

Available from: http://dx.doi.org/10.1111/j.1467-789X.2012.01022.x

The definitive version is available at www.onlinelibrary.wiley.com

Accessed from: http://hdl.handle.net/1959.13/939834
The quality of dietary intake methodology and reporting in child and adolescent obesity intervention trials: a systematic review.

Tracy Burrows1*, Rebecca K Golley2*, Amina Kambalia3, Sarah A. McNaughton4, Anthea Magarey5, Richard R Rosenkranz6, Margaret Alldman-Farinelli7, Anna M Rangan7, Helen Truby8, Clare Collins1.

1 School of Health Sciences, Faculty of Health, Priority Research Centre for Physical Activity and Nutrition, University of Newcastle, Newcastle, New South Wales, Australia; 2 Public Health, School of Health Sciences, Sansom Institute for Health Research, University of South Australia, Adelaide, Australia; 3 Clinical and Population Perinatal Research, Kolling Institute of Medical Research, University of Sydney at Royal North Shore Hospital, New South Wales, Australia; 4 Centre for Physical Activity and Nutrition Research, School of Exercise and Nutrition Sciences, Deakin University, Burwood, Victoria, Australia; 5 Nutrition and Dietetics, Flinders University, Adelaide, SA, Australia; 6 Department of Human Nutrition, Kansas State University, Manhattan, KS, USA; 7 Nutrition and Metabolism, School of Molecular Bioscience, The University of Sydney, NSW, Australia; 8 Nutrition and Dietetics, Monash University, Clayton, Victoria.

Authors are part of the food and nutrition stream of the Australian Child and Adolescent Obesity Research Network (ACAORN). This is a network established to foster and coordinate research collaboration among Australian and New Zealand child and adolescent obesity researchers.

Author Contributions: *Co-first authors contributed equally to this work. All authors provided input to data collection and preparation of manuscript. All authors have approved the final article. None of the authors had any financial support or relationships that may pose conflict of interest.

Address Correspondence to:

Dr Tracy Burrows
PhD, BHSce (N&D), GTTT, Adv APD
School of Health Sciences, Faculty of Health, University of Newcastle,
University Drive, Callaghan, Newcastle, NSW, Australia, 2308
Running Head: The quality of dietary intake methods reporting

Abstract word count: 229

Manuscript word count: 3613

Number of figures: 3

Number of tables: 1

Key words: diet, nutrition, methodology, obesity, overweight, children, interventions, systematic review

Disclosure of interest: The authors have no conflicts of interest to disclose.

Acknowledgements: We wish to thank the librarian Debbie Booth, University of Newcastle who designed the electronic search strategies, Ms Lucy Bell, University South Australia for assistance with screening and data extraction and Ms Roberta Asher for pilot data extraction and study retrieval. Funding was received from the Australian Child and Adolescent Obesity Research Network. RKG was supported by a National Health and Medical Research Council (NHMRC) Public Health Postdoctoral Fellowship (ID 478115). AK is funded by an Australian National Health and Medical Research Council (NHMRC) Centers for Research Excellence (APP1001066). SAM is supported by an Australian Research Council Future Fellowship (FT100100581). CC is support by an NHMRC Career Development Fellowship.
ABSTRACT

Assessing dietary intake is important in evaluating childhood obesity intervention effectiveness. The purpose of this review was to evaluate the dietary intake methods and reporting in intervention studies that included a dietary component to treat overweight or obese children.

A systematic review of studies published in the English language, between 1985 and August 2010 in health databases. The search identified 2295 papers, of which 335 were retrieved and 31 met the inclusion criteria. Twenty-three studies reported energy intake as an outcome measure, 20 reported macronutrient intakes and 10 studies reported food intake outcomes. The most common dietary method employed was the food diary (n=13), followed by 24-hour recall (n=5), food frequency questionnaire (FFQ) (n=4) and, dietary questionnaire (n=4). The quality of the dietary intake methods reporting was rated as ‘poor’ in 15 studies (52%) and only three were rated as ‘excellent.’ The reporting quality of FFQs tended to be higher than food diaries/recalls.

Deficiencies in the quality of dietary intake methods reporting in child obesity studies were identified. Use of a dietary intake methods reporting checklist is recommended. This will enable the quality of dietary intake results to be evaluated, and an increased ability to replicate study methodology by other researchers.
BACKGROUND

Dietary intake is a major determinant in the development, prevention and management of child and adolescent overweight and obesity. There are limited published data that report on children’s dietary intake in the context of obesity interventions. In a 2006 systematic review of child obesity treatment studies that included a dietary intervention component, 23 of 37 randomized controlled trials (RCTs) indicated that changes in dietary intake were measured. However, only 11 studies actually reported dietary outcomes.

The lack of reporting of dietary outcomes is likely due to the challenges of measuring dietary intake, particularly in children and adolescents. A number of issues need to be considered when assessing dietary intake. This includes whether a comprehensive assessment of usual diet is required versus specific food components or dietary patterns; as well as consideration of subject burden, cost, administrative and analytic burdens. These issues are discussed in detail elsewhere.

