A systematic review to identify behavioural models underpinning school-based interventions in pre-primary and primary settings for the prevention of obesity in children aged 4-6 years

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None of the authors have any conflicts of interests to declare.

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1. Introduction

There is a need to move beyond current practices in obesity prevention, but before this can be achieved, an analysis and understanding of current practices in the specific target population is required. The ToyBox project will use a multidisciplinary analysis to identify the key behaviours related to obesity in early childhood and conduct new behavioural research to explain why young children eat the foods they eat and why they do, or do not, participate in physical activities. Based on the findings, a new intervention programme will be developed and implemented to achieve a primary aim of influencing behaviours of children aged 4-6 to prevent obesity.

The aim of this comprehensive systematic review was to identify the most important behavioural models underpinning school-based interventions aimed at preventing or counteracting obesity in 4-6 year olds, and once identified, to be used to provide the theoretical framework of the ToyBox intervention.

The findings from this review (Task 4.2) will be combined with the findings from a critical review (Task 4.1) of effective educational strategies within the same setting/population, to provide a combined synthesis of evidence that will be discussed by relevant partners and will be used to formulate recommendations (Task 4.3). These recommendations will then be used to inform the development of the evidence-based Toybox intervention by Work Package 6.

2. Methodology

Primary studies that included obesity prevention interventions in children aged 4, 5 and 6 years old were incorporated into the review.

Epidemiological studies relevant to the research question with controlled assignment of participants were included in the review, including:

- Randomized control trials (RCT)
- Non-randomized control trials
- Random allocation
- Double-Blind and Single-Blind method
- Intervention and evaluation studies
- Matched population studies

Studies which have follow up of 6 months or longer were included.

Relevant exposures of interest included patterns of diet, food and drink consumption, energy intake, energy expenditure, physical activity and inactivity, body composition and/or weight, dietary and physical activity behaviours and behaviour change.

Outcomes of interest included markers of weight gain; markers of body composition; physical activity behaviour changes and dietary behaviour changes.

Systematic reviews

Potentially relevant systematic reviews (from 1995 onwards) were examined for studies which fitted the pre-set inclusion criteria; these reviews can be found in Appendix 5.

Quality issues

Quality issues (e.g. ascertainment of outcome, population studied, sample size, and adjustment for potential confounding) were assessed to explore the reasons for heterogeneity in study results, to guide interpretation of findings, to aid determination of the strength of inferences and to guide recommendations.

3. Results of the search

Searching was conducted in April 2010, with relevant literature included in the review up to and including the search date.

The overall aim of the data synthesis is to collate and summarise the results of the studies included in the review. Although meta-analyses was intended where sufficient data existed, it was not possible to run any meta-analytic comparisons from the included studies due to insufficient data (i.e. the availability of adequate information in an appropriate format and at identical points in time). Therefore, only narrative approaches to data analysis have been employed in this review.

Databases

The following databases were searched as part of the searching process: MEDLINE, EMBASE, CINAHL, PsycINFO, Cochrane library incorporating: DARE database, Systematic review database, HTA database.

Search strategy

A systematic search of the literature was conducted to identify relevant primary studies. Only primary studies reported from 1995 were included, as behaviour patterns have been subject to change since then.

A systematic search of the literature was also conducted to identify relevant systematic reviews; as with primary studies, only recent reviews of potential relevance were considered, from 1995 onwards.

The search strategy itself was designed by combining relevant search terms; the search strategy being adapted for each database where appropriate. There is an enormous amount of literature around the subject areas studied, and the search strategy was refined a number of times in order to optimise the selectivity of the search while maintaining sensitivity.

The full list of search terms for this review can be found in Appendix 6.

The search hits from MEDLINE, EMBASE, CINAHL, PsycINFO, Cochrane library incorporating: DARE database, Systematic review database, HTA database, were downloaded and entered into Endnote reference management software, combined and duplicates were removed. These searches resulted in the identification of 11,276 articles.

Table 1: Summary of the literature search

Database	**Hits from search**
MEDLINE	7,373
EMBASE	6,899
CINAHL	976
Cochrane Library	1,066
PsycINFO	1,110
TOTAL (combined and de-duplicated)	**11,276**

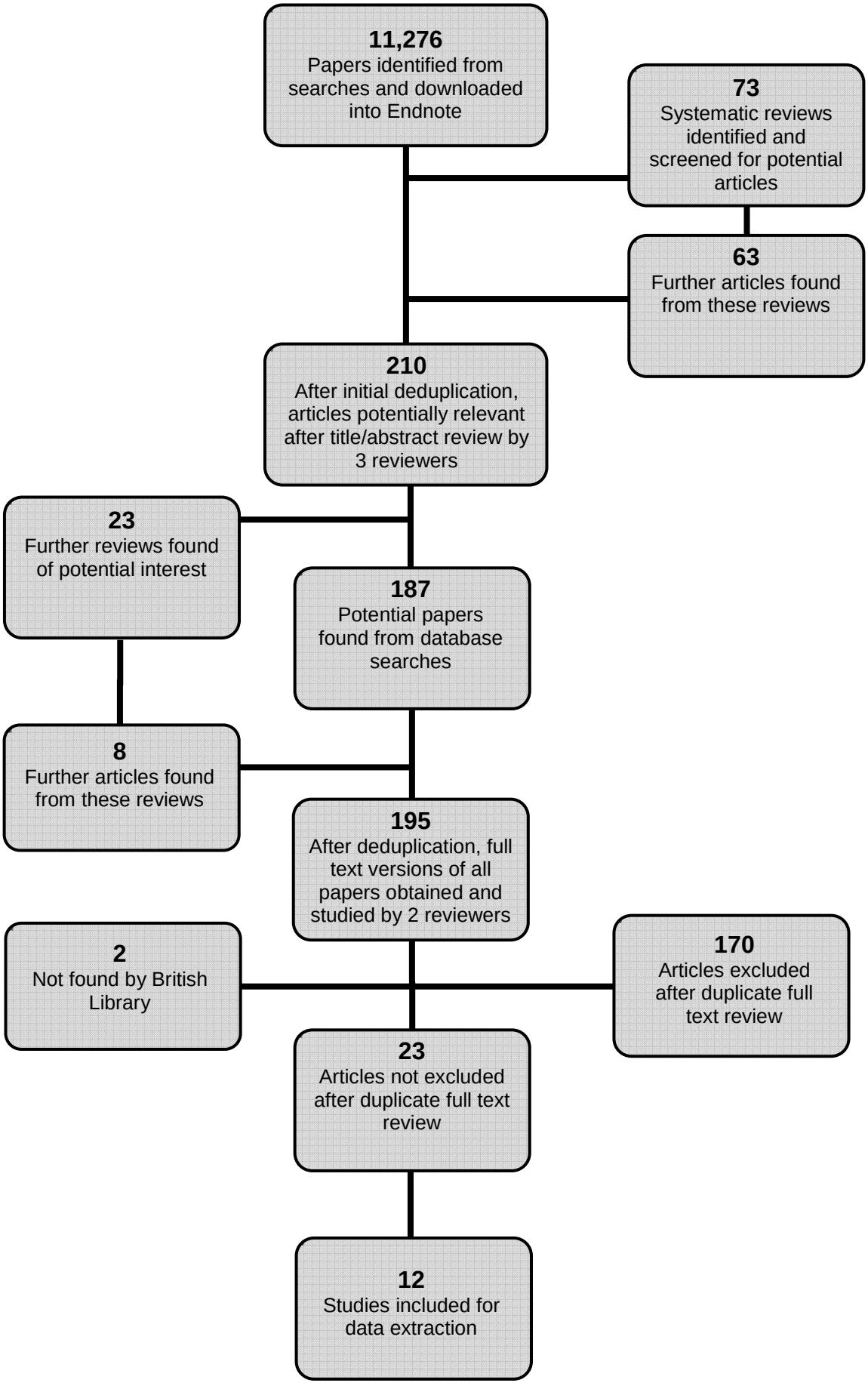
The articles identified from the searches (in Endnote) were initially screened – on the basis of titles and abstracts – by three reviewers (WD, CN, HM) to remove any articles that were clearly not relevant. Hand searching of systematic reviews and key reviews was also undertaken; 73 of which were identified and screened for further articles. This process itself produced 63 articles of potential interest.

From the remaining list, 210 articles were identified as being 'potentially relevant for the review'; 187 original papers and 23 additional systematic reviews. From these reviews, a further 8 papers were identified, resulting in 195 being put forward for possible inclusion. Full text versions of all of these papers were obtained. Inclusion or exclusion of articles into the review was carried out in duplicate (WD, HM, CN) and any disagreements resolved by a fourth reviewer (CS).

Twenty three papers remained after the duplicated full text review stage, with all papers included for data extraction. A number of these papers were publications based on the same study, which meant a total of twelve individual studies formed part of this review.

Each of the studies included in the review can be comprised of single or multiple papers. One reference for each study has been awarded the status of the ‘primary reference’. We have ensured simple identification of each study by allocating a numbered reference to these primary references for each study (e.g. (1) refers to Manios 2002).

Figure 1: Flowchart of search



4. Description of studies

4.1 Amount of data and study types

Numbers of study types:

Nine studies are included in this review (1-9), and although full data was unavailable for three further studies (10-12) they are deemed important and relevant to the objectives of this review and are therefore also reported here pending further analysis. As such, this review will include all 12 studies in this and subsequent sections. Three studies were non-randomised control trials (1, 5, 8), nine studies were RCTs of which five were reported as a cluster-RCT (7, 9-12). Studies were quality assessed (see Section 4.2 of this report).

Amount of data extracted:

Data on the following outcome measures were extracted:

Body weight and adiposity (and associated risk factors):

All twelve studies included anthropometric outcome measures, reporting weight, BMI, BMI z-score, weight or overweight/obese classification status, skinfold measurements and waist circumference. For four studies, health risk indicators, including blood cholesterol and blood pressure and heart rate, were measured (1, 5, 11, 12).

Physical activity and dietary behaviours:

Nine studies included outcome measures of children's dietary behaviour reporting fruit and vegetable intake, intake of water and beverages, snacking behaviour and nutrient intake (1-6, 8, 10, 11). In two of these studies, parents' own dietary behaviours were also reported (2, 3). Ten studies reported outcome measures of total physical activity, total moderate-vigorous physical activity (MVPA), running and fitness tests, motor and movement skills, and sedentary behaviours (e.g. TV viewing). Outcome measures for two studies did not include measures of physical activity change (2, 7). In two studies, parents' physical activity and/or sedentary behaviours were also self-reported (3, 6).

Determinants of lifestyle behaviours:

Seven studies reported parents' and/or children's health knowledge, parents' attitudes to health, parental support and role modelling (1, 2, 5, 6, 8, 11, 12). In all but one (11) of these studies, determinants of lifestyle behaviour were primary outcome measures.

4.2 Quality assessments

A modified version of the Effective Public Health Practice Project Quality Assessment Tool for Quantitative Studies (13) was implemented for the studies included, examining the following criteria: (i) selection bias, (ii) study design, (iii) confounders, (iv) blinding, (v) data collection methods and (vi) withdrawals and dropouts. Based on combined scores for all criteria, studies were rated as high quality (n=7) (1, 3, 5, 8-10, 12) and moderate quality (n=5) (2, 4, 6, 7, 11).

An additional quality score, associated with theories used in the development of the interventions and any subsequent evaluation, was calculated using (i) reporting of theoretical/behavioural model(s) underpinning the intervention, (ii) specification of intervention adequate for replication and (iii) reporting process evaluation of intervention program. Based on combined scores for all criteria, studies were rated as having moderate quality (n=4) (2, 5, 7, 8) and high quality (n=8) (1, 3, 4, 6, 9-12).

4.3 Populations studied

All twelve studies included in this review involved children age 4-6.9 years at baseline or at the start of the intervention program. Studies were conducted in Europe (1, 6, 8-10, 12), N. America (3, 5), Asia (2, 7) and the Antipodes (4, 11). Six non-European studies were included, although the ToyBox Project has a clearly defined European focus, to allow the consideration of potentially valuable information that these studies could provide. Recommendations from WP4 will be based on the findings from the included European projects, but where relevant information existed in other studies, this has been incorporated into the results and discussion sections, The intervention programs were delivered within the school-setting in all studies reviewed, with levels of parental involvement throughout the intervention period varying between studies. One study (8) had an additional family intervention

component which was offered to some families with overweight/obese children and/or parents, in addition to the school-based component. Parents in all the studies provided consent for their child(ren) to take part. Parents in ten studies (1-4, 6-11), provided data (usually by completing a questionnaire) as part of the intervention programme, either self-reported or reported on their children's behalf. Parents in seven of these studies also received components of the intervention programme (1-4, 8-10), for example, training and awareness-raising sessions were delivered to parents by interventionists, resources including healthy lifestyle messages were provided, and parents were often encouraged to find opportunities for increasing physical activity and/or healthy eating within the home.

4.4 Length of follow-up

All but one (8) of the studies assessed intervention effects during and/or at the end of the intervention period (between 14 weeks and 6 years from baseline). Four studies (1, 3, 8, 9) also made follow-up assessments post-intervention (between 1 and 10 years from baseline).

4.5 Interventions

Interventions varied in duration: up to six months duration (n=3) (3, 8, 9), six to twelve months duration (n=5) (2, 4, 5, 7, 12) more than twelve months duration (n=3) (1, 6, 10), and one of the intervention programs is ongoing (11).

Main target behaviours:

Studies reported that interventions were developed to target key behaviours: to increase physical activity (7, 12); to increase physical activity and healthy eating (1-6, 10); to increase physical activity and reduce sedentary behaviour (9); and to increase physical activity and healthy eating, and reduce sedentary behaviour (8, 11).

Theoretical underpinning:

Intervention development was guided by a variety of psychological and behavioural models, with some interventions underpinned by more than one theory or model. The most common theory used was Bandura's (14-16) Social Cognitive Theory

(SCT) / Social Learning Theory (SLT). Four studies made explicit reference to these theories ((1); SCT) and (3, 6, 10); SLT).

Six studies reported a single behavioural model or theoretical framework guiding the intervention development (1, 6, 9-12), one study intervention was guided by two theoretical models (4), one study intervention was underpinned by three behavioural models (3) and four studies did not report any theoretical basis for their intervention development (2, 5, 7, 8), although an existing behaviour change program did shape the intervention development in one of these studies (7). The theoretical models used can be seen in Table 2 below.

Parental involvement:

For this review, the level of parental involvement within each study intervention is categorized as low (parents provided consent only), medium (parents provided (self/child)-reported health questionnaires) and high (parents were exposed to intervention components). Of the six European studies, four had high parental involvement (1, 8-10) and two had medium parental involvement (6, 12). Of the six non-European studies, three studies scored high (2-4) for parental involvement, one study had a medium level of parental involvement (11) and two studies had low parental involvement (5, 7). Of the four studies that did not explicitly state any theoretical underpinning of the intervention program, two studies had high levels of parental involvement (2, 8) and two were scored as low (5, 7).

