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The effectiveness of interventions to promote fruit and vegetable intake in school-aged children – a Tech Brief

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It was authored by Marita Broadstock (Research Fellow), who conducted the critical appraisals, prepared the report and coordinated the project.

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LEVEL OF EVIDENCE CONSIDERED IN TECHNICAL BRIEFS

Technical Briefs (Tech Briefs) are rapidly produced assessments of the *best available evidence* for a topic of highly limited scope. They are less rigorous than systematic reviews. Best evidence is indicated by research designs which are least susceptible to bias according to the National Health and Medical Research Council's (NHMRC) criteria (see **Appendix 1**). Where methodologically acceptable and applicable, appraised evidence is limited to systematic reviews, meta-analyses, evidence based clinical practice guidelines, health technology assessments and randomised controlled trials (RCTs). Where not available, poorer quality evidence may be considered.

CONFLICT OF INTEREST

None.

EXECUTIVE SUMMARY

Aim and scope

This Technical Brief aimed to review evidence for the effectiveness of interventions to promote fruit and vegetable intake in school aged children (i.e., aged between 5 and 18 years at commencement of the intervention). Eligible studies were those reporting on interventions that took place in school, home, or community in Western/developed nations. They reported on randomized controlled trials of at least 20 participants in the intervention group with at least 12-week follow-up. Included studies were those that evaluated interventions that were designed to impact on the intake of fruit and/or vegetables by influencing the personal choices of the child/youth. The following interventions were excluded: clinical, surgical or medical interventions, individualised counselling, and interventions offering solely environmental/structural changes. High quality secondary research (systematic reviews and meta analyses) were considered best evidence on the topic. These were included where selection criteria overlapped with that of the current study and where at least some fruit and/or vegetable choice/intake outcomes for children were reported for appraised studies.

Methods

The search strategy considered original articles published between January 2000 and November 28, 2005 inclusive in the English language. The search included major bibliographic and review databases and secondary sources, and mostly published and indexed literature. Databases included: Medline, Embase, Cinahl, Psychinfo, Current Contents, Cochrane Library Controlled Trials Register, Evidence-based medicine reviews, Cochrane Database of Systematic Reviews, Database of Abstracts of Reviews of Effectiveness (DARE), NHS Economic Evaluation Database, and Health Technology Assessment Database. Search terms and keywords included: nutrition, diet, food, child nutrition fruit, vegetables, health promotion, health education, social marketing, education, healthy eating, intervention, and program.

As sufficiently high-quality and relevant systematic reviews were identified, these alone were included in the Technical Brief. Summaries of appraisal results were presented in Evidence Tables which detailed study design, study setting, sample, methods, results, reported conclusions, and reviewer comments based on the limitations and validity of the review. Review conclusions, implications for practice, gaps in the literature and directions for research were synthesized and overall conclusions made.

Key results and conclusions

From the search strategy, 732 potentially relevant articles/abstracts were identified, of which 59 were retrieved. Of these, seven systematic reviews (reported in eight secondary research articles/reports) were identified as eligible for appraisal and were included in the review.

The following conclusions are based on the current evidence available from this report's critical appraisal of secondary literature published on the effectiveness of interventions to promote fruit and vegetable intake in school-aged children:

- many interventions have resulted in statistically significant increases in fruit and vegetable intake, at least in the short term
- increases in fruit and vegetable intake have been modest, averaging around half a serving per day; and of questionable clinical significance
- multifaceted interventions extending over at least two months have tended to be most successful in altering food intake
- some reviewers have suggested that more successful interventions appeared to have had a theoretical basis, included small groups, included goal setting, and targeted specific behaviour change (e.g., increase fruit intake).

Implications for practice

Whilst the current evidence base is limited, several implications for practice have been suggested by the appraised systematic reviews. These include:

- develop interventions from a theoretical base
- promote specific behaviour changes (e.g., increase fruit and vegetable intake) rather than nutritional knowledge
- encourage individual goal setting
- employ multifaceted interventions (school curricula, mass media, parent mailings)
- extend interventions over at least 8-10 weeks.

It has also been suggested that to make substantive changes to nutritional outcomes, interventions need to be developed beyond the individual-level to include the population-level, macro-level public policy and environmental interventions (Ammerman et al. 2002).

Programme providers in New Zealand considering transferring programmes already implemented elsewhere need to bear in mind how these can be best adapted to suit features of their target community, resources and outcome priorities. Pilot testing, process evaluation and ongoing monitoring and follow-up are also crucial to determine programme fidelity and efficacy.

Further research required

Future research needs to address specific methodological limitations including the need for more detailed reporting of sample characteristics, response and retention rates, randomization methods, theoretical basis of intervention, program delivery and integrity, and cost. Other priorities include the need for sample size calculations; evaluation of maintenance interventions; blind outcome assessment; analysis at level of allocation, cluster analysis and intention to treat analysis; and longer follow-up (beyond one year). Key gaps in the literature were identified, including the need for investigation of the reasons for subgroup differences; studies comparing specific strategies and different levels of intensity within the same population; and efficacy studies of successful interventions in the “real world”, including cost effectiveness data. Crucially, there needs to be consensus from experts about what constitutes clinically important differences in outcomes in terms of risk for chronic disease, morbidity and mortality.

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BACKGROUND

The research question for the review was “What is the effectiveness of interventions designed to promote fruit and/or vegetable intake in school-aged children?”

This Technical Brief was initially requested by Harriette Carr (Senior Analyst, Public Health Directorate) and was then developed for Jaynie Gardyne (Advisor, DHB Funding and Performance Directorate) from the Ministry of Health, New Zealand Government. The objective for the review was to inform the establishment and implementation of a national nutrition and social marketing campaign with a focus on children and their caregivers. This campaign features on the “Healthy Eating, Healthy Action” plan, is an important part of implementing the Cancer Control Strategy Action Plan, will complement the SPARC Push Play campaign for physical activity, and will provide support for existing programmes in public health nutrition (Harriette Carr, *personal communication*, 10 June 2005).

Nutrition plays an important role in the prevention of chronic disease, including cancer and cardiovascular disease, and there is convincing evidence that a higher intake of fruit and vegetables, and a lower intake of saturated fats, are associated with better health (Ammerman et al. 2002). According to the World Cancer Research Fund report (1997), the most convincing data support the protective effect of fruits and vegetables (Ammerman et al. 2002). Higher intake of fruits and vegetables have been associated with lower rates of cancers (e.g., lung, breast, prostate, colon, esophageal, bladder, stomach), cardiovascular diseases, stroke, Type 2 diabetes, and obesity; see Perry et al (2004). Whilst the precise mechanisms for action are uncertain, fruits and vegetables are the most important sources of essential nutrients including vitamin C and folate, and dietary factors including fibre and flavanoids which have been linked to prevention of various cancers and other chronic disease (Ciliska et al. 2000). Fruit and vegetables have also been promoted as playing a role in weight management. Their intake has enhanced satiety and decreased hunger, contributing to reduced caloric density and reduced total caloric intake; see Rolls et al (2004), cited in Ciliska (2004)).

This review topic focused on interventions relating to school aged children. In the U.S., only 20% of children and adolescents meet national recommendations of consuming at least five servings per day of fruit and vegetables; see French and Stables (2003), for discussion of this literature. Youth are an important target group for interventions relating to fruit and vegetable intake as there are nutritional benefits during periods of growth and development, and because young people form eating preferences and patterns that track into adulthood and can affect risk for adult chronic disease; see Perry et al (2004). Interventions have frequently been set in schools because of schools’ ready access to children and young people, the amount of time youth spend at school, and the powerful influence schools have on the physical, social and normative environment of their students (Lytle et al. 2004). Targeting all children also avoids stigmatizing some and misclassifying others (Thomas et al. 2004).

SELECTION CRITERIA

Study inclusion criteria

Publication type

Studies published between January 2000 and November 28, 2005 inclusive in the English language.

Study design

Secondary research including systematic reviews and meta-analyses where selection criteria overlapped with that of the current study (but not necessarily publication date of included studies) and where at least some fruit and/or vegetable choice/intake outcomes for children were reported for appraised studies. The focus of appraisal was on data relevant to fruit and vegetable outcomes which are of primary interest in this Technical Brief.

As discussed under “Appraisal Methodology” below, Technical Briefs are concerned with *best* (most reliable and robust) evidence. Therefore, where sufficiently high-quality systematic reviews or meta-analyses covering the scope of this topic were identified, these alone were included in the review. Eligible trials (randomised controlled trials, or group/cluster randomised controlled trials where there were at least 6 groups randomly allocated to intervention or control conditions) published beyond the search date of included secondary paper/s were also considered. However, they were only formally appraised where they provided data which altered the conclusions of the Technical Brief based on appraised secondary research.

Population

The target group were children who are school-aged (i.e., between 5 and 18 years) at commencement of the intervention. Studies where interventions targeted families or communities were eligible if outcome data could be extracted for children.

Setting

Studies reporting on interventions which took place in the following settings: home, school, community. Studies were considered which were conducted in Western/developed countries.

Intervention

Studies were included which reported on interventions that were designed to impact on the intake of fruit and/or vegetables of the target population by influencing the personal choices of the child. Interventions must have allowed food intake to be freely chosen by participants (not controlled by the study). Interventions included dietary education (e.g., through curriculum), social marketing and multi-media (e.g., information, promotion, sampling events) and social support (e.g., role-modeling).

Interventions targeting parental or teacher behaviour were eligible where outcomes related to children’s choice or intake of fruit and vegetables.

Comparator

Studies were included which included a non-intervention concurrent control group that received usual care or another active intervention (head-to-head comparisons).

Outcomes

Studies included baseline and post-intervention measurements of the primary outcomes: changes in intake or food choice relating to fruit and/or vegetables. All dietary assessment techniques were included (e.g., diet recall lists, food frequency questionnaires completed by participant or parent observing food intake).

Secondary outcomes measured in eligible studies were also reported if they accompanied the reporting of primary outcomes. Secondary outcomes included other dietary changes, sugary drink consumption, knowledge/awareness of nutritional messages, intention to increase fruit and/or vegetable intake, and cost outcomes. For systematic reviews, secondary outcomes were reported where mentioned in the conclusions.

Follow-up

Post-intervention assessment of primary outcomes were made at least 12 weeks after baseline.

Sample size

Studies with samples of at least 20 participants allocated to the intervention group.

Study exclusion criteria

Research papers were excluded if they:

- were not published in English
- were “correspondence”, book chapters, conference proceedings, abstracts
- reported studies with samples of fewer than 20 participants in the intervention group
- reported animal studies
- did not clearly describe their methods and results, or had significant discrepancies
- concerned *primarily* participants who were not representative of a general population of school aged children (therefore excluding studies specifically of sub-populations of children with obesity, eating disorders, known illnesses, or who were at heightened risk for cardiovascular disease, etc)
- concerned interventions which:
 - were clinical/surgical/medical in nature
 - offered drug therapies
 - (only) involved environmental, structural change interventions (e.g., changing pricing on certain foods, removing certain foods from canteens, changing school lunch offerings, subsidising or providing foods free). Note that multi-component interventions were eligible for inclusion where at least part of the intervention was eligible for inclusion.
 - offered individualised counseling or were applied in a clinic setting.

MAIN SEARCH TERMS

Details of the search strategy are presented in **Appendix 2**.

MeSH headings: nutrition, exp diet, exp food, child nutrition, exp fruit, exp vegetables, health promotion, health education, social marketing, education ([ed.fs] as a floated subheading), child, adolescent, caregivers, outcome assessment (health care), program evaluation

EMBASE subject heading (additional to MeSH) : child nutrition

CINAHL subject headings (additional to MeSH) : child nutrition, adolescent nutrition, health fairs, nutrition education

Additional keywords: (used in all databases): healthy eating, intervention, program\$

Validated filters for clinical trials (including randomised trials), systematic reviews, meta-analyses, and observational studies (longitudinal, cohort, case control, cross sectional) were applied to the results of the subject searches in the Medline, Embase, and Cinahl databases.

References to articles from developing countries were excluded in the search where it was possible using database indexing.

The subject headings listed above were adapted for use in the databases and other sources without indexing.

