

## Review Article

# The implementation and effectiveness of school-based nutrition promotion programmes using a health-promoting schools approach: a systematic review

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### Abstract

*Objective:* To evaluate implementation and effectiveness of nutrition promotion programmes using the health-promoting schools (HPS) approach, to indicate areas where further research is needed and to make recommendations for practice in this field.

*Design:* The searched electronic databases included: CINAHL, Cochrane Library, Health Reference Center, Informit Search, MEDLINE, ProQuest, PsycINFO, PubMed, ScienceDirect, Scopus, Social Services Abstracts and Web of Science. Inclusion criteria were: (i) controlled or before-and-after studies evaluating a nutrition intervention and involving the HPS approach, either fully or in part; (ii) provision of information about components and delivery of the intervention; and (iii) report on all evaluated outcomes.

*Setting:* Schools.

*Subjects:* Students, parents and school staff.

*Results:* All included studies described intervention delivery and six reported on process evaluation. In intervention schools school environment and ethos were more supportive, appropriate curriculum was delivered and parents and/or the community were more engaged and involved. Students participated in interventions at differing levels, but the majority was satisfied with the intervention. The evidence indicates that nutrition promotion programmes using the HPS approach can increase participants' consumption of high-fibre foods, healthier snacks, water, milk, fruit and vegetables. It can also reduce participants' 'breakfast skipping', as well as reduce intakes of red food, low-nutrient dense foods, fatty and cream foods, sweet drinks consumption and eating disorders. It can help to develop hygienic habits and improved food safety behaviours.

*Conclusions:* More professional training for teachers in the HPS approach, further qualitative studies, longer intervention periods, improved follow-up evaluations and adequate funding are required for future school-based nutrition promotion programmes.

**Keywords**  
Systematic review  
Health-promoting schools  
Nutrition  
Implementation and effectiveness

Good nutrition is vital to all human beings and adequately nourished people enjoy optimal growth, health and well-being<sup>(1)</sup>. In recent years, there has been a growing concern about the diet and nutrition of young people with the recognition that health promotion from an early stage of life has a major impact on health and well-being during childhood and beyond<sup>(2)</sup>. Studies indicate that good nutrition is especially important during the first years of life, since these are crucial years for normal physical and mental development. In addition, healthy eating habits in childhood not only help to prevent undernutrition,

growth retardation and acute child nutrition problems, but also chronic, long-term health problems such as obesity, CHD, type 2 diabetes and stroke<sup>(3–5)</sup>.

Research suggests that nutrition promotion is an accessible and effective tool in developing healthy nutrition-related practice and dietary habits in youth<sup>(6)</sup>. Further, the adolescents who benefit from nutrition promotion can act as change agents by spreading the messages to a large segment of the population<sup>(7)</sup>. Fortunately, the importance of early learning of nutrition-related knowledge, attitudes and behaviours has long been

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recognized<sup>(8,9)</sup>. When it comes to nutrition promotion among young people, studies show that schools can play a major role in dietary change. Evidence indicates that when children go to school, parental influence on diet decreases and food provided in schools and the influence of peers become more important<sup>(10)</sup>. Also, the school food environment is increasingly recognized as having a significant influence over children's eating behaviours because of the amount of time spent at school and the large percentage of food intake consumed while at school<sup>(11)</sup>. An additional potential benefit of school nutrition promotion is that by improving the nutrition and health of schoolchildren, their educational performance and learning may be enhanced<sup>(12)</sup>. A consensus is emerging within research and stakeholder communities that action at the school level must be a priority. Such action can create a supportive environment that enables children to make healthy food choices that, ultimately, will reduce future morbidity and mortality associated with overweight and obesity<sup>(3,13–16)</sup>.

Since the mid-1990s a whole-school approach, embodied by the health-promoting school (HPS) model, is increasingly being endorsed as an effective way to promote nutrition and health in the school setting<sup>(17,18)</sup>. This holistic approach is underpinned by Bronfenbrenner's ecological theory<sup>(19,20)</sup> and has been strongly supported by the WHO<sup>(21)</sup>. In addition to promoting adoption of a curriculum in which health is specifically integrated, it recognizes the significance of school-based health policies, links with health services and partnerships between the school, the family and community<sup>(22,23)</sup>. Schools have the opportunity to teach young people about food and nutrition and can demonstrate the importance of a balanced diet for future health by providing healthy choices in the school canteen and by working in partnership with parents and the wider community<sup>(24)</sup>.

While recent reviews evaluate either the process of nutrition interventions<sup>(25,26)</sup> or the outcome of nutrition programmes<sup>(27)</sup>, relatively few reviews include both these two parts<sup>(28)</sup>. Even though some reviews involve both process and outcome evaluations of the intervention, they usually only focus on a specific aspect of nutrition promotion, such as nutrition policy<sup>(29)</sup>, breakfast<sup>(30)</sup> or fruit and vegetable consumption<sup>(31,32)</sup>. Further, few reviews focus on school-based nutrition programmes that have used a fully comprehensive or holistic HPS approach<sup>(8,33)</sup>. The current paper provides a systematic review of the evaluation of both the implementation and effectiveness of nutrition promotion programmes involving a wide range of nutritional aspects and using the HPS approach, either adopted in full or adopted partially. The objectives of the study are to evaluate the implementation and effectiveness of school-based nutrition promotion programmes using the HPS approach, to indicate areas where further research is needed and also to make recommendations for practice in this field, if research findings permit.

## Experimental methods

### Literature search

The retrieval of published studies for the present review included a structured search in the following electronic databases: CINAHL, Cochrane Library, Health Reference Center, Informit Search, MEDLINE, ProQuest, PsycINFO, PubMed, ScienceDirect, Scopus, Social Services Abstracts and Web of Science, published before 30 September 2011. No language restrictions were applied. The search strategy was designed to be inclusive and focused on two key elements: nutrition and health-promoting school. In addition, reference lists of all retrieved articles were screened for potentially eligible articles.

### Study selection

To be included in the present review, studies needed to meet the following three criteria.

1. They had to be controlled studies, or before-and-after studies, evaluating school-based interventions on nutrition involving health-promoting activities in all or one or two of the following three areas:

- (a) the school ethos and/or environment, such as school policy;
- (b) the curriculum, specifically the nutrition curriculum;
- (c) the family and/or community;

and demonstrate active participation by the school.

2. They had to provide information about the components and delivery of the intervention.
3. They had to report all evaluated outcomes.

There were no restrictions on study duration, follow-up period, control condition or who delivered the intervention.

To identify the relevant studies, the reviewers reviewed all titles and abstracts generated from the searches. Articles were rejected on initial screening only if the reviewers could determine from the title and abstract that the article did not meet the inclusion criteria. If abstracts were not available or unable to provide sufficient exclusion information, the entire article was retrieved to screen the full text. At the screening stage, all previously screened studies were again re-checked against the eligibility of inclusion criteria.

