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Evidence Check

Obesity prevention approaches for children delivered in primary schools

An **Evidence Check** rapid review brokered by the Sax Institute for the NSW Office of Preventive Health. October 2019.

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This report was prepared by Rebecca K Hodder, Luke Wolfenden, Kate M O'Brien, Courtney Barnes, Alison Brown and Fiona Stacey.

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Effectiveness of obesity prevention approaches targeting children aged 5–12 years delivered in primary schools

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Executive summary

Background and context

An Evidence Check rapid review, commissioned by the NSW Office of Preventive Health, was undertaken to review research relating to the effectiveness of childhood obesity prevention programs delivered in primary schools. The Evidence Check review will be used to inform the program review and refresh of the 'Live Life Well @ School' program as part of the NSW Healthy Children Initiative.

Purpose of the Evidence Check review

To conduct an Evidence Check rapid review of recent research relating to the effectiveness of childhood obesity prevention programs delivered in primary schools. Specifically, the review will address:

- ***Question 1:*** *What is the effectiveness of obesity prevention programs targeting children aged 5–12 years delivered in the primary school setting?*
- ***Question 2:*** *Is there any evidence on how to best implement obesity prevention programs within the primary school setting to optimise uptake and effectiveness?*

Summary of methods

Review Questions

Question 1: *What is the effectiveness of obesity prevention programs targeting children aged 5–12 years delivered in the primary school setting?*

An update of a 2016 review of reviews by the Physical Activity Nutrition Obesity Research Group (PANORG), "*Obesity Prevention in Children and Young People aged 0-18 Years*"[1], was conducted, which was limited to those reviews that reported obesity prevention, physical activity or diet-focused programs that are implemented within primary schools.

A search of health government websites was also conducted to identify any emerging Australian intervention evidence. Findings from new reviews identified in the update and the resulting studies from the government website search were synthesised narratively.

Question 2: Is there any evidence on how to best implement obesity prevention programs within the primary school setting to optimise uptake and effectiveness?

An update of a 2017 Cochrane review by Wolfenden et al., "*Strategies for enhancing the implementation of school-based policies or practices targeting risk factors for chronic disease*"[2], was conducted, limited to those trials that reported obesity prevention programs implemented within primary schools. The findings from new studies identified in the update and those from the original review were synthesised narratively. Australian intervention studies identified in Question 1 were also reviewed for eligibility.

Summary of findings

Question 1: *What is the effectiveness of obesity prevention programs targeting children aged 5–12 years delivered in the primary schools setting?*

Twelve new reviews and six emerging Australian studies with available data were identified that met eligibility criteria. Moderate- to critically low-quality evidence of effectiveness was found for primary school-based interventions targeting nutrition and physical activity for reducing student body mass index (BMI); physical activity interventions for reducing student BMI and increasing physical activity; and nutrition-focused interventions in improving diet-related outcomes. Effective combined nutrition and physical activity

approaches included those targeting diet and/or physical activity that included social marketing aspects; long-term physical activity, or physical activity and nutrition; and combined physical activity, sedentary behaviour and nutrition with direct parental involvement. Physical activity approaches found to be effective included those targeting fundamental movement skills and physical activity levels; physical education (PE); and education and lifestyle interventions. Effective nutrition-focused interventions included lunchbox interventions and interventions focused on improving the nutritional quality of student dietary intake.

Emerging Australian intervention evidence was found for an implementation intervention that was effective in increasing teacher scheduling of physical activity and student physical activity; a school uniform intervention that was effective in increasing student physical activity; a multicomponent online canteen intervention effective in improving nutrition quality of student lunch orders; and a multicomponent m-health intervention that was effective in improving nutrition quality in student lunchboxes.

Question 2: *Is there any evidence on how to best implement obesity prevention programs within the primary school setting to optimise uptake and effectiveness?*

Eight new studies identified via the updated search, 22 of 27 studies from the original review, and two unpublished studies met eligibility criteria. Of the 32 included trials, 20 reported significant improvements in at least one implementation outcome, three trials did not report any significant improvements in implementation and nine did not report any significance tests on such outcomes. Among 11 trials reporting dichotomous implementation outcomes of strategies — the proportion of schools or school staff (e.g. classes) implementing a targeted policy or practice — versus a minimal or usual practice control, the median unadjusted (improvement) effect size was 16.2% and ranged from -0.2% to 66.6%. Six trials reported the percentage of an intervention program or program content that had been implemented, the effects of which were mixed. The unadjusted median effect in the proportion of program or program content implemented relative to the control was 23.65% (range -8% to 43%). Five trials reported the impact of implementation strategies on the time per week spent by teachers in implementing physical activity or PE lessons, with improvements, relative to control, ranging from 5.7 minutes per week to 54.9 minutes per week (median=36.6 minutes per week). While there was considerable heterogeneity in studies, effective implementation strategies were identified to improve implementation of canteen policies, time for organised physical activity and the quality of physical activity program delivery. Careful selection of implementation support to address the identified implementation barriers of specific policies or practices is recommended to maximise the impact of future implementation efforts in this setting.

Overall conclusions and recommendations

The rapid evidence review identified new research regarding both the effectiveness of, and effective implementation strategies for, childhood obesity prevention programs delivered within primary schools as outlined below.

Question 1: *What is the effectiveness of obesity prevention programs targeting children aged 5-12 years delivered in the primary schools setting?*

This review identified evidence to support the following strategies as effective in improving child obesity and related outcomes: multicomponent child obesity prevention interventions; interventions that combined nutrition and physical activity; interventions that focused on physical activity or nutrition only; Interventions on school food service and environments; and active travel strategies. As a result, these approaches are recommended for implementation within NSW primary schools after an assessment of their contextual relevance.

Emerging evidence of effectiveness was also identified in a number of intervention studies conducted within NSW into approaches focusing on physical activity, nutrition, and school canteens. As they are relevant to

the NSW context, these intervention approaches should also be considered for implementation within NSW primary schools.

Question 2: *Is there any evidence on how to best implement obesity prevention programs within the primary school setting to optimise uptake and effectiveness?*

A number of effective implementation strategies for childhood obesity prevention were identified and are recommended to improve implementation within NSW primary schools. These include: audit and feedback; continuous quality improvement; external funding; education materials; education meetings; education outreach visits; local consensus processes; local opinion leaders; and tailored interventions to improve implementation of healthy canteen policies.

Careful selection of implementation support to address the identified implementation barriers of specific policies or practices is recommended to maximise the impact of future implementation efforts within NSW primary schools

Background and context

The prevention of childhood overweight and obesity is a priority for the NSW Government and, until recently, was identified as a priority by the State Premier. As part of this priority, the NSW Government and related partners are committed to continuing work to reduce the prevalence of childhood overweight and obesity by 5% by 2025.

The NSW Office of Preventive Health (the Agency) delivers state-wide preventive health programs on behalf of the NSW Ministry of Health. The mission of the Agency is to develop, evaluate and support the implementation of world-class preventive health and health promotion programs in NSW to improve population health, reduce health inequalities and reduce hospitalisations. The Agency works closely with the Centre for Population Health within the NSW Ministry of Health on the prevention of childhood overweight and obesity and all its work.

One component of the Agency's work is the NSW Healthy Children Initiative. A key program within that Initiative is Live Life Well @ School, which is a school-based program that has been available to all NSW Department of Education schools since 2008 and to all primary schools in NSW since 2011.

Live Life Well @ School is a collaborative effort between NSW Health, the NSW Department of Education, Catholic and independent school sectors. It is available in all NSW primary schools to promote healthy eating and physical activity to students and their families.

The program aims to enhance teachers' knowledge, skills and confidence in teaching nutrition and physical activity (including fundamental movement skills) as part of the K–6 Personal Development, Health and Physical Activity (PDHPE) syllabus. The program utilises a 'whole-of-school' approach consistent with classroom teaching and school policies and encourages community links. The Agency delivers this program by working with Local Health District (LHD) health promotion staff to liaise with local primary schools.

The Agency is currently refreshing the Live Life Well @ School program. To inform this program review and redesign, the Agency commissioned the Sax Institute to broker this review of the latest evidence for effective programs delivered in primary schools to reduce childhood obesity. In addition, the review examined recent evidence about what implementation approaches are most successful when delivering obesity prevention programs in primary schools.

Existing evidence for the effectiveness of obesity prevention approaches targeting children

In 2016, the Agency commissioned The Physical Activity Nutrition Obesity Research Group (PANORG) at the University of Sydney, via the Sax Institute, to undertake a rapid evidence review with a focus on obesity prevention in children and adolescents (0–18 years).[1] The purpose of that review was to examine new evidence (published since 2011) and to provide advice on obesity prevention policy options for this target population. The rapid evidence review identified 93 new reviews focused on obesity prevention (published between 2011 and 2016) and identified a range of evidence-based best practice and policy options,[1] including those that could be delivered within primary schools.

Purpose of this rapid evidence review

To conduct a rapid review of recent research relating to the effectiveness of childhood obesity prevention programs delivered in primary schools, as commissioned by the NSW Office of Preventive Health. Specifically, the review addressed:

- Question 1: What is the effectiveness of obesity prevention programs targeting children aged 5-12 years delivered in the primary school setting?

- Question 2: Is there any evidence on how to best implement obesity prevention programs within the primary school setting to optimise uptake and effectiveness?

Question 1: What is the effectiveness of obesity prevention programs targeting children aged 5-12 years, delivered in the primary school setting?

Objectives

The primary aim of the review of reviews was to examine any new evidence regarding the effectiveness of obesity prevention programs targeting children aged 5–12 years delivered in the primary school setting. This is an update of a previous review of reviews that was conducted as part of a rapid evidence review entitled "*Obesity prevention in children and young people aged 0–18 years*"[1] which was limited to reviews that reported obesity prevention, physical activity or diet-focused programs that were implemented within primary schools only.

In addition, a search of health government websites was conducted to identify any emerging evidence on Australian interventions regarding the effectiveness of obesity prevention programs targeting children aged 5–12 years delivered in the primary school setting.

Methods

Search strategy

Review of published literature

The searches of electronic databases of the earlier existing review by PANORG were replicated. This involved searches of Medline, Embase, CINAHL, the Cochrane database of systematic reviews, Scopus, and the Health Technology Assessment database from November 2015 to 7 June 2019 (Appendix 1 Medline search strategy). The combination of relevant keywords used in the previous Evidence Review by PANORG[1] including search terms for participants, intervention, study design, and comparator consistent with the US National Library Medical Subject Headings (MeSH®) Thesaurus was used, with the exclusion of terms related to interventions implemented in non-primary school settings. The search strategy was reviewed and performed by an information specialist and modified to suit each database. A search within Google Scholar was conducted using a simplified search strategy and the first 200 records examined for any relevant reviews.

Emerging Australian intervention evidence

National, State (NSW) and NSW LHD government websites were searched in July 2019 for eligible research or grant schemes awarded in the last five years using key terms "child", "school/school-based", "primary", "community", and "obesity".

Selection criteria

Review of published literature

To be included reviews needed to meet the following eligibility criteria:

- **Study type:** meta-analyses and systematic reviews of randomised trials or of longitudinal studies.
- **Publication date:** published in English between November 2015 and 7 June 2019.
- **Population of interest:** children and young people aged 5–12 years. Reviews were included if at least 60% of the included reviews targeted children and young people aged 5–12 years or if results were reported separately for children aged 5–12 years.
- **Country:** include schools and populations in Australia and similar to Australia, including United States (US), United Kingdom (UK), Western Europe, Canada and New Zealand.
- **Intervention:** synthesise evidence of effectiveness (i.e. evaluation of intervention impacts and outcomes) of primary school-based prevention interventions to improve physical activity, diet or weight status. Reviews were included if at least 60% of the included reviews included primary school-based interventions or if results were reported separately for primary school-based interventions.
- **Impacts and outcomes:**
    - Objectively or subjectively measured physical activity and eating behaviours:
        - Physical activity-related outcomes: intensity levels, duration of physical activity, frequency of physical activity or sedentary behaviour (e.g. screen time), or related knowledge
        - Eating behaviours: types of food eaten (e.g. vegetables, fruits, energy-dense nutrient-poor foods), diet quality (food indices), breakfast programs, meals eaten out, fast food or take-away food consumption, portion size, or nutrition-related knowledge.
    - Objectively or subjectively measured weight outcomes (including weight, BMI, waist circumference or anthropometric measure).

Emerging Australian intervention evidence

To be included in this review, intervention studies needed to meet the same eligibility criteria as the review of reviews, except studies were not required to be randomised trials or longitudinal studies from grants/funding awarded in the last five years. Chief investigators of potentially eligible studies were contacted to inquire whether any relevant outcome data had been published, or if not published, whether the investigators would share any unpublished outcome data. Investigators were also asked if they were aware of any other potentially eligible Australian studies that may be eligible for the review that had either been recently published, or were yet to be published.

Data collection and analysis

Review of published literature

Independent authors screened the titles, abstracts, and full texts of all identified reviews. One author extracted data from eligible studies using a standardised data extraction tool (design, participants, interventions, outcomes) and assessed overall quality of the evidence (assessed as high, moderate, low or critically low using the current version of the Assessing the Methodology Quality of Systematic Reviews tool (AMSTAR2)).[3] In the original review, studies assessed as being of 'critically low' quality using the original AMSTAR tool[1] were excluded from synthesis (i.e. these studies are not described in the results or the conclusions). The original AMSTAR tool has a different cut off point for 'critically low' studies than the AMSTAR2, which defines studies as 'critically low' if scoring less than 4. For consistency with the original 2016 review of reviews methods, the quality of the evidence in newly identified studies were also assessed using the original AMSTAR tool and excluded from the synthesis if assessed as 'critically low'. Data extraction and quality assessment was cross-checked by a second author.

Emerging Australian intervention evidence

Available data from eligible studies were extracted by one author (design, participants, interventions, outcomes).

Findings of the updated review of reviews and emerging Australian intervention evidence are reported narratively.

Results

Review of reviews

The updated search identified 2612 unique records of which 68 full-text records were assessed for eligibility and 12 new studies were included (see Figure 1).[4-15] See Appendix 2 for characteristics of included reviews.