SEARCH SOURCES

The NZHTA CORE Search was employed. Characteristics of the Core search include: essential sources only, major databases and secondary sources, and mostly published and indexed literature.

Bibliographic databases

Medline
Embase
Cinahl

Psychinfo
 Current Contents
 Cochrane Library Controlled Trials Register

Review databases

Evidence-based medicine reviews
 Cochrane Database of Systematic Reviews
 Database of Abstracts of Reviews of Effectiveness (DARE)
 NHS Economic Evaluation Database
 Health Technology Assessment Database

Other sources

Calgary Health Region Community Prevention of Obesity in Canada
 City of Hamilton Ontario Effective Public Health Practice Project
 References of all retrieved articles
 Articles published in English language only were considered.

The search was restricted to literature published since January 2000. Following initial scoping searches, the final literature searching was completed on 29 November, 2005.

APPRAISAL METHODOLOGY

Summaries of appraisal results were entered into *Evidence Tables* which detail study design, study setting, sample, methods, results, reported conclusions and NZHTA reviewer comments based on the limitations and validity of the review. The evidence presented in the selected studies were assessed and classified according to the NHMRC's revised hierarchy of evidence (**Appendix 1**).

Appraisal of secondary studies including systematic reviews, specific criteria assessed whether the review asked a focused question, if the eligibility criteria for included trials were explicit, whether the search strategy was likely to be comprehensive, and whether results of included studies were similar.

The Evidence Tables for secondary research studies appraised in the review presented key information summaries described below:

- review/meta-analysis citation including authors, year published, country of origin
- review scope/aim, search strategy (including publication date range considered, databases, keywords)
- criteria for inclusion and exclusion of studies in the review.
- review results (primarily those relevant to the current TB topic), and authors' conclusions
- reviewer's (MB) critical comments
- authors' recommendations for future research and implications for practice.

For a detailed description of review methods, results and conclusions of the systematic reviews appraised, the reader is referred to the original papers cited.

RESULTS

From the above search strategy 732 potentially relevant articles/abstracts were identified, of which 59 were retrieved. Of these retrieved articles, 51 were excluded as ineligible for appraisal. Seven systematic reviews, reported in eight retrieved articles, were eligible for inclusion and were appraised (these citations are listed in **Appendix 3**). Included papers are presented in the Evidence Tables (**Table 1**) below in chronological order of publication date (most recently published last).

Table 1. Evidence Tables of appraised secondary research relating to effectiveness of interventions to promote fruit and vegetable intake in school-aged children.

Authors, country	Aim and search method	Inclusion and exclusion criteria	Results and authors' conclusions	Comments
<p>Cliska et al (2000). Canada</p>	<p>Aim To assess the effectiveness of community-based interventions to increase fruit and vegetable consumption in people aged four years and older. Search period: first year of database – August 1998 Databases searched: CINAHL, Cochrane Library, Current Contents, Dissertation Abstracts, EMBASE, ERIC, Healthstar, Medline, Public Health Effectiveness Project Database, PsycINFO, and Sociological Abstracts. Search terms: fruit, vegetables, community based, nutrition, health promotion, evaluate, terms for types of interventions, and outcome terms. Handsearching of a large number of relevant Journals from first issue or 1988, and retrieval from reference lists of relevant articles published from 1988. <i>continued overpage</i></p>	<p>Inclusion criteria were applied in a two-stage process. First, articles needed to be judged as relevant, and then rated as being "moderately" or "strongly" valid Inclusion criteria <i>Relevance</i> <ul style="list-style-type: none"> ▪ intervention intended to alter fruit and vegetable consumption ▪ intervention fits with roles and strategies of public health staff ▪ involved participants four years or older ▪ prospective study with comparison group ▪ provided information on process or outcome <i>Validity</i> <ul style="list-style-type: none"> ▪ relevant papers rated as "valid" based on scores across following explicit criteria: selection bias, study design, confounders, data collection methods, and handling of withdrawals and dropouts <i>continued overpage</i></p>	<p>Retrieved 189 articles of which 60 were rated as relevant; 18 of which (reporting on 15 independent research studies) were included in the review as being rated as strongly (n=1 article) or moderately valid (n=17 article). Only six studies (reported in seven articles) evaluated interventions with school age children, and only data and conclusions relating to these are discussed here. Three of the six studies evaluated largely curriculum-based interventions of up to 12 weeks duration, two in schools and one with girl scout troops. In the two school-based studies, posters, activities and cafeteria promotions supported class-based curriculum. One was a cohort analytic study (Graves et al. 1982; Shannon et al. 1982) which reported a significant increase in consumption of some vegetables. The review did not report how many analyses were conducted and whether these may have been chance effects. The other school-based study (Shannon and Chen 1988) was a randomised controlled trial by the same research team that found no overall significant difference between comparison groups in food intake. A randomised controlled trial (Cullen et al. 1997) involving 22 scout troops provided four, weekly sessions based on behavioural modification strategies including having a buddy, self-monitoring, problem solving, food preparation, taste testing and information packs sent to parents. At 1-week follow-up there was a small but statistically significant increase in daily fruit and vegetable consumption in the intervention group (0.39 servings) but this effect was not maintained at 3 month follow-up. The three other studies provided more intense or prolonged interventions, all based in schools. The 5-A-Day Power Plus study (Perry et al. 1998a) was a controlled trial evaluating a multicomponent intervention including 16 classroom sessions, food preparation, taste testing, comic books about nutrition, team competitions, cafeteria promotions, producer/industry presentations, and information packs sent to parents. At the end of the intervention (which occurred over the last part of grade 4 and first part of grade 5), there were no differences in total fruit and vegetable intake measured by 24 hour recall but an increase in fruit servings per day (p<.02). Observed lunch intake revealed increased servings of fruit and vegetables/day for the intervention group compared with the control (1.53 cf 1.06, p<.001). <i>continued overpage</i></p>	<p>Comments <ul style="list-style-type: none"> ▪ comprehensive search strategy, including extensive hand-searching of Journals, checking of reference lists, and grey literature. (unclear what is meant by "computer lists", possibly internet sites). ▪ only English language publications and those obtainable in local holdings or interlibrary loan in time were retrieved, with 14 not retrieved. ▪ explicit selection criteria including a rigorous, two-stage process of identifying studies of at least moderate study quality using independent ratings by two people. ▪ appraisal and data extraction performed by independent reviewers using explicit validity criteria ▪ brief background section presenting rationale for focus of review on fruit and vegetable intake based on links with prevention of cancer and chronic disease. ▪ brief narrative summary of study design, intervention and results for each included study ▪ tables present study design, rated quality (moderate or strong), scholastic grade level of participants and number of groups/schools, intervention type, outcomes and whether statistically significant, and critical comments ▪ some information lacking in tables and narrative summaries, such as number of participants. ▪ some inconsistency between data presented in tables and text (e.g., 5-A-Day described as being 16 weeks in Discussion instead of 8) ▪ data on intervention studies with parents of young children, and adults (worksite and non-worksite based) also reported, as well as other outcomes such as physical activity and fat content were reported. ▪ discussion synthesises and interprets results <i>continued overpage</i></p>

Table 1 (continued)

Authors, country	Aim and search method	Inclusion and exclusion criteria	Results and authors' conclusions	Comments
Cliska et al (2000) <i>continued</i>	Grey literature sought from Canadian Produce Manufacturers Association and "computer lists" relevant to nutrition.	<p>Exclusion criteria</p> <ul style="list-style-type: none"> ▪ none mentioned <p>Synthesis: two trained reviewers independently rated retrieved articles for relevance and validity. Data abstraction performed by two raters with any discrepancies discussed and agreed through consensus (with a third rater if necessary).</p>	<p>The Child and Adolescent Trial for Cardiovascular Health (CATCH) (Perry et al. 1998b) was a large controlled trial across 96 schools involving curriculum, food preparation, taste testing, physical activity lessons, family education and activities, and extensive food service promotion activities. Follow-up was after 3 years of intervention. The CATCH trial revealed no differences in fruit and vegetable intake by 24 hour recall overall.</p> <p>Finally, The GIMME 5 study (Nicklas et al. 1998) was a controlled trial in 12 schools evaluating a multicomponent intervention based on the PRECEDE theoretical model which addresses the following levels of behaviour change: awareness development, interest stimulation, skills training, reinforcement, application, and maintenance. The program involved curriculum, parent education and activities such as taste testing, recipes and food tips, and cafeteria food service changes (variety, availability, appeal of fruit and vegetables). At follow-up one year after completion of the three year intervention period, the intervention group exhibited a significant increase in fruit and vegetable servings/day of 2.63 to 3.00 ($p < .05$). There was also a greater movement in the intervention groups compared with the control toward the preparation stage if behaviour change from the precontemplation and contemplation stages.</p> <p>Authors' conclusions The authors suggested that the results of the six studies of school aged children could be explained by the intensity and clarity of messages delivered. The studies that produced significant effects on fruit and vegetable intake tended to involve more intensive, multipronged and prolonged interventions compared to largely curriculum-based interventions lasting fewer than 10 weeks. The exception was the multifaceted 3 year long CATCH trial intervention which was more focused on food messages and physical activity, and affected fat intake and physical activity but not non-targeted outcomes of fruit and vegetable intake. The reviewers noted that the authors of this trial suggest that more general food messages are not likely to change specific non-targeted behaviours.</p>	<p>discussed limitations of review, including that the language and retrieval limitations may have meant that some pertinent studies were excluded that may have altered the conclusions of the review. Listed ongoing investigations that would provide relevant information in the future presented implications for practice including the need to ensure that interventions have been developed from a theoretical base, have a specific message about increasing fruit and vegetable intake, and a component about behaviour change. Suggested that there was an urgent need for resources to evaluate community-based nutrition programmes, presented implications for future research including the need to ensure that the method of randomisation is made explicit in reports, improve tracking to ensure greater retention of follow-up, ensure the outcome assessor is blind to group allocation to intervention or control, use valid and reliable outcome measures, control seasonality (in terms of availability and consumption of fruits and vegetables), the need for multisite studies to increase sample sizes, and the need for a more coordinated approach to evaluations generally.</p> <ul style="list-style-type: none"> ▪ results in studies to date have been modest. Questioned the clinical significance of statistically significant findings, such as an increase in intake of 0.2 servings per day, in terms of risk for chronic disease, morbidity and mortality. ▪ discussed the need to investigate the cost-benefit of large-scale nutritional interventions.