### Quality assessment

A standardized quality assessment tool, the Effective Public Health Practice Project Quality Assessment Tool (EPHPP Tool) for Quantitative Studies 2003, was used to appraise the methodological rigor of the included studies<sup>(34)</sup>. The six criteria included for quality assessments were:

1. selection bias (i.e. 'are the individuals selected to participate in the study likely to be representative of the target population?');

2. study design (i.e. 'was the study described as randomized?');
3. confounding (i.e. 'were there important differences between groups prior to the intervention?');
4. blinding (i.e. 'were the study participants aware of the research question?');
5. data collection methods (i.e. 'were data collection tools shown to be valid and reliable?'); withdrawals and drop-outs (i.e. 'were withdrawals and drop-outs reported in terms of number and/or reasons per group?');
6. withdrawals and drop-outs (i.e. 'were withdrawals and drop-outs reported in terms of number and/or reasons per group?').

Each criterion was rated as strong, moderate or weak, and then summed to obtain an overall score for each study. Studies with at least four criteria rated as strong and with no criteria rated as weak were given an overall rating of 'strong'. Those studies receiving fewer than four strong ratings and only one weak rating were given an overall rating of 'moderate', and those studies with two or more criteria rated as weak were given an overall study rating of 'weak'. It should be noted that as blinding is not possible for health promotion programmes, papers do not report this aspect and are not marked as weak rating in this regard.

#### **Data extraction**

To review the characteristics of the included studies, the reviewers extracted detailed information into a summary table. Data extraction included study and intervention characteristics as well as main outcomes. The study characteristics included specifics about the aims, participants and sample size, study design and outcomes. The intervention characteristics included specifics about the intervention components.

#### **Data synthesis**

A qualitative synthesis is presented. This details both the evidence presented regarding the implementation of the various nutrition interventions and also the evidence regarding the effectiveness of the selected interventions. The implementation of nutrition intervention was assessed from three aspects: (i) degree of intervention implementation; (ii) participation; and (iii) satisfaction. The effectiveness of nutrition intervention was assessed from three aspects as well: (i) participants' knowledge; (ii) participants' attitudes and skills; and (iii) participants' behaviours.

## **Results**

#### **Literature search**

The evidence available to support using the HPS approach to school-based nutrition promotion was limited, but promising. The search identified 402 articles relevant to HPS and nutrition and left 372 records after

duplicates were removed. Two hundred and sixty-eight articles were deemed to be irrelevant, forty-five articles were reviews, thirty-two articles were cross-sectional surveys and twenty-seven were evaluation articles with a focus on nutrition promotion programmes. Of the twenty-seven evaluation articles, two articles were excluded as they did not provide information about the components and delivery of the intervention and six articles were excluded as they did not report all evaluated outcomes. Of the nineteen included articles<sup>(35–53)</sup>, three articles involved interventions on nutrition policy only, six articles referred to interventions on nutrition education only and ten articles involved interventions using a comprehensive or holistic HPS approach (Fig. 1). The authors, aims, sample size, design, duration and strategies of interventions and main outcomes for each of these included studies are summarized in Table 1.

#### **Range and scope**

The research fields ranged from breakfast eating habits and knowledge, consumption of healthier foods (fruits, vegetables and snacks) and drinks (water), knowledge and attitudes towards nutrition, food classification and hygiene to eating disorders. The minimum intervention period was 1 week and the maximum intervention period was 2 years.

#### **Methodological quality**

The results of the quality assessment are presented in Table 2. Only five of the nineteen studies achieved an overall rating as strong, five were rated as moderate and nine were rated as weak. All studies had some methodological weaknesses and none of the included studies fulfilled all the necessary quality criteria. Seven of the studies were adequately powered randomized controlled trials, five were controlled trials and seven were before-and-after comparisons. No studies were blinded and all participants in eight studies were aware of the research questions.

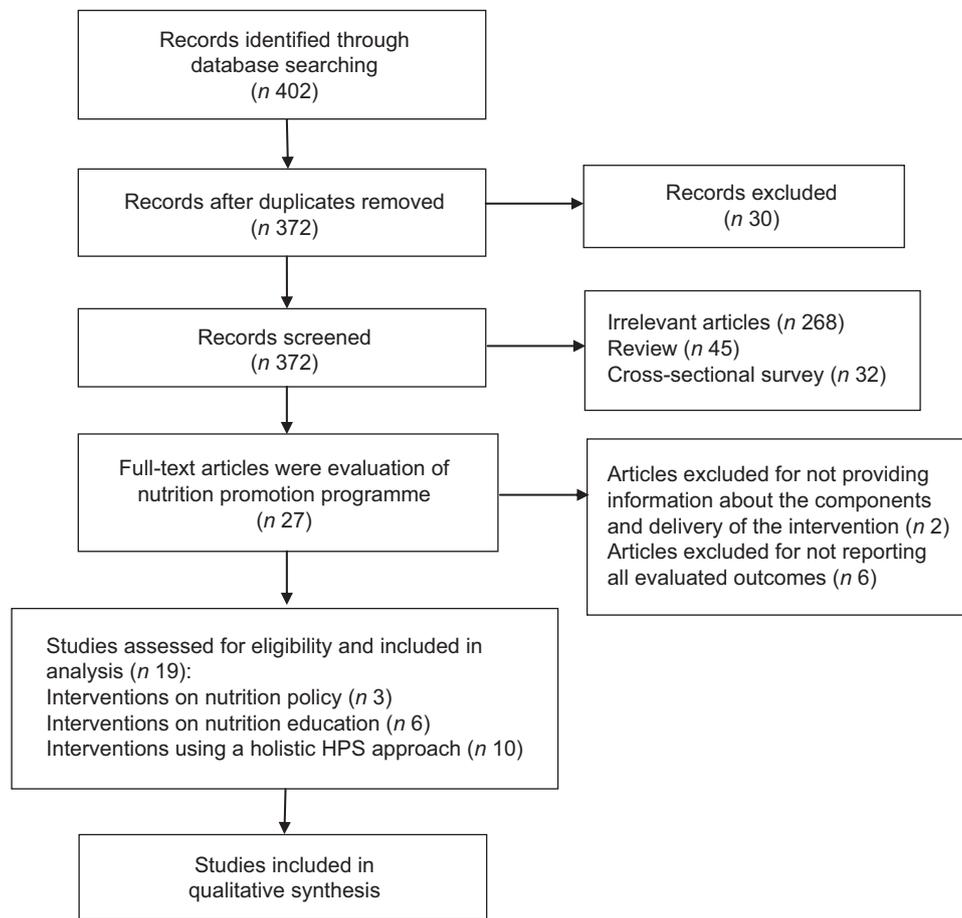
#### **Evidence on implementation of nutrition intervention**

All included studies described their intervention components and only six of these articles reported on a process evaluation. Of these six articles, three used quantitative methods, two used qualitative method and one used both quantitative and qualitative methods.

#### **Degree of intervention implementation**

##### *School environment and ethos*

*School policies and climate.* The intervention schools established policies that placed a high priority on health and nutrition promotion and increased their emphasis on collaboration among students, teachers and other school staff<sup>(35–40)</sup>, such as operating a breakfast club<sup>(41)</sup> or creating a traffic light nutrition tool<sup>(42)</sup>.



**Fig. 1** Flowchart for the selection of articles on health-promoting schools and health promotion in schools on nutrition

*School facilities.* Studies found that physical and operational improvements were made to intervention schools' kitchens and dining areas<sup>(38)</sup>, cooking equipment, healthy foods and clean drinking water were provided<sup>(35,40,43)</sup>, and quality of the lunches and food safety had improved<sup>(36,44)</sup>.

