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Interventions for increasing fruit and vegetable consumption in children aged 5 years and under (Review)

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[Intervention Review]

Interventions for increasing fruit and vegetable consumption in children aged 5 years and under

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A B S T R A C T

Background

Insufficient consumption of fruits and vegetables in childhood increases the risk of future chronic diseases including cardiovascular disease.

Objectives

To assess the effectiveness, cost-effectiveness and associated adverse events of interventions designed to increase the consumption of fruit and/or vegetables amongst children aged five years and under.

Search methods

The Cochrane Central Register of Controlled Trials (CENTRAL) in *The Cochrane Library* Issue 2, 2010, MEDLINE (1950 to 2010 April week 4), EMBASE (1947 to 2010 week 18), CINAHL (up to 12 May 2010), PsycINFO (up to 12 May 2010) and *Proquest Dissertations and Theses* (up to February 2011) were searched to identify eligible trials, as well as electronic trial registers (also up to February 2011). The reference lists of included trials were reviewed and handsearches of three international nutrition journals were also performed. Authors of all included trials were contacted in order to identify further potentially relevant trials.

Selection criteria

We included randomised controlled trials (RCTs), including cluster-randomised controlled trials, of any intervention primarily targeting fruit and/or vegetable consumption among children aged five years and under and incorporating a biochemical or dietary assessment of fruit and/or vegetable consumption. Two review authors independently screened the titles and abstracts of identified papers. A third review author with expertise in review methodology resolved any disagreements regarding study eligibility.

Data collection and analysis

Two review authors independently extracted data and assessed the risk of bias of the included studies. A third reviewer resolved disagreements between review authors. Fixed-effect models were used to perform meta-analysis for the primary review outcomes where a sufficient number of trials with suitable data and homogeneity were identified.

Main results

Five trials, with 13 trial arms and 3967 participants were included in the review. Two trials examined the impact of specific feeding practices (e.g. repeated food exposure) in increasing child intake of a target vegetable. Two trials assessed the effectiveness of home visiting programs implemented in disadvantaged communities and one trial investigated the effect of a preschool-based intervention in increasing child fruit and vegetable intake. Risk of bias of included studies was low although three of the five trials were judged to be at high risk of performance bias. Meta-analysis of two trials examining repeated food exposure versus a no intervention comparison found no significant difference in target vegetable consumption in the short term (mean difference (MD) 1.37, 95% confidence interval (CI) -2.78 to 5.52). Coupling repeated food exposure with a tangible non-food or social reward, was effective in increasing targeted vegetable consumption in the short term based on one trial. Home visiting programs provided to disadvantaged groups did not significantly increase overall fruit intake in the short term (standardised mean difference (SMD) 0.01, 95% CI -0.09 to 0.11). Similarly, a multi-component preschool-based intervention failed to significantly increase child consumption of vegetables, but did report a small significant increase in mean child consumption of fruit, six months following baseline assessment. None of the trials investigated intervention cost-effectiveness or reported information regarding any adverse events or unintended adverse consequences of the intervention.

Authors' conclusions

Despite the importance of encouraging fruit and vegetable consumption among children aged five years and under, this review identified few randomised controlled trials investigating interventions to achieve this.

PLAIN LANGUAGE SUMMARY

Interventions for increasing fruit and vegetable consumption in children aged 5 years and under

Insufficient fruit and vegetable consumption represents a considerable health burden in developed countries. Consumption of fruit and vegetables is associated with reductions in the risk of future chronic disease. Early childhood represents a critical period for the establishment of child dietary habits. Interventions to increase consumption of fruit and vegetables in early childhood may, therefore, represent an effective strategy in reducing the disease burden associated with insufficient fruit and vegetable intake. The aim of this review was to assess the impact of interventions designed to increase the consumption of fruit and/or vegetables among children aged five years and under. To identify relevant studies, we searched a variety of electronic bibliographic databases and relevant journals, and considered studies cited by trials included in the review. We also contacted the authors of included trials and asked if they knew of other trials which may be relevant. Any randomised trial of an intervention which primarily sought to increase the fruit and/or vegetable intake of children five years of age and under, and included a dietary or biochemical assessment of consumption, was eligible. Two reviewers independently searched for and extracted relevant information from trials included in the review. Overall, 10,740 citations were examined yielding five trials with 3967 participants which met the review eligibility criteria and were included in the review. Of the five trials, two examined child feeding interventions, two examined home visiting interventions and one examined the impact of a preschool-based intervention. The findings of the included studies suggest that repeatedly exposing children to a target vegetable does not significantly increase short-term (< three months) child consumption of the target vegetable. One trial which examined coupling repeated food exposure with a tangible non-food, or social reward, found that such strategies were effective in increasing short-term (< three months) targeted vegetable consumption. Home visiting interventions were found to be ineffective in increasing child consumption of fruit and/or vegetables overall. Although the preschool-based intervention failed to significantly increase vegetable consumption, a small significant increase in mean child consumption of fruit was reported. The review highlights the paucity of randomised trials of fruit and vegetable interventions for children of this age, and the lack of effective interventions evaluated using such designs available to health policy makers and practitioners.

BACKGROUND

Description of the condition

Chronic diseases are illnesses which are typically prolonged in duration, do not resolve spontaneously and are rarely cured completely (Australian Institute of Health and Welfare 2002). Insufficient consumption of fruits and vegetables is associated with a range of chronic diseases such as cancer and cardiovascular disease (World Health Organization 2003; World Health Organization 2011). Globally, 2.9% of all deaths and 1.1% of all disability-adjusted life years (DALYs) each year are attributable to inadequate fruit and vegetable intake (World Health Organization 2009). Low fruit and vegetable consumption is responsible for 11% of all ischaemic heart disease and 9% of all stroke deaths (World Health Organization 2009). Increasing global fruit and vegetable intake, therefore, represents a public health priority and has the capacity to reduce the burden of coronary heart disease by 31% (Lock 2005).

Consumption of at least 400 grams per day of fruit and vegetables is recommended to reduce the risk of chronic diseases (World Health Organization 1997). Nationally representative surveys, however, indicate that throughout most regions of the globe, daily consumption of fruits and vegetables is well below such recommendations (Lock 2005).

Population surveys of children indicate the need to increase the intake of fruits and vegetables (Lock 2005; World Health Organization 2004a; Yngve 2005). For example, less than a third of school-aged children from European nations report consuming vegetables on a daily basis (World Health Organization 2004a). While the mean intake of fruit and vegetables is below the WHO recommendations across all WHO regions, South American, African, and South East Asian nations report the lowest quantities of child fruit and vegetable intake, where school-aged children typically consume less than 300 grams per day (Lock 2005).

Longitudinal studies suggest that eating behaviours established in childhood are likely to persist into adulthood (Lien 2001; Mikkilä 2004). Encouraging healthy eating among children may, therefore, represent a particularly effective primary prevention strategy for reducing the risk of chronic diseases (Maynard 2003; Ness 2005). Thirty seven year follow-up data from the Boyd Orr cohort study of British children, for example, found lower rates of all cause cardiovascular mortality among children with greater intake of vegetables in childhood (Ness 2005). In addition, adequate fruit and vegetable intake during childhood may have a number of immediate beneficial impacts, including reducing the risk of micro-nutrient deficiencies and a number of respiratory illnesses (Antova 2003; Forastiere 2005; World Health Organization 2003).

Description of the intervention

The aetiology of fruit and vegetable consumption is complex, involving the dynamic interaction of a variety of factors. Given such complexity, a number of frameworks have been utilised to guide the development of interventions to increase fruit and vegetable intake (Klepp 2005; Miller 2000; World Health Organization 2004b). The conceptual framework developed for the international Pro Children Project suggests that interventions targeting a variety of cultural, physical and social environment factors, as well as those targeting personal factors may be effective in positively influencing fruit and vegetable intake among children (Klepp 2005).

Despite the range of potential intervention targets, previous trials have tended to focus on those determinants more amenable to intervention, such as nutrition knowledge and skills, or the food environment of settings such as schools (Hector 2008). Among school-aged children, systematic reviews suggest that the strongest evidence exists for the efficacy of interventions specifically targeting fruit and vegetable consumption rather than broader healthy eating interventions, multi-component school-based interventions, and interventions incorporating a parent or family element (Blanchette 2005; Burchett 2003; Ciliska 2000; French 2003; Knai 2006). Similar strategies would be hypothesised to be effective for children aged five years and under.

How the intervention might work

A number of theories have been used to explain a mechanism by which interventions may be able to influence fruit and vegetable consumption of children (Rasmussen 2006). In most instances, psychosocial theories such as Social Cognitive Theory (Bandura 1986), the Theory of Planned Behaviour (Ajzen 1991), or the Stages of Change Trans-theoretical Model (Prochaska 1984) have been used to explain possible causal pathways to fruit and vegetable consumption (Rasmussen 2006). Collectively, such theories assert that changes to attitudes, knowledge and skills and perceived norms and expectancies are required for behavioural change. The international Pro Children Project incorporated Social-Ecological Theory in its conceptual theoretical framework of determinants of children's fruit and vegetable consumption (Klepp 2005). Interventions derived from Social-Ecological Theory recognise the importance of more structural influences on the fruit and vegetable consumption of children, for example, the availability or accessibility of fruit and vegetables in the home or in settings such as schools which children frequent.

Why it is important to do this review

Previous reviews have identified a number of factors associated with fruit and vegetable consumption among children (Blanchette 2005; Pearson 2008; Rasmussen 2006; van der Horst 2007). While such reviews provide important information for the development of interventions, only systematic reviews of intervention trials are able to determine the efficacy of strategies to increase child fruit and vegetable consumption. A number of such reviews have been published (Burchett 2003; Ciliska 2000; Delgado-Noguera 2011; French 2003; Howerton 2007; Knai 2006). However, few have included children aged five years and under, and most lacked important information relevant to practice, such as the effectiveness of interventions for various subpopulations (such as minority groups), the cost-effectiveness of interventions, or the presence of any unintended adverse effects of the intervention. Similarly, as positive impacts of health behaviour interventions may not be sustained, an examination of the longer-term (> 12 months post-intervention) effectiveness of interventions is important for policy makers and practitioners to assess the potential health benefit of fruit and vegetable intervention (Fjeldsoe 2011; Jones 2011). Previous reviews have not specifically examined the impact of interventions based on the length of post-intervention follow-up. Therefore, a comprehensive systematic review on this issue is required to provide guidance for practitioners and policy makers interested in implementing strategies to

promote the consumption of fruits and vegetables in early childhood.

OBJECTIVES

To assess the effectiveness, cost-effectiveness and associated adverse events of interventions designed to increase the consumption of fruit and/or vegetables among children aged five years and under.

METHODS

Criteria for considering studies for this review

Types of studies

Eligible trials were randomised controlled trials (RCTs), including cluster-randomised controlled trials, that were published in a peer reviewed journal and that:

1. compared two or more alternative intervention programs to increase the consumption of fruit and/or vegetables of children aged five years and under; or

2. compared an intervention program to increase the consumption of fruit and/or vegetables of children aged five years and under with a standard care or no intervention control group.

Randomised trials which did not include fruit or vegetable intake as the primary trial outcome were excluded.

Types of participants

Participants could include:

1. children aged five years and under. Trials including children older than five years were included only if the mean age of the study sample at baseline was five years or less;

2. parents, guardians and families responsible for the care of children aged five years and under;

3. professionals responsible for the care of children aged five years and under including childcare staff and health professionals.

Types of interventions

Any educational, experiential, health promotion and/or psychological or family or behavioural therapy or counselling or management or structural or policy or legislative reform interventions designed to increase fruit and/or vegetable consumption in children aged five years and under (as defined in types of participants) were considered for inclusion. Interventions could be conducted in any setting including the home, childcare/preschool services, health services, or community settings.

Comparison: Any alternate intervention to encourage fruit and vegetable consumption as described above, or a no intervention control or attention control or wait-list control.

Types of outcome measures

Studies with evaluated outcomes measuring biomedical and/or dietary indices were included.

Primary outcomes

The primary outcome was fruit and vegetable intake. Fruit and vegetable intake could be assessed using a variety of measures including:

a) Change in the number of portions or serves of daily fruit and/or vegetable intakes at follow-up as measured by diet recalls, food diaries, food frequency questionnaires or diet records completed by an adult on behalf of the child. Short-term effects (< 12 months post-intervention) and long-term effects (at least 12 months post-intervention) were included.

b) Change in grams of fruit and/or vegetable intakes at follow-up as measured by diet recalls, food diaries, food frequency questionnaires or diet records completed by an adult on behalf of the child. Short-term effects (< 12 months post-intervention) and long-term effects (at least 12 months post-intervention) were included.

c) Changes in biomedical markers of fruit and/or vegetable consumption, such as α-carotene, β-carotene, cryptoxanthin, lycopene and lutein. Short-term effects (< 12 months post-intervention) and long-term effects (at least 12 months post-intervention) were included.

Secondary outcomes

a) Estimates of absolute costs and cost-effectiveness of interventions to increase the consumption of fruits and/or vegetables reported in identified studies were included.

b) Any reported adverse events of an intervention to increase the consumption of fruits and vegetables reported in identified studies were included. This could include any physical, behavioural, psychological or financial impact on the child, parent or family, or the service or facility where an intervention may have been implemented.

Search methods for identification of studies

We obtained relevant trials published in any language via searches of electronic bibliographic databases, dissertations, handsearching of relevant journals, and following direct communication with authors of included studies.

Electronic searches

We searched electronic databases including the Cochrane Central Register of Controlled Trials (CENTRAL) in *The Cochrane Library* Issue 2, 2010, MEDLINE (1950 to 2010 April week 4), EMBASE (1947 to 2010 week 18), CINAHL (up to 12 May 2010) and PsycINFO (up to 12 May 2010). The search strategies are described in Appendix 1.

Searching other resources

We searched the reference lists of relevant articles and performed a handsearch of all articles published between 2006 and October 2010 in three relevant international peer reviewed journals (*Journal of Nutrition Education and Behavior, Public Health Nutrition,* and *Journal of the American Dietetic Association*).

We searched the metaRegister of clinical trials, www.controlled-trials.com/mrct/, (up to February 2011) and the WHO International Clinical Trials Registry Platform, www.who.int/ictrp/, (up to February 2011). Databases of published dissertations *(Proquest*

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Dissertations and Theses) were searched (up to February 2011) to identify and contact key authors in an attempt to obtain trials published in peer reviewed journals as well as ongoing trials. Ongoing studies are described, where available, detailing the primary author, research question(s), methods and outcome measures.

Data collection and analysis

Selection of studies

Two review authors (FS and RH) independently screened titles and abstracts of identified papers. Review authors were not blind to the details of the study author or journal. Review authors applied a standardised screening tool to assess eligibility. Papers were screened against the eligibility criteria for the review in a sequential manner, and a paper was excluded based on the first reason for exclusion (order: Participants, Outcome, Comparator, Intervention, RCT). Based on the paper's title and abstract, papers which clearly did not meet the eligibility criteria of the review were excluded. Two review authors (RH and FS) then independently examined the full text of all remaining papers. Information regarding the reason for ineligibility of any paper for which the full text was reviewed was documented and is presented in the table 'Characteristics of excluded studies'. A third review author with expertise in review methodology (LW) resolved any disagreement between review authors (FS and RH) regarding study eligibility. For those papers which did not provide sufficient information to determine eligibility, we contacted the study authors for clarification.