Table 2: Theoretical model used in the development of interventions and level of parental involvement within intervention programmes

Theory	European Studies	Intervention techniques	Parental involvement
Social Cognitive Theory (SCT)	Manios et al. (2002)	Provide information on behaviour-health link; modelling; self-monitoring of behaviour; behavioural contracting, skill development; praise and reinforcement	High
Social Learning Theory (SLT)	Warren et al. (2003)	Provide information on behaviour-health link; incentives and reinforcement; skill development; a non-competitive environment for PA and opportunity to try new foods	Medium
	Bayer et al. (2009)	Provide information on behaviour-health link; encourage parents and teachers to model healthy PA and dietary behaviour; create health-promoting environments for children	High
Health Education Model	Reilly et al. (2006)	Increased school-based PA; provide information on behaviour-health link using posters in school and in providing a family resource pack	High
Socio-ecological conceptual model (Egger & Swinburn, 1997).	Kriemler et al. (2010)	Increase level of compulsory PA in school; children receive daily PA homework	Medium
None stated	Danielzik et al. (2007)	Provide information on behaviour-health link; skill development; increased PA through running games	High
Theory	**Non-European Studies**	**Intervention techniques**	**Parental involvement**
Self Determination Theory	Fitzgibbon et al. (2006)	Provide activities that promote choices related to food and physical activity: avoid coercion. Facilitate self-regulatory skills.	High
Social Learning Theory (SLT)		Provide information on behaviour-health link; modelling to encourage exploration of new foods and try new activities; increase aerobic exercise through PA games in school	
Transtheoretical Model / Stages of change		Target parents with information on behaviour-health link for themselves/their children; involve parents in PA sessions and classes on healthy eating	
Health Belief Model (HBM)	Adams et al. (2008)	Provide parents with information on behaviour-health link; support and encourage parents to provide healthy eating and active play opportunities for their children	High
Competence Motivational Theory (CMT)		A games-based approach to movement skills development, to enable children to have fun and experience success developing skills	
Through Schools Approach	Graham et al. (2008)	Aim to increase PA, reduce sedentary time and optimise nutritional intake through changes in the school environment and culture (e.g. promoting water intake in school, modify tuck-shop sales etc.)	Medium
None stated	Hu et al. (2010)	Provide information on behaviour-health link through the provision of monthly nutrition classes for parents and their children, story-books, pamphlets, and health promotional posters within the kindergarten setting	High
None stated	Stock et al. (2007)	A peer-led health promotion program - provide information on behaviour-health link; lessons were delivered to kindergarten children by older children in the school on PA, nutrition and healthy body image	Low
None stated	Mo-Suwan et al. (1998)	Intervention shaped by Superkids-Superfit Exercise Curriculum, which "stresses non-competitive activities as well as competitive sports...with the goal of increasing the amount of conditioning activity each child receives over the course of a school year (Harsha, 1995, p. 111).	Low

5. Results by theoretical model

5.1 Interventions underpinned by Social Cognitive Theory / Social Learning Theory

Four studies (1, 3, 6, 10) reported Bandura's Social Cognitive Theory or Social Learning Theory (14-16) as the model underpinning the development of intervention strategies.

Cretan Health and Nutrition Education Program (1)

Intervention summary: School-based intervention with 'high' parental involvement.

Weight status outcomes: The BMI of the intervention group was significantly lower than control group at mid intervention, end of intervention and at follow up. Intervention group skinfold tests were significantly less than control group at mid intervention. Intervention group serum lipids were significantly improved at mid intervention and end of intervention. Lower increase in blood pressure was observed in the intervention group at follow up.

Behaviour change outcomes: Fitness indices and MVPA were significantly improved in the intervention group at mid- and end of intervention. Significant differences between intervention group and control group were observed for nutrient intake at end of intervention.

Determinants of behaviour change: Greater improvements were observed in intervention group for children's and parents health knowledge scores at mid intervention.

The authors emphasised parental involvement and expanded PE classes as pertinent to the effectiveness of the intervention (17).

Hip-Hop to Health Jr. (3)

Intervention summary: School-based intervention with 'high' parental involvement. Intervention was developed using three behavioural models including SLT (please refer to 5.5.1 for results of this study).

The 'Be Smart' Study (6)

Intervention summary: School-based intervention with 'medium' parental involvement. There were three intervention groups: 1) Nutrition, 2) Physical Activity (PA), 3) Nutrition and PA) and one control group.

Weight status outcomes: There were no significant differences between the intervention group and control group for BMI at end of intervention.

Behaviour change outcomes: At the end of the intervention period, there were small increases in the number of children walking to and from school and increasing activity in the playground, although there were no statistically significant differences between intervention group and control group for physical activity. There were significant increases in all groups for vegetable consumption at final assessment. There were no significant differences in nutrient intake between the groups at baseline or end of intervention. There were no intervention effects on parents' reports of physical activity and dietary intake.

Determinants of behaviour change: Nutrition and physical activity knowledge scores improved in all children between baseline and end of intervention and an intervention effect on scores for each section was reported (6): For the nutrition questions children in the Nutrition Group scored significantly higher than children in the control group (P=0.004) and children in the PA Group (P=0.002). Children in the Nutrition & PA Group scored significantly better than non-study children (P=0.039). For the physical activity questions all intervention groups scored better than the control group: (P=0.001 and P=0.000) for the PA Group and the Nutrition & PA Groups respectively. There were no intervention effects on parents' nutrition knowledge.

Tiger Kids Study (10)

Intervention summary: School-based intervention with 'high' parental involvement. There were two cohorts with end of intervention at six months and eighteen months respectively. Baseline measurements were not taken in either cohort. Outcome measures are reported for intervention group and control group differences at six and eighteen months after the start of the intervention.

Weight status outcomes: The authors were contacted for data but this was not received at the time of report writing. However, there was no statistical difference between intervention group and control group for overweight and obesity at end of intervention in both cohorts.

Behaviour change outcomes: There was a significantly higher consumption of fruit and vegetables reported in the intervention group in both cohorts (X^2 $P < 0.0001$) and (X^2 $P = 0.0002$). A lower consumption of high calorie drinks (X^2 $P = 0.0001$) and snacks while watching TV (NS, $P=0.055$) was only observed in the intervention group in the first cohort (end of intervention at 6 months). Motoric testing (side-to-side jumps and jumps over a bar) scores did not differ significantly between the intervention group and control group at end of intervention in both cohorts.

Determinants of behaviour change: N/A

5.2 Interventions underpinned by the Health Education Model

One study, the Magic Trial (9) reported the Health Education Model (HEM) as the model underpinning the development of intervention strategies.

The Magic Trial (9)

Intervention summary: Nursery-based and home-based intervention with 'high' parental involvement. The Health Education Model was used in the development of the home-based element of the intervention.

Weight status outcomes: There were no significant differences between the intervention group and control group for BMI at end of intervention and follow up

Behaviour change outcomes: Physical activity and sedentary behaviours measured using accelerometry did not differ between the intervention group and control group at end of intervention. Children in the intervention group had significantly higher performance in movement skills tests than control children at end of intervention

Determinants of behaviour change: N/A

5.3 Interventions underpinned by the Socio-ecological conceptual model

One study, the KISS Study (12) reported the Socio-ecological conceptual model (18) in the development of the intervention used.

"Kinder-Sportstudie" The 'KISS' Study (12)

Intervention summary: School-based intervention with 'medium' parental involvement. There were two cohorts (6.9 years and 11.1 years). Breakdown data for the younger cohort was unavailable. The results reported are for both cohorts adjusted for age:

Weight status outcomes: There were significant favourable differences in the intervention group compared to the control group for body fat measurement: sum of 4 skinfolds (P = 0.009) and BMI (P=0.003) at end of intervention.

Behaviour change outcomes: The intervention had a significant effect on children's aerobic fitness, increasing 'in-school' MVPA and running time in a shuttle run test in (P<0.001) and (P=0.04) respectively at end of intervention.

Determinants of behaviour change: Physical quality of life and psychological quality of life scores did not differ significantly between the intervention group and control group children at end of intervention.

5.4 Intervention underpinned by a Through Schools Approach (19)

Project Energize (11)

Intervention summary: School-based intervention with 'medium' parental involvement. This program involves two cohorts of children (5 year-old and 10 year-olds) each with intervention and control groups. A key feature of this intervention is 'Team Energize' – a team of trained to work with enrolled schools' teaching and administrative staff, school boards and parent representatives to support the delivery and development of the intervention programme in each school. A school 'stock-take' is carried out to assess the nutrition and activity resources of each school: the intervention is individualized to each school on a needs-based assessment. The intervention program is ongoing to date.

Weight status outcomes: The data for anthropometric outcome measures for each cohort was unavailable (authors were contacted but no response was received at the time of report writing). However, authors reported that for the 5 year old cohort there were no significant differences between the intervention group and control group for BMI, BMI z-score, % body fat or Fat Mass Index (FMI) at 2 years from baseline (11).

Behaviour change outcomes: Authors reported that as children (both age groups) get older, they undertake less active play and more screen time. This holds true for both intervention group and control group. However, within the 5-year-old cohort, they decreased their active play and increased their total screen time at a slower rate than the control group.

Determinants of behaviour change: There was an intervention effect on children's health knowledge at 2 years follow-up. Overall intervention group children had significantly higher scores than control group children for healthy drinking ($p<0.001$), but there was no significant difference between the intervention group and control group on scores for healthy 'breakfast' foods ($p>0.05$).

5.5 Interventions underpinned by multiple behavioural models

Two studies – Hip-Hop to Health Jr. (3) and the Tooty Fruity Vegie in Schools Program (4) reported using two or more behavioural models in the development of school-based interventions.

5.5.1 Intervention underpinned by Social Learning Theory (SLT) (14-16), Social Determination Theory (20-22) and Transtheoretical Model / Stages of change (23).

Hip-Hop to Health Jr. (3)

Intervention summary: School-based intervention with 'high' parental involvement. The intervention was developed using three behavioural models aimed at behaviour change in children (SLT & SDT) and in parents (TTM/SoC).

Weight status outcomes (Latino cohort): intervention group BMI was not significantly different from the control group at end of intervention and at 1 and 2 year follow up. (Black cohort): intervention group BMI was not significant at end of intervention, but was significantly lower at 1 year follow up ($P = 0.002$) and at 2 years follow up ($P = 0.008$).

Behaviour change outcomes (Latino cohort): There were no significant differences between intervention group and control group for dietary or physical activity change outcomes. (Black cohort): intervention group saturated fat intake was significantly lower in the intervention group at 1 year follow up ($P = 0.002$), but not at end of intervention or at 2 years follow up.

Determinants of behaviour change: not reported

5.5.2 Intervention underpinned by the Health Belief Model (HBM) (24) and Competence Motivational Theory (CMT) (25)

Tooty Fruity Vegie in Schools Program (4)

Intervention summary: School-based intervention with 'high' parental involvement. The Health Belief Model (HBM) was used to shape intervention strategies to encourage parents to provide healthy eating and active play opportunities. Competence Motivational Theory (CMT) "suggests that children's motivation to participate in physical activity is influenced by their actual and perceived competence, social support and enjoyment of the activities" (4). This theoretical approach guided the choice of practical physical activities and experiential food strategies for the children.

Weight status outcomes: Authors were contacted for data but this was not received at the time of report writing. However the authors reported that there was no significant intervention effect on BMI or overweight status. There was a significant change in the mean waist circumference of children in both intervention and control groups at 2 years follow-up (P=0.0012) but children in the control preschools had significantly increased more than in the intervention schools. There were significantly less children who had an early adiposity rebound in intervention preschools when compared to controls (p=0.017) and this difference was still significant when the model adjusted for age (p=0.04)

Behaviour change outcomes: intervention group children improved their movement skills significantly more than control group children (P<0.0001) at 9 months from baseline. Mean combined number of fruit and vegetable servings in lunch boxes increased significantly for children in the intervention group when compared to the control group (p<0.0001).

Determinants of behaviour: N/A

5.6 Studies where theoretical underpinning of intervention was not reported

Four studies (2, 5, 7, 8) did not report the use of any theoretical or behavioural models in the development of their interventions.

Nutrition education intervention program (2)

Intervention summary: Kindergarten-based intervention with 'high' parental involvement. No theoretical basis for the development of the intervention was reported in this study, however much emphasis was placed on educating parents about the importance of healthy diet and physical activity, "Parents and kindergarten teachers play key roles in helping pre-schoolers to develop positive dietary behaviours" (2). Strategies implemented overlap with a number of components of Social Learning Theory particularly in relation to providing information, modelling and skill development.

Weight status outcomes: There was no intervention effect on weight and BMI at mid intervention and end of intervention.

Behaviour change outcomes: Eating unhealthy snacks and watching TV during dinner reduced significantly in the intervention group compared to the control group ($P < 0.05$) at end of intervention. Eating breakfast, taking part in outdoor activity and helping with household duties improved significantly within the intervention group compared to the control group ($P < 0.05$) at end of intervention.

Determinants of behaviour: intervention group parents performed better than control group parents on nutritional knowledge at mid intervention (P=0.0008) and at end of intervention (P<0.0001). Some aspects of parents' dietary attitudes to managing their children's diet and eating behaviours improved in the intervention group compared with the control group (P<0.05) and (p<0.001) respectively, at end of intervention.

Healthy Buddies Program (5)

Intervention summary: School-based intervention with 'low' parental involvement.

Weight status outcomes: There was no intervention effect on weight and BMI at end of intervention

Behaviour change outcomes: Increase in distance covered in the 9-minutes run at follow-up did not differ significantly between control and intervention groups at end of intervention. There was no overall effect of the intervention on health behaviour

scores. There was a trend toward a higher increase in health behaviour scores for intervention group compared with control group, but the difference was only significant for female students in the intervention group compared with female children in the control group (school x gender interaction; $F = 6.4$, $P = 0.013$).

Determinants of behaviour: Intervention group children showed a markedly greater increase in health knowledge scores ($F = 33.9$, $P<0.001$) and in health attitude scores ($F = 4.2$, $P = 0.043$) compared with the control group.

School-based exercise program (7)

Intervention summary: School-based intervention with 'low' parental involvement.

Weight status outcomes: There were no significant differences between the intervention group and control group on weight and BMI at end of intervention. Authors reported that among the intervention group subjects, girls had less gain in weight and hence had significantly lower mean BMI and WHCU than did the boys (t test, $P < 0.01$).

Behaviour change outcomes: N/A

Determinants of behaviour: N/A

Kiel Obesity Prevention Study (KOPS) (8)

Intervention summary: School-based intervention with 'high' parental involvement.

Weight status outcomes: There was no intervention effect on overweight and obesity at end of intervention. Authors reported that the effect of intervention increased with SES resulting in a lower prevalence of overweight in children of high SES (P=0.03), and that the effect was marginally significant in children of normal weight mothers (P=0.05).

Behaviour change outcomes: There were no significances between intervention group and control group on lifestyle scores based on healthy eating, physical activity and sedentary behaviours. Authors report that although these results are not significant, lifestyle scores tended to improve in the intervention group after 4 years.