*School health services.* In one study, all of the intervention schools initiated regular physical examinations for students and teachers and began to keep files with students' health records<sup>(35)</sup>.

*Staff training.* Training sessions and newsletters were provided for principals, teachers and cafeteria staff<sup>(43)</sup>.

#### *Curriculum*

In general, the curriculum strategies included: (i) classes with an increased focus on health and nutrition; (ii) adoption of a unit on body image and healthy eating; (iii) nutrition information provided to teachers to encourage increased use in curriculum; (iv) students delivering healthy eating messages in the form of poetry and skits at assembly; (v) production of a show by the school drama club, or an educational role-model story and characters; (vi) pupil competitions to produce promotional resources for healthier choices to be displayed

in the school; (vii) peer-support activities; (viii) play, poster/video presentations; (ix) visiting a health promotion exhibition; and (x) various kinds of publicity materials delivery<sup>(36–39,43,45–53)</sup>.

#### *Partnerships with parents and the wider community*

In the selected articles, the interventions involving parents included: (i) a parental nutritional newsletter, pamphlets, letters and handouts; (ii) a parent education forum; (iii) involvement of parents in their children's homework assignments, education sessions, workshops, class activities and special events; and (iv) a parental version of the web-based computer tailored tool that enabled parents to get personalized feedback on their dietary intake level<sup>(36–39,45–47)</sup>. Partnerships with communities included, for example, breakfast provision<sup>(36)</sup>, advice and support from local nutritionists<sup>(39)</sup> and free seasonal fruit provision<sup>(46)</sup>.

#### *Degree of participation in the intervention*

In summary, students and parents in different countries and schools differed significantly in their participation levels. Even though all intervention schools spent the required minimum time on their nutrition project, the content of the

**Table 1** A summary of the aims, design and major outcomes of the nineteen studies considered in the current review

| Authors                                 | Aims   | Sample size  | Design | Duration of interventions | Interventions   | Main outcomes   |
|---|--|--|--------|---------------------------|---|---|
| Shi-Chang <i>et al.</i> <sup>(35)</sup> | Improve the nutrition and health status of students, school personnel and parents; develop a model project for nutrition interventions for the development of HPS in China | Baseline: 2575 primary-school students and 4277 secondary-school students, 661 personnel and 998 parents/guardians. Evaluation: 2389 primary-school students and 3346 secondary-school students, 679 personnel and 1158 parents/guardians. Primary-school students: grades 3, 4 and 5; secondary school-students: grades 1 and 2 | CT     | 18 months                 | <p>School environment and ethos:</p> <ul style="list-style-type: none"> <li>● School-based working groups</li> <li>● Nutrition training for school staff, topics included the importance of a balanced diet, nutritional deficiencies and their effects, and good hygienic practices</li> <li>● School-wide health promotion efforts</li> </ul> <p>Curriculum:</p> <ul style="list-style-type: none"> <li>● Distribution of materials on school nutrition</li> <li>● Nutrition education for students, students attended a health education class once every two weeks</li> <li>● Student competitions</li> </ul> <p>Partnerships with parents and the wider community:</p> <ul style="list-style-type: none"> <li>● Students disseminated information about good nutrition to their families and to the community</li> <li>● Parents received leaflets about healthy nutrition as well as school lunch menus with a variety of balanced meals that they could prepare at home</li> <li>● Parents and community members were invited to the schools for lectures and workshops, and students went on the streets to hand out or read health and nutrition information to passersby</li> </ul> | There were improvements in nutrition knowledge attitudes and behaviour among all target groups. Primary-school students at intervention schools made the greatest knowledge gains in the areas of Chinese dietary guidelines and adequate dietary principles. Scores of secondary-school students who reported liking school lunches rose at intervention schools from 17.9% to 45.2%. School staff who reported taking lunch at school increased in intervention schools from 87.5% to 93.9%. The largest increases in nutrition knowledge among all target groups occurred among parents and guardians. At the intervention schools, parents increased their knowledge in the areas of nutritional deficiencies and nutrient-rich foods |
| Radcliffe <i>et al.</i> <sup>(36)</sup> | Determine the efficacy of a breakfast promotion intervention based on HPS processes  | 792 students in 7th grade (11–12 years; <i>n</i> 341 for the control group; <i>n</i> 451 for the intervention group)   | RCT    | 6 months                  | <p>School environment and ethos:</p> <ul style="list-style-type: none"> <li>● Events to promote breakfast</li> <li>● Allocation of a breakfast eating area on school grounds</li> <li>● Change in timetable to enable an earlier snack time in the morning</li> <li>● Trial of breakfast provision at the tuck shop</li> </ul> <p>Assessment of tuck-shop breakfast menu</p> <ul style="list-style-type: none"> <li>● Improvement in the nutritional quality of breakfast foods sold at the tuck shop</li> </ul> <p>Curriculum:</p> <ul style="list-style-type: none"> <li>● Classes with an increased focus on health, nutrition and breakfast</li> </ul>  | Breakfast skipping increased by a greater percentage in control group <i>v.</i> intervention group (20.2% <i>v.</i> 4.5%). The proportion of children reporting that they ate at least one 'poor food choice' for breakfast on the day of the survey decreased from 16.4% to 14.8% for the intervention group, while this rate was more than doubled (9.7% to 19.9%) for the control group  |

Table 1 Continued

| Authors                            | Aims   | Sample size  | Design | Duration of interventions | Interventions  | Main outcomes   |
|------------------------------------|--|--|--------|---------------------------|--|---|
|                                    |  |  |        |                           | <ul style="list-style-type: none"> <li>● Adoption of a unit on body image and healthy eating</li> <li>● Breakfast information provided to teachers to encourage its use in curriculum</li> <li>● Development of breakfast recipe books and trialling of recipes in class</li> <li>● Students delivering breakfast messages in the form of poetry and skits at assembly</li> </ul> Partnerships with parents and the wider community: <ul style="list-style-type: none"> <li>● Short information pieces on the importance of breakfast in the school newsletter</li> <li>● Parents' education forum on the issue of breakfast</li> <li>● Involvement of parents in class activities and special events</li> <li>● Breakfast provision to all students by food companies for a 1-week period</li> <li>● Breakfast made available to students at a neighbouring service outside school hours</li> </ul> |   |
| Wind <i>et al.</i> <sup>(37)</sup> | Investigate the degree of implementation and appreciation of a comprehensive school-randomized fruit and vegetable intervention programme and to what extent these factors were associated with changes in reported fruit and vegetable intake | 868 schoolchildren aged 10–13 years, 863 parents and 818 teachers from sixty-two schools | RCT    | 6 months                  | School environment and ethos: <ul style="list-style-type: none"> <li>● Distribution of fruit and vegetables</li> </ul> Curriculum: <ul style="list-style-type: none"> <li>● Sixteen lessons guided by worksheets and a web-based computer-assisted feedback tool that children were asked to complete three times during the intervention period</li> <li>● Four of the lessons involved homework assignments</li> </ul> Partnerships with parents and the wider community: <ul style="list-style-type: none"> <li>● Parents were encouraged to be involved in the project through the homework assignments of their child, parental newsletters and a parent version of the web-based computer-assisted tool that enabled them to get personalized feedback on their own fruit and vegetable intake level</li> </ul>  | Teacher-reported level of implementation of the school curriculum and schoolchildren's appreciation of the project were important determinants of changes in fruit and vegetable intake |