Table 1 (continued)

Authors, country	Aim and search method	Inclusion and exclusion criteria	Results and authors' conclusions	Comments
<p>Ammerman et al (2002). Research Triangle Institute-University of North Carolina at Chapel Hill Evidence based Practice Center (Ammerman et al. 2001). USA</p>	<p>Aim To assess the overall effectiveness of behavioural dietary interventions in promoting dietary change (with respect to dietary fat and fruit and vegetable intake) related to chronic disease risk reduction. Search period: 1975 – August 1999 (with some papers beyond this period included after being strongly recommended by peer reviewers of the original report). Databases searched: Medline, PsycINFO, EMBASE, CINAHL, AGENCY, and AGRICOLA. (Primary) search terms: health behavior, attitude to health, health promotion, behavior change, food habits, fruit, vegetables, prevent, counsel, cardiovascular disease, cancer, neoplasms. Bibliographies of identified articles and reviews. Discussed outputs with an expert advisory panel (which identified additional papers post August 1999).</p>	<p>Inclusion criteria</p> <ul style="list-style-type: none"> ▪ randomised controlled trials or non-RCTs (with nonequivalent control or comparison group designs) ▪ conducted on humans, including children, adolescents, and adults ▪ healthy or high-risk populations ▪ non-institutionalised populations ▪ published in English and conducted in North America, Europe or Australia ▪ had samples of at least 40 participants at follow-up ▪ interventions allowed diet to be freely chosen by participants, and interventions must have a dietary component ▪ reporting of outcomes for fruit and vegetable consumption or dietary fat intake ▪ report follow-up data <p>Exclusion criteria</p> <ul style="list-style-type: none"> ▪ studies reporting only on infants ▪ studies of populations with type 1 diabetes <p><i>continued overpage</i></p>	<p>Appraised 104 articles reporting on 92 independent studies. A meta-analysis was not possible for studies reporting on fruit and vegetable outcomes, principally due to lack of statistical detail in reporting of some studies, and heterogeneity. For three school-based studies reporting on total fat, a mean difference in change between groups of 2.19% points of energy was found (95% CI, 1.49 – 2.89). The differences in change analysis was performed for 12 studies reporting fruit and vegetable intake as servings per day (including studies of adults). Intervention groups increased their intake of fruit and vegetables 16.6% (as a median difference, ranging between -3.7 to +60.9) more than control groups, representing an average increase of 0.6 servings of fruit and vegetables per day. For the six studies reporting two follow-up periods, the intervention effect reduced from 16.8% (median difference compared with control groups) at first follow-up to 6.7% (median difference) at second follow-up. Researchers investigated the relative effectiveness of interventions evaluated as a function of a range of attributes. For the studies reporting on fruit and vegetable outcomes, analyses for the difference in change results were not possible (due to there being fewer than five studies in each compared group) relevant to sample age and risk status, theoretical basis of the intervention, study quality, and aspects of the intervention including whether it had family components, small groups, or cultural specificity. There was no significant difference in the difference in change results in comparisons of studies which involved social support, goal setting, or food related activities in their interventions. For the significant findings analysis, 22 studies (including studies of adults) reported results for fruit and vegetable consumption (not just servings per day), with 17 of these (77%) finding a significant effect in increasing fruit and vegetable intake. <i>continued overpage</i></p>	<p>The Ammerman et al (2002) publication from the Journal <i>Preventive Medicine</i> reports from a review originally published as an Evidence Report and Quality for the Agency for Healthcare Research and Quality (AHRQ) by the Research Triangle Institute-University of North Carolina at Chapel Hill Evidence based Practice Center (Ammerman et al. 2001). Results from Ammerman et al (2002) are reported here.</p> <p>Comments</p> <ul style="list-style-type: none"> ▪ reasonably comprehensive search strategy but does not include review databases. Does include checking of reference lists. ▪ allowing the expert panel to identify "significant" research that falls out of the parameters of the review (in terms of publication date) could lead to biases, particularly toward studies reporting positive results which may have more impact; detailed and explicit selection criteria ▪ appraisal and data extraction performed by independent reviewers using data extraction and quality rating form. Study quality rated and data synthesized quantitatively using three approaches of secondary analysis. ▪ brief background section presenting rationale for focus of review, including a Figure outlining hypothesized framework for how behavioural dietary interventions can impact on behaviour and moderating influences. ▪ tables present details of types of abstracted data, points allocated for quality ratings, and secondary analysis strategies and results. ▪ thorough discussion of results, noting key methodological flaws and limitations ▪ data on intake of dietary fat also reported. ▪ note that results and secondary analyses include studies with samples of adults and high-risk populations. <p><i>continued overpage</i></p>

Table 1 (continued)

Authors, country	Aim and search method	Inclusion and exclusion criteria	Results and authors' conclusions	Comments
Ammerman et al (2002) <i>continued</i>		<ul style="list-style-type: none"> ▪ evaluations of interventions controlling diet <p>Synthesis: two trained reviewers independently extracted data and completed forms rating study quality across several dimensions.</p> <p>Secondary analyses: (a) a meta-analysis; (b) a standardized quantitative analysis of the difference in change (from baseline to follow-up) for control and intervention groups (difference in change analysis); (c) a semi-quantitative analysis summarizing whether the reported intervention effect was significant (significant findings analysis).</p>	<p>For the significant findings analyses, it was not possible to compare the relative effectiveness of studies as a function of participant risk status, study quality, or whether the intervention included small groups or cultural specificity. There was no significant difference in studies' significance of findings as a function of participant age, or whether the intervention evaluated had family components, or social support. However, studies which included goal setting, and food related activities, had a slightly higher (5.9% difference) proportion of studies reporting a significant intervention effect. Notably, at least 20% more studies which had a stated theoretical basis reported a significant intervention effect. Whilst interesting, the authors emphasise the limitation of this sort of analysis given that these features are not independent, and grouped interventions may have very little else in common.</p> <p>Authors' conclusions</p> <p>Results suggest that a significant number of studies (17 of 22 identified) demonstrated significant improvements in dietary intake of fruit and vegetables (0.6 servings per day), although this increase reduces over (follow-up) time. With respect to studies reporting on dietary fat as well as fruit and vegetable intake, interventions appeared to be more successful at positively changing dietary behaviour among populations at risk of (or diagnosed with) disease than among general, healthy populations. In broad terms, studies reporting on interventions appeared to be somewhat more likely to lead to a significant effect on intake of fruit and vegetables if the intervention had a theoretical basis, included small groups, or included goal setting.</p> <p>The majority of interventions reviewed resulted in meaningful improvements in dietary behaviours associated with the prevention of chronic disease, particularly among individuals at elevated risk. The lack of similarity across studies in outcome measures, study design, analysis strategy, and intervention technique hampered the ability to draw broad conclusions about the most effective behavioural dietary interventions.</p>	<ul style="list-style-type: none"> ▪ discussed gaps in the literature including the need for: good quality research in high-risk populations such as low-income or ethnic subgroups, longer term (beyond one year) evaluations, evaluations of programmes designed to prevent relapse, and comparison data on cost effectiveness. ▪ discussed limitations of approach, including that a meta-analysis was not possible for change in fruit and vegetable intake. Lack of studies prevented meaningful estimates when comparing intervention characteristics such as intervention intensity and setting. ▪ presented recommendations for future research including the need for programme evaluations to report on information relating to generalisability of the sample, response rates, intervention intensity, training in intervention delivery, theoretical basis and application, and use of maintenance interventions. Discussion of the need for interventions beyond the individual-level to include the population-level, macro-level state and national public policy and environmental interventions. Future studies comparing specific strategies and different levels of intensity within the same population will help fine-tune knowledge.

Table 1 (continued)

Authors, country	Aim and search method	Inclusion and exclusion criteria	Results and authors' conclusions	Comments
French and Stables (2003)	Aim To review studies investigating environmental interventions targeting changes in fruit and vegetable intake in school-based settings.	Inclusion criteria <ul style="list-style-type: none"> ▪ interventions that target changes in fruit and vegetable intake in school-based settings. • school-based interventions targeting other eating behaviour were also included for "illustrative and comparative purposes". 	The scope of this review related primarily to environmental interventions (excluded in this Technical Brief). However, six studies were multicomponent and included intervention components that are eligible for the current review. Six RCTs evaluated fruit and vegetable outcomes. Four RCTs were reviewed that aimed to increase fruit and vegetable intake as part of multibehaviour interventions across schools. All trials included classroom lessons/workshops, parent involvement, and food service training or grocery store activities.	Comments <ul style="list-style-type: none"> ▪ comprehensive range of search terms employed ▪ a limited range of databases searched, however references of included studies were used to identify other eligible studies ▪ lack of specific detail on selection criteria ▪ background section describes rationale for interventions in this area and target group ▪ detailed description of the school food environment in the USA ▪ overviews of theoretical models and intervention components of included studies ▪ detailed narrative descriptions and critical commentary of randomised and nonrandomised studies relating to (i) multicomponent interventions to increase fruit and vegetable intake, (ii) environmental interventions to increase fruit and vegetable intake, (iii) multicomponent interventions to increase several eating behaviours, including fruit and vegetable intake, and (iv) environmental interventions targeting food choices other than fruit and vegetable intake (e.g., high fat foods), (sections (i) and (iii) are relevant to the current Technical Brief) ▪ clear and detailed tabular presentation of key features of appraised study's sample, methods, design, intervention and results ▪ concise summaries for each section and overall review ▪ brief conclusions
USA	Search period: not provided (but before publication date of 2003) Search described as "selective, not exhaustive". Databases searched: Medline, PubMed, Social Science Citation Index, Agricola. Search terms: "school food environment", "school food policy", "competitive foods", "pricing", "availability", "vegetables", "fruits", "school nutrition", "food choices", "five-a-day", "adolescent nutrition", "child nutrition". Relevant references cited within appraised articles were also identified for retrieval.	Exclusion criteria <ul style="list-style-type: none"> ▪ none stated. Mentions excluding a study due to "poor methodology" but no detail of selection criteria relating to study design. It is apparent from the results that RCTs and nonrandomised, quasi-experimental studies were included. 	Two RCTs evaluating multicomponent interventions which aimed to change food choices, with outcomes including fruit and vegetable intake. Results were mixed. The CATCH trial (Perry et al. 1998b) was a 3-year intervention programme including classroom education/behaviour change curricula, physical education intervention, food service cafeteria intervention, and a parent/home component. No significant impact at 24 hour recall of fruit and vegetable intake was demonstrated. Another trial (Gortmaker et al. 1999) evaluated a 2-year intervention involving teacher-led classroom lessons aimed at reducing obesity. A significant increase was reported in fruit and vegetable servings per day in girls only. This trial included classroom lessons implemented by teachers targeting low fat foods, fruit and vegetable intake, physical activity, and television watching (notably, there was no environmental component to this intervention). All but one of the above trials offering multicomponent interventions relevant to the current Technical Brief based their intervention design on Social Cognitive Theory principles; the other trial used the Stages of Change/precede-proceed theoretical framework. <i>continued overpage</i>	<ul style="list-style-type: none"> ▪ brief conclusions ▪ <i>continued overpage</i>

Table 1 (continued)

Authors, country	Aim and search method	Inclusion and exclusion criteria	Results and authors' conclusions	Comments
French and Stables (2003) <i>continued</i>			<p>Authors' conclusions</p> <p>In the studies considered in this review (which included non randomised trials), the authors report that multicomponent school interventions were effective in increasing fruit intake with increases ranging from 0.2 to 0.6 servings per day, whilst impact on vegetable intake was less effective with increases ranging from 0.0 – 0.3 servings per day. Total fruit and vegetable intake increases ranged from 0.0 to 0.6 servings per day.</p> <p>Most programmes included classroom education and behaviour change curricula, food service changes (environmental change), and parent home activity components. As separate evaluations of individual components have not been done, evaluation of the relative impact of these components is not possible. Environmental change interventions in schools show potential for positively affecting fruit and vegetable consumption among youth.</p>	<p>Comments</p> <ul style="list-style-type: none"> suggested that <u>future research</u> is merited to separately evaluate school-based environmental intervention components for their independent, additive, or synergistic effects on vegetable and fruit choices among youth. Also recommend the wider dissemination of strategies that have produced significant and meaningful results in research settings to determine their feasibility, efficacy, and cost-effectiveness in "real-world" settings.