All reviews included studies conducted from a variety of countries, including Australia, with the exception of one which synthesised studies conducted in the US only.[14] Across the reviews, the majority of studies were conducted in the US, UK, Germany, Spain, The Netherlands, Italy, Greece, Canada and New Zealand. Between six and 85 intervention studies were included in the 12 reviews, which involved between 2446 and 72,934 participants. Of the 12 included reviews, seven assessed the effectiveness of school-based combined nutrition and/or physical activity interventions,[4, 6, 9, 10, 12, 14, 15] three assessed the effectiveness of school-based physical activity interventions,[7, 8, 13] and two assessed the effectiveness of school-based nutrition interventions.[5, 11]

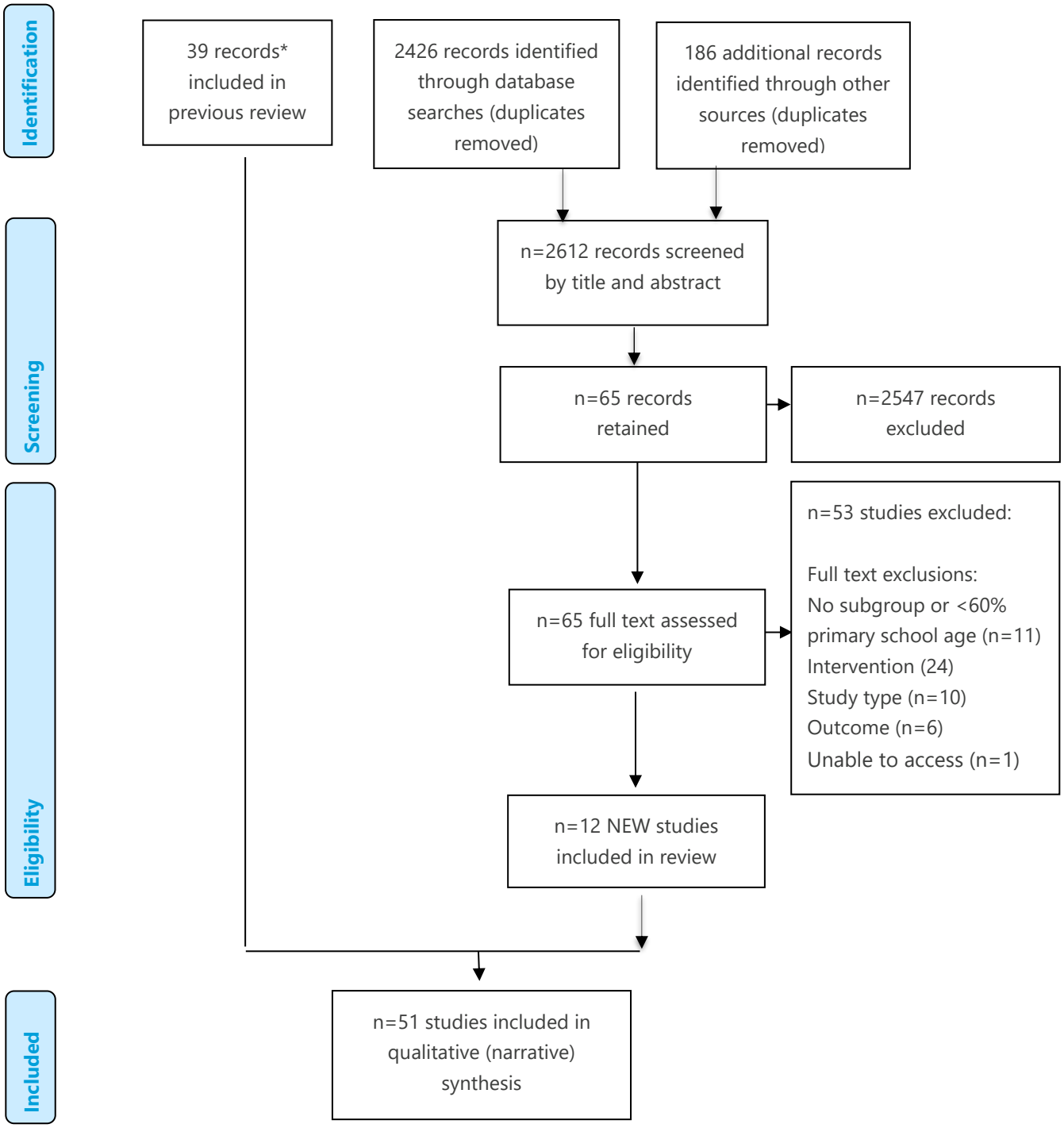

Figure 1. PRISMA Flow Diagram review of reviews

*Estimated number of reviews reporting results in primary schools from 2016 rapid evidence review

Emerging Australian intervention evidence

A total of 57 government websites were searched (28 national, 14 state (NSW), 15 NSW LHD; Appendix 3 – government websites). Nineteen eligible grants were identified from the government website search (Appendix 4 for list of grants) and study investigators from all 19 grants were contacted to request any published or available unpublished outcome data. Of those, outcome data was available or provided in confidence for six individual studies, all of which were cluster-randomised controlled trials (C-RCTs) conducted within the NSW Hunter New England (HNE) LHD (Appendix 5). Two studies assessed the effectiveness of school-based physical activity interventions, one study assessed the effectiveness of a school uniform intervention, and the remaining three studies assessed the effectiveness of school-based nutrition interventions.

Effectiveness of obesity prevention approaches in the primary school setting

Combined nutrition and/or physical activity interventions

Evidence from review of reviews

Of the seven reviews that assessed the effectiveness of school-based combined nutrition and/or physical activity interventions,[4, 6, 9, 10, 12, 14, 15] moderate quality evidence of effectiveness was found for a positive impact on student BMI in two reviews (Table 1).[6, 12] A systematic review and meta-analysis of 85 RCTs found school-based lifestyle interventions that targeted diet and/or physical activity and/or education to be effective in reducing student BMI compared to controls (standardised mean difference [SMD] -0.072; 95% confidence interval [CI]: -0.11 to -0.04).[12] A narrative review of RCTs and non-randomised trials found universal school-based interventions that targeted both healthy eating and physical activity were effective in reducing BMI in nine of 15 analyses when compared to controls.[6]

Four reviews of critically low-quality evidence were identified which reported a positive effect on student BMI.[4, 9, 10, 15] The four reviews assessed the effectiveness of nutrition and/or physical activity interventions that included social marketing aspects,[4] education and lifestyle interventions targeting diet and physical activity,[9] long-term school-based interventions targeting physical activity, or physical activity and nutrition,[10] and physical activity, sedentary behaviour and nutrition interventions with direct parent involvement.[15] One further review of critically low-quality evidence reported obesity prevention interventions that involved nurses had not effect on student BMI compared to controls.[14]

The effectiveness of combined nutrition and/or physical activity interventions was assessed in one critically low-quality review. The effectiveness of physical activity, sedentary behaviour and nutrition interventions with direct parent involvement found the intervention to be effective in improving physical activity, sedentary behaviours and diet related outcomes compared to control.[15]

Physical activity interventions

Review of review evidence

Of the four reviews that assessed the effectiveness of school-based physical activity interventions,[7-9, 13] all were rated as critically low-quality evidence. Three of those reviews reported a positive intervention effect of BMI or anthropometric outcomes.[8, 9, 13] One review reported educational and lifestyle interventions targeting physical activity to be effective in reducing student BMI compared to control (SMD=-0.13; 95%CI: -0.19 to -0.06).[9] Another review reported PE interventions to be effective in reducing student BMI in five of seven included studies.[8] A review of any school-based physical activity interventions reported a positive intervention effect on waist circumference compared to control (SMD=-0.14; 95%CI: -0.22 to -0.07).[13]

Two of the reviews that assessed the effectiveness of physical activity interventions assessed impact on student physical activity. Both reported positive intervention effects on outcomes related to student physical

activity compared to control arms.[7, 8] One review assessed the effectiveness of interventions targeting fundamental movement skills and physical activity levels and reported small positive effects on student physical activity levels (SMD=0.23; 95%CI: 0.03 to 0.42) and moderate to vigorous physical activity (SMD=0.29; 95%CI: 0.08 to 0.51).[7] PE interventions were found to be effective in improving physical activity levels in six of eight included studies in the other review.[8]

Emerging Australian intervention evidence

Two intervention studies were identified that assessed the effectiveness of a multicomponent implementation intervention in increasing the scheduling of planned physical activity in primary schools (in line with NSW recommended 150 minutes across the school week) and student physical activity levels compared to control groups. One C-RCT conducted by Nathan et al. in 12 primary schools reported a significant positive effect of the intervention on teacher scheduling of physical activity each week, and on physical activity counts per student for moderate to vigorous physical activity, and reductions in sedentary behaviour (unpublished data under editorial review). The other C-RCT conducted by Nathan et al. in 61 primary schools had similar results, reporting significant positive effects of the intervention on teacher scheduling of physical activity, PE, energisers and integrated lessons but not sport (unpublished data shared in confidence by study investigators). Data regarding student physical activity levels was being analysed at the time of writing this report. A further pilot study conducted by Nathan et al. was identified, that aimed to assess the impact of a school uniform intervention on student physical activity levels during school hours. Students in the intervention group were asked to wear their school sports uniform on a day they would normally wear a traditional uniform, whereas control students continued their normal uniform practices. The study found a significant positive effect for intervention group girls in the minutes of light physical activity, step counts, counts per minute and sedentary time, but no effect on moderate to vigorous physical activity (unpublished data shared in confidence by study investigators).

School food service and environment interventions, including school canteens

Review of review evidence

Three reviews assessed the effectiveness of school-based nutrition interventions.[5, 9, 11] Low-quality evidence in a review of lunchbox interventions to improve the nutritional quality of student dietary intake reported a positive intervention effect on fruit and vegetable intake (two of three included studies) and no effect on BMI (one included study) compared to control groups.[11] Critically low-evidence was found in two other reviews.[5, 9] One review, which assessed the effectiveness of any school-based nutrition intervention that targeted the quality of student dietary intake, found such interventions were effective in improving fruit and vegetable intake (16 of 20 included studies), but not fat intake or consumption of energy-dense nutrient-poor foods compared to controls.[5] The other review reported education and lifestyle interventions targeting diet were not effective in reducing student BMI.[9]

Emerging Australian intervention evidence

Two intervention studies were identified that assessed the effectiveness of online canteen ordering systems to implement school canteen policies.[16, 17] One C-RCT study, assessed the effect of a multistrategy consumer behaviour intervention involving modification of online canteen menu displays on student online lunch orders.[16] The study found a significant positive effect on the mean content per student lunch order in energy (difference 2567.25kJ; 95%CI: 2697.95 to 2436.55kJ), saturated fat (difference 22.37g; 95%CI: 23.08 to 21.67g), and sodium (difference 2227.56mg; 95%CI: 2334.93 to 2120.19), but not sugar.[16] The other C-RCT which examined the effect of positioning fruit and vegetable snack items first and last on an online menu, found no effect of the intervention on the proportion of fruit and vegetable snack food purchases (odds ratio [OR]=1.14; 95%CI: 0.79 to 1.63).[17]

One intervention study was identified that assessed the potential efficacy, feasibility and acceptability of a mobile health (m-health) intervention in improving the energy and nutritional quality of foods packed in children's lunchboxes. The C-RCT conducted by Sutherland et al. in 12 schools assessed the effectiveness of a multicomponent intervention involving nutritional guidelines, flipchart lessons, messages to parents and physical resources compared to control. The study found the intervention to be effective in increasing the mean lunchbox energy from recommended foods (MD 83.13kJ; 95%CI: 2.65 to 163.61), but not the mean energy of foods packed within lunchboxes.

Table 1. Summary of evidence of obesity prevention approaches in primary schools

Author, year	AMSTAR2	Included interventions	Outcomes and effects*			
			BMI/weight related-outcomes	MVPA/PA/ fitness outcomes	Screen time/ sedentary behaviours	Diet-related outcomes
Brown, 2016[6]	Moderate	Universal school-based interventions targeting both healthy eating and physical activity	+	–	–	–
Oosterhoff, 2016[12]	Moderate	Lifestyle interventions targeting diet and/or PA and/or education	+	–	–	–
Nathan, 2019[11]	Low	Lunchbox interventions to aiming improve food and beverages packed and consumed	No effect	–	–	+
Aceves-Martins, 2016[4]	Critically low	Interventions including social marketing benchmark criteria domains targeting diet and/or PA	+	–	–	–
Black, 2017[5]	Critically low	Nutrition programs aimed to improve nutritional the quality of dietary intake	–	–	–	+
Engel, 2018[7]	Critically low	Interventions targeting FMS and PA levels	–	+	–	–
Errisuriz, 2018[8]	Critically low	PE-based interventions	+	+	–	–
Gori, 2017[9]	Critically low	Educational and lifestyle interventions targeting diet only	No effect	–	–	–
		Educational and lifestyle interventions targeting PA only	+		–	–
		Educational and lifestyle interventions targeting diet and PA	+	–	–	–
Mei, 2016[10]	Critically low	Long-term (≥12 months) school-based interventions targeting PA or PA and nutrition	+	–	–	–
Pozuelo-Carrascosa, 2018[13]	Critically low	PA interventions	+	–	–	–
Schroeder, 2016[14]	Critically low	Obesity prevention interventions involving nurses	No effect	–	–	–
Verjans-Janssen, 2018[15]	Critically low	Physical activity, sedentary behaviour and nutrition interventions with direct parental involvement	+	+	+	+

AMSTAR2=Assessing the Methodology Quality of Systematic Reviews; BMI=body mass index; FMS=fundamental movement skills; MVPA=moderate-to-vigorous physical activity; PA=physical activity; PE=physical education. + Positive effect – Not applicable *Evidence based on overall reported effect or majority of included studies in narrative synthesis

Summary of findings

Effectiveness of primary school setting obesity prevention approaches

The updated review of reviews found consistent moderate- to critically low-quality evidence that primary school-based interventions targeting nutrition and physical activity are effective in reducing student BMI. Effective intervention approaches included those targeting diet and/or physical activity and/or education; diet and/or physical activity that include social marketing aspects; long-term physical activity or physical activity and nutrition (>12 months); and combined physical activity, sedentary behaviour and nutrition components with direct parental involvement.

Consistent critically low-quality evidence was also found for primary school-based interventions that targeted physical activity in terms of effectiveness in impacting student BMI and physical activity levels. Effective intervention approaches included those targeting fundamental movement skills and physical activity levels; PE; and education and lifestyle interventions.

These findings, where comparable, are consistent with the previous 2016 rapid evidence review which concluded that overall there was strong evidence for the effectiveness of multicomponent child obesity prevention programs implemented within primary schools in improving BMI. The previous review found that school-based interventions that were comprehensive – combining education and environmental components rather than using one component in isolation – and invested in for a duration of at least one-year, were more likely to be effective. The 2016 review found strong evidence of effectiveness for i) physical-activity only interventions delivered in primary schools with home involvement; and ii) combined diet–physical activity interventions delivered in primary schools when both home and community components were included. Moderate quality evidence of effectiveness was also reported for environmental approaches including i) organised physical activities during breaks, before and after school, ii) improved availability of physical activity opportunities in and around the school environment; iii) increased PE lesson time; iv) improved availability or accessibility of healthy food options; v) restricted availability and accessibility of unhealthy food options; and vi) and sedentary behaviour interventions.

Emerging Australian intervention evidence was identified for an implementation intervention that was effective in increasing teacher scheduling of planned physical activity and student physical activity levels, and a school uniform intervention in increasing student physical activity levels.

School food services and environments including school canteens

The updated review of reviews found consistent low- to critically low-quality evidence that nutrition-focused interventions were effective in improving student diet-related outcomes compared to control groups, but not BMI. Effective school-based intervention approaches for diet-related outcomes included lunchbox interventions to improve packing and consumption of healthy food and beverages by students, and interventions focused on improving the nutritional quality of dietary intake.

Additionally, the previous rapid evidence review found strong and consistent evidence that multicomponent interventions, particularly interventions of longer duration, which included changes to the nutrition environment, could be effective in influencing weight status and specific food consumption patterns, such as an increase in fruit and vegetable consumption. Program success factors appeared to centre on i) changing the availability of foods at school; ii) incorporating a mix of educational and environmental interventions; and (iii) ensuring sustained duration of interventions. The 2016 review also reported emerging evidence at the time of publication supporting i) interventions targeting portion size; ii) audit and feedback to support implementation of healthy school canteens; and (iii) investing in more intense/higher 'dose' programs to support healthy food provision in schools; and iv) broad implementation

of healthy food procurement policies to increase the overall demand for healthier products, and to drive the reformulation of foods by food manufacturers.

The current review identified emerging Australian intervention evidence for a multicomponent consumer behaviour intervention involving modification of online menu displays effective in improving nutritional outcomes in student online lunch orders, and a multi-component m-health intervention involving messaging to parents effective in improving nutritional quality of lunchboxes.

Active travel strategies

The updated review of published literature did not identify any studies that examined the effectiveness of primary school-based active travel strategies. However, the 2016 rapid evidence review found that there was consistent moderate-quality evidence that active travel strategies could result in modest increases in physical activity and fitness. Specifically, the review reported that school students who were active travellers accumulated more daily moderate-to-vigorous physical activity (MVPA) than those using motorised transport, in the majority of studies. The effect on obesity was reported to be inconclusive.

Applicability of evidence to NSW primary schools

The majority of studies included in the new reviews were conducted outside of Australia. As a result, there may be some contextual differences between school settings in other countries and with NSW primary schools. However eligible reviews predominantly included studies conducted in the US, UK, Western Europe, Canada and New Zealand – countries that are considered similar in terms of schools and populations. All identified emerging Australian studies with available outcome data were conducted within Hunter New England Local Health District primary schools, and are as a result are highly contextually-relevant to NSW primary schools.

Question 2: Is there any evidence on how to best implement obesity prevention programs within the primary school setting to optimise uptake and effectiveness?

Objectives

The primary aim of this review was to examine the effectiveness of strategies that aim to improve the implementation of school-based policies, programs or practices to address child diet, physical activity, or obesity. This review was an update of an existing review by Wolfenden et al. titled "*Strategies for enhancing the implementation of school-based policies or practices targeting risk factors for chronic disease*", published by the Cochrane Review Library in 2017.[2]

Methods

Search strategy

The original search was undertaken for studies published up to 31 August 2016. This updated review included studies published up until April 2019. The following electronic databases were searched: Cochrane Library including the Cochrane Central Register of Controlled Trials (CENTRAL); MEDLINE; MEDLINE In-Process & Other Non-Indexed Citations; Embase Classic and Embase; PsycINFO; Education Resource Information Center (ERIC); Cumulative Index to Nursing and Allied Health Literature (CINAHL); Dissertations and Theses; and SCOPUS (Appendix 6 Medline search strategy). Australian intervention studies identified in Question 1 were also reviewed for eligibility.