Additionally, there are many methods to assess dietary intake each with advantages and disadvantages, including threats to deriving reliable and valid estimates of energy, food, or nutrient intake.

Good quality reporting of dietary intake methods is an important part of being able to replicate studies, interpret dietary intake findings and consider potential measurement bias. There are no universal recommendations to guide adequate reporting of dietary methods or the validity of dietary assessment methods. However the checklist by Nelson and colleagues provides an overview of the details required. Similarly the score developed by Serra-Majem and colleagues provides a means of evaluating the quality of dietary intake validation studies. To our knowledge, no research to date has critiqued the dietary assessment methods and reporting used in child obesity intervention studies that include an outcome measure of dietary intake.

Therefore the aim of this review was to evaluate the quality of reporting of dietary intake methods in intervention trials for treatment of overweight or obesity in children and adolescents that included a dietary component and reported a dietary outcome.
METHODS

This systematic review followed a prospectively prepared protocol, and is reported using the PRISMA reporting guidelines for systematic reviews.9

Search strategy

A two-phased search strategy was undertaken to identify studies in the English language published between 1985 and August 2010. With the expertise of a librarian, investigators conducted an initial search in MEDLINE and Cumulative Index to Nursing and Allied Health Literature (CINAHL) to establish appropriate search terms. A second systematic search of all relevant databases (PREMEDLINE/MEDLINE, Cochrane Library, EMBASE (Excerpta Medica Database), CINAHL, Web of Science, Scopus and PsycINFO) was performed using key words. These were: dietetic, diet, nutrition, healthy eating and dietary intervention, paediatric (pediatric), child, adolescent, family, parent, school, overweight, obesity, intervention, weight control or weight management or weight loss or healthy weight. An example of a full search strategy is presented in Table S1. Full electronic search strategies are available upon request. Electronic searches were supplemented by cross-checking reference lists of relevant publications.

Selection criteria

To be eligible for inclusion, studies needed to: be a RCT or controlled clinical trial; examine an intervention for treatment of overweight and/or obesity that included a dietary component; target children/adolescents (defined for this review as < 20 years of age) who were defined as overweight or obese; and report a measure of dietary intake as an outcome (i.e. energy intake, macro and/or micronutrient intakes, grams of food groups/items, percentage of energy from foods groups/items, frequency of consumption of foods). Studies that only included a dietary-related outcome (i.e. measures of disordered eating, food habits, or dietary knowledge) were excluded. To limit the heterogeneity of studies reviewed, studies that were of overall poor study methodology were excluded. Overall study quality was assessed using the standardised critical appraisal tool from the American Dietetic Association (ADA).10 Ten quality questions were rated (yes/no) spanning: clarity
of research question, selection bias, randomisation, drop out, blinding, clarity of intervention
description, validity of measures, appropriateness of statistical analyses, conclusions drawn, and
funding sources. An overall quality rating was assigned: Positive if five or more questions were
rated “Yes” (including questions 2, 3, 6, 7); Neutral if questions 2, 3, 6, and 7 were rated “No”;
Negative if six or more questions were rated “No” or two or more of questions 2, 3, 6, 7 were rated
"No". Only studies rated positive or neutral were included in the review.

Selection strategy and procedures

Articles were assessed for eligibility independently by two investigators in two stages; the
first screening stage involved titles and abstracts, and the second involved the full text. In case of
discrepancy between the investigators at stage one screening, the paper was automatically included
into stage two screening. Any discrepancies at stage two screening were resolved through
discussion among three investigators.

Critical appraisal

Dietary assessment methods and reporting quality assessment were performed
independently by two reviewers using a checklist developed specifically for this review (Table S2).
The checklist was informed by the dietary assessment methods checklist of Nelson and colleagues
and the EURReca (European Micronutrients Recommendations Aligned) scoring system. The
review checklist consisted of six components: methodology validated in similar population,
appropriate validation statistics used, data collection quality, reporting of scoring or details of food
composition database, and two method specific components (e.g. scale frequency, multiple recall
days, seasonality considered). A summary score of the components was calculated. The maximum
score was seven and studies were rated as: poor (≤2), acceptable (≤2.5 - ≥3.5), good (≥3.5 - ≤5) or
excellent (≥5.0).

For those studies which referenced a validation study for the dietary assessment method, the
reference(s) were retrieved and were assessed for study design (validation or reliability study),
appropriateness of the validation study population, their comparative (reference) method and the statistical analysis performed.