Data extraction and management

Two review authors (RW and BB or EJ) independently extracted data from each included trial. Review authors were not blind to the details of the study author or journal. Data were recorded on data extraction forms designed and piloted specifically for this review. Consultation with a third review author with expertise in review methodology (LW) resolved discrepancies between review authors (RW and BB or EJ) regarding data extraction. Attempts were made to contact authors of included papers in instances where the information required for data extraction was not available from the published report, or was unclear. One review author transcribed extracted data into the systematic review software 'Review Manager'. Where available, the following information was extracted from included trials:

1. Information on the study, research design and methods such as: the study authors; date of publication; date of study initiation; study duration; setting; number of participants; participants' age, gender, ethnicity, and socioeconomic position; sequence generation; allocation concealment; blinding of participants, personnel and outcome assessors; and other concerns regarding bias.

2. Information on the experimental conditions of the trial such as the number of experimental conditions; and intervention and comparator components, duration, number of contacts, modalities, interventionist and integrity.

3. Information on the trial outcomes and results such as rates of recruitment and attrition; sample size; number of participants per experimental condition; mean and standard deviation of the primary or secondary outcomes described above;

any subgroup analyses by gender, population group or intervention characteristics; and incomplete outcome data.

Assessment of risk of bias in included studies

Two review authors independently assessed the risk of bias in the included studies (RW and BB or EJ). A third review author with expertise in review methodology was consulted to resolve any disagreements between review authors (LW). Authors used the tool outlined in the *Cochrane Handbook for Systematic Reviews of Interventions* (Higgins 2011) to assess the risk of bias. The tool requires an explicit judgement by the review authors, based on trial information, regarding the risk of bias attributable to the generation of the random sequence, the allocation concealment, the blinding of participants, personnel and outcome assessors, the completeness of outcome data, selective reporting and any other potential threats to validity. Judgements regarding the risk of bias for each trial were recorded in the 'Risk of Bias' table accompanying the review.

Measures of treatment effect

Where meta-analyses were performed, the intervention effect was expressed as a mean difference where outcomes were reported using a standard metric (such as grams) and as a standardised mean difference where outcomes were reported using different methods or metrics of fruit and vegetable intake.

Unit of analysis issues

Cluster randomised trials in the review were assessed for unit of analysis error.

Dealing with missing data

Where available, outcomes of trials reporting an intention-to-treat analysis were reported. Sensitivity analyses to explore the impact on the overall assessment of treatment effects of the inclusion of trials not reporting an intention-to-treat analysis, with high rates of participant attrition or with other missing data, were not performed given meta-analyses were only conducted on data pooled from two trials.

Assessment of heterogeneity

Statistical heterogeneity was assessed via visual inspection of forest plots of the included trials and using the I^2 statistic where data from included trials could be pooled. Examination of the trial characteristics (participants, design, interventions, outcomes and risk of bias) was also performed to identify the source of heterogeneity.

Assessment of reporting biases

Assessment of reporting bias was difficult given the heterogeneity of the included trial interventions and the limited number of included trials, precluding visual inspection of the funnel plots.

Data synthesis

Trial outcomes were assessed using a variety of dietary assessment tools and were reported in various metrics - including vitamin C from fruit, fruit or vegetable serves - and grams. We used fixed-effect models to perform meta-analysis. Meta-analysis was performed using the 'Review Manager' software. We did not conduct meta-analysis where a high level of heterogeneity was

evident. In instances where data could not be combined in a meta-analysis, we have provided a narrative summary of the trial findings according to the review objectives.

Subgroup analysis and investigation of heterogeneity

The impact of interventions for the following subgroups were summarised narratively:

1. interventions targeting boys and girls;

2. interventions targeting minority groups including indigenous populations;

3. interventions delivered in various settings including health and children's services;

4. interventions of varying intensities defined in terms of the number and duration of intervention contacts or components;

5. interventions delivered in different modes such as via telephone, the Internet or face-to-face.

Sensitivity analysis

Sensitivity analyses could not be conducted as meta-analysis was performed on data pooled from just two trials.

R E S U L T S

Description of studies

See: Characteristics of included studies; Characteristics of excluded studies; Characteristics of ongoing studies.

Results of the search

The searches generated 10,740 citations. Screening of titles and abstracts identified 145 papers for formal inclusion or exclusion. (See Figure 1). Of these, five trials (Cooke 2011; Haire-Joshu 2008; Vereecken 2009; Wardle 2003a; Watt 2009) met the inclusion criteria. All authors of included trials were contacted to provide information to facilitate assessment of risk of bias or to permit meta-analysis. All authors responded to requests for such information.

Figure 1. Study flow diagram.

Figure 1. (Continued)

Published protocols (potentially eligible) N = 5; Unable to be located N = 2; Unpublished protocols, no response from authors N = 19; Potentially eligible dissertation but unable to locate N = 1.

145 full-text articles assessed for eligibility

5 studies (in 6 papers) excluded at data extraction stage.

No aim to increase fruit and vegetables N = 3

No explicitly stated fruit or vegetable outcome N = 1
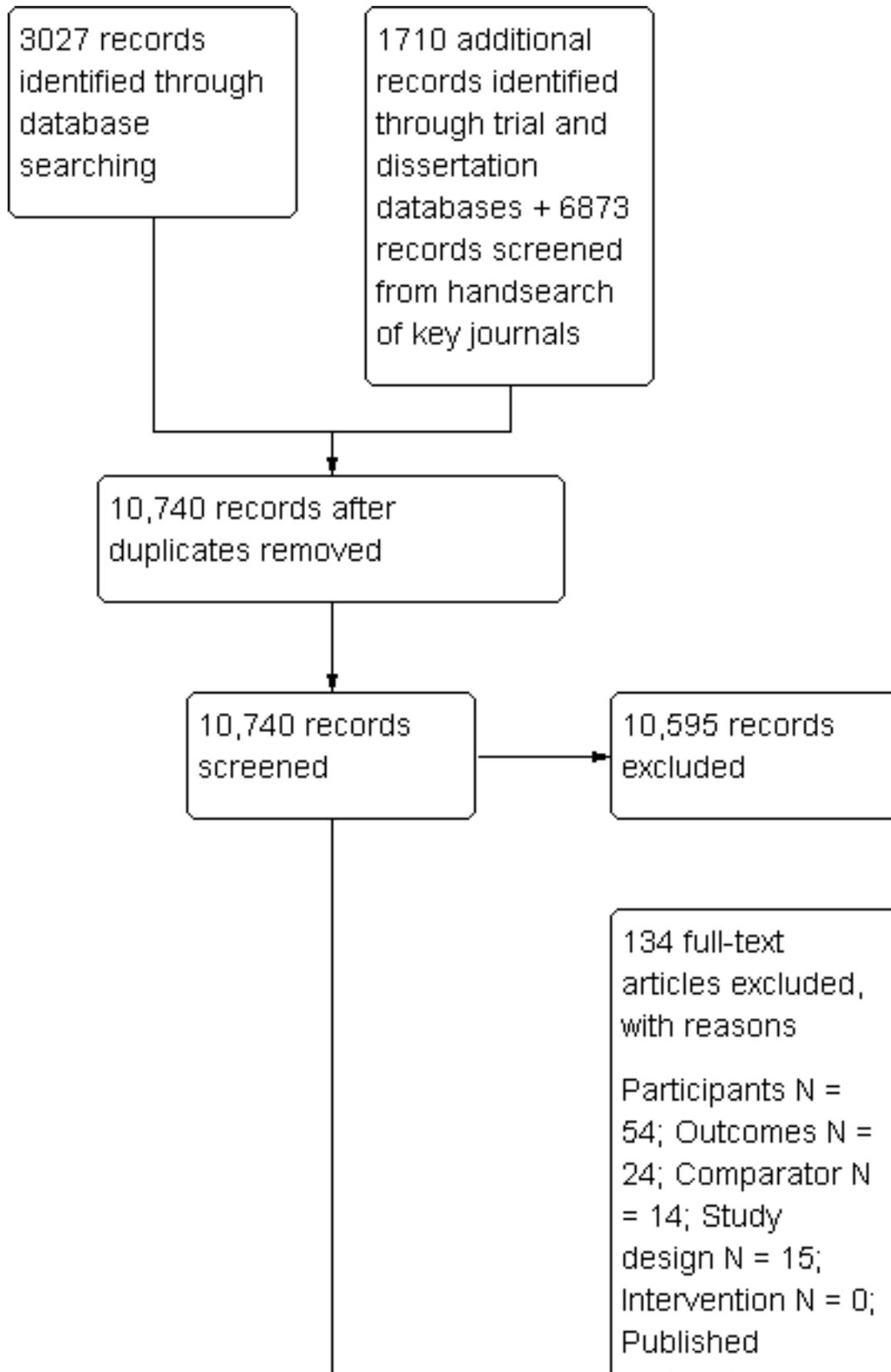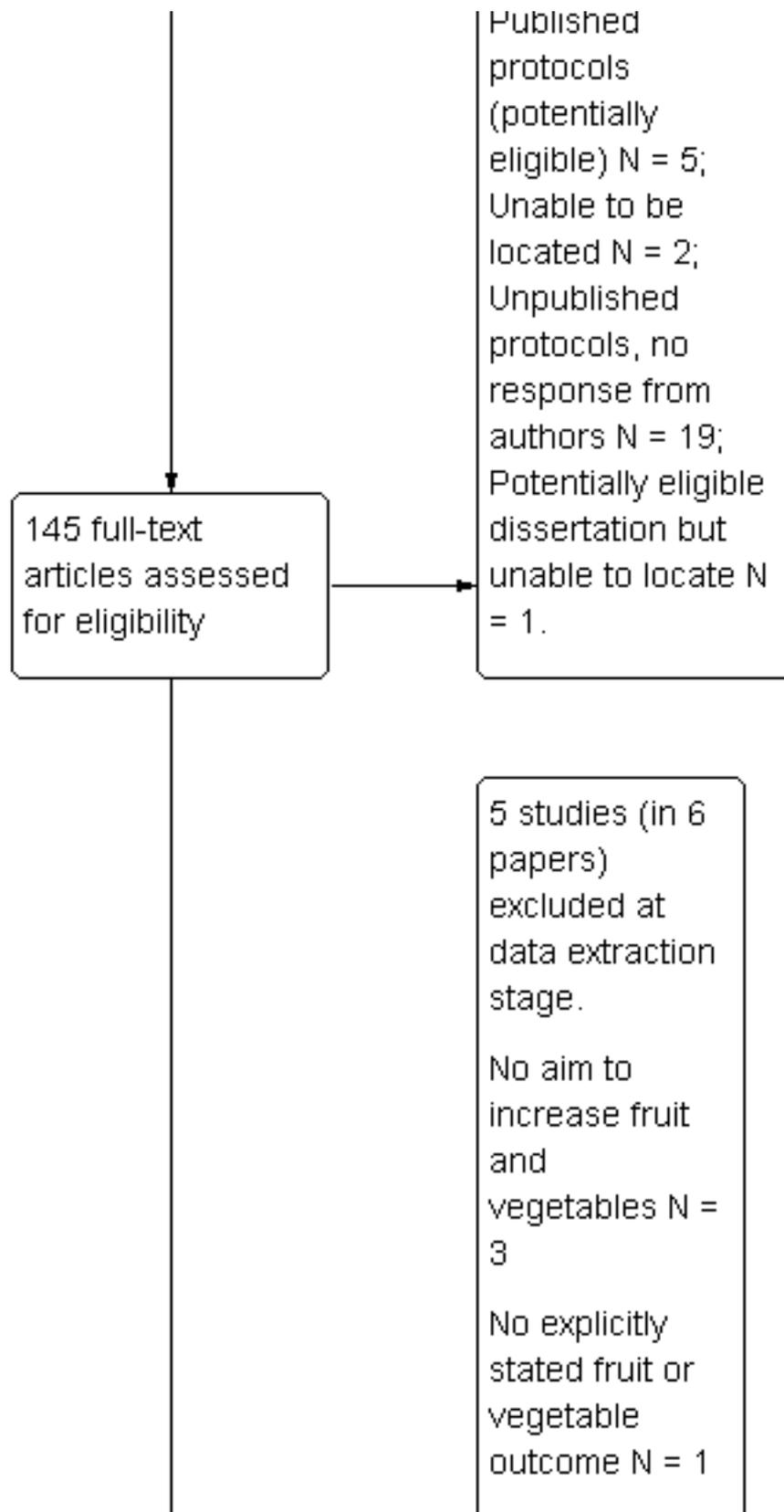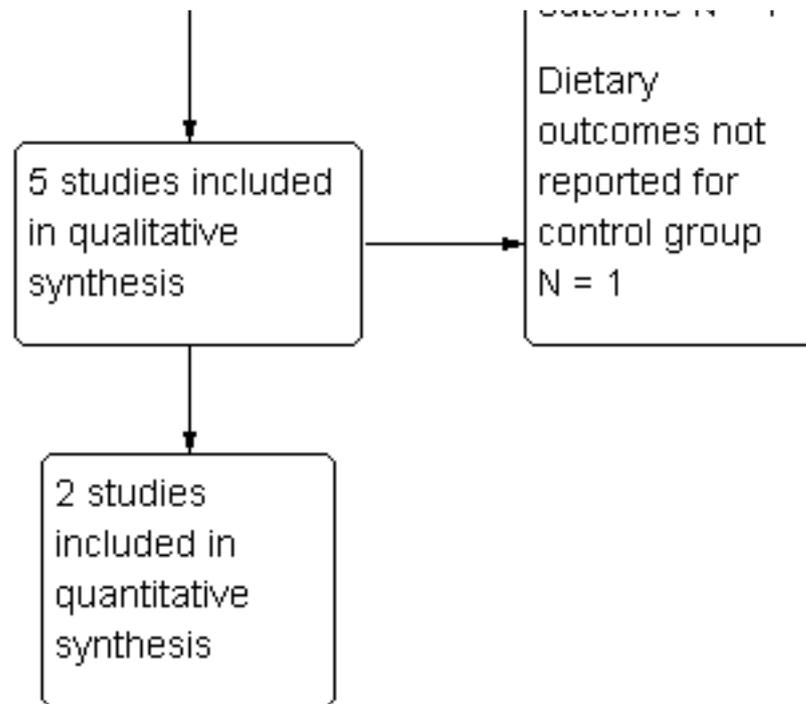
Figure 1. (Continued)

Included studies

There were 13 trial arms with 3967 participants randomised across the five included trials. A description of these trials appears in the Characteristics of included studies table. Two trials, both conducted in the UK examined the immediate or short-term (< 12 month) impact of specific feeding practices in increasing children's intake of a target vegetable (Cooke 2011; Wardle 2003a). Cooke and colleagues randomised 16 school classes of children aged four to six years to one of four conditions. First, 12 exposures over three weeks to a target vegetable coupled with a tangible non-food reward (sticker) if a child tasted the vegetable; second, exposure coupled with a social reward (praise) if a child tasted the vegetable; third, exposure alone; or fourth, a no treatment control (Cooke 2011). Intake of the target vegetable was assessed using electronic scales (grams) as part of a free-choice ad libitum consumption task at baseline, immediately post-intervention, and one and three months post-intervention.