Selection criteria

'Implementation' was defined as the use of strategies to adopt and integrate evidence-based health interventions and to change practice patterns within specific settings. Any trial (randomised or non-randomised) conducted at any scale with a parallel control group, that compared a strategy to implement school-based policies or practices to address diet, physical activity, overweight or obesity, tobacco or alcohol use by school staff to 'no intervention', 'usual' practice' or a different implementation strategy, was eligible for inclusion. Strategies could include quality improvement initiatives, education and training, performance feedback, prompts and reminders, implementation resources (e.g. manuals), financial incentives, penalties, communication and social marketing strategies, professional networking, the use of opinion leaders, implementation consensus processes or other strategies. Study participants could be any stakeholders who may influence the uptake, implementation or sustainability of the target health-promoting policy, practice or program in schools, including teachers, managers, cooks or other staff of schools and education departments. Studies with any objectively or subjectively (self-reported) assessed measure of school policy, program or practice implementation that related to successful implementation – including uptake, partial/complete uptake (e.g. consistent with protocol/design), or routine use – were

included. Such data may have been obtained from audits of school records, questionnaires or surveys of staff, direct observation or recordings, examination of routinely -collected information from government departments (such as compliance with food standards or breaches of department regulations) or other sources. For this report, only trials undertaken in US, UK, Western Europe, Canada, New Zealand and Australia that were identified in the original or search update were included.

Data collection and analysis

Citation screening, data extraction and assessment of risk of bias was performed by review authors in pairs. All new studies identified in the update search were classified using the National Health and Medical Research Council (NHMRC) evidence hierarchy. Disagreements between review authors were resolved via consensus, or if required, by a third author.

Considerable trial heterogeneity precluded meta-analysis. Trial findings were synthesised narratively according to broad implementation outcome by describing the effect size of the primary outcome measure for policy or practice implementation. Effect sizes were calculated by subtracting the change from baseline on the primary implementation outcome for the control (or comparison) group from the change from baseline in the experimental or intervention group. For trials with multiple follow-up periods, data from the final follow-up period reported was extracted. If data to enable calculation of change from baseline were unavailable, the differences between groups post-intervention was used. Where there were two or more primary implementation outcome measures, the median effect size of the primary outcomes was calculated, and the range reported. Where the primary outcome measure was not identified by the study authors in the published manuscripts, the implementation outcome on which the trial sample size calculation was based was used or, in its absence, the median effect size of all measures judged to be implementation outcomes reported in a manuscript was calculated and the range reported. The inclusion of such effect sizes is for descriptive purposes and should not be considered as pooled estimates of effect as they do not weight study effects by the inverse of their variance, nor do they consider study issues of study quality or design.

Results

The search identified 3820 unique records of which 62 full-text records and two unpublished studies were assessed for eligibility. Eight new published studies[18-25] and two unpublished studies were included (see Figure 2). See Appendix 7 for characteristics of included studies. Of the 27 trials included in the original Cochrane review, 22 trials[26-46] were included in this review update (see Figure 2 for reasons for exclusion). Of the 32 trials included in total, 20 were conducted in the United States, eight in Australia, two in Canada, and one each in New Zealand and the Netherlands. Twenty included studies employed RCT designs. Sixteen trials tested strategies to implement healthy eating policies, programs or practices, 12 tested strategies targeting physical activity policies or practices, and four tested strategies targeting nutrition and physical activity. A comprehensive description of the existing studies in the Cochrane Review are available in the 'Characteristics of Included studies' table of the manuscript.[2] All trials examined multi-strategic implementation strategies. The number of implementation strategies, as characterised by the EPOC Taxonomy (see Appendix 8) ranged from two to nine. While there was considerable heterogeneity in the strategies tested, the most common implementation strategies included educational materials, educational outreach and educational meetings. A summary of the implementation strategies and effects of all included trials is provided in Table 2.

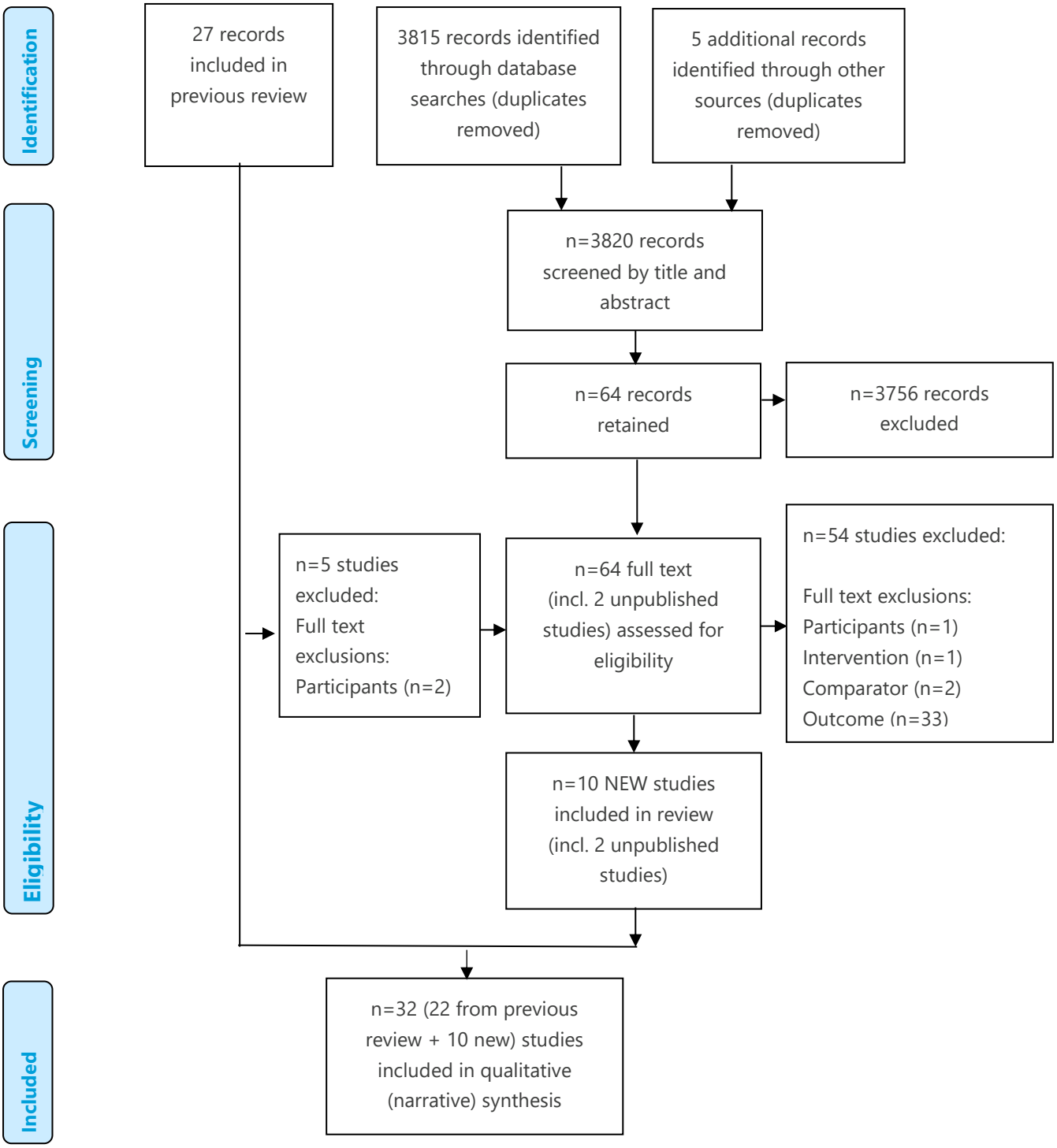

Figure 2. PRISMA Flow Diagram implementation studies

Table 2. Summary of intervention, measures and absolute intervention effect size in included studies

Trial	Targeted risk factor	Implementation strategies	Comparison	Primary implementation outcome and measures	Effect size	P <0.05
Alaimo, 2015[26]	N	Clinical practice guidelines, educational materials, educational outreach visits, external funding, local consensus processes, tailored interventions	Usual practice or waiting-list control	**Continuous:** i) Nutrition policy score and ii) Nutrition education and/or practice score (2 measures)	**Median (range)** 0.65 (0.2 to 1.1)	0/2
Cunningham-Sabo, 2003[27]	N	Clinical practice guidelines, educational materials, educational meetings, educational outreach visits	Usual practice	**Continuous:** Nutrient content of school meals % of calories from fat breakfast/ lunch (2 measures)	**Median (range)** -3% (-3.3% to -2.7%)	1/2
Delk, 2014[28]	PA	Local consensus process, educational meetings, clinical practice guidelines, educational outreach visits, tailored interventions, other	Different implementation strategy	**Continuous:** % of teachers that conducted activity breaks weekly (1 measure 2 comparisons) **Dichotomous:** % implementing a variety of policies and practices (2 measures 4 comparisons)	**Median (range)** 13.3% (11.1% to 15.4%) **Median (range)** 26.5% (19.4% to 31.9%)	6/6
French, 2004[29]	N	Local consensus processes, tailored intervention, educational meetings, pay for performance	Usual practice or waiting-list control	**Continuous:** % of program implementation (5 measures)	**Median (range)** 33% (11% to 41%)	5/5
Heath, 2002[30]	N	Educational materials, educational meetings, educational outreach visits	Usual practice	**Continuous:** % fat in school meal (2 measures) Sodium of school meals (2 measures)	**Median (range)** -1.7% (-4.4% to 1%) **Median (range)** -29.5 (-48 to -11)	1/4

Trial	Targeted risk factor	Implementation strategies	Comparison	Primary implementation outcome and measures	Effect size	P <0.05
Hoelscher, 2010[31]	N/PA	Educational materials, educational meetings, educational outreach visits, pay for performance, other, the use of information and communication technology, local consensus process	Different implementation strategy	**Continuous:** Mean number of lessons/ or activities (5 measures) **Dichotomous:** % implementing a variety of policies and practices (2 measures)	**Median (range)** 0.8 (-0.4 to 1. 2) **Median (range)** 4.4% (3.6% to 5.2%)	4/7
Lytle, 2006[32]	N	Educational materials, educational meetings, local opinion leaders, local consensus processes	Usual practice or waitling-list control	**Dichotomous:** % of schools offering or selling targeted foods (4 measures)	**Median (range)** 8.5% (4% to 12%)	2/4
Mobley, 2012[33]	N	Educational games, educational meetings, external funding, tailored intervention, educational materials, educational outreach, other, the use of information and communication technology	Usual practice or waiting-list control	**Dichotomous:** % schools meeting various nutrition goals (12 measures)	**Median (range)** 15.5% (0% to 88%)	Not reported
Nathan, 2012[34]	N	Educational materials educational meetings, local consensus processes, local opinion leaders, other, monitoring the performance of the delivery of the healthcare, tailored interventions	Minimal support control	**Dichotomous:** % Schools implementing a vegetable and fruit break (1 measure)	**Mean difference (95%CI)** 16.2% (5.6% to 26.8%)	1/1
Nathan, 2016[35]	N	Audit and feedback, continuous quality improvement, education	Usual practice	**Dichotomous:**	**Median (range)** 35.5% (30.0% to 41.1%)	2/2

Trial	Targeted risk factor	Implementation strategies	Comparison	Primary implementation outcome and measures	Effect size	P <0.05
		materials, education meeting, local consensus process, local opinion leader, tailored intervention, other		% implementing a variety of policies and practices (2 measures)		
Naylor, 2006[36]	PA	Educational materials, educational meetings, educational outreach meetings, local consensus process, other, tailored Interventions	Usual practice or waiting-list control	**Continuous:** Minutes per week of physical activity implemented in the classroom (1 measure 2 comparisons)	**Median (range)** 54.9 minutes (46.4 to 63.4)	2/2
Perry, 1997[38]	N/PA	Educational materials, educational meetings, educational outreach visits, other	Usual practice or waiting-list control	**Continuous:** % of kilocalories from fat in school lunch (1 measure) Mean milligrams of sodium in lunches (1 measure) Cholesterol milligrams in lunches (1 measure) Quality of PE lesson % of 7 activities observed (1 measure)	**Mean difference (95%CI):** -4.3% (-5.8% to -2.8%) **Mean difference (95%CI):** -100.5 (-167.6 to -33.4) **Mean difference (95%CI):** -8.3 (-16.7 to 0.1) **Mean difference (95%CI):** 14.3% (11.6% to 17.0%)	3/4
Perry, 2004[37]	N	Educational meetings, educational outreach visits, educational materials, local consensus processes, other	Usual practice or waiting-list control	**Continuous:** % of program implementation (2 measures) Mean number of fruit and vegetables available (2 measures)	**Median (range):** 14% (-2% to 30%) **Median (range):** 0.64 (0.48 to 0.80)	2/4

Trial	Targeted risk factor	Implementation strategies	Comparison	Primary implementation outcome and measures	Effect size	P <0.05
Sallis, 1997[39]	PA	Educational materials, educational meetings, educational outreach visits, length of consultation, other	Usual practice or waiting-list control	**Continuous:** Duration (minutes) per week of PE lessons (1 measure) Frequency (per week) of PE lessons (1 measure)	**Mean difference (95%CI):** 26.6 (15.3 to 37.9) **Mean difference (95%CI):** 0.8 (0.3 to 1.3)	2/2
Saunders, 2006[47]	PA	Educational materials, educational meetings, educational outreach visits, local consensus processes, local opinion leaders, other	Usual practice or waiting-list control	**Continuous:** School-level policy and practice related to physical activity from the school administrator's perspective (9 measures)	N/A	Not reported
Simons-Morton, 1988[40]	N	Educational materials, educational outreach visits, local consensus processes, local opinion leaders, managerial supervision, monitoring of performance, other	Usual practice	**Continuous:** Macronutrient content of school meals (2 measures)	N/A	Not reported
Story, 2000[41]	N	Educational meetings, other	Usual practice	**Continuous:** Mean number of fruit and vegetables available (2 measures) % of guidelines implemented and % of promotions held (4 measures)	**Median (range):** 1.15 (1 to 1.3) **Median (range):** 38.4% (28.5% to 43.8%)	6/6
Sutherland, 2017[42]	PA	Audit and feedback, education materials, education meeting, education outreach visits, local opinion leader, other	Usual practice or waiting-list control	**Dichotomous:** % implementing a variety of policies and practices (2 measures) **Continuous:** PE lesson quality score (1 measures)	**Median (range):** 19% (16% to 22%) **Mean difference:** 21.5	0/2 1/1 0/4

Trial	Targeted risk factor	Implementation strategies	Comparison	Primary implementation outcome and measures	Effect size	P <0.05
				% of program implementation (4 measures)	**Median (range):** -8% (-18% to 2%)	
Whatley Blum, 2007[43]	N	Clinical practice guidelines, educational materials, educational meetings, educational outreach visits, external funding, distribution of supplies, local consensus process, other	Usual practice or waiting-list control	**Continuous:** % of food and beverage items meeting guideline nutrient and portion criteria (6 measures)	**Median (range):** 42.95% (15.7% to 60.6%)	5/6
Wolfenden, 2017[44]	N	Audit and feedback, continuous Quality improvement, external funding, education materials, education meeting, education outreach visits, local consensus process, local opinion leader, tailored intervention, other	Usual practice	**Dichotomous:** % implementing a variety of policies and practices (2 measures)	**Median (range):** 66.6% (60.5% to 72.6%)	2/2
Yoong, 2016[45]	N	Audit and feedback, continuous quality improvement, education materials, tailored intervention	Usual practice	**Dichotomous:** % implementing a variety of policies and practices (2 measures)	**Median (range):** 21.6% (15.6% to 27.5%)	0/2
Young, 2008[46]	PA	Education materials, education meetings, educational Outreach visits, inter-professional education, local consensus processes, local opinion leaders	Usual practice	**Dichotomous:** % implementing a variety of policies and practices (7 measures) **Continuous:** Average number of physical activity programs taught (1 measure)	**Median (range):** 9.3% (-6.8% to 55.5%) **Effect Size (95%CI):** 5.1 (-0.4 to 10.6)	1/8
NEW PAPERS IDENTIFIED IN THIS UPDATED REVIEW						

