Public Health 182 (2020) 116–124

Contents lists available at ScienceDirect

Public Health

journal homepage: www.elsevier.com/locate/puhe

Review Paper

The impact of the World Health Organization Health Promoting Schools framework approach on diet and physical activity behaviours of adolescents in secondary schools: a systematic review

C. McHugh*, A. Hurst, A. Bethel, J. Lloyd, S. Logan, K. Wyatt

University of Exeter Medical School, South Cloisters, St Luke's Campus, Exeter, Devon EX1 2LU, UK

ARTICLE INFO

Article history:
Received 9 September 2019
Received in revised form
5 December 2019
Accepted 5 February 2020
Available online 4 April 2020

Keywords:
Adolescent health
Health promotion
Schools
Diet
Physical activity
Systematic review

ABSTRACT

Objective: To examine the effectiveness of interventions using the World Health Organization Health Promoting Schools (HPSs) framework approach in increasing physical activity (PA) and improving the diet of 11–18-year-olds.
Study design: A systematic review guided by the National Health Services Centre for Reviews and Dissemination framework and reported in accordance with the Preferred Reporting Items for Systematic reviews and Meta-Analyses.
Methods: Nine databases and trial registries were searched from 2013 to 2018 for cluster randomised controlled trials involving adolescents' aged 11–18 years. We also included relevant studies from a 2014 Cochrane Review of HPS approach on health behaviours. Data were extracted from included studies and assessed for quality.
Results: Twelve eligible studies were identified from seven countries. The studies varied in outcome measures, sample size, quality and duration of intervention and follow-up. Only four of the included studies were of high to moderate quality. We found some evidence of effectiveness for physical activity only interventions and limited evidence of effectiveness for nutrition only and combined PA and nutrition interventions.
Conclusions: There were no discernible patterns across the studies to suggest effective mechanisms for the HPS approach. The family/community component was poorly developed and superficially reported in all studies. Future research should seek to understand how best to work in partnership with secondary schools, to foster and sustain a healthy eating and physical activity culture, which aligns with their core aims. More attention should be paid to the restriction of unhealthy foods in the school environment.

Introduction

There has been a tenfold increase in child and adolescent obesity figures globally over the last four decades.[1] In accordance with the World Health Organization (WHO), 80% of the world's adolescents are not active enough,[2] have high sugar diets[3] and do not consume the recommended amount of fruit and vegetables.[4] There are many potential influences affecting adolescents physical activity (PA) and diet choices, however schools are seen as good environments to role model and educate students on health behaviours from a broad social spectrum. As part of the Ottawa Charter, the WHO developed a Health Promoting Schools (HPSs) framework[5] to support schools globally to create a positive health environment. This whole-school approach has three main components: (1) health education in the curriculum; (2) changes to the school ethos and physical environment; and (3) involving families and/or communities to support health promotion.

Using a whole-school approach has been advocated globally by organizations such as WHO and many countries have adapted the HPS framework to fit their local context,[6] for example, England used this approach to develop a 'National Healthy Schools Programme' which ran between 1999 and 2011; however owing to government funding cuts,[7] this award is currently only

* *Corresponding author.*Tel.: +1392 727419.
E-mail addresses: c.a.mchugh@exeter.ac.uk (C. McHugh), a.j.hurst@exeter.ac.uk (A. Hurst), A.Bethel@exeter.ac.uk (A. Bethel), J.J.Lloyd@exeter.ac.uk (J. Lloyd), Stuart.Logan@exeter.ac.uk (S. Logan), k.m.wyatt@exeter.ac.uk (K. Wyatt).

https://doi.org/10.1016/j.puhe.2020.02.006

operational in some parts of the UK. A previous review of the HPS approach found some evidence for it positively affecting body mass index (BMI), PA, physical fitness and fruit and vegetable (F&V) intake in children aged 5–18 years.[8] However, this review highlighted a high level of heterogeneity in study design and a lack of studies conducted with adolescents. Therefore, our review focused on secondary,[a] school-based, cluster randomised controlled trials (RCTs) taking an HPS approach to promote a healthy diet and/or increase the PA of 11–18-year-olds, highlighting the delivery methods used, as well as their scalability.

Methods

The protocol for this review is registered on PROSPERO: CRD42018094335.[9] Relevant studies from the Langford et al. Cochrane review[8] that met our criteria were included alongside new studies resulting from the search strategy as laid out in the following context.

Search strategy

The search strategy was developed using a combination of relevant controlled vocabulary and free text terms (Fig. 1). The search was run in May 2018 in: MEDLINE, Embase, PsycINFO (via OvidSP), CDSR and Central, CINAHL Complete, BEI, ERIC and AEI, a date restriction of 2013 to date was used to identify additional studies from the previous review. No language restrictions were used. Search results were downloaded into EndNote X8; two reviewers independently screened titles, abstracts and full texts using the inclusion/exclusion criteria. Backward citation searching was manually undertaken by the reviewers and forward citation searching was undertaken in the Web of Science Core Collection and Scopus using the 12 included articles; these results were single screened.

Types of studies

Studies were included if they were RCTs clustered at the level of school, district or geographical area; studies where clusters were at the classroom level were excluded. Feasibility and pilot studies where only one school was allocated to intervention and control group were also excluded.

Types of participants

All students in a mainstream secondary school setting, aged 11–18 yrs. Studies that included 11-year-olds but were in a primary school setting were excluded. Studies that focused on single sex but were in a mixed sex school were excluded.

Types of interventions

Interventions aimed at changing diet and/or PA levels, which addressed all the components of the WHO HPS framework were considered.

[a] For this review, we used secondary school to refer to schools following on from primary or elementary education. This includes high or middle schools. Students are aged 11–18 years.