The second UK trial randomised 156 children aged two to six years and their parents into one of three experimental conditions (Wardle 2003a) including, repeated exposure to a target vegetable over 14 consecutive days, nutrition information, and a no treatment control. Intake of the target vegetable was assessed pre-intervention and approximately two weeks later using electronic scales measuring the weight of vegetable on the plate before and after ad libitum consumption.

Two studies tested the impact of home visiting programs implemented in disadvantaged communities (Haire-Joshu 2008; Watt 2009). Watt and colleagues recruited 312 mothers of babies from baby clinics serving disadvantaged areas of London (Watt 2009). In addition to standard health service support, mothers were randomised to receive an intervention consisting of monthly home visits from when the infant was aged 3 to 12 months. Home

visits were delivered by trained volunteers who provided practical and non-judgemental support on infant feeding practices with an emphasis on the importance of fruit and vegetable consumption. Mothers allocated to the control group received standard health professional support only (e.g. health visitors and GPs). Baseline data were collected when infants were 10 weeks old, with follow-up data collected immediately post-intervention and six months post-intervention. The primary trial outcome, vitamin C from fruit, was calculated as part of a multiple pass 24 hour food recall and using data from a National Nutrition Survey.

High 5 for Kids (H5-KIDS) was a USA home visiting initiative designed to increase the fruit and vegetable intake of disadvantaged children aged two to five years (Haire-Joshu 2008) enrolled in a general parenting and child development program ('Parents as Teachers'). The parent educator delivered intervention focused on parental knowledge and modelling of fruit and vegetable intake, non-coercive feeding practices and the availability of fruit and vegetables, and consisted of a tailored newsletter, four home visits, print and audio-materials. Families allocated to the control group received only the core 'Parents as Teachers' program, consisting of home visits, on-site group activities and newsletters. Child fruit and vegetable intake was assessed via telephone using a Food Frequency Questionnaire 6 to 11 months after baseline.

One preschool-based intervention was included in the review. The Beastly Healthy at School intervention contained strategies to increase fruit and vegetable consumption targeting the child, parent and the school environment (Vereecken 2009). Children aged approximately three to five years of age attending eight Belgium preschools were randomised to receive the intervention, while children attending another eight preschools were allocated to the control. No details were provided regarding the nature of any support or any usual nutritional activities provided to

control preschools. Fruit and vegetable intake was assessed using a Food Frequency Questionnaire reported by parents at a six-month follow-up for 308 and 168 children allocated to intervention and control preschools, respectively.

Excluded studies

Following an assessment of study titles and abstracts, the full texts of 145 articles were sought for further review for study eligibility (Figure 1). Of these, the eligibility of 27 trials could not be established as the study had not been published or was only a protocol (N = 24), or could not be located (N = 3). One hundred and seven studies were considered ineligible following the trial screening process (Reasons for exclusion included Participants N = 54; Outcomes N = 24; Comparator N = 14; Intervention N = 0; Study design N = 15). Additionally, six studies (reporting the findings of five trials) were excluded at the point of data extraction given closer inspection of the eligibility criteria. Specifically, two studies, based on the same trial of an atherosclerosis prevention intervention, had no explicit aim to increase fruit and vegetable consumption of children despite reporting longitudinal fruit and vegetable consumption (Ruottinen 2008; Talvia 2006). A co-twin study reported by Faith and colleagues also did not aim to increase fruit and vegetable intake, rather, sought to test a methodological concept (Faith 2006). Similarly, an intervention described by Aboud and colleagues did not primarily aim to increase fruit and vegetable consumption and only assessed fruit and vegetable consumption post-hoc to describe the mechanism behind a change in weight status among study participants (Aboud 2008). Khoshnevisan and colleagues reported dietary outcomes for the intervention group only and was, therefore, excluded (Khoshnevisan 2004) and a study by Johnson and colleagues (Johnson 1993) was excluded as the outcome measure was not a quantity-based assessment of fruit and vegetable consumption.

Risk of bias in included studies

Random sequence generation

In four of the five studies, the randomisation sequence was generated by computer or random numbers tables (Cooke 2011; Haire-Joshu 2008; Vereecken 2009; Watt 2009) and the method of sequence generation in the remaining study (Wardle 2003a) was unclear.

Allocation

In two of the five studies (Wardle 2003a; Watt 2009), participant allocation was concealed from recruiters, thus representing a low risk of selection bias. The risk was unclear in two studies (Cooke 2011; Vereecken 2009), and was considered to be high in the remaining study (Haire-Joshu 2008) where recruiters were aware of participants' allocation as they were being recruited.

Blinding

Performance bias

In four of the five studies (Haire-Joshu 2008; Vereecken 2009; Wardle 2003a; Watt 2009) the intervention was delivered (at least in part) to parents who were not blinded to group allocation, and in three of these trials (Haire-Joshu 2008; Vereecken 2009; Watt 2009) parents also provided outcome data regarding their children's fruit and vegetable consumption. These three studies were determined to be at high risk of performance bias given the potential for

reported trial outcomes to be influenced by the parents' knowledge of group allocation. Two trials (Cooke 2011; Wardle 2003a) used an objective outcome measure (weight of vegetable consumed as assessed by electronic scales), and as such were deemed to have a low risk of performance bias, despite those delivering the intervention being aware of participant allocation.

Detection bias

In one trial (Vereecken 2009) children's fruit and vegetable consumption was reported by parents who were not blind to group allocation, and as such there was considered to be a potentially high risk of detection bias. In the other four trials (Cooke 2011; Haire-Joshu 2008; Wardle 2003a; Watt 2009), a third party (such as a research assistant or telephone interviewer) was used to collect data regarding children's fruit and vegetable consumption. In two of these trials (Haire-Joshu 2008; Watt 2009) outcome assessors were blind to allocation, representing a low risk of detection bias, while in the other two trials (Cooke 2011; Wardle 2003a) outcomes were objectively assessed (ad libitum consumption of a target vegetable was measured pre- and post-intervention), and even though outcome assessors were not blind to participant allocation, the risk that detection bias would influence trial outcomes was deemed to be low.

Incomplete outcome data

All studies had data missing at follow-up. Three studies were judged to have a low risk of attrition bias (Cooke 2011; Haire-Joshu 2008; Wardle 2003a) due to high retention rates (> 80%) which were similar across all groups. In two studies (Vereecken 2009; Watt 2009) there was judged to be a high risk of attrition bias due to high attrition rates at follow-up (Vereecken 45% to 47%; Watt 30% to 34%).

Selective reporting

One trial was prospectively registered with trial outcomes pre-specified (Watt 2009) and the reported outcomes matched those in the register, representing a low risk of reporting bias. For all other trials, there was insufficient information to determine risk of bias due to selective reporting.

Other potential sources of bias

There was little evidence of unit of analysis error. All cluster randomised trials either adjusted their analyses to take the effects of clustering into account (Cooke 2011; Vereecken 2009) and/or conducted tests to determine that adjustment was not required (Cooke 2011; Haire-Joshu 2008). Details regarding such analyses are provided in the Characteristics of included studies. The study by Wardle and colleagues (Wardle 2003a) conducted analyses using all available data as well as data from only those participants in the exposure arm who received at least 10 out of a possible 14 exposures. Meta-analysis was performed on the restricted sample of participants from the exposure arm (N = 34) as raw data for the full sample (N = 48) was not reported. No further sources of bias could be identified.

Effects of interventions

Primary outcome: Effectiveness of intervention in increasing the consumption of fruit and/or vegetables

All included trials reported the impact of the effectiveness of the intervention on a measure of child fruit or vegetable intake. Variability in the measurement and reporting of intervention effects as change from baseline or final value scores precluded statistical examination of heterogeneity. Nonetheless, examination of the interventions tested, trial settings and study populations suggested that the included trials were heterogeneous. Therefore, meta-analyses were conducted pooling data from trials where intervention, settings and study populations were considered similar. Otherwise, we have provided a narrative synthesis of trial findings.

The effects of interventions targeting child feeding practices were mixed (Cooke 2011; Wardle 2003a). Meta-analysis of 281 participants from two trials comparing repeated food exposure alone to no treatment (Cooke 2011; Wardle 2003a) revealed no overall intervention effect at the three month post-intervention follow-up (MD 1.37, 95% CI -2.78 to 5.52) (Analysis 1.1). The findings of the meta-analysis should be interpreted with caution as outcome data from both trials were positively skewed and were not transformed as part of pooled analyses. A single trial comparing repeated food exposures coupled with a tangible reward (sticker); or repeated food exposures coupled with a social reward (praise); with a no treatment control condition found significantly higher vegetable consumption (by up to approximately 30 grams) immediately post-intervention and at the one and three months post-intervention follow-up (Cooke 2011). Consumption among children in this trial receiving repeated food exposure plus tangible reward was also higher than among children receiving a repeated exposure alone immediately post-intervention and at one to three months post-intervention follow-up. Comparison between the two reward conditions revealed a significantly greater intake of the target vegetable among children receiving exposure plus tangible reward versus the exposure plus social reward immediately post-intervention but not at the later follow-up.

The trial by Wardle and colleagues also tested the provision of basic nutrition information to parents in one experimental arm (Wardle 2003a). This did not significantly increase mean target vegetable consumption immediately post-intervention.

Meta-analysis pooling final outcome data (< 12 months post-intervention) of 1518 participants from the two home visiting intervention trials revealed no significant increase in child consumption of fruit (SMD 0.01, 95% CI -0.09 to 0.11) (Analysis 2.1) (Haire-Joshu 2008; Watt 2009). While the trial conducted by Watt and colleagues (Watt 2009) failed to find greater consumption of vitamin C from fruit between groups at post-intervention assessments (the primary trial outcome), children of mothers allocated to the intervention group were more likely to consume apples, pears, boiled potatoes and carrots, but not bananas or leafy green vegetables (the secondary outcome of the trial). Similarly, the H5-KIDS program found no overall increase in child intake of fruit or vegetable relative to children in the comparison condition (Haire-Joshu 2008) but did report a significant positive intervention effect (of up to one third of a serve) in a sub-group analysis of healthy weight (relative to overweight) children for combined fruit and vegetable consumption.

The Beastly Healthy at School, multi-component preschool-based intervention had a small but significant impact on child fruit consumption (Vereecken 2009). Children attending intervention preschools increased their fruit consumption by 6 grams from

baseline at the six month follow-up, while fruit consumption among children in control preschools reduced by 4 grams over the same period. There were no differences between groups for vegetable consumption.

Interventions targeting boys and girls

All trials included in this review included both boys and girls. The impacts of intervention for gender subgroups were not reported in any of the included trials.

Interventions targeting minority groups and indigenous populations

Three of the included trials examined the impact of interventions on predominantly disadvantaged populations (Cooke 2011; Haire-Joshu 2008; Watt 2009). One trial recruited participants through schools where the proportion of children who had English as a second language, came from minority ethnic backgrounds or were eligible for free school meals was above average (Cooke 2011). The study demonstrated that repeated food exposure coupled with reward significantly increased the consumption of a target vegetable. Similarly, both home visiting interventions recruited participants from disadvantaged communities including underserved families, single or minority parent homes, or those living in poverty (Haire-Joshu 2008; Watt 2009). The trials did not improve overall child fruit or vegetable intake as assessed by the primary trial outcome measures (Haire-Joshu 2008; Watt 2009).

Interventions delivered in various settings

While two of the included trials recruited study participants from preschools/schools (Cooke 2011; Vereecken 2009) only one trial assessed the impact of an intervention targeting the policies or practices of this setting. The intervention had a small but significant increase in child consumption of fruit but not vegetables (Vereecken 2009). The remaining studies were home-based interventions, of which intervention effects were mixed.

Interventions of varying intensity

In trials that incorporated home visits, the number of scheduled visits ranged from four contacts (Haire-Joshu 2008) to nine contacts (Watt 2009), with visits in both interventions lasting approximately 60 minutes. Despite the differences between the two trials in terms of intervention intensity, both studies failed to find overall positive intervention effects on the primary trial outcome. In the more intensive trial, the average number of completed visits was five (Watt 2009), whereas the intervention of lesser intensity was delivered in its entirety to 78% of participants (Haire-Joshu 2008). The two trials examining the impact of repeated food exposure were similar with regard to intensity, with Wardle and colleagues reporting a maximum of 14 exposures over consecutive days (Wardle 2003a), and Cooke and colleagues reporting a maximum of 12 exposures over consecutive school days (Cooke 2011). In the multi-component preschool-based intervention the duration or frequency of intervention contacts was not reported (Vereecken 2009).

Interventions delivered in different modalities

Three of the five trials used face-to-face intervention delivery only (Cooke 2011; Wardle 2003a; Watt 2009). The remaining two trials used face-to-face in combination with other strategies: computer-tailored newsletters and storybooks (Haire-Joshu 2008),

and school-based education, training, policy and environment change (Vereecken 2009). Trials which employed face-to-face only intervention delivery formats, and those which incorporated a broader range of intervention modalities reported mixed findings in terms of intervention effects.

Secondary outcome I: Cost or cost-effectiveness of interventions to increase the consumption of fruit and/or vegetables

None of the included trials reported any information on intervention costs, or conducted cost analyses.

Secondary outcome II: Adverse effects of interventions to increase the consumption of fruit and/or vegetables

None of the trials reported information regarding any adverse events or unintended adverse consequences of the intervention.

DISCUSSION

Summary of main results

Despite the importance of encouraging fruit and vegetable consumption among children in early childhood, the review identified few randomised controlled trials of interventions investigating this. The included trials were heterogeneous, and collectively the findings were equivocal, providing few effective options for policy makers to improve child fruit and vegetable intake.

Two trials investigating home visiting programs provided to disadvantaged groups did not have a clear positive intervention effect on fruit and vegetable intake immediately after the intervention or six months post-intervention (Haire-Joshu 2008; Watt 2009). A multi-component preschool-based intervention failed to significantly increase child consumption of vegetables, but did report a small significant increase in mean child consumption of fruit six months following baseline assessment (Vereecken 2009). Two trials examining feeding strategies to encourage child consumption of a target vegetable (Cooke 2011; Wardle 2003a) indicated that repeated food exposure alone is not effective in increasing vegetable intake post-intervention. However, coupling repeated food exposure with a tangible non-food, or social reward, was effective in increasing targeted vegetable consumption in the short term (< three months post-intervention) (Cooke 2011).