Determinants of behaviour: N/A

6. Findings and Questions

Trends emerging from the review (see Table 3 below)

Weight status change

- For the four studies that reported favourable changes in weight status for intervention group children (1, 3, 4, 12) all were categorised as having high or medium parental involvement (see page 12 for classification).
- In the four studies mentioned above, authors also reported favourable and significant effects of the intervention on physical activity and/or dietary behaviour change.
- Duration of follow-up varied for the studies reporting significant weight status change (9 months, 10 months, 2 years and 10 years follow-up), and follow-up time was equally variable (6 months to 4 years) for the eight studies reporting no significant intervention effects on weight status outcome measures (2, 5-11).
- Of the four studies reporting a significant intervention effect on weight status, two reported the use of multiple (two or more) behavioural models in the development of the intervention program (3, 4) and two studies reported the use of a single model (1, 12).

Physical activity and dietary behaviour change

- In the seven studies reporting significant changes in physical activity and/or dietary behaviours at follow-up, one had a medium level of parental involvement (12) and six had high levels of parental involvement in the intervention program (1-4, 9, 10, 12); that is, elements of the school-based interventions were tailored and delivered to parents of intervention group children.
- Six of the seven studies reporting significant changes in physical activity and/or dietary behaviours discussed interventions that were underpinned by behavioural models (1, 3, 4, 9, 10, 12).
- Of the five studies reporting no significant changes in physical activity and/or dietary behaviour, two interventions had high levels of parental involvement (3, 8) and three had medium and low levels (5, 6, 11).

As expected, for the five studies reporting no significant intervention effect on physical activity and dietary behaviour, no significant change in weight status was also reported.

Table 3: Impact of intervention on outcome measures (Longest follow-up times, theoretical models and parental involvement are also stated for each study).

Key: NS=Not significant results reported; *= Significant results reported;
- = Outcome not measured; P.I. = Parental involvement; DU = data unavailable

European studies	Model	P.I.	Weight	PA & Dietary Behaviour	Determinants	Follow-up
Manios et al. (2002)	SCT	High	*	*	*	10 years
Warren et al. (2003)	SLT	Med	NS	NS	*	14-16 months
Bayer et al. (2009)	SLT	High	NS	*DU	-	6 months (cohort 1)
			NS	*DU	-	18 months (cohort 2)
Reilly et al. (2006)	HEM	High	NS	*	-	1 year
Kriemler et al. (2010)	SEC model	Med	*DU	*DU	NS DU	10 months
Danielzik et al. (2007)	None reported	High	NS	NS	NS	4 years
Non-European studies	**Model**	**P.I.**	**Weight**	**PA & Dietary Behaviour**	**Determinants**	**Longest follow up**
Fitzgibbon et al. (2006)	SDT; SLT; TTM	High	*	*	-	2 years (cohort 1)
			NS	NS	-	2 years (cohort 2)
Adams et al. (2008)	HBM; CMT	High	*	*	-	9 months
Graham et al. (2008)	Through Schools Approach	Med	NS DU	NS DU	-	2 years
Hu et al. (2010)	None reported	High	NS	*	*	1 year
Stock et al. (2007)	None reported	Low	NS	NS	*	10 months
Mo-Suwan et al. (1998)	None reported	Low	NS	-	-	8 months

Determinants of behaviour change

- Four studies (1, 2, 5, 6) reported significant changes for outcome measures of determinants of behaviour change (such as parents' and children's health knowledge, parents' attitudes to health, parental support and role modelling). Two of these studies reported the use of Social Cognitive Theory/Social Learning Theory (14-16) in the development of the intervention program (1, 6). Two studies (2, 5) did not report the use of behavioural models although there were elements common to all four intervention programs: providing information on behaviour-health link; skill development and modelling and reinforcement. Parental involvement was high or medium in three studies (1, 2, 6) and while parental involvement was low in the fourth study (5), the intervention program was delivered in school to a young cohort of children by their older peers. To some extent this supports claims that teachers, parents and older children can be useful role models in shaping young children's perceptions of healthy living.
- In two studies (8, 12) determinants of behaviour change were not significant. For one study (11) data for measures of determinants of behaviour were unavailable (authors were contacted but no response was received at the time of report writing).
- Determinants of behaviour change were not outcome measures in five studies (3, 4, 7, 9, 10).

Behavioural models/theories underpinning intervention programmes

- Eight studies reported using one or more behavioural model in the development of the intervention used (1, 3, 4, 6, 9-12). Of these studies, seven reported favourable intervention effects on at least one outcome measure (see Table 3). One (11) reported no intervention effect on outcome measures. The 'through schools approach' used in the development of this intervention allowed elements of the intervention to be individualised to each school on a 'school-needs' basis, and it is possible that the null effect can be attributed to a low level of standardisation of the intervention.

- Four studies did not report the use of behavioural models in the development of interventions used (2, 5, 7, 8). Of these studies, two reported favourable intervention effects on at least one outcome measure (2, 5).

Research of relevant studies conducted through the various stages of this review, highlights the predominance of Bandura's (14-16) Social Cognitive Theory (SCT) / Social Learning Theory (SLT) in the development of interventions to prevent obesity in children of various ages. SCT describes behaviour change as an interaction between *personal*, *behavioural* and *environmental* factors. Skills, self-efficacy, and outcome expectancies are the primary *personal* concepts within SCT for understanding behaviour change. Modelling, rewarding/reinforcement (from parents, teachers, carers and peers), and *availability* (e.g. provision of fruit within the school-context) are the primary *environmental* variables within SCT for understanding behaviour change. As young children are generally guided by parents and teachers in their dietary intake and levels/types of physical activity, Baranowski et al. suggest that "environmental variables [e.g. parenting or availability] (as targets for interventions) offer the most promise with younger children" (26).

To some extent the findings from this review support this; interventions that were developed using SCT/SLT incorporated personal and environmental intervention components such as providing opportunities for skills development (relating to dietary practices and PA activities for parents and children), promoting self-efficacy (for example, providing opportunities for children engaged in physical activities to experience success or a sense of accomplishment). Outcome expectancies are likely to be shaped by children's knowledge and understanding of behaviour-health links: this component was present in the four interventions underpinned by SCT/SLT. However it is important to consider that interventions underpinned by other behavioural models or no theoretical models, also involved educational components - specifically the provision of information on behaviour-health links (see Table 3).

Overall, there was consensus among authors that parental involvement had been central to the success of the intervention programmes implemented, in terms of favourable and significant outcomes, trends in preferred directions and engagement and adherence to the intervention program.

In Table 3, outcome measures are presented as ‘weight status changes’ ‘physical activity and dietary changes’ and ‘determinants of behaviour changes’ and significant changes within these categories are also presented for each study.

Intervention strategies identified in the five studies (1-4, 12) that had significant results in two or more of these outcome measure categories will now be considered.

Duration of interventions and models used in development

Four of the intervention programmes were implemented for 1 year or more (1, 2, 4, 12) with approximately 2 hours or less of intervention contact time per week. In one study (3) the intervention was implemented for 14 weeks, with more than 2 hours of intervention contact time per week, described as an intensive intervention delivered to children for 45 minutes, three times each week. Interventions were underpinned by behavioural models in four studies (1, 3, 4, 12): Bandura’s (14-16) Social Cognitive Theory / Social Learning Theory (1, 3), Self-Determination Theory (20-22), Transtheoretical/stages of change model (23) (aimed at parents) (3), one study (12) used the socio-ecological conceptual model (18), and the Health Belief Model (24) combined with Competence Motivational Theory (25) in one study (4). Two studies used more than one behavioural model in the development of the intervention used (3, 4).

Parental Involvement

The level of parental involvement within the intervention programmes with significant changes in all, or at least two of the three categories (‘weight status changes’ ‘physical activity and dietary changes’ and ‘determinants of behaviour changes’) was high in four studies (1-4) and moderate in one (12).

Education Components

All five studies (1-4, 12) had classroom-based components as part of the intervention programme, where information on behaviour-health links was provided to children and parents. Educational sessions were delivered as part of the intervention to children in the classroom, to parents in school-based sessions; information on healthful behaviours was also provided in the form of flyers, booklets, and homework for parents.

In the Cretan Health and Nutrition Education Program (1) the intervention was designed to be teacher-delivered. Health and nutrition sessions were delivered to children (a total of 13 to 17 hours over 1 year). Work books and teaching aids were developed specifically for the intervention. Physical activity sessions (which had practical and theoretical components) were delivered by trained instructors (two 45-minute sessions each week), in both the classroom and in the playground. Classroom modules were designed to develop behavioural capability, expectations and self-efficacy for healthful eating, physical activity and fitness. Parents attended meetings and presentations on topics relevant to dietary and exercising behaviours, and were encouraged to modify their own and their child's dietary and physical activity habits. Two parent meetings were held in school annually.

In the Nutrition education intervention program (2) interactive classes were delivered by trained graduate students and research assistants to children and parents, on the benefits of healthy diets and physical activity. Sessions were informative regarding food preparation and cooking methods and were designed to facilitate skill development. The nutrition sessions were delivered monthly (eight sessions were implemented during the course of the one-year intervention programme). Information was also provided to parents in the form of pamphlets and an illustrated book with a nutritional theme was distributed by teachers to all intervention group children.

Children in the Hip-Hop to Health Jr. programme (3) took part in 45-minute classes, three times per week for 14 weeks. Each session began with five minutes of warm up exercises and was followed by a 20-minute classroom-based activity related to healthy eating or exercise. Children spent the last 20-minutes of the session engaged in aerobic activity. The sessions were delivered by Head Start teachers. Parents also had an opportunity to attend 30-minute aerobic sessions, twice each week for 14 weeks. They received newsletters informing them of the nutrition and physical activity sessions their children were involved in, and parents were asked to complete homework assignments each week on similar topics.

In the Tooty-Fruity Vegie programme (4), health professionals (dieticians, health promotion officers or child and family health nurses) gave interactive workshops on positive parenting and healthy eating, to parents. Parents were also encouraged to

attend positive parenting courses which were free or at reduced costs), and were provided with information and support at school-based workshops delivered by health professionals. Children were involved in interactive sessions with health professionals each term and teaching staff were trained and provided with a manual of ideas for including positive food messages in art, drama, role-play, music and stories. Preschool staff were also trained to implement physical activity sessions: each session was repeated twice per week and each term was repeated twice for the duration of the one year programme.

Additional physical education lessons were delivered to children in the 'KISS' study (12) by 'expert P.E. teachers'. Two 45-minute sessions were delivered each week in addition to their usual P.E. curriculum throughout the school year. Existing P.E. classes were delivered by their usual classroom teacher, who was present at the 'extra' classes for training purposes. Parents were not involved in school-based elements of the intervention but were provided with information in leaflets: families were encouraged to be physically active and children were encouraged to reduce TV/media time.

Interactive learning (Diet and Physical Activity)

Learning about the behaviour-health link was also 'hands-on' throughout all five intervention programmes with significant results in the three categories of particular interest (1-4, 12). Parents and children attended presentations and interactive sessions at school, and the interactive sessions with teachers, parents and children were offered as opportunities for skill development.

In all five studies, parents were given opportunities to learn more about healthy diets for their children (1-4, 12). In two studies parents and children were involved in interactive sessions aimed at facilitating skill development in food preparation and cooking (2, 4) In one study parents and children were encouraged to taste the foods prepared in the sessions and the children were also given the opportunity to grow their own vegetables (4).

Physical activity was a component of all five interventions (1-4, 12): in four studies (1, 3, 4, 12), children were actively engaged in physical activity as part of the intervention programme (for example additional physical education lessons, games

and activities involving physical activity. Sessions in all five studies were developed to encourage children to try new healthful dietary and physical activity related behaviours and to promote skill development.

Intervention targets

The intervention targets in these studies were to increase physical activity and healthy eating (1-4) and to increase physical activity only (12). However, although increased healthy eating was not a target of the latter intervention (12), all children and parents in the study were provided with nutritional information in the form of three flyers: general nutrition, vitamins and healthy snacks for school.

7. Conclusions

Social Cognitive Theory (SCT)/ Social Learning Theory (SLT) (14-16) was used most often in the development of intervention programmes, either as a single model or in combination with other behavioural models. Studies that used SCT/SLT in the development of the intervention (1,3,6,10) had significant favourable changes in one outcome measure category (6), two outcome measure categories (2,3,4,12) and in three outcome measure categories (1) (see Table 3 for further information).

The key components of SCT/SLT that are used in the development of these interventions are modelling (observational learning) and techniques to facilitate skill development and increased self-efficacy. Parental involvement was high or medium in the studies that used SCT/SLT and parents were encouraged to work with their children to facilitate healthful behaviour change through positive reinforcement, praise and modelling healthful behaviours themselves.

It is difficult to identify specific effective components of school-based obesity prevention interventions. It may be wise to consider the combinations of strategies that have evidence which demonstrates positive behaviour change and favourable changes in weight status, and the importance of intervention contact time (e.g. number of hours per week) vis-à-vis the duration of the intervention programme.

From the review, it is clear that interventions that combine

a) high levels of parental involvement and interactive school-based learning and
b) that target physical activity *plus* dietary change

require further consideration in the development of useful interventions for children aged 4-6 years old.

Appendices

Appendix 1 – References to included studies

Twelve studies have been included in this review. Where more than one paper was used to supply information about a study, all papers have been referenced but one *'primary reference'* has been chosen as an overall identifier for the study. These primary references are listed below with bold font and an asterisk (*). Papers that also belong to the same study follow underneath the primary reference.

1. Manios 2002

*Manios, Y., J. Moschandreas, et al. (2002). Health and nutrition education in primary schools of Crete: changes in chronic disease risk factors following a 6-year intervention programme. *British Journal of Nutrition* 88: 315–324.

Kafatos, A., Y. Manios, et al. (2005). Health and nutrition education in primary schools of Crete: follow-up changes in body mass index and overweight status. *European Journal of Clinical Nutrition* 59: 1090–1092.

Kafatos, I., Y. Manios, et al. (2007). Health and nutrition education program in primary schools of Crete: changes in blood pressure over 10 years. *European Journal of Clinical Nutrition* 61(7): 837-845.

Manios, Y., A. Kafatos, et al. (1998). The effects of a health education intervention initiated at first grade over a 3 year period: physical activity and fitness indices. *Health Education Research: Theory & Practice* 13(4): 593-606.

Manios, Y., J. Moschandreas, et al. (1999). Evaluation of a Health and Nutrition Education Program in Primary School Children of Crete over a Three-Year Period. *Preventive Medicine* 28: 149–159.

2. Hu 2010

*Hu, C., D. Ye, et al. (2010). Evaluation of a kindergarten-based nutrition education intervention for pre-school children in China. *Public Health Nutrition* 13(2): 253-260.

3. Fitzgibbon 2006

*Fitzgibbon, M. L., M. R. Stolley, et al. (2006). Hip-Hop to Health Jr. for Latino Preschool Children. *Obesity* 14: 1616–1625.

Fitzgibbon, M. L., M. R. Stolley, et al. (2002). A community-based obesity prevention for minority children: rationale and study design for "Hip-Hop to Health Jr." *Preventive Medicine*. 34: 289-97.

Fitzgibbon, M. L., M. R. Stolley, et al. (2005). Two-year follow-up results for Hip Hop to Health Jr: A randomized controlled trial for overweight prevention in preschool minority children. *Journal of Pediatrics* 146: 618-625.

Stolley, M. R., M. L. Fitzgibbon, et al. (2003). Hip-Hop to Health Jr., an obesity prevention program for minority preschool children: baseline characteristics of participants. *Preventive Medicine* 36: 320–329.