Types of outcomes measures

Self-reported or objectively measured primary PA and/or diet outcomes including weight status if this was available as set out in the study protocol.[9]

Data extraction

Titles and abstracts were screened by two reviewers and any discrepancies were discussed and resolved by a third reviewer. Data were extracted on included studies as detailed in the protocol. In addition, we recorded how each included study addressed each HPS component, and if they had conducted a cost-effectiveness and/or process evaluation.

Quality appraisal

The Cochrane Risk of Bias Tool for RCTs[10] was used to assess the risk of bias. Two authors individually assessed each study and any disagreements were discussed with the third reviewer. Each study was rated for overall quality and categorised as low, moderate, moderate/high or high.

Data synthesis

Included studies were categorised as to whether they aimed to affect diet, physical activity or both. Intervention types were considered separately to assess heterogeneity and to ascertain whether the studies were sufficiently homogenous to allow a meta-analysis.

Results

Bibliographic databases searches

The databases searches found a total of 6672 results; of these, 4154 were screened at title and abstract and 74 full texts were retrieved for detailed inspection. Four new studies[11–14] were included from this search, as well as eight identified studies from Langford et al.[15–22] making a total of 12 included studies for this review (Fig. 2). Three trials registries (Clinicaltrials.gov, ICTRP and TRoPHI) were searched in December 2018, as well as forward and backward citation chasing; no further studies were found.

Study characteristics

Table 1 details the study characteristics; six studies were conducted in the United States,[13,15,16,18,19,22] and one each in Ecuador,[11] Belgium,[21] Finland,[17] France,[20] Australia[12] and India.[14] The sample sizes ranged from 462 to 25,000 participants, there was limited reporting of the schools' structure or organization. The age of students ranged from 11 to 15 years, no studies were found for students aged 16–18 years. All studies reported the age and gender of participants. Eight studies[12–16,18,19,22] reported ethnicity and nine[11–13,15,18–22] reported socioeconomic status. Four studies conducted long-term follow-up (more than 24 months),[13,15,19,20] six medium (24-12 months)[11,12,16,18,21,22] and two short-term follow-up (12 months or less).[14,17]

Study quality

Eight studies were assessed as low quality,[13,14,16–19,21,22] two moderate,[11,20] one as moderate/high[15] and one as high[12] (Fig. 3). Nine studies[11–13,17–22] reported the theory used to develop the intervention, however, only two studies explicitly identified using

1 teen*.tw.
2 adolescen*.tw.
3 young person*.tw
4 young people*.tw.
5 youth*.tw.
6 pupil*.tw.
7 student*.tw.
8 exp ADOLESCENT/
9 1 or 2 or 3 or 4 or 5 or 6 or 7 or 8
10 Physical* activ*.tw.
11 physical* fit*.tw.
12 nutrition*.tw.
13 diet*.tw.
14 fruit*.tw.
15 vegetable*.tw.
16 obes*.tw.
17 bmi.tw.
18 body mass index.tw.
19 overweight.tw.
20 physical* inactiv*.tw.
21 weight.tw.
22 (sugar adj2 intake*).tw.
23 (calorie adj2 intake*).tw.
24 sedentary.tw.
25 (promot* or policy or policies or educat* or environment* or ethos* or attitud* or curricul* or behav* or intervention* or cultur* or family).tw.
26 health*.tw.
27 (health* adj2 (promot* or policy or policies or educat* or environment* or ethos* or attitud* or curricul* or behav* or intervention* or cultur* or family)).tw.
28 *Health Behavior/
29 *Health Promotion/
30 *Health Education/
31 diabet*.tw.
32 randomized controlled trial.pt.
33 controlled clinical trial.pt.
34 randomized.ab.
35 placebo.ab.
36 clinical trials as topic.sh.
37 randomly.ab.
38 trial.ti.
39 32 or 33 or 34 or 35 or 36 or 37
40 exp animals/ not humans.sh.
41 39 not 40
42 *Schools/
43 school*.tw.
44 42 or 43
45 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 27 or 28 or 29 or 30 or 31
46 9 and 41 and 44 and 45
47 "Health Promoting Schools framework".tw.
48 "Health Promoting Schools (HPS) framework".tw.
49 hps framework.tw.
50 47 or 48 or 49
51 46 or 50
52 limit 51 to yr="2013 -Current"

Fig. 1. Search terms.

the HPS framework one of which was rated high quality[12] and the other as low.[12,14] The extent to which studies developed the processes within each HPS component varied considerably (Table 2). Owing to the heterogeneity of the studies, a narrative synthesis was conducted.[23] Only three of the included studies[11,15,16] reported on adverse events. One described potential events but reported that none occurred,[16] one did not specify what was classified as an adverse event[11] and one reported the occurrence of non-intervention–related adverse events as dizziness during blood collection.[15]

Effect of the intervention

Nutrition studies ($n = 4$)

Three studies primarily measured F&V consumption using self-report instruments, whereas one measured incidence of overweight/obesity by body mass index, standardised for age and gender (BMIz).[16] All studies in this category were of low quality (Fig. 3). These studies sought to promote and increase the consumption of healthy foods such as F&V, through increasing the availability of healthy options, with two studies also restricting

