95% CI: 0.95 to 1.43) and at six-month follow-up (MD servings/d: 1.18, 95% CI: 0.97 to 1.39).

Inconsistent effects were found for intervention effectiveness on sugar sweetened beverage intake. Eight studies from the systematic review by Calvert S, et al. (2018) measured this outcome with three reporting significant positive effects for the intervention on sugar sweetened beverage intake. Studies were largely of weak quality or judged to be at high risk of bias.

Evidence is lacking and therefore not conclusive for the effectiveness of school based food and nutrition education interventions on protein intake or sodium intake. Only one study was identified across the three systematic reviews which measured protein intake, by the systematic review by Morgan

E, et al. (2020). It found no difference between the intervention with a caregiver component and the intervention without a caregiver component on the percentage of total energy intake from protein (MD: -0.06%, 95% CI: -1.06 to 0.94). Two studies also identified from the Morgan E, et al. (2020) systematic review both found no difference between intervention with caregiver component and intervention without caregiver component on sodium intake (results could not be pooled).

Only the systematic review by Morgan E, et al. (2020) looked at anthropometric outcomes. Meta-analysis of two studies found no difference between interventions with caregiver components and interventions without caregiver components on children's BMI (SMD: -0.08, 95% CI: -0.31 to 0.14, I^2 0%). **Despite both studies showing no effect in favour of the intervention with caregiver component for BMI, the number of studies is too small to allow firm conclusions to be drawn.**

Intervention Detail



There was a large amount of variation in sample size and intervention duration between the included studies across the three systematic reviews. Participant numbers in individual studies ranged from 88 to 32,482, with intervention durations ranging from two weeks to three school years.

Interventions covered across the three systematic reviews consisted of nutritional education, often in combination with multiple other components, such as environmental components, training and support for teachers or physical activity.

Nutritional education components were delivered in various ways, such as via traditional classroom education (based around a variety of theories/frameworks for change), board games, personal nutrition challenges, experimental learning activities & peer led education (Medeiros G, et al., 2022), healthy eating lessons, healthy eating activities, worksheets, practical sessions, or homework (Medeiros G, et al., 2022; Calvert S, et al., 2018; Morgan E, et al., 2020).

Additionally, interventions included in the systematic review by Morgan E, et al. (2020) included a caregiver component, such as activities for parents and children to complete together at home with prize incentives, or nutritional comic books to read. These were compared with the same interventions but without the addition of a caregiver component. Some interventions included in the systematic review by Calvert S, et al. (2018) also included a peer or parent component.



Interventions were delivered by a range of people including one or a combination of school staff, researchers, trained project staff, volunteers, peers, nutritional professional, professional cooks, nurses or self-directed (Calvert S, et al., 2018 and Morgan E, et al., 2020).

Some interventions included in the systematic review by Morgan E, et al. (2020) were designed specifically to reach children from low-income households or other vulnerable populations.

Other things to consider



- Four primary studies appear in more than one of the three systematic reviews included in this summary. Three of them appear in the systematic reviews by both Calvert S, et al. (2018) and Medeiros G, et al. (2022) and one appears in both the Calvert S, et al. (2018) and the Morgan E, et al. (2020) systematic reviews.
- Morgan E, et al. (2020) also includes slight overlap of primary studies (< 5%) with seven other systematic reviews in this review of systematic reviews and moderate overlap (5.6%) with one other systematic review.
- Medeiros G, et al. (2022) also includes slight overlap of primary studies (< 5%) with five other systematic reviews in this review of systematic reviews.
- Calvert S, et al. (2018) also includes slight overlap of primary studies (< 5%) with seven other systematic reviews in this review of systematic reviews.
- The systematic reviews by Morgan E, et al. (2020) and Medeiros G, et al. (2022) included only RCTs or Cluster RCTs, whereas the systematic review by Calvert S, et al. (2018) included a range of study designs.
- Studies included in the three systematic reviews came from a range of countries, with the highest numbers in each systematic review being from the USA. Two studies from the UK were included (one each in the systematic reviews by Calvert S, et al., 2018 and Medeiros G, et al., 2022).
- The systematic review by Morgan E, et al. (2020) aims to examine whether adding a caregiver component to interventions make a difference compared to the same intervention with no caregiver component. However, the systematic review does not consider whether either of these interventions are better than no intervention.
- Two of the systematic reviews focused on adolescent populations, although the age ranges covered differed slightly. Medeiros G, et al. (2022) included populations aged 10 to 19 years, whereas Calvert S, et al. (2018) included studies in 11 to 16 year olds. The systematic review by Morgan E, et al. (2020) looked at children of all ages (two to 18 years). Further in-depth analysis may reveal differences in findings for particular population groups.



- Similarly, further in-depth analysis into the different durations of interventions included across the three systematic reviews could help reveal an optimum intervention duration for effectiveness.
- All three systematic reviews used the Cochrane risk of bias tool to assess included study quality. The systematic reviews by Medeiros G, et al. (2022) and Calvert S, et al. (2018) had a mix of articles rated as either high, low or unclear risk of bias. The systematic review by Calvert S, et al. (2018) also used the EPHPP tool to assess study quality, with eighteen studies rated as being of weak quality, six as moderate quality and five as strong quality. Morgan E, et al. (2020) used GRADE to assess the overall quality of the evidence and rated this as low.
- Both narrative synthesis and meta-analysis were undertaken in two systematic reviews (Medeiros G, et al., 2022; Morgan E, et al., 2020), whereas Calvert S, et al. (2018) only undertook narrative synthesis of results.
- The systematic review by Morgan E, et al. (2020) also examined physical activity behaviour change interventions with a caregiver component and combined diet and physical activity interventions with a caregiver component. Whilst dietary interventions are discussed here, physical activity and combined interventions are discussed elsewhere in this report.
- For some studies across systematic reviews, significant effects were only seen in certain sub populations (e.g. girls or boys), or where the intervention had several comparison groups, only in certain groups (Calvert S, et al., 2018; Medeiros G, et al., 2022).
- All three systematic reviews also reported on additional outcomes to those reported here, but as they are outside of the scope of this review of systematic reviews, they have not been extracted.

Limits to what we know



- The interventions took place across a range of countries with differing school systems and so generalisability to Wales should be considered.
- Authors highlight that considerable heterogeneity was evident in the timing and methods of measurements for all included outcomes, limiting analysis (Morgan E, et al., 2020).
- Medeiros G, et al. (2020) reported that food consumption data was estimated using food frequency questionnaires or 24 hour dietary recall, thus increasing the potential for measurement error and selective under- or over-estimation of intake. Morgan E, et al. (2020) had initially proposed to only include outcomes measured using validated tools, however, they noted that owing to the age of included studies it was not feasible to do this, so included all tools. Similarly, Calvert S, et al. (2018) reported the majority of their dietary behaviour measures were collected via self-reported means.



- Medeiros G, et al. (2020) identified a lack of information in the included studies regarding sustained intervention effectiveness in regard to healthy food consumption. Morgan E, et al. (2020) also highlighted the need for future research to include follow-up data after the end of the intervention.
- Authors also reported a lack of description or selective reporting in the original studies of the implemented intervention; this includes, but is not restricted to, the inadequate description of some intervention components (e.g. the specific feedback messages incorporated in the intervention), which makes it difficult to identify specific intervention components that are successful at changing dietary behaviours, and how and why this was effective (Calvert S, et al. 2019).
- Calvert S, et al. (2019) also highlighted the included studies incorporated a wide range of interventions that have diverse components, measurements and target behaviours, making it difficult to form conclusions about their collective effectiveness.

References

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4.7.8 School based computer-delivered nutrition interventions.

School based computer-delivered nutrition interventions

Directional thinking



There is mixed evidence for the effectiveness of school based computer-delivered dietary interventions across the range of outcomes. One systematic review which included 13 studies (published across 15 papers) was identified which aimed to assess the effects of school based computer-delivered interventions for the promotion of healthy eating (Beck-Silva K, et al., 2021).

There was some evidence supporting the use of school based computer-delivered dietary interventions for reducing fat intake, but this is not conclusive. Three out of seven studies in the systematic review found a significant reduction in fat intake or % of fat from energy in favour of the intervention, three found no significant differences between the intervention and control for fat intake outcomes, and the final study found a significant reduction in girls only. Two of those studies were pooled in a meta-analysis, which found a significant reduction in the average consumption of fats for participants completing computer based interventions, compared to baseline (SMD: -0.14, 95% CI: -0.24 to -0.05, I^2 0.00%). However, as studies were largely rated as being as medium risk of bias, it is not possible to draw a firm conclusion on effectiveness.

However, **there is moderate to good quality evidence supporting the use of this intervention for reducing sugar sweetened beverage intake.** Three studies identified in the systematic review measured sugar sweetened beverage intake or soft drink consumption and all found significant reductions in intake/ consumption in the intervention groups, post intervention. Two of the studies were assessed as being at low risk of bias, and one as being at medium risk.

The evidence is inconsistent for school based computer-delivered dietary interventions for increasing fruit and vegetable intake. Four out of seven studies measuring this reported a significant increase in either fruit, vegetable or combined fruit and vegetable intake in the intervention groups, post-intervention. However, meta-analysis of the three studies that could be pooled found that computer based interventions had no significant effect on participants fruit and vegetable consumption compared to baseline (SMD: 0.09, 95% CI: -0.08 to 0.26, I^2 77.11%). All studies were judged to be at medium risk of bias, except for one which was judged as being at low risk of bias.



BMI was measured by five studies included in the systematic review, however **there is moderate to good quality evidence that school based computer-delivered dietary interventions are likely to be ineffective for reducing BMI.** One study observed a significant reduction in BMI in the intervention group ($p < 0.001$) post intervention, three observed no differences between intervention and control groups post intervention, and the final observed a statistically significant increase in BMI in the intervention group compared to control post intervention ($p < 0.05$). Meta-analysis of three of the studies which could be pooled found that computer based interventions had no significant effect on participants BMI scores, compared to baseline (WMD: -0.02, 95% CI: -0.18 to 0.14, I^2 26.68%). Three of the studies were judged as being at low risk of bias, and two were judged as being at medium risk of bias.

Very few of the included studies in the systematic review measured fibre, therefore the evidence of effectiveness for this outcome is lacking. One study (judged to be of medium risk of bias) measured fibre intake and reported that the intervention increased participants regular consumption of fibre ($p < 0.001$). However, as only one study measured this outcome, it is not possible to draw a firm conclusion on this interventions effectiveness for increasing fibre intake.

The systematic review authors conclude that “longer-term interventions (greater than 1 year), with frequent exposure to the instrument, the support of parents and holders of a single theoretical component of behavioural changes, prove to be more advantageous in adopting healthy practices” (Beck-Silva K, et al., 2021).

Intervention Detail

Intervention durations ranged from one session to 16 sessions and follow-up time ranged from between three months and 24 months. Interventions were undertaken in participants ranging from 12 to 19 years old.

Computer-delivered nutritional interventions were delivered via the internet in 10 studies and via CD-ROM in three. Two of the internet studies also included a traditional nutritional education element. Some interventions also involved parents and/or teachers. Content of the educational interventions was not described.



Many interventions were personalised and provided respondents with adapted feedback and personally adapted suggestions to aid behaviour change. Feedback was based on participants individual responses to food consumption and other administered questionnaires. Four interventions did not offer personalised feedback.

Content and personalised feedback in the interventions were usually influenced by one or more theories of change such as the transtheoretical model, the theory of planned behaviour, the social cognitive theory and attitude, or the social influence and self-efficacy model.

Ten included studies compared the nutritional intervention delivered via computer with a control group that did not receive any nutritional intervention, whereas two compared a nutritional intervention delivered via computer combined with traditional nutritional education with a control who received the traditional nutritional intervention only. The final study was a three arm trial comparing a group receiving computer delivered nutritional education, with a group receiving traditional nutritional education and a control group receiving no nutritional education.

The systematic review authors noted that interventions also including the involvement of family tended to produce better results.

Other things to consider



- Slight levels of primary study overlap (< 5%) are observed between the systematic review by Beck-Silva K, et al. (2021) summarised here and five other systematic reviews included elsewhere in this review of systematic reviews. A moderate level of overlap (5.8%) was observed between Beck-Silva K, et al. (2021) and the systematic review by Morgan E, et al. (2020).
- Study samples ranged from 89 to 2,840 participants, with seven having less than 500 participants, three having between 500 and 1,000 and 3 having more than 1,000 participants. Seven of the included studies were cluster RCTs and six were quasi-experimental studies.
- Included studies were mostly undertaken in the USA (n=6), with two undertaken in Belgium, two in the Netherlands, one in Canada, one in Brazil and one which took place across multiple European cities.
- Study quality was assessed using a non-standardised tool developed for a different systematic review and found to be mixed. However only one included study was rated to be at high risk of bias. Four were described as being at low risk of bias, and eight at moderate risk of bias.

- Where studies were rated as being at moderate risk of bias, this was largely due to study design, randomisation method, blinding, and adjustments in statistical analysis.
- Systematic review authors also used GRADE to assess the overall certainty of evidence and observed that according to the GRADE system, included studies presented moderate certainty of evidence for fat consumption and BMI, and low certainty of evidence for fruit consumption.
- Studies included in the systematic review were published between 1999 and 2019. It may be important to consider the advances made in computer technology in this time.

Limits to what we know



- Authors caution that a large amount of heterogeneity in intervention methodologies and outcome variables was identified, which compromises the comparability of the results found.
- Furthermore, the meta-analysis of fruit and vegetable consumption had high heterogeneity (I^2 77.11%), suggesting studies may not have been appropriate to combine.
- Many interventions utilised theoretical models to help tailor content and personalise feedback, but it cannot be determined whether any positive post-intervention results were due to the particular theoretical model used.
- In many cases, follow-up was also short and so it could not be determined whether positive effects were maintained in the longer term.
- The authors also caution that the systematic review may be subject to publication bias, due to a possible gap in the literature dealing with this topic in the age group studied and a possible absence of published articles demonstrating negative results with the use of technology.
- None of the included studies were conducted in the UK, so generalisability of the findings to Wales should be considered. It is unclear from the systematic review how outcome measures were obtained (self-reported or objectively measured), which may further limit the reliability of the findings.
- As the systematic review appeared to include both RCTs and quasi-experimental studies, it is unclear if the quality assessment tool used was suitable to assess both study designs.

References

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4.7.9 Interventions aiming to improve home packed food and beverages consumed by children in school.

Interventions aiming to improve home packed food and beverages consumed by children in school.

Directional thinking



Evidence for the effectiveness of interventions which aim to improve home packed food and beverages consumed by children in school or preschool is inconsistent or lacking for dietary and anthropometric outcomes. One systematic review which included ten interventions (reported in 13 papers) assessed the effectiveness of interventions aiming to improve the foods and beverages packed and consumed by children attending school or preschools (Nathan N, et al., 2019). Five of these studies had relevant outcomes.

The systematic review by Nathan N, et al. (2019) found inconsistent evidence for the intervention's effectiveness on increasing children's fruit and vegetable intake. The systematic review included three studies (all considered high risk of bias) conducted within the school setting. One study found a significant improvement in vegetable consumption (6.2g, SE: 1.8g, 95% CI: 2.7 to 9.8), but not fruit consumption (9.0g, SE: 5.7g, 95% CI: -2.5 to 20.4). A pilot study found a significant improvement in fruit and vegetable consumption ($p > 0.001$). The final study, a larger trial of the pilot study, found no change in fruit and vegetable consumption in intervention students at 3 months (no effect size reported) or 12 month follow up (Cohen's $d = 0.26$, 95% CI: -0.30 to 0.01) compared to baseline.

The systematic review also found inconsistent evidence for the intervention's effectiveness in reducing children's BMI z score. The systematic review included two studies which measured BMI z score. One (unclear risk of bias) found a significant adjusted difference on BMI z score of -0.15 (SE: 0.07, $p = 0.022$) among children attending preschool intervention services compared to control. The second (low risk of bias) reported a BMI z score reduction of 0.1 points in both intervention and control arms, and authors attributed this to both groups receiving a physical activity component at school.

Due to inconsistent findings across studies included in the systematic review, it is not possible to draw firm conclusions on whether interventions aiming to improve home packed food and beverages consumed by children in schools are effective for either reducing BMI z score or improving children's fruit and vegetable intake.



Furthermore, **although the systematic review authors sought to assess the intervention effect on children's waist circumference and prevalence of overweight and obesity, evidence exploring these outcomes was lacking.** One study (unclear risk of bias) measuring waist circumference and prevalence of overweight and obesity was identified, which found a significant adjusted difference in waist circumference among children attending intervention services compared to control (-0.80cm, SE: 0.35, p=0.020). However, no significant effect between the intervention and control groups was identified for prevalence of overweight and obesity (effect size not reported). **Due to the lack of studies, it is not possible to draw a conclusion on the effectiveness of the intervention on waist circumference or prevalence of overweight or obesity.**

Intervention Detail

Of the five relevant studies included in this summary, four took place in schools and one in preschool. The included interventions aimed to target food provided from home for consumption during attendance at school or preschool. This was either explicitly or as part of a broader obesity prevention intervention. Intervention durations across the studies ranged from four to 12 months.

Of the five included studies, all were multicomponent and included strategies to increase parental nutrition knowledge via delivery modes such as pamphlets, newsletters, posters or parent workshops. Four also included education for children through videos, games, curriculum or activities. Three interventions provided physical resources such as lunch packs or containers. Two provided incentives for children to taste vegetables and fruit. The preschool study intervention incorporated policy development.

Three interventions were stand alone lunchbox interventions, whereas one was part of larger child obesity prevention programme, which also incorporated strategies to target physical activity. The remaining intervention was not described.

Other things to consider

- Slight levels of primary study overlap (< 5%) are observed between the systematic review by Nathan N, et al. (2019) summarised here and four other systematic reviews included elsewhere in this review of systematic reviews.
- Participant age ranged from four to 11 years in the school studies and between 29 and 73 months in the preschool study. The number of schools also ranged between 11 and 88 in each study and participant



numbers varied between 238 pupils and 2,443 pupils in the school studies and 560 children in the preschool study.

- Three of the included studies were cluster RCTs and two were quasi-experimental studies.
- Three studies were conducted in the UK, one in Australia and one in Israel.
- Systematic review authors undertook narrative synthesis of the five relevant studies, with additional meta-analysis of studies suitable to be pooled.
- Follow-up data collection in studies with relevant outcomes ranged from five to seven months in one trial, 12 months in three trials and 21 months in the remaining trial.
- The systematic review also included outcomes that were not of interest to this review of systematic reviews, and so have not been extracted here. This included outcomes around lunchbox content.

Limits to what we know



- All five studies were rated as being at high risk of bias in at least one domain using the Cochrane risk of bias tool. All five were rated as being at high risk of performance bias due to blinding of participants or personnel. Three were also rated as high risk of attrition bias, and three at high risk of selection bias due to random sequence generation (n=1) or allocation concealment (n=2).
- The external validity of the systematic review findings was limited given different school food environments internationally.
- As most of the trials had follow-up periods of less than 12-months it is not possible to know if intervention effects were sustained over longer periods of time.
- The longest follow-up period within each study was used in the meta-analysis, however, it is possible that intervention effects may have attenuated in studies with longer follow-up periods than those with shorter follow-up periods.
- High levels of heterogeneity were also evident from forest plots. The source of heterogeneity was unclear and could be due to differences in population, intervention, outcome or other methodological factors including those not reported in the included trials.
- Outcome measures were generally self-reported or observational methods, limiting the certainty of findings. Anthropometrics were objectively measured.

References

1. Nathan N, et al., (2019). The effectiveness of lunchbox interventions on improving the foods and beverages packed and consumed by children at centre-based care or



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4.7.10 School gardening programmes.

School gardening programmes

Directional thinking



The evidence for the effectiveness of school gardening programmes is **largely inconsistent for dietary outcomes**. Two systematic reviews were identified that included a total of 42 unique primary studies (Qi Y, et al., 2021; Chan C, et al., 2022).

The systematic review by Qi Y, et al. (2021) undertook a meta-analysis of five studies and found that school gardening programmes had a significant positive effect on fruit and vegetable intake when compared with control receiving no intervention (WMD: 0.59, 95% CI: 0.21 to 0.98). However, a larger narrative synthesis undertaken by Chan C, et al. (2022) found a more inconsistent picture, reporting that overall, in 15 out of 26 studies, school gardening programmes had no effect on vegetable intake, whereas 11 found a significant improvement in vegetable intake. In studies measuring fruit intake, 15 of the 17 studies found school gardening programmes had no effect, with only two finding a significant improvement in fruit intake.

When split by intervention component, the systematic review by Chan C, et al. (2022) did however find that **results were more favourable in students undertaking school based gardening interventions which had no parental involvement, for vegetable intake only** (six out of 10 studies identified found significant improvements).

Four studies identified in the systematic review by Chan C, et al. (2022) all showed that **school gardening programmes significantly increased fibre intake ($p < 0.05$)**. In contrast, two studies which measured sugar sweetened beverage intake both found no significant improvements for students undertaking school gardening based interventions. However, as only small numbers of studies were identified which examined these outcomes, the evidence is not conclusive.

The systematic review by Qi Y, et al. (2021) also examined anthropometric outcomes. Meta-analysis was conducted for studies measuring BMI, BMI z score and waist circumference, but **no effect was found for school gardening programmes on any of the anthropometric outcomes measured**, when compared with control (BMI WMD: -0.49, 95% CI: -1.63 to 0.65, 5 studies. BMI z score WMD: -0.12, 95% CI: -0.26 to 0.02, 5 studies. Waist circumference WMD: -0.98, 95% CI: -2.61 to 0.64, six studies).

Across the two systematic reviews, quality assessment concluded that no studies were at high risk of bias, suggesting that the **evidence on the effectiveness of school based gardening programmes is moderate to good quality.**

Intervention Detail



Interventions provided opportunities for children to plant, water, weed, harvest and taste various fruits and vegetables. Some also integrated nutritional education, cooking activities and sports participation and changes to the school food environment, such as by introducing meat free Mondays, sourcing local produce for school meals or providing healthy snack programmes (Qi Y, et al., 2021; Chan C, et al., 2022).

There was a large amount of variation in sample size between the included studies, with participant numbers ranging from 44 to 4,300 (Qi Y, et al. 2021; Chan C, et al. 2022). The duration of the interventions ranged from six weeks to four years.

The systematic review by Qi Y, et al. (2021) focused solely on primary school aged children, whereas the systematic review by Chan C, et al. (2022) covered a wider age range including preschool, primary and secondary school age children.

Eighteen of the 35 studies in the systematic review by Chan C, et al. (2022) also included parental involvement.

Two of the studies in the systematic review by Qi Y, et al. (2021) included a physical activity component.

Other things to consider

- There was some overlap in primary studies included across the two systematic reviews, with nine out of the 42 unique studies appearing in both systematic reviews. All the overlapping studies were RCTs.
- Slight levels of primary study overlap (< 5%) are also observed between the systematic review by Chan C, et al. (2022) summarised here and four other systematic reviews included elsewhere in this review of systematic reviews, and the systematic review by Qi Y, et al. (2021) summarised here and three other systematic reviews summarised elsewhere in this review of systematic reviews.



- The systematic review by Qi Y, et al. (2021) included only RCTs, whereas in the systematic review by Chan C, et al. (2022) six included studies were RCTs, seven were cluster RCTs, 10 were non-RCTs, nine were pre-post test studies, one was a mixed methods study and RCT and the final was described by the authors as an intervention trial.
- There was little information provided in either systematic review about where the included studies were undertaken. The systematic review by Qi Y, et al. (2021) provided no information on countries, whereas the systematic review by Chan C, et al. (2022) stated that twenty-nine studies were undertaken in high income countries and six in lower-middle income countries.
- As the systematic reviews included studies undertaken in a variety of age groups, further in-depth analysis may reveal differences in findings for particular population groups.
- Further analysis by differing intervention components could also reveal insights into which components might produce more favourable effects, such as with the systematic review by Chan C, et al (2022). They examined differences between school gardening programmes with parental involvement and those without parental involvement, and found more favourable effects for programmes without parental involvement on increasing vegetable intake, than for programmes with parental involvement.
- As the durations of the included interventions varied greatly, further examination could potentially reveal the optimum length to produce more favourable effects.
- The systematic reviews also assessed other outcomes that were out of the scope of this review of systematic reviews and therefore not covered here. This included outcomes such as fruit and vegetable knowledge, motivation, and preference (Qi Y, et al., 2021).

Limits to what we know



- The interventions took place across a range of countries, with differing school systems and so generalisability to Wales should be considered.
- Although studies were generally rated as being at low or unclear risk of bias, study authors describe some concerns with a lack of accurate information on blinding or methods used for randomisation, or lack of reporting of all predefined outcomes (Qi Y, et al., 2021).
- Heterogeneity was moderate to high in the meta-analyses of anthropometric outcomes undertaken in the systematic review by Qi Y, et al. (2021), suggesting caution in interpreting results as studies may not have been appropriate to combine.
- Dietary outcomes across the two systematic reviews were often measured by self-report, which means changes in dietary intake may not be reflected accurately.



- Little data was provided on longer-term effects across the two systematic reviews, so we are unable to determine if any significant effects were maintained over time. Further research into this may be needed.

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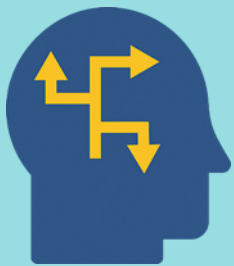
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4.7.11 School based physical activity interventions to improve obesity related outcomes.

School based physical activity interventions to improve obesity related outcomes

Directional thinking



The evidence for school based physical activity interventions to improve obesity related outcomes is inconsistent and it is not possible to form a conclusion.

One systematic review was identified (Yuksel H, et al., 2020) which aimed to examine the effectiveness of school based interventions to promote physical activity and physical fitness for preventing obesity. The systematic review included a total of 19 studies, 15 of which assessed BMI as an outcome.

Eight of the 15 studies assessing BMI identified a statistically significant difference in favour of the intervention group (effect sizes not reported). Six identified no significant difference between groups, and in the final study, a significant difference was identified in favour of the intervention group in girls, but not in boys.

Systematic review authors also examined intervention duration and obesity effectiveness, by comparing studies lasting less than six months and the studies lasting longer than six months. The intervention success rate of the BMI variable was 62.5% (five out of eight studies) for studies with an intervention longer than six months. Studies with less than six months intervention duration, the success rate was 66.66% (four out of six studies).

In interventions where the main focus was on physical activity (as opposed to the main focus being education, guidance or support to staff and teachers) BMI improved significantly in eight out of 11 studies. Where interventions were more focused on education, guidance or support to staff, BMI improved significantly in half of studies (two out of four studies).

Eight of the studies in the systematic review also measured body fat percentage as an outcome (calculated either by skin fold thickness, waist circumference or digital measurements). Significant improvements were observed for the intervention group compared to control in four of the eight studies.

All studies in the systematic review were assessed as being of methodologically strong or moderate quality. However **due to the inconsistent findings across the studies measuring these outcomes, it is not possible to form a conclusion on the effectiveness of physical activity interventions for improving BMI or body fat percentage.**

Intervention Detail

Interventions included in the systematic review were undertaken in either primary schools (n=13) or secondary schools (n=6).

Physical activity components were often in the form of increasing the duration of physical education delivered in schools or changing its content. Other components included performing extracurricular physical activities, doing activities during breaks or lunch breaks and giving activity breaks during lessons other than physical education. Alternatively, a few interventions focused more on education, guidance, counselling and orientation support components, but still with the aim of increasing physical activity / preventing obesity.

Study durations in the systematic review ranged from 8 weeks to 5 years, with 11 having a duration of 12 months or less and eight having a duration of more than 12 months.

Other things to consider



- Slight levels of primary study overlap (< 5%) are observed between this systematic review and three other systematic reviews included elsewhere in this review of systematic reviews. A moderate level of primary study overlap was also observed between the systematic review summarised here and the systematic review by Podnar H, et al. (2021), summarised in section [4.7.12](#).
- Study designs of included studies included RCTs (n=2), non-RCTs (n=4), quasi-experimental studies (n=3), and two described as being 'mixed effects models and repeated measures design'.
- Four studies were conducted in the USA, two in Australia, and one each in China, Czech Republic, England, France, Iceland, India, Israel, Norway, Pakistan, Scotland, South Africa and Switzerland.
- Some of the included studies in the systematic review also examined outcomes not relevant to this review of systematic reviews, such as moderate to vigorous physical activity. These have not been extracted here.
- Anthropometric outcomes were generally objectively measured.



Limits to what we know



- The studies in the systematic review take place in a range of different countries with only two being undertaken across the UK. Therefore, generalisability of the interventions to Wales should be considered further.
- Studies in the systematic review were undertaken in both primary and secondary school settings. Further consideration should be given to whether the effects were consistent across settings.
- Studies in the systematic review were rated by authors as being either of strong (n=10) or moderate (n=9) quality using the effective public health practice project (EPHPP) checklist, and no studies were rated as weak quality.
- The authors state that since the contents and types of physical activity programmes are generally multicomponent, it is difficult to isolate the most effective components.

References

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4.7.12 School based interventions targeting diet and physical activity to prevent obesity.

School based interventions targeting diet and physical activity to prevent obesity

Directional thinking



The evidence of effectiveness of school based interventions targeting diet and physical activity on improving BMI or BMI z score is inconsistent across systematic reviews. All five systematic reviews analysed the interventions effects on BMI and BMI z score (Nally S, et al., 2021; Podnar H, et al., 2021; Morgan E, et al., 2020; Buchanan, L. et al., 2023; Verjans-Janssen S, et al., 2018).

Meta-analyses in the systematic review by Nally S, et al. (2021) found a small but significant reduction in BMI and BMI z score for a range of school based interventions compared to control (BMI: -0.39 kg/m^2 , 95% CI: -0.47 to -0.30 , I^2 86%, 21 studies; BMI z score: -0.05 , 95% CI: -0.08 to -0.02 , I^2 96%). Similarly, meta-analyses in the systematic review by Podnar H, et al. (2021) identified that overall, interventions had a favourable effect on both BMI and BMI z score compared to control (BMI: -0.16 kg/m^2 , 95% CI: -0.25 to -0.07 ; BMI z score: -0.07 , 95% CI: -0.10 to -0.05 ; study numbers not reported). However, heterogeneity was high in both systematic reviews.

The systematic review by Podnar H, et al. (2021) also analysed some intervention types separately. They found that **interventions primarily designed to improve physical fitness** (-0.10 , 95% CI: -0.16 to -0.03 , 13 studies), **physical activity** (-0.09 , 95% CI: -0.12 to -0.06 , 23 studies), **or increase physical activity & decrease sedentary behaviours** (-0.06 , 95% CI: -0.09 to -0.03) showed significant improvements in BMI z score, but not BMI.

Studies in the systematic review by Nally S, et al. (2021) were generally rated by authors as being of moderate to good quality cluster RCTs or RCTs, whereas the RCTs or quasi-experimental studies in the systematic review by Podnar H, et al. (2021) were generally assessed as being at moderate to high risk of bias. The authors in the systematic review by Nally S, et al. (2021) report identifying an outlier in the meta-analysis, and that once this outlier was removed, the average treatment effect decreased to become non-significant (-0.02 , 95% CI: -0.05 to 0.01). However, it is unclear from how this has been reported whether this relates to the meta-analysis for BMI or BMI z score.

Meta-analysis was also undertaken in four studies which targeted diet and physical activity from the systematic review by Morgan E, et al. (2020). These



studies compared interventions targeting diet and physical activity that included a caregiver component to those without a caregiver component and found no difference between groups for BMI (SMD: 0.05, 95% CI: -0.04 to 0.15, I^2 0%).

Meta-analyses were not conducted in the final two systematic reviews (Buchanan, L. et al., 2023; Verjans-Janssen S, et al., 2018). The review by Buchanan L, et al. (2023) combined 10 studies measuring BMI z score to calculate a median intervention effect, which found a decrease of 0.07 (IQR -0.19 to -0.02). Individually however, 9 out of the 10 studies found no significant differences between the intervention and control groups, and the 10th found a significant difference in the intervention group for girls but not boys, when compared to control. Two further studies measuring BMI z score were not amenable to be combined; one reported no significant effects related to the comparison group, and one reported a beta decrease of 0.019 ($p=0.54$).

Eighteen studies from the systematic review by Verjans-Janssen S, et al. (2018) measured BMI or BMI z score and were synthesised narratively. The evidence was inconsistent, with seven studies reporting positive results for the intervention on BMI and BMI z score. One study reported the intervention to be positively effective for reducing BMI but not BMI z score and three found effective results for particular subgroups, (such as subgroups of overweight children at baseline, and boys) but not in the overall sample. Six studies reported that the intervention was ineffective for improving BMI and BMI z-score and one study found a negative result. Study quality was also inconsistent (strong for three, moderate for five, weak for three). **The systematic review authors noted that interventions with a duration of longer than one year seemed more likely to lead to favourable results regarding weight status.**

Other anthropometric outcomes were analysed in three of the systematic reviews (Morgan E, et al., 2020; Podnar H, et al., 2021; Buchanan L, et al. 2023).