Overall completeness and applicability of evidence

The paucity of published randomised trials identified in this review is surprising given efforts globally to increase fruit and vegetable intake (World Health Organization 2003). Nonetheless, previous systematic reviews of broader dietary interventions for children five years and under have similarly identified few randomised trials (Hesketh 2010). None of the included trials in this review examined long-term (> 12 months post-intervention) effects of interventions, reported cost analyses or examined any unintended
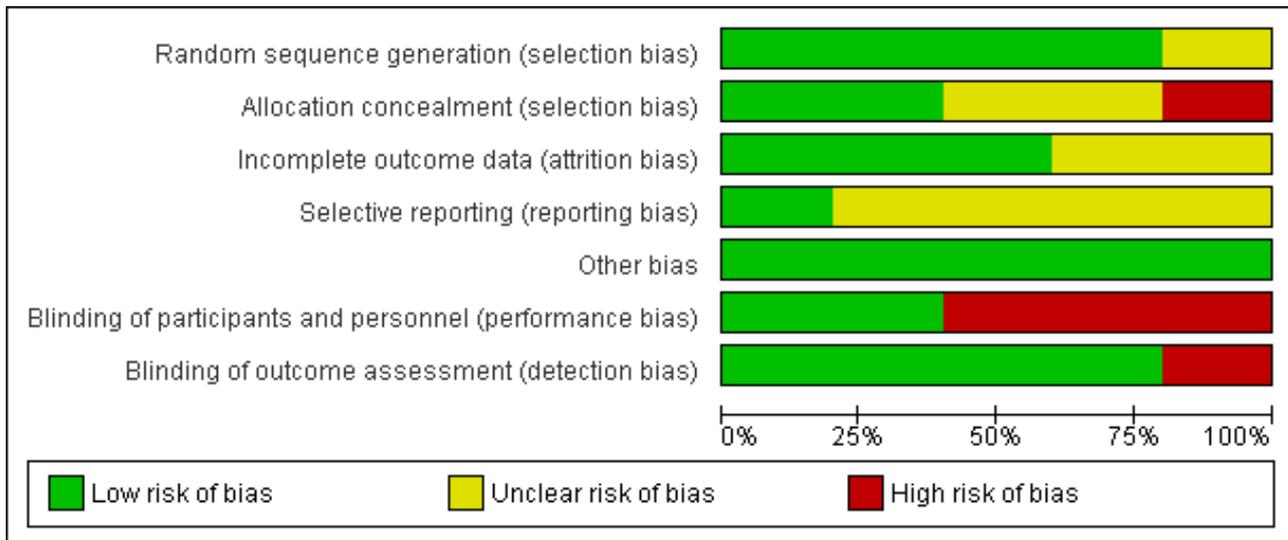
adverse effects. These factors are important considerations for health practitioners and policy makers but are often not reported in randomised trials (Waters 2011) or examined in systematic reviews (Hopewell 2008; Wolfenden 2010). Furthermore, the limited number of trials identified for inclusion also prevented thorough examination of the impact of the interventions by gender, for indigenous populations, across various settings, of different intensities or delivered using various modalities. Encouragingly, a number of trial protocols (see Characteristics of ongoing studies) were identified which may address some of these gaps in the literature and are likely to be eligible for inclusion in future updates of the review. These include a multi-component preschool-based intervention (Adams 2009), and a brief four contact telephone-based intervention delivered by trained non-health professionals (Wyse 2010).

The external validity of the review findings are limited. All trials were conducted in North America or Western Europe. None of the included trials compared participant characteristics to their sampled population and some did not specify trial inclusion or exclusion criteria (Haire-Joshu 2008; Vereecken 2009). Where recruitment was conducted via schools, clinics or Parents as Teacher programs, participation rates were generally high (> 80%) and study attrition ranged from 12% to 34% (Cooke 2011; Haire-Joshu 2008; Watt 2009). With the exception of the Beastly Healthy at School study participation rates of sites subject to randomisation in cluster trials was not reported. In the Beastly Healthy at School trial the preschool participation rate was just 10% suggesting the trial findings may not generalise (Vereecken 2009). The study by Wardle and colleagues, recruited a convenience sample of 156 children and parents from a larger cohort, who had previously participated in a separate study, and expressed interest in future research participation (Wardle 2003a). Such participants may differ systematically to parents of children five years and under in the broader community (Trauth 2000).

Quality of the evidence

In many cases trial quality was difficult to assess given a lack of available information reported in the published manuscripts. On the basis of the information provided one of the five trials was judged to be of high methodological quality (Cooke 2011), with three studies judged to be of moderate quality (Haire-Joshu 2008; Wardle 2003a; Watt 2009), and one study judged to be of low quality (Vereecken 2009). Only one study had been prospectively registered (Watt 2009). The most significant issue affecting the quality of the included trials was the inability to blind participants to group allocation, exposing trials to performance bias which can inflate the intervention effect (Figure 2). Similarly, social desirability bias, which can also inflate intervention effects is likely within trials that did not blind participants to group allocation or use an objective outcome measure (Hebert 1995). Finally, opportunities for meta-analysis could be improved by consistent assessment measures of fruit and vegetable intake and the reporting of trial outcomes in a manner consistent with CONSORT guidelines.

Figure 2.   Risk of bias graph: review authors' judgements about each risk of bias item presented as percentages across all included studies.

Random sequence generation (selection bias)
Allocation concealment (selection bias)
Incomplete outcome data (attrition bias)
Selective reporting (reporting bias)
Other bias
Blinding of participants and personnel (performance bias)
Blinding of outcome assessment (detection bias)

0%   25%   50%   75%   100%

☐ Low risk of bias   ☐ Unclear risk of bias   ☐ High risk of bias

Potential biases in the review process

The review employed a comprehensive and rigorous methodology including a broad search strategy, the screening of trials and extraction of data by two independent reviewers, and the appraisal of risk of bias within the included studies. Furthermore, the review did not restrict publications based on language. Two aspects of selection bias, however, are worth noting. First, we excluded trials where fruit and vegetable intake was not considered to be a primary trial outcome to avoid any potential confounding effects of other behavioural interventions (such as physical activity). This restriction may lead to over-estimates of intervention effects if in practice they are delivered in the context of other health initiatives. Second, the review included only trials which had been published in peer reviewed journals, which may also lead to overly positive estimates of intervention effects given the tendency for trials with positive findings to be more likely to be published, or published more quickly in peer reviewed journals (Higgins 2011).

Agreements and disagreements with other studies or reviews

The equivocal findings of this review regarding the impact of home visiting programs are similar to those reported in previous reviews of dietary interventions. For example, a comprehensive review of the impact of home visiting programs concluded that there was little evidence to recommend home visiting as means of improving child diet given the mixed findings of the reviewed studies (Elkan 2000). Among the trials with a positive intervention effect included in the review by Elkan and colleagues (Elkan 2000) was a pre/post study of an intensive intervention provided to low income mothers of children aged one to four years (James 1992). In this study, dietician-trained GPs and health visitors provided advice and support as part of a primary care home visiting intervention lasting up to 20 weeks. Post-intervention improvements in diet were reported, including the consumption of fruits and vegetables. A more recent home visiting intervention (Worobey 2004) identified in a later review (Campbell 2007) also employed a pre/post design to examine a home visiting intervention delivered to predominantly low income Hispanic children under six years by a public health

nurse. The intervention sought to improve macronutrient intake, as well as reduce high fat snack consumption and increase healthy snack consumption. Post-intervention assessments found reductions in caloric intake but no change in macronutrients (Worobey 2004).

Similarly, there are few controlled trials available to put into context the mixed findings of the multi-component preschool-based intervention reported by Vereecken and colleagues (Vereecken 2009). A recent systematic review of interventions to improve diet, physical activity or prevent weight gain for children five years of age or under, and which included both randomised and non-randomised designs, identified nine studies of interventions implemented in preschool or childcare settings (Hesketh 2010). Three studies included some assessment of dietary outcome. In the first, Head Start preschools were assigned to either; a menu intervention to reduce the fat content of meals provided to children in care; the same menu intervention plus nutrition education; or a third usual care control condition (Williams 2004). Both intervention arms of the trial reduced the fat content of foods served to children relative to the preschools in the control condition. The remaining two trials assessed the impact of a healthy eating and physical activity obesity prevention program 'Hip-Hop to Health Jr', implemented in two different populations attending Head Start preschools (Fitzgibbon 2005; Fitzgibbon 2006). In one trial (Fitzgibbon 2005), intervention children reported less saturated fat intake at the one year follow-up, but not total fat or dietary fibre. No improvements in dietary intake were reported in the second trial (Fitzgibbon 2006). Nonetheless, systematic reviews of school-based fruit and vegetable interventions have frequently concluded that multi-component initiatives are effective in increasing fruit and vegetable consumption in older children, suggesting that such strategies warrant investigation in preschools (Burchett 2003; Ciliska 2000; French 2003; Knai 2006).

An early systematic review of healthy eating interventions for children aged under five years (Tedstone 1998) published by the Health Education Authority concluded that repeated food exposure

is effective in enhancing children's willingness to consume novel foods provided tasting was included as a part of the exposure. Enhanced food acceptance following repeated food exposure has also been reported in other reviews and controlled trials (Contento 1995). As Cooke and colleagues point out in the background review of research for their randomised trial, evidence regarding the use of rewards to encourage child consumption of targeted foods appears more equivocal (Cooke 2011). The positive impact of both social and non-tangible rewards reported in Cooke, were, however, consistent with previous trials in community settings using tangible non-food rewards and social reward targeting the fruit or vegetable intake of school aged children (Hendy 1999).

AUTHORS' CONCLUSIONS

Implications for practice

This review provides little specific direction for health policy makers and practitioners interested in achieving increases in the fruit and vegetable consumption of children aged five years and under. Among those trials which significantly increased consumption, the effect sizes were small and intervention effects typically assessed only in the short term.

Notwithstanding this, a number of the intervention settings and strategies reported in the included studies have potential public health appeal. Home visiting appears to be effective in reaching disadvantaged populations, as evidenced by the high response and low attrition rates in the included home visiting studies (Haire-Joshu 2008; Watt 2009). Both studies also tested strategies which could be considered suitable for broader dissemination. In the trial by Watt and colleagues, the intervention was delivered by volunteers, a low cost approach to intervention delivery. Haire-Joshu and colleagues, incorporated the fruit and vegetable program into an existing service for disadvantaged families, a cost efficient and potentially sustainable intervention approach, which was also reported to be highly acceptable to both the parent educators who delivered the program and the parents who received it. Such findings suggest that, provided effective programs can be developed, programs delivered via home visiting may have merit in improving fruit and vegetable intake among disadvantaged families.

Findings from the two trials of feeding strategies have broad application (Cooke 2011; Wardle 2003a). The findings of one trial suggest that the pairing of repeated food exposure and a tangible non-food reward, or social reward is effective in increasing children's consumption of a target vegetable, at least in the short term. Such strategies could, therefore, be considered for inclusion in future interventions targeting children aged five years and under, across a variety of settings, particularly those targeting parent-child feeding interactions in the home.

Given the large numbers of children that attend such childcare services, and the capacity of these services to influence children's diets whilst in their care, childcare services are often advocated as important settings to improve child diet (Story 2006). While the trial by Vereeken and colleagues reported in this review significantly

increased children's fruit consumption, the effect size was meagre. The authors attribute increased access to fruit at intervention preschools as primarily responsible for the intervention effect. This is consistent with previous reviews of the correlates of child fruit and vegetable intake (Blanchette 2005; Rasmussen 2006) suggesting that simply providing fruits to children whilst in care is likely to increase their consumption. Furthermore, despite parent newsletters, information evenings and other preschool-based activities, the authors suggest that greater engagement of parents may be required, a strategy also found to enhance the impact of school-based nutrition programs (Knai 2006).

Given the lack of high quality research in this area, there is considerable scope for policy makers, researchers and practitioners to develop and evaluate the impact of a variety of initiatives to improve child fruit and vegetable intake. Behavioural interventions delivered via health professionals, telephone or computer-based programs, interventions delivered through preschools, play-groups, sports clubs, or co-operatives, and those which address access issues through subsidies or other incentives all have merit, and rigorous evaluation of such interventions for children of aged five years and under would contribute greatly to the available evidence base to inform practice. As the aetiology of child diet is complex, interventions which target multiple determinants across a number of settings may be most likely to be effective.

Implications for research

The review identified a number of opportunities for future intervention research targeting the fruit and vegetable consumption of children aged five years and under including:

- the investigation of potential adverse effects of interventions (e.g. increased family grocery costs, or adverse effects on parent self esteem or sense of competence) as a routine part of intervention trials;
- examination of the cost-effectiveness of interventions found to be effective;
- interventions with extended periods of follow-up;
- interventions delivered using electronic modalities such as the web or smartphones;
- interventions implemented across a broader range of settings including heath services and sports clubs.

ACKNOWLEDGEMENTS

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CHARACTERISTICS OF STUDIES

Characteristics of included studies *[ordered by study ID]*

Cooke 2011

Methods	Cluster randomised controlled trial
Participants	**Description:** 422 children in reception (4 to 5 years) and Year 1 (5 to 6 years) from 16 classes in eight schools. **N (Randomised):** 16 classes, 472 children **% Female:** 47% female **Age:** Reception: 4 to 5 years (N = 216) Year 1: 5 to 6 years (N = 206) **SES and ethnicity:** *"To ensure adequate representation of children from families of low socioeconomic status, we selected schools in which the proportions of pupils who were eligible for free school meals, who spoke English as a second language, and who came from minority ethnic backgrounds were above the national average."* No individual child data on these variables were reported. **Inclusion/exclusion criteria:** Not stated **Recruitment:** Recruited from 16 classes in eight schools (492 children, 472 consented)

Cooke 2011 *(Continued)*

	Recruitment rate:

Children: 96% (472/492)

Schools: unknown

Region:

United Kingdom |
| Interventions | **Number of experimental conditions:** 4

Number of participants (analysed):

Exposure + tangible non-food reward (sticker) = 99

Exposure + social reward (praise) = 106

Exposure alone = 105

Control = 112

Description of interventions:

"Children in the intervention conditions (ETR, EP, EA)* were seen individually from Day 3 to Day 14 and offered a small piece of their target vegetable."

Exposure + tangible non-food reward: *"Children in the ETR condition were told that if they tasted the vegetable, they could choose a sticker as a reward."*

Exposure + social reward: *"Children in the EP condition were praised if they tasted the vegetable (e.g. "Brilliant, you're a great taster")*

Exposure alone: *"Children in the EA condition were invited to taste the target vegetable but received minimal social interaction."*

Duration:

3 weeks

Number of contacts:

12 exposure sessions

Setting:

School

Modality:

Face-to-face, exposure

Interventionist:

Trained researchers

Integrity:

"Children in the three intervention groups agreed to taste their target vegetable in most sessions"

Exposure + tangible non-food reward (sticker): *M* = 11.34 sessions, *SD* = 1.45

Exposure + social reward (praise): *M* = 10.45 sessions, *SD* = 1.94;

Exposure alone: *M* = 9.97 sessions,*SD* = 2.87. |

Cooke 2011 *(Continued)*

"Post hoc analyses showed higher compliance in the ETR condition than in the EP or EA conditions (p < 0.05), and compliance in the latter two conditions did not differ."