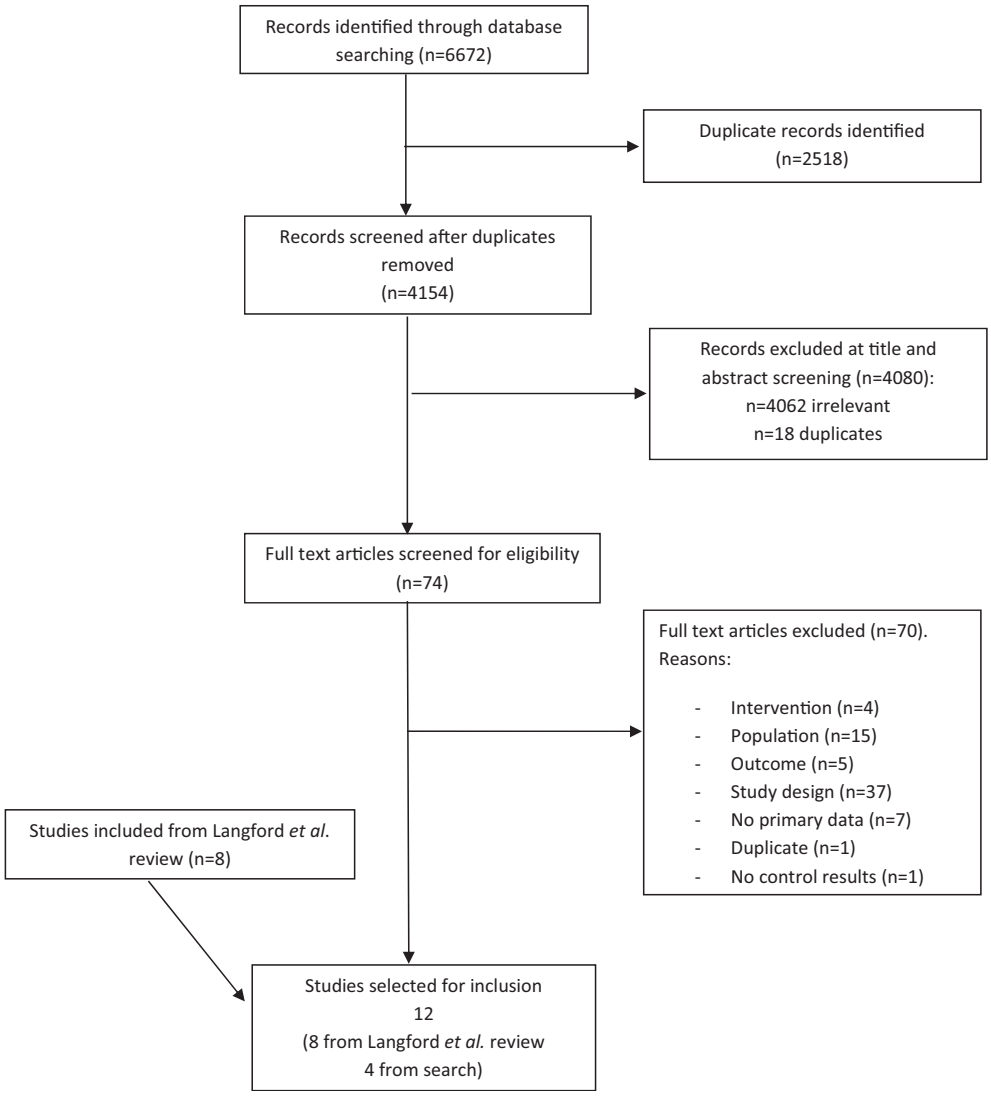

Fig. 2. Prisma flow chart showing the search process.

unhealthy foods.[16,17] Of the studies which increased the availability of healthy options, neither reported an effect on F&V intake.[18,19] The two studies that included the restriction of unhealthy foods, as well as increasing healthy options, reported a small decrease in sucrose intake (12.8%–10.5%) of the total energy intake[17] and in the incidence of overweight (7.5% fewer)[16] immediately after intervention. One study addressed the HPS components with more intensity, over a longer time period and resulted in fewer children becoming overweight after two years.[16]

PA studies (n = 3)

A different primary outcome measure was used for each of the PA only studies: physical fitness test,[11] daily moderate-vigorous physical activity level (MVPA) using accelerometry[12] and BMIz[20] making it hard to make comparisons regarding the magnitude of effect. All were of moderate to high quality (Fig. 3). These studies focused primarily on increasing individual PA levels, through a mixture of classroom activities, during existing physical education (PE) classes. All reported a significant positive effect (Table 1). All three addressed the family/community component in similar ways (Table 2); however, over two years Sutherland et al.[33] a high quality study, had the most developed ethos and environment and curriculum component, possibly owing to explicitly using the HPS framework.

PA and nutrition studies (n = 5)

Most studies in this category were low quality with only one being rated as moderate/high[15] (Fig. 3). Three of these studies used PE lessons to address individual PA levels, and provide knowledge on nutrition,[15,21,22] whereas one study showed a short film about PA during class[13] and another had separate health education lectures[14] (Table 2). All of the studies increased the provision and marketing of healthy food options, with only one restricting the provision of unhealthy foods.[15] Four studies were looking to affect diet and PA to affect weight status and used objective weight measures, with the other study using observed PA levels and reviewed school menus for fat content[22] to assess effectiveness. There was no meaningful significant effect reported in prevalence of overweight/obesity and BMIz; one study reported a smaller increase in BMIz at follow-up, although this was only in girls and did not reach statistical significance.[21] One study which was rated moderate to high in quality, used an objective measure and had well-developed HPS components found no effect on the prevalence of obesity;[15] however, fewer students became overweight at follow-up. The study that

Table 1
Study characteristics.