**Data extraction and analysis**

Data were extracted into standardised tables by one investigator and checked for completeness and accuracy by a second. A meta-analysis was not possible, given the heterogeneity of the intervention strategies and outcomes measured. Data synthesis comprised grouping studies by dietary assessment method and comparing in terms of study characteristics and dietary assessment methods reporting quality.
RESULTS

General description of included studies

The search identified 2295 papers of which a total of 31 papers met the review inclusion criteria (Figure 1). The most common reason for exclusion was study population (n=125), and 95 studies were excluded as no dietary intake outcomes were reported. The majority of included studies were RCTs (n=27) (Table 1) and were published from 2007, with no retrieved papers published prior to 2000. Eighteen studies were conducted in the Americas \(^{11-28}\), four were conducted in Europe, \(^{29-32}\), four in Mediterranean and Middle Eastern countries, \(^{33-36}\) and three in Australia. \(^{37-39}\)

Twelve studies were conducted in a community setting, \(^{11-13, 15, 16, 18, 20-22, 27, 28, 37}\) seven in hospitals, \(^{14, 17, 29-31, 33, 35}\) four in universities, \(^{19, 24, 26, 36}\) and four in primary health care settings. \(^{25, 34, 38, 39}\) Six studies targeted children less than 10 years of age, \(^{11, 17, 23, 37-39}\) 13 studies focused on older children, \(^{12-16, 21, 25-28, 31, 40, 41}\) while 12 studies included both younger and older children (Table 1). The number of study participants ranged from 16 to 258, with most studies including between 20 and 50 participants per group (Table 1).

Interventions were heterogeneous and included various combinations of the cornerstones of child weight management; diet, physical activity, and behaviour modification (Figure 2). The group comparison was diet versus physical activity in nine studies, \(^{12, 13, 16, 17, 19, 26, 37, 41}\) a comparison of different dietary approaches in seven studies, \(^{14, 21, 27-29, 31, 37}\) and alternative delivery approaches in five studies. \(^{15, 22, 23, 28, 33}\) Fourteen studies included a no-intervention control arm. \(^{11-15, 24, 26, 30, 32, 35, 36, 38-40}\) Most studies had short-term interventions, mean 13 weeks (range 6 to 25) (Table 1). Follow-up was generally limited to the end of the intervention \(^{11-13, 15, 17-19, 27, 28, 36, 40}\) and varied between eight weeks \(^{18}\) and two years. \(^{17}\)

Dietary assessment methods and reporting

Twenty three of the 31 studies reviewed reported energy intake as an outcome measure, and 20 reported macronutrient intakes (Table 1). In contrast, only 10 studies reported food group intake outcomes. The most common method for assessing dietary intake was a food diary/record (n=13...
studies), with five using 24 hour records/recalls, four using food frequency questionnaires (FFQ i.e.
questionnaires focusing specifically on assessment of frequency of food intake) and four using
dietary questionnaires (Figure 2). The remaining five studies used multiple dietary assessment or
other methods.

The reporting of the dietary assessment methods was rated as ‘poor’ for 15 of the 31 studies
(Table 1). A registered dietitian was reported as administering the dietary assessment method in 10
studies, with a further 11 studies reporting use of personnel who had received some training in
dietary assessment. The reporting of dietary methods was generally limited by a lack of information
on the instrument quality and validity, the qualifications of the person who administered the dietary
assessment, and the food composition database that was used to derive energy and nutrient intakes.
Of the 31 studies, 11 studies made reference to a dietary validation study for the dietary assessment
tool used in the study 16, 17, 20, 25, 27, 28, 32, 33, 35-37. Of the studies that did not cite a validation reference,
11 used a food record, either weighed or estimated. The four studies using a food record that did
reference a validation study all cited the same reference. One validation study was conducted in an
adult population, limiting its applicability to the population in which it was used.

Among the referenced validation studies the test dietary intake assessment method was
compared with another dietary method, with the exception of three studies which used objective
standards. Two studies compared a food diary or a diet history with Doubly Labelled Water (DLW)
and a FFQ was compared against biomarkers of fruit and vegetable intake.

The most common statistical approach used to compare two methods was correlation
coefficients (n=8 studies). Three studies compared mean intake by the two methods using T-tests.
Three studies used Bland-Altman plots to assess the level of agreement between methods, and one
used Kappa statistic. Correlation coefficients for FFQs were modest and ranged between 0.26 and
0.63 and between 0.50 and 0.6 for 24 hour recalls. Repeatability was only assessed in three studies,
although one was conducted in adults and not the child population where it was applied.
The dietary assessment methods reporting for studies using a food diary/record was generally poor (Figure 3), with only three studies rated as good/excellent. However, seven did report that the food diary/records were administered by a trained person (Figure 3). Most of the studies using 24-hour recalls were rated as good for dietary methods reporting quality and tended to be administered by a registered dietitian (Figure 3). Studies that used multiple dietary intake methods used 24-hour recalls in addition to either a food frequency questionnaire (n=2) or a diet history interview (n=1). Studies using dietary questionnaires were more variable (Figures 2 and 3). The validity of the dietary questionnaires was not addressed in any of the studies and none were reported as being administered by trained staff. All the studies utilising dietary questionnaires were rated as poor for dietary methods reporting (Table 1).

DISCUSSION

Principal findings

To the authors’ knowledge, this is the first systematic review to evaluate the quality of dietary intake methods reporting in intervention studies evaluating childhood obesity interventions that included a dietary component. Studies were only selected for inclusion in the review if their overall study design quality was high. Despite this, there were limitations in the dietary intake methods detail provided in the majority of studies reviewed. The quality of dietary assessment methods reporting was rated as ‘poor’ in 15/31 studies reviewed and only three were rated as ‘excellent’. This is surprising given dietary intake is commonly a key focus of intervention for both treatment and prevention of childhood obesity. Poor dietary intake methods’ reporting has implications for a reader’s ability to replicate studies, interpret dietary intake findings and consider potential measurement bias.