Table 1 (continued)

Authors, country	Aim and search method	Inclusion and exclusion criteria	Results and authors' conclusions	Comments
Bautista-Castano et al. (2004) UK	<p>Aim To review studies investigating interventions conducted in the environment of family, schools and community, and directed towards the prevention of childhood obesity.</p> <p>Search period: 1993 – December 2003.</p> <p>Databases searched: Medline, ACP Journal club, Evidence-based Medicine, Clinical Evidence, Bandolier, and all the specialist journals in relevant journals available physically or electronically in a range of health and educational institutions in the Canary Islands and Barcelona.</p> <p>Search terms: 'obesity', 'children', 'childhood', 'prevention'.</p>	<p>Inclusion criteria</p> <ul style="list-style-type: none"> ▪ Children aged 0 – 18 years ▪ Published in English, Spanish, Italian or Portuguese ▪ Studies conducted on humans ▪ Prevention interventions that deal with pondural status ▪ Randomised controlled trials (RCTs) and non-randomised interventions with control groups, observed for a minimum of 12 weeks. <p>Exclusion criteria</p> <ul style="list-style-type: none"> ▪ none stated. <p>Synthesis: narrative.</p>	<p>Fourteen intervention studies selected for narrative review. As the focus of this review was prevention of childhood obesity, results relating to fruit and vegetable intake were only reported incidentally for two studies, and these are summarized below.</p> <p>The first by Gortmaker et al (1999) was a controlled study of the impact of a 2-year, school-based intervention offering nutritional education (aimed to increase fruit and vegetable intake) and physical activity (aimed to reduce television watching). In girls only, following the intervention there was: decreased prevalence of obesity (OR: 0.47; 95% CI: 0.24-0.93), greater remission of obesity (OR: 2.16; 95% CI: 1.07-4.35), fewer hours watching television, and greater consumption in fruit and vegetable intake (no statistical details reported by the reviewers).</p> <p>Another relevant study is the RCT by Saha et al (Sahota et al. 2001a; Sahota et al. 2001b) which evaluated the Active Programme Promoting Lifestyle Education in School (APPLES) project targeting 7-11 year olds and running over one academic year. The intervention was multifaceted and included nutritional education, behavioural modification, physical activity, and school food interventions. Intervention schools demonstrated an increase in consumption of vegetables, and improvement in life-style attitudes, knowledge and habits compared with control groups schools, but actual differences and statistics were not reported in the review.</p> <p>Other studies were described that reported on dietary outcomes other than fruit and vegetable intake.</p> <p>Authors' conclusions The following conclusions were made based on all the studies considered, not only those reporting on fruit and vegetable intake. Conclusions reflected the focus on the study on prevention of childhood obesity.</p> <p><i>continued overpage</i></p>	<p>The scope of this review related primarily to interventions designed to impact on obesity. The search strategy was limited and critical appraisal perfunctory.</p> <p>Comments</p> <ul style="list-style-type: none"> ▪ inclusive selection criteria, considering studies of children of all ages, and controlled studies which were non-randomised as well as RCTs ▪ limited range of databases and Journals searched, including a bias towards those available at researchers' local institutions ▪ very limited search terms ▪ included some non-English publications ▪ narrative description of appraised studies organized by intervention type, with minimal critical analysis ▪ tabular presentation of key features of appraised studies, including sample, intervention type, obesity outcomes and effectiveness in terms of obesity prevention ▪ limited description of interventions apart from classifying what sorts of intervention strategy was used or area targeted ▪ minimal statistical details reported ▪ very brief summary of methodological limitations of the literature, and future directions for research ▪ the authors acknowledge that methodological differences across the studies considered make it difficult to make a clear evaluation of the efficacy of these interventions.

Table 1 (continued)

Authors, country	Aim and search method	Inclusion and exclusion criteria	Results and authors' conclusions	Comments
Bautista-Castano et al. (2004) <i>continued</i>			<p>Nutritional education and promotion of physical activity together with behavioural modifications, decrease in sedentary activities and the collaboration of the family, are determining factors in the prevention of childhood obesity. Parental involvement can help. Interventions involving school canteen facilities is not decisive in improving intervention effectiveness, whilst decreasing sedentary activity does positively influence the effectiveness of interventions designed to prevent childhood obesity. Interventions have a beneficial impact on children's health, regardless of their impact on obesity, as far as they improve dietary habits which could lead to a decrease in cardiovascular disease risk factors. Interventions applied over 6-12 months seem to be more effective than short- or longer-term interventions. The need for well-designed studies that examine a range of interventions remains a priority.</p>	

Table 1 (continued)

Authors, country	Aim and search method	Inclusion and exclusion criteria	Results and authors' conclusions	Comments
<p>Cliska (2004) Canada</p>	<p>Aim To assess the effectiveness of interventions to improve nutritional intake in children and youth.</p> <p>Search period: Jan 1985 – August 2003</p> <p>Databases searched: BIOSIS, CENTRAL, CINAHL, Cochrane Databases of Systematic Reviews and Randomised Controlled Trials, EMBASE, ERIC, Medline, PsycINFO, Sociological Abstracts, and Sports Discus</p> <p>Search terms: an extensive list of search terms is provided relating to effectiveness, content (obesity, fitness, food, eating), strategies, population and public health fields.</p> <p>Handsearching of 24 peer reviewed, relevant Journals from June 1998, to June 2003.</p> <p>Retrieval from reference lists of potentially relevant articles.</p> <p><i>continued overpage</i></p>	<p>Inclusion criteria</p> <ul style="list-style-type: none"> ▪ Primary prevention interventions relevant to public health/health promotion in Canada ▪ Population included school-aged children and youth from 6-18 years ▪ Interventions (single or multifaceted) that assessed effectiveness focused on improving nutritional intake ▪ Setting included school, family, and/or community ▪ Outcomes included fruit and vegetable intake, caloric intake, and percent calories from fat ▪ Prospective study with comparison control group <p><i>continued overpage</i></p>	<p>Included 76 articles describing 57 studies. The review considered three groups of studies, those targeting: primary school students, high school students, and prevention of eating disorders (not reported here as these did not report relevant outcomes). Only those rated as being "strong" methodologically overall are discussed in the text and here.</p> <p>Improving nutrition for primary school students</p> <p>Of 13 high quality studies discussed, 10 reported on fruit and vegetable outcomes. These studies/outcomes are discussed below (the other three focused on reducing fat and salt and increasing complex carbohydrates).</p> <p>Seven of the 10 studies relevant to the current review were focused on increasing fruit and vegetable servings to five per day. In the "Gimme 5 Primary School" study (Baranowski et al. 2000; Davis et al. 2000), teachers gave three sessions per week for six weeks, supported by homework assignments, and videos and newsletters to parents, in a two year intervention. Fruit and vegetable intake increased by 0.2 servings per day. A similar intervention given to grade 4 and 5 students (Domel et al. 1993) resulted in a significant (statistically) increase of 0.3 servings per day. The "High 5" trial (Reynolds et al. 2000a; Reynolds et al. 2000b; Reynolds et al. 2002) evaluated a programme similar to the Gimme 5 intervention except that it added cafeteria changes and parent education. Fruit and vegetable intake was 3.96 servings per day in the intervention group compared with 2.28 in the control group at follow-up, maintained at two-year follow-up. The similar "5-A-Day Power Plus" (Perry et al. 1998a; Story et al. 2000) intervention involved 16 classroom sessions, education packs to parents, point of purchase promotions, and industry talks. Fruit intake by 24-hour recall for Grade 4 students increased by 0.62 servings per day, and by 0.5 servings by observations at lunchtime, but there were no differences in total fruit and vegetable intake as measured by 24-hour recall. The "California 5-A-Day Power Play" (Foerster et al. 1998) evaluated a very similar intervention with nearly 4000 Grade 4 and 5 students in three comparison groups. There was an increase of 0.4 servings of fruits and vegetables per day in the school plus community intervention group, and an increase of 0.2 servings in the school only intervention group, significantly higher than in the control group.</p> <p><i>continued overpage</i></p>	<p>This review represents a chapter in a larger Canadian report by Thomas et al (2004) for the Effective Public Health Practice Project</p> <p>Comments</p> <ul style="list-style-type: none"> ▪ comprehensive search strategy, including extensive hand-searching of Journals, checking of reference lists, grey literature, and contact with experts ▪ whilst language restriction was not applied to the search, only French articles were translated ▪ explicit selection criteria ▪ due to time constraints appraisal and data extraction performed by independent reviewers using explicit quality criteria ▪ the report presents a background section presenting rationale for focus of review on fruit and vegetable intake based on enhanced satiety and decreased hunger which can contribute to reduced caloric intake and density and play a role in weight management. A more detailed background to the prevalence, health consequences, financial consequences, and developmental pathway of obesity, and rationale for targeting children, is provided in the full report by Thomas et al (2004). ▪ synthesis of descriptive information of 57 studies considered in the review (including those related to eating disorders) considering characteristics such as country study was conducted in, participant characteristics, language published in, theoretical basis of interventions, interveners, and setting for studies. Overview and synthesis of quality assessments also reported narratively as well as in detailed tables. ▪ brief narrative description of those studies with strong methodological quality. <p><i>continued overpage</i></p>

Table 1 (continued)

Authors, country	Aim and search method	Inclusion and exclusion criteria	Results and authors' conclusions	Comments
Cliska (2004) <i>continued</i>	<p>Grey literature including contacting experts in the areas, other key informants, and searching Canadian, American, Australian and European agency websites.</p> <p>Note: The search strategy was employed for several separate review topics as part of a larger report on physical activity enhancement and obesity prevention (Thomas et al. 2004).</p>	<p>Exclusion criteria</p> <ul style="list-style-type: none"> ▪ therapeutic nutrition and physical activity programmes ▪ studies of children with known illnesses ▪ studies of obese or overweight children ▪ studies that only measured changes in vitamin or fibre intake, knowledge or attitudes. <p>Synthesis: two reviewers independently rated retrieved articles for relevance. All relevant articles were also assessed for methodological quality across six criteria: selection bias, allocation bias, confounders, blinding of outcome assessors, data collection methods, and withdrawals and dropouts. Discrepancies were resolved through consensus. Data was extracted and appraisal conducted using a standardised form.</p>	<p>The "Integrated Nutrition Programme" (Auld et al. 1998) intervention involved 24 weeks of classes by a special resources teacher with six parent-taught lunchtime sessions, newsletters to parents, and a family "fun night". At year four of implementation for grades 3-5 students, servings of fruit and vegetables had increased by 0.4 in the intervention group compared with the control, and by 1.2 servings per day as measured by 24-hour recall. The "Teens Eating for Energy at School" (TEENS) study (Birnbaum et al. 2002; Lytle and Perry 2001; Story et al. 2002) randomised classrooms (from grades 7-10) into four interventions, including school environment alone (cafeteria promotions and appeal, taste testing, table tents, etc.), classroom sessions (series of 10) plus environmental, classroom plus environmental plus peer leaders (who assisted teachers), and no intervention/control. Parent packs of home activities were also included. After the first year, the three-prong intervention led to the largest increase in intake of fruit and vegetables of 0.85 servings per day compared with the control group.</p> <p>Two studies targeted scout troops. The Girl Scout study (Cullen et al. 1997) evaluated four weekly sessions with behavioural interventions including goal setting, a buddy, recipe preparation, taste-testing, and information packages to parents. Fruit and vegetable consumption by 24-hour recall increased significantly from 3.0 to 3.39 servings per day, but this was not maintained at three-month follow-up. The other study involved Boy Scout troops (Baranowski et al. 2002) which involved eight meetings and seven home activities also involving behavioural interventions including goal setting, self monitoring, problem-solving, rewards, recipe preparation, and taste-testing. No statistical difference in fruit and vegetable consumption was found between the randomised intervention and control groups.</p> <p>Finally, a pilot study (Perry et al. 1985) aimed to reduce fat and salt and increase complex carbohydrates through the "Hearty Heart and Friends" intervention for Grade 3 and 4 students. It involved nine brief slide sessions of cartoon role-models, daily food and activity records, homework assignments, recipes and snack preparation, parental assistance in the classroom activities, and an aerobic exercise routine. Twenty-four hour food recall demonstrated a significant intervention effect increasing fruit and vegetable intake.</p> <p><i>continued overpage</i></p>	<p>detailed tables present study design, rated quality (moderate or strong), grade level of participants and number of groups/schools, intervention type, outcomes and whether statistically significant, and critical comments</p> <p>occasional discrepancies between text and tables</p> <p>a meta analysis was not performed due to time constraints</p> <p>data on intervention studies targeting eating disorders were also reported.</p> <p>did not consider cost benefit or cost effectiveness information</p> <p>presented implications for practice and policy including that multifaceted interventions require considerable planning and cooperation; educational interventions should promote specific behaviour changes rather than nutritional knowledge; single session interventions do not change food-related behaviour; and researchers/clinicians need to attend to the level of clinical significance of findings, as well as their statistical significance.</p> <p>presented implications for future research including children's food behaviour can be altered by targeted messages of sufficient intensity, and that cost effectiveness analyses should be included in future nutritional studies.</p>

Table 1 (continued)