Date of study:

Unknown

Description of control:

No treatment control: *"Children in the control group did not receive taste exposure to the target vegetable during the intervention period."*

Outcomes	**Outcome relating to children's fruit and vegetable consumption:**
	Ad libitum consumption of target vegetable (grams). *"The child was then invited to eat as much of the vegetable as he or she wanted, with intake (in grams) assessed by weighing the dish before and after consumption using a digital scale"* (NB. *"Care was taken to ensure that children in the ETR condition understood that the sticker reward was no longer available."*)
	Length of follow-up from baseline:
	Acquisition data: day 15
	Maintenance data: 1 month and 3 months later
	Subgroup analyses:
	None
	Loss to follow-up (at 1 month and 3 months follow-up):
	Exposure + tangible non-food reward (sticker): 7%, 9%
	Exposure + social reward (praise): 8%, 5%
	Exposure alone: 8%, 8%
	Control: 11%, 6%
	Analysis:
	Analysis adjusted for clustering *"Clustering by school was minimal; therefore, the final analyses adjusted only for clustering by class."*
	Sample size calculation was performed
Notes	*"On the basis of evidence that 10 exposures are needed to alter preferences, we decided to repeat all analyses for a restricted subset of children who tasted their target vegetable on at least 10 days (n=365). Because there were no significant differences between the restricted and the full samples, results are reported for the full sample."*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Contact with the author indicated that the study used blocked randomisation performed using an online randomiser program.
Allocation concealment (selection bias)	Unclear risk	Randomisation occurred prior to consent. Head teachers were not aware of group allocation. It is unclear if study personnel knew of allocation.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Although reasons for missing data were not provided by group, rates of loss to follow up were low and similar across all experimental arms of the trial at both follow-up points (Exposure+sticker = 6.5%, 8.8%; Exposure+praise = 8.2%,

Cooke 2011 *(Continued)*

		5.0%; Exposure alone = 8.2%, 8.2%; Control = 10.9%, 5.7%, provided by the author). No reasons were reported for loss to follow up.
Selective reporting (reporting bias)	Unclear risk	Insufficient information to permit judgment Trial was registered, but not prospectively (ISRCTN42922680)
Other bias	Low risk	No further risks of bias identified
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Contact with the author indicated that personnel were not blind to group allocations and that there was the potential that participants became aware of group allocation. However, given the objective outcome measure, review authors judged that the outcome would not be influenced by lack of blinding
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Contact with the author indicated that some, but not all of the outcome assessors were blind to group allocation. The outcome measurement (grams of target vegetable consumed, as measured by a digital scale), however, was objective and unlikely to have been influenced by lack of blinding.

Haire-Joshu 2008

Methods	Cluster randomised controlled trial
Participants	**Description:** Parents and their children participating in the 'Parents as Teachers' (PAT) program sites in rural Missouri (USA) **N (Randomised):** 16 PAT sites, 1658 families **Age:** Children: 1 to 3 y: intervention = 67%, control = 61% 4 to 6 y: intervention = 33%, control = 40% Parents: < 25 y: intervention = 28%, control = 21% 25 to 29 y: intervention = 35%, control = 33% 30 to 34 y: intervention = 21%, control = 24% 35+ y: intervention = 17%, control = 23% **% Female:** Children: intervention = 47%, control = 49% Parents: intervention = 99%, control = 98% **SES and ethnicity:** Parent - Not high school graduate: intervention = 16%, control = 11% Parent - College graduate: intervention = 20%, control = 25%

Haire-Joshu 2008 *(Continued)*

Household income:

< USD 20K: intervention = 30%, control = 25%

USD 20K to 35K: intervention = 30%, control = 25%

USD 35K to 50K: intervention = 13%, control = 18%

USD 50+K: intervention = 28%, control = 32%

Ethnicity - White race: intervention = 86%, control = 80%

Inclusion/exclusion criteria:

Not specified

Recruitment:

"16 PAT programs from rural, southeast Missouri were recruited into the study. Within these sites 2012 families enrolled were assessed for eligibility and willingness to participate by parent educators." PAT is a *"parenting and child development program with over 3000 sites across all 50 states and 8 US territories."* PAT provides free services on *"an annual basis to parents at the time of pregnancy until the youngest child is 3 years of age. However, PAT extends services until the youngest child is 5 years of age in the case of underserved families, defined as single or minority parent homes, those living in poverty or low parent education. In addition, underserved families may receive additional home visits as a means of ensuring complete delivery of the curriculum."*

Recruitment rate:

Families: 79% families

PAT sites: unknown

Region:

Rural southeast Missouri (USA)

Interventions	**Number of experimental conditions:** 2

Number of participants (analysed):

Intervention = 605, Control = 701

Description of intervention:

Intervention families received the standard PAT program plus the 'Hi 5 for Kids' (H5-KIDS) protocol. *"H5-KIDS was comprised of three components: a tailored newsletter, a series of home visits, and materials for the parent and child, including storybooks."*

Computer tailored nutrition newsletter

"To develop the tailored newsletter, parents were first formally enrolled in H5-KIDS and completed a pretest interview. Relevant data was then imported into an in-house computer-based tailoring program. Scores were calculated based on FV knowledge and intake, frequency of parental modeling, style of parenting (coercive or non-coercive), and quality of the home food environment (FV availability). Each newsletter began with a bulleted tailored statement that included the self reported servings of FVs the parent and the child consumed per day. Additional parent data (e.g. FV knowledge, parental role modeling, non-coercive parenting skills, FV availability) were each uniquely used to individualize messages and describe the themes of each of the four storybook sets the family would receive at their home visits. For example, if participant data indicated a parent did not eat FV in front of their child very often (< 7/week), the tailored messages would emphasize the importance of modeling FV intake in front of the child as a means of improving consumption, and provide relevant examples of how this could be accomplished. The parent was then referred to H5-KIDS storybooks that provided examples of modeling for the child. In contrast, parents who scored appropriately in each individual area received messages of praise encouraging

Haire-Joshu 2008 *(Continued)*

them to continue their behaviors. Newsletters were mailed to the parent's home at the beginning of the program."

Home visits

"Parent educators delivered four H5-KIDS home visits, each of which addressed the core program areas (knowledge, parental modeling of FV intake, non-coercive feeding practices, FV availability). Parent educators then reinforced the core content in subsequent visits. Consistent with the philosophy of the PAT program, each visit provided examples of parent–child activities designed around healthy nutrition, that the parent could use to promote the child's language and cognitive ability, and fine and gross motor skill development (e.g. having the child learn the names and colors of various FV; child assists with selecting a variety of FV for breakfast). As part of each visit, parents also received materials and informational handouts with suggestions for improving feeding practices and the food environment in the home. Consistent with the standard PAT program, each home visit was designed to allow for 60 min of contact."

Sing-a-long storybooks with audio cassette

"At each home visit children received a H5-KIDS sing-a-long storybook with audio cassette tape and a coloring book. Each storybook reinforced one of the core areas of the H5-KIDS program through the use of child friendly characters and appealing storylines presented through songs."

Duration:

60 minutes per home visit

Number of contacts:

4 H5-KIDS home visits plus 5 standard PAT home visits

Setting:

The Home

Modality:

Face-to-face via home visits

Interventionist:

Parent educators who received 4 hours of training on nutrition content and overview of materials

Integrity:

"The H5-KIDS program was delivered in its entirety to 78% of intervention families."

Date of study:

2001 to 2006

Description of control:

"Parent educators deliver a standardized curriculum via at least five home visits, on-site group activities and newsletters." ("PAT ... empowers parents ... by encouraging positive parent-child communication and increasing parents' knowledge of ways to stimulate children's social and physical development.")

Outcomes	**Outcome relating to children's fruit and vegetable consumption:**
	Child's daily servings of fruits and of vegetables assessed using the Saint Louis University for Kids Food Frequency Questionnaire (SLU4Kids FFQ) administered via parent telephone survey.
	Length of follow-up from baseline:
	Average time to follow-up was 7 months (range 6 to 11 months)
	Subgroup analyses:

Haire-Joshu 2008 *(Continued)*

Normal weight vs overweight children

Loss to follow-up:

Intervention: 15% (+ 5% missing or inconsistent data)

Control: 17% (+ 5% missing or inconsistent data)

Analysis:

Analysis was not adjusted, but justification was provided. *"There was minimal impact of grouping by site on the principle measures of impact in this study (ICC child fruit and vegetable servings = 0.00095 and ICC parent fruit and vegetable servings = 0.01). Therefore, the analyses did not adjust for group."*

Sample size calculation was performed.

Notes	The proportion of normal weight vs overweight children not reported, making it difficult to interpret the subgroup analysis.

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	*"A computer generated number table was used for random assignment to intervention or control."*
Allocation concealment (selection bias)	High risk	*"Families enrolled in PAT were assessed for eligibility and willingness to participate by parent educators."* Contact with the author indicated that parent educators were aware of site allocation when they were enrolling participants to the trial.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Rates of loss to follow-up (intervention = 15%, control = 17%) and missing/ inconsistent data (intervention = 5%, control = 5%) were similar across groups. No information was provided about reasons for loss to follow-up.
Selective reporting (reporting bias)	Unclear risk	A subgroup analysis was conducted based on child's weight status (normal vs overweight). *"A final limitation of the study is the limited power to definitely assess the impact of the intervention of children within weight status subgroups."* It is unclear whether the subgroup analysis was pre-specified.
Other bias	Low risk	Rationale provided for not adjusting analysis for clustering. *"There was minimal impact of grouping by site on the principle measures of impact in this study (ICC child fruit and vegetable servings = 0.00095 and ICC parent fruit and vegetable servings = 0.01). Therefore, the analyses did not adjust for group."* No further risks of bias identified.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Study personnel were aware of allocation - *"Sites were not blind to assignment."* Contact with the author indicated that parent participants completed a consent form which described the activities of their experimental condition, and were therefore unlikely to be blind to allocation. Given the trial outcomes were based on parental report, the review authors judged there were potential for performance bias.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Contact with the author indicated that outcome assessors were blind to group allocation.

Vereecken 2009

Methods	Cluster randomised controlled trial
Participants	**Description:**
	Children attending 16 preschools in East Flanders (Belgium)
	N (Randomised)
	16 schools, 1432 preschoolers
	Age: (DOB)
	< 2002: intervention = 41%, control = 51%
	2002: intervention = 28%, control = 24%
	2003: intervention = 31%, control = 26%
	% Female:
	Intervention = 53%, control = 44%
	SES and ethnicity:
	Predominantly low parental education
	Low education (mother): intervention = 49%, control = 49%
	Low education (father): intervention = 60%, control = 57%
	Ethnicity: No information provided
	Inclusion/exclusion criteria:
	Not specified
	Recruitment:
	Schools were approached by mail for consent. All parents of preschoolers attending the consenting schools were asked to fill in a food frequency questionnaire
	Recruitment rate:
	Parents: 54%
	Schools: 10% (40 out of 403 schools consented, although only 8 were selected in the end)
	Region:
	East Flanders (Belgium)
Interventions	**Number of experimental conditions:** 2
	Number of participants (analysed):
	Intervention = 308, Control = 168
	Description of intervention:
	8 preschools received a multi-component intervention to assist schools to implement a healthy school food policy. *"The main objectives were to increase the consumption of fruit, vegetables and water and to decrease the consumption of sugared milk drinks and fruit juice."*
	The main strategies to influence the child and the different environmental factors included:

Vereecken 2009 *(Continued)*

"Child: Guided and self-guided activities based on experiential education (e.g. tasting) and developmental education (e.g. explanation of concepts of food triangle); Role model, feed back and reinforcement by teachers; Educational role-model story and characters; Availability of healthy foods; Availability of cooking equipment.

Parents: Newsletters; Suggestions for the back and forth diary; Work sheets and creations by children; Parent evenings and other school activities with parents

Teacher: Training sessions; Manual including didactic and policy aspects; Digital learning environment; Newsletters; Group discussions with teachers; Examples of good practices

School environment: Newsletters; Training sessions for principals and cafeteria staff; Help on demand via e-mail; Examples of good practices; Policy aspects in the teachers' manual; Feedback to schools."

Duration:

6 months

Number of contacts:

Unclear (multi-component)

Setting:

Preschool

Modality:

Multiple (staff training, experiential education, newsletters, email support, resources)

Interventionist:

Not specified

Integrity:

No information provided

Date of study:

Sept 2006 - April 2007

Description of control:

8 preschools received the control: no information provided

Outcomes	**Outcome relating to children's fruit and vegetable consumption:**
	Daily consumption of fresh fruit and vegetables (grams) as reported by parents in a written food frequency questionnaire.
	Length of follow-up from baseline:
	6 months (March/April 2007)
	Subgroup analyses:
	None
	Loss to follow-up
	Intervention: 47%
	Control: 45%
	Analysis:

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Vereecken 2009 *(Continued)*

Contact with the author indicated that the analysis was adjusted for clustering by school.

Unknown if sample size calculation was performed

Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	Contact with the author indicated that a computerised random number generator was used.
Allocation concealment (selection bias)	Unclear risk	Contact with the author indicated that schools did not know their allocation prior to consenting to the study. It is unclear if study personnel responsible for recruitment were aware of group allocation.
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Although similar across groups (intervention = 47%, control = 45%), rates of loss to follow-up were high. Contact with the author indicated that no information was collected on reasons for loss to follow-up.
Selective reporting (reporting bias)	Unclear risk	Insufficient information to permit judgement.
Other bias	Low risk	Contact with the author indicated that analysis was adjusted for clustering. No further risk of bias identified.
Blinding of participants and personnel (performance bias) All outcomes	High risk	Contact with the author indicated that parents and school staff were not blind to group allocation and that parents could have attended information sessions organised by the researchers, or observed posters, newsletters or intervention materials in intervention schools. Given that the relevant trial outcomes were based on parental reports, the review authors judged that there was a risk of bias.
Blinding of outcome assessment (detection bias) All outcomes	High risk	Contact with the author indicated that parents and school staff were not blind to group allocation and that parents could have attended information sessions organised by the researchers, or observed posters newsletters or intervention materials in intervention schools. Given that the relevant trial outcomes were based on parental reports, the review authors judged that there was a risk of bias. (NB. There were no independent outcome assessors in this trial, the parents completed and returned a food frequency questionnaire about their child's food intake).

Wardle 2003a

Methods	Randomised controlled trial
Participants	**Description:** Children aged 2 to 6 years and their principle care giver (parent) who were recruited from a larger study **N (Randomised):** 156 children **Age:**

Wardle 2003a *(Continued)*

Child: 34 to 82 months (mean = 53 months)

Parent: mean = 36 years

% female:

Children (by group): Exposure = 34%, Nutrition Information = 58%, Control = 51%

Parent (overall): 95%

SES and ethnicity:

"68% of parents had left full-time education at the age of 21 or over" and *"the majority of parents held further education qualifications."*

Ethnicity = 74% white / Caucasian

Inclusion/exclusion criteria:

No explicit inclusion/exclusion criteria stated for this trial, or for the trial from which participants were recruited. 13 children (1 girl, 12 boys) were excluded when they didn't comply with the experimental procedures during the pre-experimental taste test.

Recruitment:

Participants were recruited from a larger study on the predictors of children's fruit and vegetable intake and expressed an interest in participating in further research to modify their children's acceptance of vegetables.