Choice of dietary assessment method did appear to be related to the quality of the dietary assessment methods reporting. The reporting quality of studies that used food frequency questionnaires tended to be rated as ‘excellent’ or ‘good’, compared to studies that used 24-hour
recalls or food diaries. These findings may reflect the high degree of structure associated with food frequency questionnaires which may make it easier to report method details appropriately or that FFQs can be quite varied and specific to foods/population groups which require more detail. In comparison, food recalls and diaries are complex and their administration involves a number of detailed steps. This complexity may make it difficult to comprehensively but concisely provide sufficient detail on these methods when word count for the overall article is limited. Twenty-four hour recalls may also have a perception that this approach is a standardised methodology and does not require further detail. The dietary assessment methods reporting of dietary questionnaires was particularly poor. This may reflect that dietary questionnaires themselves are a relatively recent addition to the dietary assessment methods repertoire and lack rigorous testing. There may also be the perception that nutrition experts need not be involved in their development and validation.

The review highlights the limited use or availability of validated tools to assess dietary intake in paediatric populations. Dietary intake assessment is complex and all methods have a number of threats to validity and reliability, including those considered ‘gold standard’ such as weighed food records and 24 hour recalls. It is important to use methods that are age-appropriate and have been developed, piloted and validated for assessing children’s dietary intake. Without adequate piloting in the study population, or use of methods that have been validated in a similar study population, it is not possible to interpret dietary intake findings. For example, were the changes in dietary intake (or lack thereof) observed due to the intervention or measurement error? Choosing existing validated tools or undertaking a validation sub-study needs to be considered when planning a study. It is also important to report or reference the validation details when reporting dietary intake outcomes.

Selection of the most appropriate dietary assessment tool depends on many factors, including type of information needed (i.e. foods, nutrients, or specific dietary behaviours), the level of accuracy required, the research constraints (i.e. money, time, staff and respondent characteristics) and the suitability of that method to the study design. None of the studies provided a rationale for
their choice of dietary assessment method. The most common method for assessing dietary intake was the food diary/record, whereby the respondent (or parent, in case of children) recorded the foods and beverages and the amounts of each consumed over one or more days. Although this method was commonly used and is considered a gold standard its accuracy is questionable. Researchers using food records in child obesity interventions should take particular care to ensure quality use within a study and quality reporting of the method. Only 10 studies reported actual changes in food consumption, with most reporting outcomes such as energy and macronutrients. This lack of food-based outcome data makes development of practical food-based guidelines for obesity interventions for children and adolescents difficult. The use of 24 hour recalls or FFQs appear to provide the most meaningful results in terms of study quality and flexibility for a range of diet outcomes. Technology-assisted versions of these methods may increase the feasibility of incorporating these methods into future child obesity intervention trials by reducing participant and researcher-burden.

The checklist used to rate the quality of the dietary assessment methods reporting was developed for the purposes of the present review. It was informed by the “Checklist for the Methods Section of Dietary Investigations” which was proposed by the UK Nutritional Epidemiology Group in the early 1990s as a guide for reporting on nutrition. Results of this review indicate infrequent application of this checklist or similar principles, and highlights the need for journal editors to set higher standards for studies reporting dietary methods in the context of child obesity interventions. This will encourage authors to fully describe their dietary methods and incorporate meaningful and valid measures of dietary intake. The majority of studies that did not reference a dietary validation study used food records, perhaps because this is considered the closest to a ‘gold standard’. However, given the limitations associated with all dietary assessment methods, the same reporting standards should apply to food records, including transparent reporting of validity properties in a similar population.
The majority of validation studies used correlation statistics which indicate whether two methods are associated. Associations between dietary methods may be an artefact of correlated errors and correlation coefficients of the magnitude observed in this review (around 0.6) suggest that ~40% of individuals would be misclassified by one method compared to the other. C. deMoor et al suggest a correlation coefficient of 0.9 or higher is needed to avoid misclassification bias. We would recommend alternative statistical approaches be reported in validation studies. Techniques such as Bland and Altman plots or methods assessing misclassification (e.g. kappa statistic) provide more useful information on agreement between methods and are more transparent in potential error or bias associated with different dietary assessment methods. Repeatability and sensitivity to detecting change of dietary assessment method was rarely assessed. This is particularly important in the context of child obesity intervention studies and should be considered or evaluated when selecting dietary assessment methods in future studies.

**Strengths and limitations**

Strengths of this systematic review include an extensive literature search, rigorous adherence to a predefined protocol and use of an evidence-based set of items for reporting in systematic reviews. In addition, this review was conducted using systematic and standardised search methodologies in/among several electronic databases to identify eligible papers. A limitation is that the search strategy only identified studies published in English in the peer-reviewed literature. Studies among children and adolescents reported in other forums, including trade journals, conferences, and committee meetings were not included and pose a possible publication bias. While most of the high quality scientific literature is published in peer-reviewed sources, the poor quality or negative findings associated with dietary intake data raises the potential of publication bias. However, this only reinforces the need to consider carefully the collection and reporting quality when dietary intake is a study outcome.