Authors, country	Aim and search method	Inclusion and exclusion criteria	Results and authors' conclusions	Comments
Cliska (2004) <i>continued</i>			<p>Improving nutrition for secondary school students</p> <p>Of four high quality studies discussed, two reported fruit and vegetable outcomes.</p> <p>The "Gimme 5 High School" study (Nicklas et al. 1997; Nicklas et al. 1998; Nicklas and O'Neil 2000; O'Neil and Nicklas 2002) was a very intensive study over three years incorporating a mass media campaign in intervention schools, five workshops, increased fruit and vegetable availability and appeal in cafeterias, and recipes, calendars, tips and information sent to parents. Fruit and vegetable intake increased significantly at one and two years (the actual increase was not reported by Cliska (2004). This was maintained at 3 years but there was no difference with the control group at that time as it had also increased its consumption, which was attributed to the impact of a community-run 5-A-Day campaign.</p> <p>A small pilot study conducted in Greece (Hassapidou et al. 1997) investigated the impact of 10 dietitian-led classroom sessions, workbooks and pamphlets for home use. No significant impact on fruit and vegetable consumption was found, although the study was reportedly underpowered.</p> <p>Author's conclusions</p> <p>For primary and high school students, multifaceted interventions (school curricula, mass media, parent mailings, cafeteria changes) over at least 8-10 weeks showed the most promise of altering food intake. Educational messages targeting behaviour change as opposed to knowledge acquisition of specific behaviours (e.g., increase fruit intake) were also more successful in changing food behaviours. Several studies found statistically significant results, however the clinical significance of some of these is questionable (e.g., an increase in 0.3 servings per day).</p>	

Table 1 (continued)

Authors, country	Aim and search method	Inclusion and exclusion criteria	Results and authors' conclusions	Comments
Thomas (2004) Canada	<p>Aim To assess the effectiveness of interventions targeting children and youth aimed at improving nutritional intake, increasing physical activity, and/or preventing obesity.</p> <p>Search period: Jan 1985 – August 2003</p> <p>Databases searched: BIOSIS, CENTRAL, CINAHL, Cochrane Databases of Systematic Reviews and Randomised Controlled Trials, EMBASE, ERIC, Medline, PsycINFO, and Sociological Abstracts, and Sports Discus</p> <p>Search terms: an extensive list of search terms is provided relating to effectiveness, content (obesity, fitness, food, eating), strategies, population and public health fields.</p> <p>Handsearching of 24 peer reviewed, relevant Journals from June 1998, to June 2003.</p> <p>Retrieval from reference lists of potentially relevant articles.</p> <p><i>continued overpage</i></p>	<p>Inclusion criteria</p> <ul style="list-style-type: none"> ▪ Primary prevention interventions relevant to public health/health promotion in Canada ▪ Population included school-aged children and youth from 6-18 years ▪ Interventions (single or multifaceted) that assessed effectiveness focused on improving nutritional intake, enhancing physical activity, and/or decreasing physical inactivity ▪ Setting included school, family, and/or community ▪ Outcomes included body weight or BMI, fruit and vegetable intake, caloric intake, percent calories from fat, self reported changes in the duration, rate or frequency of physical activity, changes in VO₂max, sit-ups per minute, mile run time, and self reported changes in inactivity. <p>Psychological measures were also considered such as self-efficacy.</p> <p><i>continued overpage</i></p>	<p>Included 241 articles describing 51 studies. There were nutritional outcomes in many of these studies (e.g., fat content, salt, sugar, serum cholesterol, calories) but only a selection reported fruit and/or vegetable outcomes. Only RCTs were discussed in the text of Thomas (2004) because of the methodological limitations of cohort studies.</p> <p>There were nine RCTs reporting on fruit and vegetable outcomes and these are discussed here. Three studies (Baranowski et al. 2003; Beech et al. 2003; Story et al. 2003) employing the Girls Health Enrichment Multi-site Studies (GEMS) program reported relevant outcomes. All had small samples (range: 35-60) of 8-10 year old African-American girls recruited from low-income neighbourhoods. Interventions varied between studies but all involved a 12-week program of interactive exercises such as games, dance, and snack preparation. No significant difference in fruit/fruit juice and vegetable servings was observed, although Thomas (2004) noted that the samples were very small and the intervention was not very intensive.</p> <p>The Hopper Family Participation Project 2 (Hopper et al. 1996) targeted grade 2-4 students randomised to one of three groups: school only, school and home and control. The school intervention included four sessions per week of non-competitive physical activity and two interactive classroom sessions per week on nutrition, for 10 weeks. The school and family intervention also included information packets and activities for the family, and points and rewards for participation. The intervention groups consumed significantly more servings of fruit and vegetables per day than controls (p<0.05), although Thomas (2004) describes the actual difference (not reported) as small, possibly due to the short duration of the intervention.</p> <p>The Active Programme Promoting Lifestyle Education in School (APPLES) (Sahota et al. 2001a; Sahota et al. 2001b) trial targeted a sample of 636 7-11 year olds from 10 schools. The intervention included teacher training, playground activities, changes to school meals, and the development of school action plans to promote healthy eating and physical activity over one academic year. Children in the intervention group reported eating more vegetables (0.3 portions/day) than the control group, which Thomas (2004) suggests may not be clinically important. The intensity of the intervention was not reported by the study researchers.</p> <p><i>continued overpage</i></p>	<p>Alongside Clijcka (2004), this review represents a chapter in a larger Canadian report by Thomas et al (2004) for the Effective Public Health Practice Project.</p> <p>Comments</p> <ul style="list-style-type: none"> ▪ comprehensive search strategy, including extensive hand-searching of Journals, checking of reference lists, grey literature, and contact with experts ▪ explicit selection criteria ▪ whilst language restriction was not applied to the search, only French articles were translated due to time constraints. ▪ appraisal and data extraction performed by independent reviewers using explicit quality criteria ▪ the report provides an introduction to the health consequences and prevalence of obesity. The specific chapter presents a background section presenting rationale for focus of review on nutrition and physical activity outcomes. A more detailed background to the prevalence, health consequences, financial consequences, and developmental pathway of obesity, and rationale for targeting children is provided in the full report by Thomas et al (2004). ▪ brief narrative description of those RCTs with strong methodological quality. ▪ very detailed tables present study design, rated quality (moderate or strong), grade level of participants and number of groups/schools, intervention type, outcomes and whether statistically significant, and critical comments ▪ occasional discrepancies between text and tables. ▪ data on intervention studies targeting physical activity outcomes alone were also reported. ▪ did not consider cost benefit or cost effectiveness information <p><i>continued overpage</i></p>

Table 1 (continued)

Authors, country	Aim and search method	Inclusion and exclusion criteria	Results and authors' conclusions	Comments
<p>Thomas (2004) <i>continued</i></p>	<p>Grey literature including contacting experts in the areas, other key informants, and searching Canadian, American, Australian and European agency websites.</p> <p>Note: The search strategy was employed for several separate review topics as part of a larger report on physical activity enhancement and obesity prevention (Thomas et al. 2004).</p>	<ul style="list-style-type: none"> ▪ prospective study with comparison control group <p>Exclusion criteria</p> <ul style="list-style-type: none"> ▪ therapeutic nutrition and physical activity programmes ▪ studies of children with known illnesses or overweight children ▪ studies that only measured changes in vitamin or fibre intake, knowledge or attitudes. <p>Synthesis: two reviewers independently rated retrieved articles for relevance, and all relevant articles were assessed for methodological quality across six criteria: selection bias, allocation bias, confounders, blinding of outcome assessors, data collection methods, and withdrawals and dropouts. Discrepancies were resolved through consensus. Data was extracted and appraisal conducted using a standardised form.</p>	<p>In the UK, Warren et al (2003) conducted the Be Smart Program with 218 5-7 year old students from high-income families. These intervention groups received 20 weeks of sessions over 14 months. Included Eat Smart (interactive sessions focused on nutrition), Play Smart (promoting physical activity in daily life), and a combined intervention which included homework and a newsletter to be shared with parents. A Be Smart control group received food-related (but not nutrition) education. At one month follow-up, fruit intake increased slightly ($p < 0.05$) in the Eat Smart and the Be Smart (control) groups, although this difference is described as not clinically significant by Thomas (2004) who suggests that the lack of effect may be due to relatively good diets at baseline.</p> <p>Planet Health (Gortmaker et al. 1999) included 1,295 children aged 11-12 years. The two-year programme included 32 lessons aimed to reduce television watching, promote physical activity, and improve dietary intake. At follow-up, using an in-intention-to-treat analysis, there was an increased consumption of fruit and vegetables in girls (0.32 serves/day, $p = 0.03$), which Thomas (2004) states is not clinically significant. The New Moves (Neumark-Sztainer et al. 2003) trial considered an ethnically mixed group of 201 females in grades 9-12 in the USA. Over 16 weeks, students received four physical activity classes per week, and a class each alternate fortnight of either social support or nutritional guidance. There were no significant differences on fruit and vegetable intake at post-intervention or 8 month follow-up. The control group received usual curriculum. Thomas (2004) suggested that the short programme duration may have accounted for the lack of effect. Finally, Wilson et al (2002) conducted a pilot study with 53 11-15 year old African-American young people from low-income families. One intervention group received 2-hour sessions based on social cognitive theory relating to target behaviours for nine weeks; the second intervention group received the same classes as strategic self-preservation videos and motivational interviewing; and the control group learnt about health related issues for 12 weeks. Whilst there were no between group differences, the intervention groups both increased their fruit and vegetable intake compared with baseline.</p> <p>Authors' conclusions There was no synthesis of fruit and vegetable results. Generally, results were mixed, modest, and of questionable clinical significance.</p>	<p>presented implications for practice, including introducing individual goal setting in the areas of nutrition and physical activity in schools</p> <p>Presented implications for future research</p> <ul style="list-style-type: none"> ▪ successful interventions, as determined by an RCT, should be replicated following sample size calculations to ensure that the study has sufficient power to detect between group differences. Experts need to arrive at a consensus about what constitutes clinically important differences in outcomes. ▪ blind outcome assessment should be conducted. ▪ analysis needs to be at the same level as unit (e.g., school, classroom, region) of allocation to intervention group and control group and include cluster analysis, intention to treat analysis, and longer follow-up. ▪ studies need to report the integrity (fidelity) of program delivery and the number of participants actually receiving the intervention, and the "dose" they do receive (e.g., how many sessions). ▪ quantitative and qualitative investigations of the reasons for subgroup differences (e.g., gender, income, race) is needed. ▪ the theoretical basis of an intervention should be made explicit. The challenges of employing an ecological model should be addressed. ▪ the authors raise the possibility that intervention studies concerning weight could draw attention to body image and inadvertently lead to increased body dissatisfaction in overweight participants. Investigation of the possible negative outcomes of such research is needed. <p>Noted that most studies used reliable and valid outcome measures, with most reporting acceptable withdrawal/drop-out rates.</p>

Table 1 (continued)