Two systematic reviews examined the interventions effect on prevalence of overweight and obesity and found inconsistent results (Morgan E, et al., 2020; Buchanan L, et al., 2023). Morgan E, et al. (2020) conducted a meta-analysis of three studies measuring the prevalence of overweight and obesity and found no difference between the intervention with caregiver component groups and the intervention without caregiver component groups (RR: 1.02, 95% CI: 0.89 to 1.17, I^2 0%).



Buchanan L, et al. (2023) narratively synthesised nine studies which measured overweight or obesity prevalence. Eight were pooled together to calculate a median increase (IQR/Range) which was favourable for the intervention. The baseline median overweight and obesity prevalence combined for these studies was 38.4%, with a reported decrease of 2.5 percentage points (IQR: -8.1 to -1.6 percentage points). One additional study assessed only obesity prevalence and reported an increase of 1.1 percentage points after the intervention. When the outcomes were looked at individually rather than pooled, one found a significant effect for the intervention on overweight and obesity prevalence, three found no significant effects, and in the remaining five, significance was not reported.

Podnar H, et al. (2021) conducted a meta-analysis of studies measuring percentage body fat. This showed that overall, **interventions had a favourable outcome on percentage body fat, compared to control** (%BF: -0.34%, 95% CI: -0.55 to -0.13, study numbers not reported). However, individual **subgroup analysis by intervention focus (physical fitness, physical activity, or physical activity & sedentary behaviour) found no differences between the intervention and control groups for percentage body fat**. Meta-analysis could not be undertaken for interventions designed to improve physical fitness whilst also reducing sedentary behaviour due to the limited number of studies.

Dietary outcomes:

Four of the five systematic reviews looked at school based interventions targeting diet and physical activities effect on nutritional outcomes (Verjans-Janssen S, et al, 2018; Nally S, et al., 2021; Morgan E, et al., 2020; Buchanan L, et al., 2023).

All four systematic reviews reported on fruit and vegetable intake outcomes. Findings were generally inconsistent across systematic reviews.

Two meta-analyses were conducted in the systematic review by Nally S, et al. (2021) which examined the interventions effect on combined fruit and vegetable intake, both of which found no significant difference between the **intervention and control groups** (portions of fruit and vegetables consumed per day MD: 0.05, 95% CI: -0.08 to 0.17, I^2 0%, 5 studies; fruit and vegetable intake measured in g/day MD: 10.45, 95% CI: -17.53 to 38.43, I^2 0%, 2 studies). **Studies were generally of good to moderate quality.**



Narrative synthesis was more inconsistent. The Buchanan L, et al. (2023) systematic review included 10 studies measuring fruit and vegetable intake either separately or combined and calculated median increases (IQI/Range). They found that four studies reported a median relative increase of 12.1% (range -4.6% to 73.4%) for fruit and vegetable intake for the total day, and five studies reported a median relative increase of 3.0% (IQI 2.5% to 9.1%) for frequency of fruit and vegetable intake for the total day. One study reported no change in fruit and vegetable intake at lunchtime.

When looked at separately, eight of the studies in the Buchanan L, et al. (2023) systematic review measured combined fruit and vegetable intake, of which significance was reported in five studies. Two of these found a significant effect for the intervention on fruit and vegetable intake, whereas three found no significant effect for the intervention.

Similarly, the systematic review by Verjans-Janssen S, et al. (2018) identified four studies measuring combined fruit and vegetable consumption, half (n=2) of which found a statistically significant increase in consumption in favour of the intervention ($p < 0.05$).

The systematic review by Morgan E, et al. (2020) identified one study which included combined fruit and vegetable intake as an outcome. This study found no difference in combined fruit and vegetable intake between the intervention with caregiver component group, and the intervention without caregiver component group at the end of the intervention (MD: 0.38 servings/d, 95% CI: -0.51 to 1.27).

Three of the systematic reviews also reported findings from studies that measured fruit intake and/or vegetable intake separately, rather than combined, with results generally inconsistent across studies (Buchanan L, et al., 2023; Morgan E, et al., 2020; Verjans-Janssen S, et al., 2018). Buchanan L, et al. (2023) included two studies reporting fruit and/or vegetable intake separately. One found a significant effect for the intervention on fruit intake, but no significant effect on vegetable intake. The other found no significant effect on either fruit or vegetable intake.

One study was identified in the systematic review by Morgan E, et al. (2020) which measured vegetable intake separately. This study found no difference in vegetable intake between the intervention with caregiver component group, and the intervention without caregiver component group at the end of the intervention (MD: -0.04 servings/d, 95% CI: -0.21 to 0.13). However, meta-analysis of two studies from the same systematic review which



measured fruit intake found a slight increase in the intervention with caregiver component group, compared to the intervention without a caregiver component group at the end of the intervention (SMD: 0.23, 95% CI: 0.03 to 0.43, I^2 0%).

Two out of four studies in the systematic review by Verjans-Janssen S, et al. (2018) which measured fruit consumption separately found statistically significant increases in favour of the intervention ($p < 0.05$), and two out of five found statistically significant increases in vegetable consumption ($p < 0.05$).

Three systematic reviews reported the effectiveness of school based interventions targeting diet and physical activity on sugar sweetened beverage intake (Buchanan L, et al., 2023; Morgan E, et al., 2020; Verjans-Janssen S, et al. 2018). **Findings were inconsistent across the three systematic reviews.**

There is some evidence supporting the use of school based combined diet and physical activity interventions with caregiver components for reducing sugar sweetened beverage intake, but this is not conclusive. Meta-analysis of three studies in the systematic review by Morgan E, et al. (2020) found a slight reduction in sugar sweetened beverage intake in the intervention with caregiver component group, compared to the intervention without a caregiver component group, after the intervention (SMD: -0.28 , 95% CI: -0.44 to -0.12 , I^2 0%).

However, of the eight studies from the systematic review by Buchanan L, et al. (2023) reporting sugar sweetened beverage intake, only two found that school based interventions targeting diet and physical activity had a significant positive effect on this outcome. Five found the intervention to have no significant effect and in one the intervention was found to have a significant effect on fruit drink consumption, but not on soft drink consumption. Systematic review authors analysed six of these to calculate median increases (IQI/Range) and found that three studies reported a median relative decrease of 13.3% (range -29.2% to -4.0%) in sugar sweetened beverage intake per day, and three studies reported a median relative increase of 7.1% (range -9.0% to 15.4%) in the frequency of sugar sweetened beverage intake.

Similarly, one of the five studies measuring sugar sweetened beverage intake in the systematic review by Verjans-Janssen S, et al. (2018) found a significant reduction in sugar sweetened beverage intake for the intervention. One study identified a significant increase in sugar sweetened beverage intake,



and the remaining three studies identified no intervention effect on sugar sweetened beverage consumption.

Two systematic reviews reported intervention effectiveness on other dietary outcomes. **Meta-analyses in the systematic review by Morgan E, et al. 2020 found no differences between combined diet and physical activity interventions with caregiver components and interventions without caregiver components on percentage total energy intake from fat (four studies), saturated fat (two studies), protein (two studies) or carbohydrates (two studies), or on sodium intake (two studies).** Similarly, narrative synthesis from the systematic review by Verjans-Janssen S, et al. (2018) found that only one of four studies looking at fat intake found a statistically significant positive reduction for the intervention ($p < 0.05$). **Therefore, there is some evidence that school based interventions targeting diet and physical activity might not be effective for reducing fat, protein, carbohydrate or sodium intake, but this is not conclusive, largely due to only small numbers of studies assessing these outcomes.**

Intervention Detail

The majority of interventions in this summary targeted multiple areas for obesity prevention. These were generally dietary behaviour and physical activity, with some also targeting sedentary behaviour. Some interventions in the systematic review by Podnar H, et al. (2021) only included physical activity components (51 out of 146 studies), however due to the way the systematic review synthesis was conducted these could not be analysed separately. Similarly, a small number of studies in the systematic review by Nally S, et al. (2021) targeted physical activity and sedentary behaviour only, but not dietary behaviour (eight out of 34). One intervention with relevant outcomes in the systematic review by Verjans-Janssen S, et al. (2018) targeted physical activity only and three targeted dietary behaviours only.

Interventions were all primarily school based, although some did also extend to community or home settings (Podnar H, et al., 2021; Verjans-Janssen S, et al., 2018; Nally S, et al., 2021; Buchanan L, et al., 2023). Three systematic reviews focused on primary schools (Nally S, et al., 2021; Podnar H, et al., 2021; Verjans-Janssen S, et al., 2018), whereas in two all school types were eligible for inclusion (Morgan E, et al., 2020; Buchanan L, et al., 2023). Where reported, numbers of schools participating in studies ranged from one to 154 (Nally S, et al., 2021; Verjans-Janssen S, et al., 2018).

Exact study durations were not always specified by the included systematic reviews, with some categorising them into general durations instead. Where specified, durations in studies ranged from four weeks to four years (Nally S,



et al., 2021; Verjans-Janssen S, et al., 2018; Buchanan L, et al., 2023; Morgan E, et al., 2020). Where categorised durations ranged from <6 months to >12 months (Podnar H, et al., 2021).

Common dietary intervention components identified across the five systematic reviews included making changes to school meals (Buchanan L, et al., 2023), school nutrition programmes (Morgan E, et al., 2020), free fruit allocation (Nally S, et al., 2020), nutritional information packets for caregivers (Morgan E, et al., 2020), environmental change strategies (Morgan E, et al., 2020; Nally S, et al., 2021), education programmes for students; online or via active methods such as cooking classes (Morgan E, et al., 2020; Verjans-Janssen S, et al., 2018; Nally S, et al., 2021), or parental education (Morgan E, et al., 2020; Verjans-Janssen S, et al., 2018).

Common physical activity components included increased or better quality physical education classes (Buchanan L, et al., 2023; Verjans-Janssen S, et al., 2018; Nally S, et al., 2021), increasing physical activity outside of physical education classes; such as active academic lessons or brisk walking during school time (Buchanan L, et al., 2023; Nally S, et al., 2021), caregiver education sessions (Morgan E, et al., 2023), provision of pedometers (Morgan E, et al., 2023), step logs (Morgan E, et al., 2023) and exercise promotion programmes (Morgan E, et al., 2023),

Other strategies included gardening (Nally S, et al., 2021), changes to the physical school environment such as providing more play/gym equipment (Verjans-Janssen S, et al., 2018), policy changes (Verjans-Janssen S, et al., 2018), interactive drama activities (Nally S, et al., 2021), counselling sessions (Nally S, et al., 2021) and take-home activities (Nally S, et al., 2021).

Components taking place outside of the school setting included before or after-school activities, telephone counselling, family cooking nights, fruit and vegetable bazaars or activities in supermarkets (Verjans-Janssen S, et al., 2018; Nally S, et al., 2021; Buchanan L, et al., 2023).

All studies in the systematic review by Verjans-Janssen S, et al. (2018) involved parents directly, with a large number also applying indirect involvement strategies such as via newsletters. Direct parental involvement was predominantly via group educational sessions. The systematic review by Morgan E, et al. (2020) also only included interventions with a caregiver component and compared these to interventions without a caregiver component. The caregiver components were mostly delivered at an individual or family level, however two were delivered in a group class

context. In the systematic review by Podnar H, et al. (2021), 81 out of 146 studies attempted to involve parents or guardians.

Other things to consider



- Slight levels of primary study overlap (< 5%) exist between several of the systematic reviews summarised here, with a moderate level of primary study overlap between the systematic reviews by Podnar H, et al. (2021) and Verjans-Janssen S, et al. (2018) (6.9%), and Nally S, et al. (2021) and Verjans-Janssen S, et al. (2018) (7.4%). High levels of primary study overlap exist between the systematic reviews by Nally S, et al. (2021) and Podnar H, et al. (2021) (12.8%).
- Only slight amounts of overlap (< 5%) were observed between systematic reviews included in this summary and those included elsewhere in this review of systematic reviews, with the exception of Morgan E, et al. (2020) which had moderate levels of primary study overlap (5.6%) with Beck-Silva K, et al. (2022), and Podnar H, et al. (2021) which also had moderate levels of overlap with Yuksel H, et al. (2020) (5.1% overlap).
- Relevant studies from the systematic reviews by Morgan E, et al. (2020) and Nally S, et al. (2021) were all RCTs or cluster RCTs. Whereas the other three systematic reviews also included other study designs such as quasi-experimental studies, pre-post test designs and repeated cross-sectional studies (Verjans-Janssen S, et al., 2018; Buchanan L, et al., 2023, Podnar H, et al., 2021).
- The majority of studies included across the five systematic reviews were undertaken in the USA, or Europe. Six studies in the systematic review by Nally S, et al. (2021) were undertaken in the UK. No UK studies were included in the systematic reviews by Morgan E, et al. (2020) or Verjans-Janssen S, et al. (2018). In two systematic reviews it was unclear how many studies were undertaken in the UK as studies were just categorised as Europe (Buchanan L, et al. 2023; Podnar H, et al. 2021).
- The systematic review by Buchanan L, et al. (2023) reported the mean age of study participants was 8.8 years. Age ranges were reported across four systematic reviews and ranged from 4 to 14 years in relevant studies (Morgan E, et al., 2020; Nally S, et al., 2021; Podnar H, et al., 2021; Verjans-Janssen S, et al., 2018)
- Where reported, numbers of children participating at baseline in relevant studies across the systematic reviews ranged from 51 to 9,867 (Verjans-Janssen S, et al., 2018; Nally S, et al. 2021; Morgan E, et al. 2020), and numbers of schools ranged from one to 154 (Verjans-Janssen S, et al., 2018; Nally S, et al. 2021)
- Studies were implemented across a range of school types and year groups (e.g., kindergarten, elementary schools, middle schools, high schools, primary schools, secondary schools).



- The systematic reviews by Buchanan L, et al. (2023) and Podnar H, et al. (2021) reported on socioeconomic status. Thirteen interventions in the systematic review reported on socioeconomic status, with nine implemented in low-income student populations and four implemented in mixed or middle-income student populations. The remainder did not report socioeconomic status.
- In the systematic review by Podnar H et al. (2021), twenty six of the included studies (out of 146) focused on students from low socioeconomic backgrounds, and four focused on specific ethnic groups. The rest focused on the general population.
- Buchanan L, et al. (2023) also reported on geography, describing 10 studies included in the systematic review as urban in location, six as urban and rural and three as rural only (in five studies, the degree of urbanisation was not reported).
- The systematic review by Podnar H, et al. (2021) found that overall, mean pooled effects of interventions for the primary prevention of obesity were larger in girls than boys.

Limits to what we know



- Anthropometric measures such as BMI and BMI z score were generally measured objectively across the systematic reviews, however dietary outcomes were often collected via subjective measures.
- Duration of follow-up was rarely reported across the systematic reviews. In the systematic review by Podnar H et al. (2021) sustainability of intervention effects was analysed in roughly 30% of the included studies, although only around half of these followed participants for at least 1 year after the end of the intervention. Generally, it was not always clear from the included systematic reviews how long participants were followed up for, and so longer-term effects of the interventions remain less clear.
- Studies were conducted across a range of countries and school systems, most notably the USA, so generalisability to Wales should be considered further.
- Two systematic reviews included studies across a range of age groups and schools. However, the systematic reviews by Nally S, et al. (2021), Verjans-Janssen S, et al. (2018) and Podnar H, et al. (2021) only included primary school age children and so findings may not be generalisable to children of other age groups.
- Relevant studies in the systematic review by Nally S, et al. (2021) were generally rated as being of good to moderate quality. However study quality was more mixed across the remaining four systematic reviews. Common reasons for weak quality ratings across the systematic reviews included information not being reported (Verjans-Janssen S, et al., 2018), missing information on validity and reliability of data collection instruments or drop out rates (Verjans-Janssen S, et al., 2018),



incomplete outcome data, selective reporting, recruitment bias and incorrect analysis (Morgan E, et al., 2020).

- The authors of the Verjans-Janssen S, et al. (2018) systematic review comment that methodological quality was difficult to rate in most papers due to lack of detail, and as a result, the quality of included studies might be underestimated.
- High heterogeneity was observed in those systematic reviews conducting meta-analyses, suggesting that studies might not have been appropriate to combine and limiting the robustness of the findings (Podnar H, et al., 2021; Nally S, et al., 2021). Reviewers suggest that this is likely as a result of variability in participants, settings, intervention components, outcomes and trial design (Nally S, et al., 2021).
- Furthermore, authors of the systematic review by Podnar H, et al. (2021) did not always report the numbers of studies contributing to the meta-analyses, limiting our ability to interpret the results.
- In the systematic review by Podnar H, et al. (2021), 91 interventions included a dietary component, whereas 51 did not. However meta-analyses concluded that including a dietary component improved only the effect of physical activity interventions on BMI z score (-0.06, 95% CI: -0.12 to 0.01). The systematic review authors suggest that due to the number of studies also including a dietary component, it is difficult to ascribe positive findings of the interventions reported in the systematic review specifically to increases in energy expenditure, however the subgroup analysis did only provide limited evidence for moderating effect of a dietary component in physical activity directed programs for one outcome measure, and no such effect was found in the fitness orientated interventions. Nevertheless, the authors suggest that given the complex nature of the disease, multifaceted interventions targeting both sides of the energy equation should be advocated for as the most beneficial approach for the primary prevention of obesity.
- In the systematic review by Podnar H, et al. (2021), a large number of studies describing physical activity interventions failed to document the exact duration of the physical activity element, and even fewer studies quantified the intensity of implemented activities. This meant it was not possible to describe the dose-response relationship.
- The systematic review by Verjans-Janssen S, et al. (2018) comment that inconclusive results for nutritional behaviour may be due to the duration of the intervention. It takes time to change dietary habits and therefore it may be likely that interventions of a longer duration could be more effective for these outcomes, however this possible association was not explored as the majority of studies including this outcome were of relatively short duration (one year or less).
- Systematic review authors (Verjans-Janssen S, et al., 2018) also comment on the incomplete intervention descriptions which impeded comparison and extraction of information and may have biased the results presented in the systematic review.



- The authors of the systematic review by Verjans-Janssen S, et al. (2018) comment behavioural change techniques used in the intervention studies were not taken into account. This was due to substantial missing information across studies which limited the comparability of the results. However, taking these into account might have been an important factor in understanding the variation in intervention effectiveness.

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4.7.13 School based interventions with implementation strategies.

Strategies to improve the implementation of school based interventions targeting student diet, physical activity, or obesity.

Directional thinking



There is mixed evidence for the effectiveness of strategies to improve the implementation of school based interventions targeting student diet, physical activity, or obesity. One systematic review was identified investigating strategies to improve school implementation of interventions to address student diet, physical activity, or obesity (Wolfenden L, et al., 2022). A total of 38 primary studies were included in this systematic review, but 23 included outcomes relevant to our review of systematic reviews and are therefore described here. Fourteen of these were assessed by systematic review authors as suitable for meta-analysis.

There is some evidence that strategies to improve the implementation of school based interventions targeting student diet, physical activity, or obesity are effective for improving dietary intake, but this is not conclusive. Meta-analysis of eleven RCTs or cluster-RCTs found strategies to support the implementation of nutrition policies and practices were associated with a small, but significant effect (SMD: 0.08, 95% CI: 0.02 to 0.15, I^2 63%; 16,649 participants; low-certainty evidence) relative to control.

Narrative synthesis of four non-RCTs reported a 'diet' measure, which combined different measures including sugar sweetened beverages, fat, and total calorie intake. Two of these studies were undertaken in the context of obesity prevention. The direction of effect for all studies favoured students at schools receiving implementation support relative to control. One non-RCT reported results of boys and girls separately and found little difference in the consumption of sugar sweetened beverages compared to control schools. Another study found percentage of kilocalories from fat varied between -0.7 and 0.2 among students in schools receiving implementation support compared to control schools. A further two studies reported little to no difference on measures of total calories and healthy food index.

Despite their being some evidence that strategies to improve the implementation of school based interventions targeting student diet, physical activity, or obesity may result in improved dietary outcomes, the evidence is not conclusive as studies were generally assessed as being at high risk of bias in multiple areas.



There is moderate to good quality evidence that strategies to improve the implementation of school based interventions targeting student diet, physical activity, or obesity are unlikely to be effective for improving obesity-related outcomes. Meta-analysis of eight RCTs reporting student BMI or BMI z score outcomes found that incorporating implementation strategies probably results in little to no difference in obesity (SMD: -0.02 , 95% CI: -0.05 to 0.02 , I^2 5%; 18,618 participants; moderate-certainty evidence).

Three non-RCTs reported mixed effects on measures of BMI and BMI z score. One reported a positive effect in favour of schools and students receiving implementation support. The second, a comparative effectiveness trial called the Travis County CATCH Project, found students in schools receiving support to implement the CATCH BasicPlus and community intervention had 7% greater reductions in the proportion of overweight students ($p=0.051$) and a 1.7% reduction in the proportion of students who were obese ($p=0.33$) compared to those implementing only CATCH BasicPlus intervention. Another study reported no difference in BMI between groups at follow-up (data not reported). Although post-intervention BMI was not reported in a third trial, interim analysis suggested the SPARK programme had no impact on child BMI.

Intervention Detail

It was not possible to identify the intervention components of those with relevant outcomes included in this summary, so all 38 studies in the systematic review are summarised here.

A wide range of implementation strategies were utilised, often in combination. The most common strategies included educational materials ($n=28$), educational meetings ($n=28$) and educational outreach visits ($n=24$). Some other common strategies used were local consensus process ($n=21$), tailored intervention ($n=17$), local opinion leader ($n=14$), amongst "others" ($n=20$). Nine studies implemented audit and feedback strategies, and external funding. Clinical practice guideline strategies were utilised in five studies, and continuous improvement strategies in four studies. Education games, managerial supervision, pay for performance, use of communication technology and monitoring performance of delivery were employed by two studies respectively. Only one study used length of consultation.



Seventeen trials tested strategies to implement healthy eating policies, programmes or practices and 12 tested strategies targeting physical activity policies or practices.

Six trials targeted a combination of health behaviours, with four of these examining the implementation of healthy eating and physical activity policies or practices, and one trial examining policies or practices to healthy eating and physical activity initiatives. Of the 36 studies that compared the implementation strategy to a control group, 33 compared to usual practice or waitlist control and the other three compared to minimal support.

Thirty-one studies comparing the implementation strategy to a control group were two arm trials, and five included more than two trial arms.

Although all interventions were undertaken in school settings, these varied from primary, secondary schools & higher education facilities.

Intervention duration ranged between 20 weeks and five years.

Other things to consider



- Of the 23 relevant primary studies, six were RCTs, 10 were cluster-RCTs and seven were non-RCTs.
- Slight levels of primary study overlap (< 5%) are also observed between the systematic review by Wolfenden L, et al. (2022) summarised here and nine other systematic reviews included elsewhere in this review of systematic reviews.
- This systematic review also investigated tobacco, alcohol use and physical activity outcome measures which are out of scope of this review of systematic reviews. Dietary outcome measures also used indirect measures such as purchase of less-healthy products. As these did not meet our inclusion criteria they have not been reported in this summary.
- Numbers of participants were not reported across all studies, but where they were, the number of participants ranged from 294 to 2,965.
- Outcomes and follow-up data were measured at different intervals.
- Sample size ranged from two schools to 723 schools.
- Twenty-one trials were conducted in elementary schools (aged between five and 12 years), eight studies were conducted with

children aged 11 to 14 years and seven studies with children aged 12 to 18 years old. One trial had participants from the three age groups.

- Follow-up data was collected at different points across all included studies ranging from 3 months to 5 years.
- Fourteen of 23 studies with relevant outcomes were conducted in the USA, five were conducted in Australia and one in New Zealand, the Netherlands, India and South Africa, respectively.

Limits to what we know



- Most included primary studies utilised self-reporting or 24-hr recall methods for data collection and responses were often corroborated by separate parties such as teachers or family members.
- Seven of the 23 relevant primary studies were rated as being at high risk of bias, seven as at unclear risk of bias and nine as at low risk of bias.
- All trials were considered to be at high risk of performance bias, and all non-randomised designs were considered to be at high risk of selection bias from both random sequence generation and allocation concealment.
- Most trials recruited relatively small numbers of schools or school staff, limiting the precision of estimated effects.
- Systematic review authors noted that terminology in implementation science is still evolving, which may have increased the likelihood that relevant studies may not have been captured in the search strategy.
- It is important to note that some of the interventions targeted specific population groups such as low-income populations, areas with large populations of asylum and refugee seekers and population groups at risk of diabetes.
- As none of the relevant studies were conducted in the UK and very few in Europe, generalisability of the findings to Wales should be explored further. Likewise, the variability in school systems across the globe and the age groups included in the relevant studies (which includes students in primary, secondary schools & higher education), should also be considered when applying the findings to the Welsh context.

References

1. Wolfenden L, et al., (2022). Strategies for enhancing the implementation of school-based policies or practices targeting diet, physical activity, obesity, tobacco or alcohol use. *Cochrane Database of Systematic Reviews*. CD011677.



4.7.14 Home/family and community-based interventions targeting children.

Home/family and community-based interventions targeting children

Directional thinking



The evidence for the effectiveness of home/family and community-based interventions targeting children's BMI or sugar sweetened beverage intake is largely inconsistent. However, there is good to moderate-quality evidence indicating that increasing the availability of low-calorie beverages in homes can effectively reduce sugar sweetened beverage consumption.

Two systematic reviews were identified that examined home, family, or community-based interventions targeting children (Moss S, et al., 2022 & von Philipsborn P, et al., 2019). They included a total of 82 unique primary studies. Due to the reported results, we have not been able to separate analyses for home, family and community based interventions and therefore these are discussed and synthesised together below.

The systematic review by Moss S, et al. (2022) included 24 studies of home, family, or community based interventions (sometimes in combination) which aimed to improve weight status, physical activity, sedentary behaviour and/or developmental outcomes in children aged 2-5 years. However, only 17 included outcomes are relevant to this review of systematic reviews and are therefore reported here. All 17 studies measured BMI as an outcome. Five of these studies were home and/or family based interventions, four were community-based interventions and eight included both home/family elements and community elements.

The systematic review conducted by von Philipsborn P, et al. (2019) aimed to identify the effects of environmental interventions on the consumption of sugar sweetened beverages and their effects on health among a general population. It included 58 primary studies aimed at children or teenagers, four of which were included in the home environment and are eligible for consideration here.

Home/family interventions:

Of the five home/family interventions measuring BMI, four reported that the intervention had a statistically significant positive effect on BMI ($p < 0.05$) and one reported a non-significant effect on BMI ($p > 0.05$) (Moss S, et al., 2022).



The systematic review by von Philipsborn P, et al. (2019) identified two home based interventions which examined the effect of improving access to non-caloric beverages compared with no intervention on teenagers BMI. One study found a significant reduction in BMI at 12 months (-0.57 kg/m^2 , 95% CI: -1.12 to -0.01), but this was not maintained after an additional 12 months follow-up (-0.29 kg/m^2 , 95% CI: -1.07 to 0.49). The other study found a significant reduction in BMI for participants in the upper-baseline BMI tertile (-0.75 kg/m^2 , 95% CI: -1.43 to -0.07) but this improvement was not apparent for the whole sample (-0.14 kg/m^2 , 95% CI: -0.54 to 0.26).

Despite evidence suggesting home based interventions may be effective for improving BMI in children across the two systematic reviews, **studies were inconsistent in quality and therefore the findings for BMI are not conclusive.**

However, **good to moderate quality evidence from the systematic review by von Philipsborn P, et al. (2019) suggests that increasing the availability of low calorie beverages in homes can effectively reduce sugar sweetened beverage consumption.** Three out of three well-conducted studies identified in the systematic review demonstrated significant reductions in sugar sweetened beverage consumption following the delivery of water, milk, or diet beverages to participants' homes.

Evidence supporting the provision of active video gaming equipment to teenagers for reducing sugar sweetened beverage intake is lacking. One study reported that the share of participants consuming more than 1,400 ml of sugar sweetened beverages a day decreased non-significantly (OR: 0.71, 95% CI: 0.36 to 1.41) at 10 month follow-up (von Philipsborn P, et al., 2019).

Community based interventions:

Four studies in the systematic review by Moss S, et al. (2022) were community based interventions and measured children's BMI. The results were inconsistent, with two reporting that the intervention had a statistically significant positive effect on BMI ($p < 0.05$), and two reporting a non-significant effect on BMI ($p > 0.05$).

Multi-setting home/community interventions:



The remaining eight studies included in the systematic review by Moss S, et al. (2022) included elements delivered both at home/to families, and in the community. Four of these reported that the interventions had a statistically significant positive effect on BMI ($p < 0.05$) and four reported a non-significant effect on BMI ($p > 0.05$). **The evidence for multi-setting home/community based interventions is also therefore inconsistent.**

Intervention Detail

The interventions differed between the included systematic reviews. Studies from the systematic review by von Philipsborn P, et al. (2019) included:

- **Home based interventions** that offered home delivery of non-caloric beverages to teenagers, or low calorie flavoured milk to pre-adolescent children (aged 8 – 10 years). Participants also received dietary counselling throughout the duration of the intervention.
- One other study provided active video gaming equipment to the homes of teenagers spending 2 hours or more a week using non-active video games.
- All studies from this review were RCTs where the intervention group was compared to a no intervention control group.
- Interventions ranged from 16 weeks to 12 months and included samples ranging from 93 to 262.

In the systematic review by Moss S, et al. (2022), the authors identified the following intervention types as those which were effective for reducing BMI/weight status in children aged 2-5 years:

Home visits: researchers visit families at home to monitor behaviours, set behavioural goals, monitor progress, and deliver intervention components (i.e., materials, discussions, activities).

Distribution of educational materials: provide families with printed, individualised educational materials or tool kits targeting their specific goals, along with information and strategies targeting physical activity and other activities they can incorporate into daily life.

Direct contact with parents: parents receive tailored behaviour change emails, telephone calls and text messages specific towards check-ins, reinforcement, and encouragement.



Encouraging community engagement: scheduling group informational sessions focusing on physical activity promotion, TV use, overall sedentary behaviour, FMS promotion and parenting skills. Parents may be assigned to social groups for enhanced peer support. Children could also participate in group activity sessions with their peers.

Peer education: utilisation of peer educators (other parents) to deliver presentations and group seminars.

Most of the studies (80%) in the systematic review by Moss S, et al. (2022) implemented a home/family based approach (n=19), however 42% of these (n = 8) also incorporated some aspects of community-based approaches. Many intervention components across the systematic reviews are aimed at parents (Moss S, et al., 2022) even though the overall goal is to reduce children's weight.

Other things to consider



- There was no overlap in primary studies between the two systematic reviews examined in this summary (Moss S, et al., 2022; von Philipsborn P, et al., 2019).
- Slight levels of primary study overlap (< 5%) are also observed between the systematic review by Moss S, et al. (2022) summarised here and one other systematic review included elsewhere in this review of systematic reviews. There were also moderate levels of overlap between Moss S, et al. (2022) and the systematic review by Ward D, et al. (2017) (6.9%) and Yoong S, et al. (2023) (5.6%), which are summarised elsewhere.
- Slight levels of primary study overlap (< 5%) are also observed between the systematic review by von Philipsborn P, et al. (2019) and seven other systematic reviews summarised elsewhere in this review of systematic reviews. There were also moderate levels of overlap (5.8%) between von Philipsborn P, et al. (2019) and the systematic review by Micha R, et al. (2018) (5.8% overlap).
- The systematic reviews examine interventions in the home/family or community, and are therefore grouped by which setting they are conducted in. As a result, the intervention approaches within this group are highly heterogeneous. This should be considered when examining findings of home/family or community based interventions.
- The two systematic reviews are focused on different populations. Moss S, et al. (2022) investigated interventions on two to five year-olds whereas the systematic review by von Philipsborn P, et al. (2019) examined studies in both adults and children, however for the purpose of this summary we only included outcomes from interventions in children and

young people. Specifically, the included populations were teenagers or those aged 8 to 10 years.

- Sample numbers ranged from 11 to 2,434. This large variation could influence the reliability and validity of the findings.
- Intervention durations across the two systematic reviews ranged from six weeks to 24 months.
- Included studies from von Philipsborn P, et al. (2019) were all RCTs and in the systematic review by Moss S, et al. (2022), 14 out of 19 studies were RCTs. The remaining studies were prospective, before and after studies or mixed between-subjects design.
- Studies were conducted in the USA (n = 14), Australia (n = 3), Canada (n = 2), Switzerland (n = 2), Finland (n = 2), the Netherlands (n = 2), Chile (n = 1) and other Eastern European countries (n = 2).
- One systematic review (Moss S, et al., 2022) investigated the effects of interventions on child-development outcomes. As well as BMI (reported above), this systematic review contains sedentary behaviour, screen-time, physical activity and motor skills outcomes.
- One study found that providing active video gaming equipment caused one in five participants from the intervention group to report having experienced an injury (the most frequently mentioned injuries were bruises or strained muscles/tendons) while playing. No other adverse events were reported across other interventions.