4. Adams 2009

*Adams, J., A. Zask, et al. (2009). Tooty Fruity Vegie in Preschools: an obesity prevention intervention in preschools targeting children's movement skills and eating behaviours. *Health Promotion Journal of Australia* 20(2): 112-119.

Adams, J. et al. (2008). Tooty Fruity Vegie in Preschools Program Report. North Coast Area Health Service Report, Lismore, NSW, Australia.

5. Stock 2007

*Stock, S., C. Miranda, et al. (2007). Healthy Buddies: A Novel, Peer-Led Health Promotion Program for the Prevention of Obesity and Eating Disorders in Children in Elementary School. *Pediatrics* 120: e1059-e1068.

6. Warren 2003

*Warren, J. M., C. J. K. Henry, et al. (2003). Evaluation of a pilot school programme aimed at the prevention of obesity in children. *Health Promotion International* 18(4): 287-296.

7. Mo-suwan 1998

*Mo-suwan, L., S. Pongprapai, et al. (1998). Effects of a controlled trial of a school-based exercise program on the obesity indexes of preschool children. *American Journal of Clinical Nutrition* 68: 1006–11.

8. Danielzik 2007

*Danielzik, S., S. Pust, et al. (2007). School-based interventions to prevent overweight and obesity in prepubertal children: process and 4-years outcome evaluation of the Kiel Obesity Prevention Study (KOPS). *Acta Paediatrica* 96: 19–25.

Asbeck, I., K. Langnase, et al. (2000). Education in nutrition and family counselling on a local level. *Akt Ernahrungs-medizin*. 25: 33-37.

Muller, M.J., Mast, M., Kortzinger, I., Grund, A., and Langnase, K. (1999). Physical activity and diet in 5 to 7 year old children. *Public Health Nutr*. 2: 443-444.

Muller, M. J., I. Asbeck, et al. (2001). Prevention of obesity—more than an intention. Concept and first results of the Kiel Obesity Prevention Study (KOPS). *International Journal of Obesity* 25 Suppl 1: S66–S74.

Plachta-Danielzik, S., S. Pust, et al. (2007). Four-year Follow-up of School-based Intervention on Overweight Children: The KOPS Study. *Obesity* 15: 3159 –3169.

9. Reilly 2006

*Reilly, J. J., L. Kelly, et al. (2006). Physical activity to prevent obesity in young children: cluster randomised controlled trial. *British Medical Journal* 333(7577): 1041.

10. Bayer 2009

*Bayer, O., R. von Kries, et al. (2009). Short- and mid-term effects of a setting based prevention program to reduce obesity risk factors in children: A cluster-randomized trial. *Clinical Nutrition* 28: 122–128.

11. Graham 2008

*Graham, D., S. Appleton, et al. (2008). Increasing activity and improving nutrition through a schools-based programme: Project Energize. 1. Design, programme, randomisation and evaluation methodology. *Public Health Nutrition* 11(10): 1076-1084.

Graham, D. et al. (2008). Project Energize: “Happy healthy children of all shapes and sizes” An Evaluation report (retrieved from the internet on 29th June 2010):.

12. Kriemler 2010

*Kriemler, S., L. Zahner, et al. (2010). Effect of school based physical activity programme (KISS) on fitness and adiposity in primary schoolchildren: cluster randomised controlled trial. *British Medical Journal* 340: c785.

Zahner, L., J. J. Puder, et al. (2006) A school-based physical activity program to improve health and fitness in children aged 6-13 years (“Kinder-Sportstudie KISS”): study design of a randomized controlled trial, *BMC Public Health*, 6: 147.

Appendix 2 – Primary (1-12) and Additional (13-26) References

1. Manios Y, Moschandreas J, Hatzis C, Kafatos A. Health and nutrition education in primary schools of Crete: changes in chronic disease risk factors following a 6-year intervention programme. Br J Nutr. 2002;88(3):315-24.
2. Hu C, Ye D, Li Y, Huang Y, Li L, Gao Y, et al. Evaluation of a kindergarten-based nutrition education intervention for pre-school children in China. Public Health Nutr. 2010;13(2):253-60.
3. Fitzgibbon ML, Stolley MR, Schiffer L, Van Horn L, KauferChristoffel K, Dyer A. Hip-Hop to Health Jr. for Latino preschool children. Obesity (Silver Spring). 2006;14(9):1616-25.
4. Adams J, Zask A, Dietrich U. Tooty Fruity Vegie in Preschools: an obesity prevention intervention in preschools targeting children's movement skills and eating behaviours. Health Promot J Aust. 2009;20(2):112-9.
5. Stock S, Miranda C, Evans S, Plessis S, Ridley J, Yeh S, et al. Healthy Buddies: a novel, peer-led health promotion program for the prevention of obesity and eating disorders in children in elementary school. Pediatrics. 2007;120(4):e1059-68.
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10. Bayer O, von Kries R, Strauss A, Mitschek C, Toschke AM, Hose A, et al. Short- and mid-term effects of a setting based prevention program to reduce obesity risk factors in children: a cluster-randomized trial. Clin Nutr. 2009;28(2):122-8.
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Appendix 3 – Summary Table of Included Studies

Study 1	Participants	Outcome measures	Intervention	Theoretical underpinning	Key results:	Impact of intervention
Manios & Kafatos et al (1998 – 2007) Greece CCT Quality rating: low	Primary school children (& their parents) Mean Age in years (SD): 6.3 (0.3) Data collection at: Baseline, 3 years, (end of intervention at 6 years) and follow-up at 10 years	Children's and parents' health knowledge; Children's physical activity; Children's fitness; anthropometrics; body composition; dietary intake	Duration: 6 years Delivery: program delivered in the classroom and playground – aimed at developing behavioural capability, expectations and self-efficacy for healthful eating, physical activity and fitness School-based with parental involvement Target behaviour: Increase PA and healthy eating	TU Stated (by authors): Social Cognitive Theory (SCT) Quality rating: High	At 3 years, statistically greater improvements were observed in intervention group compared to control group – children's and parents health knowledge; children's fitness indices and PA outside school; suprailiac skinfold and BMI (M, 1998) At 3-years, positive serum lipid level changes occurred mainly in the intervention group; BMI increased les in the intervention group than in the control group (M, 1999) Difference between intervention group and control group at 6-year follow-up : Serum lipids; BMI, anthropometrics and fitness indices and leisure-time MVPA, and daily nutrient intake (M, 2002) At 4-years follow-up children in the intervention group had a lower BMI on average than the control group (overweight prevalence NS) (K, 2005) Lower increase in BP in the intervention group after 10 years (K, 2007)	Significant impact on primary outcome measures Significant intervention effect on weight and BMI, MVPA, ($P<0.001$) at end of intervention and on BP at 10 years follow up ($P<0.001$) Authors emphasise parental involvement and expanded PE classes as pertinent to the effectiveness of the intervention.
Study 2	Participants	Outcome measures	Intervention	Theoretical underpinning	Key results	Impact of intervention
Hu, C. (2010) China RCT Quality rating: low	Kindergarten children (& their parents) Mean Age in years (SD): 4.6 (0.6) Data collection at: Baseline, 6 months and end of intervention at 12 months	Parent-reported nutrition-related eating behaviours; parental nutrition knowledge; parents' attitudes regarding their child's dietary behaviours; parents' dietary behaviours; children's weight and height and BMI	Duration: 1 year Delivery: Classroom-based nutrition education program. Components delivered to children and parents; skills for food arranging and cooking, and the benefits of physical activity; illustrated books given to children; pamphlets given to parents; nutritional posters displayed in kindergartens School-based with parental involvement Target behaviour: Increase PA and healthy eating	TU Stated (by authors): None specified Reviewers comments: Emphasis was placed on educating parents about the importance of healthy diet and physical activity. "Parents and kindergarten teachers play key roles in helping pre-schoolers to develop positive dietary behaviours" (p.254). Quality rating: Moderate	Unhealthy behaviours such as eating unhealthy snacks and watching TV during dinner reduced significantly in the intervention group compared to the control group ($P < 0.05$) Healthy lifestyle behaviour 'eating breakfast' improved significantly within the intervention group compared to the control group ($P < 0.0001$) There were no significant differences between groups for weight, height and BMI at 6 and 12 months follow-up.	No sig impact on height, weight or BMI The intervention had a significant impact on both intervention group children's dietary behaviours and parents' dietary behaviours and attitudes to planning their children's diets. Authors emphasise the importance of **parental involvement** in this intervention.

Study 3	Participants	Outcome measures	Intervention	Theoretical underpinning	Key results	Impact of intervention
Fitzgibbon et al (2002-2006) USA Hip-Hop to Health Jr. RCT Quality rating: low	Pre-school children (& their parents) 2 cohorts: Mean Age in months (SD): Latino 50.9 ( ) Black 49.7 ( ) Data collection at: Baseline & end of intervention (14 weeks), follow up at 1-year and 2-years from baseline	Dietary intake (parents and children); physical activity and sedentary behaviours (measures for parents and children) Acculturation; parental support and role modelling (parents only) BMI, BMI z-scores (children only)	Duration: 14 weeks (45-minute sessions, 3 times/wk) Delivery: Class-based activities and a PA component to emphasise the importance of healthy eating and exercise, to encourage the exploration of new foods and to emphasise the relationships between diet, PA and healthy bodies School-based with parental involvement Target behaviour: Increase PA and healthy eating. Improve parents' knowledge of healthy eating	TU Stated (by authors): Social Learning Theory (SLT), Self-determination Theory (aimed at the children) Transtheoretical model / stages of change (aimed at the parents) Quality rating: High	**Latino children:** There were no significant differences between intervention group and control group in either primary or secondary outcomes at post-intervention (14 wks), Year 1 or Year 2 follow-up. **Black children:** intervention group children had significantly smaller increases in BMI than control group children at Year 1 and Year 2 follow-up. Calories from sat fat was the only dietary indices to be significant between groups at Year 1.	Authors suggest that the null findings with the Latino cohort may due to cultural factors – and that the parental component of the intervention was not intensive enough for this sample of low-acculturated Latinos.
Study 4	**Participants**	**Outcome measures**	**Intervention**	**Theoretical underpinning**	**Key results:**	**Impact of intervention**
Adams et al. (2008, 2009) Australia Tooty Fruity Vegie in Schools Program RCT Quality rating: low	Pre-school children (& their parents) Mean Age in years (SD): Data collection at: Baseline and 9 months from baseline	Gross motor skills; change in BMI; Overweight and obesity status; waist circumference; commencement of adiposity rebound; child's nutrition and physical activity habits (reported by parent)	Duration: 1 year Delivery: Intervention strategies included skills development and awareness-raising for parents (through workshops), staff and children. Health promotion posters used within intervention group preschools and access to water was ensured. Children received classroom based educational curriculum and activities relating to healthy eating. Also involved in a physical activity based component to help children develop fundamental movement skills. School-based (with parental involvement) Target behaviour: Increase children's PA and healthy eating. Improve parents' knowledge of healthy eating	TU Stated (by authors): Health Belief Model (HBM) - used to shape intervention strategies to encourage parents to provide healthy eating and active play opportunities (re: importance of parental involvement) Competence Motivational Theory (CMT) – suggests that children's motivation to participate in physical activity is influenced by their actual and perceived competence, social support and enjoyment of the activities. This guided the choice of practical physical activities and experiential food strategies for the children (see p. 113). Quality rating: High	**Movement** - Both intervention group and control group improved their movement skills. However, children in the intervention group improved their movement skills significantly more than the control group ($p<0.0001$) **Fruit & Veg in lunch box** – Mean combined number of F&V serves in lunch boxes, increased significantly for children in the intervention group when compared to the control group ($p<0.0001$) **BMI** – changes in overweight and obesity were in the desired direction, although there was no significant intervention effect on BMI or overweight status. **Adiposity Rebound** – There were significantly less children who had an early adiposity rebound in intervention preschools when compared to controls ($p=0.017$) and this difference was still significant when the model adjusted for age ($p=0.04$) (should be interpreted with caution – see page 12).	Significant impact on movement skills; F&V serves in lunchboxes; waist circumference No significant impact on BMI Authors emphasise that impact of the intervention on both parents' and children's behaviour towards increasing physical activity levels and reducing intake of EDNP food and drink. They conclude that the intervention has shown promising signs that it has had a positive effect on overweight and obesity indicators.

Study 5	Participants	Outcome measures	Intervention	Theoretical underpinning	Key results	Impact of intervention
(Stock et al, 2007) Canada Healthy Buddies Program CCT Quality rating: low	'Primary' age children (& their parents) 5 and 6 years old (mean age unavailable) Data collection at: Baseline and end of intervention at 10 months	Healthy living questionnaire scores; height, weight, blood pressure, and heart rate; BMI; fitness test (9-minute run).	Duration: 10 months Delivery: Classroom-based health education program delivered by teachers to older children and then delivered by older children to the kindergarten children. Included components focusing on: regular physical activity; healthy eating; healthy body image, self-esteem and social responsibility. School-based Target behaviour: Increase PA and healthy eating. Improve knowledge of and attitudes towards healthy living	TU Stated (by authors): None specified Reviewers comments: The program was developed around the prescribed learning outcomes from the British Columbia Ministry of Education. Quality rating: Moderate	***Anthropometrics -** Changes in weight, BMI and heart rate between baseline and follow-up measures were not significantly affected by the intervention. ****PA** - Increase in distance covered in the 9-minutes run at follow-up did not differ significantly between control and intervention groups **Health Knowledge** - Intervention group children showed a markedly greater increase in health knowledge scores ($F = 33.9$, $P<0.001$) **Health Behaviour** - There was a trend toward a higher increase in health behaviour scores for intervention group compared with control group, but the difference was only significant for female students in the intervention group compared with female children in the control group (school x gender interaction; $F = 6.4$, $P = 0.013$) **Health Attitudes** – scores had improved significantly more for children in the intervention group compared with the control group ($F = 4.2$, $P = 0.043$	The intervention was not effective on weight and BMI, and fitness indices. The Intervention did have an effect on children's health knowledge, attitudes and for girls, their behaviour. Authors emphasise the potential for peer-delivered health education programs in achieving positive health outcomes
Study 6	Participants	Outcome measures	Intervention	Theoretical underpinning	Key results	Impact of intervention
(Warren et al. 2003) England The 'Be Smart' Study RCT Quality rating: low	Primary school children Mean Age in years (SD): 6.1 (0.6) Data collection at: Baseline and end of intervention at 14-16 months	Height, Weight, BMI, Skinfold, Circumferences. Nutrition knowledge, PA, Diet (reported via questionnaires by children and parents)	Duration: 14 months Delivery: Classroom-based Nutrition and Physical activity programmes. 3 intervention groups and 1 control: intervention group (Diet) intervention group (PA) intervention group (Diet and PA) control group (Control) School-based (with parental involvement) Target behaviour: Increase PA and healthy eating	TU Stated (by authors): Social Learning Theory (SLT) (Bandura, 1986) Quality rating: High	NO significant differences between intervention and control groups. Some significant changes overall, such as rise in vegetable consumption at final assessment, see below Nutrition knowledge scores improved in all children between baseline and final stage ($p < 0.01$), particularly for EAT SMART and EAT/PLAY SMART IGs ($p<0.001$)	No significant impact of intervention