Authors, country	Aim and search method	Inclusion and exclusion criteria	Results and authors' conclusions	Comments
Summerbell, Waters, Edmunds, Kelly, Brown, and Campbell (2005)	<p>Aim To assess the effectiveness of interventions designed to prevent obesity in childhood through diet, physical activity, and/or lifestyle and social support.</p> <p>Search period: 1990 – February 2005.</p> <p>Databases searched: Medline, PsycINFO, EMBASE, CINAHL, and CENTRAL; extensive range of review and HTA databases/websites; Food Standards Agency and Department of Health websites (see report for full details)</p> <p>Search terms: extensive; included terms relating to weight gain or loss, therapy, children, parents, diets, exercise, health promotion, school, community, family, prevention, and study design terms (see report for full details)</p> <p><i>continued overpage</i></p>	<p>Inclusion criteria</p> <ul style="list-style-type: none"> ▪ RCTs and controlled clinical trials ▪ for those with randomisation of groups, studies required at least 6 groups ▪ minimum duration of 12 weeks ▪ children/youth less than 18 years ▪ interventions involving diet, physical activity, and/or lifestyle and social support ▪ community, school or clinic setting ▪ reported on baseline and follow-up for one or more primary outcomes: weight and height, percent fat content, BMI, ponderal index, skin-fold thickness. ▪ English and Non English language publications <p>Exclusion criteria</p> <ul style="list-style-type: none"> ▪ interventions designed to treat childhood obesity or eating disorders <p><i>continued overpage</i></p>	<p>Twenty-two studies included: 10 long-term (at least 12 months) and 12 shorter-term. Data on fruit and vegetable outcomes were reported in the review for only two appraised studies, described briefly below.</p> <p>One high-quality RCT called Planet Health (Gortmaker et al, 1999), included 1295 ethnically diverse children in 10 US schools, aged 11-12 years. The programme was a behavioural choice, curriculum-based and teacher-led intervention promoting physical activity, modification of dietary intake, and reduction in sedentary activity (especially television watching). At 18 month follow-up, there was an increased consumption of fruit and vegetables in girls (0.32 serves/day; 95% CI 0.14 to 0.5; $p < .003$), resulting in a smaller daily increment in total energy intake of -575kJ ($p = .05$). There was also reduced television watching in boys and girls (-0.58 hours, $p = .001$).</p> <p>The other included study of relevance was a high quality English RCT (Sahota et al, 2001a; Sahota et al, 2001b). This trial of 634 children from 10 schools evaluated a multidisciplinary and multi-component intervention (known as APPLES) aimed at the whole school, including parents, based on action plans for each school. The intervention included teacher resources, playground activities, support for physical education and environmental changes to school meals and tuckshops. After one year, children in the intervention group reported higher consumption of vegetables (weighted mean difference 0.3 portions/day, 95% CI 0.2 to 0.4).</p> <p><i>continued overpage</i></p>	<p>This review was produced for the Cochrane Collaboration.</p> <p>Comments</p> <ul style="list-style-type: none"> ▪ highly comprehensive search strategy, including extensive database searching, contact with experts and checking of reference lists. ▪ detailed and explicit selection criteria ▪ brief background section describes the growing problem of childhood obesity, possible contributing causes, the policy context, and an overview of relevant reviews published since 2002. ▪ appraisal and data extraction performed by two independent reviewers using an extraction form ▪ overviews of theoretical models and intervention components of included studies ▪ detailed narrative descriptions and critical commentary of each included study, organized into sections grouped by length of intervention, and type of intervention (dietary, physical activity, dietary compared with physical activity, and dietary and physical activity interventions combined). ▪ detailed tables presenting standard characteristics and methodological quality features of each study. ▪ discussion of results, emphasizing differences between 2000 and 2004, noting key methodological flaws and limitations (including that control group participants receive detailed measurements which themselves could impact on outcomes), and the lack of economic data. ▪ conclusions noting specific and useful implications for practice, and for research, relating to obesity.

Table 1 (continued)

Authors, country	Aim and search method	Inclusion and exclusion criteria	Results and authors' conclusions	Comments
<p>Summerbell, Waters, Edmunds, Kelly, Brown, and Campbell (2005) <i>continued</i></p>	<p>Experts were contacted to identify eligible papers. Reference lists of systematic reviews published since 2000 were scanned to identify additional articles for retrieval.</p>	<p>Synthesis: two reviewers independently extracted data using a quality assessment tool and assessed study quality.</p>	<p>Authors' conclusions Conclusions were made about all included studies generally, and not specifically to those reporting fruit and vegetable outcomes.</p> <p>Nearly all studies included in the review resulted in some improvement in diet or physical activity. There is not enough evidence from trials to prove that any one particular programme can prevent obesity in children, although comprehensive strategies to address dietary and physical activity change, together with psycho-social support and environmental change, may help. The majority of studies were short-term. Appropriateness of development, design, duration and intensity of interventions to prevent obesity in childhood needs to be reconsidered alongside comprehensive reporting of the intervention scope and process.</p> <p>There was a trend for newer interventions to involve their respective communities and to include evaluations. Further research might usefully assess changes made on behalf of entire populations, such as improvements in the types of foods available at schools and in the availability of safe places to run and play, and should assess health effects and costs over several years.</p>	

Secondary Studies

Included studies were all systematic reviews that included randomised controlled trials as well as non-randomised controlled studies. These reviews therefore represent level III.1 evidence according to NHMRC's hierarchy of evidence (see **Appendix 1**).

Scope of reviews

The seven systematic reviews appraised were published between 2000 and 2005, three came from Canada, two from the USA, one from the UK, and one was for the international Cochrane Collaboration.

Two reviews were primarily focused on interventions designed to reduce obesity (Bautista-Castano et al. 2004; Summerbell et al. 2005). The other five reviews were concerned with interventions designed to improve nutritional intake, two of which considered fruit and vegetable consumption as the primary outcomes of interest (Ciliska et al. 2000; French and Stables 2003).

Five reviews considered studies relating to children up to the age of 18 years, and the other two reviews appraised considered studies intervening with children, adolescents or adults (Ammerman et al. 2002; Ciliska et al. 2000). Only studies relating to children relevant to this review are discussed in the Evidence Table.

Search strategies

Five well-conducted reviews employed comprehensive search strategies and involved two independent reviewers conducting data extraction and assessed study quality using predetermined criteria. The other two reviews (Bautista-Castano et al. 2004; Summerbell et al. 2005) searched a somewhat limited range of databases, and no detail was given of data extraction or synthesis methods. Results and authors' conclusions for each review are briefly summarised here. See the Evidence Tables for fuller description of appraised studies and their respective findings.

Results and reported conclusions

Results and reported conclusions of the seven reviews relevant to this Technical Brief are summarised in **Table 2**.

Two reviews focused on evaluations of interventions aimed at preventing obesity (Bautista-Castano et al. 2004; Summerbell et al. 2005). Summerbell et al (2005) conducted a systematic review for the Cochrane Collaboration in 2002, updated in 2005, assessing the effectiveness of interventions designed to prevent obesity in childhood. Data on fruit and vegetable outcomes were reported in the review for only two appraised studies, the RCT evaluating the Planet Health programme (Gortmaker et al. 1999), and the RCT evaluating the Active Programme Promoting Lifestyle Education in School (APPLES) project (Sahota et al. 2001a; Sahota et al. 2001b). Conclusions were not made specifically to those reporting fruit and vegetable outcomes, but the authors observed that nearly all studies included in the review resulted in some improvement in diet or physical activity. They also noted that there was a trend for newer interventions to involve their respective communities and to include evaluations, although most were only short-term. Bautista-Castano et al (2004) also reviewed studies directed towards preventing obesity, employing a limited search strategy with minimal critical appraisal. The review presented the same two studies reporting on fruit and vegetable intake which were discussed by Summerbell et al (2005). Conclusions in Bautista-Castano et al's (2004) review focused on the 14 studies appraised as they related to obesity prevention.

The carefully conducted systematic review by Ciliska et al (2000) considered studies of community-based interventions to increase fruit and vegetable consumption. The extensive search strategy identified six studies with samples of school-aged children were identified; three were short-term studies evaluating largely curriculum-based interventions, and three were evaluations of longer-term, multi-component, school-based interventions. The authors suggested that the results could be explained by the intensity and clarity of messages delivered. They concluded that significant effects on fruit and vegetable intake tended to occur in the studies evaluating more intensive, multifaceted and prolonged interventions such as the 5-A-Day Power Plus study (Perry et al. 1998a) and the Gimme 5 study (Nicklas et al. 1998). The exception was the CATCH trial (Perry et al. 1998b), which did not specifically target fruit and vegetable consumption in its intervention.

Ammerman et al (2002) conducted a careful and rigorous review of 104 studies evaluating interventions promoting dietary changes in fat intake as well as fruit and vegetable intake. Of 22 studies identified reporting fruit and vegetable outcomes, 17 demonstrated significant improvements in dietary intake of fruit and vegetables (median difference between groups of 0.6 servings per day), although this effect reduced over (follow-up) time. The authors concluded that, in broad terms, studies appeared to be somewhat more likely to lead to a significant effect on intake of fruit and vegetables if the intervention had a theoretical basis, included small groups, or included goal setting. However, the authors cautioned that the lack of similarity across studies in outcome measures, study design, analysis strategy, and intervention technique hampered the ability to draw broad conclusions about the most effective behavioural dietary interventions. This review has limited relevance to the current Technical Brief as it included studies with samples including adults, and individuals at elevated risk of chronic disease.

French and Stables (2003) conducted a review related primarily to environmental interventions in school-based settings. Whilst environmental interventions are explicitly excluded in this Technical Brief, studies were identified with interventions which included components relevant to the current review, such as classroom lessons/workshops and parental involvement. Following a fairly limited search strategy, six RCTs were identified reporting on fruit and vegetable outcomes. No meta-analysis was conducted, but the authors collated results across studies. They reporting that interventions were effective in increasing fruit intake from 0.2 to 0.6 servings per day, whilst impact on vegetable intake was less effective with increases ranging from 0.0 – 0.3 servings per day. Total fruit and vegetable intake increases ranged from 0.0 to 0.6 servings per day in the studies appraised.

A Canadian report edited by Thomas, Ciliska, Micucci, Wilson-Abra et al (2004) for the Effective Public Health Practice Project included two chapters reporting on reviews of relevance to this Technical Brief, one by Ciliska (2004) on interventions aimed at improving nutritional intake in children and youth, and a review by Thomas (2004) which considered interventions aimed at improving nutritional intake as well as increasing physical activity, and/or preventing obesity in children and youth. The same comprehensive search strategy was used for both topics.

In Ciliska's (2004) review relating to nutritional interventions, 15 high quality studies were identified which reported on fruit and vegetable outcomes: 13 for primary school students, and two for secondary school students. It was concluded that, for primary and high school students, multifaceted interventions (school curricula, mass media, parent mailings, cafeteria changes) over at least 8-10 weeks showed the most promise of altering food intake. Ciliska (2004) also argued that educational messages targeting behaviour change as opposed to knowledge acquisition of specific behaviours (e.g., increase fruit intake) were more successful in changing food behaviours. These conclusions concur with those of Ciliska et al (2000) reported above. Whilst several studies found statistically significant results, Ciliska (2004) suggested that the clinical significance of some of these is questionable (e.g., an increase in 0.3 servings per day).

The systematic review by Thomas (2004) accompanying Ciliska's (2004) review considered intervention targeting nutritional intake as well as increasing physical activity, and/or preventing obesity. Nine RCTs reporting on fruit and vegetable outcomes were discussed in detail. Whilst there was no explicit synthesis of fruit and vegetable results, generally, results were mixed, modest, and of questionable clinical significance. Possible explanations for modest or absent intervention effects were suggested by Thomas. These included that: control groups often were provided regular physical education or health programmes; the duration or intensity of the programme was lacking; the small sample size meant that the study lacked statistical power to detect between-group differences; some teachers were not trained or motivated to deliver the programmes effectively; the intervention did not consider students' social or cultural context; and that students were not fully exposed to the intervention.

Table 2. Summary of results and conclusions from appraised secondary research relevant to this Technical Brief.