Limits to what we know



- As no studies were conducted within the UK, generalisability of the findings to Wales should be explored further.
- Most of the included studies in the systematic review by Moss S, et al. (2022) were rated as weak quality and as being at high risk of reporting bias. Despite the included studies in the systematic review by von Philipsborn P, et al. (2019) being rated as good quality, the use of self-reported measures for primary outcomes was cited as a common issue. These methodological weaknesses may limit the confidence of their results.
- Little data was provided on longer-term effects across the two systematic reviews, so we are unable to determine if any significant effects were maintained over time. Further research into this may be needed.
- The majority of measures of sugar sweetened beverage intake were collected by food frequency questionnaires or dietary recall and thus this may have introduced some potential biases into the findings.
- Moss S, et al. (2022) highlighted that very few studies were identified targeting younger aged children and the studies included in this summary investigated children and teenagers aged eight and above. In addition, participant age ranges often varied making tailored and age-group specific conclusions unclear.



- Intervention detail was often poorly reported in the systematic review conducted by Moss S, et al. (2022) and although von Philipsborn P, et al. (2019) provided a good level of intervention detail, only four of their included studies are taken into consideration in this summary.

References

1. Moss S, et al., (2022). Home- and Community-Based Interventions for Physical Activity and Early Child Development: A Systematic Review of Effective Strategies. *International Journal of Environmental Research and Public Health*, 19.
2. von Philipsborn P, et al., (2019). Environmental interventions to reduce the consumption of sugar-sweetened beverages and their effects on health. *Cochrane Database of Systematic Reviews*. CD012292.

5 Discussion

This review of systematic reviews provides a broad overview of the breadth of the evidence relating to the effectiveness of universal, whole system and settings based interventions to stabilize or reduce the prevalence of overweight and obesity in children, or adults aged between 18 and 65 years. Twenty-six systematic reviews meeting the inclusion criteria were identified from the search of the literature, including a total of 911 unique publications. These included a large range of different interventions, many of which were complex and multicomponent. There was also variability in settings, sample sizes and durations of interventions, making them difficult to compare.

Overall, the evidence relating to the effectiveness of these interventions is lacking, inconsistent, or not conclusive. This is largely due to the complexity and variability of interventions in this area, the population and settings, and the often poor choice of study design used to test such interventions.

The majority of evidence identified focused on school based interventions for children, but we also identified some systematic reviews covering home/family or community based interventions for children, preschool based interventions, and workplace interventions for adults. Some systematic reviews also covered multiple types of interventions across the general population.

The majority of the evidence was collected from interventions undertaken in the USA and Europe, with few identified from the UK. This may limit the generalisability of the evidence to Wales. As many interventions were also settings based (predominantly in school settings), variation in settings and systems (such as school systems) across included studies and countries should also be given careful consideration as it may further hinder generalisability to the Welsh context.

It was challenging to group the various interventions explored across the systematic reviews together for synthesis, as many were multicomponent, consisting of both common and distinct components from one another. Due to this, some overlap in primary studies across the 15 different intervention summaries exists. Even though systematic reviews may have had different aims and inclusion criteria, the multicomponent nature of the interventions means they were eligible for inclusion in more than one systematic review, which is why they appear in more than one intervention summary. Intervention detail was also lacking from the systematic reviews, so it was sometimes difficult to be consistent and accurate when categorising systematic reviews for synthesis. Most systematic reviews focused on anthropometric outcomes (predominantly BMI/BMI z score, or prevalence of overweight and obesity), sugar sweetened beverage intake or fruit and vegetable intake. However, there were some additional food related outcomes studied (including fat, fibre, sodium, sugar, dairy items, and whole grain food intake). The majority of food related outcome data were obtained by self-report methods which are inherently subject to recall bias. However, in order to strengthen our certainty of the evidence, where possible, we excluded proxy measures used to estimate consumption (such as sales data), which may not accurately reflect consumption.



5.1 Summary of evidence

5.1.1 Adults/general population

Two intervention summaries explored interventions focusing either on adults or the general population (summaries [4.5.1](#) and [4.6.1](#)). These included evidence from three systematic reviews (Allan J, et al., 2017; Panchbhaya A, et al., 2022; von Philipsborn P, et al., 2019). One of the three systematic reviews included in this category, focusing on the reduction of sugar-sweetened beverages, was a Cochrane systematic review which follow strict and rigorous methodology (von Philipsborn P, et al., 2019). The remaining two focused on workplace interventions, with one specific to healthcare workers (Panchbhaya A, et al., 2022).

Evidence of effectiveness for environmental interventions aiming to reduce sugar sweetened beverage consumption among the population was generally lacking, and where there was evidence, this was often inconsistent. Inconsistent findings were due to the variability of intervention components, settings, sample sizes and duration of the interventions. Evidence from one systematic review (von Philipsborn P, et al., 2019) suggests that there is **some evidence supporting the use of government food benefit programmes (which included incentives for buying fruit and vegetables and restrictions on the purchases of sugar sweetened beverages) for reducing sugar sweetened beverage consumption**. However, this is not conclusive due to the small numbers of studies.

Evidence from two systematic reviews indicate that **workplace dietary behaviour change interventions** with environmental, educational, or behavioural components (or a combination) **can increase fruit and vegetable consumption**. However, the evidence around whether these interventions can reduce BMI was more inconsistent. Only five of the primary studies across the two systematic reviews were conducted in the UK, and all of these were undertaken in healthcare workers, which may limit findings to this population only. Nevertheless, the majority of included primary studies were randomised or non-randomised controlled trials.

The authors of the von Philipsborn P, et al. (2019) systematic review note that few studies considered contextual and implementation factors, including barriers to and enablers of implementation. Such information can be important for sustained and scaled-up implementation. Similarly, only a few studies systematically examined target group and stakeholder perceptions, which can be essential for mobilising and sustaining public and political support. Process evaluations and mixed methods approaches could help to generate evidence on such aspects.

5.1.2 Children: preschool settings

One intervention summary ([section 4.7.1](#)) includes evidence from three systematic reviews examining



interventions focusing on preschool age children (Ward D, et al., 2017; Yoong S, et al., 2023; Morgan E, et al., 2020). The evidence for the effectiveness of interventions in early years care and education settings that target healthy eating, physical activity and/or screen time was found to be largely inconsistent. Some **limited evidence was identified suggesting these interventions may have a positive effect on children's overall diet quality and may increase children's consumption of fruit.** However, the evidence suggests these interventions may have no effect on anthropometric measures.

Interventions were generally multicomponent with strategies to improve healthy eating and increase physical activity. One systematic review highlighted that the strength of single behaviour interventions in general had higher correlations with anthropometric outcomes than did the combined diet and physical activity interventions (Ward D, et al., 2017). The review authors suggested this may be due to combined interventions not being sufficiently powered on all outcomes included.

A lack of evidence was identified looking at the impact of these interventions on children aged six months to two years, as the majority of identified evidence considered preschool children from age 2 upwards.

Measuring dietary and physical activity behaviours in young children is very challenging, so measurement limitations could explain some of the inconsistent and unexpected findings (Ward D, et al., 2017).

Very few studies in this group were conducted in the UK, with the majority conducted in the USA, which could impact generalisability of the findings to Wales.

5.1.3 Children: school settings

Twenty-three systematic reviews were identified examining school based interventions generating 12 intervention summaries ([sections 4.7.2 to 4.7.13](#)). Of these, one publication incorporated four systematic reviews ([section 4.7.12](#); Wethington H, et al., 2020) and one was not synthesised due to complete overlap of primary studies with another systematic review ([section 4.7.5](#); Marcano-Olivier M, et al., 2019).

Intervention duration and participant numbers varied greatly across included primary studies and interventions involved a wide range of single or multicomponent elements. Components frequently aimed to change the school environment in some way, elicit behaviour change or provide education. This included introducing regulations, policies, improving access or provision, small prizes, classroom education, board games, computer games, challenges, newsletters, planting opportunities, cooking activities, sports participation, workshops and learning activity components. In addition, some interventions also included parental or family elements. Theoretical models were sometimes utilised

to help tailor content and personalise feedback, however systematic review authors generally could not determine whether any positive post-intervention results were due to a particular theoretical model used (Beck-Silva K, et al., 2021).

The diverse components, measurements and target behaviours of the interventions identified make it difficult to form firm conclusions about their collective effectiveness. Although findings remain largely inconsistent, not conclusive or lacking, **moderate to good quality evidence was identified indicating:**

- Policies focusing on school competitive food and beverage standards (defined as foods and beverages sold outside of school meal programs and competing with school meal programs) are unlikely to be effective at reducing BMI z score ([section 4.7.6](#))
- **School based computer-delivered nutrition interventions are effective for reducing sugar sweetened beverage intake**, but moderate to good quality evidence suggests they are likely to be ineffective for reducing BMI ([section 4.7.8](#))
- **School gardening programmes significantly increased fibre intake** ([section 4.7.10](#))
- Strategies to improve the implementation of school based interventions targeting student diet, physical activity, or obesity are unlikely to be effective for improving obesity-related outcomes ([section 4.7.13](#))

Although all interventions were conducted within school settings, some interventions also incorporated a community element. Types of school also varied (such as primary, secondary, kindergarten, middle or high schools, in urban or rural settings) and further in depth analysis may reveal differences in findings for particular age or school groups. There is the possibility of unmeasured heterogeneity due to variations in the educational systems and schools within and across countries where interventions were conducted.

Only a small number of systematic reviews undertook any further analysis to identify differential effects by one or more sociodemographic characteristic (such as age, sex BMI, socioeconomic status, or ethnicity). A small number of interventions targeted specific population groups such as low-income populations, or groups at risk of diabetes. Although systematic reviews targeting specific population groups did not meet our inclusion criteria, some systematic reviews included a mix of studies targeted at certain population groups or at the general population. Where the majority of primary studies included in a systematic review involved the general population, the systematic review was defined as meeting our inclusion criteria. However, generally we were unable to extrapolate the findings of those undertaken in general populations from these systematic reviews for our summaries, due to the way systematic review authors had conducted their own synthesis.

5.1.4 Children: home and community settings

One intervention summary ([4.7.14](#)) including evidence from two systematic reviews (Moss S, et al., 2022; von Philipsborn P, et al., 2019) examined home, family or community based interventions targeting children. Due to reporting within the systematic reviews, it was not possible to separate the findings into different summaries for home or community based interventions, so these were synthesised together.

The evidence for the effectiveness of home/family and community based interventions targeting children's BMI or sugar sweetened beverage intake was largely inconsistent. However, **there was good to moderate quality evidence indicating that increasing the availability of low-calorie beverages in homes can reduce sugar sweetened beverage consumption.**

Interventions were often conducted across settings (i.e. home and community, rather than one or the other). One of the systematic reviews focused on children aged two to five years old (Moss S, et al., 2022), whilst the other focused on the general population, but included several studies aimed at children and teenagers aged eight and over which were included in this category (von Philipsborn P, et al., 2019).

None of the studies were undertaken in the UK, which may limit generalisability, and little data was provided on longer-term effects across the two systematic reviews, meaning we are unable to ascertain if significant effects were maintained over time.

5.2 How does this review of systematic reviews build on previous research?

Our original intention and aim for this work was to update the previous review of systematic reviews Public Health Wales Evidence Service published on this topic in 2019 (Public Health Wales, 2019). However, as the work progressed it became clear that this would not be possible. The previous work was produced specifically to support the Healthy Weight Healthy Wales Strategy which meant the work was guided by stakeholders in terms of its direction and the level of detail required. In contrast this review has been produced to provide an overview of all interventions aimed at reducing overweight and obesity and is intended for more general stakeholder use.

The evidence base for overweight and obesity interventions is extremely mixed and complex, with content and delivery of interventions varying greatly. As has been highlighted elsewhere (Morgan E, et al., 2020), this complexity has meant that identifying effectiveness was extremely challenging. Direct comparison of the systematic reviews identified in the previous work and those identified here was not possible, due to differences in terminology used to categorise interventions, and lack of detail about the interventions within the systematic reviews themselves.

Therefore, rather than directly updating our previous review of systematic reviews, our approach to

this work has been to build on the previous work by synthesising a broader range of interventions and providing more detail about the interventions themselves where it was possible to extract this information. We hope that this new approach, which includes more narrative synthesis of the evidence base, and highlights where gaps exist, is more useful to stakeholders wishing to implement such interventions.

Although the new approach meant it would not be appropriate to undertake a direct comparison between the evidence identified in this review of systematic reviews and the previous work, it is still useful to highlight how the evidence base has changed since the last review. Our current review of systematic reviews has searched and synthesised secondary evidence published since 2017 to provide an up to date examination of the same evidence base.

Both reviews identified a vast range of multicomponent interventions aimed at reducing overweight and obesity. The causes of obesity are complex, and population level or settings based interventions target a variety of different areas in an attempt to reduce or stabilise rates of overweight/obesity, such as diet, the physical environment, physical activity, or sedentary behaviour. In many cases, the aims and target behaviours of the interventions identified in our current review of systematic reviews differ from those examined in the 2019 publication.

Unlike the 2019 review of systematic reviews, **our current work failed to identify any whole system or whole of community interventions which are defined as population level multi-strategy interventions delivered across entire communities (Wolfenden L, et al., 2014)**. The 2019 review of systematic reviews identified two systematic reviews focusing on whole of community interventions to prevent obesity (Wolfenden L, et al., 2014; Boelsen-Robinson T, et al., 2015). One of these focused on children (Wolfenden L, et al., 2014) and one included people of any age (Boelsen-Robinson T, et al., 2015). The whole of community interventions identified by these systematic reviews were multicomponent in nature, often across three or more settings, with schools or childcare services commonly being the primary intervention setting. Community engagement was also often employed (Wolfenden L, et al., 2014; Boelsen-Robinson T, et al., 2015). Both systematic reviews found evidence to support whole of community interventions for the prevention of weight gain, but it was not conclusive, largely due to the weak quality of included studies.

Although our most recent search identified a systematic review with interventions focusing on the general population (von Philipsborn P, et al., 2019), these included a range of different interventions aimed at reducing sugar sweetened beverage intake, such as government food benefit programmes, financial incentives, and urban planning restrictions. These were largely considered universal interventions, rather than whole of community, due to the lack of multiple settings and lack of community involvement.

Interventions in workplace settings were identified in both this and the previous work, however the interventions themselves varied. The 2019 review of systematic reviews identified workplace

interventions focusing on changes in physical activity, or multiple areas to prevent weight gain. However, this review of systematic reviews identified workplace interventions targeting dietary behaviour change through a variety of environmental, educational, and behavioural change strategies (Allan J, et al., 2017; Panchbhaya A, et al., 2022).

Both reviews of systematic reviews identified a majority of interventions focusing on children within the school setting. A small number investigated preschool aged children, but studies were predominantly looking at primary or secondary aged children. Interventions were wide ranging, with systematic reviews often investigating a very specific type of school based intervention. This review of systematic reviews has been able to synthesise the evidence around some quite specific school based interventions that were not covered in depth by the previous work, such as:

- School based computer delivered nutrition interventions ([4.7.8](#))
- Interventions aiming to improve home packed food and beverages consumed by children in school ([4.7.9](#))
- School gardening programmes ([4.7.10](#))

Both this and the previous work include intervention summaries which outline the intervention effectiveness, aspects to consider and limitations of the evidence. However, this review of systematic reviews has incorporated an intervention section to provide stakeholders with additional information on the intervention components, where this detail was described by the systematic reviews. Readers will benefit from reading the intervention summaries in order to understand the context surrounding the intervention findings in more detail.

6 Limitations

Several limitations of the included systematic reviews were identified. Generally, little intervention detail was provided, which made grouping similar types of intervention for synthesis difficult. This may have had an impact on our findings as coupled with the lack of intervention detail, intervention characteristics that may modify the effect could not be pulled from the systematic reviews, introducing heterogeneity into our findings. Furthermore, as the majority of interventions were multicomponent in nature and few systematic reviews undertook further analyses to identify which intervention components were more successful, it was not possible to isolate which intervention components (or combination of components) may have been responsible for producing an effect. However, despite these limitations, our work provides a good overview of these multicomponent interventions in general.

Anthropometric outcomes were generally measured objectively, however dietary outcomes such as those measuring food and beverage intake were often collected via self-reported measures. Therefore, recall bias may be an issue in studies measuring dietary outcomes.

Systematic review authors often reported that long term follow up was lacking from primary studies, and that this was a significant limitation to their systematic reviews. Consequently, the longer term impacts of interventions remain largely unknown. This might be especially important to consider in those primary studies where effectiveness for dietary outcomes were identified, but not anthropometric outcomes. It is possible that adequate time had not passed for the effect of the intervention to translate into anthropometric outcomes.

The majority of systematic reviews included in this review of systematic reviews were focused on children and were undertaken within school settings. Although some of these covered all age ranges, some were specific to populations such as preschool age children or primary age children. Therefore, these interventions may not be generalisable to all school age children, and consideration should be undertaken before implementing interventions to the optimum age range interventions in children should be targeted towards.

This review of systematic reviews was conducted using a robust and systematic methodology adhering to a review protocol set out in advance. All review stages were undertaken by multiple reviewers independently in duplicate and consistency checked to try to minimise bias. Nevertheless, some limitations do remain. Although a comprehensive search was undertaken across multiple databases and robust secondary sources for this update, there is the possibility that searching additional databases may have identified further systematic reviews meeting our inclusion criteria. Searches were also limited to English language publications and therefore relevant research published in other languages may have been missed.

As this review of systematic reviews was limited to inclusion of systematic reviews (due to the broad topic area covered), our ability to extrapolate the finer detail of interventions was limited. This was generally due to a lack of intervention detail included in the systematic reviews. Consequently, intervention summaries in this review of systematic reviews were broad, with some overlap in primary studies across the 15 summaries. Although intervention detail was lacking from the systematic reviews, the broad topic area and time frame made conducting a review of systematic reviews the most feasible option. Further work examining primary studies in more focused areas of interest could be a logical next step if stakeholders wish to consider any of the interventions identified in this report further.

Very few included interventions were conducted in Wales, limiting the direct applicability of the findings to the Welsh context. However, we did limit our review of systematic reviews to include only those systematic reviews where the majority of included studies were undertaken in OECD countries (which may be more comparable to Wales). Nevertheless, it is important to recognise that the Welsh population may differ from those in other countries where interventions were conducted, potentially affecting the effectiveness and generalisability of the interventions. Similarly, things such as school systems may also differ widely across countries, and so interventions generalisability to Welsh



settings needs to be considered. Additional research is needed to evaluate the effectiveness of these interventions in a Welsh setting before drawing firm conclusions about their applicability to Wales.

7 Conclusions

Overall, **the evidence relating the effectiveness of universal, whole system and settings-based interventions for stabilizing or reducing the prevalence of overweight and obesity is generally lacking, inconsistent, or not conclusive.** Given the complexity of factors contributing to overweight and obesity, it is not surprising that the majority of interventions identified were multicomponent and often behavioural in nature. However, this has made it extremely challenging to draw firm conclusions about the overall effectiveness of universal, whole system or settings based interventions to prevent overweight/obesity in both adults and children.

In addition to adding to the evidence base identified in previous work, this review of systematic reviews confirms that although inconsistencies across the evidence base still remain, this is likely down to the varied nature of interventions, study aims, populations studied, settings and outcomes examined, rather than the interventions themselves. In depth consideration is required to examine these interventions within the Welsh context, and there are some interesting intervention components identified that may be worthy of further investigation and consideration. This could be achieved via conducting further, more focused reviews of primary evidence as well as further evaluation of interventions. In addition, further investigation into specific intervention types may be useful to identify which components are effective in specific populations.

By grouping similar interventions for synthesis in order to create 15 intervention summaries which provide a more detailed look into the interventions as described by the systematic review authors, we hope that the information provided will prove invaluable to those wishing to build on current interventions in place within Wales.



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9 Appendix A: Search Strategy

ADULTS

Ovid MEDLINE(R) ALL <1946 to July 27, 2023>

1	(obes* or overweight or fat or "body fat" or "body mass index" or "bmi" or "body weight change*" or "weight loss" or (weight adj3 change)).ab,ti.	889748
2	(universal or setting* or "setting based" or "settings based" or population* or adult* or communit* or environment* or (place adj2 work)).ab,ti.	5700689
3	1 and 2	279889
4	((obes* or overweight or fat or "body fat" or "body mass index" or "bmi" or "body weight change*" or "weight loss" or (weight adj3 change)) and (universal or setting* or "setting based" or "settings based" or population* or adult* or communit* or environment* or (place adj2 work))) not child* not infan* not adolescen* not teen* not young not youth not school* not college*).ab,ti.	210425
5	((prevent* or intervention*) not management not control).ab,ti.	2106064
6	(plan* or nutrition* or diet* or tool* or behavio?r or strateg* or "health promotion*" or (weight adj3 reduc*)).ab,ti.	5387694
7	5 and 6	572862
8	4 and 7	17307
9	limit 8 to (yr="2017 -Current" and (meta analysis or "systematic review"))	481

CHILDREN

Ovid MEDLINE(R) ALL <1946 to July 27, 2023>

1	(obes* or overweight or fat or "body fat" or "body mass index" or "bmi" or "body weight change*" or "weight loss" or (weight adj3 change)).ab,ti.	889748
2	(universal or setting* or "setting based" or "settings based" or population* or communit* or environment*).ab,ti.	4603379
3	1 and 2	212460
4	((obes* or overweight or fat or "body fat" or "body mass index" or "bmi" or "body weight change*" or "weight loss" or (weight adj3 change)) and (universal or setting* or "setting based" or "settings based" or population* or communit* or environment*)) not adult*).ab,ti.	166244
5	((obes* or overweight or fat or "body fat" or "body mass index" or "bmi" or "body weight change*" or "weight loss" or (weight adj3 change)) and (universal or setting* or "setting based" or "settings based" or population* or communit* or environment*)) not (work adj2 place)).ab,ti.	212412
6	4 and 5	166206
7	((prevent* or intervention*) not management not control).ab,ti.	2106064
8	(plan* or nutrition* or diet* or tool* or behavio?r or strateg* or "health promotion*" or (weight adj3 reduc*)).ab,ti.	5387694
9	7 and 8	572862
10	6 and 9	15786
11	limit 10 to (yr="2017 -Current" and (meta analysis or "systematic review"))	368



10 Appendix B: Critical Appraisal Checklist

Questions to assist with critical appraisal of a systematic review³

Paper citation:

Note: Although the critical appraisal tool asks for 'yes', 'no' or 'can't tell' answers, it can be really useful to write as much information as you can to help answer the questions and in case you are asked to recall the article months after you've undertaken the work or justify inclusion/exclusion.

Screening questions

1. **What is the aim of this review?**
2. **The elements outlined below will help you determine whether review address a clearly focused issue.** *Not necessarily grounds for exclusion if the information can be gleaned from the text*

What is the population studied?

What is the intervention given?

What is the comparator if relevant?

What are the outcomes considered?

3. **Have the authors assessed the quality of the included studies?** *See notes (Yes/No/Can't tell)*

Is it worth continuing? Yes/ No/Discuss

³ Adapted from Health Evidence Bulletins - Wales: Questions to assist with the critical appraisal of a systematic review [including at least one randomised controlled trial] (Type I evidence); [including at least one non-randomised intervention study] (Type III evidence); or [of observational studies] (Type IV evidence), AMSTAR – A checklist for appraisal of systematic reviews, Available at: <http://www.biomedcentral.com/1471-2288/7/10>. Sources used by HEBW: CASP questions (taken from Oxman AD *et al.* Users' guides to the medical literature. VI How to use an overview. *Journal of the American Medical Association*. 1994; **272**(17): 1367-1371) and Barker, JM. Project for the enhancement of the Welsh Protocols for Investment in Health Gain. Project Methodology. Cardiff: Duthie Library. UWCM, 1996. HEBW systematic review definition is based on the criteria used by NHS CRD for Database of Abstracts of Reviews of Effects (DARE.) <http://agatha.york.ac.uk/faq4.htm>



Note: This review is not a systematic review if the answer to question 3 is 'No'. There is no need to continue if you are only considering evidence from systematic reviews to inform your decision. In this instance go to question 17.

Note: The following questions below will not necessarily affect inclusion, but issues picked up here should be reflected within your review as comments in the data extraction table- see question 16

Can I trust this systematic review?

4. Was a detailed 'a priori' design provided i.e. a protocol?

The research question, search strategy and inclusion criteria should be established before the review is conducted for it to be systematic and transparent in the intended methods.

5. The elements outlined below will help you determine whether the literature search was well described and comprehensive.

Which Databases were searched and when?

Yes / No/ Can't tell

Were the search terms &/ or strategy provided?

Did the authors check contents lists of key topic journals for relevant studies (hand search)?

Did the authors check the reference list of the studies included to identify further relevant studies?

Did the authors contact researchers in the field to identify further studies or ongoing/unpublished work?

Did the authors search for grey literature? *See notes for definition*

Are all languages included?

Were the search results provided?

6. The elements outlined below will help you determine whether study selection was clearly described.

Yes/ No/ Can't tell

Are the inclusion and exclusion criteria stated?



Was there a flow diagram (PRISMA)?

Was the inclusion/exclusion process conducted by at least two reviewers (consistency/ repeatability check)?

Is a list of included/excluded studies provided?

7. Were the characteristics of included studies provided?

You need to be able to see the details of all of the studies they included in the interests of transparency. This would normally be in a table and include characteristics such as: participant characteristics, setting, study design, duration, intervention, outcomes measured. Data extraction to produce this, and describe the results of included studies, should also have involved a consistency/ repeatability check.

8. How did the authors assess the quality of the included studies? *See notes for more information on quality*

What clear, pre-determined criteria and/or checklist did the authors use?

Yes/ No/ Can't tell

Was quality assessment conducted by at least two people (consistency/repeatability checks)?

Have the authors reported the quality of each individual study? Yes

9. Was any conflict of interest stated?

Potential sources of support should be clearly acknowledged in both the systematic review and the included studies.

What did the systematic review find?

10. Are the results of included studies clearly displayed?

This may be included along with the study characteristics in a table, or in a separate table.

11. Were all important outcomes considered?

Consider reliability. Are outcome measures objective (i.e. a direct measure of change) or subjective (e.g. self-reported)?

12. How have the results of included studies been synthesised? *Indicate with a cross*



Narrative Synthesis

Meta-analysis

If a meta-analysis was conducted, consider whether it was appropriate to do this by considering the following questions

Were the studies sufficiently similar in design and outcomes measured?

Have the authors investigated differences and similarities between the studies and their effect sizes (Heterogeneity)?

What action was taken by authors where heterogeneity was high?

Are the reasons for any variation in the results discussed?

13. Was the likelihood of publication bias considered and discussed?

This could have been explored in a funnel plot, egger regression test or other available test, or considered in the discussion section.

14. Did the authors discuss the implications of the quality of the included studies and did this inform their conclusions?

This may be found in the results/discussion sections. The results of the methodological rigor and scientific quality should be considered in the analysis and the conclusions of the review, and explicitly stated in formulating recommendations.

Are the results relevant locally?

15. To what extent can the results be applied to the local population (generalisability)?

e.g. Cultural and/or socio-demographic differences, genetic differences, differences in local setting?

Limitations

16. After considering your responses to questions 4-15 what caveats or comments you would wish to add to your data extraction table?

Decision



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Iechyd Cyhoeddus
Cymru
Public Health
Wales

17. Accept for further use as a systematic review? (Yes/ No/ Discuss)

Record the decision and reasoning in your include/ exclude table. If the answer is 'Yes' then proceed to data extraction.

11 Appendix C: Data Extraction

Study details	Results of the systematic review	Main findings and evidence grading
<p>Allan J, et al. (2017). Environmental interventions for altering eating behaviours of employees in the workplace: a systematic review. <i>Obesity reviews</i>, 18, 214-226.</p> <p>Type of source: Systematic review.</p> <p>Interventions: Environmental interventions targeting eating behaviour in the workplace.</p> <p>Relevant Outcomes: Fruit and vegetable consumption, BMI, body fat %, body weight.</p> <p>Study Population: Adult employees.</p>	<p>Description of included studies: Twenty two studies (published in 24 articles) were included in the systematic review. Thirteen were conducted in the USA, seven in Europe (two in Denmark and five in the Netherlands), one in Brazil and one in Japan. Based on 19 trials that evaluated individuals rather than sales data, sample sizes in the studies ranged from 38 to 3,119 participants (mean [SD] = 815.4 [888.5]; median [IQR] = 439 [786.0]). No information was provided within the systematic review about which workplace settings were included.</p> <p>The majority of interventions were comprised of multiple different elements (e.g. educational messages used in combination with point of purchase prompts or changes to the availability of healthy foods). The duration of intervention delivery ranged from two weeks to two years. Typical outcome measures were self-reported fruit and vegetable consumption, sales data and physiological outcomes (such as weight and BMI).</p> <p>Quality of included studies: The Cochrane risk of bias tool and TIDieR checklist were used to assess risk of bias and quality of reporting within included primary studies. Many primary studies had a high or unknown risk of bias and reporting of interventions was suboptimal.</p> <p>Synthesis:</p>	<p>Intervention: Workplace environmental, or 'choice-architecture', interventions aiming to change behaviour by changing properties/contents of the environment.</p> <p>Outcome: Fruit and/or vegetable consumption</p> <p>Evidence Statement C: There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Outcome: Fat intake</p> <p>Evidence Statement C: There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Outcome: Weight measures (BMI, weight change and prevalence overweight/obesity)</p> <p>Evidence Statement D: The evidence is inconsistent, and it is not possible to draw a conclusion.</p>

<p>Studies were included up to: Not specified. The most recent study was published in 2014.</p> <p>Included study types: one randomised controlled trial, nine cluster randomised trials, two trials with intervention/control clusters matched on relevant characteristics (e.g. size of the workplace), four trials with intervention/control clusters without randomisation or matching, four pre–post evaluations and two interrupted time series studies.</p>	<p>Due to substantial heterogeneity in study design, study quality, types of interventions and outcome measures, meta-analysis was not possible, and data were synthesised narratively.</p> <p>Findings:</p> <p><u>Fruit and vegetable consumption (self-reported):</u></p> <p>Three studies measured combined fruit and vegetable intake. One found a significant positive difference in favour of the intervention and two found a positive difference in favour of the intervention, but significance was not reported.</p> <p>Three studies measured fruit intake separately. Two found a significant positive difference in favour of the intervention group and one found no difference between groups.</p> <p>Four studies measured vegetable intake separately. Three found a significant positive difference in favour of the intervention group and one found no difference between groups.</p> <p><u>Fat intake:</u></p> <p>Fat intake was usually reported as self-reported consumption or intake. Three out of four primary studies reported statistically significant reductions in fat intake in the intervention group compared to the control group. A single study found no statistically significant difference between groups.</p> <p><u>Weight measures:</u></p>	<p>Author’s conclusions: This systematic review reveals that the current evidence base does not enable clear recommendations to be made on the implementation of environmental interventions to change eating behaviour within the workplace setting. Across the 22 included studies, more than half (59%) produced significant effects on behaviour, with effects reported being: increases in fruit and/or vegetable consumption, increases in sales of healthy options and reductions in the number of calories purchased. Although the results look promising, effect sizes could often not be calculated, and where they could (usually for studies with significant effects), they had small–medium effects. Little evidence was identified that these interventions resulted in meaningful (or significant) changes in weight or BMI.</p> <p>Limitations: Across the included studies, reporting quality was suboptimal. In particular, there was little reporting of effect sizes (or data allow their calculation). This is a substantial barrier to efficient evidence synthesis. Similarly, intervention descriptions were usually insufficiently detailed to code risk of bias with a high degree of confidence. Only one out of the 22 primary studies had a registered protocol, and none included all of the information that current best practice guidelines recommend. Most studies failed to report planned or actual strategies to assess intervention fidelity.</p>
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	<p>Two out of three primary studies found no statistically significant differences in weight, or BMI following the intervention. One primary study reported no statistically significant difference in prevalence of overweight/obese employees at intervention sites yet reported statistically significant effect estimates on weight and BMI at 12 and 24 months post-intervention.</p>	<p>Comments: Included studies assessed a range of different workplaces from predominantly OECD countries.</p> <p>This systematic review reports on outcome measures not included in the criterion for our review of systematic reviews. Therefore, data on additional measures such as fruit and vegetable sales and caloric intake were not reported in this table.</p>
<p>Beck Silva K, et al. (2022). Effects of computer-based interventions on food consumption and anthropometric parameters of adolescents: A systematic review and meta-analysis. <i>Critical reviews in food science and nutrition</i>, 1-13.</p> <p>Type of source: Systematic review and meta-analysis.</p> <p>Interventions: Computer-based nutrition interventions in school settings.</p> <p>Relevant Outcomes:</p>	<p>Description of included studies: The aim of this systematic review was to assess the effects of computer-based interventions for the promotion of healthy eating on anthropometric indicators and food consumption of adolescents at school.</p> <p>Fifteen papers (reporting 13 studies) were included, totalling 9,603 participants, with individual study samples ranging from 89 to 2,840. Participants were aged between 12 and 19 years old. Seven of the included studies were cluster RCTs and six were quasi-experimental studies.</p> <p>Six studies were undertaken in the USA, 1 in Canada, 5 in Europe (2 in Belgium, 2 in the Netherlands, 1 in multiple European cities), and one in Brazil.</p> <p>Interventions were nutrition based and ranged from one session to sixteen.</p> <p>Follow-up time ranged from 3 months and 24 months.</p>	<p>Intervention: Computer-based nutrition intervention</p> <p>Outcome: Sugar sweetened beverage consumption</p> <p>Evidence Statement B: This intervention is supported by moderate to good quality evidence of its effectiveness.</p> <p>Outcome: Fat consumption</p> <p>Evidence Statement C: There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Outcome: Fruit and vegetable intake</p> <p>Evidence Statement D:</p>

<p>Food consumption, anthropometric measures (weight, BMI, sliding BMI z score, waist circumference).</p> <p>Study Population: Healthy adolescents aged 10 to 19 years old.</p> <p>Studies were included up to: August 2021.</p> <p>Included study types: Controlled studies (RCTs and quasi-experimental studies with a control group).</p>	<p>Most interventions offered personalized feedback based on the participants' individual responses to food consumption and other administered questionnaires. Four other studies did not provide individual feedback to participants. Some interventions involved teachers and parents, but not all.</p> <p>Quality of included studies: Quality was assessed using the assessment criteria described by the Center for Reviews and Dissemination. Four studies were rated as a low risk of bias, eight studies were rated as being of medium risk of bias and one study as high risk of bias.</p> <p>Synthesis: Random effect meta-analysis were calculated to compare the results between the intervention group and the control group, due to the high heterogeneity observed between the studies, both in terms of exposure and in terms of the outcome.</p> <p>GRADE was used to assess the certainty of evidence for fruit and fat consumption, and BMI.</p> <p>Findings:</p> <p><u>Fat consumption:</u></p> <p>Three out of seven studies in the systematic review a significant reduction in fat intake or % of fat from energy in favour of the intervention, three found no significant differences between the intervention and control for fat intake outcomes, and the final study found a significant reduction in girls only.</p>	<p>The evidence is inconsistent, and it is not possible to draw a conclusion.</p> <p>Outcome: BMI</p> <p>Evidence statement F: There is moderate to good quality evidence that this intervention is unlikely to be effective.</p> <p>Outcome: Fibre consumption</p> <p>Evidence statement H:</p> <p>Evidence about the effectiveness of this intervention is lacking.</p> <p>Author's conclusions: The evidence of the positive effect of the use of digital technology (website and CD-ROM) in educational programs with a focus on promoting a healthy lifestyle on some components of food consumption and anthropometric parameters in adolescents is discrete, with a small reduction recorded for consumption of fats. It can be suggested that long-term interventions (greater than 1 year), with frequent exposure to the instrument, with the support of parents and holders of a single theoretical component of behavioral changes, prove to be more advantageous in adopting healthy practices. The certainty of evidence observed that the studies presented moderate certainty of evidence for</p>
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Meta-analysis of two studies that could be pooled found a reduction in the average consumption of fats was identified in participants completing computer based interventions, compared to the baseline (SMD: -0.14; 95% CI: -0.24 to -0.05, I²=0%).