Table 1 Continued

| Authors                         | Aims  | Sample size   | Design           | Duration of interventions | Interventions   | Main outcomes  |
|---------------------------------|---|---|------------------|---------------------------|---|--|
| Parker and Fox <sup>(38)</sup>  | Evaluate the effectiveness of multiple interventions targeted at lunches in secondary schools with the aim of increasing the consumption of healthier foods by children during the school day | 1012 pupils for intervention schools and 772 pupils for control schools | CT               | 2 years                   | <p>School environment and ethos:</p> <ul style="list-style-type: none"> <li>● Formation of school food group and identification of priorities</li> <li>● Regular school food group meetings</li> <li>● Equipment and items purchased for improving eating environment and continuation of fast food area for healthier options</li> <li>● Development of photo menu boards as a promotional tool in liaison with learning support teachers</li> </ul> <p>Curriculum:</p> <ul style="list-style-type: none"> <li>● Peer-related activities, working with drama teacher, production and performance of 'The Food Show' by drama club pupils</li> <li>● Launch of photo menu boards in dining area and learning support classroom</li> <li>● British Nutrition Foundation teaching pack provided</li> <li>● Food-tasting workshops within a series of PSE lessons, followed by related competition to design 'food and health' resources</li> </ul> <p>Partnerships with parents and the wider community:</p> <ul style="list-style-type: none"> <li>● Promotion of healthier eating and the school food group at new intake parents' evening</li> </ul> | There were positive changes in consumption of fruit and non-fried potato in one intervention school, and for high-fibre bread and non-cream cakes at the other in the short term. Only that for high-fibre bread was close to being sustained at the end of the 2 years. The dietary consumption target for vegetables/salad was achieved by the final monitoring period in one school   |
| Rana and Alvaro <sup>(39)</sup> | Assess the effectiveness of using a HPS framework to deliver a nutrition intervention in schools  | 154 participants from schools, local community health staff             | Before and after | 1 year                    | <p>School environment and ethos:</p> <ul style="list-style-type: none"> <li>● Distribution of healthy eating resources and planning tools for school staff</li> </ul> <p>Curriculum:</p> <ul style="list-style-type: none"> <li>● Access to the online nutrition programme</li> <li>● Access to an online discussion group</li> <li>● Access to an online food safety training programme</li> </ul> <p>Partnerships with parents and the wider community:</p> <ul style="list-style-type: none"> <li>● Three workshops for up to five school community members</li> <li>● Distribution of parent fact sheets</li> <li>● Nutritionist support</li> </ul>   | Twenty-nine workshops were provided across ten metropolitan and rural locations; 254 participants from sixty schools attended workshops, with an average of three people from each school. An average of 90% of all respondents found workshops useful/very useful, with most participants reporting they had increased knowledge and skills about healthy eating, healthy eating guidelines and menu planning at the end of the workshops |

Table 1 Continued

| Authors                                | Aims  | Sample size   | Design                  | Duration of interventions | Interventions  | Main outcomes  |
|--|---|---|-------------------------|---------------------------|--|--|
| McVey <i>et al.</i> <sup>(45)</sup>    | Evaluate a comprehensive school-based universal prevention programme involving students, parents, teachers, school administrators and local public health professionals | Baseline survey: 982 middle-school students (grades 6 and 7) and ninety-one teachers/school administrators; 84 % of students attended the survey immediately following the intervention and 71 % again 6 months later | RCT                     | 8-month                   | <p>School environment and ethos:</p> <ul style="list-style-type: none"> <li>● School staff training</li> </ul> <p>Curriculum:</p> <ul style="list-style-type: none"> <li>● In-class curriculum</li> <li>● Girl Talk peer-support group</li> <li>● Play presentation</li> <li>● Focus group for male students</li> <li>● Posters/video presentation</li> </ul> <p>Partnerships with parents and the wider community:</p> <ul style="list-style-type: none"> <li>● Parent education (workshops, newsletters/handouts, school functions)</li> <li>● Training of local public health nurses</li> </ul>   | Participants in intervention programme had a positive influence by reducing the internalization of media ideals among students and by reducing disordered eating among female students. The intervention programme was also associated with reductions in weight-loss behaviours among students, although this effect was lost by the 6-month follow-up. There were no intervention effects for teachers |
| Laurence <i>et al.</i> <sup>(46)</sup> | Evaluate the effectiveness of the HPS framework to increase fruit and water consumption among children of primary-school age  | Baseline: 691 primary-school students.<br>Year 1: 795 students;<br>Year 2: 420 students;<br>Year 3: 410 students  | Interrupted time series | 2 years                   | <p>School environment and ethos:</p> <ul style="list-style-type: none"> <li>● Nomination of lead teacher within each school and development of annual plans</li> <li>● Scheduling of a 'fruit break' within all classes across the school</li> <li>● Development of school 'fruit and water' policies to encourage consumption of fruit and water on a daily basis within class time (and prohibition of sweet drinks and other snacks during class)</li> </ul> <p>Curriculum:</p> <ul style="list-style-type: none"> <li>● Existing nutrition education curriculum resources provided to schools for teacher use as appropriate</li> <li>● Teachers link nutrition curriculum activities with seasonal 'Fresh Fruit Week', e.g. fresh food market tours, taste testing</li> <li>● Water bottles printed with student-designed fruit and water logos distributed at each school programme launch</li> </ul> <p>Partnerships with parents and the wider community:</p> <ul style="list-style-type: none"> <li>● Community dietitian appointed to coordinate programme planning, implementation and evaluation across all schools and facilitate project steering committee</li> </ul> | There were significant increases in the proportion of children bringing fresh fruit, and filled water bottles, and reductions in the proportion of children bringing sweet drinks. These significant changes in dietary patterns were sustained for up to 2 years following programme implementation   |

Table 1 Continued

| Authors                               | Aims   | Sample size   | Design           | Duration of interventions | Interventions  | Main outcomes   |
|---------------------------------------|--|---|------------------|---------------------------|--|---|
| O'Brien <i>et al.</i> <sup>(47)</sup> | Evaluate the nutritional and dietary habits of primary-school children in socio-economically disadvantaged area prior to and following a healthy eating intervention programme | Twenty boys and twenty girls aged 8–9 years   | Before and after | 4 weeks                   | <ul style="list-style-type: none"> <li>● Seasonal 'Fresh Fruit Weeks' held two to four times a year in which all students received free seasonal fruit over 4 d through linkages with a community delivery service and fruit wholesalers</li> <li>● The Fresh Kids programme incorporated within the Municipal Public Health Plan</li> <li>● Monthly nutrition newsletter distributed to parents</li> <li>● Bilingual nutrition education sessions for parents available</li> </ul>  | There were significant increases in the consumption of energy, protein, fat and Ca. While most of the nutrients were consumed in appropriate amounts, the percentage of energy from fat was higher than recommendations, while Fe intakes were below recommendations                                    |
| Young <sup>(40)</sup>                 | To investigate the effect of a healthy eating health promotion initiative on the knowledge, attitudes and behaviour of secondary-school pupils                                 | Second-year pupils in secondary schools. Intervention school: <i>n</i> 50; control school B: <i>n</i> 53; control school C: <i>n</i> 55 | CT               | 2 years                   | <p>School environment and ethos:</p> <ul style="list-style-type: none"> <li>● Head teacher highlights the theme of healthy eating at school assemblies and healthy eating is regularly featured in dining room displays during health weeks</li> <li>● Changes made to the provision of food and drinks available for both snacks and meals</li> <li>● Changes also made to methods of preparing food and to its ingredients</li> <li>● No vending machines or mobile shops in the school grounds</li> </ul> <p>Curriculum:</p> <ul style="list-style-type: none"> <li>● Various subjects of curriculum</li> </ul> | The levels of knowledge of healthy eating were similar in the intervention and control schools, but there were significant differences in eating behaviour between the schools. Pupils in the intervention school demonstrated healthier snack selection at school and a greater uptake of school meals |