Study 7	Participants	Outcome measures	Intervention	Theoretical underpinning	Key results	Impact of intervention
Mo-Suwan et al. 1998 Thailand Cluster RCT Quality rating: low	Kindergarten children Mean Age in years (SD): 4.5 (0.4) Data collection at: Baseline, 3 months, 5 months and end of intervention at 8 months	Weight, height, BMI, WHCU, TSF	Duration: 8 months Delivery: Kindergarten-based; involved physical activity sessions in the morning (15 min walk) and afternoon (20 min aerobic dance), 3 times/wk. No dietary component School-based Target behaviour: Increase PA	TU Stated (by authors): Not specified Reviewers comments: Intervention shaped by Superkids-Superfit Exercise Curriculum for Cardiovascular Health, which "stresses non-competitive activities as well as competitive sports". This program has the goal of "increasing the amount of conditioning activity each child receives over the course of a school year" (Harsha, 1995, p. 111). Quality rating: Moderate	No significant differences between the intervention and control groups on outcome measures Among the exercise subjects, girls had less gain in weight and hence had significantly lower mean BMI and WHCU than did the boys (t test, $P < 0.01$)	None between intervention group and control group overall. Girls in the exercise group had a lower likelihood of having an increasing BMI slope than the control girls did
Study 8	Participants	Outcome measures	Intervention	Theoretical underpinning	Key results	Impact of intervention
Danielzik et al. (2001-2007) Germany KOPS Study CCT Quality rating: low	Primary school children (& their parents) Median Age in years (IQR): control group: 6.3 (6.0-6.5) intervention group: 6.3 (5.9-6.5) Data collection at: Baseline, and follow-up at 4 years from baseline	Height, weight, skinfolds, WC, fat mass, BMI Dietary behaviour, PA and sedentary behaviour	Duration: 2-3 weeks (delivered in 6 sessions) Delivery: School-based intervention promoting messages of healthy living. Messages were aimed at children, parents and teachers. 6 nutrition sessions were delivered to children in the intervention group. After each session, running games were offered for 20 minutes. School-based (with a family intervention offered to some families with overweight/obese children and/or parents) Target behaviour: Increase PA and healthy eating and reduce sedentary behaviours	TU Stated (by authors): Not specified Reviewers comments: KOPS program based on assumption that attitudes, and various social and material factors are predictive for weight changes. "Lifestyle changes are accomplished by increased knowledge, self monitoring, increased self-esteem and personal autonomy…" (p.69) Quality rating: Moderate	At follow-up there was no significant difference in prevalence of overweight and obesity.	No effect of intervention between groups. The effect of intervention increased with SES, resulting in a lower prevalence of overweight in children of high SES (P=0.03). The effect was marginally significant in children of normal weight mothers (P=0.05)

Study 9	Participants	Outcome measures	Intervention	Theoretical underpinning	Key results	Impact of intervention
Reilly et al. (2006) Scotland The MAGIC Trial Cluster RCT Quality rating: low	Pre-school children Mean Age in years (SD): intervention group: 4.2 (0.3) control group: 4.1 (0.3) Data collection at: Baseline, end of intervention at 6 months and follow-up at 12 months	BMI; Total PA and sedentary behaviours	Duration: 24 weeks (6 months) Delivery: **Nursery element**: Three, 30 minute sessions of physical activity each week over 24 weeks, with trained staff. For six weeks during the intervention, posters focusing on increasing PA through walking and play, were displayed in each intervention nursery. **Home-based element:** (i) each family received a resource pack with guidance on linking PA at nursery and at home, and 2 simple health education leaflets. (ii) families were encouraged to seek opportunities to reduce the time spent watching television School-based (with parental involvement) Target behaviour: Increase PA and reduce sedentary behaviour	TU Stated (by authors): **Home-based element:** Health education model **Nursery element:** not specified reviewers comments: **Nursery element:** Intention was to increase levels of PA and children's fundamental movement skills and meet guideline requirements. Quality rating: High		No significant impact of intervention
Study 10	**Participants**	**Outcome measures**	**Intervention**	**Theoretical underpinning**	**Key results**	**Impact of intervention**
Bayer et al. (2009) Germany Tiger Kids Study Cluster RCT Quality rating: low	Kindergarten children (& their parents) Mean Age in years (SD): Data collection at: 6 months and 18 months from start of intervention (2 cohorts)	**Anthropometrics:** weight and height (to calculate overweight /obesity status). Motoric testing (incl. side-to-side jumps) – assessed in school. **Food frequency data:** food and drink consumption, purchase of low fat milk products, infrequent consumption of snacks while watching TV - assessed by parental questionnaire	Duration: 2 years Delivery: Kindergarten teachers were provided with information folders and modules and a CD with songs ready for use. Information for parents included information evenings and resources such as TippCards with health messages. There was also a website for support and information. School-based (with parental involvement) Target behaviour: Increase PA and healthy eating	TU Stated (by authors): Social Learning Theory (SLT) (Bandura, 1977) Quality rating: High	There was a reproducible higher …consumption of F&V reported in the intervention group in both samples (X^2 P < 0.0001) and (X^2 P = 0.0002). A lower consumption of high calorie drinks (X^2 P = 0.0001) and snacks while watching TV (NS, P=0.055) was only observed in the intervention group in the first sample Waiting for breakdown data	Significant impact on dietary behaviours - Intervention achieved a higher fruit and vegetable consumption in the home environment in two different samples assessed 6 and 18 months after the initiation of the program

Study 11	Participants	Outcome measures	Intervention	Theoretical underpinning	Key results	Impact of intervention
Graham et al. (2008a,b) New Zealand Project Energize Cluster RCT Quality rating: medium	Primary school children (& their parents) Mean age in months (SD): 68.5 ( ) Data collection at: Baseline and 2 years from baseline	**Anthropometrics:** Weight, height, body fat, arm and waist circumference, resting BP, pulse rate, BMI z score were also calculated **Household questionnaire** completed by caregiver: **School stock-take**: A profile of the school's nutrition and activity resources. Child's **dental health** was also assessed using a standard framework.	Duration: Ongoing Delivery: The intervention programme was individualized to each school on a needs based assessment (stock-take). Nutrition and Physical activity elements could be addressed. School-based (with parental involvement) Target behaviour: Increase PA and healthy eating, and reduce sedentary behaviour	TU Stated (by authors): Through Schools Approach This is intervention at the organizational level (rather than the personal or interpersonal). Quality rating: High	Waiting for breakdown data. There was a significant difference in systolic BP in favour of the intervention group in the subgroup: 5-year-old NZ European females	**For the 5-year-old cohort:** In the intervention group there were no overall differences in BMI, BMI z-score, % body fat, or FMI compared to the control group. As children (both age groups) get older, they undertake less active play and more screen time. This holds true for both intervention group and control group. However, within the 5-year-old cohort, they decreased their active play and increased their total screen time at a slower rate than the control group.
Study 12	Participants	Outcome measures	Intervention	Theoretical underpinning	Key results	Impact of intervention
Kriemler at al. (2006, 2010) Switzerland KISS study Cluster RCT Quality rating: medium	Primary school children Mean age in years (SD): 6.9 (0.3) Data collection at: Baseline and Post-I at 10 months	BMI, WC, skinfolds. Total PA, total MVPA, shuttle-run test, cardiovascular risk score including blood serum measures and BP Physical and psychological quality of life	Duration: 9 months Delivery: School-based Target behaviour: Increase PA	Socio-ecological conceptual model focusing on increasing daily physical activity (Egger & Swinburn, 1997). Quality rating: High	Waiting for breakdown data.	A school based, multi-component physical activity intervention including compulsory elements improved physical activity and fitness and reduced adiposity in children.

Appendix 4 – Excluded references

PAPER / PUBLICATION	REASON FOR EXCLUSION
Adamson, A., P. Curtis, et al. (2000). A family-based intervention to increase consumption of starchy foods. *Nutrition & Food Science* 30(1): 19-23.	Age of children.
Aeberli, I., M. Kaspar, et al. (2007). Dietary intake and physical activity of normal weight and overweight 6- to 14-year-old Swiss children. *Swiss Medical Weekly* 137: 424-430.	No relevant exposures.
Albertson, A. M., G. H. Anderson, et al. (2003). Ready-to-eat cereal consumption: Its relationship with BMI and nutrient intake of children aged 4 to 12 years. *Journal of the American Dietetic Association* 103(12): 1613-1619.	No before/after measures.
Alexy, U., W. Sichert-Hellert, et al. (1999). Fruit juice consumption and the prevalence of obesity and short stature in German preschool children: Results of the DONALD study. *Journal of Pediatric Gastroenterology and Nutrition* 29(3): 343-349.	No relevant outcomes.
Alhassan, S., J. R. Sirard, et al. (2007). The effects of increasing outdoor play time on physical activity in Latino preschool children. *International Journal of Pediatric Obesity* 2: 153-158.	Short follow-up period.
Anderson, A. S., M. M. Hetherington, et al. (2001). Results from a school-based nutrition education intervention aimed at increasing fruit and vegetable intake in primary-school aged children [Abstract]. *Proceedings of the Nutrition Society* 60: 143A.	No relevant outcomes.
Ariza, A. J., E. H. Chen, et al. (2004). Risk factors for overweight in five- to six year-old Hispanic-American children: A pilot study. *Journal of Urban Health* 81(1): 150-161.	No before/after measures.
Ayala, G. X., J. P. Elder, et al. (2010). Longitudinal intervention effects on parenting of the aventuras para ninos study. *American Journal of Preventive Medicine* 38(2): 154-162.	No relevant exposures/outcomes.
Aytur, S. and L. Hughes (2008). Physical activity to prevent obesity in young children: Cluster randomized controlled trial. *American Journal of Health Promotion* 22(4): 301-302.	Reference article/editorial.
Baranowski, T., M. Davis, et al. (2000). Gimme 5 fruit, juice, and vegetables for fun and health: outcome evaluation. *Health Education and Behaviour* 27, 96–111.	Age of children.
Baranowski, T., J. C. Baranowski, et al. (2003). The fun, food and fitness project (FFFP): The Baylor GEMS pilot study. *Ethnicity & Disease* 13: 30-39.	Age of children.

PAPER / PUBLICATION	REASON FOR EXCLUSION
Beech, B. M., R. C. Klesges, et al. (2003). Child- and parent-targeted interventions: The Memphis GEMS pilot study. *Ethnicity & Disease* 13: 40-53.	Age of children.
Blenkinsop, S., D. Teeman, et al. (2007). The further evaluation of the school fruit and vegetable scheme (Evaluation Research) *National Foundation for Educational Research.*	No relevant outcomes.
Caballero, B., S. Davis, et al (1998). Pathways: A school-based program for the primary prevention of obesity in American Indian children. *Journal of Nutritional Biochemistry* 9: 535-543.	Age of children.
Caballero, B., T. Clay, et al. (2003). Pathways: A school-based, randomized control trial for the prevention of obesity in American Indian schoolchildren. *The American Journal of Clinical Nutrition* 78: 1030-1038.	Age of children.
Campbell, K. J., D. A. Crawford, et al. (2006). Family food environment and dietary behaviours likely to promote fatness in 5-6 year-old children. *International Journal of Obesity* 30: 1272-1280.	No relevant outcomes.
Campbell, K., K. Hesketh, et al. (2008). The infant feeding activity and nutrition trial (INFANT) and early intervention to prevent childhood obesity: Cluster-randomized control trial. *Public Health* 8(103).	Age of children.
Carrel, A. L., R. R. Clark, et al. (2005). Improvement of fitness, body composition, and insulin sensitivity in overweight children in a school-based exercise program. *Archives of Pediatrics & Adolescent Medicine* 159: 963-968.	Age of children.
Chomitz, V. R., R. J. McGowan, et al. (2010). Healthy living Cambridge kids: A community-based participatory effort to promote healthy weight and fitness. *Obesity* 18(S1): 45-53.	Age of children.
Coleman, K. J., C. L. Tiller, et al. (2005). Prevention of the epidemic increase in child risk of overweight in low-income schools. *Archives of Pediatrics & Adolescent Medicine* 159: 217-224.	Age of children.
Coon, K. A., J. Goldberg, et al. (2001). Relationships between use of television during meals and children's food consumption patterns. *Pediatrics* 107(1): 1-9.	No relevant outcomes / age of children.
D'Agostino, C., T. D'Andrea, et al. (1999). Healthy Start: a new comprehensive preschool health education program. *Journal of Health Education* 30: 9–12.	No before/after measures.
Davies, P. S., J. Gregory, et al. (1995). Physical activity and body fatness in pre-school children. *International Journal of Obesity* 19: 6–10.	Cross-sectional study design.

PAPER / PUBLICATION	REASON FOR EXCLUSION
Damon, S., S. Dietrich, et al. (2005). PRESTO-prevention study of obesity: A project to prevent obesity during childhood and adolescence. *Acta Paediatrica* 94(S448): 47-48.	Age of children.
Datar, A. and R. Sturm (2004). Physical Education in Elementary School and Body Mass Index: Evidence from the Early Childhood Longitudinal Study. *American Journal of Public Health* 94: 1501–1506.	Not an intervention.
DeForche, B., I. De Bourdeaudhuij, et al. (2009). Objectively measured physical activity, physical activity related personality and body mass index in 6- to 10-year-old children: A cross sectional study. *International Journal of Behavioral Nutrition and Physical Activity* 6:25.	No before/after measures.
Dennison, B., T. J. Russon, et al. (2004). An Intervention to Reduce Television Viewing by Preschool Children. *Archives of Pediatrics and Adolescence Medicine* 158: 170-176.	Data unclear – no response from authors following request.
Dubois, L., A. Farmer, et al. (2007). Regular sugar-sweetened beverage consumption between meals increases risk of overweight among preschool aged children. *Journal of the American Dietetic Association* 107: 924-934.	No before/after measures.
Dubois, L., A. Farmer, et al. (2008). Social factors and television use during meals and snacks is associated with higher BMI among pre-school children. *Public Health Nutrition* 11(12): 1267-1279.	No before/after measures.
Evidence-Based Health Care & Public Health (2004). School anti- "fizzy drinks" programme helps to prevent obesity in children. *Evidence-Based Health Care & Public Health* 8: 368-369.	Age of children.
Economos, C. D., R. R. Hyatt, et al. (2007). A community intervention reduces BMI z score in children: Shape up Somerville first year results. *Obesity* 15(5): 1325-1336.	Age of children.
Eliakim, A., D. Nemet, et al. (2007) The Effects of Nutritional-Physical Activity School-based Intervention on Fatness and Fitness in Preschool Children. *Journal of Pediatric Endocrinology and Metabolism* 20: 711-718.	Short follow-up period.
Epstein, L. H., J. N. Roemmich, et al. (2008). A randomized trial of the effects of reducing television viewing and computer use on body mass index in young children. *Archives of Pediatrics & Adolescent Medicine* 162(3): 239-245.	Not school setting.
Epstein, L. H., L. M. Valoski, et al. (1995). Effects of decreasing sedentary behaviour and increasing activity on weight change in obese children. *Health Psychology* 14(2): 109-115.	Age of children.