Anthropometrics:

Five studies assessed anthropometric parameters. One found a significant reduction in BMI in the intervention group (p<0.001) post intervention, whereas another found a significant increase in BMI in the intervention group (p<0.05). Three found no differences between the intervention and control groups post-intervention.

Meta-analysis of three studies that could be pooled found that computer based interventions had no significant effect on participants BMI scores, compared to baseline (WMD: -0.02, 95% CI: -0.18 to 0.14, I² 26.68%)

Fruit and/or vegetable consumption:

Narrative synthesis found four out of seven studies assessing fruit and/or vegetable (separately or combined) intake reported a significant increase post-intervention.

Meta-analysis of three studies that could be pooled found that computer based interventions had no significant effect on participants fruit and vegetable consumption compared to baseline (SMD: 0.09; 95% CI: -0.08 to 0.26, I² 77.1%).

Sugar sweetened beverage intake:

fat consumption and BMI and low certainty of evidence for fruit consumption.

Limitations:

The authors report a small number of relevant studies related to the topic; due to its heterogeneity (great variation in the design of the interventions and in the characteristics of the studies – time and frequency of interventions, places where the studies are carried out, method of recruiting participants and theoretical bases used), which can influence the impact of nutritional education on the behaviours; the fact that the use of digital technology as an educational tool in the field of nutrition is new; and the risk of moderate bias in most studies.

They also highlight that this systematic review may be subject to publication bias, due to the gap in the literature dealing with this topic in the age group studied and also the possible absence of published articles that demonstrate negative results with the use of technology.

Comments:

No major caveats.

	<p>Three studies reported findings for SSB intake/soft drink consumption. All found significant reductions in intake/consumption in the intervention groups.</p> <p><u>Fibre intake:</u></p> <p>One study reported that the intervention increased participants regular consumption of fibre (p<0.001).</p>	
<p>Bramante C, et al. (2019). Systematic review of natural experiments for childhood obesity prevention and control. <i>American Journal of Preventive Medicine</i>, 56, 147-158.</p> <p>Type of source: Systematic review.</p> <p>Interventions: Interventions with an environmental focus such as food/beverage, physical activity, or both; and stratified by setting (i.e., school, community, both).</p>	<p>Description of included studies: This systematic review evaluated the effectiveness of population level policies and programs from natural experiments for childhood obesity prevention.</p> <p>Thirty-three studies reporting on childhood BMI outcomes were included. Most studies (n=29, 89%) were conducted in the USA, with two studies from Canada and Australia, respectively.</p> <p>Among 29 studies from the USA, 35% evaluated local policies, 31% state/regional policies, 24% U.S./federal-level policies, and 10% (n=3) non-governmental policies.</p> <p>The majority (n=24, 73%) of studies were conducted in the school setting. Among school based studies, most (n=14, 58%) focused primarily on the food/beverage environment, six (25%) primarily on the physical activity environment, and four (17%) on multiple environments.</p>	<p>Intervention: School based interventions with an environmental (built environment) and physical activity focus.</p> <p>Outcome: BMI Sugar sweetened beverage intake</p> <p>Evidence Statement D: The evidence is inconsistent, and it is not possible to draw a conclusion.</p> <p>Intervention: School based interventions with a food and beverage focus.</p> <p>Outcome: BMI</p> <p>Evidence Statement C:</p>

<p>Relevant Outcomes: BMI, diet behaviours, physical activity behaviour.</p> <p>Study Population: Paediatric population.</p> <p>Studies were included up to: August 24, 2017.</p> <p>Included study types: Natural experiments.</p>	<p>Most studies were conducted across several grade levels: 12 (50%) included elementary schools, 13 (54%) included middle schools, and 11 (46%) included high schools. One study was conducted in an early childcare setting. Few studies (n=7, 21%) included a community setting, four of which included both community and school settings. Of the remaining three studies set in the community only, two focused on the food/beverage environment and the other on the PA/built environment.</p> <p>Quality of included studies:</p> <p>Study quality was assessed using the Effective Public Health Practice Project (EPHPP) tool. Risk of bias was deemed high for most (n= 25, 76%) studies. Seven studies had medium risk of bias and one study had a low risk of bias.</p> <p>Synthesis:</p> <p>Narrative synthesis of included studies was undertaken. Although individual effect sizes for some outcomes such as BMI were compared on a forest plot, the effect sizes were not pooled into a meta-analysis.</p> <p>Findings:</p> <p>For all 33 included studies, twenty-four were school-based programs and seven included a community setting, and two studies involved other settings (such as increasing parental awareness).</p> <p><u>BMI:</u></p> <p>Twenty-four studies were set in the school environment.</p>	<p>There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Outcome: Sugar sweetened beverage intake</p> <p>Evidence Statement D: The evidence is inconsistent, and it is not possible to draw a conclusion.</p> <p>Intervention: School based interventions with multiple environmental foci.</p> <p>Outcome: BMI</p> <p>Evidence Statement C: There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Intervention: Community based interventions with multiple foci.</p> <p>Outcome: BMI Sugar sweetened beverage intake</p> <p>Evidence statement C: There is some evidence supporting the use of this intervention, but it is not conclusive.</p>
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Three of the six school-based studies focusing on the PA/built environment achieved statistically significant ($p < 0.05$) effects in reducing BMI and three demonstrated no evidence of effect.

Eight of the 14 school-based studies focusing on the food and beverage environment achieved statistically significant ($p < 0.05$) effects in reducing BMI. Three studies were unfavourable and three showed no effect.

All four studies that took place in a school setting and focused on multiple foci, achieved statistically significant ($p < 0.05$) effects in reducing BMI. Two of these four studies also focused on healthy messaging and achieved the largest improvement in BMI.

All four studies that took place in both schools and in the community with multiple foci identified a statistically significant effect for reducing BMI ($p < 0.05$).

Of the two studies aimed at increasing parental awareness of child's BMI, neither showed an effect.

In the sensitivity analysis, four of eight studies with low or moderate risk of bias showed favourable effects on BMI.

Sugar sweetened beverages:

Nine studies reported sugar sweetened beverage intake. Five focused on school based interventions, and four included a community setting.

Intervention:

Community based interventions with a food and beverage focus.

Outcome:

BMI
Sugar sweetened beverage intake

Evidence statement D:

The evidence is inconsistent, and it is not possible to draw a conclusion.

Intervention:

Community based interventions with a physical activity/built environment focus.

Outcome:

BMI

Evidence statement E:

There is some evidence suggesting that this intervention is ineffective, but it is not conclusive.

Intervention:

Interventions to increase parental awareness of children's BMI.

Outcome:

BMI
Sugar sweetened beverage intake

Three of the four studies conducted in the school setting focusing on the food/beverage environment showed a statistically significant reduction in sugar sweetened beverage intake ($p < 0.05$). These three studies evaluated state- or school-wide policies to decrease access to sugar sweetened beverages. The remaining study showed no effect. One study focusing on PA/built environment identified no effect in sugar sweetened beverage intake.

Of the four interventions including a community focus, two had multi foci, and two had a food and beverage focus. All found inconsistent results.

Fruit and vegetable intake:

Eight studies reported fruit and vegetable intake. Of the three food/beverage school environment focused interventions, the four including a community setting and the one including parental awareness, all showed inconsistent results. Only one school and one community setting intervention showing statistically significant increase in fruit and vegetable intake ($p < 0.05$), with the remaining four showing no effect and one showing unfavourable effects on fruit and vegetable consumption.

Evidence statement E:

There is some evidence suggesting that this intervention is ineffective, but it is not conclusive.

Author's conclusions:

Natural experiments evaluating school-based policies focusing on both the food/beverage and physical activity environments (versus targeting only one) consistently showed improvement in BMI. However, most studies had high risk of bias, highlighting the need for improved methods for evaluation of natural experiments for childhood obesity prevention.

Limitations:

Most of the studies included in this systematic review lacked clear descriptions policies and programs that were implemented. For example, studies lacked detail in the changes made to food and beverage choices for children, beyond describing them as "healthy changes." From what was described in the papers, it was difficult to determine what the key elements were in many of the interventions reviewed.

Additionally, systematic review authors highlight the potential for publication bias as this systematic review may not have captured all the evidence in this field. Overall, the strength of evidence for this body of

		<p>literature is limited, with no category of study achieving moderate or high strength of evidence.</p> <p>Comments: No UK studies included. Primarily studies were from USA, Canada and Australia.</p> <p>Primary studies were identified from a larger systematic review that included 294 studies looking at methods for evaluations natural experiments in Obesity (Bennett, WL et al., 2018). No additional searches were undertaken.</p>
<p>Buchanan, L. et al., (2023). A Community Guide Systematic Review: School Dietary and Physical Activity Interventions. <i>American Journal of Preventive Medicine</i>, 64, 441-451</p> <p>Type of source: Community guide systematic review.</p> <p>Interventions: Interventions combining school meal or fruit and vegetable snack programs with physical education</p>	<p>Description of included studies: The aim of the systematic review was to examine the effectiveness of interventions in schools combining school meal or fruit and vegetable snack programs and physical activity.</p> <p>Twenty four studies (from 30 publications) were included in the systematic review. Seventeen studies included a comparison group, one study was a repeat cross-sectional with comparison, and six studies were pre-post studies.</p> <p>Fourteen interventions were from USA, six from Europe, two from New Zealand and one each from Canada and Iceland.</p> <p>Study participants had a mean age of 8.8 years. Seventeen studies were implemented students in kindergarten through to fifth grade, five were implemented in elementary and middle combined, one was implemented in middle school, and one was implemented in</p>	<p>Intervention: Interventions that combined school meal or fruit and vegetable snack programs with physical education classes or programs/policies aimed at providing increased opportunities for physical activity.</p> <p>Outcome: Fruit and vegetable intake</p> <p>Evidence Statement: B This intervention is supported by good to moderate quality evidence of its effectiveness.</p> <p>Outcome: Sugar sweetened beverage Intake</p> <p>Evidence Statement: D</p>

<p>classes or programs/policies aiming to provide increased opportunities for physical activity.</p> <p>Relevant Outcomes: Dietary outcomes, anthropometric outcomes.</p> <p>Study Population: Children (kindergarten through to high school age).</p> <p>Studies were included up to: November 2019.</p> <p>Included study types: Controlled trials, quasi-experimental design, time series, before-after study, or post-only studies with a comparison group.</p>	<p>middle and high school combined. Intervention duration ranged from 9 months to 42 months, with a median of 24 months.</p> <p>Seventeen studies included a school meal changes component (which was the most common dietary component). Ten studies included a combination of increasing time spent engaged in PA during PE classes and providing other opportunities for PA during the day (which was the most common PA component).</p> <p>Seventeen studies also included intervention components outside of the school setting such as distributing newsletters encouraging families to make changes, activity packs, family activities and community involvement.</p> <p>Quality of included studies: The authors used the community guide QA tool. The suitability of each study design was rated as greatest, moderate, or least, depending on the degree to which the design protected against threats to validity.</p> <p>Seven studies were rated as being of good quality of execution, and 17 studies were rated to have fair quality of execution.</p> <p>Synthesis: Twenty-four studies were included in the narrative synthesis.</p> <p>Findings:</p> <p><u>Fruit and vegetable intake:</u></p> <p>Ten studies reported Fruit and vegetable intake. Systematic review authors analysed all 10 together to calculate median</p>	<p>The evidence is inconsistent, and it is not possible to draw a conclusion.</p> <p>Outcome: Overweight and obesity prevalence</p> <p>Evidence Statement: B This intervention is supported by good to moderate quality evidence of its effectiveness.</p> <p>Outcome: BMI z-score</p> <p>Evidence Statement: B This intervention is supported by good to moderate quality evidence of its effectiveness.</p> <p>Author's conclusions: Schools can be an important setting for addressing childhood obesity because of the number of hours children spend in schools and because of the role played by schools in providing meals or FV snacks and opportunities for physical activity. Interventions that combine healthy school meals or FV snacks in combination with opportunities for increasing physical activity are an effective way for children to improve FV intake, increase physical activity, and maintain weight status.</p>
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increases (IQI/Range) and found that four studies reported a median relative increase of 12.1% (range -4.6% to 73.4%) for FV intake for the total day. Five studies reported a median relative increase of 3.0% (IQI 2.5% to 9.1%) for frequency of FV intake for the total day. One study reported no change in FV intake at lunch.

Individually, two of the 10 studies reported fruit intake and vegetable intake separately. One found a significant effect for the intervention on fruit intake, but no significant effect on vegetable intake. The other found no significant effect on either fruit or vegetable intake. The remaining eight studies measured combined fruit and vegetable intake. Two found a significant effect for the intervention, three found no significant effect for the intervention and in three studies, significance was not reported.

Sugar sweetened beverage intake:

Systematic review authors analysed six studies reporting sugar-sweetened beverage intake and calculated median increases (IQI/Range). Three studies reported a median relative decrease of 13.3% (range -29.2% to -4.0%) in SSB intake per day. Three studies reported a median relative increase of 7.1% (range -9.0% to 15.4%) in the frequency of SSB intake.

Individually, the DE shows eight interventions reporting SSB intake. Two of these found the intervention to have a significant effect on SSB intake, five found the intervention to have no significant effect and in one the intervention was found to have a significant effect on fruit drink consumption, but not on soft drink consumption.

Changes in weight related outcomes:

Limitations:

First, most articles were from peer-reviewed literature, and there is a potential publication bias. However, not all studies published positive effects. The authors attempted to address publication bias further by searching grey literature, but no dissertations or other non-peer-reviewed reports met the inclusion criteria. Second, a formal meta-analysis was not possible owing to varied study designs, few studies reporting CIs or SEs, and reported measures being heterogeneous. Finally, the maintenance of dietary and weight-related outcomes is unknown because too few studies reported long-term effects.

Comments:

Quality appraisal of this systematic review has identified the following:

- The authors have not considered the quality of the included studies when formulating their findings and conclusions.
- Protocol was not reported.
- None of the included studies were from the UK.

	<p>Nine interventions measured overweight or obesity prevalence. Systematic review authors analysed eight together to calculate median increases (IQI/Range) and found that results were favourable for the intervention. The baseline median overweight and obesity prevalence combined for these studies was 38.4%, with a reported decrease of 2.5 percentage points (IQI -8.1 to -1.6 percentage points). One additional study following the WHO definition assessed only obesity prevalence and reported an increase of 1.1 percentage points.</p> <p>Individually, one found a significant effect for the intervention on overweight and obesity prevalence, three found no significant effects, and in the remaining five, significance was not reported.</p> <p>Twelve studies reported BMI z-score; ten studies were able to be combined to calculate a median effect, which was a decrease of 0.07 (IQI -0.19 to -0.02). Two studies reported BMI z that could not be combined with the other ten studies. One study reported no significant effects related to the comparison group, and one study reported a beta decrease of 0.019 ($p=0.54$).</p> <p>Individually, nine out of the 10 studies in the DE which report BMI z-score found no significant differences between the intervention and control groups. One study found a significant difference for girls but not boys in the intervention groups, compared to control.</p>	
<p>Calvert S, et al. (2018). Delivering in-school interventions to improve dietary behaviours amongst 11- to 16-year-olds: A</p>	<p>Description of included studies: The primary aim of this current systematic review is to evaluate the effectiveness of school-based interventions in improving dietary behaviour for 11 to 16 year olds. The secondary aim is to identify intervention characteristics and moderators that may</p>	<p>Intervention: School based interventions to improve dietary behaviours in 11 to 16 year olds.</p> <p>Outcome:</p>

<p>systematic review. <i>Obesity Reviews</i>, 20, 543-553.</p> <p>Type of source: Systematic review.</p> <p>Interventions: School based healthy eating interventions.</p> <p>Relevant Outcomes: Change in dietary behaviours.</p> <p>Study Population: Students aged 11 to 16 years old.</p> <p>Studies were included up to: May 2018.</p> <p>Included study types: RCTs, quasi-experimental and cohort studies.</p>	<p>contribute to the effectiveness of such school-based dietary behaviour change interventions.</p> <p>This systematic review included 29 studies. Ten were conducted in the USA, three in Australia, two each in Canada, Norway, England and Denmark, and one each in Greece, China, Taiwan, Israel, Belgium, Spain, Tunisia, and the Netherlands.</p> <p>Of the 29 included studies, 19 were RCTs, seven were of quasi-experimental design, and three were cohort studies.</p> <p>Numbers of participants per study ranged from 88 to 32,482. Intervention durations ranged from two weeks to three school years.</p> <p>Interventions were generally multicomponent, with components such as healthy eating lesson components, healthy eating activities, worksheets, practical sessions, or homework. Some studies involved peers or parents.</p> <p>Quality of included studies: The Effective Public Health Practice Project tool (EPHPP) was used to rate the quality of the studies included within the systematic review. Eighteen were rated 'weak' quality, Six were 'moderate' and five were rated as 'strong'.</p> <p>All studies were also assessed individually for their risk of bias using 6 domains of the Cochrane Risk of Bias tool. Seven studies were judged to be of low risk of bias, and seven were judged to be at high risk of bias.</p> <p>Synthesis:</p>	<p>Fruit and vegetable consumption Fat intake</p> <p>Evidence Statement C: There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Outcome: Sugar sweetened beverage consumption</p> <p>Evidence Statement: D The evidence is inconsistent, and it is not possible to draw a conclusion.</p> <p>Author's conclusions: The findings of this systematic review suggest that interventions that aim to improve dietary behaviours in 11 to 16 year olds within a school setting should potentially consider the following components: involve peers in the delivery of the intervention, include educational media to deliver intervention messages, increase the availability of healthy foods in the school environment, and incorporate computerized tailored feedback that includes normative behaviours.</p> <p>Limitations: The lack of description or selective reporting in the original studies of the implemented intervention e.g., the inadequate description of some intervention components such as the specific feedback messages incorporated in the intervention, the intervention and study design, and levels of exposure of</p>
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Narrative synthesis was undertaken.

Findings:

The systematic review identified 29 studies that attempted to modify adolescents' dietary behaviours through school-based interventions, with 24 interventions reporting positive changes in at least one dietary behaviour outcome.

For the 24 interventions reporting positive outcomes:

- Seven studies found significant positive effects for the intervention on fruit consumption.
- Six studies found significant positive effects for the intervention on vegetable consumption.
- Five studies found significant positive effects for the intervention on combined fruit and vegetable consumption.
- Eight studies measured sugar sweetened beverage intake and three found significant positive effects for the intervention on sugar sweetened beverage intake.
- Three studies reported on fat intake, and two found significant positive effects for the intervention.

Some studies measured more than one outcome. It should also be noted that in some studies, significant effects were only seen in certain sub populations (e.g., girls or boys) or where the intervention had several interventional comparison groups, in only certain comparison groups.

the intervention to participants; makes it difficult to draw conclusions from some studies because of the lack of specific detail in the descriptions of interventional components, as well as difficulty in identifying what was successful at changing dietary behaviours, and how and why this was effective. A further potential limitation was the non-feasibility of conducting a meta-analysis owing to the heterogeneity of the behaviour measurements used, behaviour targeted, and results reported; however, to try to reduce the bias, a grey literature database was also searched. The systematic review also was limited to studies published in "English language only," which potentially could have limited the studies retrieved and the generalizability: however, the current systematic review did include studies from a wide variety of countries.

Comments:

This systematic review focuses on studies reporting positive outcomes for interventions. For the five studies which the authors report found no significant changes in any dietary outcome, the authors do not report which dietary measures this relates to, or any effect sizes. Therefore, grading for this systematic review should be interpreted with caution.

Mainly OECD countries were included.

It should be noted that some of the included studies were published in the 1980's and 1990's.

<p>Chambers T, et al. (2021). Interventions using behavioural insights to influence children's diet-related outcomes: A systematic review. <i>Obesity Reviews</i>, 22, e13152.</p> <p>Type of source: Systematic review.</p> <p>Interventions: Behaviour-changing interventions (BIs) aimed at improving diet-related outcomes that used one or more behaviour-changing interventions.</p> <p>Relevant Outcomes: Change in food and beverage consumption.</p> <p>Study Population: Children <18 years old.</p> <p>Studies were included up to: January 2019.</p> <p>Included study types:</p>	<p>Description of included studies: To assess the effectiveness and equity potential of interventions using behavioural insights to improve children's diet-related outcomes.</p> <p>Of the 108 articles and 137 interventions included for qualitative analysis, 99 studies included relevant outcomes. Fifty-three were RCTs, 25 before and after studies, 19 controlled before and after studies and 11 non-RCTs.</p> <p>Seventy-six studies were conducted in the USA, 11 in the UK, seven in the Netherlands, 4 in Belgium, and one each in Denmark, Mexico, Portugal, Canada, Ireland, Singapore, Cyprus, Italy and China. One further study took place in both Belgium and the Netherlands. Individual participant numbers ranged between 15 and 8,000 people. Some studies did not report individual participant numbers, but rather reported numbers of schools, meal orders, or observations made.</p> <p>Educational settings were the most common setting, covering 78% (n=107). The remaining studies were conducted in food retail, community venue, lab and home settings. Interventions durations ranged from less than one week and 104 weeks.</p> <p>Quality of included studies: The Cochrane risk of bias tool was used for RCTs, and the Newcastle-Ottawa risk of bias tool for the other study designs.</p> <p>Most RCT studies had many sources of potential bias. The greatest risk of bias came from the randomisation procedure (87% of studies graded high or unclear risk), attrition bias (59% graded high</p>	<p>Intervention: School based interventions, using behavioural insights to influence children's dietary behaviour.</p> <p>Outcome: Fruit and vegetable consumption</p> <p>Evidence Statement C: There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Author's conclusions: Overall, interventions using BIs can influence children's diet-related outcomes. Interventions manipulating defaults, changes to the physical environment and incentives were the most effective, along with interventions adopting multiple BIs simultaneously. Interventions in education settings were most common and effective, with more evidence required in home and food retail settings.</p> <p>Limitations: Due to heterogeneity between studies, the authors categorised intervention effectiveness into a binary variable, either significant or nonsignificant finding, which may overstate the effectiveness of some interventions. Further, without calculating intervention effect sizes, we lack precision on the magnitude of the intervention effectiveness.</p>
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<p>RCTs, non-RCTs, before and after studies (controlled and uncontrolled).</p>	<p>or unclear risk) and knowledge allocation (100% graded high or unclear risk).</p> <p>For Non-RCTs, before-and-after studies, controlled before-after studies 41 out of 58 studies were graded with a high risk of bias (twenty-nine of these were before–after studies) and 17 graded as low risk of bias. Most (66%) were graded as high risk for not appropriately adjusting for common confounders, or extra confounders (81%). Attrition bias was also an issue in 39 studies (67%).</p> <p>Synthesis: Narrative synthesis was conducted.</p> <p>Findings:</p> <p><u>Fruit and vegetable intake:</u></p> <p>Ninety-nine primary studies measured fruit and vegetable intake as an outcome, 73 out of 99 found a significant difference at $p < 0.05$ level.</p> <p>Further in-depth analysis identified slight differential effects by one or more sociodemographic characteristic (including sex, age, socioeconomic status, and ethnicity), but not for BMI.</p> <p>Effectiveness of interventions using behavioural insights to influence children's diet-related outcomes were stratified by behavioural insight. There were no statistically significant differences in effectiveness between interventions utilising different behavioural insights ($p=0.119$), including between those using multiple insights and those using single insights. However,</p>	<p>Studies failing to produce statistically significant results are less likely to be published than studies with significant findings and may have led to an overestimation in the effectiveness of Bis studies.</p> <p>This systematic review excluded all multicomponent studies that included a non-Bis aspect, such as an education curriculum.</p> <p>The lack of intervention follow-up made the examination of obesity-related outcomes impracticable—leading to very few studies investigating changes in weight status. improved obesity-related outcomes.</p> <p>Comments:</p> <p>Quality appraisal has highlighted the following points:</p> <ul style="list-style-type: none"> - Systematic review authors did not report individual study effect sizes. Studies were categorised with a + or – for significant findings or not. - Risk of bias results were not reported for each individual study. - Systematic review authors did not discuss the implications of study quality when formulating their findings and conclusions.
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	<p>information provision when used in isolation was identified as the least effective approach when compared to the others.</p>	
<p>Chan C, et al., (2022). Evaluating the impacts of school garden-based programmes on diet and nutrition-related knowledge, attitudes, and practices among the school children: a systematic review. <i>BMC Public Health</i>, 22, 1251.</p> <p>Type of source: Systematic review.</p> <p>Interventions: School gardening, kitchen-gardening, garden curriculum or horticulture activities.</p> <p>Relevant Outcomes: Diet and nutrition related behaviours and practices (e.g., fruit and vegetable intake).</p> <p>Study Population:</p>	<p>Description of included studies: This study aimed to systematically review the impacts of school garden-based programmes on diet and nutrition related knowledge, attitudes and practices amongst school-aged children, and to explore the key features of its effectiveness.</p> <p>Thirty-five studies were included in this systematic review. Seventeen investigated school garden based interventions without parental involvement, and 18 investigated school garden based interventions with parental involvement. Studies recruited a total of 25,726 school children from 341 schools and 8 nursery centres, from 12 different countries.</p> <p>Twenty-nine studies were conducted in developed countries, six in lower-middle income countries.</p> <p>Six RCTs, seven cluster RCTs, 10 non-RCTs, nine pre-post test, one quasi-experimental study, one RCT + mixed methods study and one intervention trial were included in the systematic review (as described by authors).</p> <p>Sample sizes ranged from one to 49 schools and 44 to 4300 participants with 29 of the studies recruiting more than 100 participants. Participants age ranged from 2 to 19 years old with the majority between 8 and 12 years. Intervention durations ranged from 6 weeks to 4 years.</p>	<p>Intervention: School-garden based interventions without parental involvement</p> <p>Outcome: Vegetable intake Fruit intake</p> <p>Evidence Statement: D The evidence is inconsistent, and it is not possible to draw a conclusion.</p> <p>Outcome: Fibre intake</p> <p>Evidence Statement: C There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Outcome: Salt intake</p> <p>Evidence Statement: H Evidence about the effectiveness of the intervention is lacking.</p> <p>Intervention:</p>

<p>School children and adolescents aged 3-18 attending nursery, kindergarten, primary, secondary, high and special schools.</p> <p>Studies were included up to: February 2021.</p> <p>Included study types: Any experimental study designs.</p>	<p>Integrated school gardening activities included outdoor or indoor classroom gardening, harvesting lessons, cooking lessons, experimental activities utilising harvests, taste tests, nutrition related education, physical education, healthy snack programmes, posters, charts, meat free Mondays & using locally sourced produce in school meals.</p> <p>Quality of included studies: Based on the Quality Criteria Checklist from the Academy of Nutrition and Dietetics (2016), none of the included studies was rated as high risk of bias. Eighteen studies had low risk of bias ratings and 17 were rated as 'unclear'.</p> <p>Most of the studies (n=33) failed to apply appropriate statistical analysis (n=33), describe allocation concealment or blinding of researchers, participants or data collectors (n=32).</p> <p>Synthesis: Narrative synthesis was conducted. Meta-analysis was unable to be performed due to heterogeneity and variation in study design, outcome measurement and intervention concept.</p> <p>Findings: Fruit and vegetable intake was an outcome in 26 of the included studies.</p> <p><u>Vegetable intake:</u> School garden based interventions without parental involvement: - Ten studies; six finding significant improvements in children's vegetable intake. Four finding no significant improvements.</p>	<p>School gardening based interventions with parental involvement.</p> <p>Outcome: Vegetable intake Fruit intake</p> <p>Evidence Statement: F There is moderate to good quality evidence that this intervention is unlikely to be effective.</p> <p>Outcome: Fibre intake</p> <p>Evidence statement: C There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Outcome: Sugar sweetened beverage intake</p> <p>Evidence statement: E There is some evidence suggesting that this intervention is ineffective but it is not conclusive.</p> <p>Author's conclusions: Impacts of school gardening based interventions on measured outcomes were highly influenced by various social and environmental factors with it being shown to be more effective when conducted at a younger age, for instance, in pre- or primary school-age children. In addition, positive outcomes found in children's</p>
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School garden based interventions with parental involvement:

- Sixteen studies; five finding favourable improvements in children's vegetable intake. Eleven finding no significant improvements.

Fruit intake

School garden based interventions without parental involvement:

- Four studies; two finding significant improvements in children's fruit intake. Two finding no significant improvements.

School garden based interventions with parental involvement:

- Thirteen studies; all finding no significant improvement on children's fruit intake.

Dietary fibre:

School garden based interventions without parental involvement:

- Two studies; both findings significant improvement in dietary fibre intake.

School garden based interventions with parental involvement:

- Two studies; both finding significant improvement in dietary fibre intake.

Salt intake:

School garden based interventions without parental involvement:

- One study; positive reduction in children's salt intake, however statistical significance not reported.

nutritional knowledge and dietary practices when conducted in a shorter intervention duration, and smaller sample size or smaller child-to staff ratio, were possibly due to being more focused and accurately measured. Parental involvement may help to better promote children's attitudes, behaviours and willingness to consume fruits and vegetables.

Limitations:

Heterogeneity of the intervention components, sample sizes, study designs and outcome measures between studies implied that the synthesis of the meta-analysis was not possible. Therefore, a single summary estimate of the impacts of school gardening based interventions failed to be generated.

Comments:

Quality assessment of the systematic review has highlighted the following:

- Systematic review authors did not address/discuss the possibility of publication bias.
- Effect sizes were not reported or measured.
- Generalisability should be considered as range of countries were included, some more generalisable than others.
- Risk of bias for 17 of the 35 included studies was rated as 'unclear'.