Author, year, country, programme	Number of schools, consented participants & mean age	Intervention duration	Number (time of follow up)	Theory	Primary outcome category/measure	Primary outcome results	Attrition numbers at final follow up (by group if reported)
Nutrition							
Foster et al. 2008[16,a] USA, School Nutrition Policy Initiative	10 middle schools; 1349 (int 749, con 600); Mean age: 11.2 ± 1.0yrs	2yrs	2 (end of each yr)	NR	Incidence of overweight and obesity (BMIz and percentiles)	Significantly fewer children in the intervention schools (7.5%) than in the control schools (14.9%) became overweight after 2yrs ($P = 0.03$)	Int: 270 (36.0%), con: 235 (39.2%)
Hoppu *et al.*, 2010[17,a] Finland	12 secondary schools; 769; Mean age: 13.8yrs	8mths	1 (1 yrs)	SCT	F&V intake, consumption of rye bread and sweets. (food intake questionnaires)	No difference in F&V. In intervention girls rye bread increased ($P = 0.03$); sweets decreased ($P = 0.006$). Sucrose intake for intervention pupils decreased from 12.8% to 10.5% of total energy intake ($P = 0.01$).	110 (14.3%)
Lytle *et al.*, 2004[18,a] USA, TEENS	16 middle schools; 3878 survey, 640 24 hr recall; Mean age: 12 −13yrs	2yrs	2 (end of each yr)	SCT	F&V intake (24hr recall interviews)	Total F&V intake showed no significant difference.	185 (28.9%)
Nicklas *et al.*, 1998[19,a] USA, Gimme 5	12 high schools; 2213; Mean age: 14 −15yrs	3yrs	3 (end of each yr)	PRECEDE model	F&V intake (self-administered KAP questionnaire)	No significant difference.	unclear
PA							
Andrade *et al.*, 2014[11] Equador, ACTIVITAL	20 schools; 1440 (int 700, con 740); Mean age: 12.9 ± 0.8yrs	11mths (Study duration 28mths)	1 (28mths)	SCT, IMBSM, control theory, TTM and TPB.	Physical fitness (EUROFIT test battery)	Vertical jump (intervention effect 2.5 cm; 95% CI: 0.8 −4.2; $P = 0.01$). Speed shuttle run (intervention effect −0.8 s, 95% CI: −1.58 −0.07; $P = 0.05$).	Int: 150 (21.4%), con: 207 (28.0%)
Simon *et al.*, 2006[20,a] France, ICAPS	8 middle schools; 954 (int 479, con 475); Mean age: 11.6 ± 0.02yrs	4yrs	3 (end of 2nd, 3rd & 4th yr)	SEM framework	BMI & BMIz	Intervention students had lower increase in BMI ($P = 0.01$) and age- and gender-adjusted BMI ($P < 0.02$) over time than controls.	Int: 105 (21.9%), con: 117 (24.6%)
Sutherland *et al.*, 2016[12] Australia, PA4E1	10 schools; 1233 (int 696, con 537); Mean age: 12yrs	2yrs	2 (end of each yr)	SCT & SEM framework	MVPA (daily mins by accelerometers)	Significant effect on daily minutes of MVPA 7.0 mins increase (95% CI: 2.7−11.4, $P < 0.002$)	Int: 136 (19.5%), con: 112 (20.9%)
Author, year, country, programme	Number of schools, consented participants & mean age	Intervention duration	Number (time of follow up)	Theory	Primary outcome category/measure	Primary outcome results	Attrition numbers at final follow up (by group if reported)
Nutrition and PA							
Bogart *et al.*, 2014[13] USA, SNaX	10 middle schools; 2439 (int 1178, con 1261); Mean age: 12.2yrs ± 0.68yrs	5wks	1 (2yr post-intervention)	Diffusion of innovation theory	BMI percentile (BMI and CDCP categorization)	Non-significant effect overall on BMI but those obese had reduced BMI at follow up (b = −2.33 percentiles; SE, 0.83; $P = 0.005$) compared with control students.	Int: 349 (29.6%), con: 722 (57.3%)
Foster *et al.*, 2010[15,a] USA, HEALTHY	42 middle schools; 6358 (int 3189, con 3169) Mean age: 11.3 ± 0.6yrs	3yrs	1 (3yrs)	NR	Prevalence of overweight and obesity (BMI ≥ 85%) and BMIz	No difference in combined prevalence of overweight & obesity.	int: 882 (27.7%), con: 873 (27.5%)
Haerens *et al.*, 2006[21,a] Belgium	15 middle schools; 2840; Mean age: 13.06 ± 0.81yrs	2yrs	2 (end of each yr)	TPB, SCT, ASE model, TTM	BMI and BMIz	In girls BMI and BMIz increased significantly less in the intervention with parental support group[b] compared with the control group ($P < 0.05$) or the intervention-alone group ($P = 0.05$). Non-significant difference for boys.	Unclear

Table 1 (*continued*)

Author, year, country, programme	Number of schools, consented participants & mean age	Intervention duration	Number (time of follow up)	Theory	Primary outcome category/measure	Primary outcome results	Attrition numbers at final follow up (by group if reported)
Sallis *et al.*, 2003[22,a] USA, M-SPAN	24 middle schools; 25,000; Mean age: 11 −14yrs	2yrs	2 (end of each yr)	SEM	PA levels and fat intake (SOFIT & SOPLAY observation & menu analysis)	PA: effect for total group ($P < 0.009$); for boys ($P < 0.001$) and not for girls ($P < 0.40$). Fat: No effect for total fat ($P < 0.91$) or saturated fat ($P < 0.79$)	Unclear
Thakur *et al.*, 2016[14] India	4 schools; 462 (int 201, con 261); Mean age: 13yrs	20wks	1 (1yr)	NR	Change in weight/ BMIz	No significant difference in BMI. Intervention group showed decrease in weight by -0.08 (95%CI: −0.15 to −0.00, $P = 0.048$) z-score units.	Int: 44 (21.9%), con: 45 (17.2%)

ASE, Attitude, social influence and self-efficacy; CDCP, Centers for disease control and prevention; con, control group; HPS, Health Promoting School; IMBSM, information-motivation behavioural skills model; int, intervention group; KAP, Knowledge, attitudes, and practices; mths, months; NR, not reported; PA, physical activity; RCT, randomised control trial; SEM, Social Ecological Model; SCT, social cognitive theory; SOFIT, System for observing fitness instruction time; SOPLAY, System for Observing Play and Leisure Activity of Youth; TPB, theory of planned behaviour; TTM, transtheoretical model; wks, weeks; yrs, years.

[a] Studies included within the Langford Review.