Trial	Targeted risk factor	Implementation strategies	Comparison	Primary implementation outcome and measures	Effect size	P <0.05
Ang, 2018[18]	N/PA	Educational outreach visits, educational materials	Usual practice	**Dichotomous:** % implementing a variety of policies and practices (2 measures)	**Median (range):** 14.6% (0% to 29.2%)	NR
Bremer, 2018[19]	PA	Educational meetings, educational materials	Usual practice	**Continuous:** Quantity of PE lessons (1 measure)	**Mean difference:** t(27)=−0.23	0/1
Cheung, 2018[20]	PA	Educational meeting, educational materials	Usual practice	**Continuous:** Mean minutes of physical activity offered per week (3 measures)	**Median (range):** 5.7 (-2.4 to 13)	NR
Egan, 2018[21]	PA	Educational materials Educational outreach visit or academic detailing, tailored intervention, audit and feedback	Alternate intervention or usual practice	**Continuous:** Mean implementation score for components of movement integration (5 measures)	**Median (range):** -2.79 (-4.92 to 3.66)	NR
Evenhuis, 2018[22]	N	Educational materials, educational meeting, audit with feedback	Educational materials	**Continuous:** Availability of healthier food products on display (1 measure) Healthier product accessibility criteria (1 measure)	**Mean difference:** 16.79 **Mean difference:** 9	NR
Farmer, 2017[23]	PA	Incentives, local consensus approach, tailored interventions	Usual practice	**Dichotomous:** % implementing a variety of policies and practices (1 measure) **Continuous:** Provision of play opportunities (1 measure)	**Mean difference (95%CI):** -0.20 (-11.46 to 11.06) **Mean difference (95%CI):** 4.50 (1.82 to 7.18)	0/1 1/1
Nathan, unpublished data	PA	Educational outreach visits, centralised technical support, mandate change, identify and	Usual practice	**Continuous:** Mean minutes of teacher's scheduled PA per day	Unpublished data	1/1

Trial	Targeted risk factor	Implementation strategies	Comparison	Primary implementation outcome and measures	Effect size	P <0.05
		prepare champions, provide ongoing consultation, educational material				
Nathan, unpublished data	PA	Educational outreach visits, centralised technical support, mandate change, identify and prepare champions, provide ongoing consultation, educational material, change physical structure and equipment	Usual practice	Mean minutes of teacher's scheduled PA per day	Unpublished data	1/1
Taylor, 2018[24]	N	Incentives, educational materials, educational outreach visits	Usual practice or waiting-list control	**Continuous:** Quantity of fruit and vegetables available (2 measures)	**Median (range):** 1.23 (-0.79 to 3.26)	NR
Waters, 2017[25]	N/PA	Educational materials Educational outreach visits Local consensus approach Tailored interventions	Usual practice	**Dichotomous:** % implementing a variety of policies and practices (3 measures)	**Median (range):** 7% (-11.7% - 15%)	NR

CI=confidence interval; N=nutrition; NR=not reported; PA=physical activity; PE=physical education.

Overall effect of implementation supports on policy or practice implementation

Of the 32 included trials, 20 reported significant improvements in at least one implementation outcome (including the two unpublished trials);[23, 27-32, 34-39, 41-44, 46] three trials did not report any significant improvements in implementation[19, 26, 45]; and nine did not report any significance tests on such outcomes.[18, 20-22, 24, 25, 33, 40, 47] Among 11 trials reporting dichotomous implementation outcomes of strategies — the proportion of schools or school staff (e.g. classes) implementing a targeted policy or practice — versus a minimal or usual practice control, the median unadjusted (improvement) effect size was 16.2% and ranged from –0.2% to 66.6%.[18, 23, 25, 32-35, 42, 44-46] While the effects were highly variable, and there is not a clear dose-response relationship, the greatest effect was from trials with the greatest number of implementation support strategies (see Figure 3).

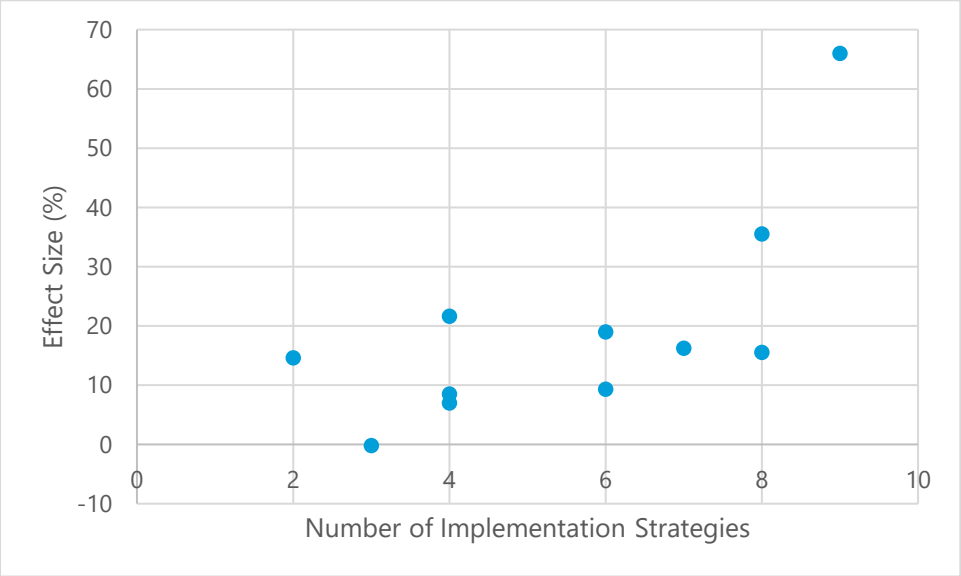

Figure 3. Effect size (% implementation improvement) by number of implementation strategies

Six trials reported the percentage of an intervention program or program content that had been implemented, the effects of which were mixed.[29, 37, 38, 41-43] The unadjusted median effect, relative to the control in the proportion of program or program content implemented, was 23.65% (range –8% to 43%)[29, 37, 38, 41-43] Five trials reported the impact of implementation strategies on the time per week that teachers spent implementing physical activity or PE lessons, with improvements, relative to control ranging from 5.7 minutes per week to 54.9 minutes per week (median=36.6 minutes per week; including the two unpublished trials).[20, 36, 39] Among trials reporting other continuous implementation outcomes, findings were mixed.[26-28, 30, 31, 40, 46, 47]

There was an insufficient number of studies, and too much variability of included studies to examine the impact of specific implementation support strategies or combinations thereof. However, most trials included training (educational meetings), resources (educational materials) in addition to other strategies. In some instances, such strategies were sufficient to achieve improvements in some measures of implementation.

Implementation of nutrition policies and practices

Studies to improve implementation of nutrition policies and practices were dominated by trials to improve the nutritional content or availability of health foods as part of US school food services. In general, such

trials reported small improvements in macronutrient measures. For example, Cunningham et al. reported reductions in the percent energy from fat at school breakfast and lunch from –3.3% to –2.7%.[27] Percent fat in school meals reduced by up to 4% in the trial by Heath et al.[30] Similarly, in the trial by Perry et al., modest although significant reductions were reported in the percent kilo-calories from fat (–4.3%) and milligrams of sodium (–100.5) in school lunches.[38] Significant improvements were also reported across a range of measures of the percent of food and beverage items meeting nutrient and portion criteria in a trial by Whatley Blum et al.[43] US studies targeting improvements in the availability of fruits and vegetables in à la carte lines typically significantly increased the mean number of fruit and vegetables options available by 0.5 to 1[37, 41] or the proportion of schools selling such foods by 4–12%.[32]

There is a strong body of evidence from Australian randomised trials demonstrating improvement in the availability of healthy foods at school canteens.[35, 44, 45] The three trials demonstrated a dose-response relationship between the intensity of implementation support and school compliance with canteen policies. In the trial by Wolfenden et al., assessing the most intensive implementation strategy – comprised of 9 elements – more than 70% of schools receiving implementation support (versus 3% in the control) did not regularly sell foods that were restricted or banned from sale by healthy canteen guidelines, and more than 80% (versus 27% in the control) had more than half of all foods for sale as healthy ('green') products.[44] Australian trials also reported significant improvement relative to control (16%) in the implementation of fruit and vegetable breaks during class time.[34] Large changes were also reported in a small randomised trial (12 schools per group), in the presence of a written school nutrition or policy, but not canteen policy, in a trial by Waters et al.[25]

Implementation of physical activity policies or practices

Trials testing strategies to improve the implementation of physical activity policies and practices focused on measures of time that classroom teachers spent in PE or in structured physical activity each week, the quality of PE lessons, or the implementation of specific elements of physical activity interventions.[18-21, 23, 25, 28, 31, 36, 38, 39, 42, 46, 47] Trials targeting the time spent on physical education typically saw significant improvements following implementation support.[20, 36, 39] For example, in their Canadian trial, Naylor et al. reported significant improvements classroom time spent on physical education relative to control of up to one hour per week.[36] Similarly, two trials by Nathan (unpublished data, shared in confidence), found significant improvements in minutes per day that teacher's scheduled physical activity relative to control. Sallis et al. found significant increases in the duration per week of PE lessons relative to control of 26.6 minutes, and significant increases in the frequency of PE lessons a week.[39] However, Cheung et al. found far smaller changes in the mean minutes of physical activity offered per week, ranging from -2.4 to 13 minutes (significance not reported).[20]

Three trials compared implementation strategies to a usual care or minimal support control on measures of lesson quality.[19, 38, 42] Perry et al. reported a significant increase of 14% relative to control, in the proportion of quality activities observed, relative to control in PE lessons following implementation support.[38] Significant improvements were also reported in physical activity program quality score in an Australian randomised trial by Sutherland et al.[42] but not in a measures of quality of PE lessons in a more recent trial by Bremer et al.[19] among schools receiving implementation support. Among trials that assessed changes in the implementation of a physical activity policy, practice or program,[18, 23, 25, 42, 46] effects were modest with median effect sizes ranging from no change (–0.2%) in the trial by Farmer et al.[23] to a change of almost 20% in the Australian randomised trial by Sutherland et al.[42]

Summary of findings

The review found considerable heterogeneity of the effects of implementation strategies and improvements that were typically, but not uniformly modest. However, the findings show evidence of effective strategies

for enhancing the nutritional quality of foods served at schools, compliance of canteens with nutrition policies, the time children spent in PE, and the quality of PE lessons, among other interventions.

There was an insufficient number of studies and too much variability among the implementation strategies tested to examine the impact of specific implementation support strategies or combinations thereof. However, there appears to be no consistent relationship between the effects of specific implementation strategies. As such, it is likely that the effects of implementation strategies are highly dependent on context, the factors impeding implementation, and the extent to which the selected implementation strategies adequately address these.

Applicability of evidence to NSW primary schools

The majority of trials (n=24) included in the review were undertaken outside Australia. However, of the eight Australian trials included, seven were conducted in NSW. Further, these trials focused largely on implementation of the NSW Fresh Tastes @ School canteen strategy,[35, 44, 45] and enhancing the time students spent in organised school-based physical activity (unpublished data, shared in confidence), and the quality of PE lessons.[42] The findings of the review pertaining to strategies to implement these interventions, therefore, are relevant to the NSW primary schools context. The findings of the effects of other strategies, in particular those related to food service, have limited relevance to NSW given such food services are not commonly adopted in NSW school systems.

Overall conclusions and recommendations

Question 1: *What is the effectiveness of obesity prevention programs targeting children aged 5-12 years delivered in the primary school setting?*

On the basis of this evidence synthesis from identified reviews (both the update and the 2016 review of published literature) and emerging Australian intervention evidence, the following school-based obesity prevention approaches are recommended in NSW primary schools:

- Multicomponent child obesity prevention interventions, including those that are comprehensive; combine educational and environmental components; and of at least one year duration.
- Combined nutrition and physical activity interventions, including those that include home and community components; include social marketing aspects; are of long duration (greater than one year); and include direct parental involvement.
- Physical activity interventions, including those that include the following aspects: home involvement; targeting of fundamental movement skills and physical activity levels; PE; education and lifestyle interventions; organised physical activities during breaks, before and after school; improved availability of physical activity opportunities in and around the school environment; increased PE lesson time; implementation interventions focused on increasing teacher scheduling of planned physical activity; and policy interventions regarding school uniforms.
- Nutrition-focused interventions, including lunchbox interventions to improve packing and consumption of food and beverages brought to school by students; interventions focused on improving the nutritional quality of student dietary intake; and m-health interventions involving messaging to parents regarding nutrition quality of food in lunchboxes.
- School food service and environment interventions (including school canteens), including those that: target improved availability or accessibility of healthy food options; restrict availability and accessibility of unhealthy food options; interventions that target portion size; audit and feedback to support implementation of healthy school canteens; higher 'dose' programs (based on total summary measure of intensity, frequency, duration) to support healthy food provision in schools; online canteen interventions.
- Active travel interventions (as reported in the original review, no new reviews that assessed these intervention approaches were identified in this updated review).

Careful consideration of the effective obesity prevention approaches identified within the review of published literature is required to ensure contextual relevance for implementation within NSW primary schools.

Question 2: *Is there any evidence on how to best implement obesity prevention programs within the primary school setting to optimise uptake and effectiveness?*

On the basis of the updated evidence synthesis of strategies to enhance the implementation of school-based policies or practices targeting obesity prevention, the following strategies are recommended to improve implementation of interventions in NSW primary schools:

- Given the review failed to identify a consistently effective implementation strategy, the careful selection of implementation support to address the identified implementation barriers of a specific policy or practice is recommended to maximise the impact of future implementation efforts in this setting. To achieve this, formative evaluation will need to be undertaken to understand implementation barriers and local context, and implementation science methods will need to be used to identify appropriate implementation support strategies to address these factors.
- Implementation strategies comprised of audit and feedback; continuous quality improvement; external funding, education materials, education meeting, education outreach visits, local consensus process, local opinion leader, and tailored interventions are effective in improving implementation of healthy canteen policies in NSW (trials). Such strategies could be considered for replication and/or adaptation.
- Implementation strategies comprised of educational outreach visits, centralised technical support; mandated change; identifying and preparing champions; providing ongoing consultation; provision of educational materials; changing physical structure and equipment; have all been found to be effective in improving the time students have scheduled for structured physical activity in NSW schools. Such strategies could be considered for replication and/or adaptation.
- Educational meetings and educational materials appear insufficient to improve measures of PE lessons or program quality. However, when combined with other strategies including audit and feedback, education outreach visits, involvement of local opinion leaders and consensus processes appear to be effective. Such strategies could be considered for replication and/or adaptation for this intervention in NSW.
- A variety of implementation support strategies have proven beneficial in improving the nutritional quality of foods provided to children as part of school food services, although this appears to be of little relevance in the NSW context.

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Appendices

Appendix 1. Review of reviews search strategy.