	<p><u>Sugar sweetened beverage intake:</u></p> <p>School garden based interventions with parental involvement:</p> <ul style="list-style-type: none"> - Two studies; both finding no significant improvements in SSB intake. 	
<p>Mandracchia F, et al., (2021). Interventions to Promote Healthy Meals in Full-Service Restaurants and Canteens: A Systematic Review and Meta-Analysis. <i>Nutrients</i>, 13.</p> <p>Type of source: Systematic review, meta-analysis</p> <p>Interventions: Restaurant- and canteen-based interventions concerning the promotion of healthy meals.</p> <p>Relevant Outcomes: Dietary intake</p> <p>Study Population: Adults and children</p>	<p>Description of included studies: Of the 41 included primary studies; 35 were RCTs, and 6 were non-RCTs. The interventions were predominantly set in schools/childcare centres (29 studies), but also included workplaces (4 studies) and other community settings (8 studies). Most were conducted in the United States (n = 20) and Australia (n = 11), with one each conducted in Belgium, Brazil, Denmark, Ecuador, Ireland, Lebanon, Malaysia, Mexico, Scotland, and the UK. Interventions ranged in duration from one week to three years.</p> <p>Interventions applied different consumer-based and establishment-based strategies to improve customers' dietary intake regarding consumed food and beverage items and the nutritional composition of food in terms of micro- and macronutrients.</p> <p>Quality of included studies: The risk of bias and quality assessment of the included intervention studies was performed using the standardized framework of the Quality Assessment Tool for Quantitative Studies Dictionary developed for the Effective Public Health Practice Project.</p>	<p>Intervention: Full-service restaurant and canteen-based interventions to promote healthy meals.</p> <p>Outcome: Increase in healthy food group (servings/day) Increase in fibre (g/day) Decrease in nutrients (g/day; fat, saturated fat and sugar)</p> <p>Evidence Statement C: There is some evidence supporting the use of this intervention but it is not conclusive.</p> <p>Author's conclusions: The results from the present systematic review showed that restaurant- and canteen-based interventions are effective in improving healthy dietary outcomes, mainly in the school setting, with a beneficial impact on children. Specifically, the strategies that showed higher effectiveness in schools were the addition of healthier menu options combined with on-site support, training</p>

<p>Studies were included up to: 2020</p> <p>Included study types: RCTs and non-RCTs</p>	<p>Based on this, the quality of most of the included studies was assessed to be of weak quality since the majority had no blinding, poor data collection methods, selection bias or confounders.</p> <p>Synthesis: Results of the systematic review were narratively synthesised. In addition, meta-analysis was also undertaken for dietary intake and food availability outcomes. Due to the poor quality of the included primary studies, the meta-analysis was performed considering RCT and non-RCT intervention studies together and was repeated by excluding non-RCTs to assure results with higher quality.</p> <p>Findings: Not every study examined in this systematic review included outcomes of interest to our review of systematic reviews, therefore <i>only the findings for interventions with relevant outcomes have been extracted below:</i></p> <p><u>Dietary intake:</u> Meta-analyses of nine studies found that the intervention significantly increased servings/day of healthy food groups (fruit, vegetables, whole grains, lean meat and dairy and alternatives, combined) by +0.24 (95% CI: 0.16 to 0.32 p<0.001).</p> <p>Individual analyses of each food group is as follows:</p> <ul style="list-style-type: none"> - Fruit servings/day: 0.13 (95 % CI: -0.14 to 0.30, p=0.12; 7 studies). - Vegetables servings/day: 0.17 (95% CI: -0.00 to 0.34, p=0.06; 7 studies). 	<p>for the school canteen staff, performance monitoring and feedback reports.</p> <p>Limitations: The authors report that for the meta-analysis, the wide heterogeneity of the included studies in terms of outcomes and units of measure, and the huge quantity of different outcomes included, as well as the lack of specific numerical data in the articles, made it difficult to compare interventions and reduced the interventions included.</p> <p>Also, most of the included studies were assessed to be of weak quality since the majority had no blinding, poor data collection methods, selection bias or confounders.</p> <p>Comments: This systematic review reports on outcome measures not included in the criterion for our review of systematic reviews. Therefore, data on additional measures such as food availability and food purchases were not reported in this table.</p> <p>Included studies were predominantly from OECD countries, and mostly from school settings.</p> <p>Tests for heterogeneity were high (I^2 99% to 100%) across all outcomes reported.</p>
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	<ul style="list-style-type: none"> - Whole grains servings/day: 0.60 (95% CI: 0.30 to 0.90, p<0.01; 4 studies). - Lean meat and alternatives serving/day: 0.20 (95% CI: -0.11 to 0.50, p=0.20; 3 studies). - Dairy food items and alternatives servings/day: 0.21 [95 % CI: 0.01 to 0.40, p=0.04; 3 studies). <p>Meta-analyses of five studies found the intervention significantly increased fibre intake by +0.50g/day (95% CI: 0.08 to 0.92, p = 0.02). However, when non-RCTs were excluded from the meta-analysis, the effectiveness was no longer statistically significant.</p> <p>Meta-analyses of five studies found a positive decrease of -4.17g/day of nutrients such as saturated fat, fat and added sugar (95% CI: -5.43 to -2.92, p<0.001).</p> <p>Individual analyses of each nutrient are as follows:</p> <ul style="list-style-type: none"> - Saturated fat intake: -4.64g/day (95% CI: -7.21 to -2.08, p<0.05; 3 studies). - Fat intake -8.95g/day (95% CI: -14.56 to -3.34, p<0.05; 5 studies). - Sugar intake -0.60g/day (95% CI: -14.42 to 13.23, p=0.93; 3 studies). 	
<p>Marcano-Olivier M, et al., (2019). Using Nudges to Promote Healthy Food Choices in the School Dining Room: A Systematic Review of Previous</p>	<p>Description of included studies:</p> <p>The aim of this systematic review was to review the effects of behavioural nudge interventions modifying choice architecture of school canteens at lunchtime, to influence children’s food selection and consumption. Twenty-five studies were included in the</p>	<p>Intervention: Behavioural nudge interventions to modify the choice architecture of school canteens.</p> <p>Outcome: Fruit and vegetable consumption</p>

<p>Investigations. <i>Journal of School Health</i>, 90, 143–157.</p> <p>Type of source: Systematic review.</p> <p>Interventions: Nudging, choice architecture, environmental interventions.</p> <p>Relevant Outcomes: Healthy eating, fruit and vegetable consumption, healthy choices.</p> <p>Study Population: School children.</p> <p>Studies were included up to: Not stated.</p> <p>Included study types: Cohort, cohort analytic.</p>	<p>systematic review, and of these fifteen studies aimed to employ nudges to increase fruit and/or vegetable selection and/or consumption.</p> <p>Studies were described as being either cohort, or cohort analytic, with one study having an unclear study design.</p> <p>Twenty-four studies took place in the USA and one in the UK.</p> <p>Quality of included studies: The quality of included studies was assessed using the Quality Assessment Tool for Quantitative Studies (QATQS). One category “withdrawals and dropouts” was not assessed because systematic review authors agreed that in most of the reviewed studies individual consent and individualised data were not recorded.</p> <p>Of the 25 included studies, four yielded a strong global rating, 12 were rated moderate and nine were rated as weak.</p> <p>Synthesis Findings were reported narratively.</p> <p>Findings: <u>Fruit and vegetable consumption</u></p> <p>Six primary studies reported vegetable consumption and four identified an increase in consumption compared to baseline or control. Another study identified an increase in consumption when using dual nudging interventions, but not single interventions. The final study reported an increase in selection, but not consumption.</p>	<p>Evidence Statement C: There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Author’s conclusions: Consumption was often estimated by comparing pre-consumption records, based either on visual observation or on target food item sales, with subsequent plate waste records, without reporting the validity or reliability of these measures. These limitations were reflected in the typically weak ratings on the QATQS component describing data collection methods. Poor methods can only yield inconclusive results, and because reviewed studies did not employ sound data collection methods, no firm conclusions ought to be drawn.</p> <p>Limitations: Authors excluded complex interventions and only included single component nudge interventions.</p> <p>Comments: All but one of the included studies took place in the USA, so generalisability to Wales should be considered.</p> <p>Several of the included studies were conducted by the same research team (? Same study). For example, four studies were contained the same lead author (Hanks, AS). And were published within two years of each other.</p>
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	<p>Six primary studies reported fruit consumption outcomes. Two identified an increase in consumption compared to baseline or control, three identified an increase in selection, but not consumption compared to baseline or control and one study reported no difference in consumption compared to control.</p> <p>Three primary studies reported both fruit and vegetable consumption combined. One study identified an increase in consumption of both, while another study identified an increase in consumption of fruit compared to baseline, but not vegetable consumption. The third study identified an increase in consumption overall compared to baseline in only one of the two intervention schools. However, they noted the likelihood of consumption increased once students had selected it in both schools during the intervention.</p>	<p>Individual study effect sizes were not always reported (p values were only reported if statistically significant).</p> <p>Authors did not state whether screening for inclusion was conducted in duplicate.</p>
<p>Medeiros G, et al., (2022). Effect of School-Based Food and Nutrition Education Interventions on the Food Consumption of Adolescents: A Systematic Review and Meta-Analysis. <i>International journal of environmental research and public health</i>, 19.</p> <p>Type of source: Systematic review and meta-analysis.</p> <p>Interventions:</p>	<p>Description of included studies: The aim of the review was to evaluate the effects of school-based food and nutrition education interventions on adolescent food consumption.</p> <p>Twenty-four randomised controlled trials (RCTs) were included in the systematic review (11 RCTs in the meta-analysis). The included RCTs were published between 1997 to 2019.</p> <p>Nine studies were from the USA, two each from Iran, Greece, and the Netherlands, and one each from, Italy, Norway, Brazil, Trinidad & Tobago, UK, Belgium, Finland, Ecuador and China.</p> <p>Studies were undertaken in school settings. Some interventions were based on different theories and models such as Social Cognitive Theory (seven studies) and Theory of Planned Behaviour</p>	<p>Intervention: School based food and nutrition education interventions.</p> <p>Outcome: Combined fruit and vegetable Consumption</p> <p>Evidence Statement: F There is moderate to good quality evidence that this intervention is unlikely to be effective.</p> <p>Outcome: Fruit Consumption (measured separately) Vegetable consumption (measured separately)</p>

<p>School-based food and nutrition education interventions.</p> <p>Relevant Outcomes: Food Consumption</p> <p>Study Population: Adolescent aged 10-19 years</p> <p>Studies were included up to: June 2019</p> <p>Included study types: RCT</p>	<p>(four studies). Ten studies did not claim to be based on any theory or model.</p> <p>Most studies (67%) were multicomponent. Nine studies included environmental components, 13 included family components, four included training and support for teachers, and eight focused only on students. Four studies combined physical activity alongside nutritional education.</p> <p>Quality of included studies: The methodological quality of the studies was assessed by the Cochrane risk of bias tool for randomized trials (ROB 2). Seven articles were evaluated as 'low' risk of bias, three as 'high' risk of bias, and 14 as expressing 'some concerns' regarding risk of bias for the outcome of food consumption.</p> <p>The "randomisation process" and "selection of the reported result" domains included the highest number of studies with "some concern" regarding risk of bias. In the "randomization process" domain, half of the studies did not have a detailed description of the processes of generating and hiding the random sequences. In "selection of the reported result", in 54% of the studies, the authors did not report or did not provide sufficient detail to classify the risk of bias regarding the data that produced the food consumption outcome.</p> <p>Synthesis: Twenty-four studies were included in the narrative synthesis and 11 in the meta-analysis (random-effects model).</p> <p>Findings:</p>	<p>Evidence Statement: C There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Author's conclusions: Food and nutrition education interventions in schools presented favourable results in the food consumption of adolescents. From the quantitative synthesis (meta-analysis), the results were favourable for fruit and vegetable consumption increase but with a greater effect on vegetable consumption. Evidence on fruit and vegetable consumption may be weaker due to the scarcity of comparable studies.</p> <p>Limitations: A limitation of the inserted intervention studies is that food consumption was estimated using a food frequency questionnaire or 24 h dietary recall, thus increasing the potential for measurement error and selective underestimation or overestimation of intake, which may compromise the validity of the questionnaire.</p> <p>Comments: Quality appraisal of this systematic review has identified the following:</p> <ul style="list-style-type: none"> - Systematic review authors did not undertake a search for grey literature. - Systematic review authors have not considered the quality of the included studies when formulating their findings and conclusions.
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	<p><u>Fruit and Vegetable consumption (aggregate):</u></p> <p>Meta-analysis of four studies (seven intervention arms) found no statistically significant effect for school-based food and nutrition education interventions on fruit and vegetable consumption (SMD: 0.00, 95% CI: -0.11 to 0.11). There was a substantial level of heterogeneity (I^2 66%; $p=0.007$).</p> <p><u>Fruit Consumption:</u></p> <p>Meta-analysis of five studies (six intervention arms) found a significant effect for school-based food and nutrition interventions on fruit consumption (MD servings/day 0.09, 95% CI: 0.05 to 0.14; I^2 50%).</p> <p><u>Vegetable Consumption:</u></p> <p>Meta-analysis of two studies (three intervention arms) found a significant effect for school-based food and nutrition interventions on vegetable consumption (MD times/week 0.59, 95% CI: 0.15 to 1.03; I^2 0%).</p>	<ul style="list-style-type: none"> - Publication bias has not discussed/considered.
<p>Micha R, et al. (2018). Effectiveness of school food environment policies on children's dietary behaviors: A systematic review and meta-analysis. <i>PLoS ONE</i>, 13, e0194555.</p> <p>Type of source:</p>	<p>Description of included studies:</p> <p>This systematic review reviewed and quantified the impact of school food environment policies on dietary habits, adiposity, and metabolic risk in children.</p> <p>Ninety-one (39 RCTs and 52 quasi-experimental with or without external control) studies were included in the systematic review.</p>	<p>Intervention:</p> <p>Policies focusing on direct provision of healthful foods and beverages.</p> <p>Outcome:</p> <p>Habitual fruit intake</p> <p>Evidence Statement: C</p>

<p>Systematic review and meta-analysis.</p> <p>Interventions: School food environment policies.</p> <p>Relevant Outcomes: Intake of foods/ beverages, adiposity.</p> <p>Study Population: Children.</p> <p>Studies were included up to: December 2017.</p> <p>Included study types: RCTs or quasi-experimental studies.</p>	<p>Fifty-five studies were from the USA, 11 from the UK, seven from the Netherlands, six from Norway, three from Canada, two from South Korea and one each from Sweden, Germany, Finland, Denmark, France, New Zealand and Iran.</p> <p>Interventions included national law, local or national policy, local and statewide programs. Duration ranged between one and 47 months, but this did not consider periods that schools were closed (such as holidays).</p> <p>About half of interventions (N=49, 54%) were multi-component, with the relative contribution of the food environment policy component ranging from 30% to 100%.</p> <p>Additional intervention components in multicomponent strategies included education (nutrition curricula), promotion/marketing, family/parent outreach and point-of-purchase labelling.</p> <p>Forty-seven studies were in primary schools setting, 27 in secondary schools, one in preschool, and 13 in mixed schools; one didn't specify.</p> <p>Interventions providing healthful foods and beverages were mainly in classrooms (direct provision) or via increased availability in cafeterias, tuck shops or vending machines (indirect provision).</p> <p>Longest follow-up was 47 months in RCTs and 60 months in quasi-experimental studies.</p> <p>Quality of included studies: Quality assessment was performed by review of study design, assessment of exposure, assessment of outcome, control of</p>	<p>There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Outcome: Habitual vegetable intake</p> <p>Evidence Statement: E There is some evidence suggesting that this intervention is ineffective, but it is not conclusive.</p> <p>Outcome: Fruit and vegetable intake</p> <p>Evidence Statement: C There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Outcome: Adiposity and metabolic measures</p> <p>Evidence Statement: E There is some evidence suggesting that this intervention is ineffective, but it is not conclusive.</p> <p>Intervention: Policies focusing on competitive food and beverage standards.</p> <p>Outcome: Habitual sugar sweetened beverage intake</p>
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confounding, and evidence of bias. Each of the 5 quality criteria was evaluated and scored on an integer scale (0 or 1, with 1 being better) and summed. Quality scores from 0 to 3 were considered lower quality and 4 to 5 higher quality. Forty-three included studies scored as high quality and 48 as low quality.

Synthesis:

Both narrative synthesis and meta-analysis (random-effects model) was performed. Meta-regression and subgroup analysis was carried out to explore potential sources of heterogeneity. Out of 91 included studies, only 21 were included in the qualitative assessment due to the types of outcomes reported.

Findings:

Policies focusing on direct provision of healthful foods and beverages:

Fruits Consumption:

Meta-analysis of six randomized and nine quasi-experimental design found a significant effect for interventions (with average duration 12 months) on habitual fruit intake (SE: 0.27 servings/d, 95% CI: 0.17 to 0.36; I^2 78.3%, $p=0.000$). Seven high and eight low quality studies.

Vegetable Consumption:

Meta-analysis of three randomized and eight quasi-experimental studies found no effect for interventions (with average duration 13.4 months) on habitual vegetable intake (SE: 0.04 servings/d,

Evidence Statement: C

There is some evidence supporting the use of this intervention, but it is not conclusive.

Outcome:

In-school sugar sweetened beverage intake

Evidence Statement: E

There is some evidence suggesting that this intervention is ineffective, but it is not conclusive.

Outcome:

In-school lunch total fat intake and saturated fat intake

Evidence Statement: E

There is some evidence suggesting that this intervention is ineffective, but it is not conclusive.

Outcome:

Prevalence or odds of childhood overweight, obesity, overweight/obesity, BMI kg/m^2 .

Evidence Statement: E

There is some evidence suggesting that this intervention is ineffective, but it is not conclusive.

Outcome:

BMI z score

Evidence Statement: F

There is moderate to good quality evidence that this intervention is unlikely to be effective.

95% CI: 0.00 to 0.08; I^2 23.4%, $p=0.000$). Four high and seven low quality studies.

Combined fruits and vegetables:

Meta-analysis of six randomized and ten quasi-experimental studies found a significant effect for interventions (with average duration 15.4 months) on combined fruit and vegetable intake (SE servings/d 0.28, 95% CI: 0.17 to 0.40; I^2 90.2%, $p=0.000$). Six high quality and ten low quality studies.

Obesity:

Meta-analysis of two studies (one RCT and one QED) found significant effect of intervention on obesity (OR 1.25, 95% CI: 1.07 to 1.46). One high and one low quality study.

Odds of overweight/obesity:

Meta-analysis of two RCT studies found no effect of intervention on overweight (OR 1.04, 95% CI: 0.91 to 1.19). Both high quality.

BMI:

Meta-analysis of three studies (Two RCTs and one QED) found no effect of intervention on BMI (0.19 kg/m², 95% CI: -0.12 to 0.50). Two high quality and one low quality.

BMI z-score:

Meta-analysis of two RCT studies found no effect of intervention on BMI z-score (0.01, 95% CI: -0.04 to 0.05).

Intervention:

Policies focusing school meal standards.

Outcome:

Habitual fruit intake

Evidence Statement: C

There is some evidence supporting the use of this intervention, but it is not conclusive.

Outcome:

Habitual vegetable intake

Evidence Statement: E

There is some evidence suggesting that this intervention is ineffective, but it is not conclusive.

Outcome:

Fruit and vegetable intake

Evidence Statement: E

There is some evidence suggesting that this intervention is ineffective, but it is not conclusive.

Outcome:

Dietary fats intake

Evidence Statement: C

There is some evidence supporting the use of this intervention, but it is not conclusive.

Policies focusing on competitive food and beverage standards:

Sugar-sweetened beverage intake:

Meta-analysis of three QED studies found a significant effect for interventions on habitual SSB intake (ES -0.18 servings/d, 95% CI: -0.31 to -0.05; I^2 73.7%, $p=0.022$). Three low quality studies. Meta-analysis of five (four QED, one RCT) studies found no effect for interventions on in-school SSB intake (ES -0.02, 95% CI: -0.04 to 0.01, I^2 59.6%, $p=0.042$). One high quality and four low quality studies.

Other targeted dietary factors:

Meta-analysis of three studies found no effect of intervention on in-school lunch total fat intake (-0.55 g/d, 95% CI: -3.31 to 2.22), similarly, meta-analysis of two studies found no effect of intervention on in-school lunch saturated fat intake (-0.20 g/d, 95% CI: -2.10, 1.70).

Overweight/obesity prevalence:

Meta-analysis of five studies assessed overweight prevalence (-0.95%, 95% CI: -2.23 to 0.33), and four studies assessed the odds of childhood overweight (OR 0.93, 95% CI: 0.86 to 1.02). Nine studies assessed obesity prevalence (-1.02%, 95% CI: -2.56 to 0.52) and six studies assessed odds of childhood obesity (OR 0.99, 95% CI: 0.93 to 1.06). Five studies assessed overweight/obesity prevalence (0.24%, 95% CI: -0.54 to 1.02) and two studies assessed the odds of overweight/obesity (OR 1.01, 95% CI: 0.84 to 1.21).

Outcome:

Sodium Intake

Evidence Statement: C

There is some evidence supporting the use of this intervention, but it is not conclusive.

Outcome:

BMI percentile

Evidence Statement: C

There is some evidence supporting the use of this intervention, but it is not conclusive.

Author's conclusions:

Specific school food environment policy interventions can improve targeted dietary behaviours; effects on adiposity and metabolic risk require further investigation.

Limitations:

Majority of the included studies were low quality, which weaken or bias results. Possibility of unmeasured heterogeneity due to variations in the education systems and schools within and across countries. Intensity or success of policy implementation can modify results, which is difficult to quantify. Socioeconomic indicators, cost and effectiveness were not reported in the included studies.

BMI:

Five studies assessed BMI (-0.06 kg/m², 95% CI: -0.41 to 0.28), and five studies assessed BMI z-score (-0.01, 95% CI: -0.03 to 0.02).

Policies focusing school meal standards:

Fruit and vegetable intake:

Meta-analysis of two studies found significant effect of intervention on habitual fruit intake (ES 0.76 servings/d, 95% CI: 0.37 to 1.16), but no effect on habitual vegetable intake (ES 0.30 servings/d, 95% CI: -0.001 to 0.59). Five studies assessed fruit and vegetable consumption and found no significant intervention effect (ES 0.12 servings/d, 95% CI: -0.08 to 0.31).

Dietary fat intake:

Six studies assessed habitual total fat, which decreased by 1.49 %E/d (95% CI: -2.42 to -0.57, I² 90.9%, p=0.000). Nine studies assessed in-school lunch total fat intake, which decreased by 8.27 %E/d (95% CI: -10.03 to -6.52, I² 82.0%, p=0.000). Four studies assessed habitual saturated fat, which decreased by 0.93 %E/d (95% CI: -1.15 to -0.70: I² 0.0%, p=0.488). Nine studies assessed in-school lunch saturated fat, which decreased by 2.75 %E/d (95% CI: -4.39 to -1.11, I² 97.9%, p=0.000).

Sodium Intake:

School meal standards for sodium decreased habitual intake (n=4; -170 mg/d, 95% CI -242 to -98), in-school lunch intake (n=6; -227

The authors also note that the intervention periods of identified publications largely preceded widespread implementation of the new US school lunch standards, Smart Snacks Standards, FFVP, or revised UK school meal standards.

Comments:

Authors did not use a standard quality assessment tool. The name and reference of the tool is not mentioned. It is not clear if it is created and tested by the authors or taken from existing tool.

There is a small discrepancy between how the authors report the meta-analysis result in the narrative and in the figure regarding vegetable consumption. Authors mentioned in the narrative section CI 0.01 to 0.08 but in the figure, it is CI 0.00 to 0.08. Authors also used a binary (high-low) quality appraisal of studies. This has impacted our ability to grade.

	<p>mg/d, 95% CI: -384 to -69), and in-school meal (lunch and breakfast) intake (n=7; -221 mg/d, 95% CI: -371 to -71).</p> <p><u>BMI percentile:</u></p> <p>Two studies assessed changes in BMI percentile, which significantly decreased (ES -1.01, 95% CI: -1.62 to -0.39).</p>	
<p>Morgan E, et al., (2020) Caregiver involvement in interventions for improving children's dietary intake and physical activity behaviors. <i>Cochrane Database of Systematic Review</i>. Issue 1. Art. No.: CD012547.</p> <p>Type of source: Systematic review and meta-analysis.</p> <p>Interventions: Caregiver involvement in interventions to improve children's dietary intake and/or physical activity behaviours.</p> <p>Relevant Outcomes:</p>	<p>Description of included studies: The aim of the systematic review was to assess effects of caregiver involvement in interventions for improving children's dietary intake and physical activity behaviours, including those intended to prevent overweight and obesity.</p> <p>The systematic review included 23 studies (20 cluster-RCTs, three RCTs) published between 1982 and 2019, with approximately 12,192 children in the eligible intervention arms.</p> <p>Fourteen studies were conducted in the USA, three in Belgium, two in Canada and one each in Australia, Germany, Iran and China. Most of the participants were recruited from schools, preschools, or day-care centres.</p> <p>Seven studies focused on dietary behaviour change, six on physical activity behaviour change, and 10 on both diet and physical activity behaviour change.</p> <p>The caregiver component of the intervention was most often delivered at home (n=11). Others were delivered in schools,</p>	<p>Intervention: Dietary behaviour change interventions with a caregiver component versus interventions without a caregiver component.</p> <p>Outcome: Sodium intake</p> <p>Evidence Statement: E There is some evidence suggesting that this intervention is ineffective, but it is not conclusive.</p> <p>Outcome: BMI</p> <p>Evidence Statement: E There is some evidence suggesting this intervention is ineffective, but it is not conclusive.</p> <p>Outcome: Fruit intake</p>

<p>Children’s dietary intake, prevalence of overweight and obesity, BMI.</p> <p>Study Population: Caregiver–child units, where the child was aged 2 to 18 years and was actively involved in the intervention.</p> <p>Studies were included up to: January 2019.</p> <p>Included study types: Randomised controlled trials (RCTs) and quasi-RCTs.</p>	<p>unspecified locations, online, or through a combination of the above.</p> <p>Quality of included studies: For RCTs, seven criteria (random sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective reporting, other sources of bias) were used to assess risk of bias. For cluster-RCTs, authors added and assessed the domains on recruitment bias, baseline imbalances, loss of clusters & incorrect analysis.</p> <p>Most studies were deemed to be at high risk of bias in at least one of the criteria assessed.</p> <p>The overall quality of evidence was rated as being low (using the GRADE approach).</p> <p>Synthesis: Twenty-three studies (49 reports) were included in the qualitative synthesis, but 16 contributed data towards the meta-analyses (random-effects model).</p> <p>Findings:</p> <p>Dietary behaviour change interventions with a caregiver component versus interventions without a caregiver component:</p> <p>Seven studies were identified that compared dietary behaviour change interventions with and without a caregiver component.</p> <p>Percentage total energy intake from fat:</p>	<p>Evidence statement: D The evidence is inconsistent, and it is not possible to draw a conclusion.</p> <p>Outcome: Vegetable intake</p> <p>Evidence statement: C There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Outcome: Total energy intake from fat Total energy intake from saturated fat Total energy intake from protein Sugar-sweetened beverage intake Prevalence of overweight/obesity</p> <p>Evidence Statement: H Evidence about the effectiveness of the intervention is lacking.</p> <p>Intervention: Physical activity interventions with a caregiver component versus interventions without a caregiver component.</p> <p>Outcome: BMI</p> <p>Evidence Statement: E</p>
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- No difference between intervention with caregiver component and intervention without caregiver component (MD -0.34, 95% CI: -2.10 to 1.42) [1 study, n=207].

Percentage total energy intake from saturated fat:

- No difference between intervention with caregiver component and intervention without caregiver component (MD -0.42%, 95% CI: -1.25 to 0.41) [1 study, n=207].

Percentage total energy intake from protein:

- No difference between intervention with caregiver component and intervention without caregiver component (MD -0.06%, 95% CI: -1.06 to 0.94) [1 study, n=207].

Sodium intake:

- Two studies, both showing no difference between intervention with caregiver component and intervention without caregiver component for sodium intake (results could not be pooled) [n=292].

BMI:

- Meta-analysis found no difference between intervention with caregiver component and intervention without caregiver component (SMD -0.08, 95% CI: -0.31 to 0.14, I² 0%) [2 studies, n=313].

Fruit intake:

There is some evidence suggesting this intervention is ineffective, but it is not conclusive.

Outcome:

Total energy intake from saturated fat
Sodium intake
Fruit and vegetable intake
Sugar sweetened beverage intake

Evidence Statement: H

Evidence about the effectiveness of the intervention is lacking.

Intervention:

Combined dietary and physical activity interventions with a caregiver component versus interventions without a caregiver component.

Outcome:

Sugar-sweetened beverage intake
Fruit intake

Evidence Statement: C

There is some evidence supporting the use of this intervention, but it is not conclusive.

Outcome:

Percentage total energy intake from fat
Percentage total energy intake from saturated fat
Percentage total energy intake from carbohydrates
Percentage total energy intake from protein

- Two studies; one found no significant difference between intervention with caregiver component and intervention without caregiver component (p value not reported) [n = 33]. The other found higher fruit intake in the intervention with a caregiver component arm at the end of the intervention (MD 1.19 servings/d, 95% CI: 0.95 to 1.43) and at six-month follow-up (MD 1.18 servings/d, 95% CI: 0.97 to 1.39) [1 study, n=420].

Vegetable intake:

- Two studies, both reported vegetable intake was significantly higher in the intervention with caregiver component group than the intervention without caregiver component group at the end of the intervention (MD and p value not reported for one study; second study MD 0.56 servings/d, 95% CI: 0.34 to 0.78) and follow-up (MD 0.58 servings/d, 95% CI: 0.36 to 0.80) [1 study, n=420].

No trials were identified which reported data on sugar sweetened beverage intake, or prevalence of overweight and obesity after baseline.

Physical activity interventions with a caregiver component versus interventions without a caregiver component:

Six studies compared physical activity interventions with and without a caregiver component, only two included relevant outcomes.

BMI:

Sodium intake

Evidence statement: E

There is some evidence suggesting that this intervention is ineffective, but it is not conclusive.

Outcome:

Combined fruit and vegetable intake
Vegetable intake

Evidence Statement: H

Evidence about the effectiveness of the intervention is lacking.

Outcome:

BMI
Prevalence of overweight/obesity

Evidence Statement: E

There is some evidence suggesting that this intervention is ineffective, but it is not conclusive.