Table 1 Continued

| Authors                                 | Aims   | Sample size   | Design           | Duration of interventions | Interventions   | Main outcomes  |
|---|--|---|------------------|---------------------------|---|--|
| Vereecken <i>et al.</i> <sup>(43)</sup> | To investigate the impact of the intervention on children's food consumption   | Children: 618 intervention and 445 control.<br>Parents: 308 intervention and 168 control  | RCT              | 6 months                  | Partnerships with parents and the wider community:<br><ul style="list-style-type: none"> <li>● Parental cooperation seen as central to the healthy eating initiative</li> <li>● School handbook describes the type of changes made by the school</li> </ul> School environment and ethos:<br><ul style="list-style-type: none"> <li>● Availability of healthy foods and cooking equipment</li> <li>● Training sessions and newsletters for principals, teachers and cafeteria staff</li> </ul> Curriculum:<br><ul style="list-style-type: none"> <li>● Experiential education (e. g. tasting) and developmental education (e.g. explanation of concepts of food triangle)</li> <li>● Educational role-model story and characters</li> </ul> Partnerships with parents and the wider community:<br><ul style="list-style-type: none"> <li>● Newsletters for parents</li> <li>● Parent evenings and other school activities with parents</li> </ul> | There was increased fruit consumption for intervention children in comparison with control children, although the effect was significant only for the parental reported fruit consumption and not for the teachers' audit  |
| Shemilt <i>et al.</i> <sup>(41)</sup>   | To measure the health, educational and social impacts of breakfast club provision in schools serving deprived areas across England                               | 6076 pupils   | RCT              | 1 year                    | Operate breakfast club in schools   | A higher proportion of primary-aged breakfast club attendees reported eating fruit for breakfast in comparison to non-attendees  |
| Ellis and Ellis <sup>(42)</sup>         | To evaluate the impact of a school traffic light nutrition education tool on the knowledge, attitude and behaviour of children                                   | Sixty-nine children aged 5–7 years  | Before and after | 8 weeks                   | A school traffic light nutrition tool is created, which seeks to encourage children to freely eat green food, eat amber food in moderation and stop and think before eating red food  | Knowledge improved significantly. Positive attitude scores and asking behaviour for red food decreased, but disappointingly positive feelings and asking behaviour for green food also diminished. Children's refusing behaviour for red food increased  |
| Mullally <i>et al.</i> <sup>(44)</sup>  | To assess the nutritional benefits of the new policy by examining changes in student food consumption prior to and 1 year following implementation of the policy | Students in 5th and 6th grade from eleven elementary schools. Baseline (2001/2002): <i>n</i> 971; evaluation (2007): <i>n</i> 555 | Before and after | 1 year                    | 'School Nutrition Policy' addresses such issues as the quality of food available in the school environment, student access to food, food used in school fundraising initiatives, food safety and nutrition education  | Relative to students in 2001/2002, students surveyed in 2007 were 2·14 times more likely to report consuming less than three daily servings of low-nutrient-dense foods and were more likely to meet recommendations for vegetables and fruits (OR = 1·44) and milk and alternatives (OR = 1·27) |

Table 1 Continued

| Authors                                     | Aims   | Sample size  | Design           | Duration of interventions   | Interventions  | Main outcomes  |
|---|--|--|------------------|---|--|--|
| Freeman and Bunting <sup>(48)</sup>         | To assess the effectiveness of a child-to-child approach to promote healthier snacking in primary-school children  | Baseline: intervention group = 128 children aged 11 years and 112 aged 5 years; control group = 124 children aged 11 years and 118 aged 5 years. Evaluation: intervention group = 118 children aged 11 years and 111 aged 5 years; control group = 112 children aged 11 years and 118 aged 5 years | RCT              | 6 weeks   | The child-to-child programme was developed with teachers, nutritionists and health promotion officers. Older intervention children were given the 'snack facts' programme and became 'teachers' in the child-to-child intervention                               | Older intervention children had greater increases in their mean knowledge scores compared with control children. Older intervention children had greater decreases in mean cariogenic snacking scores compared with control children. Younger children attending lower SES schools had significant decrease in mean cariogenic snacking score compared with older children attending lower SES schools                                   |
| Bullen and Benton <sup>(49)</sup>           | To investigate the effect of a nutrition education intervention and 4 h of related teaching on the nutrition concepts  | Twenty grade 4 children in a primary school  | Before and after | A visit to a mobile 'Life Education Centre' (between 45 and 60 min); a series of lessons (total time 3–4 h) | Visiting a health promotion exhibition and receiving lessons emphasizing food/health-related concepts  | There was no significant change in the participants' conceptual understanding of food  |
| Kreisel <sup>(50)</sup>                     | To evaluate the efficacy and feasibility of using a computer-based teaching tool for nutrition and lifestyle education developed for primary-school children               | Third and fourth grade students aged 8–11 years. Intervention schools ( <i>n</i> 8), 271 pupils; control schools ( <i>n</i> 7), 126 pupils   | RCT              | 2 weeks   | The teachers of control schools were instructed to use only the non-computer-based materials; in the intervention schools the teachers were instructed to additionally have pupils use Cool Food Planet KIDZ for a total of at least 50 min during class time    | Nutrition knowledge increased significantly in both intervention and control schools, irrespective of the teaching tool used. The significant effect was maintained at 3 months' follow-up. There was no detectable difference in nutrition knowledge post-intervention or at follow-up between the two study groups. In intervention schools, younger pupils (8–9 years) had better nutrition knowledge than older pupils (10–11 years) |
| Vijayapushpam <i>et al.</i> <sup>(51)</sup> | To assess the impact of a classroom-based nutrition and health education intervention among student community volunteers in improving their knowledge on individual topics | 687 undergraduate student volunteers   | Before and after | Six lectures of about 45 min to 1 h duration each, spread over a week                                       | The classroom-based lecture method was adopted for imparting nutrition and health education. Different communication materials such as charts, colour folders, slides and transparencies were developed and pre-tested for use as teaching aids by the lecturers | A significant mean improvement of 11.36 was observed in the overall nutrition and health knowledge scores of the student volunteers after the education intervention; knowledge on individual topics related to energy, proteins, fats, adolescent phase, obesity, some lifestyle diseases and infectious diseases improved significantly  |