**Implications**
This systematic review highlights the need for improvement in the quality of dietary intake assessment methods and reporting in childhood obesity studies. Like many other areas of scientific research, such as the reporting of randomized controlled trials 47 or systematic reviews, 48 results of this review reinforce the need for transparent and comprehensive reporting of dietary methods. Increased quantity and quality of information on the dietary measures, interventions and outcomes used in childhood obesity studies will further knowledge on the dietary treatments that promote weight loss. Further, developing an evidence base for making public health and clinical decisions requires assessing the quality and outcomes of individual studies. However, to make the best use of dietary intake information in quantitative research syntheses requires transparent reporting of the methods and outcomes, with sufficient detail and clarity to allow evaluation of the differences and similarities among studies. 49 As novel dietary assessment methods which utilise new technologies such as the Internet or mobile phones become available 50, 51, this review will need to be updated and compare the studies using these newer methods to the older and see if it changes what can be learnt from the intervention studies about what aspects of diet are amenable to change.

**Recommendations**

Assessing the diets of children and adolescents presents unique methodological challenges. There are age related limits on what aspects of diet can be reported due to child cognitive abilities or using parent proxies who may or may not know what is consumed by the child for all or part of the day. In addition, dietary outcomes in overweight and obesity studies are often secondary outcomes and may be given less attention and resources. However, adoption of the following recommendations would improve dietary methods and reporting quality in future studies;

- Twenty-four hour recalls or FFQs provide good quality dietary assessments. The choice between methods should be guided by the research question and outcomes of interest and consideration of the inherent strengths and limitations of any dietary assessment method.
Consideration should be given for using FFQs with another method such as 24 hour recall or WFR as a comparative method in at least a population sub sample.

- The validity properties of the method selected should be known in child and adolescent (and preferably overweight/obese) populations. Studies are needed to better understand the validity of WFR, 24 hour recalls and dietary questionnaires in the context of obesity interventions in children and adolescents.

- To ensure that study findings are interpretable and replicable, special attention is needed to improve the reporting of dietary method validity details or reference, the qualifications or training of those who administer the dietary assessment, and the food composition database used to derive energy and nutrient intakes.

There are excellent resources readily available to investigators to ensure that the appropriate dietary tool is selected, administered properly and is adequately described in the study methods. These include the Australian Child and Adolescent Obesity Research Network online decision tree which can assist researchers in the selection of appropriate dietary intake methodologies for studies in the context of child obesity, a detailed online interactive decision matrix provided by the Medical Research Council, the checklist by Nelson et al. which is a must for researchers reporting studies that include assessment of dietary intake, and existing publications in measuring dietary intake in children and adolescents in the context of overweight and obesity.