Author's conclusions:

Current evidence is insufficient to support the inclusion of caregiver involvement in interventions to improve children's dietary intake or physical activity behaviour, or both. For most outcomes, the quality of the evidence is adversely impacted by the small number of studies with available data, limited effective sample sizes, risk of bias, and imprecision. To establish the value of caregiver involvement, additional studies measuring clinically important outcomes using valid and reliable

<p>- Two studies were pooled, both showing no difference between the intervention with caregiver component group, and the intervention without caregiver component group at the end of the intervention (MD 0.07, 95% CI: -0.21 to 0.35, I² 37%) [2 studies, n=441] or at one-year follow-up (MD -0.18, 95% CI: -0.58 to 0.22) [1 study, n=306].</p> <p>No trials in this comparison reported data for percentage of children's total energy intake from saturated fat, sodium intake, fruit, and vegetable intake, sugar sweetened beverage intake and prevalence of overweight and obesity.</p> <p>Combined dietary and physical activity interventions with a caregiver component versus interventions without a caregiver component:</p> <p>Ten studies compared combined dietary and physical activity interventions with and without a caregiver component.</p> <p><u>Percentage total energy intake from fat:</u></p> <p>- Meta-analysis of four studies found no difference between the intervention with caregiver component group, and the intervention without caregiver component group at the end of the intervention (MD 1.17%, 95% CI: -0.65 to 3.00%, I² 0%) [4 studies, n=563].</p> <p><u>Percentage total energy intake from saturated fat:</u></p> <p>- Meta-analysis of two studies found no difference between found no difference between the intervention with caregiver component group, and the intervention without caregiver</p>	<p>measures, employing appropriate design and power, and following established reporting guidelines are needed, as is evidence on how such interventions might contribute to health equity.</p> <p>Limitations: Most of the included studies are old and high or unclear risk of bias, the available evidence is not enough to support the benefits of having caregiver involvement in the interventions to improve children's dietary intake and physical activity.</p> <p>Comments: None of the include studies was from the UK. Therefore, consideration should be given to generalisability to Wales.</p> <p>Publication bias not considered/discussed.</p>
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	<p>component group at the end of the intervention at the end of the intervention (MD 0.06%, 95% CI: -0.67 to 0.80, I^2 0%) [2 studies, n=216].</p> <p><u>Percentage total energy intake from carbohydrates:</u></p> <ul style="list-style-type: none"> - Meta-analysis of two studies found no difference between the intervention with caregiver component group, and the intervention without caregiver component group at the end of the intervention (MD -0.88%, 95% CI: -3.49 to 1.74, I^2 0%) [2 studies, n=266]. <p><u>Percentage total energy intake from protein:</u></p> <p>Meta-analysis of two studies found no difference between the intervention with caregiver component group, and the intervention without caregiver component group at the end of the intervention (MD 0.45%, 95% CI: -0.80 to 1.69, I^2 0%) [2 studies, n=241].</p> <p><u>Sugar sweetened beverage intake:</u></p> <ul style="list-style-type: none"> - Meta-analysis of three studies found a slight reduction in SSB in the intervention with caregiver component group, compared to the intervention without a caregiver component group, after the intervention (SMD -0.28, 95% CI: -0.44 to -0.12, I^2 0%) [3 studies, n=651]. <p><u>Sodium intake:</u></p> <ul style="list-style-type: none"> - Meta-analysis of two studies found no difference between the intervention with caregiver component group, and the 	
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	<p>intervention without caregiver component group the end of the intervention (MD 35.94 mg/d, 95% CI: -322.60 to 394.47, I² 0%) [2 studies, n=315].</p> <p><u>Combined fruit and vegetable intake:</u></p> <ul style="list-style-type: none"> - No difference between the intervention with caregiver component group, and the intervention without caregiver component group at the end of the intervention (MD 0.38 servings/d, 95% CI: -0.51 to 1.27, 1 study, n=134) <p><u>Fruit intake:</u></p> <ul style="list-style-type: none"> - Meta-analysis of two studies found a slight increase in fruit intake in the intervention with caregiver component group, compared to the intervention without a caregiver component group at the end of the intervention (SMD 0.23, 95% CI: 0.03 to 0.43, I² 0%) [2 studies, n=417]). <p><u>Vegetable intake:</u></p> <ul style="list-style-type: none"> - no difference between the intervention with caregiver component group, and the intervention without caregiver component group at the end of the intervention (MD -0.04 servings/d, 95% CI: -0.21 to 0.13, 1 study, n=59). <p><u>BMI:</u></p> <ul style="list-style-type: none"> - Meta-analysis of four studies found no difference between the intervention with caregiver component group, and the intervention without caregiver component group (SMD 0.05, 95% CI: -0.04 to 0.15, 4 studies, n=1,861). 	
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	<p><u>Prevalence of overweight and obesity:</u></p> <ul style="list-style-type: none"> - Meta-analysis of three studies found no difference in prevalence of overweight and obesity between the intervention with caregiver component group, and the intervention without caregiver component group at the end of the intervention (RR 1.02, 95% CI: 0.89 to 1.17, p=0.85, I² 0%) [3 studies, n=1,866]. 	
<p>Moss S, et al., (2022). Home- and Community-Based Interventions for Physical Activity and Early Child Development: A Systematic Review of Effective Strategies. <i>Int. J. Environ. Res. Public Health.</i> 19.</p> <p>Type of source: Systematic review.</p> <p>Interventions: Home/family and community-based interventions.</p> <p>Relevant Outcomes: BMI.</p>	<p>Description of included studies: The purpose of this systematic review was to examine and analyse the effects of home/family- and community-based interventions on weight status, Physical activity, sedentary behaviour, and developmental outcomes in early childhood (2–5 years old).</p> <p>Twenty-four studies (8,351 participants) published between 2011 to 2021 were included in this systematic review. Most of the studies were RCTs (n=13).</p> <p>Twelve studies were from the USA, three from Australia, two each from Canada, Switzerland, Finland, one from the Netherlands and Belgium and one spanning six countries in Europe.</p> <p>Nineteen studies incorporated home/family-based approaches and 14 community-based approaches.</p> <p>Studies ranged in intervention duration from 6 weeks to 24 months.</p> <p>Quality of included studies:</p>	<p>Intervention: Home/Family interventions aiming to improve weight status, physical activity, sedentary behaviour and/or developmental outcomes in children aged 2-5 years.</p> <p>Outcome: BMI</p> <p>Evidence Statement: C There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Intervention: Community-based interventions aiming to improve weight status, physical activity, sedentary behaviour and/or developmental outcomes in children aged 2-5 years.</p> <p>Outcome: BMI</p>

<p>Study Population: Children between the ages of 2–5 years old.</p> <p>Studies were included up to: August 2021.</p> <p>Included study types: RCTs, Randomised Cluster Designs (RCD), pre-post design, mixed between-subject design, and prospective designs.</p>	<p>The Effective Public Health Practice Project Quality Assessment (EPHPP) tool was used for quality assessment, which assessed six domains including, selection bias, design, confounders, blinding, data collection methods, and withdrawals and dropouts. Most studies received a global rating as weak due to selection bias, not controlling for confounding variables, and lack of blinding. Only two articles were rated as strong.</p> <p>Synthesis: Narrative synthesis was undertaken. Effect sizes (ES) were calculated for each study and represented as the standardized mean difference. Three studies did not provide sufficient results to calculate ES. Results are interpreted as small ($ES \geq 0.2$), moderate ($ES > 0.5$), large ($ES > 0.8$), or very large ($ES \geq 1.3$).</p> <p>Findings: Less than one third of studies yielded an effect size of at least moderate effect (>0.5) in their measured outcomes. Three studies did not yield enough information for calculation. Findings for relevant outcomes extracted below:</p> <p>Effects of Home/Family-Based Interventions: Five home/family based interventions included in the systematic review measured BMI as an outcome. Four reported that the intervention had a statistically significant positive effect on BMI ($P < 0.05$) and one reported a non-significant effect on BMI ($p > 0.05$).</p> <p>Effects of Community-Based Interventions:</p>	<p>Evidence Statement: D The evidence is inconsistent, and it is not possible to draw a conclusion.</p> <p>Intervention: Multicomponent home/family & community based interventions</p> <p>Outcome: BMI</p> <p>Evidence Statement: D The evidence is inconsistent, and it is not possible to draw a conclusion.</p> <p>Author’s conclusions: Only 25% of the included studies found significant improvement in physical activity after intervention. Distributing educational material to parents/families, consistent, direct contact with parents, and encouraging community engagement were identified as effective strategies to promote physical activity, healthy weight status, and motor skills in young children.</p> <p>Limitations: Most of the included studies were rated as weak, which limits confidence in the results.</p> <p>Heterogeneity in the outcome measures makes external validity challenging.</p>
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	<p>Four community based interventions included in the systematic review measured BMI as an outcome. Two reported that the intervention had a statistically significant positive effect on BMI ($P < 0.05$), and two reported a non-significant effect on BMI ($p > 0.05$).</p> <p>Effects of multicomponent home/family & community based interventions:</p> <p>Eight studies included elements delivered both at home/to families and in the community. Four of these reported the intervention had a significant positive effect on BMI ($P < 0.05$) and four reported a non-significant effect on BMI ($P > 0.05$).</p>	<p>Comments: No protocol published which limits its transparency and robustness.</p> <p>Exclusion/Inclusion criteria not explicitly reported. Search strategy is not comprehensive. Grey literature search not performed.</p> <p>Quality assessment not undertaken in duplicate.</p> <p>No included studies from the UK, which may limit the generalisability of the findings to Wales.</p> <p>Publication bias not considered.</p>
<p>Nally S, et al., (2021). The Effectiveness of School-Based Interventions on Obesity-Related Behaviours in Primary School Children: A Systematic Review and Meta-Analysis of Randomised Controlled Trials. <i>Children</i>, 8, 489.</p> <p>Type of source: Systematic review and meta-analysis</p> <p>Interventions:</p>	<p>Description of included studies: The primary aim was to assess the effectiveness of school based interventions on primary school children at changing obesity-related behaviours and/or a change in BMI/BMI z-score. Secondary aims were to identify the most effective elements (e.g., physical activity, sedentary behaviour and/or nutrition), used in these interventions, to examine the characteristics of the interventions and to quantify their effect through meta-analysis.</p> <p>Forty-eight studies were included in this systematic review. Thirty-five were cluster RCTs, and 13 were RCTs, involving 46,235 children at baseline. Numbers of children participating in the studies at baseline ranged from 51 to 3,135, with the average age of participants in each study ranging from 6 years to 10.9 years.</p>	<p>Intervention: Primary school interventions aiming to change obesity related behaviours, that lasted at least 12 weeks.</p> <p>Outcome: Fruit and vegetable consumption</p> <p>Evidence Statement: F There is moderate to good quality evidence that this intervention is unlikely to be effective.</p> <p>Outcome: BMI and BMI z-score</p> <p>Evidence Statement: B</p>

<p>Primary school interventions aiming to change obesity related behaviours, that lasted at least 12 weeks.</p> <p>Relevant Outcomes: BMI, fruit and vegetable consumption.</p> <p>Study Population: Children aged 5 to 12 years old.</p> <p>Studies were included up to: December 2020.</p> <p>Included study types: RCTs and Cluster RCTs.</p>	<p>Number of schools participating in studies ranged from one school to 154 schools.</p> <p>Six studies were from the UK, seven from the USA, five from Germany, four each from Spain and China, three each from Norway and Australia, two each from Lebanon, Greece and Italy, one each from Iran, Mexico, New Zealand, Chile, the Netherlands, Sweden, Canada, Ireland, Argentina, and Portugal.</p> <p>Thirty-four studies were multicomponent interventions, with 21 of these targeting a change in physical activity, sedentary behaviour and nutritional behaviour, eight targeting a change in physical activity and sedentary behaviour only and five targeting a change in physical activity and nutritional behaviour only. The remaining studies were single component, with eight targeting a change in PA and six targeting a change in nutrition.</p> <p>Intervention strategies included school environment adaptations, interactive drama activities, modified PE lessons, extracurricular PA sessions, gardening, cooking workshops, educational sessions, counselling sessions and provision of further opportunities to be physical active, active academic lessons, brisk walking during school time, free fruit allocation or take home activities.</p> <p>Duration of interventions ranged from 12 weeks to four years. All the interventions were school based. Nine interventions had a duration of less than 6 months, whereas 39 were over six months in duration.</p> <p>Twenty one studies explicitly reported that the interventions incorporated one or more behaviour change theories.</p>	<p>This intervention is supported by moderate quality evidence of its effectiveness.</p> <p>Author's conclusions: Significant intervention effects were found between groups in BMI kg/m² and BMI z-scores; nevertheless, the findings were inconsistent, and the heterogeneity observed across all outcomes was not explained by subgrouping. Furthermore, the meta-analyses of the included interventions to prevent childhood obesity showed significant overall effects on BMI, but inconclusive results were found regarding nutrition behaviour compared with the control condition.</p> <p>Limitations: The authors report that high levels of heterogeneity detected across the included studies limits the robustness of these findings. Pooled results indicate high levels of inconsistency across the included RCTs, and the majority of the analyses remained largely unexplained despite a large set of planned subgroup analyses. Therefore, the inconsistency is likely the result of variability in participants, settings, intervention components, outcomes and trial design.</p> <p>The researchers also caution that the review was restricted to English language publications, therefore making it possible some non-English language publications were overlooked. They also had to rely on limited descriptions of the interventions when classifying studies.</p>
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Quality of included studies:

Cochrane risk of bias tool was used to assess the quality of the included studies. All studies had a low risk of bias for selective reporting, 21 had unclear risk of bias due to insufficient descriptions in terms of random sequence generation. Most of the studies rated as low risk of bias in terms of selection bias (n=38), performance bias (n=37), detection bias (n=34), and attrition bias (n=39).

Synthesis:

All 48 studies were included in the narrative synthesis and 38 were included in meta-analysis (random-effects model).

Sensitivity analysis and sub-group analysis was undertaken to find sources of heterogeneity.

Findings:

Effects of Interventions on Changing Nutrition Behaviour:

Meta-analysis of five studies found no significant effects on portions of fruit and vegetables consumed per day in the intervention group compared to control (MD 0.05, 95% CI: -0.08 to 0.17, I² 0%)

Meta-analysis of two studies also found no significant effects on examined fruit and vegetable intake (g/day) in the intervention group compared to control (MD 10.45, 95% CI = -17.53 to 38.43, I² 0%).

Effect of Interventions on Changing BMI and BMI z-Score:

Comments:

Quality assessment has flagged that the authors did not undertake a grey literature search, and their search strategy was also limited to English language publications only. Implications regarding the quality of included studies were also not used to inform the systematic reviews findings/conclusions.

It should be noted that four interventions did not measure BMI at any timepoint, and one used a self-reported measure for height and weight. The remainder of the interventions measured height and weight objectively.

It should also be noted that a small discrepancy was identified. Authors report in narrative that 35 studies were multicomponent, but on further breakdown into the components only 34 are listed. Further analysis of the supplementary characteristics of included studies table identifies 34 studies as being multicomponent.

	<p>Meta-analysis of 21 studies showed a small significant reduction in BMI in the intervention group compared to control (BMI -0.39 kg/m², 95% CI: -0.47 to -0.30, I² 86%).</p> <p>Similarly, meta-analysis of 20 studies found a small significant reduction in BMI z-score in the intervention group compared to control (BMI z score -0.05, 95% CI: -0.08 to -0.02, I² 96%) compared with the control group.</p> <p>The authors report identifying an outlier and that once this outlier was removed, the average treatment effect decreased to become non-significant (-0.02, 95% CI -0.05 to 0.01). However, it is unclear from how this has been reported whether this relates to the meta-analysis for BMI or BMI z-score.</p>	
<p>Nathan N., et al., (2019). The effectiveness of lunchbox interventions on improving the foods and beverages packed and consumed by children at centre-based care or school: a systematic review and meta-analysis. <i>Int J Behav Nutr Phys Act.</i> 16, 38.</p> <p>Type of source: Systematic review and meta-analysis.</p> <p>Interventions:</p>	<p>Description of included studies: The primary aim of the systematic review was to assess the effectiveness of lunchbox interventions aiming to improve the foods and beverages packed and consumed by children attending centre-based care or school, and to assess the effectiveness of these interventions on child adiposity (e.g., weight or BMI) or waist circumference.</p> <p>Ten studies (reported in 13 papers) were included. Eight were cluster RCTs and two were quasi-experimental studies.</p> <p>Four studies were undertaken in centre-based care (e.g., preschools), and recruited participants between the ages of three and six. Six studies were undertaken in school settings and recruited participants aged between four and 14.</p>	<p>Intervention: Interventions aiming to improve the foods and beverages packed and consumed by children attending school or preschool.</p> <p>Outcome: Fruit and vegetable intake BMI z score</p> <p>Evidence Statement: D The evidence is inconsistent, and it is not possible to draw a conclusion.</p> <p>Outcome: Waist circumference Obesity and overweight prevalence</p>

<p>Interventions included any educational, experiential, health promotion and/or family or structural or policy or legislative interventions that targeted food provided from home for child consumption during attendance at school or centre-based care (either explicitly or as part of a broader obesity prevention intervention).</p> <p>Relevant Outcomes: Change in the number or proportion of serves, portions, or grams of food consumed, BMI z score, prevalence of overweight and obesity.</p> <p>Study Population: Children aged 2-18 years.</p> <p>Studies were included up to: January 2017.</p> <p>Included study types: RCTs, controlled clinical trials, non-RCTs.</p>	<p>Three were conducted in USA, three in the UK, two in Australia, and one each in Mexico and Israel.</p> <p>All 10 of the included trials were multicomponent. All ten included strategies to increase parental nutrition knowledge via delivery modes such as pamphlets, newsletters, posters or parent workshops. Eight included education for children through videos, games, curriculum or activities. Four interventions provided physical resources such as lunch packs or containers. Two provided incentives for children to taste vegetables and fruit. Two interventions incorporated policy development.</p> <p>Quality of included studies: The Cochrane risk of bias tool (with extended criteria for cluster RCTs (C-RCTs)) was used to assess the quality. Each study was assessed as being at 'high', 'low' or 'unclear' risk of bias for: sequence generation, allocation concealment, blinding of participants and personnel, blinding of outcome assessment, incomplete outcome data, selective outcome reporting and 'other' potential sources of bias, that is recruitment, loss of clusters, analysis, and contamination.</p> <p>All studies were rated as being at high risk of bias in at least one domain, with every study rated as being at high risk of performance bias.</p> <p>Synthesis: Narrative synthesis was undertaken in the relevant outcomes.</p> <p>Findings: <u>Fruit and vegetable intake:</u></p>	<p>Evidence statement: H Evidence about the effectiveness of the intervention is lacking.</p> <p>Author's conclusions: There is some evidence that lunchbox interventions are effective in improving the packing of vegetables in children's lunchboxes, however more robust research is required to determine the impact on children's dietary intake and adiposity.</p> <p>Limitations: Search was limited to English language which increases the chance of excluding other efficacious studies. A number of the characteristics (random sequence generation and blinding of outcome assessors) of included studies were assessed as high risk of bias, which limits the confidence of the individual studies trial findings. The source of heterogeneity was unclear. The external validity of the systematic review findings was limited given different school food environments internationally.</p> <p>Comments: Lack of grey literature search might have introduced the publication bias.</p> <p>Publication bias not considered/ discussed.</p>
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Three school based studies reported on the impact of interventions on children intake of vegetables and fruit.

One pilot study found significantly higher mean consumption of fruit, vegetables and juice among intervention students compared to control ($p > 0.001$).

One study found no change in fruit and vegetable consumption by intervention students at 3 months (effect size not reported) or 12 months (d 0.26 95% CI: -0.30 to 0.01), compared to baseline.

The final study found a significant improvement in the consumption of vegetables (6.2 g, SE 1.8 g, 95% CI: 2.7–9.8 g), but not fruit (9.0g SE 5.7 g, 95% CI: -2.5 to 20.4 g).

BMI z score:

One center-based care study reported the interventions effect on BMI. It found a significant adjusted difference on BMI z-score (-0.15, SE 0.07, $p = 0.022$) and waist circumference (-0.80 cm, SE 0.35, $p = 0.020$) among children attending intervention services relative to control.

One school-based study reported a reduction of 0.1 points in BMI z score in both intervention and control arms.

Prevalence of overweight and obesity:

One center-based care study found no significant effect on overweight and obesity prevalence (12.5% among control vs 11.5% amount intervention at follow-up).

<p>Panchbhaya A, et al., (2022). Improving the Dietary Intake of Health Care Workers through Workplace Dietary Interventions: A Systematic Review and Meta-Analysis. <i>Advances in Nutrition</i>, 13, 595-620.</p> <p>Type of source: Systematic review.</p> <p>Interventions: Workplace dietary interventions.</p> <p>Relevant Outcomes: Fruit and vegetable intake, fat intake, weight, BMI.</p> <p>Study Population: Health care workers working in any health care setting.</p> <p>Studies were included up to: September 2020.</p>	<p>Description of included studies: Thirty four interventions were described in the 39 included primary studies. Sixteen studies were conducted in the USA, 11 in Europe (five in United Kingdom, two in Netherlands, one each in Ireland, Italy and Denmark), three in Australia, two in Asia (Hong Kong and Malaysia) and one each in Canada and Israel. Sample sizes ranged from 26 to 2,285 and the intervention duration ranged from two weeks to five years. Workplace settings ranged from public and private hospitals, health centres and clinics, nursing homes, to ambulance stations.</p> <p>Study designs included 16 RCTs (18 articles) and 18 NRCTs (21 articles). From the 16 RCTs identified, 3 were cluster-randomized, 1 study was cohort-randomized, and 1 used a crossover design. A range of study designs was observed among NRCTs, including quasi-experimental, longitudinal, cross-sectional comparison, mixed measures, pilot intervention, multilevel ecological, and single-arm experimental. Eight studies did not state their study design.</p> <p>A variety of intervention types were used and often combined. The most common interventions included environmental, educational plus a behavioural element, educational only, and behavioural only. The remaining were a combination of environmental, educational, and behavioural interventions. Educational interventions comprised courses/sessions; environmental interventions included cafeteria changes, events, or campaigns; and behavioural interventions involved counselling or planning.</p>	<p>Intervention: Workplace dietary interventions consisting of either environmental, educational or behavioural components (or a combination).</p> <p>Outcome: Fruit and vegetable intake</p> <p>Evidence Statement C: There is some evidence supporting the use of this intervention but it is not conclusive.</p> <p>Outcome: Fat intake</p> <p>Evidence Statement D: The evidence is inconsistent, and it is not possible to draw a conclusion.</p> <p>Outcome: Weight change (kg)</p> <p>Evidence Statement D: The evidence is inconsistent, and it is not possible to draw a conclusion.</p> <p>Outcome: BMI (kg/m²)</p> <p>Evidence Statement E:</p>
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<p>Included study types: All study designs were included.</p>	<p>Quality of included studies: For RCTs, the Cochrane Collaboration's risk-of bias tool was used. For non-RCTs, the risk of bias in non-randomised studies of interventions (ROBINS-I) tool was used. The risks of bias in RCTs were largely unclear due to missing information, and many were at high risk of reporting bias due to selective reporting, social desirability bias, or inaccurate recall. Almost all non-RCTs were at high risk of confounding and many failed to control for prognostic variables, limiting the ability to establish causality.</p> <p>Synthesis: Narrative synthesis and exploratory meta-analyses were conducted across all outcome measures.</p> <p>Findings:</p> <p><u>Fruit and vegetable intake (self-reported):</u></p> <p>The systematic review included eight studies reporting fruit and vegetable intake. Four reported a statistically significant increase for the intervention on fruit and vegetable intake. Three reported no change in fruit and vegetable intake, and one reported an increase in fruit and vegetable intake, but statistical significance was not reported.</p> <p><u>Fat intake:</u></p> <p>Fat intake was reported in seven primary studies. The outcome was usually reported as mean servings per day. Statistically significant decreases in fat intake were observed in four primary studies. Two primary studies reported no statistically significant difference</p>	<p>There is some evidence suggesting that this intervention is ineffective, but it is not conclusive.</p> <p>Author's conclusions: Due to the heterogeneity in study design and intervention type, results were largely inconclusive. Overall, research into worksite dietary interventions among health care workers seems to be highly heterogeneous in terms of study design, sample size, and intervention type. The current paper suggests that, for decreasing fat intake, environmental interventions via cafeteria changes produce the most effective change, and educational and/or behavioural interventions produced increases in fruit and vegetable intake. Significant weight loss were observed most in interventions that included physical activity parameters.</p> <p>Limitations: Comparisons between all studies were impossible due to study design, variety of outcomes, and missing data. It was not possible to perform a meta-analysis on fruit and vegetable intake due to various reporting methods and lack of standard serving sizes. As workplace interventions are multicomponent in nature, it is impossible to measure each intervention type individually. The risk of bias in RCTs were largely unclear due to missing information, and many were at high risk of reporting bias due to selective reporting, social desirability bias, or inaccurate recall. Almost all NRCTs were at high risk of confounding and many failed to control for prognostic variables, limiting the ability to establish causality. Analysis of specific subgroups (job</p>
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between groups and the remaining study did not report an effect size.

Meta-analysis was performed on two RCTs and showed no statistically significant differences in fat intake between groups (MD: -0.39%; 95% CI: -2.95%, 2.17%; $p = 0.76$). Heterogeneity was high ($I^2 = 84\%$). The remaining studies could not be analysed due to missing data or variance in measurement units.

Weight:

Weight was a secondary outcome measure in this systematic review and was usually measured in kg. Fourteen primary studies measured changes in weight. Nine interventions from ten primary studies reported statistically significant decreases, two interventions from three primary studies reported no statistically significant effects, and three primary studies did not report an effect size (but did report a decrease).

Meta-analysis was conducted on 11 primary studies (7 RCT and 4 NRCTs). For RCTs, there were no statistically significant differences in weight between groups (MD: +2.24 kg; 95% CI: -1.34, 5.82 kg; $p = 0.22$) and low heterogeneity ($I^2 = 23\%$). For NRCTs, a statistically significant decrease in weight was observed in the groups receiving the intervention (MD: -5.08 kg; 95% CI: -6.25, -3.91 kg; $p < 0.001$) and low heterogeneity ($I^2 = 3\%$).

BMI:

BMI was reported as kg/m^2 in 14 primary studies. Statistically significant decreases were reported in seven primary studies, no

role, shift pattern, ethnicity) was not possible due to limited reporting. Also, only one database was searched as well as hand-searching one umbrella review. A single reviewer screened all included studies.

Comments:

This systematic review reports on outcome measures not included in the criterion for our review of systematic reviews. Therefore, data on additional measures such as energy intake and other cardiovascular disease markers were not reported in this table.

	<p>statistically significant difference in six, and a statistically significant increase was identified in one primary study.</p> <p>Meta-analysis of four RCTs and six NRCTs were conducted separately and showed no statistically significant differences in BMI (kg/m²) between groups (MD: -0.18; 95% CI: -1.55, 1.18; p = 0.79; moderate heterogeneity: I² = 55%; and MD: -0.67; 95% CI: -1.57, 0.24; p = 0.15; moderate heterogeneity: I² = 66%, respectively).</p>	
<p>Pineda E, et al., (2020). Improving the school food environment for the prevention of childhood obesity: What works and what doesn't. <i>Obesity Reviews</i>, 22, e13176.</p> <p>Type of source: Systematic review, meta-analysis, and meta-regression analyses</p> <p>Interventions: Interventions that focus on the school food environment and that aim to shape accessibility, affordability, desirability, and convenience of food acquirement and consumption to prevent</p>	<p>Description of included studies: This systematic review aimed to assess the effectiveness of school food environment interventions in the prevention of childhood obesity.</p> <p>One hundred studies were included in the review synthesis. Sixty-four were quasi-experimental studies, 34 were RCTs, one observational study and one study design was not available.</p> <p>Seventy-six percent examined interventions, 14% policies, 3% government programs, 6% pilot studies related to food environment interventions and obesity, and 1% explored other related literature.</p> <p>Most interventions were carried out in the United States (53%), 10% in the UK, 6% in Norway, and 6% in Latin America.</p> <p>Ninety-two percent of studies focused on the food environment within schools or food choice architecture interventions (e.g., the relative availability and presentation of different foods), whereas 4% focused on the food environment around schools. Sixty-three</p>	<p>Intervention: School food environment interventions</p> <p>Outcome: BMI z score</p> <p>Evidence Statement: C There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Outcome: Fruit intake</p> <p>Evidence Statement: C There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Outcome: Vegetable intake</p> <p>Evidence Statement: E</p>

<p>obesity/improve dietary intake.</p> <p>Relevant Outcomes: Weight, fat mass percent, BMI, ponderal index, skin-fold thickness, waist circumference, waist-hip ratio, prevalence of overweight and obesity, BMI z score, dietary intake.</p> <p>Note: dietary outcomes are reported in the results section however not defined as an outcome of interest in methods.</p> <p>Study Population: School aged children, ≤19 years of age. Excluding those with critical illness, severe comorbidities or special populations (e.g., blind or physically disabled).</p> <p>Studies were included up to: January 2020</p> <p>Included study types:</p>	<p>percent of interventions involved a single component, such as food provision, whereas 37% encompassed multiple components.</p> <p>Most of the interventions (60%) involved the direct provision of food (e.g., breakfast, lunch, snacks, or fruit and vegetables), 5% introduced or modified dietary guidelines in schools, and 9% modified existing school meals. Thirty-one percent of the interventions addressed aspects of the school food environment other than meals, such as the regulation of vending machines and kiosks or food stores, introduction of cafes, snack bars, or fruit and vegetable buffets. Thirty-seven percent of the studies tested interventions addressing both diet and physical activity.</p> <p>Quality of included studies: Cochrane risk of bias tool for randomized trials (RoB 2) for RCTs and the Risk of Bias in Non-Randomized Studies of Interventions (ROBINS-I) for non-randomized studies were used to determine the grading quality, certainty of evidence, and strength of recommendations. Risk of bias assessment was only undertaken for 96% of studies, with the remaining 4% not including enough data to undertake the assessment.</p> <p>Thirty-eight (43%) RCTs presented a high risk of bias and five (12%) presented a low risk of bias. For non-RCTs, four (7%) showed the highest score of “4,” seven (13%) presented a score of “3,” 16 (29%) presented a score “2,” 16 (29%) a score of “1,” and 12 (22%) presented a score of “0.”</p> <p>Synthesis: Effectiveness of interventions for specific outcomes are reported as percentages (of those showing a positive effect) narratively.</p>	<p>There is some evidence suggesting that this intervention is ineffective but it is not conclusive.</p> <p>Author’s conclusions: Schools offer many opportunities for developing obesity prevention strategies. Environmental changes that increase the availability of vegetables for children from an early age, the provision of healthy meals with high palatability and attractive presentation, the regulation or banning of vending machines and SSBs, and monitored program type of interventions that include the collaboration, training, education, and integration of key stake holders such as chefs, the school staff, parents, and students to increase acceptability, adaptability, and sustainability according to the local needs could contribute to the improvement of dietary intake, which could influence the reduction of childhood obesity. Limited evidence shows that schools can provide more healthful food options without economical loss by limiting nonhealthy foods and improving the salience, taste, attractiveness, and availability of healthy foods.</p> <p>Limitations: The authors conclude that there was heterogeneity across studies in terms of study design, gender and ethnicity of population, type of intervention, and measure of the health outcome.</p> <p>None of the studies disaggregated outcome data based on the discrete dietary and/or environmental components, providing a limited ability to analyse and</p>
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<p>Randomised control trials, clustered quasi-experimental design, quasi-experimental design</p>	<p>A random-effect meta-analyses to investigate the impact of interventions on BMI z score (relative weight for child age) and fruit and vegetable intake was also performed.</p> <p>Findings:</p> <p>All interventions:</p> <p>For single-component interventions, 31 (49% of single-component interventions) were effective at reducing BMI or increasing fruits and/or vegetable intake, whereas for multicomponent interventions, 21 (57% of multicomponent interventions) were effective in health outcome improvements. No statistically significant association was found between the number of components and intervention effectiveness when looking at all anthropometrical and dietary outcomes together (Pearson chi-squared=1.22, p 0.270).</p> <p>Fifty-one percent of all interventions reduced BMI or improved dietary intake; however, only 24% of these showed a sustained improvement regarding fruit and vegetable intake or the reduction of BMI/BMI z score after conclusion of the intervention. From food provision type interventions (n=60), 32% were effective in the increase of healthy food consumption. For internal school food environment interventions (n=25), 12% were effective and 3% had a partial effect in the reduction of BMI.</p> <p>Meta-analysis:</p>	<p>understand the food environments specific effect on health outcomes in school-aged children.</p> <p>Furthermore, few studies disaggregated outcome data by age group and gender, which is relevant due to the unique transition from childhood to adolescence, marked by specific physiological changes and increased behavioural autonomy and food choice.</p> <p>Comments:</p> <p>The authors state that in 4% of studies, there was not enough information provided for them to be able to undertake a quality assessment. Where quality assessment has been undertaken, it is unclear if this was done in duplicate.</p> <p>The inclusion table has 99 references in, despite authors stating there were 100 included studies. Therefore only 99 references have been considered in the overlap calculations.</p>
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	<p>Results represent the standard mean difference between intervention and control groups at baseline and after the implementation of the intervention.</p> <p><u>BMI z score (5 studies):</u></p> <p>The overall effect of the pooled study results shows a statistically significant association between the implementation of school food environment interventions and a reduction in BMI z score (standard MD -0.12, 95% CI: -0.15 to -0.10, I² 74.9%, p 0.000).</p> <p><u>Vegetable intake (13 studies):</u></p> <p>The overall effect of the pooled study results show no statistically significant association between the implementation of school food environment interventions and increased vegetable intake (standard MD 0.01, 95% CI: -0.00 to 0.02, I² 68%).</p> <p><u>Fruit intake (22 studies):</u></p> <p>The overall effect of the pooled study results show a statistically significant association between the implementation of school food environment interventions and increased fruit intake (standard MD 0.19, 95% CI: 0.16 to 0.22, I² 68.9%, p=0.000).</p>	
<p>Podnar H, et al., (2021). Comparative effectiveness of school-based interventions targeting physical activity, physical fitness or sedentary</p>	<p>Description of included studies: This systematic review aimed to determine what types of physical activity interventions in schools are the most effective in improving obesity related outcomes.</p>	<p>Intervention: School based physical activity interventions (overall).</p> <p>Outcome: BMI, BMI z score, %BF</p>