PAPER / PUBLICATION	REASON FOR EXCLUSION
Escobar-Chaves, S. L., C. M. Markham, et al. (2010). The fun families study: Intervention to reduce children's TV viewing. *Obesity* 18(S1): 99-101.	No relevant outcomes.
Ezendam, N. P. M., A. Oenema, A. et al. (2007). Design and evaluation protocol of "FATaintPHAT", a computer tailored intervention to prevent excessive weight gain in adolescents. *Public Health* 7:324.	Age of children.
Fardy, P. S., A. Azzollini, et al. (2002). Effects of school-based health promotion on obesity: The path program. *Medicine & Science in Sports & Exercise* 34(5): S68.	Age of children.
Foerster, S. B., J. Gregson, et al. (1998) The California children's 5 A Day-Power Play! Campaign: evaluation of a large-scale social marketing initiative. *Family Community Health* 21: 46-64.	Age of children.
Foster, G. D., S. Sherman, et al. (2008). A policy-based school intervention to prevent overweight and obesity. *Pediatrics* 121: 794-802.	Age of children.
Freedman, D. S., L. K. Khan, et al. (2004). Inter-relationships among childhood BMI, childhood height, and adult obesity: The Bogalusa Heart Study. *International Journal of Obesity* 28: 10-16.	No before/after measures.
Ghoneim, E. H., M. H. A. Hassan, et al. (2004). An intervention programme for improving the nutritional status of children aged 2-5 years in Alexandria. *Eastern Mediterranean Health Journal* 10(6): 828-843.	Not school setting.
Gibson, P., L. Edmunds, et al. (2002). An approach to weight management in children and adolescents (2-18 years) in primary care.	Not an intervention.
Gillis, D., M. Brauner, et al. (2007). A community-based behaviour modification intervention for childhood obesity. *Journal of Pediatric Endocrinology* 20(2): 197-203.	Treatment study/age of children.
Going, S., J. Thompson, et al. (2003). The effects of the Pathways obesity prevention program on physical activity in American Indian children. *Preventive Medicine* 37, 62-69.	Age of children.
Gortmaker, S. L., L. W. Y. Cheung, et al. (1999). Impact of a school-based interdisciplinary intervention on diet and physical activity among urban primary school children. *Archives of Pediatrics & Adolescent Medicine* 153: 975-983.	No relevant outcomes/age of children.
Gortmaker, S. L., K. Peterson, et al. (1999). Reducing obesity via a school-based interdisciplinary intervention among youth. *Archives of Pediatrics & Adolescent Medicine* 153: 409-418.	Age of children.
Green, D. J. (2006). Physical activity to prevent obesity in young children. *British Medical Journal* 333: 1171.	No intervention.

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Groner, J. A., T. Skybo, et al. (2009). Anticipatory guidance for prevention of childhood obesity: Design of the MOMS project. *Clinical Pediatrics* 48(5): 483-492.	Age of children / not school setting.
Grummer-Strawn, L. M., and Z. Mei (2004). Does breastfeeding protect against pediatric overweight? Analysis of longitudinal data from the centres for disease control and prevention pediatric nutrition surveillance system. *Pediatrics* 113(2), 80-87.	No before/after measures.
Grund, A., H. Krause, et al. (2001). Is TV viewing an index of physical activity and fitness in overweight and normal weight children? *Public Health Nutrition* 4(6): 1245-1251.	No before/after measures.
Gunner, K. B., P. M. Atkinson, et al. (2005). Health promotion strategies to encourage physical activity in infants, toddlers, and preschoolers. *Journal of Pediatric Health Care* 19: 253-258.	No before/after measures.
Gunther, A. L. B., T. Remer, et al. (2007). Early protein intake and later obesity risk: Which protein sources at which time points throughout infancy and childhood are important for body mass index and body fat percentage at 7 years of age? *The American Journal of Clinical Nutrition* 86: 1765-1772.	No before/after measures.
Gutin, B., S. Owens, et al. (1997). Effect of physical training on heart-period variability in obese children. *The Journal of Pediatrics* 130(6): 938-943.	Age of children.
Gutin, B., Z. Yin, et al. (2008). Preliminary findings of the effect of a 3-year after-school physical activity intervention on fitness and body fat: the Medical College of Georgia Fitkid Project. *International Journal of Pediatric Obesity* 3 Suppl 1: 3-9.	Age of children.
Haire-Joshu, D., M. B. Elliott, et al. (2008). High 5 for kids: The impact of a home visiting program on fruit and vegetable intake of parents and their preschool children. *Preventive Medicine* 47: 77-82.	No relevant outcomes.
Haire-Joshu, D., M. S. Nanney, et al. (2010). The use of mentoring programs to improve energy balance behaviours in high-risk children. *Obesity* 18(S1): 75-83.	Age of children.
Hakanen, M., H. Lagstrom, et al. (2006). Development of overweight in an atherosclerosis prevention trial starting in early childhood. the STRIP study. *International Journal of Obesity* 30: 618-626.	Age of children.
Harnack, L., J. H. Himes, et al. (2004). Intervention-related bias in reporting of food intake by fifth-grade children participating in an obesity prevention study. *American Journal of Epidemiology* 160(11): 1117-1121.	Age of children.

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Harnack, L., L. Lytle, et al. (2009). Low awareness of overweight status among parents of preschool-aged children, Minnesota, 2004-2005. *Preventing Chronic Disease* 6(2).	No relevant outcomes.
Harrison, M. K. and C. Peggs. (2002). The role of schools in preventing childhood obesity. *West Virginia Medical Journal* 98(6): 260-262.	Nointervention.
Harvey-Berino, J. and J. Rourke. (2003). Obesity prevention in preschool native american children: A pilot study using home visiting. *Obesity Research* 11(5): 606-611.	Age of children.
Harvey-Berino, J., A. Wellman, et al. (2000). Preventing obesity in american indian children: When to begin. *Journal of the American Dietetic Association* 100(5): 564-566.	No relevant exposures.
He, Y.F., W. Y. Wang et al. (2004). Effects of a comprehensive intervention programme on simple obesity of children in kindergarten. *Chinese Journal of Pediatrics* 42(5): 1–6.	Treatment study.
Heimendinger, J., M. Van Duyn et al. (1996) The National 5 A Day for Better Health Program: a large-scale nutrition intervention. *Journal of Public Health Management and Practice* 2: 27-35.	No relevant outcomes.
Honisett, S., S. Woolcock, et al. (2009). Developing an award program for children's settings to support healthy eating and physical activity and reduce the risk of overweight and obesity. *Public Health* 9:345.	Not an intervention.
Horne, P. J., K. Tapper, et al. (2004). Increasing children's fruit and vegetable consumption: A peer-modelling and rewards-based intervention. *European Journal of Clinical Nutrition* 58: 1649-1660.	No relevant outcomes.
Horodynski, M. A., S. Hoerr, et al. (2004). Nutrition education aimed at toddlers: a pilot program for rural, low-income families. *Family & Community Health* 27(2): 103-113.	Age of children.
Horodynski, M. A. and M. Stommel (2005). Nutrition education aimed at toddlers: An intervention study. *Pediatric Nursing* 31(5): 364-372.	Age of children.
Huang, J. P. Pokala, et al. (2009). The Health and Obesity: Prevention and Education (HOPE) Curriculum Project-curriculum development. *Pediatrics* 124(5): 1438-1446.	No intervention.
Hughes, A. R., R. McLaughlin, et al. (2007). The B'active programme for overweight primary school children in Glasgow: Determining the prevalence of overweight and obesity and piloting an activity intervention. *British Journal of Nutrition* 97: 204-209.	No before/after measures.

PAPER / PUBLICATION	REASON FOR EXCLUSION
Hughes, A. R., L. Stewart, et al. (2008). Randomized, Controlled Trial of a Best-Practice Individualized Behavioral Program for Treatment of Childhood Overweight: Scottish Childhood Overweight Treatment Trial (SCOTT). *Pediatrics* 121: e539-e546.	Not a school setting.
Iannuzzi, A. L., M. R. Licenziati, et al. (2009). Comparison of two diets of varying glycemic index on carotid subclinical atherosclerosis in obese children. *Heart & Vessels* 24(6): 419-424.	Age of children.
Jacobson, M. S. T., S. Tomopoulos, et al. (1998). Normal growth in high-risk hyperlipidemic children and adolescents with dietary intervention. *Preventive Medicine* 27(6): 775-780.	Not school setting / treatment study.
James, J., D. Kerr, et al. (2004). Preventing an increase in childhood obesity by reducing consumption of carbonated soda: cluster randomised controlled trial. *British Medical Journal* 328: 1237-1237.	Age of children.
James, J., P. Thomas, et al. (2007). Preventing childhood obesity: two year follow-up results from the Christchurch obesity prevention programme in schools (CHOPPS). *British Medical Journal* 335: 762.	Age of children.
Jan, S., C. Bellman, et al. (2009). Shape it up: a school-based education program to promote healthy eating and exercise developed by a health plan in collaboration with a college of pharmacy. *Journal of Managed Care Pharmacy* 15(5): 403-413.	Age of children / no relevant outcomes.
Jiang, J. X., X. L. Xia, et al. (2007). The effects of a 3-year obesity intervention in schoolchildren in Beijing. *Child: Care, Health & Development* 33(5): 641-646.	Age of children.
Jiang, J. X., X. L. Xia, et al. (2005). A two year family based behaviour treatment for obese children. *Archives of Disease in Childhood* 90(12): 1235-1238.	Treatment study.
Jones, R. A., A. D. Okely, et al. (2007). The HIKCUPS trial: a multi-site randomized controlled trial of a combined physical activity skill-development and dietary modification program in overweight and obese children. *BMC Public Health* 7: 15.	Treatment study.
Jouret, B., N. Ahluwalia, et al. (2009). Prevention of overweight in preschool children: Results of kindergarten-based interventions. *International Journal of Obesity* 33(10): 1075-1083.	Age of children.
Kain, J., R. Uauy, et al. (2004). School-based obesity prevention in Chilean primary school children: methodology and evaluation of a controlled study. *International Journal of Obesity & Related Metabolic Disorders: Journal of the International Association for the Study of Obesity* 28(4): 483-493.	Age of children.

PAPER / PUBLICATION	REASON FOR EXCLUSION
Kain, J., B. Leyton, et al. (2009). Two-year controlled effectiveness trial of a school-based intervention to prevent obesity in Chilean children. *Public Health Nutrition* 12(9): 1451-1461.	Age of children.
Keller, A., A. Klossek, et al. (2009). Gezielte primare Adipositaspravention bei Kindern. *Deutsche Medizinsche Wochenschrift* 134(1-2): 13-18	Not school setting/treatment study.
Kleber, M., A. Schaefer, et al. (2009). Lifestyle intervention "Obeldicks Mini" for obese children aged 4 to 7 years. *Klinische Padiatrie* 221(5): 290-294.	Treatment study.
Krahenbuhl, J. D., Y. Schutz, et al. (1998). High fat versus high carbohydrate nutritional supplementation: a one year trial in stunted rural Gambian children. *European Journal of Clinical Nutrition* 52(3): 213-222.	Treatment study.
Krebs, N. F. and M. S. Jacobson (2003). Prevention of pediatric, overweight and obesity. *Pediatrics* 112: 424–30.	No intervention.
Kubik, M. Y., M. Story, et al. (2008). Providing obesity prevention counseling to children during a primary care clinic visit: results from a pilot study. *Journal of the American Dietetic Association* 108(11): 1902-1906.	No relevant outcomes.
Lagstrom, H., E. Jokinen et al. (1997). Nutrient Intakes by Young Children in a Prospective Randomized Trial of a Low-Saturated Fat, Low-Cholesterol Diet. *Archives of Pediatric and Adolescent Medicine* 151: 181-188	No relevant outcomes / age of children.
Lagstrom, H. R. Seppanen, et al. (1999). Influence of dietary fat on the nutrient intake and growth of children from 1 to 5 y of age: the Special Turku Coronary Risk Factor Intervention Project. *American Journal of Clinical Nutrition* 69(3): 516-523.	Not school setting.
Larsen, T. M, S. Dalskov, et al. (2010). The Diet, Obesity and Genes (Diogenes) Dietary Study in eight European countries - A comprehensive design for long-term intervention. *Obesity Reviews* 11(1): 76-91.	Age of children.
Laurence, S., R. Peterken, et al. (2007). Fresh Kids: the efficacy of a Health Promoting Schools approach to increasing consumption of fruit and water in Australia. *Health Promotion International* 22(3): 218-226.	No relevant outcomes / age of children.
Lavalle, A. (2004). ACTIVATE: a childhood overweight prevention initiative. *School Nurse News* 21(3): 40-41.	No relevant exposures / age of children.
Leahy, K. E. L. L. Birch, et al. (2008). Reducing the energy density of multiple meals decreases the energy intake of preschool-age children. *American Journal of Clinical Nutrition* 88(6): 1459-1468.	No relevant outcomes.

PAPER / PUBLICATION	REASON FOR EXCLUSION
Linden, C. H. G. Ahlborg, et al. (2006). A school curriculum-based exercise program increases bone mineral accrual and bone size in prepubertal girls: two-year data from the pediatric osteoporosis prevention (POP) study. *Journal of Bone & Mineral Research* 21(6): 829-835.	Age of children.
Liu, A., X. Hu, et al. (2007). Report on Childhood Obesity in China (6) Evaluation of a Classroom-based Physical Activity Promotion Program. *Biomedical and Environmental Sciences* 20: 19-23.	Age of children.
Liu, A., X. Hu, et al. (2008). Evaluation of a classroom-based physical activity promoting programme. *Obesity Reviews* 9 (Suppl. 1): 130-134.	Age of children.
Lowe, C. F., P. J. Horne, et al. (2004). Effects of a peer modelling and rewards-based intervention to increase fruit and vegetable consumption in children. *European Journal of Clinical Nutrition* 58: 510–522.	No relevant outcomes.
Lowther, M., N. Mutrie, et al. (2002). Promoting physical activity in a socially and economically deprived community: a 12 month randomized control trial of fitness assessment and exercise consultation. *Journal of Sports Sciences* 20(7): 577-588.	Age of participants.
Ludwig, D. S., K. E. Peterson, et al. (2001). Relation between consumption of sugar-sweetened drinks and childhood obesity: a prospective, observational analysis. *Lancet* 357: 505–08.	Age of children.
Luepker, R. V., C. L. Perry, et al. (1996). Outcomes of a field trial to improve children's dietary patterns and physical activity, the CATCH (Child and Adolescent Trial for Cardiovascular Health). *Journal of the American Medical Association* 275: 768–776.	Age of children.
Macaulay, A. C., G. Paradis, et al. (1997). The Kahnawake Schools Diabetes Prevention Project: Intervention, Evaluation, and Baseline Results of a Diabetes Primary Prevention Program with a Native Community in Canada. *Preventive Medicine* 26: 779-790.	Not school setting.
Marcus, C., G. Nyberg, et al. (2009). A 4-year, cluster-randomized, controlled childhood obesity prevention study: STOPP. *International Journal of Obesity* 33(4): 408-417.	Age of children.
Maynard, M. J., G. Baker, et al. (2009). Developing obesity prevention interventions among minority ethnic children in schools and places of worship: The DEAL (DiEt and Active Living) study. *BMC Public Health* 9: 480.	Age of children.
McCallum, Z., M. Wake, et al. (2004). Six month results from the LEAP (Live, Eat and Play) trial: A randomised controlled trial of a primary care intervention for childhood overweight/mild obesity. *Pediatric Research* 55(4): 220A-221A.	Treatment study.