Database(s): Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily 1946 to June 04, 2019

#	Searches	Results
1	(child* or paed* or primary?school* or school?age* or elementary?school* or primary?student or elementary?student or kindergarten*).tw.	1326132
2	(physical* activ* or exercise or physical?fitness or activ* or motion or Movement or Skill or Sedentary?lifestyle or sedentary?time or Sedentary?behavio* or screen?time or sitting?time or inactiv* or sport*).tw.	5119889
3	(health?behavio* or Cogn* or behavio* or learning or attitud* or stigma).tw.	1709547
4	(Eating?behavio* or eat* or diet* or fruit* or vegetable* or sugar?sweetened or drink* or beverage* or soft?drink* or water or food* or nutrition or energy?dens* or sugar or energy?rich or portion?size or fast?food* or nutrient?assessment).tw.	1839166
5	(body?weight or weight or overweight or obes* or BMI or Body?Mass?Index or waist?circumference or anthropomet* or body?composition or skinfold* or high?weight or fat*).tw.	1709265
6	2 or 3 or 4 or 5	8566186
7	(active?travel* or bike or cyclist or bicycle or commut* or transport* or travel* or travel?plan* or group?travel or walking?bus or walk*).tw.	657665
8	(cafeteria* or canteen* or cafe* or school?lunch* or school?meal? or food or feeding?program or food?service* or diet* or meal? or nutrition or purchas* or sold or bought or buy or school*).tw.	1230279
9	(mass?media or campaign* or consumer?research or (health adj (communication or information)) or advertis* or marketing or social?media).tw.	96622
10	(screen?viewing or television or tv or video?games or computer or screen?media or mobile?phone or cell?phone or electronic or technolo*).tw.	820521
11	7 or 8 or 9 or 10	2673236
12	(((comprehensive* or integrative or systematic*) adj3 (bibliographic* or review* or literature)) or (meta-analy* or metaanaly* or "research synthesis" or ((information or data) adj3 synthesis) or (data adj2 extract*))).ti,ab. or (cinahl or (cochrane adj3 trial*) or embase or medline or psyclit or (psycinfo not "psycinfo database") or pubmed or scopus or "sociological abstracts").ab. or ("cochrane database" or evidence report technology assessment or evidence report technology assessment summary).jn. or	405694

#	Searches	Results
	Evidence Report: Technology Assessment*.jn. or ((review adj5 (rationale or evidence)).ti,ab. and review.pt.) or meta-analysis as topic/ or Meta-Analysis.pt.	
13	("clinical trial" or "clinical trial, phase i" or "clinical trial, phase ii" or clinical trial, phase iii or clinical trial, phase iv or controlled clinical trial or "multicenter study" or "randomized controlled trial").pt. or double-blind method/ or clinical trials as topic/ or controlled clinical?trials as topic/ or randomized?controlled?trials as topic/ or early termination of clinical trials as topic/ or multicenter studies as topic/ or ((randomi?ed adj7 trial*) or (controlled adj3 trial*) or (clinical adj2 trial*) or ((single or doubl* or tripl* or treb*) and (blind* or mask*))).ti,ab,kw. or ("4 arm" or "four?arm").ti,ab,kw.	1484174
14	cohort studies/ or longitudinal studies/ or follow-up studies/ or prospective studies/ or retrospective studies/ or cohort.mp. or longitudinal.mp. or prospective.mp. or retrospective.mp.	2445034
15	13 or 14	3520352
16	1 and 6 and 11 and 12 and 15	2761
17	**limit 16 to (english language and yr="2015 -Current")**	**1219**

Appendix 2. Characteristics of the newly identified reviews

Author, year Country	Review aim	Study type Included study design(s)	Level of evidence (NHMRC) Quality assessment (AMSTAR2)	Population Setting	Number of studies Number of participants	Intervention Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
Aceves-Martin, 2016[4] Belgium (n=1), Czech Republic (n=1), Denmark (n=1), France (n=2), Germany (n=4), Greece (n=2), Iceland (n=1), Italy (n=2), The Netherlands (n=5), Norway	To assess the effectiveness of European school-based interventions to prevent obesity relative to the inclusion of social marketing benchmark criteria (SMBC) domains in the intervention	SR and MA RCTs, non-randomised CTs	III-2 Critically low	Children aged 5–17 years Primary and secondary school	32 studies 35,058 participants	Interventions including SMBC domains focused on diet and/or PA versus Control groups without an intervention	*BMI* The BMI SMD was categorised as negative (>0), minimal (>-0.2), small (-0.2 to -0.5), medium (-0.5 to 0.8), or large (<-0.8). Interventions were, overall, minimally effective in reducing BMI in the intervention groups compared with the control groups (BMI SMD, -0.11; 95%CI, -0.20 to -0.02).	Small effect on reducing BMI identified via MA The use of 5 SMBC is more likely to increase the effectiveness of interventions to reduce BMI via MA	The authors declared no competing interests Two authors are recipients of a fellowship award from the Mexican National Council of Science and Technology (CONACyT)

Author, year Country	Review aim	Study type Included study design(s)	Level of evidence (NHMRC) Quality assessment (AMSTAR2)	Population Setting	Number of studies Number of participants	Intervention Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
(n=1), Portugal (n=1), Spain (n=2), Sweden (n=2), Switzerland (n=1), UK (n=4), Europe (n=2)							Subgroup analyses of BMI SMD for the number of SMBC reported: 4 SMBC=negative effectiveness, BMI SMD, 0.19; 95%CI, 0.02–0.36 5 SMBC=small effect size, BMI SMD, -0.25; 95%CI, -0.45 to -0.04 6 or 7 SMBC=minimal effect size, BMI SMD, -0.06, 95%CI, -0.20 to -0.07 and BMI SMD, -0.04; 95%CI, -0.10 to -0.02		
Black, 2017[5]	To assess the impact of	SR	I Critically low	Preschool and primary	31 studies	Nutrition programs aimed to	*Fruit and vegetable intake*	Majority of included studies	The authors declared no

Author, year Country	Review aim	Study type Included study design(s)	Level of evidence (NHMRC) Quality assessment (AMSTAR2)	Population Setting	Number of studies Number of participants	Intervention Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
Denmark (n=1), Scotland (n=1), US (n=13), Germany (n=2), Norway (n=2), Northern Ireland (n=1), England (n=2), Australia (n=1), Ireland (n=1), Iceland (n=1), Spain (n=1), Wales (n=1), New Zealand	family-based and school / preschool nutrition programs on the health of children aged 12 or younger	RCTs, C-RCTs		school aged children Preschool and primary school	36,639 participants	improve nutritional the quality of dietary intake versus Controls may have received no intervention, delayed intervention, or attention control	16/20 studies reported an effect, effect size ranged from null-to-small to large *Fat intake* 6/11 studies reported no effect *EDNP foods intake* 3/7 studies reported no effect (NB. 2/7 studies had limited reporting of results)	reported a positive intervention effect on F&V intake, no effect on fat intake, and no effect on EDNP foods via narrative synthesis	competing interests This study was supported by NHMRC, Australia (Program Grant No.631947) and the APHCRI, which is supported by a grant from the Common-wealth of Australia as represented by the DoH

Author, year Country	Review aim	Study type Included study design(s)	Level of evidence (NHMRC) Quality assessment (AMSTAR2)	Population Setting	Number of studies Number of participants	Intervention Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
(n=2), Cyprus (n=1), Belgium (n=1)									
Brown, 2016[6] Canada (n=1), Chile (n=1), England (n=3), Greece (n=1), Netherlands (n=1), New Zealand (n=2), Portugal (n=1), Spain (n=2), US (n=2)	To assess the effects of universal, school-based interventions with healthy eating and PA components for the prevention and treatment of obesity in primary school children	SR RCTs, non-randomised CTs	III-2 Moderate	Elementary school-aged children Elementary school	15 studies 16,995 participants	Universal school-based interventions targeting both healthy eating and physical activity versus no intervention controls	*BMI* Total intervention group: 6/14 studies reported an improvement Subgroupings: 9/15 studies reported an improvement in the total group or subgroupings	School-based interventions that include healthy eating and PA components are moderately effective methods for improving BMI in elementary school children via narrative synthesis	The authors declared no competing interests Funding was not reported

Author, year Country	Review aim	Study type Included study design(s)	Level of evidence (NHMRC) Quality assessment (AMSTAR2)	Population Setting	Number of studies Number of participants	Intervention Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
Engel, 2018[7] NR	To evaluate interventions for improving FMS and PA levels in children aged 5–12 years	SR and MA RCTs, non-randomised CTs	III-2 Critically low	School-aged children (5-12 years) Primary school	9 studies 6014 participants	Interventions targeting FMS and PA levels versus Usual practice/no intervention control, regular curriculum, active control with no FMS	*PA levels* Small effect (n=3, SMD=0.23; 95%CI 0.03 to 0.42 *MVPA* Small effect (n=3, SMD=0.29; 95%CI 0.08 to 0.51	Small effect on increasing PA levels and MVPA identified via MA	The authors declared no competing interests and no sources of funding
Errisuriz, 2018[8] US (n=6), Chile (n=1), Italy (n=2), Greece (n=1), Sweden	To examine the effectiveness of PE interventions designed to impact PA, fitness, and/or	SR Experimental and quasi-experimental trials	III-2 Critically low	Children aged 6–11 years Elementary/ primary school	12 studies 16,538 participants (n=11, 1 study NR)	PE-based interventions versus Usual practice, active control but no	*Physical activity* 6/8 studies reported an effect *BMI* 5/7 studies reported an effect	Majority of studies reported a positive intervention effect for PA and BMI, and no effect for physical	The authors declared no competing interests Funding was not reported.

Author, year Country	Review aim	Study type Included study design(s)	Level of evidence (NHMRC) Quality assessment (AMSTAR2)	Population Setting	Number of studies Number of participants	Intervention Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
(n=1), Belgium (n=1)	body composition					modification to PE	*Physical fitness (aerobic)* 6/9 studies reported no effect	fitness via narrative synthesis.	
Gori, 2017[9] Pakistan (n=1), Italy (n=2), Argentina (n=1), US (n=32), France (n=4), Australia (n=5), Belgium (n=2), Netherlands (n=3), Israel (n=1), UK (n=5), Turkey	To evaluate the effectiveness of the various educational and lifestyle interventions aimed at preventing child obesity	SR and MA RCTs, non-randomised CTs	III-2 Critically low	Children aged 6–12 years Education setting and combined setting (educational + family)	47 studies 35,923 participants (n=46, 1 study NR)	Educational and lifestyle interventions targeting diet and/or PA versus Standard care	*BMI* Education setting only: Diet only: n=3, no effect PA: n=14, significant effect -0.13 (-0.19, -0.06) PA and diet: n=12, significant effect -0.11 (-0.16, -0.06) Combined setting: PA and diet: n=6, significant effect -0.15 (-0.22, -0.07)	Diet alone was insufficient to significantly reduce BMI. PA was extremely effective when introduced in the educational setting, either alone or in association with diet in reducing BMI. The best results were	The authors declared no competing interests. Funding was not reported

Author, year Country	Review aim	Study type Included study design(s)	Level of evidence (NHMRC) Quality assessment (AMSTAR2)	Population Setting	Number of studies Number of participants	Intervention Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
(n=1), Ireland (n=1), Chile (n=1), Germany (n=2), Norway (n=1), Switzerland (n=1), Canada (n=3), Sweden (n=1), Thailand (n=1), Brazil (n=1), Spain (n=2), New Zealand (n=1)								achieved by combined (diet + physical activity) interventions delivered in the combined settings via MA	
Mei, 2016[10]	To examine the effectiveness	SR and MA	I Critically low	Children aged 6–12 years	18 studies	Long-term (≥12 months) school-based	*BMI* Children's BMI was significantly	Positive effect via MA	The authors declared no

Author, year Country	Review aim	Study type Included study design(s)	Level of evidence (NHMRC) Quality assessment (AMSTAR2)	Population Setting	Number of studies Number of participants	Intervention Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
Europe (n=9), USA (n=5), Asia (n=2), Africa (n=2)	of long-term (≥12 months) school-based PA interventions on BMI in primary school children, who are gaining BMI	RCTs, cluster CTs		Primary School	22,381 participants	interventions targeting PA or PA and nutrition versus NR	different (P<0.05) between the intervention group and the control group (SMD: -2.23 kg/m^2, 90%CI: -2.92 to -1.56)	High heterogeneity (99.8%) of studies suggests more high-quality school-based RCTs among diverse populations are needed	competing interests Funding was not reported
Nathan, 2019[11] US (n=1), UK (n=3), Mexico (n=1), Israel (n=1)	To assess the effectiveness of lunchbox interventions aiming to improve the foods and beverages packed and consumed by children at	SR and MA C-RCTs, quasi-experimental trials	III-2 Low	Primary school-aged children Primary school	6 studies 5695 participants	Lunchbox interventions to aiming improve food and beverages packed and consumed versus	*F&V* 2/3 studies reported a significant effect *High fat and sugar* 1/1 reported no effect *BMI*	Majority of included studies reported a positive intervention effect on F&V intake and no effect on high fat/sugar intake and	Author CE has received funding from Unilever UK to repeat a survey of children's packed lunches in

Author, year Country	Review aim	Study type Included study design(s)	Level of evidence (NHMRC) Quality assessment (AMSTAR2)	Population Setting	Number of studies Number of participants	Intervention Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
	centre-based care or school; and subsequent impact on children's adiposity.					No intervention, usual practice, physical activity only intervention, wait-list control	1/1 reported no effect	BMI via narrative synthesis.	England in 2016 No funding to report
Oosterhoff, 2016[12] Europe (n=37), North America (n=33), Oceania (n=7), Asia (n=5), South America (n=2), North Africa (n=1)	This systematic review and meta-analysis assess the impact of school-based lifestyle interventions on children's BMI and blood pressure	SR and MA RCTs	I Moderate	Children aged 4-12 years Elementary school	85 studies 72,934 participants	Lifestyle interventions targeting diet and/or PA and/or education versus Control group did not receive any intervention beyond the usual	BMI The estimated average effect was -0.072 (95%CI: -0.106 to -0.038), P<0.001	School-based lifestyle interventions induced favourable changes in BMI via MA.	The authors declared no competing interests Funding was not reported

Author, year Country	Review aim	Study type Included study design(s)	Level of evidence (NHMRC) Quality assessment (AMSTAR2)	Population Setting	Number of studies Number of participants	Intervention Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
						curricular activities			
Pozuelo-Carrascosa, 2018[13] UK (n=1), China (n=2), Australia (n=2), Spain (n=3), Iceland (n=1), Germany (n=2), US (n=2), France (n=1), Netherlands (n=1), Switzerland (n=2), Canada	To provide a comprehensive synthesis of the effectiveness of school-based PA interventions on cardiometabolic risk factors in children.	SR and MA RCTs	I Critically low	Children aged 3–12 years Preschool, Primary school	19 studies 11,988 participants	PA interventions versus No PA intervention	*Waist circumference* Significant effect (SMD=−0.14; 95%CI: -0.22 to -0.07; P<.001) Subgroup analyses of waist circumference by PA intensity: Moderate PA: no effect MVPA: significant effect (SMD=-0.144 [95%CI: -0.25 to -0.04; P=0.007] Vigorous: significant effect (SMD= -0.129 [95%CI: -0.25 to -0.01; P=.032]	School-based PA interventions are effective for improving WC. Although the magnitude of the effect seems to be small, it may be important for primary prevention strategies via MA	The authors declared no competing interests The authors have indicated they have no financial relationships relevant to this article to disclose Two authors supported by grants

Author, year Country	Review aim	Study type Included study design(s)	Level of evidence (NHMRC) Quality assessment (AMSTAR2)	Population Setting	Number of studies Number of participants	Intervention Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
(n=1), Greece (n=1)									
Shroeder, 2016[14] US	To examine school-based interventions involving nurses in a role beyond anthropo-metric measurement for effect on change in body measures	SR and MA RCTs, quasi-experimental	III-2 Critically low	Primary school aged children Primary school	7 studies 2446 participants	Obesity prevention interventions involving nurses versus No intervention, part of but not all of the same intervention as the intervention group, attention control	*BMI* 2 studies=no effect -0.18, (95%CI -0.38 to 0.02) *Qualitative* *BMI (incl BMI percentile, BMI Z-score)* 13/16 measures of BMI across 7 studies reported no effect	Non-significant small effect size for change in BMI, BMIz and BMI percentile via MA. Majority reported no effect for BMI (all measures) via narrative synthesis	Declaration of interest not reported This publication was supported by the NINR through Grant Numbers T32 NR014205 (KS) and R01NR013687 (JT), the NCATS through

Author, year Country	Review aim	Study type Included study design(s)	Level of evidence (NHMRC) Quality assessment (AMSTAR2)	Population Setting	Number of studies Number of participants	Intervention Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
									Grant Number UL1 TR000040 (KS), and the Jonas Center for Nursing and Veterans Healthcare (JT)
Verjans-Janssen, 2018[15] US (n=9), Greece (n=2), Mexico (n=1), Norway (n=1), China (n=5), Italy	To assess the effectiveness of school-based PA and nutrition interventions with direct parental involvement regarding children's weight status	SR RCTs, quasi-experimental, pre-test-post-test, cross-sectional trials	III-2 Critically low	Children aged 4–12 years Primary school, directly involved parents	25 studies 39,101 participants	PA, sedentary behaviour and nutrition interventions with direct parental involvement versus NR	*BMI* 11/18 studies reported a positive effect *Physical activity* 9/11 studies reported a positive effect *Sedentary behaviour*	Majority of included studies reported a positive intervention effect on BMI, PA, sedentary behaviour and nutrition behaviour	The authors declared no competing interests This present study was funded by Fonds NutsOhra (project number

Author, year Country	Review aim	Study type Included study design(s)	Level of evidence (NHMRC) Quality assessment (AMSTAR2)	Population Setting	Number of studies Number of participants	Intervention Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
(n=1), Australia (n=3), Chile (n=1), Germany (n=2)	and energy balance-related behaviours						6/8 studies reported a positive effect *Nutrition behaviour* 7/12 studies reported a positive effect		101.253) to S.P.J. Kremers, supervisor of S. Verjans-Janssen. Fonds NutsOhra has no role in the writing of this manuscript

AMSTAR=Assessing the Methodology Quality of Systematic Reviews; CTs=Controlled trials; BMI=Body Mass Index; FMS=fundamental movement skills; F&V=fruit and vegetables; MVPA=moderate-to-vigorous physical activity; MA=Meta-analysis; NHMRC=National Health and Medical Research Council; NR=not reported; PA=physical activity; PE=physical education; RCTs=Randomised controlled trials; SMBC=social marketing benchmark criteria; SMD=standardised mean difference; SR=Systematic review; WC=waist circumference.