<p>behaviour on obesity prevention in 6-to 12-year-old children: A systematic review and meta-analysis. <i>Obesity Reviews</i>, 22, e13160.</p> <p>Type of source: Systematic review and meta-analysis.</p> <p>Interventions: Interventions of any duration that aimed to either (a) increase physical activity and/or physical fitness or (b) reduce sedentary behaviour. Interventions took place primarily in a school-setting.</p> <p>Relevant Outcomes: Any obesity related outcome (e.g., BMI, BMI z score, BMI percentile, prevalence, or incidence of overweight or obesity, percentage of body fat [%BF], skinfold thicknesses, waist circumference, waist circumference percentile, and waist-to-height ratio).</p>	<p>One hundred and forty-six papers were included in the review. Of which, 91 were RCTs and 55 were quasi-experimental studies. The location of studies were grouped by continent: 64 studies were conducted in Europe, 44 in North America, nine in South America, 16 in Asia, nine in Oceania and two in Africa.</p> <p>Seventy-four studies focused on younger children (6 to 9 years) and 66 investigated interventions in children aged 10 to 12 years. Six focused on both age groups. Twenty-six were aimed at children of low socioeconomic status and four focused on a specific ethnicity, the remainder focused on the general population.</p> <p>Fifty-five studies targeted physical activity, 47 targeted physical fitness and two targeted sedentary behaviour alone. Thirty-seven studies targeted both sedentary behaviour and physical activity and the remaining six targeted sedentary behaviour and physical fitness. Ninety-five studies contained a dietary component to their intervention and 51 did not.</p> <p>Quality of included studies: Risk of bias was assessed using the Cochrane risk of bias assessment tool. Thirty-six studies were assessed as low risk, 71 studies deemed to be moderate risk, and 39 as high risk of bias.</p> <p>A formal evaluation of all available results using Egger's regression did not show evidence of publication bias for BMI (-0.11, p=0.91), BMI z score (-1.36, p=0.17) or %BF (-0.80, p=0.42).</p> <p>Synthesis: Meta-analysis combining mean differences between the intervention and control groups were calculated for BMI, BMI z-score and %BF, however obesity prevalence/incidence and waist</p>	<p>Evidence Statement: C There is some evidence supporting the use of this intervention but it is not conclusive.</p> <p>Intervention: School-based physical activity interventions designed to increase physical fitness.</p> <p>Outcome: BMI, BMI z score, %BF</p> <p>Evidence Statement: C There is some evidence supporting the use of this intervention but it is not conclusive.</p> <p>Intervention: School-based physical activity interventions designed to increase physical activity.</p> <p>Outcome: BMI, BMI z score, %BF</p> <p>Evidence Statement: C There is some evidence supporting the use of this intervention but it is not conclusive.</p> <p>Intervention: School-based physical activity interventions designed to reduce sedentary behaviours.</p> <p>Outcome: BMI, BMI z score, %BF</p> <p>Evidence Statement: C</p>
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<p>Study Population: Children aged six to 12 years.</p> <p>Studies were included up to: 15 April 2019.</p> <p>Included study types: RCTs or non-RCTs, controlled before and after studies or natural experiments.</p>	<p>circumference were found to be unsuitable for meta-analysis due to heterogeneity in reporting.</p> <p>Findings:</p> <p>Overall:</p> <p>Pooled effect sizes indicated that school-based physical activity interventions favourably affected all three outcomes analysed:</p> <ul style="list-style-type: none"> • BMI -0.16 kg m^{-2} (95% CI: -0.25 to -0.07) • BMI z-score -0.07 (95% CI: -0.10 to -0.05) • %BF -0.34% (95% CI: -0.55 to -0.13) <p>Heterogeneity was high (I^2 82% to I^2 92%) for all outcomes.</p> <p>Intervention comparisons:</p> <p>For interventions designed to improve physical fitness, meta-analyses showed significant improvements in BMI z-score, but no significant effect was found for BMI or %BF:</p> <ul style="list-style-type: none"> • BMI -0.04 (95% CI: -0.07 to 0.00; 34 studies) • BMI z-score -0.10, (95% CI: -0.16 to -0.03; 13 studies) • %BF -0.11 (95% CI: -0.26 to 0.04; 18 studies) <p>For Interventions that aimed to increase physical activity, meta-analyses showed significant improvements in BMI z score, but no significant effect was found for BMI or %BF:</p> <ul style="list-style-type: none"> • BMI z score -0.09 (95% CI: -0.12 to -0.06; 23 studies) • BMI -0.04 kg m^{-2} (95% CI: -0.09 to 0.02; 38 studies) 	<p>There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Author's conclusions: The main results of the study include the following:</p> <ol style="list-style-type: none"> 1. School based physical activity interventions appear to be an effective strategy in the primary prevention of childhood obesity among 6 to 12 year old children. 2. Interventions that combined physical activity or fitness component with strategies to reduce sedentary behaviour were actually less effective in controlling weight gain than physical activity or fitness only interventions; hence, including behavioural strategies to reduce sedentary behaviour to physical activity or fitness programmes does not provide additional benefits for primary prevention of obesity. 3. Interventions that were designed to improve physical fitness produced slightly larger effects than interventions that strived to increase physical activity. 4. Intervention effects were generally larger in girls than in boys, especially for programmes that included both physical activity /fitness and a sedentary behaviour component; and
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	<ul style="list-style-type: none"> • %BF -0.04%; 95% CI: -0.15 to 0.06; 18 studies) <p>Lastly, as only two interventions that focused exclusively on reducing sedentary behaviours were included, the pooled effects for this type of intervention were not computed.</p> <p>Interventions designed to improve physical fitness while also aiming to reduce sedentary time proved to be unsuccessful in favourably affecting BMI (SMD -0.01, 95% CI: -0.09 to 0.07), whereas reliable estimates for BMI z score and %BF could not be computed because of limited number of studies.</p> <p>By contrast, pooled results for interventions aiming to increase physical activity while also trying to reduce sedentary behaviours found significant effects for BMI z score but not for BMI and %BF. Heterogeneity was still quite large in all four groups of interventions suitable for meta-analysis and ranged from I^2 76% to 94%.</p> <ul style="list-style-type: none"> • BMI: -0.07 kg m^{-2} (95% CI: -0.13 to -0.00) • BMI z-score -0.06 (95% CI: -0.09 to -0.03) • %BF -0.01% (95% CI: -0.08 to 0.06) <p>Intervention components sub analysis:</p> <p>Longer weekly physical activity duration translated to larger effects on BMI for both fitness-only and fitness plus sedentary behaviour interventions.</p> <ul style="list-style-type: none"> • Fitness-only: BMI -0.12 kg m^{-2} (95% CI: -0.21 to -0.03) • Fitness plus sedentary behaviours: BMI -3.8 kg m^{-2} (95% CI: -6.4 to -1.1] 	<p>5. Interventions that were delivered exclusively to economically deprived children analysed here were less able to induce favourable effects on BMI compared with interventions conducted in more general settings.</p> <p>Limitations: Large variability in intervention characteristics led to statistical heterogeneity, which warrants caution when interpreting the results of meta-analysis.</p> <p>Over one third of studies that met inclusion criteria failed to provide all the data needed for a meta-analysis.</p> <p>A large number of studies describing physical activity interventions failed to document the exact duration of physical activity, and even fewer studies have quantified the intensity of implemented activities. It was not possible to describe the dose-response relationship.</p> <p>Although authors restrained from predefining specific obesity-related outcomes, a sufficient number of studies for a meta-analysis were found only for BMI, BMI z score and %BF.</p> <p>Finally, authors found only two studies that focused exclusively on reducing sedentary behaviour, they were unable to compute reliable estimates of the effects of such interventions on obesity-related outcomes.</p>
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More intense physical activity was related to larger effects for fitness-only interventions (BMI -0.15 kg m^{-2} , 95% CI: -0.30 to -0.00 ; BMI z score -0.18 kg m^{-2} , 95% CI: -0.30 to -0.05) and for physical activity plus sedentary behaviour interventions (BMI z score -0.63 kg m^{-2} , 95% CI: -1.04 to -0.21).

Including a diet component improved only the effect of physical activity interventions on BMI z-score (-0.06 , 95% CI: -0.12 to -0.01).

Regarding other characteristics, parent involvement markedly improved the effect on %BF for fitness-only interventions. Similarly, the effects on %BF seem to be much larger in this group of interventions when the interventions extend to more than one academic year. At the same time, the effects of physical activity-only programmes were somewhat smaller in long term compared with short term for BMI z score.

Gender analysis:

Point estimates for interventions that aimed to increase physical activity were generally larger in girls for most outcomes, whereas for interventions that were designed to improve physical fitness, the opposite was true.

Effectiveness of interventions in vulnerable groups of children:

In general, the effects on BMI were not seen when interventions were delivered to vulnerable groups of children (BMI -0.01 kg m^{-2} , 95% CI: -0.29 to 0.19), whereas interventions delivered to the

Comments:

Some deviation from the published protocol was noted in terms of methods:

- Risk of bias assessment only undertaken by one reviewer.
- No grey literature search undertaken.

Authors have reported favourable intervention effects where statistical significance has not been achieved.

Authors reported a conflict of interest regarding funding.

general population seem to be effective (BMI -0.05, 95% CI: -0.07 to -0.02).

Qi Y, et al., (2021). Is school gardening combined with physical activity intervention effective for improving childhood obesity? A systematic review and meta-analysis. *Nutrients*, 13, 2605.

Type of source:
Systematic review and meta-analysis.

Interventions:
School gardening activities alone or combined with physical activity.

Relevant Outcomes:
Fruit and vegetable intake, BMI, BMI z score, and waist circumference.

Study Population:
Children attending school, aged 7–12 years.

Description of included studies:

This study aimed to evaluate the effect of school gardening activities combined with physical activities on children’s dietary intake and anthropometric outcomes.

Fourteen RCTs were included, 12 of which were suitable for meta-analysis. The interventions included in the 14 studies were divided into two types: school gardening activities or gardening activities only (n=12), and interventions including both school gardening activities and physical activity (n=2).

All studies included designed school gardening activities for primary school-age children. The duration of school gardening activities ranged from 10 to 52 weeks. The total sample sizes ranged from 102 to 3153 children, among which most of the sample size ranged from 100 to 400 children. School gardening activities provided opportunities for children to plant, water, weed, harvest, and taste various fruits and vegetables. Other interventions integrated activities, such as nutritional education, cooking activities, and participating in sports.

Quality of included studies:

Authors reported that the results of Cochrane’s risk of bias assessment showed that for most studies, the overall risk of bias was low. Despite a low overall risk, all studies had some concerns and an unclear risk of bias due to lack of reporting. Due to the limited number of studies, the authors concluded it was impossible to explore the existence of publication bias.

Intervention:

School gardening activities.

Outcome:

Fruit and vegetable intake

Evidence Statement: B

This intervention is supported by moderate quality evidence of its effectiveness.

Outcome:

BMI, BMI z score and waist circumference

Evidence Statement: F

There is moderate to good quality evidence that this intervention is unlikely to be effective.

Intervention:

School gardening activities combined with physical activity.

Outcome:

Proportion of overweight/obese

Evidence Statement: E

There is some evidence suggesting that this intervention is ineffective, but it is not conclusive.

<p>Studies were included up to: January 2021.</p> <p>Included study types: RCTs</p>	<p>Synthesis: Fixed or random-effects meta-analysis was conducted (I^2 statistic calculated and where greater than 50%, the random effects model was used).</p> <p>Findings:</p> <p>School Gardening Activities (12 studies):</p> <p><u>Fruit and vegetable intake:</u></p> <p>Meta-analysis found a significant effect in favour of the intervention group (school gardening activities vs control group: WMD 0.59, 95% CI: 0.21 to 0.98, $p=0.003$, I^2 95.3%, $Z=3.01$; 5 studies).</p> <p><u>BMI:</u></p> <p>Meta-analysis found no significant difference between intervention and control (school gardening activities vs control group: WMD - 0.49, 95% CI: -1.63 to 0.65, $p=0.404$, I^2 86.3%, $Z=0.84$; 5 studies).</p> <p><u>BMI z-score:</u></p> <p>Meta-analysis found no significant difference between intervention and control (school gardening activities vs control group WMD - 0.12, 95% CI: -0.26 to 0.02, $p=0.085$, I^2 63.0%, $Z=1.72$; 5 studies).</p> <p><u>Waist circumference:</u></p>	<p>Author's conclusions: The intervention based on school gardening activities can effectively increase children's fruit and vegetable intake and improve their intake motivation, attitude, and preference for vegetables and fruits, but it has no obvious effect on reducing BMI outcomes and waist circumference.</p> <p>Limitations: Although the number of studies on school gardening activities has steadily increased in the last ten years, there were few comprehensive studies on school gardening activities combined with physical activity, which should be explored in the future.</p> <p>Second, fruit and vegetable-related outcomes in most studies were measured by self-report, which is easily affected by social recognition bias, so they may not accurately represent the changes in dietary intake.</p> <p>Thirdly, there are little data on long-term changes of fruit and vegetable intake, so authors were unable to determine if the changes of fruit and vegetable intake continued over time, and further research is needed.</p> <p>Finally, the main purpose of gardening-based interventions is to improve children's intake of fruits and vegetables. Therefore, the literature included in this study only analysed changes in fruit and vegetable intake.</p> <p>Comments:</p>
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	<p>Meta-analysis found no significant difference between intervention and control (school gardening activities vs control group: WMD -0.98, 95% CI: -2.61 to 0.64, p=0.235, I² 72.9%, Z=1.19; 6 studies).</p> <p>School gardening activities with physical activity (2 studies):</p> <p><u>Proportions of participants overweight/obese:</u></p> <p>Two studies; both found no significant difference in proportion of participants who were overweight/obese between those receiving school gardening activities, plus physical activity combined and control (p=0.8, p value not reported).</p>	<p>Overall reporting of intervention details is lacking.</p> <p>No country data provided so not possible to establish generalisability.</p> <p>Limited literature search.</p> <p>High heterogeneity found for each meta-analysis, suggesting caution interpreting results as studies may not have been appropriate to combine.</p>
<p>Verjans-Janssen S, et al., (2018) Effectiveness of school-based physical activity and nutrition interventions with direct parental involvement on children's BMI and energy balance-related behaviors—A systematic review. <i>PLoS one</i>, 13, e0204560.</p> <p>Type of source: Systematic review.</p> <p>Interventions: School-based interventions with direct parental involvement which</p>	<p>Description of included studies: The aim of this systematic review was to study the effectiveness of primary school-based physical activity, sedentary behaviour and nutrition interventions with direct parental involvement on children's BMI or BMI z score, physical activity, sedentary behaviour and nutrition behaviour.</p> <p>Twenty-five studies were included that described the effectiveness of 24 school based interventions with direct parental involvement. Ten studies were RCTs, 11 were quasi-experimental, three had a pretest-post test design and one study had a repeated cross-sectional design. Nine studies were conducted in the USA, five in China, three in Australia, two in Germany, two in Greece, one in each of Italy, Chile, Mexico and Norway.</p> <p>The interventions were conducted between 1992 and 2015. The number of schools participating in the studies ranged from one to 38. The number of children participating in the study at baseline</p>	<p>Intervention: School based interventions targeting physical activity and/or nutritional behaviours, with direct parental involvement.</p> <p>Outcome: BMI or BMI z score Nutritional behaviours</p> <p>Evidence Statement: D The evidence is inconsistent, and it is not possible to draw a conclusion.</p> <p>Author's conclusions: School based interventions with direct parental involvement have the potential to improve children's weight status, physical activity and sedentary behaviour. Based on the results, it is recommended that</p>

<p>consisted of at least one of the following types of interventions: (a) changes to the school's physical environment; (b) changes to the school's social environment; (c) changes to the school's policies; or (d) economic support for the school.</p> <p>Relevant Outcomes: BMI z score, fruit and vegetable intake, sugar sweetened beverage intake, fat (saturated or total) intake.</p> <p>Study Population: Children aged four to 12 years attending primary school.</p> <p>Studies were included up to: March 2018.</p> <p>Included study types: RCTs, quasi-experimental, pre-test-post-test and repeated cross-sectional design.</p>	<p>ranged from 97 to 9,867. The average age of children participating in the included studies ranged from 5 to 12 years. Intervention durations ranged from ten weeks to four years.</p> <p>All studies performed the follow-up measurements immediately at the end of the intervention. One study conducted longer-term (one year) follow-up measurements.</p> <p>Two interventions targeted physical activity only and three targeted nutritional behaviours only. The remaining targeted physical activity and nutritional behaviour and eight also reported targeting children's sedentary behaviour.</p> <p>All but one study included school and family components, targeting both teachers/school staff and parents.</p> <p>Quality of included studies: The methodological quality of studies was assessed using the quality assessment instrument of the Effective Public Health Practice Project (EPHPP). Quality of eight studies (32%) was rated as weak, twelve studies (48%) were rated moderate and five studies (20%) as being of high methodological quality. Weak ratings were mainly due to a lack of information regarding blinding, data collection and drop-out rates.</p> <p>Synthesis: Intervention effectiveness was narratively synthesised. Study effectiveness was described as positive, mixed or negative based on the finding's significance.</p> <p>Findings:</p>	<p>school based interventions with direct parental involvement target more than one energy balance-related behaviour, last at least one year, and focus particularly on the physical and social environment within both the school and the family environment.</p> <p>Limitations: There is a risk of publication bias, as authors only searched four databases and included only articles written in English.</p> <p>Another limitation may be the inclusion of studies with a weak methodology. In most cases, the weak methodological ratings were due to missing information.</p> <p>Authors had difficulty calculating effect sizes for all studies.</p> <p>Most intervention were poorly described in included studies impeding comparison and data extraction which may have biased results presented.</p> <p>Comments: Studies were only considered for inclusion if the intervention directly involved parents. Those indirectly involving parents (such as provision of newsletters, information sheets etc., homework with parental involvement, and parents attending health related information sessions) were excluded.</p>
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<p>Twenty-three of the 25 included studies included at least one outcome of relevance to this review and are discussed below.</p> <p><u>BMI or BMI z score:</u></p> <p>Eighteen studies measured BMI or BMI z score. Eleven out of the 18 found favourable results. Of these, seven studies found positive results for BMI and BMI z score. One study found the intervention to be positively effective for reducing BMI but not BMI z score, and the remaining three found effective results for particular subgroups only.</p> <p>Of the studies with favourable results, effect sizes for BMI or BMI z score were mainly small (ES -0.04 to -0.27), but two studies had a moderate effect size (ES -0.34 and -0.48) and one study found a large effect on BMI (ES -0.79). The study quality of these studies was strong for three studies, moderate for five studies and weak for three studies.</p> <p>Six studies reported their intervention to be ineffective regarding BMI and BMI z score, although three of these showed a positive trend (ES -0.10 and -0.01, respectively). One study found negative results.</p> <p><u>Nutrition behaviour:</u></p> <p>Twelve studies included relevant nutritional outcome measures. Of these:</p> <ul style="list-style-type: none"> • Two out four studies identified significant ($p < 0.05$) increase in fruit and vegetable consumption. 	<p>No UK studies were included which may limit the generalisability of findings.</p>
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	<ul style="list-style-type: none"> • Two of four studies found a significant ($p < 0.05$) increase in fruit consumption. • Two of five studies found a significant ($p < 0.05$) increase in vegetable consumption. • One of four studies found a significant ($p < 0.05$) reduction in fat intake. • None of the five studies measuring sugar sweetened beverage intake found a significant reduction. 	
<p>von Philipsborn P, et al. (2019). Environmental interventions to reduce the consumption of sugar-sweetened beverages (SSB) and their effects on health. <i>Cochrane Database of Systematic Reviews</i>, CD012292.</p> <p>Type of source: Systematic review</p> <p>Interventions: Environmental interventions aimed at reducing consumption of sugar-sweetened beverages and sugar-sweetened milks.</p> <p>Relevant Outcomes:</p>	<p>Description of included studies: A total of 58 studies were included in this systematic review. The studies included children, teenagers and adults, and were implemented in a variety of settings, including schools, retailing and food service establishments.</p> <p>This systematic review classified the included interventions as: labelling interventions, nutrition standards in public institutions, economic tools, advertisement and marketing regulation, whole food supply interventions, retail and food service interventions, and intersectoral approaches.</p> <p>Interventions were implemented in schools (20 studies), supermarkets and other retailing establishments (12 studies), participants' homes (7 studies), restaurants and cafés (6 studies), and other settings (13 studies).</p> <p>Thirty-eight studies were conducted in the USA, four in Australia, three in the Netherlands, two each in Canada and the UK, and one each in the following countries: Brazil, Chile, Germany, Italy, Mexico, New Zealand, Norway, Peru, and Vietnam. The mode of implementation was as follows: pilot trials by researchers with or</p>	<p>Intervention: Reduced availability of sugar sweetened beverages in schools.</p> <p>Outcome: Sugar sweetened beverage intake</p> <p>Evidence Statement C: There is some evidence supporting the use of this intervention but it is not conclusive.</p> <p>Intervention: Improved access to drinking water in schools.</p> <p>Outcome: Sugar sweetened beverage Intake Weight change</p> <p>Evidence Statement D: The evidence is inconsistent, and it is not possible to draw a conclusion.</p>

<p>Direct measures of sugar sweetened beverage intake, diet-related anthropometric measures and health outcomes e.g., BMI, waist circumference.</p> <p>Study Population: Children and adults.</p> <p>Studies were included up to: January 2018.</p> <p>Included study types: RCT, controlled interrupted time series, controlled before-and-after study, interrupted time series, cluster RCT, non-RCT,</p>	<p>without the co-operation of other actors (29 studies), mandatory government regulation or government programmes (16 studies), government pilot projects (4 studies) and voluntary industry action (9 studies).</p> <p>Thirty-five studies were implemented at the level of individual settings, such as schools or restaurants, and 23 interventions were implemented at a policy level, i.e. at the level of political jurisdictions such as states or municipalities.</p> <p>The interventions were implemented between 2001 and 2017, and the studies published between 2006 and 2018.</p> <p>Quality of included studies: Authors reworded the domains of the EPOC-adapted Cochrane 'Risk of bias' tool, using the wording used in the most recent edition of the Cochrane Handbook for Systematic Reviews of Interventions. Most studies look to be at high or unclear risk of bias in at least one domain.</p> <p>Synthesis: Narrative synthesis focused on the existence and the direction of effects, and not on the effect size. Meta analyses (random-effects models) was conducted for intervention types where two or more studies used the same study design and reported comparable outcome measures.</p> <p>Findings: Not every study examined in this review included outcomes of interest to our review, therefore <i>only the findings for interventions with relevant outcomes to this review have been extracted below:</i></p>	<p>Intervention: Small prizes for the selection healthier beverages in school cafeterias</p> <p>Outcome: Meals with unhealthy beverages per week.</p> <p>Evidence Statement H: Evidence about the effectiveness of the intervention is lacking.</p> <p>Intervention: Fruit provision in schools</p> <p>Outcome: Sugar sweetened beverage Intake</p> <p>Evidence Statement C: There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Intervention: Financial incentives to purchase low-calorie beverages implemented through supermarket loyalty cards.</p> <p>Outcome: Sugar sweetened beverage Intake</p> <p>Evidence Statement D: The evidence is inconsistent, and it is not possible to draw a conclusion.</p>
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Reduced availability of SSB in schools: [five studies with relevant outcomes]

All five studies showed a decrease in SSB intake. However, three showed a significant decrease (95% CI excludes 0) and two showed a non-significant decrease in SSB intake (95% CI includes 0).

Improved access to drinking water in schools: [Four studies with relevant outcomes]

Three studies looked at SSB intake. One found a significant decrease in the number of students consuming SSBs every day (-190ml/day 95%CI -280 to -100), one found a non-significant decrease in SSB intake (95% CI crosses 0). One found no significant effect on SSB intake (effect size not reported).

Three studies assessed weight change as an outcome. Two of the assessed z-BMI as an outcome and found no significant effects for the intervention on z-BMI score (95% CI crosses 0). The same two studies also assessed the number of students with overweight and obesity. One found a significant reduction in the share of male students who were overweight or obese (-1.2 percentage points 95% CI -1.9 to -0.5), but a non-significant decrease in the share of females who were overweight or obese (-0.6 95%CI -1.3 to 0.1). The second found a significant decrease in the overall number of students with overweight or obesity (OR 0.69, 95% CI 0.48 to 0.99) at 10 months. A final study found a significant increase in the share of students with overweight and obesity at 11 months (OR 1.27 95% CI 0.78 to 2.07).

Small prizes for the selection healthier beverages in school

Intervention:

Price discounts on low-calorie beverages in community stores

Outcome:

Sugar sweetened beverage intake

Evidence Statement H:

Evidence about the effectiveness of the intervention is lacking.

Intervention:

Healthier vending machines in workplaces and schools

Outcome:

Sugar sweetened beverage Intake

Evidence Statement D:

The evidence is inconsistent, and it is not possible to draw a conclusion.

Interventions:

Urban planning restrictions on new fast food outlets.

Outcome:

Sugar sweetened beverage Intake

Evidence Statement H:

Evidence about the effectiveness of the intervention is lacking.

Cafeterias: [one study with a relevant outcome]

One study reported a significant decrease in the number of meals with unhealthy beverages per week ($p = 0.000$).

Fruit provision in schools: [two studies with relevant outcomes]

Both studies found that the intervention led to a decrease in SSB intake ($p < 0.05$).

Financial incentives to purchase low-calorie beverages implemented through supermarket loyalty cards: [two studies with relevant outcomes]

One study found that the share of participants reporting consuming any red-labelled beverage each week decreased significantly (-23% in the intervention group versus -2% in the control group, $p = 0.01$) during the five-month intervention period. Another study found that self-reported SSB intake increased by 10ml/day (95% CI: 0 to 20) at three months.

Price discounts on low-calorie beverages in community stores: [one study with a relevant outcome]

One study showed a non-significant increase in SSB intake per capita during the intervention period (6% increase 95% CI -3 to 15) and five month follow-up (6% increase 95% CI -7 to 21).

Healthier vending machines in workplaces and schools: [two studies with relevant outcomes]

Intervention:

Government food benefit programmes *with* incentives for buying fruit and vegetables and restrictions on the purchase of SSBs.

Outcome:

Sugar sweetened beverage intake

Evidence Statement C:

There is some evidence supporting the use of this intervention, but it is not conclusive.

Intervention:

Government food benefit programmes *without* incentives for buying fruit and vegetables and restrictions on the purchase of SSBs.

Outcome:

Sugar sweetened beverage intake

Evidence Statement D:

The evidence is inconsistent, and it is not possible to draw a conclusion.

Intervention:

Improved access to low-calorie beverages in the home environment

Outcome:

Sugar sweetened beverage intake

One study reported a non-significant increase in SSB intake at 18 months follow-up (+14ml/day $p>0.05$). Another study reported that SSB consumption frequency decreased by -1.1 times/week (95% CI -1.5 to -0.7) among normal-weight participants, and by -0.8 times/week (95% CI -1.5 to -0.1) among participants with overweight and obesity at two years follow-up.

Urban planning restrictions on new fast-food outlets: [one study with relevant outcomes]

One study found a non-significant decrease in SSB intake for restricted areas compared with other parts of the city and the county (-0.9 $p>0.05$).

Government food benefit programmes with incentives for buying fruit and vegetables and restrictions on the purchase of SSBs: [three studies with relevant outcomes]

All three studies showed a decrease in SSB intake. One study showed a significant decrease in SSB intake (-180 ml/day (95% CI -338 to -22)). One study showed a non-significant decrease in sugar intake from SSBs (-1 g/day/person (95% CI -5 to 2)). And a final study found both significant and non-significant decreases in SSB intake, depending on the monetary amount of government benefit participants were awarded each month.

Government food benefit programmes without incentives for buying fruit and vegetables and restrictions on the purchase of SSBs: [Two studies with relevant outcomes]

One study reported that intake of sugar from SSB decreased by -0.5 g/day (95% CI -2 to 1) for the comparison of USD 60 versus no

Evidence Statement B:

This intervention is supported by moderate quality evidence of its effectiveness.

Outcome:

Change in BMI

Evidence Statement H:

Evidence about the effectiveness of this intervention is lacking.

Intervention:

Provision of active video-gaming equipment to teenagers

Outcome:

Sugar sweetened beverage

Evidence Statement H:

Evidence about the effectiveness of this intervention is lacking.

Author's conclusions:

The evidence included in this review shows that effective, scalable interventions exist, addressing sugar-sweetened beverage (SSB) consumption at a population level. Confidence in the certainty of effects, however, is low to moderate for most of these interventions and in relation to most outcomes, and true effects may be substantially different from those reported in this review. Given the uncertainty of the evidence, it is

	<p>USD benefit a month, increased by 1 g/day (95% CI -1 to 3) for the comparison of USD 60 versus USD 30 benefit a month, and decreased by -2 g/day (95% CI -4 to 1) for the comparison of USD 30 versus no USD benefit a month. Another study showed an increase in the median SSB intake (+34 kcal/day, 95% CI 7 to 60).</p> <p>Improved access to low-calorie beverages in the home environment: [Five studies with relevant outcomes]</p> <p>Meta-analysis of 5 RCTs showed a significant decrease in SSB intake (pooled effect estimate: -413ml/day (95%CI -684 to -143)).</p> <p>Two pilot RCTs assessed BMI change as an outcome and both found that the intervention led to a reduction BMI, however, in one the reduction was significant (-0.14kg/m² 95%CI -0.54 to 0.26), whereas in the second the reduction was non-significant (-0.14kg/m² 95%CI -0.54 to 0.26). Both studies were undertaken in teenagers.</p> <p>Provision of active video-gaming equipment to teenagers: [One study with a relevant outcome]</p> <p>One study reported that the share of participants consuming more than 1400 ml SSB a day decreased (OR 0.71, 95% CI 0.36 to 1.41) at 10 months.</p>	<p>important that the existing evidence base is strengthened.</p> <p>Limitations: Reporting bias was a major concern of included studies and publication bias was also highlighted.</p> <p>Comments: As well as direct consumption of SSBs, this review included indirect measures of SSB consumption (e.g. SSB sales). For the purposes of our review, these outcomes have not been extracted.</p> <p>Two authors declared conflicts of interest for this review. One was a consultant working primarily for health insurance companies while the other's institution has received grants from pharmaceutical companies responsible for producing slimming products. The same author has membership on the science advisory boards of Nestle and Danone.</p>
<p>Ward D, et al., (2017). Strength of obesity prevention interventions in early care and education settings: A systematic</p>	<p>Description of included studies: The goal of the current study was to systematically review obesity prevention interventions in centre-based ECE settings published 2010–2015 in order to identify the most promising intervention</p>	<p>Intervention: Early care and education setting interventions targeting healthy eating, physical activity and/or screen time.</p> <p>Outcome:</p>

<p>review. <i>Preventive medicine</i>, 95, S37-S52.</p> <p>Type of source: Systematic review.</p> <p>Interventions: Early care and education (ECE) setting interventions targeting healthy eating, physical activity and/or screen time.</p> <p>Relevant Outcomes: Objective or validated measure of dietary intake, or anthropometric outcomes.</p> <p>Study Population: Children aged 0–6 years attending a centre-based ECE setting.</p> <p>Studies were included up to: 2015.</p> <p>Included study types: All study designs, except case studies, were included</p>	<p>characteristics associated with successful behavioural and/or anthropometric outcomes.</p> <p>Forty-seven papers were included in this review that described 43 unique interventions. Thirty-two were RCTs, nine were non-experimental pre-post, four within subject cross-over, and two longitudinal follow-ups to RCTs.</p> <p>Of these interventions, over half took place in the USA (n=23), followed by Australia (n=6) and Germany (n=4). The remaining studies took place in Switzerland, Chile, and Belgium (2 studies each), and England, Colombia, Spain, and Turkey (1 study each).</p> <p>Although some interventions were designed for any child enrolled in the centre, measured child age in the studies ranged from 2+ to 6 years and were considered preschool interventions.</p> <p>Sample sizes ranged from 23 to 2062 children. Generally, the studies took place in childcare settings where many participants were low to middle socio-economic status (SES).</p> <p>Strategies to improve healthy eating included menu changes, nutrition education, changing meal service approaches, and food tastings. Strategies to improve physical activity included structured physical activity lessons, staff training, and take-home activity cards or resources.</p> <p>Seven of the 43 interventions targeted healthy eating only, 17 targeted only physical activity, 9 targeted healthy eating and physical activity, 1 targeted physical activity and screen time, and 9 targeted healthy eating, physical activity, and screen time.</p>	<p>Anthropometrics (such as BMI, BMI z-score, percentage body fat, waist circumference or skin fold thickness)</p> <p>Evidence Statement: D The evidence is inconsistent, and it is not possible to draw a conclusion.</p> <p>Outcome: Nutrition</p> <p>Evidence Statement: C There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Author’s conclusions: Preventing obesity in young children could have lifelong benefits, and many recent studies have evaluated obesity prevention interventions in preschool children. The exploratory, but quantitative, approach to the present review of ECE interventions revealed that stronger interventions, with parent engagement and environmental and policy components, tended to be positively related to anthropometric outcomes. Thus, the best evidence suggests that comprehensive, multi-level obesity prevention interventions in ECE can be recommended. The present review raised several questions that should be priorities for future research.</p> <p>Limitations: Confidence in the main findings with anthropometric outcomes should be tempered by inconsistencies across the two methods of quantifying outcomes.</p>
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<p>if a pre- and post-evaluation was conducted.</p>	<p>Twenty-five of the 43 interventions included a parental engagement component with strategies ranging from newsletters, CDs, or other handouts to more active strategies such as parent workshops or cooking.</p> <p>Duration of the interventions ranged from 8 days to 3 years, with most lasting 4 to 6 months.</p> <p>Quality of included studies: Methodological quality of each study was assessed using the Quality Assessment Tool for Quantitative Studies from the Effective Public Health Practice Project. 9 studies received a strong global rating, 14 received a moderate rating, and 20 received a weak rating.</p> <p>Synthesis: For each study, reported outcomes were coded in a systematic manner to determine intervention success. To enhance comparability among studies, only immediate post-intervention outcomes (not mid-point or maintenance outcomes) were included. Finally, only outcomes that were favourably and statistically significant ($p < 0.05$) were coded. To translate coded outcomes into intervention success, authors calculated two measures :1) overall intervention success (calculated as a percentage of successful outcomes to total number of outcomes; and 2) any intervention success, where individual study success was a dichotomous outcome (any successful outcome vs. no successful outcome). These measures were calculated for healthy eating, physical activity/screen time, and anthropometric target areas if provided. The overall intervention success and dichotomous success scores (any) were used as the dependent variables in the hypothesis testing.</p>	<p>Comments: For this systematic review, if the outcomes of a study were non-significant, "NS" was listed in their extraction of results and no further detail was provided relating specific measures related to that outcome. Therefore, we are unable to ascertain which outcomes the studies were measuring for those which yielded non-significant results.</p> <p>No reporting of review limitations.</p> <p>Only one UK study included, so generalisability should be considered further.</p>
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Findings:

Anthropometrics (including BMI and body fat measures):

Ten of the 24 studies measuring anthropometrics demonstrated that the intervention had a statistically significant effect ($p < 0.05$) on at least one anthropometric measure. The remaining 14 found no significant effects for any anthropometric measures.