Table 1 Continued

| Authors                                   | Aims   | Sample size                    | Design | Duration of interventions | Interventions   | Main outcomes  |
|---|--|--------------------------------|--------|---------------------------|---|--|
| Hamilton-Ekeke and Thomas <sup>(52)</sup> | To investigate the effectiveness of a teaching method (TLS, Teaching/Learning Sequence) based on a social constructivist paradigm on students' conceptualization of classification of food             | 172 pupils                     | RCT    | 3 weeks                   | Classes on food classification were taught with the TLS developed by the researcher   | Results before intervention revealed gross misconceptions of pupils' classification of food, while after intervention there was significant improvement of the TLS over the regular teaching method  |
| Morgan <i>et al.</i> <sup>(53)</sup>      | To investigate the impact of school garden-enhanced nutrition education on children's fruit and vegetable consumption, vegetable preferences, fruit and vegetable knowledge and quality of school life | 127 students in grades 5 and 6 | CT     | 10 weeks                  | Both treatment groups (nutrition education and garden-enhanced nutrition education) received the same classroom-based nutrition education unit. In addition to receiving the nutrition education, the two nutrition education and garden classes also participated in the planting and tending of a school garden in a unit known as 'How does your garden grow?' The unit involved the class spending approximately 45 min in the garden four times a week | Significant between-group differences were found for nutrition education and garden-enhanced nutrition education students for overall willingness to taste vegetables and overall taste ratings of vegetables. A treatment effect was found for the nutrition education and garden group for: ability to identify vegetables; willingness to taste capsicum, broccoli, tomato and pea; and student preference to eat broccoli and pea as a snack |

HPS, health-promoting school; CT, controlled trial; RCT, randomized controlled trial; PSE, Personal and Social Education; SES, socio-economic status.

**Table 2** Methodological quality of the reviewed studies ranked according to the EPHPP Tool

| Study   | Shi-Chang <i>et al.</i> <sup>(35)</sup> | Radcliffe <i>et al.</i> <sup>(36)</sup>                            | Wind <i>et al.</i> <sup>(37)</sup>          | Parker and Fox <sup>(38)</sup> | Rana and Alvaro <sup>(39)</sup> | McVey <i>et al.</i> <sup>(45)</sup> | Laurence <i>et al.</i> <sup>(46)</sup>  | O'Brien <i>et al.</i> <sup>(47)</sup> |
|---|---|--|---|--------------------------------|---------------------------------|-------------------------------------|---|---------------------------------------|
| Overall rating*   | Weak                                    | Strong   | Strong                                      | Weak                           | Moderate                        | Strong                              | Moderate                                | Weak                                  |
| <b>Selection bias</b>   |   |  |   |                                |                                 |                                     |   |                                       |
| Are the individuals selected to participate in the study likely to be representative of the target population?  | Yes                                     | Yes  | Yes   | Yes                            | Yes                             | Yes                                 | Yes                                     | Yes                                   |
| What percentage of selected individuals agreed to participate?  | NR                                      | Response rate = 95 % (intervention group) and 96 % (control group) | Response rates ranged from 56.1 % to 99.4 % | NR                             | Response rate = 86.7 %          | Response rate = 52 %                | Response rates ranged from 34 % to 95 % | Response rate = 100 %                 |
| <b>Study design</b>   |   |  |   |                                |                                 |                                     |   |                                       |
| Was the study described as randomized?  | No                                      | Yes  | Yes   | No                             | No                              | Yes                                 | No                                      | No                                    |
| If yes, was the method of randomization described?  |   | No   | No  |                                |                                 | Yes, by the flip of a coin          |   |                                       |
| If yes, was the method appropriate?   |   |  |   |                                |                                 | Yes                                 |   |                                       |
| <b>Confounders</b>  |   |  |   |                                |                                 |                                     |   |                                       |
| Were there important differences between groups prior to the intervention?                                      | No                                      | No   | No  | No                             | No                              | No                                  | No                                      | No                                    |
| If yes, indicate the percentage of relevant confounders that were controlled (either in the design or analysis) |   |  |   |                                |                                 |                                     |   |                                       |
| <b>Blinding</b>   |   |  |   |                                |                                 |                                     |   |                                       |
| Was (were) the outcomes assessor(s) aware of the intervention or exposure status of participants?               | NR                                      | NR   | NR  | NR                             | NR                              | NR                                  | NR                                      | NR                                    |
| Were the study participants aware of the research questions?  | Yes                                     | Yes  | Yes   | Yes                            | Yes                             | No                                  | Yes                                     | Yes                                   |
| <b>Data collection methods</b>  |   |  |   |                                |                                 |                                     |   |                                       |
| Were data collection tools shown to be valid?   | NR                                      | Yes  | Yes   | No                             | Yes                             | Yes                                 | Yes                                     | NR                                    |
| Were data collection tools shown to be reliable?  | Yes                                     | Yes  | Yes   | NR                             | Yes                             | Yes                                 | Yes                                     | NR                                    |
| <b>Withdrawals and drop-outs</b>  |   |  |   |                                |                                 |                                     |   |                                       |
| Were withdrawals and drop-outs reported in terms of numbers and/or reasons per group?                           | No                                      | Yes  | Yes   | No                             | No                              | Yes, no reason                      | No                                      | No                                    |
| Indicate the percentage of participants completing the study?   | No                                      | Yes  | Yes   | No                             | No                              | Yes                                 | No                                      | No                                    |

**Table 2** Continued

| Study   | Shemilt <i>et al.</i> <sup>(41)</sup> | Mullally <i>et al.</i> <sup>(44)</sup>                                  | Young <sup>(40)</sup>   | Ellis and Ellis <sup>(42)</sup>             | Vereecken <i>et al.</i> <sup>(43)</sup>                                 |                                      |
|---|---------------------------------------|---|-------------------------|---|---|--------------------------------------|
| Overall rating*   | Moderate                              | Weak  | Weak                    | Weak  | Strong  |                                      |
| <b>Selection bias</b>   |                                       |   |                         |   |   |                                      |
| Are the individuals selected to participate in the study likely to be representative of the target population?  | Yes                                   | Yes   | Yes                     | Yes   | Yes   |                                      |
| What percentage of selected individuals agreed to participate?  | NR                                    | Baseline: participation rate = 90%; follow-up: participation rate = 59% | NR                      | Response rate = 86.25%                      | Baseline: participation rate = 62%; follow-up: participation rate = 46% |                                      |
| <b>Study design</b>   |                                       |   |                         |   |   |                                      |
| Was the study described as randomized?  | Yes                                   | No  | No                      | No  | Yes   |                                      |
| If yes, was the method of randomization described?  | Yes                                   |   |                         |   | No  |                                      |
| If yes, was the method appropriate?   | Yes                                   |   |                         |   |   |                                      |
| <b>Confounders</b>  |                                       |   |                         |   |   |                                      |
| Were there important differences between groups prior to the intervention?                                      | No                                    | No  | No                      | No  | No  |                                      |
| If yes, indicate the percentage of relevant confounders that were controlled (either in the design or analysis) |                                       |   |                         |   |   |                                      |
| <b>Blinding</b>   |                                       |   |                         |   |   |                                      |
| Was (were) the outcomes assessor(s) aware of the intervention or exposure status of participants?               | NR                                    | NR  | NR                      | NR  | NR  |                                      |
| Were the study participants aware of the research questions?  | Yes                                   | Yes   | Yes                     | Yes   | Yes   |                                      |
| <b>Data collection methods</b>  |                                       |   |                         |   |   |                                      |
| Were data collection tools shown to be valid?   | Yes                                   | Yes   | Yes                     | NR  | Yes   |                                      |
| Were data collection tools shown to be reliable?  | Yes                                   | NR  | Yes                     | NR  | Yes   |                                      |
| <b>Withdrawals and drop-outs</b>  |                                       |   |                         |   |   |                                      |
| Were withdrawals and drop-outs reported in terms of numbers and/or reasons per group?                           | Yes, no reason                        | Yes, no reason  | Yes, no reason          | No  | Yes, no reason  |                                      |
| Indicate the percentage of participants completing the study?   | Yes                                   | Yes   | Yes                     | No  | Yes   |                                      |
| <hr/>   |                                       |   |                         |   |   |                                      |
| Study   | Freeman and Bunting <sup>(48)</sup>   | Bullen and Benton <sup>(49)</sup>                                       | Kreisel <sup>(50)</sup> | Vijayapushpam <i>et al.</i> <sup>(51)</sup> | Hamilton-Ekeke and Thomas <sup>(52)</sup>                               | Morgan <i>et al.</i> <sup>(53)</sup> |
| Overall rating*   | Strong                                | Weak  | Moderate                | Moderate                                    | Weak  | Moderate                             |
| <b>Selection bias</b>   |                                       |   |                         |   |   |                                      |
| Are the individuals selected to participate in the study likely to be representative of the target population?  | Yes                                   | Yes   | Yes                     | Yes   | Yes   | Yes                                  |