Appendix 3. List of government websites searched

Website	URL
National	
A Healthy and Active Australia	https://www.healthyactive.gov.au/
AusTender (The Australian Government Tender System)	https://www.tenders.gov.au/
Australian Children's Education and Care Quality Authority	https://www.acecqa.gov.au/
Australian Curriculum	https://www.australiancurriculum.edu.au/
Australian Curriculum, Assessment and Reporting Authority	https://www.acara.edu.au/
Australian Institute of Aboriginal and Torres Strait Islander Studies	https://aiatsis.gov.au/
Australian Institute of Health and Welfare	https://www.aihw.gov.au/
Australian Institute of Sport	https://www.ausport.gov.au/ais
Australian Research Council	https://www.arc.gov.au/
CSIRO (Commonwealth Scientific and Industrial Research Organisation)	https://www.csiro.au/
Department of Education and Training	https://www.education.gov.au/
Department of Health	https://www.health.gov.au/
DSS Grants Service Directory	https://serviceproviders.dss.gov.au/
Eat For Health	https://eatforhealth.gov.au/
Education Council	http://www.educationcouncil.edu.au/
Education for Young People	https://schools.aidr.org.au
Education Services Australia	https://www.esa.edu.au/
indigenous.gov.au	https://www.indigenous.gov.au/
Extension of indigenous.gov.au	https://www.pmc.gov.au/indigenous-affairs/grants-and-funding
National Health and Medical Research Council	https://www.nhmrc.gov.au/
National Health Funding Body	https://www.nhfb.gov.au/
NHMRC Public Consultations	https://consultations.nhmrc.gov.au/
Sporting Schools	https://www.sportingschools.gov.au/
Australian Institute for Teaching and School Leadership	https://www.aitsl.edu.au/
Australian Sports Foundation	https://asf.org.au/
Cancer Australia	https://canceraustralia.gov.au/
Translational Research Grants Scheme	https://www.medicalresearch.nsw.gov.au/translational-research-grants-scheme/
GrantConnect	https://www.grants.gov.au/
State (NSW)	
NSW Department of Education	https://education.nsw.gov.au/
NSW Ministry of Health	https://www.health.nsw.gov.au/
NSW gov	https://www.nsw.gov.au/
OpenGov NSW	https://www.opengov.nsw.gov.au/main
Aboriginal Affairs	http://www.aboriginalaffairs.nsw.gov.au

Aboriginal Education Consultative Group Incorporated, NSW	https://www.aecg.nsw.edu.au
Cancer Institute NSW	https://www.cancer.nsw.gov.au/
Office of the NSW Advocate for Children and Young People	http://www.acyp.nsw.gov.au/
Finance, Services and Innovation, NSW Department of	https://www.finance.nsw.gov.au/
Transport, NSW Department of	http://www.transport.nsw.gov.au
Planning and Environment, NSW Department of	https://www.planning.nsw.gov.au/
Institute of Sport, NSW	https://www.nswis.com.au/
Local Government, Office of	http://www.olg.nsw.gov.au/
Active and healthy	https://www.activeandhealthy.nsw.gov.au/
NSW Local Health District	
Central Coast Local Health District	http://www.cclhd.health.nsw.gov.au/
Far West Local Health District	http://www.fwlhd.health.nsw.gov.au
Hunter New England Local Health District	http://www.hnehealth.nsw.gov.au/Pages/home.aspx
Illawarra Shoalhaven Local Health District	http://www.islhd.health.nsw.gov.au/
Mid North Coast Local Health District	http://mnclhd.health.nsw.gov.au/
Murrumbidgee Local Health District	http://www.mlhd.health.nsw.gov.au/
Nepean Blue Mountains Local Health District	http://www.nbmlhd.health.nsw.gov.au/
Northern NSW Local Health District	https://nnswlhd.health.nsw.gov.au/
Northern Sydney Local Health District	https://www.nslhd.health.nsw.gov.au/
South Eastern Sydney Local Health District	https://www.seslhd.health.nsw.gov.au/
South Western Sydney Local Health District	https://www.swslhd.health.nsw.gov.au/
Southern NSW Local Health District	http://www.snswlhd.health.nsw.gov.au/
Sydney Local Health District	https://www.slhd.nsw.gov.au/
Western NSW Local Health District	https://wnswlhd.health.nsw.gov.au/
Western Sydney Local Health District	http://www.wslhd.health.nsw.gov.au

Appendix 4. Eligible grants from website search

Grant title	Funding source (Grant/scheme)	Chief investigator/ Organisation
A randomised controlled trial of an online intervention to improve healthy food purchases from primary school canteens	NHMRC - Standard Project Grant	A/Pr Luke Wolfenden, University of Newcastle
A randomised trial of an intervention to facilitate the implementation of a state-wide school physical activity policy	NHMRC - Partnership Project for Better Health	A/Pr Luke Wolfenden, University of Newcastle
Addressing foundational impediments to the translation of chronic disease prevention interventions in community settings	NHMRC - Population Health Career Development Fellowship	A/Pr Luke Wolfenden, University of Newcastle
Assessing the impact of a multi-component intervention to improve dietary intake of Indigenous Australian children and their families living in remote	NHMRC - Standard Project Grant	Dr Selma Liberato, Menzies School of Health Research
Campbelltown – Changing our Future: a whole of systems approach to childhood obesity in South Western Sydney	NSW Health Translational Research Grants Scheme	Recipient Professor Bin Jalaludin, SWSLHD
Enhancing behaviour change via incentives: improving childhood obesity outcomes	NHMRC - Public Health Postgraduate Scholarship	Ms Gemma Enright, The George Institute for International Health
Evidence-based physical activity promotion in primary schools: Improving children's health through sustainable partnerships	NHMRC - Partnership Project for Better Health	A/Pr Chris Lonsdale, Australian Catholic University
Improving the translation of school-based interventions targeting health risk behaviours for chronic disease	NHMRC - Australian Clinical Research Early Career Fellowship	Ms Rebecca Hodder, University of Newcastle
Increasing the implementation of a mandatory primary school physical activity policy	NHMRC - Translating Research into Practice Fellowship	Dr Nicole Nathan, University of Newcastle

Grant title	Funding source (Grant/scheme)	Chief investigator/ Organisation
NHMRC Centre for Research Excellence in Implementation for Community Chronic Disease Prevention	NHMRC - Centre of Research Excellence - Health Services	A/Pr Luke Wolfenden, University of Newcastle
Optimising the adoption and implementation of evidence-based physical activity interventions in schools	NHMRC - Research Fellowship	Prof David Lubans, University of Newcastle
Physical activity intervention for Aboriginal and Torres Strait Islander populations	NSW Health Early-Mid Career Fellowships	Dr Rebecca Stanley, Illawarra Health and Medical Research Institute
RESPOND: Reflexive Evidence and Systems Interventions to Prevent Obesity and Non-Communicable Disease	NHMRC - Partnership Project for Better Health	Prof Steven Allender, Deakin University
Scalability of the Transform-Us! program to promote children's physical activity and reduce prolonged sitting in Victorian primary schools	NHMRC - Partnership Project for Better Health	Prof Jo Salmon, Deakin University
Settings-based chronic disease prevention: translating research into practice	NHMRC - Practitioner Fellowship	A/Pr Luke Wolfenden, University of Newcastle
Swap What's Packed in the Lunchbox (SWAP-It)	NSW Health Translational Research Grants Scheme	A/Pr Luke Wolfenden, HNELHD
Use of an online canteen ordering system to implement healthy canteen policies in NSW primary schools	NHMRC - Translating Research into Practice Early Career Fellowship	Dr Rebecca Wyse, University of Newcastle
Whole of Systems Trial of Prevention Strategies for childhood obesity: WHO STOPS childhood obesity	NHMRC - Partnership Project for Better Health	Prof Steven Allender, Deakin University

Appendix 5. Characteristics of emerging Australian primary school intervention studies with available data

Grant title	Funder (Year) CI State (NSW LHD)	Study design	Level of evidence (NHMRC grade)	Population / Setting	Study aim	Intervention / Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
Use of an online canteen ordering system to implement healthy canteen policies in NSW primary schools	NHMRC (2015) Rebecca Wyse NSW (HNELHD)	C-RCT	II	Kindergarten to Grade 6 students (n=2714) NSW primary schools (n=10)	Assess the efficacy of a consumer-behaviour intervention that was implemented via an online school-canteen ordering system in reducing the energy, saturated fat, sugar, and sodium contents of primary	Online canteen menu modified the display of the online ordering system to incorporate the consumer-behaviour strategies. Standard online lunch-ordering service only and did not have access to any of the intervention strategies.	*Mean content per student online lunch order*: • *Energy*: mean difference: 2567.25 kJ; 95%CI: 2697.95 to 2436.55 kJ; P<0.001; • *Saturated fat:* mean difference: 22.37 g; 95%CI: 23.08 to 21.67 g; P<0.001; • *Sodium:* mean difference: 2227.56 mg; 95%CI: 2334.93 to 2120.19 mg; P<0.001 contents per student lunch order were significantly lower in the intervention group than in the control group at follow-up No significant differences were observed for: • *Sugar:* mean difference: 1.16 g; 95%CI: 20.50 to 2.83 g; P=0.17	Significant positive effect on mean contents of lunch order for energy, saturated fat, sodium and % energy from saturated fat Significant negative effect of % energy from sugar	The study showed that the mean energy, saturated fat, and sodium contents per student lunch order were significantly lower in subjects who were allocated to the intervention than in those who were allocated to the control

Grant title	Funder (Year) CI State (NSW LHD)	Study design	Level of evidence (NHMRC grade)	Population / Setting	Study aim	Intervention / Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
					school student lunch orders		*Nutritional quality of student online lunch purchases:* The mean percentage of energy per student online lunch order that was derived from saturated fat was significantly lower in the intervention group than in the control group at follow-up (9.32% compared with 10.69%, respectively; P<0.001) The mean percentage of energy per student lunch order that was derived from sugar was significantly higher in the intervention group than in the control group at follow-up (37.82% compared with 18.38%, respectively; P<0.001) The mean proportion per student of all online lunch items purchased that were green was significantly higher (51.21% compared with 37.93%;	No significant difference between groups for sugar	

Grant title	Funder (Year) CI State (NSW LHD)	Study design	Level of evidence (NHMRC grade)	Population / Setting	Study aim	Intervention / Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
							P<0.001), and the mean proportion of purchased items that were classified as red was significantly lower (1.21% compared with 11.11%; P<0.001) in the intervention group than in the control group, respectively, at follow-up *Source: Delaney et al. (2017) Cluster randomised controlled trial of a consumer behaviour intervention to improve healthy food purchases from online canteens. Am J Clin Nutr 2017; 106:1311–20*		
		C-RCT	II	Kindergarten to Grade 6 students (n=1938) NSW primary schools (n=6)	Determine whether the positioning of fruit and vegetable snack items first and last on an online	Online canteen menu redesign – positioning of fruits and vegetable snack items versus	*Proportion of all online lunch orders that contained at least one target item (fruit or vegetable snack food):* Increased marginally from baseline to follow-up across both intervention (9.24–10.63%) and control groups (4.48–5.23%). There was no significant difference between groups over time	No between group difference in change in proportion of lunch orders or lunch items, containing	Repositioning fruit and vegetable menu items to the first and last position within an online canteen menu does not increase the selection of

Grant title	Funder (Year) CI State (NSW LHD)	Study design	Level of evidence (NHMRC grade)	Population / Setting	Study aim	Intervention / Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
					menu increases selection of those items, as measured by the proportion of lunch orders that include those items	No change to online menus	(OR=1.136 [95%CI: 0.791 to 1.632] P=0.490). *Proportion of all individual items within all online lunch orders that are target items (fruit or vegetable snack foods):* Within both the intervention and control groups, there were very small increases in the proportion of target items purchased from baseline to follow-up (intervention: 5.17% to 6.01%; control: 2.27% to 2.64%). However, the between-group difference over time was not significant (OR=1.051 [95%CI: 0.653 to 1.618], P=0.991). Post hoc analysis indicated that this corresponded to an average of 0.12 (SD=0.36) target items per lunch order in intervention schools at follow-up (up from 0.10 items at baseline), and an average of	at least one target item	these items for primary school students at lunchtime. Encouraging the selection of healthy foods via online environments is likely to require the use of stronger intervention strategies, more comprehensive consumer behaviour interventions, and careful consideration of appropriate target

Grant title	Funder (Year) CI State (NSW LHD)	Study design	Level of evidence (NHMRC grade)	Population / Setting	Study aim	Intervention / Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
							0.05 (SD=0.23) target items per lunch order in control schools at follow-up unchanged from 0.05 items at baseline) *Source: Wyse et al. (2019). Can changing the position of online menu items increase selection of fruit and vegetable snacks? A cluster randomized trial within an online canteen ordering system in Australian primary schools. Am J Clin Nutr 109(5): 1422–1430*		menu items and purchasing contexts
A random-ised trial of an intervent-ion to facilitate the implement-ation of a state-wide	NHMRC (2017) Luke Wolfende n / Nicole Nathan	C-RCT	II	Grade 2 and 3 students (baseline n=3116) Teachers (n=409) NSW primary	Assess the effectiveness and cost-effectiveness of a multi-component implement-ation strategy in increasing	*Physically Active Children in Education (PACE)* sought to support elementary school teachers' schedule the recommended	Significant position effect of PA scheduled across the week, PA, energisers, sport and integrated lessons No student accelerometer data finalised	Significant positive effect for minutes of PA scheduled across week	

Grant title	Funder (Year) CI State (NSW LHD)	Study design	Level of evidence (NHMRC grade)	Population / Setting	Study aim	Intervention / Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
school PA policy.	NSW (HNELHD)			schools (n=61)	the minutes of planned weekly PA scheduled by classroom teachers consistent NSW Government School Sport and PA Policy. As a secondary outcome of the trial, the study will assess the effectiveness of scheduled PA on children's	150 minutes of planned PA across the school week Comparison schools were asked to continue their usual PA practices	*Source: Unpublished data shared in confidence by Associate Professor Luke Wolfenden and Dr Nicole Nathan*		

Grant title	Funder (Year) CI State (NSW LHD)	Study design	Level of evidence (NHMRC grade)	Population / Setting	Study aim	Intervention / Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
					activity levels				
N/A	HNELHD Nicole Nathan NSW (HNELHD)	C-RCT	II	Kindergarten to Grade 6 students (n=1502) Teachers (n=107) NSW Primary schools (n=12)	Assess i) the effectiveness of scheduled PA on increasing the PA levels of primary school student and ii) to assess the impact of a strategy in improving teachers' implementation of scheduled PA	*Physically Active Children in Education (PACE)* sought to support elementary school teachers' schedule the recommended 150 minutes of planned PA across the school week Comparison schools were asked to continue their usual PA practices	*Students* Students attending schools allocated to the PA intervention had significantly higher cpm, MVPA; and less sedentary behaviour at follow up compared to control schools *Teacher scheduling PA:* Teachers in intervention schools scheduled significantly more minutes of PA each week at follow-up *Source: Unpublished data shared in confidence by Dr Nicole Nathan and Associate Professor Luke Wolfenden (currently under editorial review)*	Significant positive effect for PA cpm, MVPA, sedentary behaviour and teacher scheduling	The findings of this study suggest that increasing time scheduled for structured PA may be an acceptable and effective strategy to improve student activity, and offer an evidence strategies for policy makers and practitioners to achieve implementation

Grant title	Funder (Year) CI State (NSW LHD)	Study design	Level of evidence (NHMRC grade)	Population / Setting	Study aim	Intervention / Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
N/A	Hunter Children's Research Foundat-ion Nicole Nathan NSW (HNELHD)	C-RCT	II	Grade 2–3 students (n=1842) Primary schools (n=44)	Aim of this pilot study was to assess the impact of a school uniform intervention on students aged 8–10 years PA during school hours	Nested within the *Physically Active Children in Education (PACE)* trial, children were asked to wear school sports uniform on a day they would normally wear a traditional uniform Students in control schools continued with their schools' normal uniform practices	*Girls' mean MVPA per day and mean counts per minutes during school hours:* Preliminary data suggests that within group, intervention girls participated in statistically significant more: minutes of light PA, step counts, cpm and less sedentary time, although no significant difference was reported for MVPA *Source: Unpublished data shared in confidence by Nicole Nathan*	Significant positive effect for intervention girls' light PA, cpm and sedentary time	