[b] Three conditions were examined (an intervention with parental support group, an intervention-alone group and control group).

measured PA levels and fat intake showed a significant increase in PA for boys but there was no effect on fat intake.[22] It is hard to draw conclusions from these studies as only one assessed PA and diet behaviours directly[22] so it is unclear whether the intervention failed to affect these behaviours or did not affect them sufficiently to impact weight status.

Process evaluations and cost-effectiveness

Process evaluation data were collected within eight of the included studies.[11,12,15,18–22] There was considerable variability in the methods used and the type of data captured with the majority of the reporting on issues concerning implementation, reach and the acceptability of the intervention. The level of reporting varied from brief paragraphs alongside the outcome results[12,18,20,21,24] to separate publications.[25–28] The studies which assessed intervention fidelity reported the intervention as being delivered as planned,[12,15,20,25] and one PA/diet study identified some issues around implementation and reported this as possible reason for lack of effect.[21] Three studies assessed parental engagement, and all reported that parental engagement with the intervention as low;[11,15,18] six studies looked at the acceptability of the intervention from a deliverer or pupil perspective and all reported that the intervention was widely acceptable and engaged students.[12,15,18,20,25,28] There were mixed results regarding the feasibility of delivering the intervention, with one study reporting that the intervention was 'too burdensome' for teaching staff to deliver[18] and another, which used research staff, highlighting the importance of the relationship between external and internal deliverers to successfully deliver the intervention.[15] Two studies sought to relate the underlying mechanisms of the interventions to the trial outcomes; both reported the level of implementation as affecting outcome.[18,21] One reported that low parent engagement may have adversely affected the outcome but did not articulate the

	Random sequence generation (selection bias)	Allocation concealment (selection bias)	Blinding of participants and personnel ψ(performance	Blinding of outcome assessment (detection bias)	Incomplete outcome data (attrition bias)	Selective reporting (reporting bias)	Reported outcome power calculation	Attrition rate	Quality rating
Nutrition									
Foster *et al.*, 2008[16]*	?	+	-	-	-	?	NR	High	Low
Hoppu et al., 2010[17]*	?	+	-	-	-	?	NR	Low	Low
Lytle *et al.*, 2004[18]*	?	+	-	-	-	?	80%	High	Low
Nicklas*et al.*, 1998[19]*	?	+	-	-	?	?	NR	Unclear	Low
PA									
Andrade *et al.*, 2014[11]	+	+	-	?	-	-	>80%	High	Moderate
Simon *et al.*, 2006[20]*	?	+	-	-	+	+	<90%	High	Moderate
Sutherland *et al.*, 2016[12]	+	+	-	+	?	+	>80%	Low	High
Nutrition and PA									
Bogart *et al.*, 2014[13]	?	+	-	+	-	-	NR	High	Low
Foster *et al.*, 2010[15]*	+	+	-	+	+	-	90%+	High	Moderate/High
Haeran*set al.*, 2006[21]*	?	+	-	?	?	?	>80%	Unclear	Low
Sallis*et al.*, 2003[22]*	?	+	-	-	?	?	NR	Unclear	Low
Thakur*et al.*, 2016[14]	?	+	-	-	-	?	NR	Low	Low

*included studies within the Langford Review; NR Not Reported; - negative/high risk; + positive/low risk;?unclear risk

Ψ Due to the nature of the RCT design, the blinding of participants would be considered as high risk for all studies hence this was not applied for the quality rating

Fig. 3. Bias summary of studies.

Table 2
HPS components.

Study	Curriculum	Ethos and environment	Family and community
Foster *et al.*, 2008[16,*]	50 hrs F&N education per student per school year.	Self-assessment, nutrition policy, school food provision changed, restriction of unhealthy food, school social marketing and incentives.	Various parent meetings and weekly nutrition workshops (number and attendance unclear).
Hoppu *et al.*, 2010[17,*]	Nutrition education in lessons (amount unclear)	Drama workshops for staff and pupils, increase of healthy snacks, restriction of sugary snacks. School meals unchanged.	Invite to school meal, magazine sent home on healthy eating & information provided nutrition of school food.
Lytle *et al.*, 2004[18,*]	10 behaviour based nutrition lessons (goal-setting, skills, self-monitoring) used trained peer leaders	Worked with food provider to increase F&V and healthy snacks. School meal unchanged, school council used to create & promote a healthy school environment & policy.	3 parent newsletter (including 10 behaviour coupons with incentives). Parents part of nutrition council group.
Nicklas *et al.*, 1998[19,*]	5x 55 min workshops and 5-a-day messages in all other lessons	Increase in F&V options, school social marketing (5-a-day), and staff training.	Termly parent newsletter and magazine with recipes, media displays & tastings at school parent meetings. Calendar with tips & recipes in final yr.
Andrade *et al.*, 2014[11]	Every two weeks PE lessons used 2 curriculum based books to educate on health benefits and decision making skills.	Installed a walking trail, school social marketing.	6 one hr parent workshops and an event with well-known athletes.
Simon *et al.*, 2008[20,*]	Focus in PE lessons to encourage lifelong PA behaviour (detail unclear)	New/extra PA opportunities in school breaks and after school. Sporting and 'cycle to school' events.	Regular parent meetings (number unclear), community policy makers asked to support PA environment.
Sutherland *et al.*, 2016[12]	Extensive adjustment to PE lessons to maximise lifelong PA. Goal setting, incentives, fitness progress and reports. PE teacher training	New policy to enhance PA. Created a school committee, strategies manual for school, new equipment & opportunities during school lunch breaks, promotional materials.	Termly parents newsletter, info on school website, expo of local community providers.
Bogart *et al.*, 2014[13]	A short film during class	Increase healthy foods & chilled/filtered water, school social marketing, peer leader/ advocacy group.	Take home activities to do with parents.
Foster *et al.*, 2010[15,*]	PE lessons focused on nutrition, goal-setting and increase in MVPA (detail unclear). Peer communicators used to help deliver intervention	Increase and promotion of healthy food/ drink choices. School social marketing.	Parent newsletter and home packs.
Haerens *et al.*, 2006[21,*]	Over 2yr in PE lessons 4hrs to promote PA and 2hrs healthy eating. Fitness test and tailored computer feedback	School work group, extra PA equipment & opportunities. School fruit policy (low price or free). Free water bottle to promote drinking water.	Parent meeting & information folder (including a CD-ROM with computer tailored program for adults and students). 3 newsletters & info in school paper.
Sallis *et al.*, 2003[22,*]	PE lessons changed to increase PA at school (staff training)	Extra PA opportunities, equipment & incentives; increase of low-fat food choices, training for canteen staff and incentives. School social marketing, health policy meetings (x3) and student health committee.	Parent newsletters, information posters & brochure.
Thakur *et al.*, 2016[14]	Fortnightly health education lectures by health professionals. Student lifestyle journals with SR daily diet/PA record.	One period of daily PA. Increase healthy foods choices. School social marketing. Teachers involved in student health assessment.	Child tailored dietary recommendations from dietician to partents. Parent involvement in screen-time reduction. PTA involved in health assessment.