Recruitment rate:

Parents: 28%

Region:

United Kingdom

Interventions	**Number of experimental conditions:** 3
	Number of participants (analysed):
	i) Restricted to at least 10 out of 14 exposures:
	Exposure = 34, Nutrition Information = 48, Control = 44
	ii) All available data:
	Exposure = 48, Nutrition Information = 48, Control = 44
	Description of intervention:
	Exposure: Taste exposure intervention carried out in the home where parents were asked to offer their child a taste of a target vegetable daily for 14 consecutive days. Parents were given suggestions to encourage the child to taste the vegetable. Parents were given a vegetable diary to record their experiences, and children could record their liking for the vegetable after each session using 'face' stickers.
	Nutrition Information: Parents were informed about the '5 a day' recommendations and given a leaflet with advice and suggestions for increasing children's fruit and vegetable consumption.
	Duration:
	14 days
	Number of contacts:
	14 (daily for 14 consecutive days)

Wardle 2003a *(Continued)*

	Setting:
	The home
	Modality:
	Face-to-face, exposure
	Interventionist:
	Researchers trained parents to offer the target vegetable to their child
	Integrity:
	14 participants in the exposure group failed to complete a minimum of 10 out of 14 tasting sessions.
	- 4 children completed 9 sessions, 2 completed 8 sessions, 2 completed 7 sessions, 1 completed 6 sessions, 4 completed 5 or less sessions
	Date of study:
	Not provided
	Description of control:
	"No treatment" control - parents received no further intervention
Outcomes	**Outcome relating to children's fruit and vegetable consumption:**
	Ad libitum consumption of target vegetable (grams) assessed by weighing the amount of the vegetable on the plate before and after consumption using a professional digital scale (Tanita Corporation, Japan).
	Length of follow-up from baseline:
	Approximately 2 weeks
	Subgroup analyses:
	Restricted sample to only those in the taste exposure group who received 10 or more exposures. This restricted the Exposure group from 48 to 34 children.
	Loss to follow-up:
	2% (140 provided follow-up data of 143 who were eligible and provided data at baseline).
	Exposure: 4% (children withdrawn from their study by their parents following collection of baseline data).
	Nutrition Information: 0%
	Control: 2% (children withdrawn from their study by their parents following collection of baseline data).
	Analysis:
	Adjustment for clustering not applicable
	Unknown if sample size calculation was performed
Notes	*"Two sets of analyses were carried out: (a) on a restricted sample which excluded those in the Exposure group who completed less than 10 tasting sessions (n=126) and (b) on the whole sample (n=140). Results below refer to the reduced sample size ... results for the whole sample are only included where they differed from these."*

Wardle 2003a *(Continued)*

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Unclear risk	*"Participants were randomly assigned to one of three experimental treatment groups"*. No further information provided regarding sequence generation.
Allocation concealment (selection bias)	Low risk	Contact with the author indicated that allocation was concealed in an opaque envelope opened at participants homes after baseline data collection.
Incomplete outcome data (attrition bias) All outcomes	Low risk	Rates of loss to follow-up were similar and low across the exposure (4%), nutrition information (0%) and the control conditions (2%). Reasons for loss to follow-up were provided and were similar.
Selective reporting (reporting bias)	Unclear risk	Insufficient information to permit judgement.
Other bias	Low risk	No further risk of bias identified.
Blinding of participants and personnel (performance bias) All outcomes	Low risk	Contact with the author indicated that personnel delivering the intervention were not blind to group allocation and that parents may not have been blind to group allocation. However, given the objective assessment of outcome (electronic scales), the review authors judged that the study outcome was unlikely to be affected by lack of blinding.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	Contact with the author indicated that the outcome assessors were not blind to group allocation. Given the objective measure of outcome (electronic scales) assessment is unlikely to have been influenced by lack of blinding.

Watt 2009

Methods	Randomised controlled trial
Participants	**Description:**
	New mothers attending baby clinics in disadvantaged London neighbourhoods.
	N (Randomised):
	312 mothers
	Age:
	Children: mean = 10 weeks
	Parents: mean = 30 years
	% Female:
	Children = not stated
	Parents = 100%
	SES and ethnicity:
	28% lone parents
	57% living in social housing

33% receiving income support/job seekers allowance

Ethnicity: 50% from an ethnic minority

Inclusion/exclusion criteria:

Inclusion criteria: *"Women from Registrar General occupational classes II-V (non-professional); babies born >/= 37 weeks; babies' birth weight above 2500g; singletons; women able to understand written and spoken English; and resident in the study area."*

Exclusion criteria: *"Women aged under 17 years; infants were diagnosed with a serious medical condition or were on special diets; infants aged over 12 weeks; women or their partners were from social class I (professional). Originally their intention was to restrict the sample to first-time mothers over the initial 12 week recruitment period. The inclusion criteria was therefore changed to include all new-mothers."*

Recruitment:

"Women were recruited from December 2002 to February 2004 at baby clinics located in the more disadvantaged neighbourhoods across Camden and Islington where Surestart (a national social welfare initiative targeting families with young children) programmes existed. A standardised technique was used to approach new mothers attending the baby clinics. An overview of the study was given and randomisation explained. If the women were interested, a short screening questionnaire was then used to assess their eligibility."

Recruitment rate:

Mothers: 82%

Region:

London, UK

Interventions	**Number of experimental conditions:** 2
	Number of participants (analysed):
	Intervention = 124, Control = 115 **(12 months)**
	Intervention = 108, Control = 104 **(18 months)**
	Description of intervention:
	A monthly home visiting program (from 3 to 12 months) delivered by trained local mothers, providing practical support on infant feeding practices.
	Duration:
	9 months (duration of each visit = 60 min)
	Number of contacts:
	Monthly from 3 to 12 months (maximum = 10 contacts)
	Setting:
	The home
	Modality:
	Face-to-face, via home-visiting
	Interventionist:
	Trained local volunteers *"A group of local mothers were recruited and trained to provide the support in a 12-session programme delivered over a 4-week period."*

Watt 2009 *(Continued)*

Integrity:

"On average each woman in the intervention group received five volunteer home visits (range 1-10). A small number of women were also contacted by telephone when home visits were not possible."

Date of study:

Recruited from Dec 2002 to Feb 2004

Description of control:

Usual care. *"Women in the control group only received standard professional support from health visitors and GPs."*

Outcomes	**Outcome relating to children's fruit and vegetable consumption:** Children's intake of vitamin C from fruit Secondary outcome: Proportion of children who consumed specific fruits and vegetables more than once a week **Length of follow-up from baseline:** 42 weeks and 68 weeks (when children aged 12 months and 18 months, respectively) **Subgroup analyses:** None **Loss to follow-up: (at 12 and 18 months)** Intervention: 27%, 34% Control: 20%, 30% **Analysis:** Adjustment for clustering not applicable Sample size calculation was performed
Notes	

Risk of bias

Bias	Authors' judgement	Support for judgement
Random sequence generation (selection bias)	Low risk	*"A random allocation schedule was prepared in advance using random digit computer tables."*
Allocation concealment (selection bias)	Low risk	*"Those responsible for recruiting ... were all masked to group assignment."*
Incomplete outcome data (attrition bias) All outcomes	Unclear risk	Rates of loss to follow-up were similar across intervention (27%, 34%) and control (20%, 30%) groups at both time points and were moderate. There were no substantial differences in the reasons for loss to follow-up
Selective reporting (reporting bias)	Low risk	All primary or secondary outcomes of interest were reported according to the information provided in the trial register (ISRCTN 55500035)
Other bias	Low risk	Small deviation in protocol: The original sample was restricted to first time mothers but after 12 weeks of the 14 month recruit this was broadened to all new mothers.

Watt 2009 *(Continued)*

		No further risks of bias identified
Blinding of participants and personnel (performance bias) All outcomes	High risk	Contact with the author indicated that parent participants and intervention personnel were not blind to group allocation. Given that the trial outcome was based on parental reports of children's fruit intake the reviewers judged that there was a risk of performance bias in this study.
Blinding of outcome assessment (detection bias) All outcomes	Low risk	*"Those responsible for ... assessing outcomes were all masked to group assignment."*

*ETR = exposure plus tangible non-food reward; EP = exposure plus praise; EA = exposure alone, y = year, FV = fruit and vegetables?; DOB = date of birth; ICC = intra-class correlation

Characteristics of excluded studies *[ordered by study ID]*

Study	Reason for exclusion
Aboud 2008	This responsive feeding was ineligible as its primary aim was not to increase fruit and vegetable consumption and the study only assessed children's fruit and vegetable consumption post-hoc in order to describe the mechanism behind a change in weight status among participants in the sample.
Alford 1971	Children aged 6 to 17 years.
Anliker 1993	Children aged 14 to 17 years.
Bammann 2006	No comparison group.
Bannon 2006	Outcome is food choice (apple or crackers)
Baranowski 2002	Children aged 9 to 18 years.
Bayer 2009	Child mean age 6 years.
Benjamin 2008	Outcome is quality of meals.
Berhe 1997	No comparison group.
Blom-Hoffman 2008	Child mean age 6.2 years.
Boaz 1998	Children aged 7 to 9 years.
Bollella 1999	Outcome is vitamins and minerals, not fruit and vegetable consumption.
Briefel 2006	No comparison group.
Briefel 2009	Children aged 6 to 18 years.
Briley 1999	No comparison group.
Bruening 1999	Non-equivalent control group design.
Byrne 2002	Outcome is willingness to taste kohlrabi.

Study	Reason for exclusion
Ciampolini 1991	No comparison group.
Coleman 2005	No fruit and vegetable outcomes.
Condrasky 2006	Quasi-experimental: intervention sample randomly selected from one church. Control randomly selected from a separate church.
Court 1977	No participants, these are guidelines, not research trial.
de Pee 1998	No comparison group.
de Silva-Sanigorski 2010	Quasi-experimental, repeat cross-sectional design.
Dixon 1997	Child mean age 6 years.
Dixon 2000	Children aged 6.3 to 6.8 years.
Eicholzer-Helbling 1986	Outcome no consumption measure
Epstein 2001	Children aged 6 to 11 years.
Estabrooks 2009	Children aged 8 to 12 years.
Evans 2006	Children in 4th, 5th grade school.
Faber 2002	Cross-sectional survey.
Faith 2006	The intervention programme was not specifically designed to increase consumption of fruit and vegetables, instead primary aim is to illustrate a methodological concept. *"This methodological note illustrates the use of co-twin design for testing substitution, phenomenon, a prominent behavioural economics concept. We test whether fruits and vegetables can substitute for high-fat snack foods in young children in a single meal laboratory setting."*
Fitzgibbon 2002	Outcome is weight change.
Fletcher 2009	Children aged 13 to 19 years.
Foerster 1998	Children in 4th, 5th grade school.
Folta 2006	Children in kindergarten to grade 8 school.
Freedman 2010	Outcome is child feeding attitudes and practices.
Gentile 2009	Children in 3rd, 4th, 5th grade school.
Gittelsohn 2010	Children aged 8 to 12 years.
Goldberg 2009	Children in grades 1 to 3 school.
Gosliner 2010	Quasi-experimental: child care centres in existing study matched to other child care centres, then randomised.
Gottesman 2003	No participants, not research trial.
Gottesman 2007	No participants, not research trial

Study	Reason for exclusion
Graham 2008	Outcome no fruit and vegetable consumption.
Gratton 2007	Children aged 11 to 16 years.
Hambleton 2004	Children aged 9 to 10 years.
Havas 1997	No assessments of children included in study.
Heim 2009	Children in 4th and 6th grade school
Hendy 2002	No comparison group.
Hildebrand 2010	No comparison group
Horne 2009	Child mean age 7 years.
Horodynski 2004	Non-equivalent control group study design.
Horodynski 2005	Outcome is feeding behaviours.
Hu 2010	Outcome is eating behaviours and weight, not fruit and vegetables.
Hughes 2007	Outcome is feeding styles and behaviour.
IFIC 2002	Children aged 9 to 12 years
James 1992	No comparison group.
Jayne 2009	Outcome is food choice.
Johnson 1993	This study was excluded as fruit and vegetable consumption was measured in terms of dietitian-classified 'appropriate' versus 'inappropriate' consumption levels, and as such, it failed to meet the inclusion criteria relating to the primary outcome.
Johnson 2007	Outcome is food preference and ranking.
Kalb 2005	No participants, not research trial.
Kashani 1991	Child mean age 10 years.
Kelder 1995	Children in 6th grade school.
Khoshnevisan 2004	Dietary outcomes are not reported for the control group and no comparison is made between between experimental conditions.
Kidala 2000	Quasi-experimental: 2 areas, 1 intervention, 1 control, not randomly selected.
Kilaru 2005	Outcome is proportion being fed bananas.
Korwanich 2008	Quasi-experimental: 8 intervention schools; 8 matched control schools.
LaRowe 2010	No comparison group
Leahy 2008	No fruit and vegetable outcome.

Study	Reason for exclusion
Locard 1987	No comparison group.
Low 2007	Quasi-experimental, 2 intervention areas, and 1 control area selected, in prospective longitudinal study.
Luepker 1996	Child mean age 8.8 years.
Malekafzali 2000	No fruit and vegetable consumption data.
Manios 2009	No comparison group.
Martens 2008	Children aged 12 to 14 years.
McAuley 2010	Child mean age 7.7 years.
McKenzie 1996	Child mean age 6.3 to 6.8 years.
NAPNAP 2006	Guidelines not trial, so no participants.
Nemet 2007	Child mean age 5.5 years.
Nemet 2008	Children aged 8 to 11 years.
Niederer 2009	Child mean age 5.1 years.
Noller 2006	Outcome is public health impact, not fruit and vegetable consumption.
O'Connor 2010	No comparison group.
Olvera 2010	Children aged 7 to 13 years.
Panunzio 2007	Children in 4th grade school.
Parcel 1989	Children in 3rd, 4th grade school.
Passehl 2004	Outcome is process evaluation.
Perry 1985	Children in 3rd, 4th grade school.
Perry 1998	Child mean age 8.8 years.
Rahman 1994	Outcome asks if vegetables eaten today (Yes/No). No amount provided.
Ransley 2007	Non-randomised controlled trial. 1 intervention sample and 1 matched control sample.
Reinaerts 2007	Quasi-experimental: consenting schools paired then randomised to one of two interventions. Control schools in different area identified and then matched.
Reinaerts 2008	Child mean age 8 years.
Reverdy 2008	Children aged 8 to 10 years.
Ruottinen 2008	The intervention programme was not specifically designed to increase consumption of fruit and vegetables.

Study	Reason for exclusion
	The aim of intervention, as reported in a separate paper (Lapinleimu 1995) is *"to investigate the effects of an individually supervised, eucaloric, diet with low content of fat, saturated fat and cholesterol in healthy children"*
Salminen 2005	Children aged 6 to 17 years.
Sanigorski 2008	Child mean age 8 years.
Schwartz 2007a	Study design uses convenience sample.
Schwartz 2007b	Quasi-experimental - 2 elementary schools randomly allocated to 1 intervention and 1 control.
Siega-Riz 2004	No comparison group.
Simons-Morton 1988	Children in 3rd, 4th grade school.
Solomons 1999	Review, not trial, no participants.
Sweitzer 2010	Outcome is servings packed in lunchbox, not consumed.
Talvia 2006	The intervention programme was not specifically designed to increase consumption of fruit and vegetables.
	The aim of intervention, as reported in a separate paper (Lapinleimu 1995) is *"to investigate the effects of an individually supervised, eucaloric, diet with low content of fat, saturated fat and cholesterol in healthy children"*
Taylor 2007	Child mean age 7.7 years.
Uicab-Pool 2009	Outcome is eating habits.
Van Horn 2005	Children aged 8 to 10 years.
Vecchiarelli 2005	Children school-aged.
Veldhuis 2009	Outcome is weight, not fruit and vegetable consumption.
Wardle 2003b	Child mean age 6 years.
Whaley 2010	Study design in intervention and matched control site.
Winkler 2005	Outcome is education program evaluation.
Zotor 2008	Children aged 11 to 15 years.