Grant title	Funder (Year) CI State (NSW LHD)	Study design	Level of evidence (NHMRC grade)	Population / Setting	Study aim	Intervention / Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
Swap What's Packed in the Lunchbox (SWAP-It)	None reported Rachel Sutherland NSW (HNELHD)	C-RCT	II	Kindergarten to Grade 6 students (n=1915) NSW primary schools (n=12)	Assess the potential efficacy, feasibility and acceptability of an m-health intervention to improve the energy and nutritional quality of foods packed in children's lunchboxes	*SWAP IT* aimed to improve the nutritional quality of school lunchboxes via nutrition guidelines, flipchart lessons, messages to parents and physical resources Control schools received either a PA intervention or no intervention (waitlist control).	At follow-up there was no significant differences between intervention and control group in mean energy of foods packed within lunchboxes (mean difference −118.39 kJ, 95%CI: -307.08 to 70.30, P=0.22) There was a significant increase favouring the intervention in the secondary outcome of mean total lunchbox energy from recommended foods (mean difference 83.13kJ, 95%CI: 2.65 to 163.61, P=0.04) There was a non-significant increase favouring the intervention in percentage of lunchbox energy from recommended foods (4.86%, 95%CI: -22 to 9.95, P=0.06) *Source: Sutherland et al. (2019). A randomized controlled trial to assess the potential efficacy, feasibility and*	Significant positive effect on lunchbox energy from recommended foods No effect on energy of foods packed within lunchboxes	Results indicate the intervention is highly feasible, acceptable to both schools and parents, can be delivered with a high degree of fidelity and is potentially effective in reducing overall energy of foods packed in lunchboxes. Collectively, the findings suggest that the intervention may have public health merit and are supportive of a large RCT to

Grant title	Funder (Year) CI State (NSW LHD)	Study design	Level of evidence (NHMRC grade)	Population / Setting	Study aim	Intervention / Comparator	Outcomes	Direction / magnitude of effect	Comment / notes
							acceptability of an m-health intervention targeting parents of school aged children to improve the nutritional quality of foods packed in the lunchbox 'SWAP IT'. International journal of behavioral nutrition and physical activity 16(1): 54		establish the efficacy of the program

CI=confidence interval; cpm=counts per minute; C-RCT=cluster randomised controlled trial; HNELHD=Hunter New England Local Health District; LHD=Local Health District; m-health=mobile health; MVPA=moderate-to-vigorous physical activity; NHMRC=National Health and Medical Research Council; NSW=New South Wales; OR=Odds ratio; PA=physical activity; SD=standard deviation.

Appendix 6. Implementation studies search strategy

Ovid MEDLINE(R) and Epub Ahead of Print, In-Process & Other Non-Indexed Citations and Daily 1946 to April 10, 2019

#	Searches	Results	
1	schools/	34641	
2	((primary or elementary or middle or junior or high or secondary) adj (school* or student*)).mp.	61499	
3	kinder*.mp.	22544	
4	1 or 2 or 3	106292	
5	implement*.tw.	427155	
6	Health Promotion/mt [Methods]	19229	New MESH heading added
7	"Outcome and Process Assessment (Health Care)"/	25691	New MESH heading added
8	"Process Assessment (Health Care)"/	4389	New MESH heading added
9	"Outcome Assessment (Health Care)"/	67208	New MESH heading added
10	Program Evaluation/	59115	New MESH heading added
11	Interrupted Time Series Analysis/	553	New MESH heading added
12	dissemin*.tw.	115236	Now truncated
13	adopt*.tw.	220568	Now truncated
14	practice.tw.	634669	
15	organi?ational change*.tw.	2613	
16	diffus*.tw.	353856	Now truncated
17	(system* adj2 change*).tw.	15325	
18	quality improvement*.tw.	30437	
19	transform*.tw.	452648	Now truncated
20	translat*.tw.	283791	Now truncated
21	transfer*.tw.	594534	Now truncated
22	uptake*.tw.	335586	
23	sustainab*.tw.	55964	
24	institutionali*.tw.	14726	
25	routin*.tw.	355436	
26	maintenance.tw.	254465	
27	capacity.tw.	460913	
28	incorporat*.tw.	395520	
29	adher*.tw.	172945	Now truncated
30	((polic* or practice* or program* or innovation*) adj5 (performance or feedback or prompt* or reminder* or incentive* or penalt* or communicat* or social market* or professional development or network* or leadership or opinion leader* or consensus process* or change manage* or train* or audit*)).tw.	103076	Replaces polic*.mp to align with other review
31	integrat*.tw.	460724	Truncated
32	scal* up.tw.	16615	

#	Searches	Results	
33	5 or 6 or 7 or 8 or 9 or 10 or 11 or 12 or 13 or 14 or 15 or 16 or 17 or 18 or 19 or 20 or 21 or 22 or 23 or 24 or 25 or 26 or 27 or 28 or 29 or 30 or 31 or 32	4833658	
34	exp Obesity/	195801	
35	Weight Gain/	29698	
36	exp Weight Loss/	38540	
37	obes*.tw.	269101	
38	(weight gain or weight loss).tw.	130488	
39	(overweight or over weight or overeat* or over eat*).tw.	64358	
40	weight change*.tw.	10275	
41	((bmi or body mass index) adj2 (gain or loss or change)).tw.	4130	
42	exp Primary Prevention/	143568	
43	(primary prevention or secondary prevention).tw.	30738	
44	(preventive measure* or preventative measure*).tw.	22909	
45	(preventive care or preventative care).tw.	5038	
46	(obes* adj2 (prevent* or treat*)).tw.	19978	
47	34 or 35 or 36 or 37 or 38 or 39 or 40 or 41 or 42 or 43 or 44 or 45 or 46	633369	
48	exp Exercise/	176978	
49	physical activity.tw.	94644	
50	physical inactivity.tw.	6883	
51	Motor Activity/	94188	Not exploded in this version – additional terms were not relevant to this research
52	("physical education" or "physical training").tw.	9495	This has been adjusted from the original keyword search "Physical education and training"
53	"Physical Education and Training"/	13213	Not exploded
54	Physical Fitness/	26208	
55	sedentary.tw.	27694	
56	exp Life Style/	85835	
57	exp Leisure Activities/	220470	Exp Sport removed from this version – this term appears in the exp Leisure Activities search
58	Dancing/	2669	
59	dancing.tw.	1576	
60	(exercise* adj aerobic*).tw.	186	
61	sport*.tw.	66644	
62	((lifestyle* or life style*) adj5 activ*).tw.	6082	

#	Searches	Results	
63	48 or 49 or 50 or 51 or 52 or 53 or 54 or 55 or 56 or 57 or 58 or 59 or 60 or 61 or 62	547175	
64	exp Diet/	261598	Cochrane suggested to add Healthy Diet/, however, this term is included in the exp Diet/ search so covered with this line
65	nutrition*.tw.	248427	
66	healthy eating.tw.	5898	
67	Child Nutrition Sciences/	1075	
68	fruit*.tw.	95658	
69	vegetable*.tw.	49588	
70	"Fruit and Vegetable Juices"/	1248	New subject heading added
71	canteen*.tw.	589	
72	food service*.tw.	1810	
73	menu*.tw.	4561	
74	calorie*.tw.	24033	
75	Energy Intake/	38728	
76	energy density.tw.	8494	
77	Eating/	50500	
78	Feeding Behavior/ or feeding behavio?r*.tw.	81927	Wildcard added to keyword search for behaviour
79	dietary intake.tw.	21918	
80	Food Habits/	77114	
81	Food/	31390	
82	Carbonated Beverages/ or soft drink*.mp.	5116	
83	soda.tw.	3799	
84	sweetened drink*.tw.	262	
85	Dietary Fats, Unsaturated/ or Dietary Fats/	51350	
86	confectionar*.tw.	240	
87	(school adj (lunch* or meal*)).tw.	1439	
88	menu plan*.tw.	184	
89	((feeding or food or nutrition*) adj program*).tw.	4133	
90	cafeteria*.tw.	1848	
91	Nutritional Status/	40791	
92	64 or 65 or 66 or 67 or 68 or 69 or 70 or 71 or 72 or 73 or 74 or 75 or 76 or 77 or 78 or 79 or 80 or 81 or 82 or 83 or 84 or 85 or 86 or 87 or 88 or 89 or 90 or 91	741173	
93	exp Smoking/	140042	
94	exp "Tobacco Use Cessation"/	1064	
95	smok*.tw.	258516	

#	Searches	Results	
96	Nicotine/	24526	
97	Tobacco/ or "Tobacco Use"/	30560	
98	((ceas* or cess* or prevent* or stop* or quit* or abstin* or abstain* or reduc*) adj5 (smok* or tobacco or nicotine)).tw.	51511	
99	"Tobacco Use Disorder"/	10617	
100	ex-smoker*.tw.	3769	
101	anti-smok*.tw.	1225	
102	93 or 94 or 95 or 96 or 97 or 98 or 99 or 100 or 101	335144	
103	alcohol drinking/ or binge drinking/	64411	
104	alcohol*.tw.	308065	
105	Alcoholic Intoxication/ or Alcoholism/	82939	
106	drink*.tw.	128749	
107	liquor*.tw.	7780	
108	beer*.tw.	9611	
109	wine*.tw.	18647	
110	spirit*.tw.	24880	
111	drunk*.tw.	4203	
112	intoxicat*.tw.	44075	
113	binge.tw.	11829	
114	103 or 104 or 105 or 106 or 107 or 108 or 109 or 110 or 111 or 112 or 113	508479	
115	47 or 63 or 92 or 102 or 114	2374155	
116	Randomized Controlled Trial/	479844	
117	clinical trial/ or controlled clinical trial/	537645	
118	random allocation/	98475	
119	Double-Blind Method/	150664	
120	Single-Blind Method/	26573	
121	placebos/	34301	
122	Research Design/	100656	No subject heading for Intervention Studies/ deleted – Clinical Trials/ suggested
123	Evaluation Studies/	242326	
124	Comparative Study/	1826707	
125	exp Longitudinal Studies/	122430	
126	Cross-Over Studies/	45007	
127	exp Cohort studies/	1844224	New Mesh heading added
128	Controlled Before-After Studies/	383	New Mesh heading added
129	Interrupted Time Series Analysis/	553	New Mesh heading added
130	comparative study.pt.	1826707	New pt search added

#	Searches	Results	
131	clinical trial.tw.	125184	
132	latin square.tw.	4495	
133	(time adj series).tw.	26782	
134	(before adj2 after adj3 (stud* or trial* or design*)).tw.	12708	
135	((singl* or doubl* or trebl* or tripl*) adj5 (blind* or mark)).tw.	160930	
136	placebo*.tw.	202959	
137	random*.tw.	1038274	
138	(matched adj (communit* or school* or population*)).tw.	2305	
139	control*.tw.	3546542	
140	(comparison group* or control group*).tw.	434335	
141	matched pairs.tw.	5809	
142	outcome stud*.tw.	7564	
143	(qua?iexperimental or qua?i experimental or pseudo experimental).tw.	11696	Wildcard
144	(nonrandomi?ed or non randomi?ed or psuedo randomi?ed or quasi randomi?ed).tw.	26473	
145	prospectiv*.tw.	638036	
146	volunteer*.tw.	182708	
147	116 or 117 or 118 or 119 or 120 or 121 or 122 or 123 or 124 or 125 or 126 or 127 or 128 or 129 or 130 or 131 or 132 or 133 or 134 or 135 or 136 or 137 or 138 or 139 or 140 or 141 or 142 or 143 or 144 or 145 or 146	7432338	
148	exp adolescent/ or child/	2671427	
149	(child or children or adolescen* or teen*).tw.	1276835	
150	148 or 149	3119058	
151	4 and 33 and 115 and 147 and 150	4111	
152	**limit 151 to ed=20160901-20190412**	**823**	

Appendix 7. Characteristics of the newly identified implementation trials

Author, year	Study characteristics	n (number of participants)		Intervention description and implementation strategy (EPOC)	Comparator description	Implementation outcomes:
		Baseline	Follow up			
Ang, 2018[18]	**Design:** Non-randomised CT **NHMRC Level of evidence:** III-2 **Setting:** Elementary schools **Population:** New York, US	**Intervention:** 7 (schools) **Control:** 7 (schools)	**Intervention:** 7 (schools) **Control:** 7 (schools)	**Intervention description:** WITS program provided different equipment, such as hula-hoops, skip ropes, balls, baseball, etc., and the WITS coaches were trained with a repertoire of different games and activities to get the students more physically active during outdoor and indoor recess. There were six major components that could be considered as the core of the WITS Cook for Kids program: i) Placement of WITS Chef in the school; ii) Switching to the Alternative Menu; iii) Salad bar with at least six vegetable items; iv) Unsweetened white milk as the only milk option; v) Conducting cooking classes (this component was named WITS Labs); and vi). Conducting nutrition education sessions **Implementation strategies:**	Control schools did not receive any WITS programming. They were instead given $1000 in funds for their participation, which they were requested to use for any non-food-, fitness, or health-related programming for students, such as chess club	**Outcome:** WITS schools were also evaluated on whether white milk was the only milk option, and whether the salad bar served 6 salad items or more. These two components were also evaluated in control schools since they were not exclusive to WITS schools **Measure**: Lunch PIECES tool was specifically developed for the larger main evaluation study. The data collected provided information on school lunch food items, the food environment (cafeteria), health-related programs (program) and the WITS Cook for Kids program **Results:** **White milk only milk option** Baseline: intervention 3/7, control 0/7 Follow up: intervention 3/7, control 0/7 **Salad bar served 6 salad items or more** Baseline: intervention 5/7, control 6/7 Follow-up: intervention 6/7, control 5/7

Author, year	Study characteristics	n (number of participants)		Intervention description and implementation strategy (EPOC)	Comparator description	Implementation outcomes:
		Baseline	Follow up			
				Educational outreach visits Educational materials		
Bremer, 2018[19]	**Design:** Non-randomised CT **NHMRC Level of evidence**: III-2 **Setting:** Schools between grades 4 and 8 **Population:** Ontario, Canada	**Intervention:** 19 (classes) **Control:** 11 (classes)	**Intervention:** 19 (classes) **Control:** 11 (classes)	**Intervention description:** The intervention consisted of a DPA program designed by a national organisation with expertise in school-based PA programming and delivered in school by teachers. The program was offered to students in grades 4 through 8 and consisted of 20 minutes of structured DPA in school for 20 consecutive weeks **Implementation strategies:** Educational meetings Educational materials	The remaining teachers were however still expected to provide DPA to their students, as per the Ontario education curriculum	**Outcome:** Adherence to the program, student behaviour, and PA opportunities. **Measure:** A 21-item questionnaire was developed for this study. Completed by the homeroom teacher at the last measurement point, it included 3 sections: adherence to the program, student behaviour, and PA opportunities **Results:** Quantity PE lessons: $t(27) = -0.23$, $P=0.82$
Cheung, 2019[20]	**Design**: Quasi-experimental **NHMRC Level of evidence:** III-I **Setting:** Elementary schools	**Intervention:** 71 (schools) **Control:** 62 (schools)	**Intervention:** 71 (schools) **Control:** 62 (schools)	**Intervention description:** PU30 is a state-wide CSPA-based initiative to increase PA in school which allows tailoring of the initiative at the school level to encourage 30 minutes of PA outside PE each day **Implementation strategies:** Educational meeting Educational materials	Comparison group were schools that did not receive the PU30 training	**Outcome:** Crude mean (SD) minutes of PA offered per week for trained and untrained schools at baseline (2013–2014) and follow-up (2015). **Measure:** School PA survey adapted from widely used school PA survey tools. PE teachers provided data regarding PE, before school and after schools PA opportunities, while grade teachers provided data regarding recess and in-class PA breaks.