[*] Studies included within the Langford Review.
F&N, food and nutrition; F&V, fruit and vegetable; hrs, hours; MVPA, moderate-vigorous physical activity; PA, physical activity; PE, physical education; PTA, parent-teacher association; SR, self-reported; yr, year.

rationale for greater parental engagement[18] whilst another three-arm study, which assessed the intervention plus additional parental involvement activities against the control and intervention only groups, reported no impact.[21] One process evaluation highlighted the fact that they became aware of a similar program, operating in control schools which they suggest could explain the lack of effect on outcome.[25] Only one of the studies carried out had published a separate cost-effectiveness evaluation on its primary outcome and demonstrated that it was a cost-effective intervention, although it did identity that scale-up might be an issue owing to the use of research personnel to deliver parts of the intervention.[29] No negative unintended consequences were reported in any of the studies.

Discussion

This systematic review follows on from the Langford et al. review[8] which included 34 studies addressing diet and PA behaviours, with only 8 set in secondary schools; this review identified four further trials which focused on 11–16-year-olds. The strongest evidence for the HPS approach came from interventions which sought to increase PA. Other reviews[30–33] that have looked more generally at school-based interventions to address PA in secondary school settings have reported mixed findings. One review looking at obesity prevention interventions found some evidence for PA interventions increasing levels of PA and reducing the risk of obesity in 13–18-year-olds;[34] however, Love et al.[35] reviewed school-based PA trials which had used objectively measured MVPA and found no overall effect on directly measured mean daily minutes of MVPA. Sutherland et al. conducted a high quality study in a socio-economic deprived area, explicitly used the HPS framework, collected daily MVPA and showed a significant positive effect, however scale-up might be an issue owing to costs associated with intervention delivery.

Similar to the 2019 Brown et al. review,[34] the HPS nutrition-only-interventions showed minimal effect on young people's eating behaviours. The interventions that restricted unhealthy foods[16,17] showed some effect on sucrose intake and prevalence of

overweight. Langford et al.[8] included both primary and secondary schools and found a positive effect for F&V intake; however, the current review only looked at secondary schools and found no effect for F&V intake. This may be due to a number of factors such as school structures and policies which make it easier to manipulate the food environment in the primary setting, as well as a wider selection of less healthy food choices in secondary schools. Unlike the findings in other reviews,[34,37] the combined PA and nutrition studies included in this review showed little effect on BMIz or prevalence of overweight or obesity, except one study which showed less of an increase in BMIz in girls.[21]

Interventions were heterogeneous in their design and delivery of the HPS components including the two studies[12,14] that explicitly stated that they used the framework. For example, one study[13] used a single lesson whilst another had more than 50 h of class time[16] to affect the curriculum (Table 2). Similarly, the ethos and environment component was equally diverse, with one school providing a walking trail and social marketing[9] whilst another changed school policy, set up committees, changed provision, and created strategies to support a whole-school culture change.[10] Whilst the studies which did not find any meaningful effect were all considered to be 'low' in terms of their delivery of the HPS components,[13–15,18,19,22] there was no consistent pattern in the design or delivery of the HPS framework and effectiveness. One study intensively delivered the HPS framework and had external research personnel to support the delivery of the components;[12] however, two of the studies[11,20]which reported an effect were considered to have 'low' fidelity to the HPS framework, thus making it hard to draw any conclusions about the nature and quality of delivery of the HPS components and effectiveness. Langford et al.[38] highlight that activities to address the family and community component are lacking and recommends that this needs to improve, using more creative methods to engage families. The family component in the additional studies is also lacking in development; arguably secondary schools face a far bigger challenge to engage families and communities which requires concerted effort and additional resources to enable partnership working and cultural change. Perhaps, with the limited resources available, secondary schools, may be better served by research focussing on the well-developed delivery of both the curriculum and ethos/environment components of the HPS framework. The absence of consensus regarding purpose, minimum content and integration for each component and how it might affect outcomes could be hampering efforts to further develop this approach.[36] In the evaluation of the effectiveness of HPS interventions, there seems to be a tension between HPS programmes that aim to address the whole-school culture and its policies, which take time and resources, thus being potentially burdensome for schools to implement vs the more simple and compartmentalized programmes which do not require culture change but may well be inadequate to impact behaviours sufficiently to address health outcomes to any great extent.