Authors	Scope of review	Studies of fruit and vegetable intake	Authors' conclusions	Relevance to this TechBrief
Cliska et al (2000)	Community-based interventions to increase fruit and vegetable intake in people aged 4+	Six relevant studies targeting school-aged children: one cohort analytic study, two RCTs, and three controlled trials.	The studies that produced significant effects on fruit and vegetable intake tended to involve more intensive, multipronged and prolonged interventions compared to largely curriculum-based interventions lasting fewer than 10 weeks. The exception was a trial which did not specifically target fruit and vegetable intake.	Conclusions relate to fruit and vegetable intake in school-aged children.
Ammerman et al (2002)	Behavioural dietary interventions to promote dietary change related to chronic disease risk reduction.	Twelve studies (including children and adults) included in the "differences in change" secondary analysis, and 22 studies for the "significant findings" analyses. A meta analysis was not possible for this outcome. Other dietary outcomes also analysed.	The majority of interventions reviewed resulted in meaningful improvements in dietary behaviours associated with the prevention of chronic disease, particularly among individuals at elevated risk. Results suggest that a significant number of studies (17 of 22 identified) demonstrated significant improvements in dietary intake of fruit and vegetables (0.6 servings per day), although this increase reduces over (follow-up) time. With respect to studies reporting on dietary fat as well as fruit and vegetable intake, interventions appeared to be more successful at positively changing dietary behaviour among populations at risk of (or diagnosed with) disease than among general, healthy populations. In broad terms, studies reporting on interventions appeared to be somewhat more likely to lead to a significant effect on intake of fruit and vegetables if the intervention had a theoretical basis, included small groups, or included goal setting.	Conclusions relate to various dietary outcomes, including fruit and vegetable intake, in children, youth and adults.
French and Stables (2003)	School-based environmental interventions to increase fruit and vegetable intake.	Six relevant RCTs evaluating multicomponent interventions.	Multicomponent school interventions were effective in increasing fruit intake with increases ranging from 0.2 to 0.6 servings per day, increases in vegetable intake ranging from 0.0 – 0.3 servings per day.	Conclusions relate to fruit and vegetable intake in school aged children.
Bouista-Costano et al. (2004)	Interventions directed towards the prevention of childhood obesity.	Two relevant studies: one controlled trial and one RCT.	Nutritional education and promotion of physical activity together with behavioural modifications, decrease in sedentary activities and the collaboration of the family, are determining factors in the prevention of childhood obesity. Parental involvement can help. Interventions involving school canteen facilities were not decisive in improving intervention effectiveness, whilst decreasing sedentary activity positively influences the effectiveness of interventions designed to prevent childhood obesity. Interventions applied over 6-12 months seem to be more effective than short- or longer-term interventions.	No conclusions provided specific to fruit and vegetable intake. Conclusions relate to children.
Cliska (2004)	Interventions to improve nutritional intake in children and youth.	12 relevant studies rated as methodologically 'strong', including 10 of primary school students and two targeting secondary school students.	For primary and high school students, multifaceted interventions (school curricula, mass media, parent mailings, cafeteria changes) over at least 8-10 weeks showed the most promise of altering food intake. Educational messages targeting behaviour change as opposed to knowledge acquisition of specific behaviours (e.g., increase fruit intake) were also more successful in changing food behaviours. Several studies found statistically significant results, however the clinical significance of some of these is questionable.	No conclusions provided specific to fruit and vegetable intake. Conclusions relate to children and youth.
Thomas (2004)	Interventions to improve nutritional, increase physical activity, and/or prevent obesity in children and youth.	Nine relevant RCTs.	Generally, results were mixed, modest, and of questionable clinical significance. Results support introducing individual goal setting in the areas of nutrition and physical activity in schools.	No conclusions provided specific to fruit and vegetable intake. Conclusions relate to children and youth.
Summerbell, Waters, Edmunds, Kelly, Brown, and Campbell (2005)	Interventions relating to diet, physical activity, and/or lifestyle and social support to prevent obesity in childhood.	Two relevant RCTs	Nearly all studies appraised resulted in some improvement in diet or physical activity. There is not enough evidence from trials to prove that any one particular programme can prevent obesity in children, although comprehensive strategies to address dietary and physical activity change, together with psycho-social support and environmental change, may help.	No conclusions provided specific to fruit and vegetable intake. Conclusions relate to children.

Primary Studies

Three primary research studies were identified which were published beyond the search dates of and/or were excluded from the appraised SR's described above. These fulfilled review inclusion criteria, including being RCT's with at least 20 participants allocated to the intervention group and reporting at least 12 week follow-up data on fruit and/or vegetable intake outcomes. The results of these studies do not significantly alter conclusions drawn from the appraised SR's and so they have not been formally appraised and included in this review. Their findings will be briefly summarized to support this assessment.

The Cafeteria Power Plus project (Perry et al. 2004) evaluated a multi-component intervention based on school cafeteria promotions of fruit and vegetables. At two-year follow-up, a significant but very modest increase in fruit (excluding juice) intake of 0.17 servings was observed at lunchtime in the intervention groups compared with controls ($p=.00$); there were no differences in vegetable intake.

A two-year follow-up of the TEENS ("Teens Eating for Energy at School") study (Lytle et al. 2004) found that positive interim results (with an increase of 0.85 servings of fruit and vegetables per day at one year follow-up, as described in the appraised SR by Ciliska (2004) were not sustained. At the end of the second year, there were no significant differences between treatment groups for fruit and vegetable outcomes detected. The study is notable for its careful attempt to conduct dose-response analyses.

The third trial (Prochaska and Sallis 2004) compared interventions targeting physical activity and nutrition concurrently versus physical activity alone or control conditions. Whilst changes in fruit and vegetable consumption were minimal, the study is interesting in its attempt to systematically investigate single versus multibehaviour interventions.

SUMMARY AND CONCLUSIONS

Summary of evidence

Seven systematic reviews were appraised in this Technical Brief. As the reviews included non randomized comparative studies, they represented Level III.1 evidence according to NHMRC criteria (**Appendix 1**). Two reviews were of lesser quality with respect to employing limited search strategies and data extraction and synthesis methods (Bautista-Castano et al. 2004; Summerbell et al. 2005). The Technical Brief demonstrates that there is a moderately substantial literature investigating the success of interventions designed to increase intake of fruit and vegetables in children, either as their main goal, or as part of broader attempts to impact on incidence of overweight and obesity. Significant funds have been directed to supporting several large-sampled randomized controlled trials, particularly in school settings.

Whilst results of studies appraised in the reviews considered in this Technical Brief were mixed, there is consensus in the literature reviewed that many interventions have resulted in statistically significant increases in fruit and vegetable intake, at least in the short term. Although these increases in intake have often been statistically significant, they were modest. The clinical significance of increases in fruit and vegetable intake, which often averaged around half a serving per day, has been questioned.

The lack of similarity across relevant studies considered in the included reviews with respect to intervention programme, population targeted, outcome measures, study design, and analysis strategy, hamper the ability to draw broad conclusions about the most effective nutritional interventions. However, in general, multifaceted interventions (e.g., including school curricula, behaviour change curricula, mass media, parent mailings, home activities, food service changes) which extended for at least two months tended to be most successful in altering food intake. The authors of one review argued that successful interventions appeared to have had a theoretical basis, included small groups, or included goal setting (Ammerman et al. 2002). Two separate reviews also suggested that educational messages targeting specific behaviour change (e.g., increase fruit intake) as opposed to knowledge acquisition were more successful in changing food behaviours (Ciliska et al. 2000; Ciliska 2004).

Implications for practice

Given that the impact of interventions evaluated to date has been relatively modest, the systematic reviews appraised here have emphasized the need for more research in the area. However, the current evidence base has been used to raise several potential implications for practice and in the development of future interventions. These are summarized below.

- interventions need to be developed from a theoretical base (Ammerman et al. 2002; Ciliska et al. 2000)
- educational interventions should promote specific behaviour changes (e.g., increase fruit and vegetable intake) rather than nutritional knowledge (Ciliska 2004; Ciliska et al. 2000)
- individual goal setting should be encouraged in the areas of nutrition and physical activity in schools (Ammerman et al. 2002; Thomas 2004)
- multifaceted interventions (school curricula, mass media, parent mailings, cafeteria changes) should be employed (Ciliska 2004; Ciliska et al. 2000), recognizing that these require considerable planning and cooperation (Ciliska 2004)
- single session interventions do not change food-related behaviour (Ciliska 2004)
- interventions should extend over at least 8-10 weeks (Ciliska 2004; Ciliska et al. 2000)
- intervention development should extend beyond the individual-level to include the population-level, macro-level state and national public policy and environmental intervention (Ammerman et al. 2002).

Research gaps

Gaps in the literature were also identified, including the need for:

- evaluations of programmes designed to prevent relapse (Ammerman et al. 2002)
- quantitative and qualitative investigations of the reasons for subgroup differences (e.g., by gender, income, race), particularly in high-risk populations (Thomas 2004)
- studies comparing specific strategies and different levels of intensity within the same population (Ammerman et al. 2002)
- separate evaluations of school-based environmental intervention components for their independent, additive, or synergistic effects on vegetable and fruit choices among youth (French and Stables 2003)
- comparison data on cost effectiveness (Ammerman et al. 2002)
- wider dissemination of strategies that have produced significant and meaningful results in research settings to determine their feasibility, efficacy, and cost-effectiveness in “real-world” settings (French and Stables 2003).

Methodological issues and recommendations for future research

Some authors have commented on strengths in the literature, including that most studies used reliable and valid outcome measures (such as 24 hour food recall diaries) and reported acceptable withdrawal/drop-out rates (Thomas 2004). However, all reviews offered explicit recommendations for how future research could be improved. There was significant overlap in these suggestions, and a synthesis of prominent recommendations is provided below.

Future research needs to:

- report in more detail (in publications) information relating to the following:
 - generalisability of the sample
 - response and retention rates
 - method of randomization
 - process measures describing the integrity (fidelity) of program delivery (including the number of participants actually receiving the intervention, and the “dose” they receive)
 - training provided to and role of those delivering the intervention (e.g., teacher, nutritionist, researcher)
 - theoretical basis of, and its application through, the intervention.
- improve tracking to ensure greater retention at follow-up
- control seasonality (in terms of availability and consumption of fruits and vegetables) (Ciliska et al. 2000)
- increase sample sizes in multisite studies
- perform sample size calculations to ensure that a study has sufficient power to detect between-group differences
- use valid and reliable outcome measures
- investigation of unanticipated outcomes of research and interventions on participants in the field is needed. For example, Thomas (2004) has hypothesised that intervention studies concerning weight could draw attention to body image and inadvertently lead to increased body dissatisfaction in overweight participants.
- use maintenance interventions
- ensure that the outcome assessor is blind to group allocation to intervention or control
- ensure that there is a more coordinated approach to conducting evaluations across sites
- ensure that analysis is at the same level as unit of allocation to intervention and control groups (e.g., school, classroom, region)
- include cluster analysis and intention to treat analysis
- perform longer follow-up (beyond one year)
- evaluate the separate and relative impact of individual components within multi-component interventions
- seek consensus from experts about what constitutes clinically important differences in outcomes in terms of risk for chronic disease, morbidity and mortality
- replicate successful interventions (as determined by an RCT)
- have sufficient resources to evaluate community-based nutrition programmes
- investigate the cost-benefit of large-scale nutritional interventions.

Measurement issues need to be resolved. Summerbell et al (2005) raised the hypothesis that receiving detailed measurements could impact on outcomes for control group as well as intervention group participants, which would dilute any intervention effect. More disturbing is the possibility raised by Thomas (2004) that intervention studies concerning weight could draw attention to body image and inadvertently lead to increased body dissatisfaction in overweight participants. Investigation of unanticipated outcomes of research and interventions on participants in the field is needed.

Conclusions

This Technical Brief identified seven systematic reviews of relevance to literature investigating the effectiveness of programmes designed to increase consumption of fruit and vegetables by school-aged children. These reviews, most of which were extremely well conducted, reveal a substantial literature in this area. Many studies have demonstrated increases in fruit and vegetable intake following intensive, usually multicomponent and prolonged, intervention programmes. Whilst these findings are generally consistent across the systematic reviews appraised, it should be noted that this consistency - in part - is due to the overlap of studies appraised in the reviews considered.

The increases in fruit and vegetable intake demonstrated in some studies, whilst statistically significant, are nevertheless relatively modest and often averaged around half a serving per day. The clinical significance of such increases and their maintenance over the longer term needs to be demonstrated. Addressing methodological limitations discussed above would also increase confidence in, and the usefulness of, future research in this field.

The variability of study populations, interventions, and limited reporting make it difficult to determine what works where and what would be applicable in New Zealand. In particular, many studies have taken place in schools in the US and UK where school meals are provided or subsidized, and programmes have often targeted these in their interventions, as well as in measurement of behaviour change. Programme providers in New Zealand considering transferring programmes already implemented elsewhere need to bear in mind how these can be best adapted to suit features of their target community, resources and outcome priorities. Pilot testing, process evaluation and ongoing monitoring and follow-up are also crucial to determine programme fidelity and efficacy.

NOTE: Readers are reminded of the limitations of Technical Briefs compared to more rigorous and comprehensive full systematic reviews (see section titled “levels of evidence considered in Technical Briefs” at the beginning of this report).

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APPENDIX 1: LEVELS OF EVIDENCE

- Level I Evidence obtained from a systematic review (or meta-analysis) of relevant randomised controlled trials.
- Level II Evidence obtained from at least one randomised controlled trial.
- Level III. 1 Evidence obtained from pseudorandomised controlled trials (alternate allocation or some other method).
- 2 Evidence obtained from comparative studies (including a systematic reviews of such studies) with concurrent controls and allocation not randomised, cohort studies, case control studies or interrupted time series with a control group).
- 3 Evidence obtained from comparative studies with historical control, two or more single-arm studies or interrupted time series without a parallel control group.
- Level IV Evidence obtained from case series, either post-test or pretest/post-test.