Author, year	Study characteristics	n (number of participants)		Intervention description and implementation strategy (EPOC)	Comparator description	Implementation outcomes:
		Baseline	Follow up			
	Population: Georgia, US					**Results:** **Crude mean (SD) minutes of PA offered per week:** During PE: Baseline: intervention 107.7 (4.4), control 105.6 (5.3) Follow up: intervention 104.9 (4.3), control 105.5 (5.5) During recess: Baseline: intervention 89.8 (4.2), control 100.3 (3.9) Follow up: intervention 98.7 (3.6), control 96.2 (3.6) In-class PA: Baseline: intervention 40.5 (2.6), control 30.4 (2.3) Follow up: intervention 51.9 (2.5), control 36.1 (2.6)
Egan, 2018[21]	**Design:** Non-randomised, pre-post with control group **NHMRC Level of evidence:** III-2 **Setting**: Elementary school	**Treatment 1:** 3 (classes) **Treatment 2:** 3 (classes) **Treatment 3:** 3 (classes) **Control:** 3 (classes)	**Treatment 1:** 3 (classes) **Treatment 2:** 3 (classes) **Treatment 3:** 3 (classes) **Control:** 3 (classes)	**Intervention description:** PACES is a pilot intervention program focused on increasing children's PA during regular school hours. It specifically targets two CSPAP components: (a) PE and (b) PA during school (i.e. opportunities to be active beyond PE). We employed three partnership approaches (communities of practice,	**Treatment 1:** School A received the first PACES partnership approach (community of practice) **Treatment 2:** School B received the	**Outcome:** Implementation of teacher directed transition **Outcome:** implementation of other movement - non-academic **Outcome:** Other movement academic **Outcome:** Non-teacher directed transition **Measure:** Twelve research assistants coded video records (n=57) using the SOSMART **Results:** **Mean total implementation score of movement integration**

Author, year	Study characteristics	n (number of participants)		Intervention description and implementation strategy (EPOC)	Comparator description	Implementation outcomes:
		Baseline	Follow up			
	Population: South Eastern state, US			community-based participatory research, and service learning) based on Webster, Beets et al.'s (2015) partnership model with the aim of providing external support for the participating classroom teachers in the intervention classrooms and, subsequently, increasing the extent of MI in these classrooms **Implementation strategies:** Educational materials Educational outreach visit or academic detailing Tailored intervention Audit and feedback	first two approaches (community of practice and community-based participatory research) **Treatment 3:** School C received all three approaches (community of practice, community-based participatory research, and service learning) **Control:** Comparison classrooms not receiving the program	Treatment 1: baseline 44.0, follow-up 39.13, change -4.87 Treatment 2: baseline 50.9, follow-up 54.27, change 3.37 Treatment 3: baseline 49.63, follow-up 50.73, change 1.10 Control: baseline 36.30, follow-up 35.37, change -0.93 **Mean implementation score of teacher directed transition** Treatment 1: baseline 17.83, follow-up 14.87, change -2.97 Treatment 2: baseline 17.03, follow-up 20.60, change 3.57 Treatment 3: baseline 24.40, follow-up 21.07, change -3.33 Control: baseline 18.24, follow-up 20.20, change 1.95 **Mean implementation score of other movement - non-academic** Treatment 1: baseline 3.23, follow-up 2.20, change -1.00 Treatment 2: baseline 1.83, follow-up 4.90, change 3.07 Treatment 3: baseline 1.20, follow-up 12.50, change 11.33 Control: baseline, 0.59, follow-up 0.00, change -

Author, year	Study characteristics	n (number of participants)		Intervention description and implementation strategy (EPOC)	Comparator description	Implementation outcomes:
		Baseline	Follow up			
						0.59 **Mean implementation score of other movement academic** Treatment 1: baseline 2.17, follow-up 3.60, change 1.43 Treatment 2: baseline 0.50, follow-up 1.17, change 0.67 Treatment 3: baseline 1.43, follow-up 0.80, change -0.63 Control: baseline 1.18, follow-up 5.45, change 4.28 **Mean implementation score of non-teacher directed transition** Treatment 1: baseline 20.77, follow-up 18.47, change -2.27 Treatment 2: baseline 31.53, follow-up 27.50, change -4.00 Treatment 3: baseline 22.67, follow-up 16.37, change -6.30 Control: baseline 16.16, follow-up 9.36, change -6.79
Evenhui, 2018[22]	**Design**: Quasi-experimental **NHMRC Level of evidence:** III-I	**Intervention:** 10 (schools) **Control:** 10 (schools)	**Intervention:** not reported **Control:** not reported	**Intervention description:** The intervention schools received support to implement the 'Guidelines for Healthier Canteens'; i.e. an advisory meeting and report,	Control schools received the guidelines only	**Outcome:** Changes in school canteen: product availability on display, vending machines and product accessibility **Measure:** Changes in the school canteen were assessed using the 'Canteen Scan', an online

Author, year	Study characteristics	n (number of participants)		Intervention description and implementation strategy (EPOC)	Comparator description	Implementation outcomes:
		Baseline	Follow up			
	Setting: Elementary schools **Population:** Netherlands			communication materials, newsletters, an online community and a factsheet with student's wishes/needs **Implementation strategies:** Educational materials Educational meeting Audit with feedback		tool to measure product availability on displays and vending machines, and product accessibility **Results:** **Availability of healthier products on display in school canteens**: mean (SD) Intervention: baseline 45.80 (27.12), follow up 77.29 (13.41)*, P=0.007 Control: baseline 50.40 (23.00), follow up 60.10 (15.67), p value not reported **Accessibility of healthier products within school canteens: mean (SD)** Intervention: baseline 44.00 (20.66), follow up 60.00 (21.60), P=0.03 Control: baseline 43.00 (20.58), follow up 50.00 (14.91), p value not reported
Farmer, 2017[23]	**Design:** C-RCT **NHMRC Level of evidence:** II **Setting:** Elementary schools **Population:** Otago and	**Intervention:** 8 (schools) **Control:** 8 (schools)	**Intervention:** 8 (schools) **Control:** 8 (schools)	**Intervention description:** The researchers, playworker and school community worked together to develop a playground action plan that met the needs of each school community. Following baseline evaluations of their play space, each intervention school was provided with a list of tailored suggestions for improvements. This was specific to each school	Control schools (n=8) were asked to not change their play environment	**Outcome:** PA policies within their school (break time, using PA as a punishment, promotion of community activities, adequacy and availability of facilities during school/after hours, enjoyment and promotion of PA regardless of skill level, amount and quality of PE, and safety issues). **Measure:** principals completed an 18-item questionnaire assessing PA policies within their school. Principals indicated whether the policies were fully in place (score of 3), partially in place (2), under development (1), or not in place (0). **Results:**

Author, year	Study characteristics	n (number of participants)		Intervention description and implementation strategy (EPOC)	Comparator description	Implementation outcomes:
		Baseline	Follow up			
	Auckland, New Zealand			but could include the addition of more interactive play equipment, and alterations to school rules and policies that may limit risk-taking during play, with all alterations meeting playground safety standards. The research team met with each school community to finalise the plan **Implementation strategies:** Incentives Local consensus approach Tailored interventions		**School policy regarding PA: mean (SD)** Follow up: intervention 76.2% (10.4), control 76.4% (10.6), P=0.568 **Provision of play opportunities:** mean difference: 4.50 (95%CI: 1.82 to 7.18, P=0.005
Nathan, unpublished	**Design:** C-RCT **NHMRC Level of evidence:** II **Setting:** Elementary schools **Population:** Hunter region of NSW, Australia	**Treatment 1:** 3 (schools) **Treatment 2:** 3 (schools) **Treatment 3:** 3 (schools) **Control:** 3 (schools)	**Treatment 1:** 3 (schools) **Treatment 2:** 3 (schools) **Treatment 3:** 3 (schools) **Control:** 3 (schools)	**Intervention description:** Three key opportunities were targeted to improve PA. PE teachers were supported to program PE by developing a sequential plan for each school class. Sport teachers were supported to program sufficient time for sport and maximise student activity. Teachers were supported to integrate short bouts of activity	**Treatment 1:** PA support **Treatment 2:** Lunchbox support **Treatment 3:** Both PA support and lunchbox support **Control:** Control schools did	**Outcome:** Mean minutes of teachers' scheduled PA **Measure:** at the end of each day for one school week teachers completed a paper-based log book. This included the time they engaged in all teaching activities across all subjects each day including the duration PA was provided. **Results:** Mean minutes of teachers' scheduled PA: Follow-up: significant between-group difference (P=0.04)

Author, year	Study characteristics	n (number of participants)		Intervention description and implementation strategy (EPOC)	Comparator description	Implementation outcomes:
		Baseline	Follow up			
				into class routines, such as energisers or active lessons **Implementation strategies:** Educational outreach visits Centralised technical support Mandate change Identify and prepare champions Provide ongoing consultation Educational material	not receive the intervention	
Nathan, unpublished data	**Design:** C-RCT **NHMRC Level of evidence:** II **Setting:** Elementary schools **Population:** Hunter region of NSW, Australia	**Intervention:** 31 (schools) **Control:** 31 (schools)	**Intervention:** 30 (schools) **Control:** 31 (schools)	**Intervention description:** Three key opportunities were targeted to improve PA. PE teachers were supported to program PE by developing a sequential plan for each school class. Sport teachers were supported to program sufficient time for sport and maximise student activity. Teachers were supported to integrate short bouts of activity into class routines, such as energisers or active lessons **Implementation strategies:** Educational outreach visits Centralised technical support	**Control:** Control schools did not receive the intervention	**Outcome:** The primary trial outcome is the mean minutes of PA scheduled during a 1-week data collection periods at baseline, 12- and 18-months following baseline. Scheduled PA includes time spent in PE, sport and other structured physical activities **Measure:** Teacher completion of a daily activity log-book. At the end of each day of the week of data collection, each teacher responsible for the class that day will complete a written log of the day's teaching including the time and occasions of PA for PE, sport or other structured activities **Results:** **Whole day scheduled PA** Follow-up: significant between-group difference(P<0.001)

Author, year	Study characteristics	n (number of participants)		Intervention description and implementation strategy (EPOC)	Comparator description	Implementation outcomes:
		Baseline	Follow up			
				Mandate change Identify and prepare champions Provide ongoing consultation Educational material Change physical structure and equipment		
Taylor, 2018[24]	**Design:** RCT **NHMRC Level of evidence**: II **Setting**: Elementary schools **Population**: Northern California, US	**Intervention:** 1 (school) **Control:** 1 (school)	**Intervention:** 1 (school) **Control:** 1 (school)	**Intervention description:** The SHCP incorporates 5 program objectives: (1) increase nutrition knowledge and use of science processing skills among fourth-grade children; (2) promote availability, consumption, and enjoyment of fruits and vegetables in the school environment; (3) improve dietary patterns and encourage PA; (4) foster positive changes in the school environment; and (5) facilitate development of an infrastructure to sustain the program **Implementation strategies:** Incentives Educational materials Educational outreach visits	Control schools received a delayed intervention during the 2013–2014 school year.	**Outcome:** Fruit and vegetable availability **Measure:** Fruit and vegetable availability was compared between the baseline and implementation based on produce expenditures and variety for use in the schools' NSLP. Data from procurement records were used to determine how many different types of fresh fruits and vegetables were offered. The number of fruit items excluding juice and vegetable items offered as side dishes was determined on each day of lunchtime dietary assessment **Results:** **Fruit offered daily by schools: mean (SD)** Baseline: 4.33 ± 0.82 control, 4.80 ± 1.10 intervention, P=0.44 Follow up: 4.17 ± 0.75 control, 4.17 ± 0.98, P=1.00 **Vegetables offered daily by schools: mean (SD)** Baseline: 2.67 ± 0.52 control, 5.40 ± 1.95

Author, year	Study characteristics	n (number of participants)		Intervention description and implementation strategy (EPOC)	Comparator description	Implementation outcomes:
		Baseline	Follow up			
						intervention, P=0.03 Follow up: 3.00 ± 0.89 control, 8.33 ± 0.82 intervention, P<0.001
Waters, 2017[25]	**Design:** RCT **NHMRC Level of evidence:** II **Setting:** Elementary schools **Population:** Melbourne, Australia	**Intervention:** 12 (schools) **Control:** 12 (schools)	**Intervention:** 12 (schools) **Control:** 10 (schools)	**Intervention description:** Schools were supported to develop fun and healthy programs according to the fixed requirement of a whole school combined focus on increasing fruit, vegetable and water consumption, increasing PA and encouraging positive self-esteem in children **Implementation strategies:** Educational materials Educational outreach visits Local consensus approach Tailored interventions	Continue with normal school activities and programs for healthy eating and PA	**Outcome:** Proportion of schools with written PA, healthy eating and canteen policies at baseline and follow up **Measure:** School principals were originally asked to report on whether their school had written policies relating to PA and the canteen. **Results:** **Proportion of schools with PA policy** Baseline control: 7 (70%) Follow up control: 6 (60%) Baseline intervention: 8 (66.6%) Follow up intervention: 11 (91.7%) **Proportion of schools with healthy eating policy** Follow up control: 2 (20%) Follow up intervention: 9 (75%) **Proportion of schools with canteen policy** Baseline control: 4 (40%) Follow up control: 6 (60%) Baseline intervention: 2 (16.7%) Follow up intervention: 3 (25%)

CI=Confidence interval; CSPAP=comprehensive school physical activity program; C-RCT=Cluster randomised controlled trial; CT=Controlled trial; DPA=daily physical activity; EPOC= Effective Practice and Organisation of Care; NHMRC=National Health and Medical Research Council; NSLP=National School Lunch Programs; PA=physical activity; PACES=Physical Activity Enjoyment Scale; PE=Physical education; PU30=Power Up for 30; RCT=Randomised controlled trial; SHCP= Shaping Healthy Choices Program; SD=Standard deviation; SOSMART=System for Observing Student Movement in Academic Routines and Transitions; WITS= Wellness in the Schools.

Appendix 8. Implementation strategies as characterised by Effective Practice and Organisation of Care (EPOC) taxonomy List[48]

Category	Subcategory	Definition
Interventions targeted at healthcare organisations	Organisational culture	Strategies to change organisational culture
Interventions targeted at healthcare workers	Audit and feedback	A summary of health workers' performance over a specified period of time, given to them in a written electronic or verbal format. The summary may include recommendations for clinical action
	Clinical incident reporting	System for reporting critical incidents
	Monitoring the performance of the delivery of healthcare	Monitoring of health services by individuals or healthcare organisations, for example by comparing with an external standard
	Communities of practice	Groups of people with a common interest who deepen their knowledge and expertise in this area by interacting on an ongoing basis
	Continuous quality improvement	An iterative process to review and improve care that includes involvement of healthcare teams, analysis of a process or system, a structured process improvement method or problem solving approach, and use of data analysis to assess changes
	Educational games	The use of games as an educational strategy to improve standards of care
	Educational materials	Distribution to individuals, or groups, of educational materials to support clinical care, i.e., any intervention in which knowledge is distributed. For example this may be facilitated by the internet, learning critical appraisal skills; skills for electronic retrieval of information, diagnostic formulation; question formulation
	Educational meetings	Courses, workshops, conferences or other educational meetings

Category	Subcategory	Definition
	Educational outreach visits, or academic detailing	Personal visits by a trained person to health workers in their own settings, to provide information with the aim of changing practice
	Clinical practice guidelines	Clinical guidelines are systematically developed statements to assist healthcare providers and patients to decide on appropriate health care for specific clinical circumstances'(US IOM)
	Inter-professional education	Continuing education for health professionals that involves more than one profession in joint, interactive learning
	Local consensus processes	Formal or informal local consensus processes, for example agreeing a clinical protocol to manage a patient group, adapting a guideline for a local health system or promoting the implementation of guidelines
	Local opinion leaders	The identification and use of identifiable local opinion leaders to promote good clinical practice
	Managerial supervision	Routine supervision visits by health staff
	Patient-mediated interventions	The use of patients, for example by providing patient outcomes, to change professional practice
	Public release of performance data	Informing the public about healthcare providers by the release of performance data in written or electronic form
	Reminders	Manual or computerised interventions that prompt health workers to perform an action during a consultation with a patient, for example computer decision support systems
	Routine patient-reported outcome measures	Routine administration and reporting of patient-reported outcome measures to providers and/or patients

Category	Subcategory	Definition
	Tailored interventions	Interventions to change practice that are selected based on an assessment of barriers to change, for example through interviews or surveys
Interventions targeted at specific types of practice, conditions or settings	Health conditions	• Acute stroke • Acute surgery • Alcohol
	Practice and setting	Health promotion in dental settings