PAPER / PUBLICATION	REASON FOR EXCLUSION
McCallum, Z., M. Wake, et al. (2005). Can Australian general practitioners tackle childhood overweight/obesity? Methods and processes from the LEAP (Live, Eat and Play) randomized controlled trial. *Journal of Paediatrics & Child Health* 41(9-10): 488-494.	Treatment study.
McCallum, Z., M. Wake, et al. (2007). Outcome data from the LEAP (Live, Eat and Play) trial: a randomized controlled trial of a primary care intervention for childhood overweight/mild obesity. *International Journal of Obesity* 31(4): 630-636.	Treatment study.
McGarvey, E., A. Keller, et al. (2004). Feasibility and benefits of a parent-focused preschool child obesity intervention. *American Journal of Public Health* 94(9): 1490-1495.	No relevant outcomes.
McGarvey, E. L. K. R. Collie, et al. (2006). Using focus group results to inform preschool childhood obesity prevention programming. *Ethnicity & Health* 11(3): 265-285.	No intervention.
Melgar-Quinonez, H. R. and L. L. Kaiser (2004). Relationship of Child-Feeding Practices to Overweight in Low-Income Mexican-American Preschool-Aged Children. *Journal of the American Dietetic Association* 104: 1110-1119.	Cross-sectional study design.
Moore, L.L., U. S. Nguyen, U, et al (1995). Preschool physical activity level and change in body fatness in young children. The Framingham Children's Study. *American Journal of Epidemiology* 142(9): 982–988.	No intervention.
Morabia, A. and M. C. Costanza (2006). Let the children play. *Preventive Medicine* 43(6): 435-436.	No intervention.
Mo-suwan, L. P. Tongkumchum, et al. (2000). Determinants of overweight tracking from childhood to adolescence: a 5 y follow-up study of Hat Yai schoolchildren. *International Journal of Obesity & Related Metabolic Disorders: Journal of the International Association for the Study of Obesity* 24(12): 1642-1647.	Age of children / no intervention.
Muckelbauer, R., L. Libuda, et al. (2009). A simple dietary intervention in the school setting decreased incidence of overweight in children. *Obesity Facts* 2(5): 282-285.	Age of children.
Muckelbauer, R., L. Libuda, et al. (2009). Promotion and Provision of Drinking Water in Schools for Overweight Prevention: Randomized, Controlled Cluster Trial. *Pediatrics* 123: e661-e667.	Age of children.
Nelson, J. A., K. Carpenter, et al. (2006). Diet, activity, and overweight among preschool-age children enrolled in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC). *Preventing Chronic Disease* 3(2): A49.	Cross-sectional study design / age of children.

PAPER / PUBLICATION	REASON FOR EXCLUSION
Nemet, D., S. Barkan, et al. (2005). Short- and Long-Term Beneficial Effects of a Combined Dietary-Behavioral-Physical Activity Intervention for the Treatment of Childhood Obesity. *Pediatrics* 115: e443-e449.	Treatment study.
Nemet, D., N. Barzilay-Teeni, et al. (2008). Treatment of childhood obesity in obese families. *Journal of Pediatric Endocrinology* 21(5): 461-467.	Treatment study.
Nissinen, K., V. Mikkila, et al. (2009). Sweets and sugar-sweetened soft drink intake in childhood in relation to adult BMI and overweight. The Cardiovascular Risk in Young Finns Study. *Public Health Nutrition* 12(11): 2018-2026.	No intervention.
Olivares, S., I. Zacarias, et al. (2005). Nutrition education in Chilean primary schools. *Food & Nutrition Bulletin* 26(2 Suppl 2): S179-185.	Age of children.
Pavlovic, M., A. Kadvan, et al. (2005). Diet and nutritional risk factors in schoolchildren. *Advances in Experimental Medicine and Biology* 569: 219-220.	No intervention.
Perman, J. A., T. L. Young, et al. (2008). A community-driven obesity prevention and intervention in an elementary school. *Journal of the Kentucky Medical Association* 106(3): 104-108.	Age of children.
Perry, C.L., D. B. Bishop, et al. (1998). Changing Fruit and Vegetable Consumption among Children: The 5-a-Day Power Plus Program in St. Paul, Minnesota. *American Journal of Public Health* 88; 603-609.	Age of children.
Podrabsky, M., L. C. Streichert, et al. (2007). Campus-community-school partnerships to evaluate a multicomponent nutrition intervention. *Public Health Reports* 122(4): 566-569.	No relevant outcomes / age of children.
Proctor, M. H., L. L. Moore, et al. (2003). Television viewing and change in body fat from preschool to early adolescence: The Framingham Children's Study. *International Journal of Obesity & Related Metabolic Disorders: Journal of the International Association for the Study of Obesity* 27(7): 827-833.	No intervention.
Ridgers, N. D., G. Stratton, et al. (2007). Children's physical activity levels during school recess: A quasi-experimental intervention study. *International Journal of Behavioral Nutrition and Physical Activity* 4:19.	Age of children.
Robinson, T. N. (1999). Reducing children's television viewing to prevent obesity: a randomized controlled trial. *Journal of the American Medical Association* 282(16): 1561-1567.	Age of children.
Robinson, T. N., T. D. Killen, et al. (2003). Dance and reducing television viewing to prevent weight gain in African-American girls: the Stanford GEMS pilot study. *Ethnicity & Disease* 13(1 Suppl 1): S65-77.	Age of children.

PAPER / PUBLICATION	REASON FOR EXCLUSION
Romon, M., A. Lommez, et al. (2009). Downward trends in the prevalence of childhood overweight in the setting of 12-year school- and community-based programmes. *Public Health Nutrition* 12(10): 1735-1742.	Cross-sectional study design / age of children.
Rooney, B. L., L. R. Gritt, et al. (2005). Growing healthy families: family use of pedometers to increase physical activity and slow the rate of obesity. *Wisconsin Medical Journal* 104(5): 54-60.	Age of children.
Rosado, J. L., M. del R Arellano, et al. (2008). An increase of cereal intake as an approach to weight reduction in children is effective only when accompanied by nutrition education: a randomized controlled trial. *Nutrition Journal* 7: 28.	Age of children.
Sääkslahti, A., P. Numminen, et al. (2004). Effects of a three-year intervention on children's physical activity from age 4 to 7. *Pediatric Exercise Science* 16: 167–180.	No relevant outcomes.
Sacher, P. M., M. Kolotourou, et al. (2010). Randomized controlled trial of the MEND program: a family-based community intervention for childhood obesity. *Obesity* 18 Suppl 1: S62-68.	Treatment study.
Saelens, B. E., J. F. Sallis, et al. (2002). Home environmental influences on children's television watching from early to middle childhood. *Journal of Developmental & Behavioral Pediatrics* 23(3): 127-132.	No intervention.
Sahota, P., M. C. J. Rudolf, et al. (2001). Evaluation of implementation and effect of primary school based intervention to reduce risk factors for obesity. *British Medical Journal* 323(7320): 1027-1029.	Age of children.
Sahota, P., M. C. J. Rudolf, et al. (2001). Randomised controlled trial of primary school based intervention to reduce risk factors for obesity. *British Medical Journal* 323(7320): 1029-1032.	Age of children.
Sanigorski, A. M., A. C. Bell, et al. (2008). Reducing unhealthy weight gain in children through community capacity-building: results of a quasi-experimental intervention program, Be Active Eat Well. *International Journal of Obesity* 32(7): 1060-1067.	Age of children / not school setting.
Savoye, M., M. Shaw, et al. (2007). Effects of a Weight Management Program on Body Composition and Metabolic Parameters in Overweight Children: A Randomized Controlled Trial. *Journal of the American Medical Association* 297(24): 2697-2704	Treatment study / age of children.
Scheffler, C., K. Ketelhut, et al. (2007). Does physical education modify the body composition? Results of a longitudinal study of pre-school children. *Anthropologischer Anzeiger* 65(2): 193-201.	Age of children.

PAPER / PUBLICATION	REASON FOR EXCLUSION
Schetzina, K. E., W. T. Dalton, et al. (2009). A coordinated school health approach to obesity prevention among Appalachian youth: the Winning with Wellness Pilot Project. *Family & Community Health* 32(3): 271-285.	Age of children.
Seeyave, D. M., S. Coleman, et al. (2009). Ability to delay gratification at age 4 years and risk of overweight at age 11 years. *Archives of Pediatrics & Adolescent Medicine* 163(4): 303-308.	No intervention.
Sichieri, R., A. P. Trotte, et al. (2009). School randomised trial on prevention of excessive weight gain by discouraging students from drinking sodas. *Public Health Nutrition* 12(2): 197–202.	Age of children.
Simmons, A., H. M. Mavoa, et al. (2009). Creating community action plans for obesity prevention using the ANGELO (Analysis Grid for Elements Linked to Obesity) Framework. *Health Promotion International* 24(4): 311-324.	No before/after measures.
Skinner, J. D., W. Bounds, et al. (2004). Predictors of children's body mass index: a longitudinal study of diet and growth in children aged 2–8 y. *International Journal of Obesity* 28: 476–482.	No intervention.
Spiegel, S. A. and D. Foulk (2006). Reducing overweight through a multidisciplinary school-based intervention. *Obesity* 14(1): 88-96.	Age of children.
Stratton, G. and E. Mullan (2005). The effect of multicolor playground markings on children's physical activity level during recess. *Preventive Medicine* 41: 828–33.	Short follow-up period.
Stratton, G. (2000). Promoting children's physical activity in primary school: an intervention study using playground markings. *Ergonomics* 43: 1538–1546.	Short follow-up period.
Styne, D. M, U. Shaikh. (2009). Childhood obesity - Is there hope for therapy and prevention? *Pediatric Endocrinology Reviews* 6(3): 372-374.	Editorial article.
Taylor, R. W., K. A. McAuley, et al. (2008). Two-year follow-up of an obesity prevention initiative in children: the APPLE project. *American Journal of Clinical Nutrition* 88(5): 1371-1377.	Age of children / not school setting.
Taylor, R. W., K. A. McAuley, et al. (2007). APPLE Project: 2-y findings of a community-based obesity prevention program in primary school age children. *American Journal of Clinical Nutrition* 86(3): 735-742.	Age of children / not school setting.
Taylor, R. W., K. A. McAuley, et al. (2006). Reducing weight gain in children through enhancing physical activity and nutrition: the APPLE project. *International Journal of Pediatric Obesity* 1(3): 146-152.	No relevant outcomes / age of children.
Toh, C. M., J. Cutter, et al. (2002). School based intervention has reduced obesity in Singapore. *British Medical Journal* 324: 427.	Article is a letter.

PAPER / PUBLICATION	REASON FOR EXCLUSION
Trost, S. G., D. Fees, et al. (2008). Feasibility and efficacy of a "move and learn" physical activity curriculum in preschool children. *Journal of Physical Activity & Health* 5(1): 88-103.	Short follow-up period.
Trost, S. G., R. R. Rosenkranz, et al. (2008). Physical activity levels among children attending after-school programs. *Medicine & Science in Sports & Exercise* 40(4): 622-629.	Age of children.
van Mil, E. G. A. H., A. H. C. Goris, et al. (1999). Physical activity and the prevention of childhood obesity--Europe versus the United States. *International Journal of Obesity & Related Metabolic Disorders: Journal of the International Association for the Study of Obesity* 23 Suppl 3: S41-44.	No intervention.
Veldhuis, L., M. K. Struik, et al. (2009). 'Be active, eat right', evaluation of an overweight prevention protocol among 5-year-old children: design of a cluster randomised controlled trial. *BMC Public Health* 9: 177.	Not school setting.
Wallace, C., M. Daley, et al. (2008). Consulting the community about a childhood overweight and obesity prevention and management plan. *Australian & New Zealand Journal of Public Health* 32(4): 395-396.	Article is a letter.
Wardle, J., L. J. Cooke, et al. (2003). Increasing children's acceptance of vegetables; a randomized trial of parent-led exposure. *Appetite* 40: 155-162.	No relevant outcomes / not school setting.
Weber-Cullen, K., J. Eagan, et al. (2000). Effect of a la carte and snack bar foods at school on children's lunchtime intake of fruits and vegetables. *Journal of the American Dietetic Association* 100: 1482-1486.	Cross-sectional study design.
Wechsler, H., R. S. Devereaux, et al. (2000). Using the School Environment to Promote Physical Activity and Healthy Eating. *Preventive Medicine* 31: S121-S137.	Review article.
Welsh, J. A., M. E. Cogswell, et al. (2005). Overweight Among Low-Income Preschool Children Associated with the Consumption of Sweet Drinks: Missouri, 1999-2002. *Pediatrics* 115: e223-e229.	No intervention.
Whitaker, R. C., R. A. Gooze, et al. (2009). A national survey of obesity prevention practices in Head Start. *Archives of Pediatrics & Adolescent Medicine* 163(12): 1144-1150.	Survey-based article.
Williams, C. L., M. C. Bollella, et al. (2002). "Healthy-Start": Outcome of an Intervention to Promote a Heart Healthy Diet in Preschool Children. *Journal of the American College of Nutrition* 21(1): 62–71.	Age of children.
Williams, C. L., B. A. Strobino, et al. (2004). Cardiovascular Risk Reduction in Preschool Children: The "Healthy Start" Project. *Journal of the American College of Nutrition* 23(2): 117–123.	Short follow-up period.

PAPER / PUBLICATION	REASON FOR EXCLUSION
Williams, C. L., M. M. Squillace, et al. (1998). Healthy Start: a comprehensive health education program for preschool children. *Preventive Medicine* 27(2): 216-223.	Age of children.
Williamson, D. A., A. L. Copeland, et al. (2007). Wise Mind project: a school-based environmental approach for preventing weight gain in children. *Obesity* 15(4): 906-917.	Age of children.
Wolf, A. M. and K. A. Wordsworth (2009). Obesity prevention: recommended strategies and challenges. *American Journal of Medicine* 122(4 Suppl 1): S19-23.	No intervention.
Wolman, J., E. Skelly, et al. (2008). Tackling toddler obesity through a pilot community-based family intervention. *Community Practitioner* 81(1): 28-31.	Age of children.
Yancey, A. (2007). Physical activity program for preschool children fails to reduce body mass index. *Journal of Pediatrics* 150(5): 561.	A review article.
Yin, Z., J. Hanes, et al. (2005). An environmental approach to obesity prevention in children: Medical College of Georgia FitKid Project year 1 results. *Obesity Research* 13(12): 2153-2161.	Age of children.
Zhang, X. L. (2005) Effect of behaviour modification in controlling children's obesity. *Zhongguo Linchuang Kangfu* 9(11): 166-167.	Age of children.

Appendix 5 – Systematic reviews assessed

Adamson, A. J., J. C. Mathers, et al. (2004). Effecting dietary change. *Proceedings of the Nutrition Society* 63(4): 537-47.

Agras, W. S., A. J. Mascola, et al. (2005). Risk factors for childhood overweight. Current Opinion in Pediatrics 17(5): 648-52.