Table 2 Continued

| Study   | Freeman and Bunting <sup>(48)</sup>  | Bullen and Benton <sup>(49)</sup>  | Kreisel <sup>(50)</sup> | Vijayapushpam <i>et al.</i> <sup>(51)</sup> | Hamilton-Ekeke and Thomas <sup>(52)</sup> | Morgan <i>et al.</i> <sup>(53)</sup> |
|---|--|--|-------------------------|---|---|--------------------------------------|
| What percentage of selected individuals agreed to participate?  | Baseline: participation rate = 100 %; follow-up: participation rate = 95 % | Baseline: participation rate = 100 %; follow-up: participation rate = 85 % | Response rate = 86 %    | NR  | NR  | Response rate = 87 %                 |
| Study design  |  |  |                         |   |   |                                      |
| Was the study described as randomized?  | Yes  | No   | Yes                     | Yes   | Yes                                       | No                                   |
| If yes, was the method of randomization described?  | No   |  | No                      | No  | No  |                                      |
| If yes, was the method appropriate?   |  |  |                         |   |   |                                      |
| Confounders   |  |  |                         |   |   |                                      |
| Were there important differences between groups prior to the intervention?                                      | No   | No   | No                      | No  | No  | No                                   |
| If yes, indicate the percentage of relevant confounders that were controlled (either in the design or analysis) |  |  |                         |   |   |                                      |
| Blinding  |  |  |                         |   |   |                                      |
| Was (were) the outcomes assessor(s) aware of the intervention or exposure status of participants?               | NR   | NR   | NR                      | NR  | NR  | NR                                   |
| Were the study participants aware of the research questions?  | Yes  | Yes  | Yes                     | Yes   | Yes                                       | Yes                                  |
| Data collection methods   |  |  |                         |   |   |                                      |
| Were data collection tools shown to be valid?   | Yes  | NR   | NR                      | Yes   | NR  | Yes                                  |
| Were data collection tools shown to be reliable?  | Yes  | NR   | NR                      | NR  | NR  | Yes                                  |
| Withdrawals and drop-outs   |  |  |                         |   |   |                                      |
| Were withdrawals and drop-outs reported in terms of numbers and/or reasons per group?                           | Yes, no reason   | Yes, illness   | Yes                     | Yes   | No  | Yes, no reason                       |
| Indicate the percentage of participants completing the study?   | Yes  | Yes  | Yes                     | No  | No  | Yes                                  |

EPHPP Tool, Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies 2003; NR, not reported.

\*Overall rating: strong = at least four criteria rated as strong and with no criteria rated as weak; moderate = fewer than four criteria rated as strong and only one criterion rated as weak; weak = two or more criteria rated as weak.

nutrition lessons varied between schools<sup>(37,50)</sup>. In one study, less than half of people successfully completed the online food safety training programme<sup>(39)</sup>; in another study, the average amount of time children used the intervention tool was 30 min compared with the recommended 50 min<sup>(50)</sup>.

#### *Degree of satisfaction with intervention*

Participants' satisfaction survey showed that most of the participants liked the group activities and were satisfied with sessions, workshops, information sheets and tools, and a majority of respondents indicated intervention activities and materials were 'useful', 'very good' or 'very fun'<sup>(39,45)</sup>. In another study, almost all of the pupils (97%) indicated that they wanted to join in the intervention again, while only two pupils (1.2%) gave the grade 'not good at all' to the intervention<sup>(50)</sup>.

### **Evidence of effectiveness of nutrition intervention**

#### *Diet and nutrition knowledge*

Most of the studies that aimed to improve diet and nutrition knowledge had a significant effect except for two studies showing that there was no significant change in the participants' conceptual understanding of food<sup>(49)</sup> and that the levels of knowledge of healthy eating were similar in the intervention and control schools<sup>(40)</sup>. Other studies showed that knowledge about diet and nutrition improved significantly after the intervention among the target populations; the improved knowledge included knowledge on dietary guidelines and principles, nutritional deficiencies and nutrient-rich foods<sup>(35)</sup>, healthy eating guidelines and menu planning<sup>(39)</sup>, red food and green food<sup>(42)</sup>, cariogenic snacking<sup>(48)</sup>, energy, proteins, fats, adolescent phase, obesity, lifestyle diseases and infectious diseases<sup>(51)</sup> and food classification<sup>(52)</sup>.

#### *Diet and nutrition attitudes and skills*

Of the included studies, relatively a few of them focused on diet and nutrition attitudes and skills. The limited results showed that after intervention, more students stated that nutrition and healthy dietary intake were important<sup>(35,36)</sup>, most participants had increased their skills in healthy eating and menu planning<sup>(39)</sup>, and students were more willing to taste vegetables and their ability to identify vegetables was improved<sup>(53)</sup>. In addition, children were beginning to link the nutritional information they had learnt with the contents of their own lunch boxes<sup>(47)</sup>. One study showed that although the positive attitude for red food decreased, the positive feelings for green food also diminished disappointingly<sup>(42)</sup>.

#### *Diet and nutrition behaviour*

The studies showed that nutrition intervention based on HPS processes had a wide range of benefits. It can increase participants' intakes of high-fibre foods and healthier snacks<sup>(38,40)</sup>, their consumption of water, milk, fruit and vegetables<sup>(37,38,41,43,44,46)</sup> and also their intakes

of energy and all nutrients consumed<sup>(47)</sup>. It can reduce participants' 'breakfast skipping'<sup>(35,36)</sup> as well as intakes of red food, low-nutrient dense foods, fatty and cream foods<sup>(35,38,42,44)</sup>, sweet drinks consumption<sup>(46)</sup> and eating disorders<sup>(45)</sup>. Moreover, it can help to develop hygienic habits and increase food safety behaviours<sup>(35)</sup>. Among these studies, more than a third focused on the promotion of fruit and vegetable consumption, and only one study emphasized that the positive behaviour change (high-fibre food intake) was sustained at the end of 2 years<sup>(38)</sup>.