CONCLUSION

The goal of the present review was to provide an overview of the state of dietary assessment methods reporting in childhood obesity intervention studies to inform future study design and reporting. Results indicate that authors, reviewers and journal editors need to ensure more transparent and consistent reporting of dietary methods used in childhood obesity trials if the quality of study reporting is to be improved. In particular, reporting of dietary methods can be improved if...
investigators provide information on the instrument validity, the qualifications or training of those who administer the dietary assessment, and the food composition database that was used to derive energy and nutrient intakes. Use of the checklist presented in table S2 will help to achieve this.
<table>
<thead>
<tr>
<th>Reference</th>
<th>Country, Setting</th>
<th>Participants</th>
<th>Study quality</th>
<th>Study Arms</th>
<th>Intervention duration and intensity, Follow up (retention)</th>
<th>Dietary Reporting Quality</th>
<th>Dietary Measures</th>
</tr>
</thead>
<tbody>
<tr>
<td>Albala et al 2008 11</td>
<td>Chilean Community</td>
<td>98</td>
<td>8-10</td>
<td>Positive (1) DP (2) True Control</td>
<td>16 weeks, weekly home visits and milk delivery 16 weeks (end-I, 94%)</td>
<td>Poor</td>
<td>FFQ baseline and 16 weeks with mothers present</td>
</tr>
<tr>
<td>Burrows et al 2008 37</td>
<td>Australian Community</td>
<td>165</td>
<td>5-9</td>
<td>Positive (1) P + FS + HE + NS + DA (parent) (2) PA + NP (child) (3) PA + NP + P + FS + HE + NS + DA (parent &amp; child combined)</td>
<td>6 months, 10x2hour weekly group sessions + 3xmonthly phone calls 6 months (end-I, 70%), 12 months (FU 64%)</td>
<td>Excellent</td>
<td>135-item semi-quantitative FFQ</td>
</tr>
<tr>
<td>Davis et al 2009a</td>
<td>USA Latino Community</td>
<td>54</td>
<td>14-18</td>
<td>Positive (1) HE + BT (2) HE + BT + PA (3) True Control</td>
<td>16 weeks, 4x motivational interviews + $25 grocery certificate + bi-weekly 60min strength training 16 weeks (end-I, 100%)</td>
<td>Acceptable</td>
<td>3-day food record with instructions Given measuring cups and rulers to aid in accurate reporting.</td>
</tr>
<tr>
<td>Davis et al 2009b</td>
<td>USA Latino Community</td>
<td>50</td>
<td>14-18</td>
<td>Positive (1) HE + BT (2) HE + BT + PA (strength) (3) HE + BT + PA (strength &amp; aerobic) (4) True Control</td>
<td>16 weeks, 4x motivational interviewing, 2x60 min strength training, 2x 60 min aerobic training 16 weeks (end-I, 82%)</td>
<td>Acceptable</td>
<td>As above</td>
</tr>
<tr>
<td>Ebbeling et al 2003</td>
<td>USA Hospital</td>
<td>16</td>
<td>13-21</td>
<td>Positive (1) DP (red GlyLoad) + BT + PA + NP (2) DP (red fat) + BT + PA + NP</td>
<td>6 months, 12 dietary counselling sessions + 2 follow up dietary counselling sessions 12 months (FU, 87.5%)</td>
<td>Acceptable</td>
<td>7-day food record, Measuring utensils used to educate accurate appraisal of portion sizes.</td>
</tr>
<tr>
<td>Ebbeling et al 2006</td>
<td>USA Schools Community</td>
<td>103</td>
<td>13-18</td>
<td>Positive (1) DP (2) True Control</td>
<td>25 weeks Beverages home delivered weekly 25 weeks (end-I, 100%)</td>
<td>Poor</td>
<td>2 x 24hr recall</td>
</tr>
<tr>
<td>Ellis et al 2010</td>
<td>USA African American</td>
<td>49</td>
<td>12-17</td>
<td>Neutral (1) DP + HE + NS + PA + SB + FS + BT + P +NE</td>
<td>6 months Twice per week (control group weekly) 7 months (end-I, 84%)</td>
<td>Poor</td>
<td>Questionnaire, Fat and fibre behaviour rated on a 28 item questionnaire (4 point scale)</td>
</tr>
<tr>
<td>Community</td>
<td>Hospital Type</td>
<td>Study Period</td>
<td>Sample Size</td>
<td>Positive BMI Criteria</td>
<td>Positive Intervention</td>
<td>Duration</td>
<td>Outcome</td>
</tr>
<tr>
<td>--------------------</td>
<td>---------------</td>
<td>--------------</td>
<td>-------------</td>
<td>-----------------------</td>
<td>-----------------------</td>
<td>----------</td>
<td>---------</td>
</tr>
<tr>
<td>Epstein et al 2008</td>
<td>USA Hospital</td>
<td>70</td>
<td>4-7</td>
<td>OW/OB (BMI ≥75th %ile)</td>
<td>Positive (1) P + SB (2) P</td>
<td>24 months, 5 home visits + monthly newsletters</td>
<td>Good</td>
</tr>
<tr>
<td>Ford et al 2010</td>
<td>UK Hospital</td>
<td>106</td>
<td>9-17</td>
<td>OB (BMI &gt; UK 95th %ile)</td>
<td>Positive (1) NS (Mandometer) + HE + DA (2) FS + BT + PA + HE + DA (Std Care)</td>
<td>12 months, 5 training sessions</td>
<td>Excellent</td>
</tr>
<tr>
<td>Garipagao glu et al 2009</td>
<td>Turkey Hospital</td>
<td>80</td>
<td>6-14</td>
<td>OB (BMI &gt;97th %ile, IOTF)</td>