Despite the principles of the HPS approach, its implementation predominantly uses theories focused on individual behaviour change rather than system-level theories of change. As discussed by Bonell et al.[39] future research should take the emphasis off individual behaviours and use integrated theories to change the school system to support adolescent's health choices. However, the structure and practices of secondary schools are designed to achieve national academic targets, rather than national health targets. The lack of detailed process and cost-effectiveness data of most HPS trials make it difficult to understand what a truly HPS might look like and how it might be assessed for its impact on effect of the school culture and environment, as well as health behaviours and outcomes.[40] Although the HPS framework is a whole-school approach there is currently no measure to assess its impact on school culture to see whether the intervention is operating at the level of the school.

In conclusion, evidence suggests that focussing on the school environment can effect PA behaviours; however, there is a lack of evidence of effect for diet behaviours partly owing to a limited number of studies conducted in adolescents, particularly in the UK. With some evidence suggesting that restricting unhealthy food choices in school environments vs only adding healthy options, this could be an avenue which warrants further study. However, researchers need to work with secondary schools to avoid overburdening them and aim to understand the school context and align any intervention development with the schools core aims. Future evaluation design also needs careful consideration, given approaches to change culture and policy are hard to assess in a RCT design and simple component approaches are insufficient to actually impact behaviours. The WHO HPS framework, shows promise and would seem to do no harm; however, it needs further consideration in secondary schools to agree the purpose, quality and content of each component and how these impact outcomes such that it can be integrated and sustained into school culture to support pupil health.

Author statements

Acknowledgements

Rebecca Langford provided advice and support on the protocol and included articles.

Ethical approval

None declared.

Funding

All Saints Education Trust (ASET) fund CMc's Fellowship, the views expressed are those of the authors and not necessarily those of ASET. This research was supported by the National Institute for Health Research (NIHR) Collaboration for Leadership in Applied Health Research and Care (CLAHRC) South West Peninsula, now recommissioned as NIHR Applied Research Collaboration (ARC) South West Peninsula. The views expressed are those of the authors and not necessarily those of the NHS, the NIHR or the Department of Health and Social Care.

Competing interests

None declared.

Author contributions

K.W., J.L., C.Mc and S.L. conceived and designed the review and K.W. supervised throughout. A.B. developed the search strategy with assistance from C.Mc and A.H. A.B. performed the electronic searches. C.Mc and A.H. conducted the screening of titles and abstracts, evaluated the eligibility of full text articles and extracted study data. K.W., A.H. and C.Mc assessed the included studies and interpreted the results. C.Mc drafted the manuscript with help from A.H. and A.B. K.W. and J.L. provided extensive comments on the initial draft. All authors approved the final document.

Consent for publication

Not applicable.

Availability of data and material

This is a systematic review study where all included studies are published and available in the public domain.