Aranceta, J., C. Perez-Rodrigo, et al. (2007). Prevention of overweight and obesity: a Spanish approach. *Public Health Nutrition* 10(10A): 1187–1193.

Baranowski, T., K. W. Cullen, et al. (2002). School-based obesity prevention: a blueprint for taming the epidemic. *American Journal of Health Behaviour* 26(6): 486-493.

Bautista-Castano, I., J. Doreste, et al. (2004). Effectiveness of interventions in the prevention of childhood obesity. *European Journal of Epidemiology* 19: 617–622.

Berge, J. M. (2009). A review of the familial correlates of child and adolescent obesity: What has the 21st century taught us so far? *International Journal of Adolescent Medicine and Health* 21(4): 457-483.

Bluford, D. A. A., B. Sherry, et al. (2007). Interventions to prevent or treat obesity in preschool children: a review of evaluated programs. *Obesity* 15: 1356–1372.

Brown, T., S. Kelly, et al. (2007). Prevention of obesity: a review of interventions. *Obesity Reviews* 8 (Suppl. 1): 127–130

Brown, T. and C. D. Summerbell (2009). Systematic review of school-based interventions that focus on changing dietary intake and physical activity levels to prevent childhood obesity: an update to the obesity guidance produced by the National Institute for Health and Clinical Excellence. *Obesity Reviews* 10(1): 110-141.

Campbell, K. and Hesketh, K. D. (2007). Strategies which aim to positively impact on weight, physical activity, diet and sedentary behaviours in children from zero to five years. A systematic review of the literature. *Obesity Reviews* 8: 327–338.

Caroli, M., L. Argentieri, et al. (2004). Role of television in childhood obesity prevention. *International Journal of Obesity* 28: S104–S108.

Collins, C. E., J. Warren, et al. (2006). Measuring Effectiveness of Dietetic Interventions in Child Obesity. *Archives of Pediatric Adolescent Medicine* 160: 906-922.

Committee on Nutrition (2003). Prevention of pediatric overweight and obesity policy statement. *Pediatrics* 112: 424-430.

Connelly, J. B., M. J. Duaso, et al. (2007). A systematic review of controlled trials of interventions to prevent childhood obesity and overweight: A realistic synthesis of the evidence. *Public Health* 121: 510–517.

Coon, K. A. and K. L. Tucker (2002). Television and children's consumption patterns. A review of the literature. *Minerva Pediatrica* 54(5): 423-36.

Davis, M. D., B. Gance-Cleveland, et al. (2007). Recommendations for Prevention of Childhood Obesity. *Pediatrics* 120; S229-S253.

DeMattia, L., L. Lemont, et al. (2007). Do interventions to limit sedentary behaviours change behaviour and reduce childhood obesity? A critical review of the literature. *Obesity Reviews* 8: 69–81.

Dietz, W. H. and S. L. Gortmaker (2001). Preventing obesity in children and adolescents. *Annual Review of Public Health* 22: 337-353.

Doak, C. M., T. L. Visscher, et al. (2006). The prevention of overweight and obesity in children and adolescents: a review of interventions and programmes. *Obesity Reviews* 7(1): 111-36.

Dobbins, M., K. DeCorby, et al. (2009). School-based physical activity programs for promoting physical activity and fitness in children and adolescents aged 6-18. *Cochrane Database of Systematic Reviews*, Issue 1.

Dobbins, M., D. Lockett, et al. (2001). The Effectiveness of School-Based Interventions in Promoting Physical Activity and Fitness Among Children and Youth: A Systematic Review. *Effective Public Health Practice Project*, September 2001: 1-104.

Ells, L. J., K. Campbell, et al. (2005). Prevention of childhood obesity. *Best Practice & Research Clinical Endocrinology & Metabolism* 19(3): 441-54.

Flodmark, C. E., C. Marcus, et al. (2006). Interventions to prevent obesity in children and adolescents: A systematic literature review. *International Journal of Obesity* 30(4): 579-589.

Flynn M. A. T., D. A. McNeil, et al. (2006). Reducing obesity and related chronic disease risk in children and youth: a synthesis of evidence with ‘best practice’ recommendations. *Obesity Reviews* 7 (Suppl. 1): 7–66.

Forshee R. A., P. A. Anderson, et al. (2008). Sugar-sweetened beverages and body mass index in children and adolescents: a meta-analysis. *American Journal of Clinical Nutrition* 87:1662–71.

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

Gibson, L. J., J. Peto, et al. (2006). Lack of evidence on diets for obesity for children: a systematic review. *International Journal of Epidemiology* 35: 1544–1552.

Gibson, S. (2008). Sugar-sweetened soft drinks and obesity: a systematic review of the evidence from observational studies and interventions. *Nutrition Research Reviews* 21(2): 134-147.

Glenny, A. M., S. O'Meara S, et al. (1997). The treatment and prevention of obesity: a systematic review of the literature. *International Journal of Obesity and Related Metabolic Disorders* 21: 715–37.

Gonzalez-Suarez C., A. Worley, et al. (2009). School-Based Interventions on Childhood Obesity A Meta-Analysis. *American Journal of Preventive Medicine* 37(5): 418–427.

Goran, M. I., K. D. Reynolds, et al. (1999). Role of physical activity in the prevention of obesity in children. *International Journal of Obesity & Related Metabolic Disorders: Journal of the International Association for the Study of Obesity* 23 Suppl 3: S18-33.

Guardamagna, O., V. Baracco, et al. (2009). Identification and management of dyslipidemic children. *Minerva Pediatrica* 61(4): 391-398.

Haby, M. M., T. Vos, et al. (2006). A new approach to assessing the health benefit from obesity interventions in children and adolescents: the assessing cost-effectiveness in obesity project. *International Journal of Obesity* 30: 1463–1475.

Hardeman, W., S. Griffin, et al. (2000). Interventions to prevent weight gain: a systematic review of psychological models and behaviour change methods, *International Journal of Obesity* 24: 131-143.

Harris, K. C., L. K. Kuramoto, et al. (2009). Effect of school-based physical activity interventions on body mass index in children: a meta-analysis, *Canadian Medical Association Journal* 180(7): 719-26.

Henderson, M., D. Daneman, et al. (2008). Exercise Interventions in Obese Youth: Are They Effective? *Journal of Pediatric Endocrinology & Metabolism* 21: 823-826.

Hesketh, K. D. and K. J. Campbell (2010). Interventions to Prevent Obesity in 0–5 Year Olds: An Updated Systematic Review of the Literature. *Obesity* Vol. 18 Suppl 1: S27-S35.

Holt, J., L. Warren, et al. (2006). What behavioural interventions are safe and effective for treating obesity? *Journal of Family Practice* 55(6): 536-538.

Hudson, C. E. (2008). Being Overweight and Obese: Black Children Ages 2-5 Years. *ABNF Journal* 19(3): 89-91.

Hudson, C. E. (2008). An integrative review of obesity prevention in African American children. *Issues in Comprehensive Pediatric Nursing* 31: 147-170

Kamath, C. C., K. S. Vickers, et al. (2008). Behavioral interventions to prevent childhood obesity: A systematic review and metaanalyses of randomized trials. *Journal of Clinical Endocrinology and Metabolism* 93(12): 4606-4615.

Kropski J. A., P. H. Keckley, et al. (2008) School-based Obesity Prevention Programs: An Evidence-based Review. *Obesity* 16: 1009–1018.

Li, M., Li, S., et al. (2008). A systematic review of school-based intervention studies for the prevention or reduction of excess weight among Chinese children and adolescents. *Obesity Reviews* 9: 548–559.

Libuda, L. and M. Kersting (2009). Soft drinks and body weight development in childhood: is there a relationship? *Current Opinion in Clinical Nutrition and Metabolic Care* 12(6): 596-600.

Livingstone, M. B. E., T.A. McCaffrey, et al. (2006). Childhood obesity prevention studies: lessons learned and to be learned. *Public Health Nutrition* 9(8A): 1121–1129.

Malik, V. S., M. B. Schulze, et al. (2006). Intake of sugar-sweetened beverages and weight gain: a systematic review. *American Journal of Clinical Nutrition* 84(2): 274-288.

McCallum, Z. and B. Gerner (2005). Weighty matters - an approach to childhood overweight in general practice. *Australian Family Physician* 34(9): 745-748.

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Appendix 6 - Search strategies adopted

Medline search (Original search)

1. exp obesity/
2. exp weight gain/
3. exp weight loss/
4. obes$.ti,ab.
5. (weight gain or weight loss).ti,ab.
6. (overweight or over weight).ti,ab.
7. "weight change$".ti,ab.
8. ((bmi or body mass index) adj2 (gain or loss or change)).ti,ab
9. body mass.ti,ab.
10. adipos$.ti,ab.
11. (obes$ adj2 prevention).ti,ab.
12. (counteract$ adj2 obes$).ti,ab.
13. body composition.ti,ab.
14. body constitution.ti,ab.
15. body fat$.ti,ab.
16. weight gain.ti,ab.
17. weight loss.ti,ab.
18. anthropometr$.ti,ab.
19. (skinfold and (measurement$ or thickness)).ti,ab.
20. waist circumference.ti,ab.
21. obesity index$.ti,ab.
22. Or/1-21
23. infant/ or (infant or infants).ti,ab.
24. child, preschool/ or (preschool$ or nursery$ or playschool$ or kindergarten$ or crèche$ or (pre adj school$)).ti,ab.
25. infan$.ti,ab.
26. preschool$.ti,ab.
27. nurser$.ti,ab.
28. toddler$.ti,ab.
29. kindergarten.ti,ab.
30. child$.ti,ab.
31. school$.ti,ab.
32. day nursery.ti,ab.
33. (school) adj2 (intervention).ti,ab.
34. (young$ adj1 child$).ti,ab.
35. (play adj1 group$).ti,ab.
36. (Sure adj1 Start).ti,ab.
37. Key Stage.ti,ab.
38. Or/23-37
39. exp exercise/
40. play$.ti,ab.
41. exercis$.ti,ab.
42. activ$.ti,ab.
43. (activity) adj2 (change).ti,ab.
44. run$.ti,ab.
45. walk$.ti,ab.
46. danc$.ti,ab.
47. skip$.ti,ab.
48. (outdoor and (activit$ or games)).ti,ab.
49. physical activit$.ti,ab.
50. sedentary.ti,ab.
51. exertion.ti,ab.
52. energy intake.ti,ab.
53. energy expenditure.ti,ab.
54. energy balance.ti,ab.

55. (play$ and time).ti,ab.
56. (play$ and games).ti,ab.
57. read$.ti,ab.
58. ((television or tv or tele) and viewing).ti,ab.
59. game$.ti,ab.
60. (computer and game$).ti,ab.
61. (physical activity adj2 intervention).ti,ab.
62. swimming.ti,ab.
63. (reduc$ adj2 (tv or tele or television)).ti,ab.
64. (physical education or PE).ti,ab.
65. (physical and fitness).ti,ab.
66. (leisure and time).ti,ab.
67. aerobic exercise.ti,ab.
68. Or/39-67
69. exp OBESITY/dh [Diet Therapy]
70. exp Diet, Fat-Restricted/
71. exp Diet, Reducing/
72. exp Diet Therapy/
73. exp diet/
74. exp food/
75. exp beverages/
76. diet$.ti,ab.
77. eat$.ti,ab.
78. food$.ti,ab.
79. (diet) adj2 (change).ti,ab.
80. (low calorie or calorie control$ or healthy eating).ti,ab.
81. (food habit$ or food or nutrition or nutrition policy).ti,ab.
82. (health behavio?r$ or diet$ or feeding behavio?r$).ti,ab.
83. exp Dietary Fats/
84. (fruit or vegetable$).ti,ab.
85. (high fat$ or low fat$ or fatty food$).ti,ab.
86. formula diet$.ti,ab.
87. nutri$.ti,ab.
88. (nutrition$) adj2 (change).ti,ab.
89. (free adj2 fruit).ti,ab.
90. (fruit adj2 vegetables).ti,ab.
91. fruit$.ti,ab.
92. vegetable$.ti,ab.
93. portion size$.ti,ab.
94. breakfast.ti,ab.
95. meal$.ti,ab.
96. (diet$ adj2 intervention).ti,ab.
97. (fat adj2 reduc$).ti,ab.
98. ((school or home or family) and meals).ti,ab.
99. (overeat$ or over eat$).ti,ab
100. (intake and (diet$ or food$)).ti,ab.
101. lunch.ti,ab.
102. dinner.ti,ab.
103. tea.ti,ab.
104. supper.ti,ab.
105. snack$.ti,ab.
106. drink$.ti,ab.
107. (fizzy and drink$).ti,ab.
108. (soft and drink$).ti,ab.
109. Or/69-108
110. behavio?r$ model.ti,ab.
111. theoretical model.ti,ab.
112. behavio?r$ change adj1 model.ti,ab.
113. behavio?r$ change adj1 theory.ti,ab.
114. psycholog$ adj1 theory.ti,ab.

115. social theory.ti,ab.
116. environment$ adj1 (model or theory or intervention).ti,ab.
117. individual adj1 (model or theory).ti,ab.
118. exp Behavior Therapy/
119. exp Social Support/
120. exp Family Therapy/
121. exp Psychotherapy, Group/
122. ((psychological or behavio?r$) adj (therapy or modif$ or strateg$ or intervention$)).ti,ab.
123. (group therapy or family therapy or cognitive therapy).ti,ab.
124. ((lifestyle or life style) adj (chang$ or intervention$)).ti,ab.
125. social support.ti,ab.
126. (peer adj2 support).ti,ab.
127. Obesity adj1 prevention.ti,ab.
128. (Child$) adj2 (obesity prevention).ti,ab.
129. Or/110-128
130. exp Primary Prevention/
131. (primary prevention or secondary prevention).ti,ab.
132. (preventive measure$ or preventative measure$).ti,ab.
133. (preventive care or preventative care).ti,ab.
134. (obesity adj2 (prevent$ or treat$)).ti,ab.
135. exp Random Allocation/
136. exp Double-Blind Method/
137. exp Single-Blind Method/
138. exp *Research Design/
139. exp Intervention studies/
140. exp Evaluation studies/
141. exp Cost Benefit Analysis/
142. (time adj series).tw.
143. ((singl$ or doubl$ or trebl$ or tripl$) adj5 (blind$ or mask)).ti,ab.
144. placebo$.ti,ab.
145. (matched communities or matched schools or matched populations).ti,ab.
146. (control$ adj (trial$ or stud$ or evaluation$ or experiment$)).ti,ab.
147. (comparison group$ or control group$).ti,ab.
148. matched pairs.ti,ab.
149. (outcome study or outcome studies).ti,ab.
150. (quasiexperimental or quasi experimental or pseudo experimental).ti,ab.
151. (nonrandomi?ed or non randomi?ed or pseudo randomi?ed).ti,ab.
152. randomi?ed.hw.
153. (evaluat$ adj3 (stud$ or trial$ or design$)).ti,ab.
154. incidence.ti,ab.
155. prevalence.ti,ab.
156. risk.ti,ab.
157. diet stud$
158. physical activity stud$
159. diet and physical activity stud$
160. Or/130-159
161. 38 and (68 or 109 or 129)
162. 22 and 160 and 161
163. Animals/
164. 162 not 163
165. limit 164 to (english language and humans and yr=”1995-2010”)