<td>Positive Two delivery methods (1) FS + DP + HE + NS + DA (group setting) (2) FS + DP + HE + NS + DA (individually)</td>
<td>3 months, 7 x fortnightly sessions</td>
<td>Good</td>
</tr>
<tr>
<td>Gillis et al 2007</td>
<td>Israel Primary care</td>
<td>27</td>
<td>7-16</td>
<td>BMI&gt;90 %ile (CDC)</td>
<td>Neutral (1) HE + PA + P + BT (2) HE+ PA + P</td>
<td>3 months, 12xweekly clinic visit (2) or phone call</td>
<td>Poor</td>
</tr>
<tr>
<td>Goldfield et al 2006</td>
<td>Canada Community</td>
<td>30</td>
<td>8-12</td>
<td>OW/OB (BMI&gt;8 5th %ile)</td>
<td>Neutral (1) BT + PA + SB (2) BT</td>
<td>8 weeks Biweekly meetings with research staff 8-wks (end- I, 100%)</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Gutin et al 2002 18</td>
<td>USA University</td>
<td>80</td>
<td>13-16</td>
<td>OB (&gt;85th %ile)</td>
<td>Positive (1) BT + HE + PA (LSE) (2) LSE + PA (Moderate) (3) LSE + PA (High Int)</td>
<td>8 months ,1 hr LSE biweekly; PA 5d/wk biweekly – alternate wk LSE 8 months (51%)</td>
<td>Acceptable</td>
</tr>
<tr>
<td>Janicke et al 2008 20</td>
<td>USA Community</td>
<td>93</td>
<td>8-14</td>
<td>OW (&gt;85th %ile)</td>
<td>Positive (1) FS + BT + HE + PA (Parent &amp; Child sessions) (2) FS + BT + HE +</td>
<td>16 weeks,90 minute group sessions. Weekly x 8 weeks, fortnightly 8 weeks.</td>
<td>Excellent</td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Sample Size</td>
<td>Age Range</td>
<td>BMI Cut-off</td>
<td>Intervention</td>
<td>Duration</td>
<td>Follow-up Duration</td>
</tr>
<tr>
<td>-----------------------</td>
<td>------------------</td>
<td>-------------</td>
<td>-----------</td>
<td>-------------</td>
<td>------------------------------------------------------------------------------</td>
<td>---------------------------</td>
<td>--------------------</td>
</tr>
<tr>
<td>Krebs et al 2010&lt;sup&gt;21&lt;/sup&gt;</td>
<td>USA Community</td>
<td>46</td>
<td>12-18</td>
<td>OB (≥175% IDW)</td>
<td>PA (Parent only sessions) (3) WL Control</td>
<td>16 weeks (end-I, 87%), 10 months (f’up 76%)</td>
<td></td>
</tr>
<tr>
<td>McCallum et al 2007&lt;sup&gt;38&lt;/sup&gt;</td>
<td>Australia Primary Care</td>
<td>163</td>
<td>5-9</td>
<td>OW/OB (IOTF)</td>
<td>Positive (1) DP (High Pro, Low CHO) + NP +PA (2) DP (Low Fat) + NP +PA</td>
<td>13 weeks, Fortnightly clinic visits 13 wks (end-I, 72%), 24 wk (FU 1, 59%), 36 wks (FU 2, 48%)</td>
<td></td>
</tr>
<tr>
<td>Nemet et al 2005&lt;sup&gt;35&lt;/sup&gt;</td>
<td>Israel Hospital</td>
<td>54</td>
<td>6-16</td>
<td>OB</td>
<td>Positive (1) FS + DA + NP + HE + NS + NE + PA (2) Control</td>
<td>3 months(1) I group: 6 consults over 3 mths, 30-45 mins each, parents involved; 2 x 1hr exercise training sessions/wk C group: 1 nutritional consultation with PA advice 3-months (end-I, 80%), 12-months (FU 67%)</td>
<td></td>
</tr>
<tr>
<td>Nemet et al 2006&lt;sup&gt;36&lt;/sup&gt;</td>
<td>Israel Hospital</td>
<td>24</td>
<td>6-16</td>
<td>OB (BMI &gt;95th %ile)</td>
<td>Neutral (1) FS + DA + NP + HE + NS + NE + PA (2) Control</td>
<td>3 months14 weekly meetings (8 with parent only bi weekly) 60-90mins, 12 sessions with children + 6 with parents. 2x per week 1hour exercise training + 1 x 45 min movement therapy session 3 months (end-I, 100%)</td>
<td></td>
</tr>
<tr>
<td>Park et al 2007&lt;sup&gt;40&lt;/sup&gt;</td>
<td>Korea School</td>
<td>44</td>
<td>13-15</td>
<td>OB (BMI &gt;95th %ile)</td>
<td>Positive (1) PA + BT (2) True Control</td>
<td>12 weeks PA (walking) - 6 days/week supervised sessions, DL &amp; BT -once per week 12 weeks (end-I, 91%)</td>
<td></td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Setting</td>
<td>Age</td>
<td>BMI Criteria</td>
<td>Outcome</td>
<td>Intervention 1</td>
<td>Intervention 2</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
<td>---------</td>
<td>-----</td>
<td>-------------</td>
<td>---------</td>
<td>---------------</td>
<td>---------------</td>
</tr>
<tr>
<td>Raynor et al 2002</td>
<td>USA</td>
<td>Community</td>
<td>31</td>
<td>8-12</td>
<td>Positive</td>
<td>Two delivery methods (1) PA + FS + DP + HE + BT (Grp &amp; Indvid Sessions) (2) PA + FS + DP + HE + BT (Grp Sessions Only)</td>
<td>20 weeks, 1 hr weekly meetings for 2 months, bimonthly meetings for 2 months, and 1 monthly meeting. 20 weeks (end-I, 83%, 69% for diet data)</td>
</tr>
<tr>
<td>Reinehr et al. 2010</td>
<td>Germany</td>
<td>Hospital</td>
<td>66</td>
<td>Mean 11.5</td>
<td>Neutral</td>
<td>(1) FS + BT + PA + HE (2) WL Control</td>
<td>6 months, Not stated</td>
</tr>
<tr>
<td>Resnick et al 2009</td>
<td>USA</td>
<td>School</td>
<td>46</td>
<td>grade K – 5</td>