Nutrition outcomes:

Of the 18 studies that included a dietary intake measure, the majority (72%) demonstrated at least one significant impact. Only five studies showed no effect on dietary intake. Of the five interventions, two aimed to reduce fat intake and increase consumption of fruit and vegetables, while the other three aimed to improve healthy eating more generally. Five studies were rated as weak quality, and one reported as moderate quality.

Positive effects of the interventions:

Fruit and vegetable intake:

- Seven studies reported increased intake of fruit and vegetables. Of the seven, 3 were rated as moderate quality, 3 as weak and 1 as strong.

Fruit intake:

- one weak quality study reported increased intake of fruit.

Vegetable intake:

- one strong quality study reported and in vegetable intake.

	<p><u>Milk intake:</u></p> <ul style="list-style-type: none"> - three studies (one strong, one moderate, one weak quality) reported an increase in milk consumption. <p><u>Fat intake:</u></p> <ul style="list-style-type: none"> - two weak quality studies reported decreases in fat and/or saturated fat consumption. <p><u>Sugar intake:</u></p> <ul style="list-style-type: none"> - One moderate quality study reported a decrease in sugar intake. <p>Eleven of the 18 studies with nutritional outcomes were rated as weak quality, four as moderate and three as strong quality.</p>	
<p>Wethington H, et al., (2020) Healthier Food and Beverage Interventions in Schools: Four Community Guide Systematic Reviews. <i>American Journal of Preventive Medicine</i>, 59, e15-e26.</p> <p>Type of source: Community guide systematic review.</p> <p>Interventions:</p>	<p>Description of included studies: The aim of this paper was to report findings from four Community Guide systematic reviews examining the effectiveness of interventions in schools promoting healthy eating and weight. Three of these were relevant to this systematic review.</p> <p>The first review identified 27 studies investigating the effectiveness of school meal or fruit and vegetable interventions that aimed to increase the availability of healthier foods and beverages offered in schools. Study designs included group RCTs (n=7); group non-randomised trials (n=2); repeat cross-sectional with comparison design (n=1); time series design (n=1); repeat cross-sectional design (n=3); cross-sectional with comparison design (n=7); and single group before-after study design (n=6). Fourteen primary studies were conducted in the USA, eight in</p>	<p>Intervention: Interventions supporting healthier snack foods and beverages sold or offered in schools.</p> <p>Outcome: Fruit and vegetable intake Overweight and obesity prevalence</p> <p>Evidence Statement: C There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Outcome: BMI z score</p>

<p>School-based interventions aimed at obesity prevention or healthy weight promotion.</p> <p>Relevant Outcomes: Dietary effectiveness: Fruit and vegetable intake, sugar sweetened beverage intake.</p> <p>Weight-related outcomes: BMI z-score, overweight or obesity prevalence.</p> <p>Study Population: School students (elementary, middle and high school).</p> <p>Studies were included up to: 2012-2017.</p> <p>Included study types: Group RCT, group non-RCT, prospective cohort, cross sectional, cross sectional with comparison, repeat cross sectional, repeat cross sectional with comparison, study design with</p>	<p>Europe, two in Canada, and one each in Australia, Taiwan and the UK. Fourteen studies included fruit and vegetable programmes; another 14 studies included school meal changes; three included healthy food/beverage marketing and eight included healthy eating learning opportunities. Interventions took place in elementary, middle, and high schools. Twenty five interventions were conducted in schools alone and two were conducted in schools plus the home setting.</p> <p>The second review identified 13 primary studies investigating interventions supporting healthier snack foods and beverages sold or offered in schools. These included prospective cohort (n=1); cross-sectional design with comparison (n=6); repeat cross sectional (n=3); repeat cross sectional with comparison (n=1); and other with concurrent comparison (n=2) study designs. All thirteen studies were conducted in the USA. Interventions took place in elementary, middle, and high schools and included competitive food and beverages (n=13), healthy food/beverage marketing (n=1) or healthy eating learning opportunity components (n=1) or a combination of these (n=1).</p> <p>The third review identified 12 primary studies investigating Multicomponent interventions to increase the availability of healthy foods and beverages in schools. These employed a group-RCT design (n=3); repeat cross-sectional design with (n=5); repeat cross-sectional design with comparison (n=1); cross-sectional with comparison design (n=1); and a single group before-after design (n=2). Six studies were conducted in the USA, three in Canada, and three in the UK. Ten interventions were conducted in schools alone and two were conducted in schools plus the home setting. Intervention components included a meal component (n=13), fruit and vegetable program (n=2), competitive foods and beverages</p>	<p>Evidence Statement: E There is some evidence suggesting that this intervention is ineffective, but it is not conclusive.</p> <p>Intervention: Interventions supporting healthier snack foods and beverages sold or offered in schools.</p> <p>Outcome: Sugar sweetened beverage intake</p> <p>Evidence Statement: E There is some evidence suggesting that this intervention is ineffective, but it is not conclusive.</p> <p>Outcome: Overweight or obesity score</p> <p>Evidence Statement: D The evidence is inconsistent, and it is not possible to draw a conclusion.</p> <p>Intervention: Multicomponent interventions to increase the availability of healthy foods and beverages in schools.</p> <p>Outcome: Fruit and vegetable intake Sugar sweetened beverage intake</p>
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<p>concurrent comparison, single group before-after design.</p>	<p>(n=9), celebrations and rewards (n=5), water access (n=2), healthy food/beverage marketing (n=6) or healthy eating learning opportunity (n=6).</p> <p>The fourth review identified 2 primary studies investigating interventions to increase access to water in schools. These employed a cluster RCT (Europe) and repeat cross-sectional with comparison group (USA) study design. Both studies were conducted in schools, but one included only elementary, and the other included elementary, middle and upper schools. The cluster RCT also included healthy eating learning opportunities in addition to increasing access to water.</p> <p>Quality of included studies: The suitability of each study design was rated as greatest, moderate, or least, depending on the degree to which the design protected against threats to validity. Threats to validity were used to characterise studies as having good (zero to one limitation), fair (two to four limitations), or limited (five or more) quality of execution. Studies with limited quality of execution were excluded from the analyses.</p> <p>Although individual quality assessment was not reported, the most common limitations identified were sampling (23 studies) and exposure (18 studies).</p> <p>Synthesis: Effect estimates were narratively reported.</p> <p>Findings:</p>	<p>Evidence Statement: C There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Outcome: BMI z score Overweight and obesity score</p> <p>Evidence Statement: D The evidence is inconsistent, and it is not possible to draw a conclusion.</p> <p>Intervention: Interventions to increase access to water in schools.</p> <p>Outcome: Sugar sweetened beverage intake</p> <p>Evidence Statement: H Evidence about the effectiveness of the intervention is lacking.</p> <p>Outcome: BMI/BMI z score</p> <p>Evidence Statement: C There is some evidence supporting the use of this intervention, but it is not conclusive.</p> <p>Author's conclusions:</p>
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interventions supporting healthier snack foods and beverages sold or offered in schools:

Fruit and vegetable intake:

From a total of 17 studies (18 study arms), eight studies (9 study arms) reported a median relative increase of 20% (IQR 4.3% to 38.5%) for fruit and vegetable intake for the total day. Six studies reported fruit and vegetable intake for the total day that could not be plotted (one study reported an increase in fruit and vegetable consumption, one study reported no change in fruit consumption but an increase in vegetable consumption, one study reported an increase in fruit consumption but no change in vegetable consumption, one study reported no change in fruit consumption but did not assess vegetable consumption, one study reported an increase in fruit and vegetable consumption among students with low access to fruit and vegetables, and one study reported that fruit and vegetable consumption increased in rural areas but not city or suburban areas). The remaining three study arms were not reported in the review.

BMI z-score:

A total of three studies reported BMI z score with a median increase of 0.01 (range 0.14 to 0.03).

Overweight or obesity prevalence:

A total of six studies reported change in obesity or overweight and obesity prevalence combined. Obesity prevalence only was reported in one study, with a decrease of 7.7%. Whereas a total of five studies with a baseline median overweight and obesity

A total of two school-based dietary interventions have favourable effects for improving dietary habits and modest effects for improving or maintaining weight. More evidence is needed regarding interventions with insufficient findings. When selecting an intervention, implementers may need to adapt the intervention to their school population. Findings from this review can inform researchers, school administrators, and public health decision makers about effective interventions to improve students' dietary behaviours and weight-related outcomes.

Limitations:

The authors describe several limitations. First, most articles were from peer-reviewed literature and there is a potential publication bias. However, not all studies reported positive effects. The team attempted to address this by searching grey literature, but only one dissertation met the inclusion criteria.

A formal meta-analysis was not possible, owing to varied study designs, only a few studies reporting CIs or SEs, and reported measures being heterogeneous.

Not all policy and observational studies included a pre-intervention measure. A small number of included studies were observational studies of existing laws that met inclusion criteria.

Most dietary outcomes were based on self-reported data (validated instruments were used but the

prevalence combined of 32.9% reported a decrease of 9.6% (IQI -10.7 to -1.6). Results were similar regardless of whether the focus of the intervention was a school meal or FV program.

Interventions supporting healthier snack foods and beverages sold or offered in schools:

Sugar sweetened beverage intake:

Intake of sugar sweetened beverages was reported by seven studies. Three studies reported a median increase of 0.03 sugar sweetened beverage servings per day (range -0.33 to 0.08). Information on four studies reporting sugar sweetened beverages could not be plotted owing to the use of various measures.

Overweight or obesity prevalence:

A total of three studies reported overweight or obesity prevalence following the CDC definition. One study reported a significantly decreased probability of being overweight in states with strong laws for competitive food nutrition content but no association with the probability of having obesity. One study examined the association between competitive food and beverage laws and overweight or obesity by school level. For the elementary level, strong laws were associated with reduced odds of having obesity compared to states with no laws (OR 0.57 for both four or more strong laws (95% CI: 0.34 to 0.97) and two-three strong laws (95% CI 0.36 to 0.90). Finally, one study reported that students in states with strong school competitive food and beverage laws reported no change in odds of overweight and obesity combined compared with students living in states with no laws.

psychometrics of the instruments were often not reported).

Finally, authors reported the data point closest to the conclusion of the intervention because too few studies reported maintenance. Therefore, maintenance or improvement is unknown.

Comments:

Only one UK study was included in the publication and therefore generalisability of the included interventions to Wales should be considered.

The implications of study quality are not mentioned by the authors when formulating their conclusions.

No formal protocol has been published.

Unable to ascertain quality assessment ratings of individual studies from the paper.

Multicomponent interventions to increase the availability of healthy foods and beverages in schools:

Fruit and vegetable intake:

A total of five studies reported on the effectiveness of the intervention on children's fruit and vegetable intake. Four studies reported a median relative increase of 15% for fruit and vegetable intake for the total day (IQI 1.0% to 45.0%). No information provided regarding a fifth study.

Sugar sweetened beverage intake:

Three studies reported on the effectiveness on sugar sweetened beverage intake, two of which reported a decrease in sugar sweetened beverages (range -0.3 to -0.2).

BMI z score:

Two studies reported BMI z score. One study reported a BMI z score decrease of 0.01 and one study reported no change.

Overweight or obesity score:

A total of six studies in five publications reported overweight or obesity prevalence following CDC or International Obesity Task Force definitions.

Four studies reported overweight and obesity prevalence combined. In two large U.S. studies, the average odds of overweight and obesity prevalence combined were no longer increasing during the post-policy period, and there were

	<p>population-level improvements in overweight and obesity trends (data not shown). The remaining two studies reported no change in overweight and obesity prevalence.</p> <p>One study reported obesity prevalence and found a 1.0% decrease after the intervention, and another study reported reduced odds of being overweight (OR 0.85, 95% CI: 0.59 to 1.20) or obese (OR 0.92, 95% CI: 0.73 to 1.16).</p> <p>Interventions to increase access to water in schools:</p> <p><u>Sugar sweetened beverage intake:</u></p> <p>One study reported effectiveness outcomes for sugar sweetened beverages and reported no change in soft drink consumption. Study results were reported qualitatively so no effect sizes were available.</p> <p><u>BMI z score, overweight and obesity prevalence combined:</u></p> <p>Two studies reported effectiveness outcomes of BMI z scores and both reported a small decrease in BMI z score, overweight and obesity prevalence combined. The range of BMI z score reduction was the only effect size reported (range -0.004 to -0.016).</p>	
<p>Wolfenden L, et al., (2022) Strategies for enhancing the implementation of school-based policies or practices targeting diet, physical activity, obesity,</p>	<p>Description of included studies: The aims of this systematic review were to evaluate the benefits and harms of strategies aiming to improve school implementation of interventions to address student diet, physical activity, tobacco or alcohol use, and obesity, and secondly, to evaluate the benefits and harms of strategies to improve intervention implementation</p>	<p>Intervention: School based interventions with implementations strategies.</p> <p>Outcome: Diet</p>

<p>tobacco or alcohol use. <i>Cochrane Database of Systematic Reviews</i>, CD011677</p> <p>Type of source: Systematic review.</p> <p>Interventions: School-based interventions targeting student diet, physical activity, prevention of tobacco or alcohol use, or obesity. Studies were only included if they tested implementation strategies designed to improve the implementation of these interventions.</p> <p>Relevant Outcomes: Diet: validated and non-validated measures of student diet (e.g. food records). Obesity: objectively measured BMI; other estimates of anthropometry (e.g., weight, waist circumference).</p>	<p>on measures of student diet, physical activity, obesity, tobacco use or alcohol use; describe their cost or cost-effectiveness; and any harms of strategies on schools, school staff or students.</p> <p>Thirty-eight studies were included in the systematic review. Thirty-eight studies were included in the narrative synthesis and 14 studies included in meta-analysis.</p> <p>Eight studies employed RCT designs, 18 cluster-RCT designs, and 12 non-RCT designs.</p> <p>Twenty-two studies were conducted in the USA, nine in Australia, two each in India and Canada, and one each New Zealand, the Netherlands, and South Africa.</p> <p>All trials comprised of multiple discrete implementation strategies, the most common being: educational materials, educational outreach and educational meetings.</p> <p>Quality of included studies: Two authors assessed risk of bias independently for each study. Cochrane's risk of bias 1 tool for assessing risk of bias was used, which includes assessments based on six domains. Additional criteria for cluster-RCTs and non-randomised trial designs were included. Domains were assessed as having 'low', 'high', or 'unclear' risk of bias in accordance with the Cochrane Handbook for Systematic Reviews of Interventions.</p> <p>Selective reporting bias and publication bias were also assessed.</p> <p>The overall certainty of evidence was low and ranged from very low to moderate for secondary review outcomes. Twelve studies were</p>	<p>Evidence Statement C: There is some evidence supporting the use of this intervention but it is not conclusive.</p> <p>Outcome: Obesity</p> <p>Evidence Statement: F There is moderate to good quality evidence that this intervention is unlikely to be effective.</p> <p>Author's conclusions: The use of implementation strategies may result in large increases in implementation of interventions, and slight improvements in measures of student diet. Further research is required to assess the impact of implementation strategies on such behavioural- and obesity-related outcomes.</p> <p>Limitations: Some measures of outcomes involved self-report.</p> <p>Trials examining implementation strategies in the school setting are dominated by studies conducted in the USA (22 of 38 studies).</p> <p>The overall certainty of the randomised trial evidence was moderate to very low for secondary outcomes.</p> <p>All trials were considered to be at high risk of performance bias, and all non-randomised designs were</p>
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<p>Study Population: Students aged between five and 18.</p> <p>Studies were included up to: 2016 to 2021.</p> <p>Included study types: RCTs and cluster-RCTs; non-RCTs and cluster non-RCTs; and controlled before-after studies (CBAs), cluster-CBAs.</p>	<p>at low overall risk of bias (of which seven had relevant outcomes for this report); sixteen were at an unclear overall risk of bias (of which six had relevant outcomes); ten studies were at a high risk of overall bias (of which two had relevant outcomes).</p> <p>Synthesis: For RCTs, meta-analyses of primary and secondary outcomes using a random-effects model were calculated, or in instances where there were between two and five studies, a fixed-effect model. The synthesis of the effects for non-randomised studies followed the 'Synthesis without meta-analysis' (SWiM) guidelines.</p> <p>Findings: Eleven RCTs or cluster-RCTs explored the effect of implementation strategies on child diet. Five non-RCTs reported child measures of diet.</p> <p>Eight RCTs or cluster-RCTs explored the effect of implementation strategies on obesity.</p> <p><u>Diet:</u></p> <p>Meta-analysis of the 11 RCTs found strategies to support the implementation of nutrition policies and practices were associated with a small effect (SMD 0.08, 95% CI: 0.02 to 0.15; I² 63%; 16,649 participants; low-certainty evidence). One study that could not be included in the meta-analysis found little differences in the selected measure of student intake (fat) between groups.</p> <p>For the five non-RCTs, the direction of effect for all studies favoured students at schools receiving implementation support.</p>	<p>at high risk of bias due to selection bias from both random sequence generation and allocation concealment. Most trials were small, recruiting relatively small numbers of schools or school staff, limiting the precision of estimated effects.</p> <p>Terminology in implementation science is still evolving, which may have increased the likelihood that relevant studies may not have been captured in the search strategy.</p> <p>Comments: No UK studies included.</p> <p>No conflicts of interest reported, but some declarations of interest (none effecting review credibility).</p>
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	<p><u>Obesity:</u></p> <p>All eight studies were included in the meta-analysis and reported BMI or BMI-z outcomes. Implementation strategies probably result in little to no difference in obesity (SMD -0.02, 95% CI: -0.05 to 0.02; I² 5%; 18,618 participants; moderate certainty evidence).</p>	
<p>Yoong S, et al., (2023) Healthy eating interventions delivered in early childhood education and care settings for improving the diet of children aged six months to six years (Review). <i>Cochrane Database of Systematic Reviews</i>, CD013862.</p> <p>Type of source: Systematic review.</p> <p>Interventions: Healthy eating interventions delivered in early childhood education and care settings (ECEC).</p> <p>Relevant Outcomes: Consumption of fruit or vegetables or fruit and vegetables combined,</p>	<p>Description of included studies: The aim of this systematic review was to assess the effectiveness of healthy eating interventions delivered in ECEC settings for improving dietary intake in children aged six months to six years, relative to usual care, no intervention or an alternative, non-dietary intervention.</p> <p>Secondary objectives were to assess the impact of ECEC-based healthy eating interventions on physical outcomes (e.g. child body mass index (BMI), weight, waist circumference), language and cognitive outcomes, social/emotional and quality-of-life outcomes.</p> <p>Cost and adverse consequences of ECEC-based healthy eating interventions were also explored.</p> <p>Fifty-two studies (96 articles) were included in the narrative synthesis. Thirty-eight studies were included in the meta-analysis.</p> <p>All studies were cluster-RCTs, with one being a 2 x 2 factorial trial.</p> <p>Twenty studies were conducted in the USA, six were conducted in Australia, four were conducted in Israel, and three were conducted in the UK. Two each were conducted in Belgium, Germany, the Netherlands and Norway. One each was conducted in Greece,</p>	<p>Intervention: Healthy eating interventions delivered in early childhood education and care settings.</p> <p>Outcome: Consumption of fruit</p> <p>Evidence Statement C: There is some evidence supporting the use of this intervention but it is not conclusive.</p> <p>Outcome: Consumption of vegetables</p> <p>Evidence Statement E: There is some evidence suggesting that this intervention is ineffective, but it is not conclusive.</p> <p>Outcome: Consumption of sugar sweetened beverages</p> <p>Evidence Statement C:</p>

<p>consumption of sugar-sweetened beverages.</p> <p>Absolute weight in kilograms, BMI, BMI z score (using age-appropriate cut-offs), risk of overweight and obesity, waist circumference.</p> <p>Study Population: Children aged six months to six years.</p> <p>Studies were included up to: 2022 (no time restrictions were placed on the search).</p> <p>Included study types: RCTs, including cluster-RCTs, stepped-wedge RCTs, factorial RCTs, multiple baseline RCTs and randomised cross-over trials.</p>	<p>Spain, Colombia, China, Italy, Turkey, Canada, Switzerland, Finland and Mexico. One study was based in several European countries including Belgium, Bulgaria, Germany, Greece, Poland and Spain.</p> <p>Interventions were generally multicomponent. Forty-three interventions (in 39 studies) included curriculum strategies, 56 (in 50 studies) included ethos and environment strategies and 50 (in 47 studies) included partnership strategies. Twenty-two studies also included elements in the home setting and three included elements in the community setting.</p> <p>Interventions lasted from four weeks to three years; were delivered by a range of people including healthcare providers, ECEC staff, and researchers; used different delivery methods (telephone, face-to-face, online, printed materials); and measured results in a variety of ways (e.g. parent or staff surveys, observations of children's eating, and weighing foods before and after meals).</p> <p>Quality of included studies: Pairs of review authors independently screened titles and abstracts and extracted study data. Risk of bias was assessed for all studies against 12 criteria within the Cochrane risk of bias tool (RoB 1). For the primary outcomes (dietary outcomes), 19 studies were assessed as overall high risk of bias (assessed as high risk of bias on three or more domains), with performance and detection bias being most commonly judged as high risk of bias.</p> <p>Synthesis: For studies with suitable data and homogeneity, meta-analyses using a random-effects model was performed; otherwise, findings</p>	<p>There is some evidence supporting the use of this intervention but it is not conclusive.</p> <p>Outcome: BMI and BMI z score</p> <p>Evidence Statement E: There is some evidence suggesting that this intervention is ineffective but it is not conclusive.</p> <p>Outcome: Child weight and risk of overweight and obesity</p> <p>Evidence Statement B: This intervention is supported by good to moderate quality evidence of its effectiveness.</p> <p>Author's conclusions: ECEC-based healthy eating interventions may improve child diet quality slightly, but the evidence is very uncertain, and likely increase child fruit consumption slightly. There is uncertainty about the effect of ECEC-based healthy eating interventions on vegetable consumption.</p> <p>ECEC-based healthy eating interventions may result in little to no difference in child consumption of non-core foods and sugar-sweetened beverages. Healthy eating interventions could have favourable effects on child weight and risk of overweight and obesity, although there was little to no difference in BMI and BMI z-scores.</p>
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were described using vote-counting approaches and via harvest plots.

Findings:

Six included studies measured diet quality; 18 measured fruit consumption; 21 measured vegetable consumption; six measured the consumption of fruit and vegetables together. Seven studies reported on the consumption of sugar-sweetened beverages.

Thirty-six studies measured BMI, BMI z-score, weight, overweight and obesity, or waist circumference, or a combination of some or all of these.

Consumption of fruit or vegetables:

Meta-analysis and GRADE reported moderate certainty evidence that ECEC-based healthy eating interventions are likely increase children's consumption of fruit (SMD 0.11, 95% CI: 0.04 to 0.18, $p < 0.01$, I^2 0%; 11 studies, 2901 children).

Meta-analysis and GRADE reported very low certainty evidence of ECEC-based healthy eating interventions on children's consumption of vegetables (SMD 0.12, 95% CI: -0.01 to 0.25, $p=0.08$, I^2 70%; 13 studies, 3335 children).

Consumption of non-core foods & sugar-sweetened beverages:

Meta-analysis and GRADE reported moderate certainty evidence that ECEC-based healthy eating interventions likely result in little to no difference in children's consumption of sugar-sweetened

Limitations:

Visual inspection of the forest plots indicated some asymmetry potentially due to publication bias; no studies were undertaken in low- and low- to middle-income countries. Therefore the effectiveness of these interventions in low- and lower-middle-income countries remains unknown. All but one study was undertaken in children aged between two and six years, therefore the impact of the interventions on children aged six months to two years also remains unknown.

Several factors may limit the certainty of the evidence. The most common reason for downgrading was due to studies assessed as high risk of bias overall, inconsistency and publication bias.

Attrition bias also appears prevalent across studies, particularly for measures of dietary intake.

As many of the review authors also undertake primary research related to the review topic, it is possible that they have interpreted the results to be more positive.

Authors mentioned that confidence in the evidence is low because the healthy eating programmes were conducted, delivered and assessed in different ways across the studies.

Comments:

	<p>beverages (SMD -0.10, 95% CI: -0.34 to 0.14; $p=0.41$, I^2 45%; 3 studies, 522 children).</p> <p><u>Anthropometric outcomes:</u></p> <p>ECEC-based healthy eating interventions may result in little to no difference in child BMI (MD -0.08, 95% CI: -0.23 to 0.07, $p=0.30$, I^2 65%; 15 studies, 3932 children) or in child BMI z-score (MD -0.03, 95% CI: -0.09 to 0.03, $p=0.36$, I^2 0%; 17 studies; 4766 children). ECEC-based healthy eating interventions may decrease child weight (MD -0.23, 95% CI: -0.49 to 0.03, $p=0.09$, I^2 0%; 9 studies, 2071 children) and risk of overweight and obesity (RR 0.81, 95% CI 0.65 to 1.01, $p=0.07$, I^2 0%; 5 studies, 1070 children).</p>	<p>Studies captured dietary intake using objective methods, such as plate waste audits or direct observations, as well as subjective methods (e.g. parent-reported dietary intake), such as short diet questions, food frequency questionnaires, food diaries and 24-hour recalls.</p> <p>The majority (60%) of the studies targeted multiple risk factors (primarily physical activity, 35 interventions). Therefore, the effects of interventions that target healthy eating in isolation remain unknown.</p>
<p>Yuksel H, et al., (2020). School-Based Intervention Programs for Preventing Obesity and Promoting Physical Activity and Fitness: A Systematic Review. <i>International Journal of Environmental Research and Public Health</i>, 17, 347.</p> <p>Type of source: Systematic review.</p> <p>Interventions: School based interventions.</p>	<p>Description of included studies: The aim of the review was to systematically examine the possibility of school-based interventions on promoting physical activity and physical fitness as well as preventing obesity.</p> <p>Nineteen studies examining school-based interventions were included. Eight primary studies were cluster RCTs, four were non-randomized controlled trial. Three quasi-experimental design, two RCTs and two studies as one-group, repeated measures design and mixed-effects model.</p> <p>Four primary studies were conducted in USA, two were conducted in Australia, and one each were conducted in China, Czech Republic, England, France, Iceland, India, Israel, Norway, Pakistan, Scotland, South Africa and Switzerland.</p>	<p>Intervention: School based physical activity interventions.</p> <p>Outcome: BMI & Body fat percentage</p> <p>Evidence Statement: D The evidence supporting the use of this intervention is inconsistent.</p> <p>Author's conclusions: School-based interventions can have important potential in the health promotion of children in terms of obesity, physical activity level and physical fitness. However, the quality, duration, and priority of physical activity intervention in comprehensive school based programs and teacher capacity are some of the most</p>

<p>Relevant Outcomes: BMI, body composition (waist circumference, skinfold thickness, body fat percentage).</p> <p>Study Population: Children and adolescents.</p> <p>Studies were included up to: 2010 to 2019.</p> <p>Included study types: Cluster RCTs, RCTs, non-RCTs, controlled trials, quasi-experimental studies, one-group, repeated measures design and mixed-effects model.</p>	<p>Thirteen interventions were conducted in primary schools and six in secondary schools. Interventions included either a physical activity component (n=14), or education, guidance, counselling, and orientation support components (n=5).</p> <p>Study durations ranged from 8 weeks to 5 years. With 11 having a duration of 12 months or less and eight having a duration of more than 12 months.</p> <p>Quality of included studies: Two independent researchers evaluated the quality of the full text of the studies through the 'validated quality assessment tool for quantitative studies' developed in the Effective Public Health Practice Project (EPHPP).</p> <p>Ten studies were rated as strong; nine studies were rated as moderate quality. There were no studies rated as weak.</p> <p>Synthesis: Results are presented narratively.</p> <p>Findings: Fifteen studies included outcomes relevant to this review.</p> <p>BMI: Eight of 15 studies with BMI outcomes identified a statistically significant difference in favour of the intervention group. The remaining six studies identified no statistically significant difference. In one study, a significant difference was found in girls, but not in boys.</p>	<p>important factors for preventing obesity and promoting physical activity and physical fitness. If more impact is desired in school based intervention programs, the focus of the program should be physical activity and, as far as possible, physical activities should be implemented directly. To prevent obesity and to promote physical activity and physical fitness, the characteristics of more effective programs should be examined in detail and appropriate intervention programs should be designed. Such programs should be multicomponent and longitudinal to foster children's lifelong physical activity habits. This habit requires knowledge, skills and attitudes.</p> <p>Limitations: Only English language studies were included in the review.</p> <p>The authors state that since the contents and types of physical activity programmes are generally multicomponent, it is difficult to isolate the most effective components.</p> <p>The authors state that some variables were measured subjectively (e.g., via questionnaire), although it is unclear whether this refers to physical activity outcomes which are not of interest to this particular review of reviews.</p> <p>Comments:</p>
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When the BMI variable was examined in studies more focused on physical activity, the success rate was 72.72% (eight out of 11 studies). The success rate was found to be 50% (two out of four studies) in studies using physical activity only as support.

Review authors also examined intervention duration and obesity effectiveness, by comparing studies lasting less than six months and the studies lasting longer than six months. The success rate of the BMI variable was 62.5% (five out of eight studies) for studies with an intervention longer than six months. Studies with less than six months intervention duration, the success rate was 66.66% (four out of six studies).

Body fat percentage:

In eight studies body fat percentage was calculated by skin fold thickness, waist circumference or digital measurements. Significant improvement was observed in four of the eight studies in which body fat percentage was measured.

Limited search, with unclear information about how some included studies were obtained.

5/19 studies are from non-OECD countries, two UK studies in total. Could limit generalisability to Wales.

12 Appendix D: Grading Scheme

A (dark green): This intervention is supported by high quality evidence of its effectiveness	NICE Recommended intervention/systematic review, of mostly good quality studies, with meta-analysis of majority of studies favouring intervention effect
B (light green): This intervention is supported by good to moderate quality evidence of its effectiveness	Systematic review of moderate to good quality studies with majority, or meta-analysis demonstrating positive effect. NICE grade B recommendation.
C (yellow): There is some evidence supporting the use of this intervention but it is not conclusive	Systematic review of moderate to poor quality studies with majority, or meta-analysis favouring the intervention or systematic review where studies may be of good quality and showing effect but where the number of studies is too small to allow firm conclusions to be drawn
D (orange): The evidence is inconsistent and it is not possible to draw a conclusion	Systematic review of studies with inconsistent findings
E (pink): There is some evidence suggesting that this intervention is ineffective but it is not conclusive	Systematic review of poor quality studies with majority or meta - analysis favouring control/no effect intervention or where the number of studies is too small to allow firm conclusions to be drawn
F (red): There is moderate to good quality evidence that this intervention is unlikely to be effective	Systematic review of moderate to good quality studies with majority in favour of control/no effect
G (purple): There is high quality evidence of ineffectiveness or a specific recommendation that these interventions should not be introduced in the UK	NICE specifically recommends this intervention should not be adopted or there is high quality review level evidence from meta-analysis of good quality studies that demonstrates no effect
H (grey): Evidence about the effectiveness of the intervention is lacking.	Systematic review, NICE guidance or Public Health Wales reviewers conclude that no reliable evidence of effectiveness or ineffectiveness, is available either because there are no/too few relevant studies or because the studies available are of a design inappropriate for assessing effectiveness.



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