APPENDIX 2: SEARCH STRATEGY

SEARCH STRATEGIES

Medline/Cochrane Central Register of Controlled Trials

- 1 nutrition/ (4635)
- 2 exp diet/ (28030)
- 3 exp food/ (114398)
- 4 child nutrition/ (1255)
- 5 exp FRUIT/ (11539)
- 6 exp VEGETABLES/ (18839)
- 7 or/1-6 (136906)
- 8 ed.fs. (40811)
- 9 health promotion/ (11189)
- 10 health education/ (8132)
- 11 healthy eating.tw. (429)
- 12 (intervention or program\$.tw. (160373)
- 13 Social Marketing/ (298)
- 14 or/8-13 (203376)
- 15 7 and 14 (9325)
- 16 limit 15 to english (8776)
- 17 program evaluation/ (11794)
- 18 "Outcome Assessment (Health Care)"/ (13572)
- 19 17 or 18 (24731)
- 20 16 and 19 (292)
- 21 child/ or adolescent/ or caregivers/ (349899)
- 22 20 and 21 (122)
- 23 randomized controlled trial.pt. (80519)
- 24 meta-analysis.pt. (7519)
- 25 randomized controlled trials/ or meta-analysis/ (28429)
- 26 controlled clinical trials/ or controlled clinical trial.pt. (17010)
- 27 exp clinical trials/ or clinical trial.pt. (213338)
- 28 random allocation/ or (random\$ adj2 allocat\$.tw. (18529)
- 29 single blind method/ or double blind method/ (32439)
- 30 (clinic\$ adj trial\$.tw. (44042)
- 31 ((singl\$ or doubl\$ or treb\$ or tripl\$) adj (blind\$ or mask\$ or dumm\$)).tw. (26326)
- 32 (systematic\$ adj3 (review\$ or overview)).tw. (7724)
- 33 (meta-analy\$ or metaanaly\$.tw. (9109)
- 34 exp review literature/ (1706)
- 35 (hand search\$ or relevant journals or manual search\$ or selection criteria or data extraction).ab.
(7857)
- 36 or/23-35 (265704)
- 37 letter.pt. (163464)
- 38 case report.tw. (35081)
- 39 (historical article or review of reported cases or review, multicase).pt. (61986)
- 40 or/37-39 (252839)
- 41 animal/ (894971)
- 42 human/ (2395850)
- 43 41 not (41 and 42) (597518)
- 44 36 not (40 or 43) (243403)
- 45 exp epidemiologic studies/ (354709)
- 46 exp case control studies/ (145875)
- 47 exp cohort studies/ (208035)
- 48 cross-sectional studies/ (32774)
- 49 (case control or cohort analy\$ or cross sectional).tw. (46108)
- 50 (longitudinal or retrospective).tw. (78207)
- 51 (cohort adj (study or studies)).tw. (15261)
- 52 ((follow up or observational) adj (study or studies)).tw. (14526)

- 53 or/45-52 (391248)
- 54 16 and (53 or 44) (2964)
- 55 54 and 21 (705)
- 56 22 or 55 (772)
- 57 limit 56 to yr=2000-2005 (697)
- 58 (letter or news).pt. (210844)
- 59 57 not 58 (695)
- 60 exp africa/ (29695)
- 61 exp asia/ or china/ (87081)
- 62 60 or 61 (115126)
- 63 59 not 62 (586)

Embase

- 1 nutrition/ (11832)
- 2 exp Diet/ (26598)
- 3 child nutrition/ (2219)
- 4 exp food/ (105540)
- 5 exp fruit/ or exp vegetable/ (29797)
- 6 or/1-5 (134249)
- 7 health promotion/ (14013)
- 8 health education/ (12912)
- 9 social marketing/ (79)
- 10 healthy eating.mp. (403)
- 11 (intervention or program\$.tw. (194102)
- 12 education\$.tw. (61429)
- 13 social marketing.tw. (178)
- 14 or/7-13 (250062)
- 15 Child/ (160268)
- 16 Adolescent/ (209829)
- 17 caregiver/ (8634)
- 18 or/15-17 (296358)
- 19 6 and 14 and 18 (1523)
- 20 limit 19 to yr=2000-2005 (1096)
- 21 limit 20 to english (961)
- 22 clinical trial/ (287741)
- 23 randomized controlled trial/ (86813)
- 24 randomization/ (14697)
- 25 single blind procedure/ or double blind procedure/ (43019)
- 26 crossover procedure/ (12866)
- 27 placebo/ (43197)
- 28 (randomized controlled trial\$ or randomised controlled trial\$.tw. (15729)
- 29 rct.tw. (1105)
- 30 (random\$ adj2 allocat\$.tw. (5908)
- 31 ((singl\$ or doubl\$ or tripl\$ or trebl\$) adj (blind\$ or mask\$ or dummy)).tw. (38351)
- 32 prospective study/ (43167)
- 33 case study/ (1866)
- 34 case report.tw. (50107)
- 35 abstract report/ or letter/ (186160)
- 36 or/33-35 (237078)
- 37 or/22-32 (347199)
- 38 37 not 36 (336182)
- 39 exp meta-analysis/ (20309)
- 40 (meta-analy\$ or metaanaly\$.tw. (10712)
- 41 (systematic\$ adj3 (review\$ or overview)).tw. (8200)
- 42 (reference list\$ or manual search\$ or hand search\$ or relevant journals or bibliograph\$.tw. (5081)
- 43 (data extraction or selection criteria or medline or embase or cinahl or psychlit or psychinfo).ab. (15141)
- 44 review.pt. (473044)

45 or/39-44 (496073)
 46 (letter or editorial).pt. (297993)
 47 animal/ (841)
 48 human/ (2676407)
 49 47 not (47 and 48) (478)
 50 46 or 49 (298446)
 51 45 not 50 (493962)
 52 clinical study/ (6046)
 53 case control study/ (10321)
 54 family study/ (3770)
 55 longitudinal study/ (9730)
 56 retrospective study/ (53429)
 57 prospective study/ (43167)
 58 cohort analysis/ (27164)
 59 (cohort adj (study or studies)).mp. (18488)
 60 (case control adj (study or studies)).mp. (19704)
 61 (observational adj (study or studies)).tw. (9185)
 62 (epidemiologic\$ adj (study or studies)).tw. (16881)
 63 (follow up adj (study or studies)).tw. (9870)
 64 (cross sectional adj (study or studies)).tw. (12591)
 65 or/52-64 (195599)
 66 38 or 51 or 65 (883391)
 67 21 and 66 (392)
 68 67 not 36 (392)
 69 exp africa/ or exp asia/ (117954)
 70 china/ (9863)
 71 68 not (69 or 70) (320)

Cinahl

1 Nutrition/ (4517)
 2 child nutrition/ (1801)
 3 adolescent nutrition/ (432)
 4 exp Diet/ (13982)
 5 exp Food/ (19081)
 6 exp Fruit/ (2068)
 7 exp Vegetables/ (2609)
 8 or/1-7 (31846)
 9 Health Promotion/ (10136)
 10 exp health education/ or health fairs/ or exp nutrition education/ (37446)
 11 ed.fs. (45975)
 12 (intervention or program\$).tw. (85724)
 13 social marketing.mp. (178)
 14 or/9-13 (149339)
 15 Child/ (74340)
 16 adolescents/ (65945)
 17 Caregivers/ (5673)
 18 parents/ (8273)
 19 or/15-18 (121051)
 20 8 and 14 and 19 (1272)
 21 limit 20 to english (1260)
 22 limit 21 to yr=2000-2005 (780)
 23 limit 22 to abstracts (498)
 24 exp africa/ or exp asia/ (28743)
 25 23 not 24 (446)
 26 exp clinical trials/ (33928)
 27 clinical trial.pt. (15497)
 28 (clinic\$ adj trial\$).tw. (7961)
 29 ((singl\$ or doubl\$ or trebl\$ or tripl\$) adj (blind\$ or mask\$)).tw. (4820)
 30 randomi?ed control\$ trial\$.tw. (6736)

- 31 random assignment/ (11287)
- 32 random\$.af. (72458)
- 33 quantitative studies/ (2463)
- 34 meta-analysis/ (4403)
- 35 (meta analy\$ or metaanaly\$).tw. (2741)
- 36 exp literature review/ (4368)
- 37 (systematic\$ adj (review\$ or overview)).tw. (5134)
- 38 or/26-37 (96208)
- 39 prospective studies/ (42525)
- 40 exp case control studies/ (9789)
- 41 correlational studies/ (6271)
- 42 nonconcurrent prospective studies/ (14)
- 43 cross sectional studies/ (14772)
- 44 (cohort adj (study or studies)).tw. (4187)
- 45 (observational adj (study or studies)).tw. (1836)
- 46 or/39-45 (70404)
- 47 letter.pt. (30093)
- 48 Animals/ (555)
- 49 47 or 48 (30628)
- 50 38 not 49 (95039)
- 51 46 not 49 (70011)
- 52 25 and (50 or 51) (186)

Psychinfo

- 1 nutrition/ (994)
- 2 exp diets/ (1301)
- 3 exp food/ (1311)
- 4 (fruit\$ or vegetable\$).tw. (1853)
- 5 or/1-4 (4698)
- 6 exp health education/ (2078)
- 7 health promotion/ (2400)
- 8 healthy eating.tw. (167)
- 9 (intervention or program\$).mp. (60895)
- 10 social marketing.mp. (126)
- 11 education.tw. (33386)
- 12 or/6-11 (85814)
- 13 limit 12 to (180 school age <age 6 to 12 yrs> or 200 adolescence <age 13 to 17 yrs>) (16961)
- 14 5 and 12 (1155)
- 15 limit 14 to (180 school age <age 6 to 12 yrs> or 200 adolescence <age 13 to 17 yrs>) (251)
- 16 limit 15 to all journals (219)

APPENDIX 3: APPRAISED PAPERS

Ammerman, A. S., Lindquist, C. H., Hersey, J., Jackman, A. M., Gavin, N. I., Garces, C., Lohr, K. N., et al. (2001). *The efficacy of interventions to modify dietary behavior related to cancer risk*. AHRQ Publication No. 01-E029. Bethesda, MD: Agency for Healthcare Research and Quality(AHRQ).

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Bautista-Castano, I., Doreste, J., & Serra-Majem, L. (2004). Effectiveness of interventions in the prevention of childhood obesity. *European Journal of Epidemiology*, 19, 617-622.

Ciliska, D. (2004). Interventions to improve nutritional intake in children and youth. In H. Thomas, D.

Ciliska, S. Micucci, J. Wilson-Abra, M. Dobbins & J. Dwyer (Eds.), *Effectiveness of physical activity enhancement and obesity prevention programs in children and youth*. Hamilton, Ont.: Effective Public Health Practice Project. Available from:

<http://old.hamilton.ca/phcs/ephpp/Research/Summary/2004/HealthyWeightsFull2004.pdf>

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Ciliska, D., Miles, E., O'Brien, M. A., Turl, C., Tomasik, H. H., Donovan, U., & Beyers, J. (2000). Effectiveness of community-based interventions to increase fruit and vegetable consumption. *Journal of Nutrition Education* 32, 341-352.

French, S. A., & Stables, G. (2003). Environmental interventions to promote vegetable and fruit consumption among youth in school settings. *Preventive Medicine*, 37, 593-610.

Summerbell, C. D., Waters, E., Edmunds, L. D., Kelly, S., Brown, T., & Campbell, K. J. (2005). Interventions for preventing obesity in children. *Cochrane Database of Systematic Reviews*.

Thomas, H. (2004). Interventions to increase physical activity and nutritional intake in children and youth. In H. Thomas, D. Ciliska, S. Micucci, J. Wilson-Abra, M. Dobbins & J. Dwyer (Eds.), *Effectiveness of physical activity enhancement and obesity prevention programs in children and youth*. Hamilton, Ont.: Effective Public Health Practice Project. Available from:

<http://old.hamilton.ca/phcs/ephpp/Research/Summary/2004/HealthyWeightsFull2004.pdf> Accessed on 19.12.05.