<td>Neutral</td>
<td>Two delivery methods (1) FS + PA + SB + NP + NS (Education materials mailed) (2) FS + PA + SB + NP + NS (Education materials received through personal encounters with CHW’s)</td>
<td>I group: 18 wks (average 3.4 home visits or phone calls, 5.5wks apart). C group: 30 wks 6 mailing contacts over 30 weeks. intervals) 4 weeks (end-I, 91%)</td>
</tr>
<tr>
<td>Rodearmel et al 2007</td>
<td>USA</td>
<td>University</td>
<td>218</td>
<td>7-14</td>
<td>Neutral</td>
<td>(1) FS + PA + DP + NS + HE (2) True Control</td>
<td>6 months, Not stated</td>
</tr>
<tr>
<td>Rolland-Cachera et al 2004</td>
<td>France</td>
<td>Boarding school at medical centre</td>
<td>121</td>
<td>11-16</td>
<td>Neutral</td>
<td>(1) DP (Protein 15%, CHO 54%) + PA + SB (2) DP (Protein 19%, CHO 50%) + PA + SB</td>
<td>9 months Live in at boarding school</td>
</tr>
<tr>
<td>Saelens et al 2002</td>
<td>USA</td>
<td>Primary care</td>
<td>44</td>
<td>12-16</td>
<td>Positive</td>
<td>(1) BT + PA + SB + HE + NE + P (2) PA + HE</td>
<td>16 weeks, I group: weekly (8 ) and biweekly (3) phone sessions +mail C group: 1 session with GP 4 months (FU, 88%), 7-</td>
</tr>
<tr>
<td>Study</td>
<td>Country</td>
<td>Setting</td>
<td>Sample Size</td>
<td>Age Range</td>
<td>BMI Status</td>
<td>Intervention Group 1</td>
<td>Intervention Group 2</td>
</tr>
<tr>
<td>-------</td>
<td>---------</td>
<td>---------</td>
<td>-------------</td>
<td>------------</td>
<td>------------</td>
<td>----------------------</td>
<td>----------------------</td>
</tr>
<tr>
<td>Sung et al 2002</td>
<td>Hong Kong School</td>
<td>82</td>
<td>8-11</td>
<td>OB (&gt;120% of median wt for ht)</td>
<td>Neutral</td>
<td>(1) DP + PA (2) DP</td>
<td></td>
</tr>
<tr>
<td>Ventura et al 2009</td>
<td>USA University</td>
<td>66</td>
<td>Mean age (SD): 15.5 (±1)</td>
<td>OW/Ob (&gt;85th CDC %ile)</td>
<td>Positive</td>
<td>(1) HE (2) HE + PA (3) True Control</td>
<td></td>
</tr>
<tr>
<td>Wake et al 2009</td>
<td>Australia Primary Care</td>
<td>258</td>
<td>5-10</td>
<td>OW/OB (IOTF)</td>
<td>Positive</td>
<td>(1) BT + FS + NP (2) True Control</td>
<td></td>
</tr>
<tr>
<td>Waling, et al 2010</td>
<td>Sweden University</td>
<td>92</td>
<td>8-12</td>
<td>OW/OB (IOTF)</td>
<td>Positive</td>
<td>(1) FS + PA + HE + NP + DA (2) True Control</td>
<td></td>
</tr>
<tr>
<td>Williams et al 2007</td>
<td>USA Community</td>
<td>38</td>
<td>11-15</td>
<td>OB (BMI&gt;9 5th %ile)</td>
<td>Neutral</td>
<td>(1) DP (1500kcal/day + free snack) + FS + HE + PA (2) DP (1500kcal/day + restricted snack) + FS + HE + PA</td>
<td></td>
</tr>
<tr>
<td>Williamso n et al 2005</td>
<td>USA Community</td>
<td>57</td>
<td>11-15</td>
<td>OW/OB (BMI&gt;8 5th %ile)</td>
<td>Neutral</td>
<td>(1) FS + BT + PA + HE (2) DA + HE</td>
<td></td>
</tr>
</tbody>
</table>
1. OW overweight; OB obese; CDC Centre for Disease Control; IOTF International Obesity Task Force; %ile Percentile; 2 Overall methodological study quality was assessed using the American Dietetic Association critical appraisal tool. Assessed with modified version of the EURECA tool. I- Intervention, FU- Follow up, DP- Dietary pamphlet, DA- Dietary advice, LSE- lifestyle education, DL- Diet and lifestyle, BT- Behaviour therapy, P- Parenting, PA- Physical activity, FS- family support SB- sedentary behaviour, BMI- Body Mass index, DP- Dietary Prescription, HE- Healthy Eating, NS- Nutrition skills, NE- Nutrition environment, NP- Nutrition pamphlet, DA- Dietary advice, NO- Nutrition other.
FIGURE 1
Title: Flow diagram of article identification, retrieval and inclusion for systematic review.

FIGURE 2
Title: Intervention details for randomized controlled trials included in the systematic review.
Legend: Horizontal bars represent the number of studies within each descriptive category. The sections of the horizontal bars starting from left to right by type of dietary instrument used and are represented by the following abbreviations: FD: food diary/record; 24-HR: 24 hour recall; FFQ: food frequency questionnaire; Q: questionnaire; MM: multiple methods; and Other.

FIGURE 3
Title: Study and dietary methodology and reporting quality in studies included in the systematic review.
Legend: Horizontal bars represent the number of studies within each descriptive category. The sections of the horizontal bars starting from left to right by type of dietary instrument used and are represented by the following abbreviations: FD: food diary/record; 24-HR: 24 hour recall; FFQ: food frequency questionnaire; Q: questionnaire; MM: multiple methods; and Other.
References


ACAORN. Dietary intake assessment tool