Characteristics of ongoing studies *[ordered by study ID]*

Adams 2009

Trial name or title	Tooty Fruity Vegie Program
Methods	Cluster randomised study with pre- and post-intervention evaluation (non-randomised controls)
Participants	Preschoolers attending 18 interventions and 13 control preschools in NSW (Australia)

Cochrane
Library

Trusted evidence.
Informed decisions.
Better health.

Cochrane Database of Systematic Reviews

Adams 2009 *(Continued)*

Interventions	Interventions: *"The intervention strategies included skill development and awareness-raising for parents, staff and children, and social support for parents to foster behaviour change in their children through feedback and reinforcement (positive feedback and policies on food and drinks at preschool). Project management committees (PMCs), with parents, staff and health professionals in each preschool, oversaw strategy implementation and ensured sustainability of the program after the one-year supported intervention."* Control: Received the intervention after one year.
Outcomes	Consumption of fruit and vegetables collected from a parent survey - Fruit serves eaten yesterday - Occasions child ate legumes or vegetables yesterday.
Starting date	2006
Contact information	Jillian Adams (jillian.adams@ncahs.health.nsw.gov.au)
Notes	

Campbell 2008

Trial name or title	INFANT - The Infant Feeding Activity and Nutrition Trial
Methods	Cluster randomised controlled trial
Participants	Approx 600 members of first time parents groups at maternal and child health centres within 12 LGAs.*
Interventions	Intervention: *"The intervention will be delivered by a dietitian and is comprised of six sessions delivered at three month intervals during the regular meeting time of the first-time parents' group (see Table 1). Based on an anticipatory guidance framework the intervention will incorporate a range of modes of delivery and educational strategies including brief didactic sessions, use of group discussion and peer support, exploration of perceived barriers, use of visual and written messages, follow-up delivery of messages by text-messaging and mail-outs. All educational concepts will be developed iteratively, that is, messages will be repeated and expanded upon over the course of the intervention."* Control: *"The control group families will receive usual care from their MCH nurse. In addition, these families will be sent general health newsletters (e.g. dental health, sun protective behaviours, general safety), and will receive Birthday and Christmas cards. These families' participation will be rewarded with gifts (to a maximum value of $15.00) on receipt of completed questionnaires."*
Outcomes	Child's dietary intake will be assessed by telephone administered multi-pass 24-hour recall with parents.
Starting date	Unknown
Contact information	Zoe McCallum (Zoe.mccallum@rch.org.au)
Notes	

Daniels 2009

Trial name or title	NOURISH trial

Daniels 2009 *(Continued)*

Methods	Randomised controlled trial
Participants	Approx 820 first time mothers (at least 18 years old) delivering healthy (> 2500 g), term (> 35 weeks) infants at public maternity hospitals in Brisbane (N = 3) and Adelaide (N = 3) (Australia) over a consecutive 4 month period (with full enrolment to the study to commence when the infant is 4 to 7 months). Mothers must be willing to attend sessions at designated metropolitan child health clinics.
Interventions	Intervention: Fortnightly group sessions delivered at existing child health clinics. Group sessions with 10 to 15 mothers per group. Sessions delivered by a dietitian and psychologist with paediatric experience. Six fortnightly sessions (4 to 7 months), then 6 fortnightly sessions (13 to 16 months) then monthly maintenance contacts for 6 months, plus a workbook and fridge magnet with the key messages from each module. Control: Self-directed access to 'usual' child health services at child health clinics
Outcomes	Infant intake (variety and frequency) of fruits and vegetables. Assessed at baseline and follow-up (9 and 18 months) from food intake records from 3 non-consecutive days (include a weekend day) using 2 x 24 h food records plus telephone 24 h recall
Starting date	Unknown
Contact information	Lynne Daniels (l2daniels@qut.edu.au)
Notes	

Wen 2007

Trial name or title	Healthy Beginnings Trial
Methods	Randomised controlled trial
Participants	Approx 782 first time mothers (aged 16 years and older) recruited from all pregnant women attending antenatal classes at Liverpool and Campbelltown hospitals (Australia)
Interventions	Intervention: Intensive, home-based, early intervention delivered by a specialist trained nurse - 8 visits over the first 2 years of life, plus proactive telephone support, promoting healthy feeding and physical activity and enhanced parent / child interaction. Control: Usual care (current standard practice includes one home visit by a community nurse within one month of birth and possible baby clinic visits, plus home safety materials).
Outcomes	Intake at fruit and vegetables at age 2 years. (Phase 2: Intake of fruit and vegetables at age 3, 4 & 5 years). Measured in participant's homes. (The nutrition measures are currently being validated in a sample of 2 to 4 year olds, plus questions regarding food habits from existing population health surveys).
Starting date	Unknown
Contact information	Li Ming Wen (lmwen@email.cs.nsw.gov.au)
Notes	

Wyse 2010

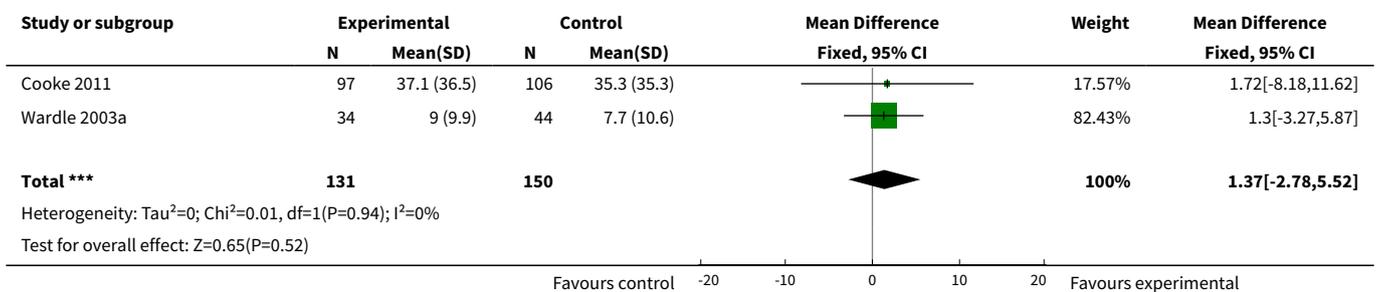|	
Trial name or title	The Healthy Habits trial
Methods	Cluster randomised controlled trial
Participants	Parents of 3 to 5 year old children from randomly selected preschools in the Hunter Region of NSW Australia.
Interventions	Intervention: 4 x weekly 30 minute telephone support calls to increase the availability and accessibility of fruit and vegetables in the home, create supportive family eating routines and role-model fruit and vegetable consumption. Control: Print resources
Outcomes	Children's fruit and vegetable consumption as measured by the Fruit and Vegetable subscale of the Children's Dietary Questionnaire administered via telephone at 2, 6, 12 and 18 months.
Starting date	Unknown
Contact information	Rebecca Wyse (rebecca.wyse@hnehealth.nsw.gov.au)
Notes	

*LGA = Local Government Area

DATA AND ANALYSES

Comparison 1. Short term impact (< 12 months) of repeated exposure intervention versus no intervention on child consumption of a target vegetable

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Vegetable intake (g)	2	281	Mean Difference (IV, Fixed, 95% CI)	1.37 [-2.78, 5.52]

Analysis 1.1. Comparison 1 Short term impact (< 12 months) of repeated exposure intervention versus no intervention on child consumption of a target vegetable, Outcome 1 Vegetable intake (g).

Study or subgroup	Experimental		Control		Mean Difference	Weight	Mean Difference
	N	Mean(SD)	N	Mean(SD)	Fixed, 95% CI		Fixed, 95% CI
Cooke 2011	97	37.1 (36.5)	106	35.3 (35.3)		17.57%	1.72[-8.18,11.62]
Wardle 2003a	34	9 (9.9)	44	7.7 (10.6)		82.43%	1.3[-3.27,5.87]
Total ***	131		150			100%	1.37[-2.78,5.52]

Heterogeneity: Tau²=0; Chi²=0.01, df=1(P=0.94); I²=0%

Test for overall effect: Z=0.65(P=0.52)

Favours control -20 -10 0 10 20 Favours experimental

Comparison 2. Short term impact (< 12 months) of home visiting intervention versus usual care.

Outcome or subgroup title	No. of studies	No. of participants	Statistical method	Effect size
1 Fruit intake	2	1518	Std. Mean Difference (IV, Fixed, 95% CI)	0.01 [-0.09, 0.11]

Analysis 2.1. Comparison 2 Short term impact (< 12 months) of home visiting intervention versus usual care., Outcome 1 Fruit intake.

Study or subgroup	Experimental		Control (usual care)		Std. Mean Difference Fixed, 95% CI	Weight	Std. Mean Difference Fixed, 95% CI
	N	Mean(SD)	N	Mean(SD)			
Haire-Joshu 2008	605	0 (1.6)	701	-0 (1.4)		85.98%	0.03[-0.08,0.14]
Watt 2009	104	19.9 (19.3)	108	21.4 (18)		14.02%	-0.08[-0.35,0.19]
Total ***	709		809			100%	0.01[-0.09,0.11]

Heterogeneity: Tau²=0; Chi²=0.52, df=1(P=0.47); I²=0%

Test for overall effect: Z=0.23(P=0.82)

Favours control -2 -1 0 1 2 Favours experimental

APPENDICES

Appendix 1. Search strategies

CENTRAL in *The Cochrane Library*

#1 MeSH descriptor Fruit explode all trees
#2 MeSH descriptor Citrus explode all trees
#3 MeSH descriptor Vegetables explode all trees
#4 fruit* in All Text
#5 vegetable* in All Text
#6 orange* in All Text
#7 apple* in All Text
#8 (pear in All Text or pears in All Text)
#9 (grape in All Text or grapes in All Text)
#10 banana* in All Text
#11 (berry in Title, Abstract or Keywords or berries in Title, Abstract or Keywords)
#12 citrus in All Text
#13 carrot* in All Text
#14 "greens" in All Text
#15 cabbage* in All Text
#16 brassica* in All Text
#17 blackberr* in All Text
#18 blueberr* in All Text
#19 cranberr* in All Text
#20 kiwi in All Text
#21 guava in All Text
#22 lingonberr* in All Text
#23 mango* in All Text
#24 melon* in All Text
#25 papaya* in All Text
#26 pineapple* in All Text
#27 raspberr* in All Text
#28 strawberr* in All Text

#29 tomato* in All Text
#30 grapefruit* in All Text
#31 mandarin* in All Text
#32 satsuma* in All Text
#33 tangerine* in All Text
#34 (plum in All Text or plums in All Text)
#35 apricot* in All Text
#36 (cherry in All Text or cherries in All Text)
#37 nectarine* in All Text
#38 (peach in All Text or peaches in All Text)
#39 celery in All Text
#40 spinach in All Text
#41 (salad in All Text or salads in All Text)
#42 (pea in All Text or peas in All Text)
#43 (bean in All Text or beans in All Text)
#44 broccoli in All Text
#45 cauliflower* in All Text
#46 beetroot* in All Text
#47 turnip* in All Text
#48 rhubarb in All Text
#49 MeSH descriptor Food Habits this term only
#50 MeSH descriptor Food Preferences this term only
#51 healthy next eating in All Text 208
#52 (#1 or #2 or #3 or #4 or #5 or #6 or #7 or #8 or #9 or #10)
#53 (#11 or #12 or #13 or #14 or #15 or #16 or #17 or #18 or #19 or #20)
#54 (#21 or #12 or #23 or #24 or #25 or #26 or #27 or #28 or #29 or #30)
#55 (#31 or #32 or #33 or #34 or #35 or #36 or #37 or #38 or #39 or #40)
#56 (#41 or #42 or #43 or #44 or #45 or #46 or #47 or #48 or #49 or #50 or #51)
#57 (#52 or #53 or #54 or #55 or #56)
#58 MeSH descriptor Health Education explode all trees
#59 MeSH descriptor Health Promotion explode all trees
#60 MeSH descriptor behavior therapy explode all trees
#61 MeSH descriptor counseling explode all trees
#62 MeSH descriptor organizational policy this term only
#63 (public in All Text and policy in All Text)
#64 MeSH descriptor public policy this term only
#65 MeSH descriptor health policy explode all trees
#66 MeSH descriptor inservice training explode all trees
#67 promot* in All Text
#68 educat* in All Text
#69 program* in All Text
#70 (policy in All Text or policies in All Text)
#71 train* in All Text
#72 (diet* in All Text near/6 intervention* in All Text)
#73 (behavi* in All Text near/6 intervention* in All Text)
#74 (#58 or #59 or #60 or #61 or #62 or #63 or #64 or #65 or #66 or #67)
#75 (#68 or #69 or #70 or #71 or #72 or #73 or #74)
#76 (#74 or #75)
#77 MeSH check word Infant
#78 MeSH descriptor Child, Preschool this term only
#79 (child in All Text or children in All Text)
#80 (pre-school* in All Text or preschool* in All Text)
#81 (infant in All Text or infants in All Text)
#82 (nursery in All Text or nurseries in All Text)
#83 MeSH descriptor Parents explode all trees
#84 (parent in All Text or parents in All Text)
#85 toddler* in All Text
#86 MeSH descriptor Nurseries this term only
#87 nurseries in All Text
#88 (#77 or #78 or #79 or #80 or #81 or #82 or #83 or #84 or #85 or #86 or #87)
#89 (#57 and #76 and #88)

MEDLINE OVID

1. exp Fruit/

2. exp Citrus/

3. exp Vegetables/

4. fruit*.tw.

5. vegetable*.tw.

6. orange*.tw.

7. apple*.tw.

8. (pear or pears).tw.

9. (grape or grapes).tw.

10. banana*.tw.

11. (berry or berries).tw.

12. citrus.tw.

13. carrot*.tw.

14. greens.tw.

15. cabbage*.tw.

16. brassica*.tw.

17. blackberr*.tw.

18. blueberr*.tw.

19. cranberr*.tw.

20. guava*.tw.

21. kiwi*.tw.

22. lingonberr*.tw.

23. mango*.tw.

24. melon*.tw.

25. papaya*.tw.

26. pineapple*.tw.

27. raspberr*.tw.

28. strawberr*.tw.

29. tomato*.tw.

30. potato*.tw.

31. onion*.tw.

32. grapefruit*.tw.

33. mandarin*.tw.

34. satsuma*.tw.

35. tangerine*.tw.

36. (plum or plums).tw.

37. apricot*.tw.

38. (cherry or cherries).tw.

39. nectarine*.tw.

40. (peach or peaches).tw.

41. celery.tw.

42. spinach*.tw.

43. (salad or salads).tw.

44. (pea or peas).tw.

45. (bean or beans).tw.

46. broccoli.tw.

47. cauliflower*.tw.

48. beetroot*.tw.

49. turnip*.tw.

50. rhubarb.tw.

51. Food Habits/

52. Food Preferences/

53. ((food or eating) adj (habit* or preference*)).tw.

54. eating behavi*.tw.

55. (health* adj eating).tw.