#### *Costs*

Only one article provided relevant information on the cost; in that programme, each school was offered a \$AUD 1500 grant to develop and implement the programme. The author commented that having external funding can be an impetus for action that supports the schools to reinforce and apply the information and skills they gain from participating in the programme<sup>(39)</sup>. Another three articles mentioned funding. One complained that due to the limited funding allocated for the evaluation, the follow-up period (11 weeks) was too short to be confident of identifying effects<sup>(41)</sup>; the second identified the same limited extra budget for the evaluation and data collection, so the evaluation depended mainly on participants' willingness and effort<sup>(43)</sup>. The third concluded that even with considerable input, it is difficult to achieve sustained dietary changes in the eating habits of secondary-school children<sup>(38)</sup>. However, there was no mention of the exact amount of input.

### **Discussion**

Childhood growth and nutrition is recognized internationally as an important area in every child's development<sup>(43,44)</sup>, and it is essential to promote nutrition among youth as health promotion from early stages in life has a major impact on health and well-being during childhood and in later life<sup>(45-47)</sup>. To evaluate the implementation and effectiveness of school-based nutrition promotion programmes using the HPS approach, we conducted a systematic review of controlled trial studies and before-and-after studies. We aimed to extend previous systematic reviews on this topic, to indicate areas where further research is needed and to make recommendations for practice in this field.

It is generally recognized that due to the complex nature of eating behaviour, it is difficult to change<sup>(54)</sup>. On the one hand, there is no clear link between knowledge gain and behaviour changes<sup>(55)</sup>. For example, one study found that all of the participants were knowledgeable about healthier and unhealthier foods and drinks, but were not able to use it to modify their daily dietary choices<sup>(48)</sup>. Another study concluded that while participants may gain factual knowledge, they do not develop the skills to bring about behavioural change<sup>(49)</sup>. On the

other hand, there are real difficulties in achieving behaviour change when teachers do not possess the specialist knowledge of nutrition education, nutrition research or health promotion techniques<sup>(56)</sup>. Thus, if teachers are to deliver high-quality nutrition promotion activities and become better role models, they require greater support and adequate training in nutritional knowledge and evaluation techniques<sup>(57)</sup>. In addition, it has been recommended that single behaviours should be targeted in a comprehensive and multifaceted manner, with evidence suggesting children and their families are less likely to incorporate numerous lifestyle changes all at once, and that more targeted and simple to adopt messages may be more effective<sup>(58,59)</sup>.

Of all the articles reviewed, only three used qualitative methods alone. Two of the articles used qualitative data to assist in explaining inconsistencies or observed differences from analysis outcomes<sup>(41,42)</sup>. The other article revealed that qualitative data brought to light valuable information, such as weaknesses of the intervention tool, recommendations for how to modify the programmes and the target population's satisfaction degree towards the programmes<sup>(50)</sup>. All three studies are critical and useful for identifying problems, adjusting the intervention strategies, summarizing aspects of the programme and providing valuable experiences for future programmes<sup>(60–62)</sup>. Further qualitative studies are required to supplement the quantitative studies in the future.

The longest intervention period lasted for 2 years, and the shortest one lasted for only 1 week. There is general agreement that the formation of healthy dietary habits is a lengthy process and restructuring is not accomplished by a few hours, or even days, of instruction; thus 1 week is clearly not long enough to produce behaviour change<sup>(25,55–57)</sup>. Other studies echoed this reservation regarding the use of nutrition interventions that are based on short exposure times. Another study found that changing children's eating behaviour is difficult due to the complex nature of their behaviours and can be particularly difficult to change using short-term interventions<sup>(53)</sup>. One study suggested that future programmes around healthy eating in schools should be held over at least a year<sup>(39)</sup>. This could pose problems, however, with another study finding it difficult to gather and maintain momentum in implementing strategies within a period of one school year and that it was important to develop strategies that were sustainable after the project ceased<sup>(36)</sup>. The evidence suggests that those who design nutrition interventions need to recognize the characteristics and patterns of social, cultural and behavioural factors within a socio-ecological perspective when exploring feasible and effective interventions for a target population<sup>(58–61)</sup>. In addition, once healthy eating habits have been cultivated it is vital to provide supportive reinforcing factors to strengthen those behaviours and to prevent healthy behaviours reverting back to unhealthier

ones<sup>(62,63)</sup>. Intensive, comprehensive, whole-of-school interventions over a substantial period of time are required for nutrition promotion programmes.

Besides longer interventions, long-term follow-up evaluation is also essential. One article showed that there were no significant changes in school-based eating at the end of a 2-year study, although there were some positive changes in the early stage of the intervention<sup>(38)</sup>. This is consistent with other reviews, particularly those studies that actually assessed changes in dietary intake, which found no overall effect in the long term but some effect in the short term or in population subgroups<sup>(64–66)</sup>. Long-term follow-up is essential if we are to determine whether nutrition interventions offer sustained benefits<sup>(67,68)</sup>. If lasting effects and the sustainability of nutritional interventions are significant, long-term follow-up evaluation is important.

However, both long-period interventions and long-term follow-up evaluations can be restricted by available funding<sup>(69,70)</sup>. One study found that having external funding or additional support and resources can empower schools to build on their intervention activities<sup>(39)</sup>. Another impact of the limited research funds available was indicated by one article in which the mean follow-up data collection period was 11 weeks – dictated by the original short time span of the funding allocated for the evaluation. The authors argue that this may be too short a period to be confident of identifying effects<sup>(41)</sup>. Another article indicated that due to the limited budget for the evaluation of the interventions and data collection, the evaluation study depended mainly on participants' willingness and efforts to fill in questionnaires and observation sheets<sup>(43)</sup>. Clearly, having adequate funding and necessary supports are vital to identifying the efficacy of comprehensive nutrition promotion programmes.

## Conclusions

No more than twenty studies have been published in the databases interrogated to evaluate the effectiveness of school-based nutrition promotion programmes using a full or partial holistic HPS approach, although nutrition promotion in schools is very common. In terms of an assessment of methodological quality, only five of the included studies achieved an overall rating as strong. All studies included described their intervention components and six of these articles reported on process evaluation. In general HPS terms, the school environment and overall ethos were more supportive for a healthy diet after the intervention, with an associated curriculum component and engagement of parents and community. Target population (students, school staff and parents) participated in the intervention at different levels and the majority of the participants were satisfied with the intervention. Evidence indicates that nutrition promotion programmes using the HPS approach, either partially or fully, can be effective.

### Implications for research

Future research should provide teachers with greater support and adequate training in nutritional knowledge and evaluation techniques to allow them to deliver high-quality nutrition promotion activities; apply a comprehensive and multifaceted manner to promote more targeted and single behaviours; and conduct more and further qualitative studies to supplement quantitative studies. In addition, longer intervention periods and long-term follow-up evaluations (both the implementation and the effectiveness of the intervention) are required for future nutrition promotion programmes as behavioural change is typically a long process and to observe lasting effects. The sustainability of nutritional interventions is worth studying in further research. Finally, having adequate funding and necessary supports are vital to nutrition promotion programmes in schools.

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