References

1. Abarca-Gómez L, Abdeen ZA, Hamid ZA, Abu-Rmeileh NM, Acosta-Cazares B, Acuin C, et al. Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: a pooled analysis of 2416 population-based measurement studies in 128·9 million children, adolescents, and adults. *Lancet* 2017;**390**:2627–42.
2. The World Health Organisation. Physical activity. 2018 [5 12/2019]; Available from: https://www.who.int/news-room/fact-sheets/detail/physical-activity.
3. The World Health Organisation. *Guideline: sugars intake for adults and children*. 2015.
4. The World Health Organisation. *Increasing fruit and vegetable consumption to reduce the risk of noncommunicable diseases*. 2014. Available from: https://www.who.int/elena/titles/bbc/fruit_vegetables_ncds/en/. [Accessed 5 December 2019].
5. The World Health Organization. *Health Promoting Schools: an Effective approach to early action on noncommunicable disease risk factors*. Health Promotion Unit; 2017.
6. The World Health Organisation. Health promoting schools. [5/12/2019]; Available from: https://www.who.int/health-topics/health-promoting-schools#tab=tab_1.
7. Arthur Sb M, Day N, Ferguson C, Gilby N, Hussey D, Morrell G, Purdon S. *Evaluation of the national healthy schools programme -final report*. National Center for Social Research; 2011.
8. Langford R, Bonell CP, Jones HE, Pouliou T, Murphy SM, Waters E, et al. The WHO Health Promoting School framework for improving the health and well-being of students and their academic achievement. *Cochrane Database Syst Rev* 2014;**4**.
9. McHugh C, Wyatt K, Bethal A, Lloyd J, Hurst A. The World Health Organisation (WHO) Health Promoting Schools (HPS) framework for diet and physical activity behaviours of adolescents in secondary school. *Prospero: Int Prospect Regist Syst Rev* 2018. Prospero Number CRD42018094335.
10. Higgins JPT, Altman DG, Gøtzsche PC, Jüni P, Moher D, Oxman AD, et al. The Cochrane Collaboration's tool for assessing risk of bias in randomised trials. *BMJ (Clin Res Ed)* 2011;**343**:d5928–.
11. Andrade S, Lachat C, Ochoa-Aviles A, Verstraeten R, Huybregts L, Roberfroid D, et al. A school-based intervention improves physical fitness in Ecuadorian adolescents: a cluster-randomized controlled trial. *Int J Behav Nutr Phys Activ* 2014;**11**(153). 2014 Dec 10, 11:153.
12. Sutherland RL, Campbell EM, Lubans DR, Morgan PJ, Nathan NK, Wolfenden L, et al. The physical activity 4 everyone cluster randomized trial: 2-year outcomes of a school physical activity intervention among adolescents. *Am J Prev Med* 2016;**51**:195–205.
13. Bogart LM, Elliott MN, Cowgill BO, Klein DJ, Hawes-Dawson J, Uyeda K, et al. Two-year bmi outcomes from a school-based intervention for nutrition and exercise: a randomized trial. *Pediatrics* 2016;**137**.
14. Thakur J, Bharti B, Tripathy J, Dhawan V, Bhansali A. Impact of 20 week lifestyle intervention package on anthropometric biochemical and behavioral characteristics of schoolchildren in North India. *J Trop Pediatr* 2016;**62**(5).
15. Foster GD, Linder B, Baranowski T, Cooper DM, Goldberg L, Harrell JS. A school-based intervention for diabetes risk reduction. *N Engl J Med* 2010;**363**.
16. Foster GD, Sherman S, Borradaile KE, Grundy KM, Vander Veur SS, Nachmani J. A policy-based school intervention to prevent overweight and obesity. *Pediatrics* 2008:121.
17. Hoppu U, Lehtisalo J, Kujala J, Keso T, Garam S, Tapanainen H. The diet of adolescents can be improved by school intervention. *Public Health Nutr* 2010;**13**.
18. Lytle LA, Murray DM, Perry CL, Story M, Birnbaum AS, Kubik MY. School-based approaches to affect adolescents' diets: results from the TEENS study. *Health Educ Behav* 2004;**31**.
19. Nicklas TA, Johnson CC, Myers L, Farris RP, Cunningham A. Outcomes of a high school program to increase fruit and vegetable consumption: gimme 5 - a fresh nutrition concept for students. *J Sch Health* 1998;**68**:248–53.
20. Simon C, Wagner A, Platat C, Arveiler D, Schweitzer B, Schlienger JL. ICAPS: a multilevel program to improve physical activity in adolescents. *Diabetes Metab* 2006;**32**.
21. Haerens L, Deforche B, Maes L, Stevens V, Cardon G, De B. Body mass effects of a physical activity and healthy food intervention in middle schools. *Obesity* 2006;**14**.
22. Sallis JF, McKenzie TL, Conway TL, Elder JP, Prochaska JJ, Brown M. Environmental interventions for eating and physical activity: a randomized controlled trial in middle schools. *Am J Prev Med* 2003;**24**.
23. Popay J, Roberts H, Sowden A, Petticrew M, Arai L, Rodgers M, et al. Guidance on the conduct of narrative synthesis in systematic reviews. In: *A product from the ESRC methods programme Version*, **1**; 2006. b92.
24. Ochoa-Avilés A, Verstraeten R, Huybregts L, Andrade S, Van Camp J, Donoso S, et al. A school-based intervention improved dietary intake outcomes and reduced waist circumference in adolescents: a cluster randomized controlled trial. *Nutr J* 2017;**16**:79.
25. Nicklas TA, O'Neil CE. Process of conducting a 5-a-day intervention with high school students: gimme 5 (Louisiana). *Health Educ Behav* 2000;**27**:201–12.
26. Volpe SL, Hall WJ, Steckler A, Schneider M, Thompson D, Mobley C, et al. Process evaluation results from the HEALTHY nutrition intervention to modify the total school food environment. *Health Educ Res* 2013;**28**:970–8.
27. Hall WJ, McMurray RG, Zeveloff A, Steckler A, Schneider M, Thompson D, et al. Process evaluation results from the healthy physical education intervention. *Health Educ Res* 2011;**27**:307–18.
28. McKenzie TL, Sallis JF, Prochaska JJ, Conway TL, Marshall SJ, Rosengard P. Evaluation of a two-year middle-school physical education intervention: M-SPAN. *Med Sci Sports Exerc* 2004;**36**:1382–8.
29. Sutherland R, Reeves P, Campbell E, Lubans DR, Morgan PJ, Nathan N, et al. Cost effectiveness of a multi-component school-based physical activity intervention targeting adolescents: the 'Physical Activity 4 Everyone' cluster randomized trial. *Int J Behav Nutr Phys Activ* 2016;**13**:94.
30. van Sluijs EMF, McMinn AM, Griffin SJ. Effectiveness of interventions to promote physical activity in children and adolescents: systematic review of controlled trials. *BMJ* 2007;**335**:703.
31. Owen MB, Curry WB, Kerner C, Newson L, Fairclough SJ. The effectiveness of school-based physical activity interventions for adolescent girls: a systematic review and meta-analysis. *Prev Med* 2017;**105**:237–49.
32. Hynynen ST, van Stralen MM, Sniehotta FF, Araújo-Soares V, Hardeman W, Chinapaw MJM, et al. A systematic review of school-based interventions targeting physical activity and sedentary behaviour among older adolescents. *Int Rev Sport Exerc Psychol* 2016;**9**:22–44.
33. Dobbins M, Husson H, DeCorby K, LaRocca RL. School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6 to 18. *Cochrane Database Syst Rev* 2013.
34. Brown T, Moore THM, Hooper L, Gao Y, Zayegh A, Ijaz S, et al. Interventions for preventing obesity in children. *Cochrane Database Syst Rev* 2019;**7**.
35. Love R, Adams J, van Sluijs EMF. Are school-based physical activity interventions effective and equitable? A meta-analysis of cluster randomized controlled trials with accelerometer-assessed activity. *Obes Rev* 2019;**20**:859–70.
36. Turunen H, Sormunen M, Jourdan D, von Seelen J, Buijs G. Health Promoting Schools-a complex approach and a major means to health improvement. *Health Promot Int* 2017;**32**:177–84.
37. Langford R, Bonell C, Jones H, Pouliou T, Murphy S, Waters E, et al. The world health Organization's health promoting schools framework: a Cochrane systematic review and meta-analysis. *BMC Publ Health* 2015;**15**:1–15.
38. Langford R, Bonell C, Jones H, Campbell R. Obesity prevention and the Health promoting Schools framework: essential components and barriers to success. *Int J Behav Nutr Phys Activ* 2015;**12**:167.
39. Bonell CP, Fletcher A, Jamal F, Wells H, Harden A, Murphy S, et al. Theories of how the school environment impacts on student health: systematic review and synthesis. *Health Place* 2013;**24**:242–9.
40. Langford R, Bonell C, Komro K, Murphy S, Magnus D, Waters E, et al. The health promoting schools framework: known unknowns and an agenda for future research. *Health Educ Behav* 2017;**44**:463–75.