56. or/1-55

57. exp Health Education/

58. exp Health Promotion/

59. exp Behavior Therapy/

60. exp Counseling/

61. organizational policy/

62. Public Policy/

63. exp Health Policy/

64. exp Inservice Training/

65. promot*.tw.

66. educat*.tw.

67. program*.tw.

68. (policy or policies).tw.

69. train*.tw.

70. (diet* adj6 intervention*).tw.

71. (behavi* adj6 intervention*).tw.

72. or/57-71

73. exp Infant/

74. Child, Preschool/

75. (child or children).tw.

76. (pre-school* or preschool*).tw.

77. (infant or infants).tw.

78. infancy.tw.

79. (nursery or nurseries).tw.

80. exp Parents/

81. (parent or parents).tw.

82. toddler*.tw.

83. Nurseries/

84. (baby or babies).tw.

85. or/73-84

86. 56 and 72 and 85

87. randomized controlled trial.pt.

88. controlled clinical trial.pt.

89. randomized.ab.

90. placebo.ab.

91. drug therapy.fs.

92. randomly.ab.

93. trial.ab.

94. groups.ab.

95. 87 or 88 or 89 or 90 or 91 or 92 or 93 or 94

96. exp animals/ not humans.sh.

97. 95 not 96

98. 86 and 97

EMBASE Classic + EMBASE (OVID)

1. exp Fruit/

2. exp Vegetables/

3. fruit*.tw.

4. vegetable*.tw.

5. orange*.tw.

6. apple*.tw.

7. (pear or pears).tw.

8. (grape or grapes).tw.

9. banana*.tw.

10. (berry or berries).tw.

11. citrus.tw.

12. carrot*.tw.

13. greens.tw.

14. cabbage*.tw.

15. brassica*.tw.

16. blackberr*.tw.

17. blueberr*.tw.

18. cranberr*.tw.

19. guava*.tw.

20. kiwi*.tw.

21. lingonberr*.tw.

22. mango*.tw.

23. melon*.tw.

24. papaya*.tw.

25. pineapple*.tw.

26. raspberr*.tw.

27. strawberr*.tw.

28. tomato*.tw.

29. grapefruit*.tw.

30. mandarin*.tw.

31. satsuma*.tw.

32. tangerine*.tw.

33. (plum or plums).tw.

34. apricot*.tw.

35. (cherry or cherries).tw.

36. nectarine*.tw.

37. (peach or peaches).tw.

38. celery.tw.

39. spinach*.tw.

40. (salad or salads).tw.

41. (pea or peas).tw.

42. (bean or beans).tw.

43. onion*.tw.

44. broccoli.tw.

45. cauliflower*.tw.

46. beetroot*.tw.

47. turnip*.tw.

48. rhubarb.tw.

49. potato*.tw.

50. exp feeding behavior/

51. ((food or eating) adj (habit* or preference*)).tw.

52. eating behavi*.tw.

53. (health* adj eating).tw.

54. or/1-53

55. exp health education/

56. consumer health information/

57. behavior therapy/

58. exp counseling/

59. policy/

60. health care policy/

61. in service training/

62. promot*.tw.

63. educat*.tw.

64. program*.tw.

65. (policy or policies).tw.

66. train*.tw.

67. (diet* adj6 intervention*).tw.

68. (behavi* adj6 intervention*).tw.

69. lifestyle modification/

70. or/55-69

71. exp infant/

72. preschool child/

73. (child or children).tw.

74. (pre-school* or preschool*).tw.

75. (infant or infants).tw.

76. infancy.tw.

77. (nursery or nurseries).tw.

78. exp parent/

79. (parent or parents).tw.

80. toddler/

81. toddler*.tw.

82. nursery/

83. kindergarten/

84. (baby or babies).tw.

85. or/71-84

86. 54 and 70 and 85

87. random$.tw.

88. factorial$.tw.

89. crossover$.tw.

90. cross over$.tw.

91. cross-over$.tw.

92. placebo$.tw.

93. (doubl$ adj blind$).tw.

94. (singl$ adj blind$).tw.

95. assign$.tw.

96. allocat$.tw.

97. volunteer$.tw.

98. crossover procedure/

99. double blind procedure/

100. randomized controlled trial/

101. single blind procedure/

102. 87 or 88 or 89 or 90 or 91 or 92 or 93 or 94 or 95 or 96 or 97 or 98 or 99 or 100 or 101

103. (animal/ or nonhuman/) not human/

104. 102 not 103

105. 86 and 104

PsycINFO (OVID)

1. fruit*.tw.

2. vegetable*.tw.

3. orange*.tw.

4. apple*.tw.

5. (pear or pears).tw.

6. (grape or grapes).tw.

7. banana*.tw.

8. (berry or berries).tw.

9. citrus.tw.

10. carrot*.tw.

11. greens.tw.

12. cabbage*.tw.

13. brassica*.tw.

14. blackberr*.tw.

15. blueberr*.tw.

16. cranberr*.tw.

17. guava*.tw.

18. kiwi*.tw.

19. lingonberr*.tw.

20. mango*.tw.

21. melon*.tw.

22. papaya*.tw.

23. pineapple*.tw.

24. raspberr*.tw.

25. strawberr*.tw.

26. tomato*.tw.

27. grapefruit*.tw.

28. mandarin*.tw.

29. satsuma*.tw.

30. tangerine*.tw.

31. (plum or plums).tw.

32. apricot*.tw.

33. (cherry or cherries).tw.

34. nectarine*.tw.

35. (peach or peaches).tw.

36. celery.tw.

37. spinach*.tw.

38. (salad or salads).tw.

39. (pea or peas).tw.

40. (bean or beans).tw.

41. broccoli.tw.

42. cauliflower*.tw.

43. beetroot*.tw.

44. turnip*.tw.

45. rhubarb.tw.

46. onion*.tw.

47. potato*.tw.

48. eating behavior/

49. food preferences/

50. eating attitudes/

51. (health* adj eating).tw.

52. eating behavi*.tw.

53. ((food or eating) adj (habit* or preference*)).tw.

54. or/1-53

55. health education/

56. health promotion/

57. health literacy/

58. lifestyle changes/

59. exp behavior therapy/

60. exp counseling/

61. organizational policy/

62. exp policy making/

63. exp inservice training/

64. promot*.tw.

65. educat*.tw.

66. program*.tw.

67. (policy or policies).tw.

68. train*.tw.

69. (diet* adj6 intervention*).tw.

70. (behavi* adj6 intervention*).tw.

71. or/55-70

72. (child or children).tw.

73. (pre-school* or preschool*).tw.

74. (infant or infants).tw.

---

75. (nursery or nurseries or kindergarten*).tw.

76. (parent or parents).tw.

77. toddler*.tw.

78. (baby or babies).tw.

79. exp parents/

80. exp nursery school students/

81. kindergarten students/

82. infancy.tw.

83. ("120" or "140" or "160").ag.

84. or/72-83

85. 54 and 71 and 84

86. random$.tw.

87. factorial$.tw.

88. crossover$.tw.

89. cross-over$.tw.

90. placebo$.tw.

91. (doubl$ adj blind$).tw.

92. (singl$ adj blind$).tw.

93. assign$.tw.

94. allocat$.tw.

95. volunteer$.tw.

96. control*.tw.

97. "2000".md.

98. or/86-97

99. 85 and 98

CINAHL Plus with Full Text

S102 S83 and S101

S101 S84 or S85 or S86 or S87 or S88 or S89 or S90 or S91 or S92 or S93 or S94 or S95 or S96 or S97 or S98 or S99 or S100

S100 TX cross-over*

S99 TX crossover*

S98 TX volunteer*

S97 (MH "Crossover Design")

S96 TX allocat*

S95 TX control*

S94 TX assign*

S93 TX placebo*

S92 (MH "Placebos")

S91 TX random*

S90 TX (doubl* N1 mask*)

S89 TX (singl* N1 mask*)

S88 TX (doubl* N1 blind*)

S87 TX (singl* N1 blind*)

S86 TX (clinic* N1 trial?)

S85 PT clinical trial

S84 (MH "Clinical Trials+")

S83 S55 and S69 and S82

S82 S70 or S71 or S72 or S73 or S74 or S75 or S76 or S77 or S78 or S79 or S80 or S81

S81 TI kindergarten or AB kindergarten

S80 (MH "Schools, Nursery")

S79 TI (baby or babies) or AB (baby or babies)

S78 TI toddler* or AB toddler*

S77 TI (parent or parents) or AB (parent or parents)

S76 (MH "Parents+")

S75 TI (nursery or nurseries) or AB (nursery or nurseries)

S74 TI (infant or infants or infancy) or AB (infant or infants or infancy)

S73 TI (pre-school* or preschool* or "pre school*") or AB (pre-school* or preschool* or "pre school*")

S72 TI (child or children) or AB (child or children)

S71 (MH "Child, Preschool")

S70 (MH "Infant+")

S69 S56 or S57 or S58 or S59 or S60 or S61 or S62 or S63 or S64 or S65 or S66 or S67 or S68

S68 TI (behavi* N5 intervention*) or AB (behavi* N5 intervention*)

S67 TI (diet* N5 intervention*) or AB (diet* N5 intervention*)

S66 TI train* or AB train*

S65 TI (policy or policies) or AB (policy or policies)

S64 TI program* or AB program*

S63 TI educat* or AB educat*

S62 TI promot* or AB promot*

S61 (MH "Public Policy+")

S60 (MH "Organizational Policies+")

S59 (MH "Counseling+")

S58 (MH "Behavior Therapy+")

S57 (MH "Health Promotion+")

S56 (MH "Health Education+")

S55 S1 or S2 or S3 or S4 or S5 or S6 or S7 or S8 or S9 or S10 or S11 or S12 or S13 or S14 or S15 or S16 or

S17 or S18 or S19 or S20 or S21 or S22 or S23 or S24 or S25 or S26 or S27 or S28 or S29 or S30 or S31 or S32 or S33 or S34 or S35 or S36 or S37 or S38 or S39 or S40 or S41 or S42 or S43 or S44 or S45 or S46 or S47 or S48 or S49 or S50 or S51 or S52 or S53 or S54

S54 TI ("food habit*" or "food preference*" or "eating habit*" or "eating preference*") or AB ("food habit*" or "food preference*" or "eating habit*" or "eating preference*")

S53 TI "health* eating" or AB "health* eating"

S52 (MH "Food Preferences")

S51 (MH "Food Habits")

S50 TI rhubarb or AB rhubarb

S49 TI onion* or AB onion*

S48 TI potato* or AB potato*

S47 TI turnip* or AB turnip*

S46 TI beetroot* or AB beetroot*

S45 TI cauliflower* or AB cauliflower*

S44 TI broccoli or AB broccoli

S43 TI (bean or beans) or AB (bean or beans)

S42 TI (pea or peas) or AB (pea or peas)

S41 TI (salad or salads) or AB (salad or salads)

S40 TI spinach* or AB spinach*

S39 TI celery or AB celery

S38 TI (peach or peaches) or AB (peach or peaches)

S37 TI nectarine* or AB nectarine*

S36 TI (cherry or cherries) or AB (cherry or cherries)

S35 TI apricot* or AB apricot*

S34 TI (plum or plums) or AB (plum or plums)

S33 TI tangerine* or AB tangerine*

S32 TI satsuma* or AB satsuma*

S31 TI mandarin* or AB mandarin*

S30 TI grapefruit* or AB grapefruit*

S29 TI tomato* or AB tomato*

S28 TI strawberr* or AB strawberr*

S27 TI raspberr* or AB raspberr*

S26 TI pineapple* or AB pineapple*

S25 TI papaya* or AB papaya*

S24 TI melon* or AB melon*

S23 TI mango* or AB mango*

S22 TI lingonberr* or AB lingonberr*

S21 TI guava* or AB guava*

S20 TI kiwi* or AB kiwi*

S19 TI cranberr* or AB cranberr*

S18 TI blueberr* or AB blueberr*

S17 TI blackberr* or AB blackberr*

S16 TI brassica* or AB brassica*

S15 TI cabbage* or AB cabbage*

S14 TI "greens" or AB "greens"

S13 TI carrot* or AB carrot*

S12 TI citrus or AB citrus

S11 TI (berry or berries) or AB (berry or berries)

S10 TI banana* or AB banana*

S9 TI (grape or grapes) or AB (grape or grapes)

S8 TI (pear or pears) or AB (pear or pears)

S7 TI apple* or AB apple*

S6 TI orange* or AB orange*

S5 TI vegetable* or AB vegetable*

S4 TI fruit* or AB fruit*

S3 (MH "Vegetables+")

S2 (MH "Citrus+")

S1 (MH "Fruit+")

metaRegister of clinical trials

(fruit or citrus or vegetable or food habits or food preferences) AND (infant or child, preschool or parents or nurser*)

WHO International Clinical Trials Registry Platform

fruit or citrus or vegetable or food habits or food preferences AND infant or child, preschool or parents or nurser*

Proquest Dissertations & Theses

(fruit or citrus or vegetable or food habits or food preferences) AND (infant or child, preschool or parents or nurser*)

CONTRIBUTIONS OF AUTHORS

Luke Wolfenden led the development of the review. All authors contributed to the conception of the research and were involved in the preparation of the review including providing critical comment on drafts. Luke Wolfenden, Fiona Stacey and Rebecca Hodder screened titles and abstracts and determined study eligibility. Rebecca Wyse, Ben Britton and Erica James extracted data from eligible trials, and assessed heterogeneity and risk of bias. Patrick McElduff provided statistical advice.

DECLARATIONS OF INTEREST

Luke Wolfenden, Rebecca Wyse and Karen Campbell are currently undertaking a randomised trial of an intervention to increase fruit and vegetable consumption. The authors have not received any benefit, in cash or kind, any hospitality, or any subsidy derived from the food industry or any other source perceived to have an interest in the outcome of the review.

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  Salary Support
- Cancer Institute NSW, Australia.

  Salary support

External sources

- No sources of support supplied

DIFFERENCES BETWEEN PROTOCOL AND REVIEW

- Trials were only included if fruit and/or vegetable intake was listed as the primary trial outcome. The protocol stated that trials listing fruit and/or vegetable intake as a secondary trial outcome would also be included.
- Classification of intervention effects as 'short-term' was amended from 3 to < 12 months in the protocol to < 12 months in the review.
- Professional associations were not contacted as part of the review search strategy, nor was the National Institute of Health Randomized Trial Records Database.
- Unpublished manuscripts were excluded from the review.
- The title and text throughout the review were amended to ensure consistent terminology regarding the description of age. Specifically, we replaced the age description of children as 'preschool' with a more precise description of 'children aged five years and under' to more accurately reflect the scope of the review. We refer only to preschools when discussing the findings of trials conducted in that setting specifically.
- As some trials included children across a range of ages, we included any trial where the mean age of the sample at baseline was five years or under.
- While two independent reviewers extracted data from each study, the role of the second independent reviewer was shared by two authors (BB and EJ).

INDEX TERMS

Medical Subject Headings (MeSH)

*Eating; *Feeding Behavior; *Fruit; *Vegetables; Conditioning (Psychology); House Calls; Randomized Controlled Trials as Topic; Reward

MeSH check words

Child, Preschool; Humans; Infant